

TECHNOLOGY INCUBATORS: NURTURING SMALL FIRMS

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris

60358

Document complet disponible sur OLIS dans son format d'origine

Complete document available on OLIS in its original format

FOREWORD

Technology incubators are a specific type of business incubator - a property-based venture which provides tangible and intangible services to new technology-based firms, entrepreneurs, and spin-offs of universities and large firms, all with the aim of helping them increase their chances of survival and generate wealth and jobs and diffuse technology. The large majority of technology incubators are affiliated with public and private sources of research knowledge, such as universities, science and technology parks, or clusters of firms with R&D capacity. Public support for business and technology incubators is generally provided at the local and regional levels of government, but central governments play a role both directly and indirectly. The justification for government support lies in market and systemic failures that limit the ability of small technology-based firms to survive and of entrepreneurs to overcome the uncertainty and obstacles associated with the early stages of firm creation. Despite lack of comprehensive research on the costs and benefits of technology incubators, this document identifies several "good practices" at the overall policy level and that of technology incubator programmes.

The analysis of technology incubator initiatives is part of the activity of the Working Group on Innovation and Technology Policy (TIP) of the OECD Committee for Scientific and Technological Policy (CSTP) to identify "good practices" in innovation and technology policies. Most of the papers in this document were presented at the *Workshop on Technology Incubators* held on 25 June 1997 and organised by the TIP Group in co-operation with the OECD's Local Employment Development Programme (LEED) of the Territorial Development Service (TDS). These have been supplemented by a rapporteur's summary prepared by the Secretariat and based on the oral report by the rapporteur, Mr. Philip Shapira of the School of Public Policy, Georgia Institute of Technology, United States. In addition, a special review of technology incubators and related initiatives to support technology-based firms in Russia and Central and Eastern European countries is included.

This document has been declassified by the Committee for Scientific and Technological Policy.

Copyright OECD, 1997

Applications for permission to reproduce or translate all or part of this material should be made to: Head of Publications Service, OECD, 2, Rue André-Pascal, 75775 Paris Cedex 16, France.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
RAPPORTEUR'S SUMMARY	5
BUILDING BUSINESS AND TECHNOLOGY INCUBATORS	12
BACKGROUND REPORT	
<i>OECD Secretariat.....</i>	<i>13</i>
BUSINESS INCUBATORS IN AUSTRALIA	
<i>David Winter, Australia/New Zealand Association of Business Incubators, Australia</i>	<i>33</i>
THE SAINT-NAZAIRE CENTRE FOR LOCAL INITIATIVES	
<i>Frédéric Choloux, Nantes-Saint-Nazaire Chamber of Commerce and Industry, France</i>	<i>40</i>
THE UK EXPERIENCE WITH SCIENCE PARKS AND TECHNOLOGY INCUBATORS	
<i>Ian Hamilton Fazey, Consultant, United Kingdom</i>	<i>44</i>
ADVANCED TELECOMMUNICATIONS AS A NEW STRATEGY FOR SCIENCE PARKS	
<i>Alfred Urban, Salzburg Technology Centre, Austria</i>	<i>49</i>
EVALUATING THE IMPACTS OF TECHNOLOGY INCUBATORS	52
TECHNOLOGY BUSINESS INCUBATION: LEARNING FROM THE US EXPERIENCE	
<i>Sarfraz A. Mian, State University of New York at Oswego, United States</i>	<i>53</i>
GEORGIA'S ADVANCED TECHNOLOGY DEVELOPMENT CENTER: AN ASSESSMENT	
<i>Rhonda Culp, University of Southern Mississippi, and Philip Shapira, Georgia Institute of Technology, United States.....</i>	<i>63</i>
TECHNOLOGY CENTRES AND BUSINESS INCUBATORS IN GERMANY	
<i>Bernd Gross, Association of German Technology and Business Incubation Centres, Germany</i>	<i>75</i>
THE EXPERIENCE OF CATCHING UP AND TRANSITION ECONOMIES	90
TECHNOLOGY INCUBATORS IN ISRAEL	
<i>Rina Pridor, Ministry of Industry and Trade, Israel</i>	<i>91</i>
KOREA'S POLICY TOWARDS TECHNOLOGY INCUBATORS	
<i>Dal Hwan Lee, S&T Policy Research Division, Science and Technology Policy Institute (STEPI), Korea</i>	<i>98</i>
TECHNOLOGY INCUBATORS IN RUSSIA AND CENTRAL AND EASTERN EUROPE	
<i>Katya Samsonova, Consultant, France</i>	<i>106</i>

EXECUTIVE SUMMARY

Since the 1980s, technology incubators have become an important policy tool in OECD and non-Member countries for helping new technology-based firms increase their chances of survival and generate wealth and jobs. Technology incubators are a specific type of business incubator: property-based ventures which provide a range of services to entrepreneurs and start-ups, including physical infrastructure (office space, laboratories), management support (business planning, training, marketing), technical support (researchers, data bases), access to financing (venture capital funds, business angel networks), legal assistance (licensing, intellectual property) and networking (with other incubators and government services).

The rationale for public support of technology incubators lies in market and systemic failures which limit the ability of small, innovative firms to survive during the early stages and of entrepreneurs to overcome the uncertainty and obstacles associated with firm start-ups. Support by OECD governments is generally provided at the local and regional levels, but central governments may also play a direct and indirect role. It is recognised that entrepreneurs face numerous challenges in starting a business, including substantial entry costs, high-fixed costs, lack of access to equity capital, insufficient technical and market information, and weak management skills. The start-up phase of a small business is associated with considerable uncertainty, and new businesses often have cash flow problems during this period. Support for business incubators is also provided on the basis of (regional) economic development objectives: stimulating job creation and industrial restructuring.

Technology incubators have four main objectives: 1) economic development; 2) technology commercialisation; 3) property venture/real estate development; and 4) entrepreneurship. Job creation is a main underlying purpose of incubator support for new business formation, especially of technology-based firms. Incubators can also play an important role in strengthening co-operation between public and private actors in regional economic development. They have an outreach role, fostering entrepreneurship and training in the local community. Moreover, incubators have a *symbolic* role in that they allow governments to demonstrate their efforts to address problems of regional development and unemployment.

Evaluations of the effects of technology incubators on firm survival rates tend to be positive, but evidence regarding their impacts on job growth and net firm creation is mixed. Because technology incubators are a recent development, their broader economic and innovative impacts may only be realised over the longer-term. Good practices with regard to technology incubators have been identified at the overall policy level and the level of the incubator. Above all, there is a need for incubators to avoid sole reliance on subsidies and to diversify sources of financing. While leveraging existing services and tailoring them to client needs is important, incubators should not over-emphasize these functions to the detriment of building linkages and networking with industry and especially investors. Technology incubators can be lucrative property-based ventures, underlining the need to balance short-term prerogatives (i.e. high occupancy rates) and longer-term goals (e.g. technology commercialisation). Sharing experiences among incubators and improving systems of evaluation are also important practices.

RAPPORTEUR'S SUMMARY

Note: This summary was prepared by the OECD Secretariat, based on the oral report by Philip Shapira, School of Public Policy, Georgia Institute of Technology, United States, who acted as rapporteur of the OECD Workshop on Technology Incubators held on 25 June 1997.

Background

Business incubators provide new firms and entrepreneurs with physical facilities and a variety of business services to help them increase their chances of surviving in the early stages of development. In general *technology* incubators are business incubators which focus on new companies with more advanced technologies. Technology incubators are known under various names and definitions in OECD countries – innovation centres, science parks, and technology centres. In Germany, for example, 20 per cent of technology centres do not offer incubation facilities but rather services. Still, a common characteristic is that the physical and intangible support they provide to these new firms are specifically tailored to helping them commercialise knowledge-intensive products and services. Another feature is that technology incubators are not usually stand-alone ventures and tend to be affiliated in one form or another with public and private sources of research knowledge including universities, public research institutions as well as large technology-based firms.

Evaluations of business and technology incubators have shown a positive impact in terms of increasing the chances of firm survival, but broader economic research is lacking. Questions also remain as to the cost of public support relative to alternative policy measures and the possibility of adding other instruments for promoting technology-based firms. Policy makers in OECD countries have recently focused attention on improving the performance of existing incubators by deepening the analysis of their impact on firm and job creation, technology diffusion, entrepreneurship and identifying good practices.

In the late 1970s and especially in the 1980s, business incubators, in particular technology incubators, became an important policy tool in the United States as local and state governments sought to reconvert declining industrial regions by promoting the development of clusters of technology-based firms. In the face of increased globalisation and structural change, technology incubators also gained ground in European countries, notably the United Kingdom, France, Germany, and Italy, as small and flexible conduits for promoting job-creating innovative firms, the commercialisation of university research and entrepreneurship.

More recently, technology incubators have been characterised by a sectoral focus on the development and diffusion of technologies such as biotechnology and information technologies. Technology incubators have also diversified their client base to include non-tenant firms, mainly SMEs. And while the number of incubators continues to increase in both OECD and non-OECD countries, the lessons from earlier initiatives, some of which were driven mainly by real estate ventures during the 1980s, have given way to efforts to integrate technology incubators more closely to the surrounding infrastructure for innovation and the broader national innovation system.

Objectives of business and technology incubators

From the workshop, it emerged clearly that there is no single model for a business or a technology incubator. The incubation of new firms is a highly flexible process with multiple stakeholders maintaining differing objectives. Nevertheless, these objectives can be broadly grouped under the following four categories:

Economic development

Incubators are a tool for promoting new businesses, especially technology-based firms. A main underlying goal of support for new business formation is job creation as was illustrated by the *Centre d'Initiatives Locales* (CIL) in Saint Nazaire, France. Faced with a local unemployment rate of 17 per cent, the goal of the CIL is to help diversify a local economy dependent on large metalworking firms. The *Georgia Advanced Technology Development Centre* (ATDC), created in the United States in 1980, emerged as a part of a state policy to diversify the industrial base to new technology sectors in the face of foreign competition. In Italy, the establishment of *Business Innovation Centres* (BICs) was the result of regional development policies in depressed northern areas and in the Mezzogiorno. While central governments may provide direct or indirect support, business and technology incubators are largely supported by local and regional governments.

Technology and business incubators, as in Germany, also play an important role in strengthening co-operation between regional public and private actors in regional development. Incubators also have a *symbolic* goal in that they allow governments to show a visible example of their efforts to address regional development and employment concerns. This is important at a time when OECD governments can no longer afford to provide costly support to large declining industries and when globalisation has rendered such direct supports largely ineffective.

Beyond general economic development, incubators are a tool for addressing *specific* or unique economic challenges. In Japan, regional development policies in support of incubators and related initiatives are driven by a desire to increase the concentration of knowledge and industry around the major metropolitan areas. In Israel, technology incubators were developed as an instrument to help integrate highly qualified immigrants from the former Soviet Union. In Germany, the ADT network of technology and business incubation centres quickly became a tool for promoting a new way of doing business in the eastern *Länder* and as a means of helping the reunification process. Finally, incubators play a role in infrastructure building, both in physical and immaterial terms. In Italy, the BICs have targeted areas without spontaneous clusters and where the lack of infrastructure impedes the growth of small firms.

Technology commercialisation

In the context of university-based incubators, there is a perception that most universities have technology which needs to be commercialised and that universities, with help from industry, can accomplish this. However, the workshop discussions showed a diversity of views on university links. On the one hand, university research results are rarely immediately commercially viable while the short-term demands of industry may comprise longer term goals of university research. Universities may also prefer, for both economic and technological reasons, to work with larger industrial firms rather than SMEs. For firms, proximity to industrial R&D is often more important than university linkages. Studies of firms located in UK science parks have found only marginal impacts on turnover and job performance when compared to similar firms located outside the park. Surveys of firms in technology incubators suggest what is most

important is not access to university research but increased credibility, prestige, access to a pool of highly qualified university graduates, access to databases and libraries and greater creditworthiness in the eyes of investors and banks.

Still, if access to university research results appears to be less important than factors such as university image or access to infrastructure, this may reflect more a mismatch in the expectations of the two parties rather than fundamental incompatibilities. Indeed, universities are a critical element in the supply of future PhDs to industry. Perhaps one of the most important impacts is cultural – making universities more aware of industry and giving academic entrepreneurs business skills. Approximately half of the estimated 4 000 firms that have emerged from German technology and business incubation centres since 1990 are university-spin-offs. Besides the commercialisation of research results the German example showed that a main goal of technology incubators is the diffusion of know-how to SMEs, not only from universities but also from applied research centres.

Property venture/real estate development

Technology and business incubators are also lucrative property-based ventures. The example of the *Italian Business Innovation Centres* (BICs) illustrated the importance of this on the supply side. On the demand side, firms may also wish to relocate in incubators because of the tangible and intangible benefits involved. In fact, while most incubators charge below market rents, many such as those associated with the universities and science parks in the United States or the United Kingdom can charge higher rents. Incubators, in particular those located in science and technology parks, can also provide the parks with a source of *future tenants*. There is, however, the potential for conflict between the profitability of a property-based venture and longer-terms goals of technology and economic development. In many cases, incubators have been forced to take on tenants among whom there are little synergies in order to maintain occupancy rates and generate sufficient operating revenue, if not profits. In the United Kingdom, for example, an estimated 35 per cent of space in science parks is occupied by accountants, insurance companies and financial services.

Entrepreneurship

Promoting entrepreneurship through incubators is another objective of public support. One of the main goals of business and technology incubators in eastern Germany but also in Russia and Central and Eastern Europe, has been the development of an entrepreneurial culture and the creation of SMEs in economies long dominated by large state-owned firms. Entrepreneurship is increasingly recognised as a critical element in the process of innovation and the creation of technology-based firms. While large firms may create spin-offs, there is some anecdotal evidence, at least in the United States, that the growth of new technology-based firms is associated with an increase in entrepreneurial activity. Entrepreneurs, however, are not a homogenous group nor are the founders of technology-based firms necessarily individuals with advanced science degrees. There is, however, evidence that the proportion of founders with science PhDs has increased in recent years.

Incubators, in particular those located in universities, can act as a laboratory for commercialising the ideas of academics and provide a “training ground” for entrepreneurs. Incubators often have an outreach role, fostering training in areas such as information technology skills in the local labour market. Finally, through the building of networks with surrounding formal and informal investors, incubators can help strengthen the link between capital and entrepreneurs.

While these objectives may not be mutually exclusive, experience suggests a need for stakeholders to clarify objectives from the outset in order to avoid friction between different actors and, just as important, to facilitate the evaluation of such initiatives. The establishment of advisory boards of incubators involving a mix of public and private stakeholders provides a mechanism for continuous monitoring and guidance.

Approaches to incubators: institutional and policy setting

In many ways the objectives of incubators reflect the policy context in which they operate at the local, regional and national levels. In the United Kingdom, the development of science parks that provide incubation support was facilitated by the structure of the property market and the relatively flexible rules with regard to the participation of academic staff in private ventures. In the United States, the development of technology incubators was driven by universities and local economic development groups. In France, incubators are sponsored by local and municipal governments. Institutional differences in the public university system and the regional tax-base may play a role. For example, most municipalities in France receive their tax receipts from levying taxes on local firms. However, as the land and property of universities belongs to the central government, establishing property-based incubators on central government-owned land may result in conflict. In Korea, technology complexes are usually independent and in most cases they have developed as industrial estates without formal links to universities. In addition, domestic firms lack a tradition of co-operation with universities.

In many countries, support for incubator initiatives is based on addressing specific gaps in the market and institutional infrastructure for small and technology-based businesses. In Israel, support has focused on the initial start-up phase where there was a financing gap in the private sector but also in public support. In many other countries such as Australia and Italy, incubators are providing services to existing small businesses which lack access to business and technological services from other private or public sources. But large companies and national laboratories are also going to incubators as a launching pad for new ideas. **Figure 1** presents a schematic presentation of technology incubation as a vehicle for linking technology, entrepreneurs, small and large firms and sources of capital.

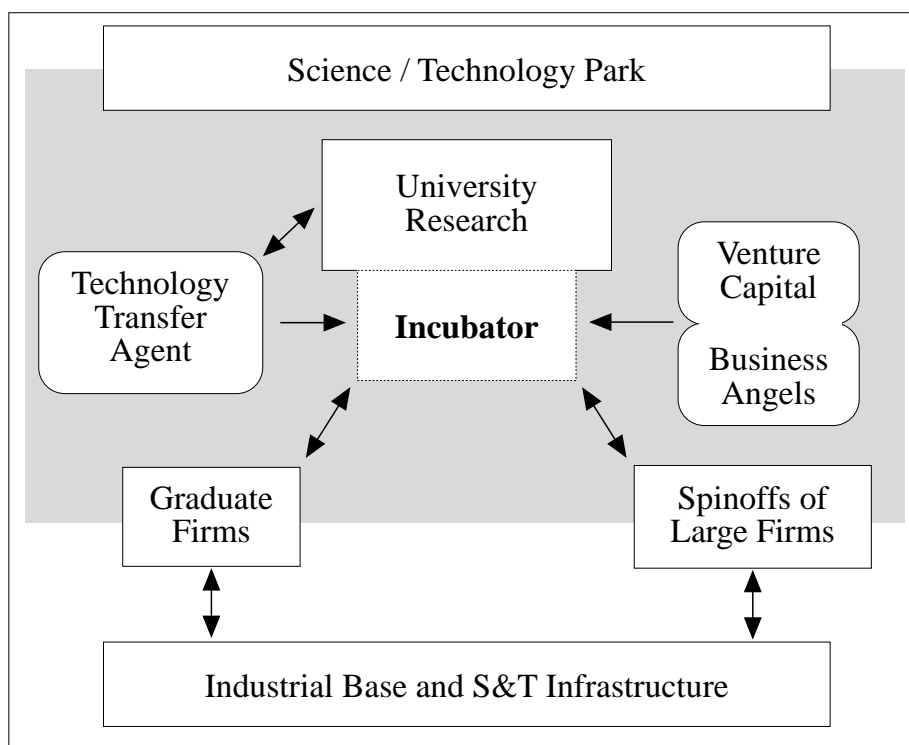
Nature and delivery of incubator services

Regardless of the objectives of stakeholders or the approach to incubation, business and technology incubators are service-oriented businesses. In contrast to general or mixed-use business incubators, technology incubators provide very specific and high value-added services. While few incubators are large enough to provide comprehensive services themselves, most provide referrals or links to existing public and private resources. Location also matters for servicing firms. In many cases, technology incubators remain isolated. The German and Austrian presentations at the workshop demonstrated the importance of networking for helping tenant firms access technology and markets. In Italy, the National Research Council's *Consorzio Roma Ricerche* is linking innovation centres, technology-oriented BICs, and science parks in Central Italy into one network for helping SMEs bridge the gap with the supply of technology services and managerial know-how.

There is a need, however, to tailor incubator services to the needs of clients. The emergence of “virtual incubators” or non-property-based ventures in many countries, not least Australia, Italy, and the United States, can be regarded as a cost-effective way of servicing small firms in areas with insufficient critical mass. Virtual incubators have also been established as a way of testing demand and tailoring future physical premises to the needs of clients. The role of services, however, should not be

overemphasised. Client surveys of firms located in the Georgia ADTC incubator showed that what firms valued most were not the services but the *credibility* from being associated with the Georgia Institute of Technology, the host university. Building relations that help entrepreneurs and new firms raise finance is perhaps another of the most important roles of incubators, particularly in regions or countries where venture capital is underdeveloped.

Figure 1. Technology incubation



Measuring the success of business and technology incubators

The success of incubators generally depends on the objectives of the stakeholders. At times, the objectives are not explicit from the outset nor are the mechanisms for measuring success necessarily linked to objectives. Nevertheless, in most OECD countries, incubators are considered successful when they generate income for stakeholders, develop new businesses which move out, create jobs, diffuse technology, and generate tax revenue. Like the process of innovation, the success of firms in technology incubators tends to be viewed in a traditional linear fashion: a young firm or a start-up would stay in the incubator for a couple of years, graduate and hopefully grow. The question arises whether the mere survival of tenant firms is a sufficient criterion for success. Certain new technology-based firms expand from 2 to 3 employees to 20 employees in a very short period and are quoted on secondary stock markets within their first few years. It is these fast-growing firms, the “gazelles” which create the most jobs and wealth among SMEs, that technology incubators should be hatching. Yet, promoting such fast growing firms is difficult, risky, and may not be possible in all circumstances.

Technology incubation also costs money and takes time. In the Italian presentation the cost of public support for a job created in a BIC was estimated at L 60 million, excluding the sunk costs of building the incubator. The CIL in France estimated the cost of public support per job created at FF 6 000. These

appear to be very economical costs compared to other public measures in OECD countries for maintaining or creating jobs. Yet there is a problem of scale as illustrated by the Italian Integrated Centre for Entrepreneurial Development (CISI), a business incubator in Taranto. In an area devastated by the closure of steel industries and the loss of 22 000 jobs, the creation by the CISI of 100 new jobs a year (assuming occupancy turnover targets are met) needs to be balanced against economic realities. In addition, there is a chance that the indirect support for jobs may benefit the relatively advantaged, i.e. the highly-skilled.

For these reasons, it is important to distinguish between direct and indirect effects as well as the short and longer-term. In addition to jobs, incubators have other impacts such as encouraging the development of an entrepreneurial culture, attracting service industries (including low-skilled jobs), and increasing property values. The BIC in Genoa, for example, was instrumental in arresting the decline of the surrounding industrial zone. The acquisition of incubator graduates by larger firms can also be considered a success. In many ways, the “failure” of firms in or exiting incubators can be regarded as a necessary step in building future successes. Entrepreneurs failing their first business venture gain valuable experience and create a network of relations that may help them succeed down the road. The experience of Silicon Valley and other vibrant clusters of knowledge production are riddled with examples of successful firms established by entrepreneurs who failed several times over before succeeding. Perhaps the glowing figures of incubators touting 80 per cent survival rates for tenant firms is too high if the firms that survive do not grow or are unable to leave the incubators after 3 to 5 years. This raises the question of whether incubators are merely helping business that otherwise would have or should have closed, remain on life support. In Israel, only 40 per cent of incubators projects are graduated, but the graduates have grown into successful firms generating wealth and skilled jobs.

Selected good practices in technology incubation

The workshop demonstrated that in spite of the growth in the number of the technology incubators in OECD countries, there is a continued lack of evaluation and, more importantly, the lack of common criteria or methodology for evaluating both business and technology incubators. In addition, there is a need for longitudinal data sets for monitoring performance of firms receiving incubator support against a statistical control group. Nevertheless, there is a wealth of accumulated experience that can provide policy makers and stakeholders with examples of “good practices” in technology incubation. Many of these are based on case studies or surveys of incubators and may reflect specific institutional and economic realities. This notwithstanding, the presentations and the ensuing discussions at the *Workshop on Technology Incubators* have helped identify good practices at the overall policy level as well as at the level of the technology incubator:

- ◇ **Define objectives and mission from the outset.** In several countries the lack of clear objectives of some incubators resulted in a conflict between economic/technology development and the need for economic self-sufficiency and stakeholder revenue.
- ◇ **Recruit entrepreneurial managers.** The examples of the Italian BICs and US technology incubators highlighted the importance of experienced and entrepreneurial incubator managers both for providing tenant firms with direction and establishing links to investors and industry.
- ◇ **Focus on “cluster-based” technologies.** Focusing on technology clusters such as software, information technologies etc. can help incubators achieve critical mass and enhance synergies between firms. This was illustrated by the *Salzburg Technology Centre*.

- ◇ **Select tenants according to “needs and fits”.** Successful incubators often stress the role of screening applicants. However, rigid selection criteria can miss potential successes. In Italy, incubator managers cautioned against relying too much on business plans and highlighted the importance of factors such as entrepreneurial experience, the marketability of products, and the overall “fit” with other incubator tenants.
- ◇ **Tailor and leverage existing services.** Technology incubators are often too small to provide an entire gamut of business and technology services. Services should be tailored to client needs. As well, brokering and networking can help tenant firms access existing resources for technology development and commercialisation. In Korea, efforts are underway to link the KAIST technology incubator to the network of *Regional Technology Centres* (RTCs) .
- ◇ **Build on local and international linkages.** Incubators have an outreach role to the local community including universities, local firms, and clients. Successful incubators need to be integrated into the local infrastructure but also to national and global sources of technologies and markets. The German network of technology and innovation centres is the largest in Europe with links to 250 centres including those in Central and Eastern Europe.
- ◇ **Diversify sources of finance.** Incubators act as gatekeepers for investors. To help match entrepreneurs and capital, incubators should build on linking firms to a variety of financing sources including venture capital funds, business angels, equity/royalty financing and soft-loans.
- ◇ **Share experience.** In Australia, Austria, France, Germany, Italy, the United Kingdom and the United States, there exist business and technology incubator associations that disseminate examples of “what works” in business incubation which is central to improving performance of incubators.
- ◇ **Improve evaluation mechanisms.** A main gap in evaluation is the lack of research on technology incubators as opposed to general business incubators. Differences in the definition of technology incubators across countries and a lack of a common methodology for evaluation weakens international comparability. Also there is a need for longer-term data sets that allow for comparing firms in technology incubators with comparable firms outside. Local and central governments as stakeholders, together with incubator associations, have a role in encouraging a “culture” of evaluation and the benchmarking of incubation practices.

BUILDING BUSINESS AND TECHNOLOGY INCUBATORS

BACKGROUND REPORT

OECD Secretariat

Business incubators: a source of jobs and growth

Defining business incubation

The ability of firms to innovate and grow is widely recognised as the fundamental driving force behind rising incomes and living standards. Small innovative firms, including new technology-based firms, are a major part of this process as they speed structural change and create new jobs to replace those destroyed by the decline of older industries or the downsizing of large firms. Public initiatives to foster the emergence of new and innovative firms have taken on an increased importance in OECD countries in recent years. In this context, business incubators have emerged as important tools of regional economic strategies and, more recently, technology and innovation policy. The aim of this paper is to briefly review business incubators as a basis for analysing the development of technology incubators, including their main characteristics and impacts.

At a general level, the concept of business incubation refers to the practice of providing low-cost, property-based facilities and shared services to nurture the development of new firms. Business incubators provide for, on a temporary basis, the use of shared premises, capital equipment, business and technical services as well as access to finance, including venture capital and “*business angel*” networks. Incubators involve a diverse set of sponsors and stakeholders including government, local development agencies, universities, science parks and non-profit actors. Private for-profit agents also sponsor business incubators, generally as part of a real estate development venture. The provision of below-market rents and shared services help reduce business set-up costs. Further, incubators provide facilities to businesses on very flexible terms. Offices are licensed or leased on a month-to-month or yearly basis. Such flexible entry-exit arrangements are an essential feature of business incubators.

Since their first inception in the 1950s in the United States, the concept of business incubators has continuously evolved and has been adapted in other OECD countries, reflecting very specific economic, institutional, regional and technological conditions. Initially a means for revitalising declining manufacturing regions by providing entrepreneurs with a breeding ground to develop new firms, business incubators became an instrument for promoting a more diversified industrial base for a regional economy and stimulating local job creation. During the late 1970s, business incubators in the United States and in other OECD countries became a tool for improving regional and national competitiveness by fostering the emergence of innovative and technology-based firms. This shift was accelerated in the 1980s by linking the incubator concept more closely to higher education and public research institutions. In the 1990s, there has been a trend to develop business incubators around specific industrial and technological clusters such as biotechnology, information technologies and environmental technologies.

The number of business incubators world-wide was estimated in 1992 at more than 2 000 (OECD, 1992), and since then business incubators have continued to develop throughout OECD and non-Member

countries. There are currently over 600 business incubators in the United States and Canada of which 550 are affiliated with the *National Business Incubation Association*, compared to only 13 in 1980 (NBIA, 1996). Only a few business incubators are developed by sole for-profit sponsors. Around 90 per cent of business incubators in the United States are sponsored by public agencies, government, academic institutions or a combination thereof. One of the reasons for this is the high fixed costs in acquiring or building physical facilities; most business incubators are not self-sufficient for a period of five to seven years.

Rationale for public support

A main justification for public support to business incubators is based on **market failure** which results in disincentives to firm creation. Entrepreneurs face significant obstacles to starting a business, e.g. high-fixed and entry costs, lack of access to equity capital, insufficient technical and market information, and weak management skills. The start-up phase of a small business is associated with considerable uncertainty and new businesses often have cash flow problems during this period. The existence of bottlenecks in the post start-up phase, in particular later-stage financing, weak management and marketing have been associated with the very high failure rate of new firms, another justification for nurturing new firms in incubators. Support for business incubators is also provided on the basis of (regional) economic development objectives: stimulating job creation and industrial restructuring. More recently, business incubators are supported as part of socio-economic policies to help under-represented groups in business development (e.g. youth, women, minority groups).

In the case of **technology incubators**, support may be justified on the basis that market or systemic failures impede the commercialisation and diffusion of technology by new firms. The greater uncertainty associated with technology increases the risks inherent to new business start-ups; incubator services help reduce this uncertainty, thereby increasing the chances for survival. On balance, evidence on survival rates of technology-based firms suggest such firms are in fact a lower risk, but the problem may be one of *perception* among investors and reflect different levels of experience in assessing risky projects (European Commission, 1996). Technology incubators are also supported as a means of increasing returns from public R&D spending by promoting its commercialisation and diffusion.

Types of business incubators

The definition, type and focus of business incubators varies greatly within and between countries. To a large extent, the sponsors of incubators determine their objectives: for example, local economic development agencies generally seek to stimulate growth and jobs while universities seek to promote technology transfer and diffusion. In the **United States**, the NBIA has identified five types of incubators according to sponsors/stakeholders: 1) *for-profit property development ventures*; 2) *non-profit (economic) development corporations*; 3) *academic institutions*; 4) *venture capital firms*; and 5) a *hybrid* of the above. Another way to categorise business incubators is according to their overriding objective and characteristics of tenant firms. Three main types of business incubators can be identified (see **Box 1**).

In **Europe**, where business incubators are a more recent development, there is an equally broad range of approaches and objectives. At the EU level, the *European Business Innovation Network* (EBN), started in 1984, has developed a network of over 120 Business Innovation Centres (BICs) throughout Europe. A 1995 survey of 83 BICs showed that 78 per cent of them offered some level of incubation support, mainly to technology-based firms (EBN, 1996). In the United Kingdom and the Netherlands, business incubators were developed in the late 1970s and took the form of “*managed workplaces*” in which small firms were

located in unused buildings and offered common services as a means of regenerating declining regions. In France, business incubators (*pépinières d'entreprises*) provide temporary accommodation for individuals and small businesses and have mainly been sponsored by local government and community actors with the goal of stimulating local job creation. A main factor behind this has been the role of regional and local governments in developing incubators adapted to their specific economic and territorial needs. In Italy business incubators are a recent development and generally target the creation of manufacturing and innovative firms in depressed industrial regions of the north and the Mezzogiorno. In general, incubation support to new firms is provided by BICs (property/services-based) and some science parks while the *Citta Recherche* network of innovation centres mainly provide services-based support to innovative SMEs. In Germany, incubation is a function largely carried out by innovation centres and technology parks.

Box 1. Typology of business incubators

General/Mixed-Use Incubators: The main goal of these incubators is to promote continuous regional industrial and economic growth through general business development. While these incubators include knowledge-intensive firms, they also include low technology firms in services and light manufacturing. A main focus of support is access to local/regional sources of technical, managerial, marketing and financial resources.

Economic Development Incubators: These are business incubators whose main aim is to stimulate specific economic objectives such as job creation and industrial restructuring. Often the result of local government initiatives, the main goal is to help create new firms and nurture existing firms that create jobs. In some countries, this goal may target *specific groups* such as youth, long-term unemployed, women and minorities. In the United States, examples include “*empowerment/micro-enterprise*” incubators.

Technology Incubators: These are incubators whose primary goal is to promote the development of technology-based firms. These are mainly located at or near universities and science and technology parks. They are characterised by institutionalised links to knowledge sources including universities, technology-transfer agencies, research centres, national laboratories and skilled R&D personnel. Specific industrial clusters and technologies may also be targeted such as biotechnology, software or information and communications technologies. A main aim is to promote technology transfer and diffusion while encouraging entrepreneurship among researchers and academics. In some countries, technology incubators not only focus on new firms but also help existing technology-based small firms, including subsidiaries of larger established firms.

Source: OECD.

Technology incubators: stimulating innovation

Emergence of technology incubators

Since the 1980s, technology incubators have become an important focus of technology and innovation policies in North America, Europe and, more recently, Japan, largely due to the growing importance of small and medium-sized enterprises (SMEs). At the aggregate level, **small technology-based firms** are significant creators of employment, facilitate structural change and stimulate economic growth. About 93 per cent of high-technology firms in the United States have less than 500 employees and 70 per cent have less than 20 employees. In 1991, small high technology companies (those with less than 500 employees) provided 25 per cent of the jobs in high-technology industries (US, SBA, 1997). Not all new technology-based firms are large creators of jobs, with such firms in the United States showing higher rates of job creation than similar firms in Europe (European Commission, 1996). While the reasons for different rates of performance may vary (e.g. access to capital, university links, competence

centres), it is widely acknowledged that the creation and growth of technology-based firms can be inhibited by lack of finance, management skills, technology and access to markets.

Technology incubators are difficult to categorise and the **concept of technology incubation** differs widely from one country to another; incubators may be distinct entities within universities or science parks or be a part of innovation centres (see **Box 2**). In some cases, technology incubators are owned and managed by the host institution but with some autonomy or they may be owned by several stakeholders. In the United States, approximately 30 per cent of the 550 NBIA-affiliated business incubators are technology-oriented (NBIA, 1995). The *Association of University-Related Research Parks* (AURRP) estimates that half of university-affiliated technology incubators in the United States are core elements of research parks. Similarly, in Europe, the growth of technology incubators has been very much tied to the development of science and technology parks wherein incubators are part of an integrated process for helping tenant firms commercialise knowledge emerging from the park. In Germany, 73 per cent of all technology and business incubation centres are located either near universities or other research establishments.

Box 2. Operators/hosts of technology incubators

There is no single model or definition of a technology incubator. In most cases, it is a knowledge-based venture affiliated with a university, science or technology park, or innovation centre. In some cases, the incubator is an integrated *function* of a science park (United Kingdom) or innovation/technology centre (Germany), or it may be a distinct unit operating within the broader knowledge-based infrastructure of a university or science and technology park (United States, Japan, France).

Innovation centres

The concept of an innovation centre is akin to that of an incubator of knowledge-based ventures. The *Association of German Technology and Business Incubation Centres* (ADT) defines an innovation centre as an infrastructure-based venture for the establishment and growth of firms. Related goals include the development of innovation in the region, co-operation between researchers and industry; provision of information and technical and management training; and strengthening regional economic development through regional and international networks for information exchange and co-operation between firms.

Science parks

A science or research park can be characterised as a complex set of activities within a limited geographic area around a university campus where high value-added research, industry and capital are combined by entrepreneurs, including academic and research personnel. The *International Association of Science Parks* (IASP) further defines science parks as being managed under a formal co-operative agreement with university research centres for the purpose of promoting the establishment and growth of knowledge-based enterprises. A main mechanism is the transfer of technical and managerial expertise to tenant firms. In some countries, the parks aim to attract existing firms as well.

Technology parks

Larger than science parks, a technology park or *technopolis* is a zone of economic activity composed of the universities, research centres, industrial and tertiary units, which realise their activities based on research and technological development. Technology parks are limited in geographic area but maintain network links to large firms and the public research infrastructure at both national and international levels. In Japan and France, the technopolis model extends over the entire surrounding urban area. In the United States, technology parks differ in so far as their main goal is to promote synergy between the surrounding research and industrial sectors and create specific “*centres of competence*”. (Coudivat and Giusti, 1991)

Source: OECD.

Technology incubators are also found in institutions which do not conduct basic research but which have strong links to the S&T infrastructure and focus on commercialising existing close-to-market technologies. The *Centre for Applied Competitive Technologies* at the San Diego City College in California, a public funded institution with links to federal laboratories, provides incubator facilities to start-ups, spin-offs of larger firms and entrepreneurs. National laboratories, such as those of NASA are also establishing incubators or partnerships with existing incubators as a means of speeding the diffusion of dual-use technologies. In the United Kingdom, the location of British Nuclear Fuels in the Birchwood Technology Park (which is not located at a university) has attracted scores of small high technology companies and consultancies. Against a background of shorter time-horizons for R&D, technology incubators are also seen as a way for existing small R&D firms to access technology and facilities that may otherwise be too time-intensive or expensive to develop on their own.

Newly-industrialised and transition countries such as Mexico, the Czech Republic, Hungary, Poland and Russia have also developed business incubator programmes, many of which focus on new technology-based firms. In Korea, where incubators did not emerge until the 1990s, in line with a more active policy towards promoting the creation and development of SMEs, five Technology Innovation Centres (TICs) which act as incubators for technology-based firms had been established by 1994. The TICs, however, tend to focus more on technological development and less on providing firms with managerial skills and access to financing. China, Chinese Taipei, and Hong Kong also promote technology-based incubators as part of their industrial development strategies and S&T policies, often in the context of science and technology parks. In these countries, technology incubators emerged from central government schemes rather than local public-private initiatives.

Incubators in science and technology parks

While the large majority of technology incubators are less than ten years old, the “incubation” of technology-based firms finds its origins in the practice of linking research universities to private industry and capital. Following the development of the Stanford Research Park in 1951 and the Research Triangle Park in North Carolina in 1959, public-private partnerships for creating a research base for the development of new firms became central to state and local economic development strategies throughout the **United States**. In an effort to replicate such hubs of technological effervescence as California’s Silicon Valley and Route 128 in Massachusetts, many other OECD countries undertook the development of science and technology parks (**Table 1**).

In the 1960s, France launched the Sofia-Antipolis Technology Park followed by similar initiatives in Toulouse and Grenoble. The “technopolis” concept in France extends beyond the cross-fertilisation between universities, research and industry to include urban development (*aménagement du territoire*).

In general, **European science and technology parks**, with the exception of a few in France, tend to be smaller than those in the United States which are quite large and involve several hundred firms and thousands of employees (**Table 2**). In the United Kingdom, public support for incubating technology-based firms dates to the establishment of the Cambridge Science Park in 1970 which was followed by a rapid growth in the number of science parks during the early 1980s. This increase in UK science parks, in particular of non-university science parks (e.g. the West of Scotland Science Park), was due in part to policies for reconvertng declining regions but also to real estate ventures. In Germany, the first innovation centre was created in Berlin in 1983. Although German innovation centres differ from science and technology parks in so far as they are not part of “park-based facilities”, they are nevertheless designed to develop close links with neighbouring universities and research institutions in order to support the technological development of tenant firms. At the same time, some German innovation

centres/incubators such as in Aachen, Berlin, Karlsruhe and Dortmund have tended to expand, taking on park-like characteristics or by integration with existing technology parks.

Table 1. Number of science and technology parks in the European Union

Country	Year	Number of parks	Number of firms	Number of employees
Austria	1993	28 innovation centres	350 tech. based firms 45 research institutes	2 800 employees
Belgium	1988	8 science parks ²	68 firms	4 000 employees
Denmark	1995	5 parks	180 firms	1 025 employees
Finland	1994	9 parks	800 firms	8 000 employees
France	1995	35 parks ¹	7 160 firms	145 834 employees
Germany	1992	124 technology centres		
Greece	1995	4 parks	41 firms ¹	690 employees
Ireland	1993	1 park	90 firms	2 400 employees
Italy	1997	23 parks (operational) ³	147 firms	6 900 employees
Luxembourg		No parks		
Netherlands	1993	7 science parks	280 firms	3 000 employees
Portugal	1995	4 parks		
Spain	1995	15 science parks	311 firms	8 307 employees
Sweden		13 science parks	500 firms	8 000 employees
United Kingdom	1995	46 science parks	1 250 firms	23 229 employees

Notes:

- 1) Greek and French data are taken from "World-wide Research and Science Park Director 1995/6". In the case of Greece, data on employment is provided by only 41 out of 55 firms. In the case of France data are provided by 35 out of 51 parks. It is probably reasonable, however, to assume the non-providers of data are likely to be newly established, and hence small, parks.
- 2) Employment data for Belgium are based on a survey data. Nearly half of the firms are part of multinational groups which may explain the high number of jobs reported.
- 3) In Italy 13 of the 23 science parks in full operation were established in the Mezzogiorno with support from the Ministry of Education and Scientific Research. The Italian Association of Science and Technology Parks (APSTI) regroups 19 Members not all of whom are included in the global figure of 23 parks. This is because the APSTI includes parks without "park" facilities as well as development agencies. The data on firms/employees are drawn from 5 parks of the 19 APSTI Members.

Source: European Commission, 1996; Association of Science and Technology Parks in Italy, 1997.

Table 2. Science and technology parks in Europe and the United States

Park	Date established	Number of firms	Employment	Average firm size
Standard Research Park, USA	1951	162	26 000	160
Research Triangle Park of North Carolina, USA	1959	71	34 0 00	479
Charleston University Research Park, USA	1968	29	12 000	414
Metro Tech., USA	1986	18	14 000	778
Irvine Spectrum, USA	1978	2 000	32 000	16
Louisiana Biomedical and Development Park, USA	1991	20	15 000	750
Sophia Antipolis, France	1969	1 034	16 200	16
Cambridge, England	1970	72	3 600	50
Tetrapole, Grenoble, Isère, France	1972	600	12 000	20
Nancy Brabois Innovation, France	1977	250	15 000	60
Villeneuve D'Ascq Technopole	1986	2 497	22 259	9
Milano Centrale Servizi, Milan, Italy	1985	40	5 000	—
Area Science Park, Trieste, Italy	1982	35	790	—
Technopolis, Bari, Italy	1984	43	500	—

Source: European Commission, 1996; Association of Science and Technology Parks in Italy (APSTI), 1997.

Following the evolution of science and technology parks from bases of industrial production towards technological development, the incorporation of incubators represents the **entrepreneurial development phase** – as distinct from the institutional building phase of the 1970s – of their development (**Figure 1**). Whereas the traditional role of universities in science parks was to attract major research laboratories (either from government or industry), their role has expanded to include support for entrepreneurs and small knowledge-based firms. One factor that contributed to the creation of technology incubators in universities and science parks, at least in the United States, has been changes in intellectual property-protection legislation which has allowed universities to keep the rights of innovations resulting from federally-supported research. Also, requirements that universities commercialise research results as a means of securing additional federal funding for research may have accelerated this trend. Similarly, in the United Kingdom, financial constraints on universities in the early 1980s and relatively flexible rules with regard to the ability of faculty to participate in commercial ventures, were factors in the development of university-based science parks (European Commission, 1995).

Figure 1. Incubators in science and technology parks

HOST INSTITUTION	University	Research facilities	Production facilities	Technology transfer office	Park facilities	Incubator	Venture capital
Science and research parks	X	X	O	X	X	X	O
Innovation centre	O	O	X	X	O	X	O
Technopolis/ Technology park	X	X	X	X	X	X	X

Notes: X = Essential or integrated feature
 O = Desirable feature; accessible through the S&T infrastructure and industry

Within this framework, however, the **targets of technology incubators** differ widely from one country to another. In Belgium and in Spain, the focus of science parks and incubators, at least initially, was on attracting branches of multinational firms. In Germany, a survey of technology and innovation centres found that 99 per cent targeted innovative start-ups and entrepreneurs (ADT, 1997). In 1985, France's Sofia-Antipolis technology park opened its first incubator in 1985, the *Centre d'Accueil des Technologies* (CAT), specifically targeting entrepreneurs based on the university-incubator model in the United States. The Montpellier Technopole also launched an incubator in 1993 with the aim of attracting branches of multinational companies. In 1994, there were over 60 business incubators associated with science and technology parks in France (European Commission, 1995). In Italy, an incubator (*Incubatore Tecnologico Bicocca*) was set up in 1994 near the Bicocca Technopole in Milan to specifically support the development of high technology firms and entrepreneurs while the Technopole Bari provides incubation facilities to local newly created SMEs. In Japan, the development of incubators in science and technology parks in the late 1980s did not target entrepreneurs *per se* but was more a tool to attract existing small firms or subsidiaries of larger technology-based firms.

Services provided by technology incubators

Whether the incubator target is an entrepreneur or spin-off of a large firm, the range of services provided by technology incubators aim to help small firms exploit and commercialise research knowledge. These services can be divided into 1) physical infrastructure, 2) management support, 3) technical support, 4) access to finance, 5) legal services and 6) networking. Technology incubators tend to provide greater assistance than general incubators to financing, legal/intellectual property rights as well as marketing (**Table 3**). Not all incubators provide comprehensive services, however, and there are differences in the value-added firms gain from such services. In some cases, for example, generic financial accounting services may not be adapted to the sector-specific needs of tenant firms.

Table 3. Types of services offered by incubator type

Services	Technology	General incubators
Space rental	100	100
Management advice	98	97
Business planning	87	85
Office services (reception, typing, etc.)	83	85
Financing assistance	87	84
Marketing assistance	83	79
Financial/accounting	70	65
Technology consulting	87	50
Legal/intellectual property assistance	72	44
Other	20	19

Source: NBIA 10th Anniversary Survey, ILGARD 1995.

Physical infrastructure

In addition to shared office space and administrative services, technology incubators require access to specific facilities such as laboratories and testing facilities. At the same time, while some incubators have a large on-site laboratory and related equipment, they tend to be technology-specific and do not always meet the needs of other firms in the incubator. For many smaller technology incubators, access to laboratories and testing facilities is provided through partnerships/referrals with universities, technology transfer agencies, or the leasing of equipment. For incubators located in science and technology parks, the infrastructure is generally provided by the parks or it may be provided through links with host universities and outside agents (e.g. national laboratories, research centres). In Canada, the Laval Science and Technology Park recently launched an incubator known as the Quebec Biotechnology Innovation Centre. Incubator firms have access to the Park's facilities such as laboratories, pilot production plants, and access to research branches of major pharmaceutical companies located in the Park.

Management support

Owners of new technology-based firms require the business know-how to develop and commercialise their innovations. Business support from technology incubators begins with the evaluation and selection

of incubator tenants based on their business plans. Many incubators have adopted review methods based on the “due diligence” concept to screen potential tenants and increase the number of quality firms. Incubators may also provide or broker technology assessment and market studies whereby the potential to commercialise and market a technology is reviewed and analysed by the entrepreneur with the help of experts. Marketing services are also very important. In some cases, marketing assistance may be provided by other tenant firms, third parties, or even by university students who conduct market research for tenant firms. The Ben Franklin Technology Centre in Pennsylvania has developed a procurement matchmaking service which helps tenant firms outsource and develop supplier relationships with local manufacturers.

Incubators also provide **training services** as a way to strengthen the longer-term ability of a tenant firms to survive. For example, some incubators may provide entrepreneurial training, business planning workshops and seminars. The Venture Program at the British Columbia Institute of Technology in Canada provides classes to entrepreneurs on building their proposed business and developing a fully operational business plan. Companies located in the Salzburg Techno-Z are provided with training in the Polytechnic University for Telecommunications, Multimedia and Art. Technology incubators can also act as a bridging institution between the vast panoply of business and export support services provided by various government agencies, chambers of commerce, small business divisions of accounting firms, etc.

Technology incubators require the active involvement of local stakeholders from the outset, including representatives from economic development agencies, entrepreneurs, investors, and universities. **Advisory boards** set the policy and objectives of the incubator, select and hire the incubator manager and oversee tenant interaction. At the level of the tenant firms, most of them are small operations and do not have a “board of directors”. Advisory boards fill this gap by acting as a monitoring presence and a source of guidance in business planning and management. Advisory boards are an important conduit for developing networks which can help tenant firms access information, technology and financing. In many instances, individual venture capitalists or business angels sit on advisory boards and assist companies in raising equity finance.

Like advisory boards, well-trained and active **managers** are important to the success of incubators and their tenant firms. Incubator managers play a critical role in selecting and screening of tenant firms and assisting them in their development. In the United Kingdom, a 1992 study of science park managers found that tenant firms expressed a higher level of satisfaction with managers who were active in day-to-day operations, although the managers’ functions tended to focus on property-related problems rather than issues related to business information or relations with higher education institutions (Westhead and Storey, 1994). Besides providing networking and referral support, incubator managers can help tenant firms recruit qualified staff. The Incubator Program at the Rensselaer Polytechnic Institute (RPI) in New York, for example, helps its tenant firms by working with the Institute’s career development office in the recruitment of graduates and student interns/trainees.

Technical support

A main objective of technology incubators is accelerating the transfer and diffusion of technological know-how. Experience from incubators at the University of Maryland and the Georgia Institute of Technology suggests that having an appropriate technology transfer environment is necessary for incubator firms to be able to acquire and use technology in their own development. Incubators at both these institutions provide links to technology/manufacturing extension services. Co-operation between technology-transfer programmes and incubator firms as well access to external technical facilities, libraries, and databases is also important. Another essential practice among university-related incubators

is the use of faculty and students on a “loan” or consulting basis. Incubators may also broker relations with outside expertise through a contract or a grant. The Business Technology Centre in Ohio for example, has established contracts with nearby “centres of excellence” which grant tenant firms access to technical facilities and research and product testing. The CIL in St. Nazaire, France co-operates with a nearby Technopole in Nantes.

Access to finance

Equity financing is essential for start-up businesses, especially technology-based firms. While venture capital funds are a potential source, they generally are not an option for firms with little experience and without a proven market record. Venture companies generally invest in later-stage investments and established firms (OECD, 1997). Trying to fill this gap is a major task of technology incubators, as well as business angels. On the one hand, incubators can help firms prepare their business plan before soliciting investors for early-stage financing. As well, incubators may organise venture forums and act as gate-keepers for investors. Incubators may also develop new venture funds drawing on private sources or in partnership with public support as in the case of the Scottish Enterprise in the United Kingdom. Access to venture funds generally signals the departure of a firm from the incubator. The Software Business Cluster (SBC), a public-private incubator in Silicon Valley devoted exclusively to emerging software companies, has helped two of its 15 tenant firms receive a combined US\$ 5 million in venture funding (SJBC, 1997).

In Spain and Italy, another tool for providing access to finance is that of mutual guaranteed loans which are obligations underwritten by and for members of small business groups. For university-related technology incubators, royalty financing based on future returns from innovations is one way of helping technology-based start-ups obtain equity capital. Incubators may also take equity in tenant firms which generates future revenue to incubators as these firms grow. The Arizona Technology Incubator founded its own seed capital fund through which each firm accepted in the incubator has access to an immediate US\$ 25 000 investment in return for the fund taking equity in the company. In Israel, technology incubators are allowed to own up to 20 per cent of their tenant firms. Among European Business Innovation Centres (BICs), some 23 per cent invest directly in projects. This not only helps the client firms expand at a critical stage but it can garner additional support and attention from outside investors, including business angels.

Legal assistance

Tenants of technology incubators often require legal assistance for incorporation, drafting licensing agreements, and ensuring intellectual property protection (e.g. patents). While legal assistance may be too expensive for all incubators to provide directly, the incubator manager can help by maintaining a legal referral service. Support may also come from the local community, university law schools or law firms that provide low-cost or pro-bono legal services. University-related incubators can tap into legal interns as a way to help tenant firms while providing law students with training and experience. This innovative approach has been used by technology incubators affiliated or located near the University of Maryland and has involved guidance from area law firms.

Intellectual property rights (IPR) protection is critical for helping tenant firms develop the market for their technology as well as accessing seed and early-stage finance. In university-based incubators, the university generally owns the rights to an innovation which is then licensed to companies. In technology parks which deal with more than one university, incubators may have to deal with different IPR regimes.

Technology incubators generally broker legal assistance for IPR rather than provide it directly. On the other hand, some incubators such as the Advanced Technology Development Centre (ATDC) of the Georgia Institute of Technology many provide direct assistance. Staff of the ATDC mentor entrepreneurs and show them how to review and prepare the filling of patents.

Networking

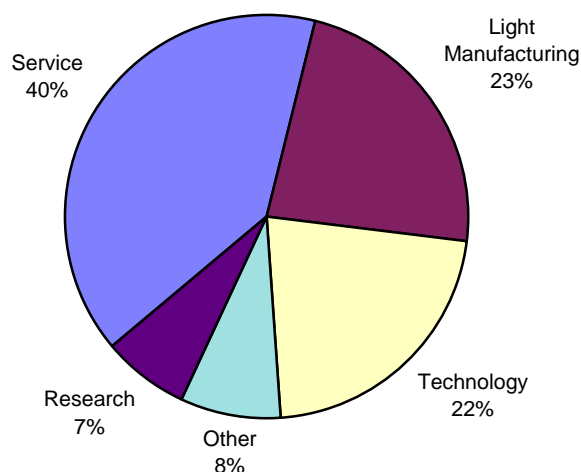
Networking is an important element of successful technology incubators. Incubators may organise venture forums/fairs to bring together potential investors and tenant firm owners. In Canada, the Ottawa-Carlton Research Institute (OCRI) holds monthly meetings to bring together experienced business executives. Increasingly, technology incubators are also establishing links with incubators in other regions or even in other countries as a way to broaden their sources of information but also as a way to build markets for their tenant firms and diversify their client base. In Austria, six regional innovation centres in the state of Salzburg are connected via the Salzburg Data Highway, a broadband network that provides companies with access to international networks. Maintaining links to graduate firms is also important. In Australia, some 72 per cent of graduate firms remain in the local area or region, a figure slightly below that of graduate firms in the United States (80 per cent).

While the large majority of incubators are sponsored by regional and local actors, **central governments** may play a role. In the United States, the federal government helps incubators by linking them to other business services such as those offered by the nationwide network of Small Business Administration Development Centres. Some technology incubators assist tenant firms with tapping other sources of finance such as development grants from the Small Business Innovation Research (SBIR) program. The US Department of Commerce's Economic Development Administration (EDA) also assists public and non-profit incubators with feasibility studies, technical assistance and construction costs. It is estimated that the federal government through its various agencies, but primarily the EDA, has provided over US\$ 100 million to US business incubators over a period of 15 years (Molnar, 1997). In the United Kingdom, the Business Links network provides ready access to business advice and support to small firms, including those in science parks.

A recent trend among both general business and technology incubators is the provision of services to existing firms outside the incubator facilities, known as **affiliate clients** and to large or established firms known as "anchor" firms (these may include graduates of incubators). The servicing of affiliates not only helps increase incubator revenue but serves as a marketing tool and a way for tenant firms to co-operate with outside firms. The NBIA estimates that 19 per cent of technology incubators provide services to outside firms; 5 per cent provide services to anchor firms with the remaining 76 per cent concentrating on regular in-house firms. **Figure 2** indicates the main clients (affiliate and regular in-house) for business incubators (technology and general) by industry type.

While most technology incubators are facilities-based from the outset, some are being created without facilities as mere providers of business and technology services to existing small firms. One reason is that this allows time for incubators to build or acquire infrastructure and facilities that are better suited to client needs. Another reason relates to the costs of large facilities-based incubators. In regions with low critical mass, occupancy rates may be insufficient for the incubator to break-even, despite the incentives of below-market rental fees and services. Depending on the sponsors of the incubator and the existing technological infrastructure, an "**incubator without walls**" may be a cost-effective option for helping new technology-based firms grow. In Australia, such "virtual incubators" are being used to help link isolated businesses in the north-western territories via computer and telecommunications networks. In Russia, three "virtual" incubators have been established in Moscow, Tomsk and Novgorod.

Figure 2. Incubator clientele by industry type



Source: NBIA 10th Anniversary Survey.

Assessing the impact of business and technology incubators

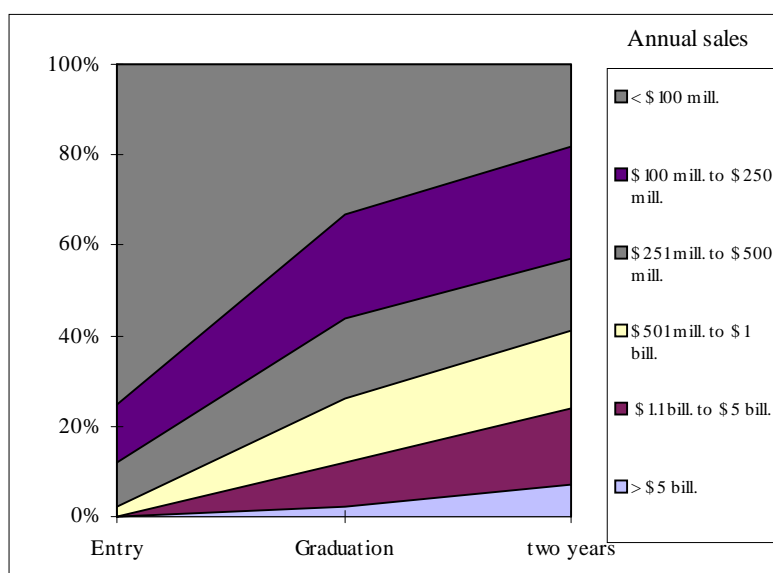
The assessment of business and technology incubators very much depends on the **criteria** used which in turn reflect the objectives of stakeholders. Economic development agencies, for example, may consider the number of business created and/or the diversification of a local economy as the most important criterion. In general, business incubators are evaluated on the following criteria, although not necessarily in this order: 1) number of jobs created; 2) number of graduates/survival rates; 3) increased sales and profits of tenant firms; 4) clients served; 5) increased incubator revenue (self-sufficiency/profit); 6) new technologies brought to market; and 7) taxes paid by incubators.

The majority of firms in US incubators remain for less than two years while the **survival rate** after five years is approximately 80 per cent, which compares to a much lower rate for new business in general (NBIA, 1995). The US Small Business Administration estimates that only 47 per cent of firms survive after four years and only 38 per cent survive after six years. Another study found that 50 per cent of graduate firms in Australia in 1986 were still in business in 1994 compared to only 5 per cent of non-incubator firms (Gardner and Kenyon, 1994). In France, only 8 to 20 per cent of incubator firms fail after two years as compared to 31 per cent of new firms in general (ANCE, 1997). A 1994 study on incubators/science parks in the Netherlands found that the tenant firms had low rates of business failure (European Commission, 1996). At the EU level, a survey of the EBN network of Business Innovation Centres (BICs) – although not incubators in a strict sense – found that the average survival rate of BICs firms is approximately 85 per cent at three to five years (excluding companies sold off) as compared to a European average of only 50 per cent after five years (EBN, 1996).

There is growing interest among policy makers as to the impact of incubators on **wealth creation**. A 1995 survey of business incubators in North America found that incubator tenant firms reported average aggregate revenues in the preceding fiscal year of US\$ 4.3 million for entrepreneurial firms served

in-house, US\$ 2.8 million for affiliate companies, and US\$ 24 million for graduates – median values were \$1.5 million for current clients, \$500 000 for affiliates and US\$ 6.6 million for incubator graduates (NBIA, 1995). A survey of 19 business incubators in Michigan found that 83 per cent of firms that started off in incubators became profitable and foresaw annual growth of 20 to 25 per cent over the next five years. Among clients that had not left the incubator, 69 per cent were profitable and expected to grow between 51 and 74 per cent over the next five years. The study also found significant impact on the local economy both in terms of investment by tenant firms and taxes paid (Molnar, et. al., 1996). A study by Coopers and Lybrand found substantial increase in sales revenue after incubator firms had graduated. Eighty per cent stayed in the incubator for two years or less: more than half graduated in a year. Eighty-seven per cent were out of the incubator and on their own for two years or less. A main weakness of this survey is that it did not compare performance to comparable firms that had *not* been “incubated” (Figure 3).

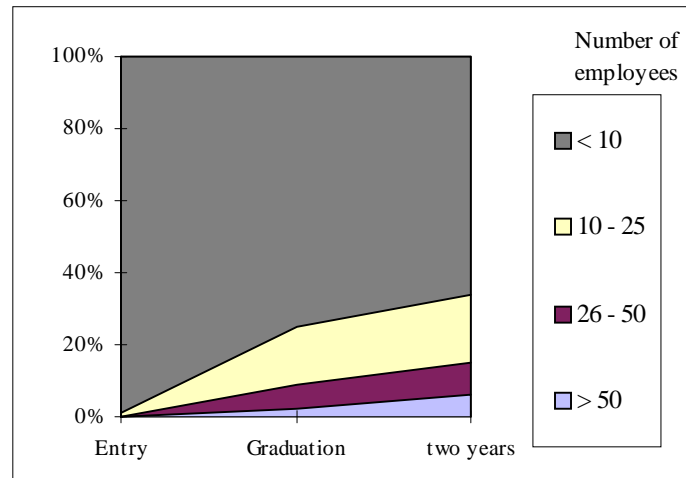
Figure 3. Annual sales of firms leaving a business incubator



Source: Coopers and Lybrand, 1990.

In terms of **job growth**, the evidence is mixed. A US study found no substantial difference in job growth between firms in Pennsylvania business incubators and firms outside (Allen and Bazan, 1990). One reason is that firms that do experience job growth do so once they have entered an “accelerated growth stage” – which generally occurs after a firm has left its nurturing environment. The NBIA estimates that graduates of incubators in 1994 created an average of 216 jobs per incubator or 23 927 jobs, excluding jobs created in “affiliate firms”. A survey of graduate firms in the US found that while nearly 99 per cent had less than 10 employees on entry in the incubator, 44 per cent had more than 10 employees after exiting the incubators and 6 per cent had more than 50 employees (Figure 4). In the United Kingdom a study of technology-based firms located on and off science parks found that resident firms had higher job growth between 1986 and 1992 than firms located off the park, however most job growth was concentrated in a small number of tenant firms (Westhead and Storey, 1994). The same study, however, found that location in a science park had no effect on overall financial performance of independent business but that their turnover did appear to benefit from being located in the park.

Figure 4. Employment growth of firms leaving a business incubator



Source: Coopers and Lybrand, 1990.

As regards university-based technology incubators, one study found that tenant companies *leaving* the incubator experienced a 49 per cent jump in employment and a rise in sales of 166 per cent on an annual basis between 1986 and 1990 (Mian, 1996). The association between the success of graduate firms from university-related incubators lends support to broader research that firms affiliated with universities have above average performance. The US Small Business Administration, for example, estimates that the return on R&D for both small and large firms involved with universities is 26 per cent, but only 14 per cent for firms not involved with a university (SBA, 1997). A 1995 Coopers and Lybrand survey found that fast-growth companies that utilise university resources boast productivity rates 59 per cent higher than peers without a university relationship, as well as 21 per cent higher annual revenues and 23 per cent more capital investments.

While data on the number of jobs and firms entering and exiting incubators is available, information on the **innovative impact** of incubators tends to be limited, partly because there is a lack of research that matches innovation inputs with outputs and because of the difficulty of quantifying objectives. Data on the patenting, licensing, and copyright activity of UK firms in science parks found no clear difference when compared to non-tenant firms. There was also no difference in the levels of educational qualification between tenant and comparable non-tenants. Tenant firms, however, did appear to have increased their links with higher education institutions, although tenant firms were no better informed than other firms about the research activities in the university (Westhead and Storey, 1994). Using technology services as a proxy for inputs, a survey of firms in six US university-related technology incubators found that the technology-related services most frequently used by over 50 per cent of client firms were: 1) students; 2) university image; 3) laboratories and workshops; 4) library/information databases; and 5) faculty consultants. In contrast, more than half of client firms did not use or access technology transfer programmes and employee education training. This however does not capture differences in the mode of delivery of services. In terms of the frequency of use and value added, there was a strong association between use of R&D activities and valued added to firms (Mian, 1996).

Other criteria may include the **indirect effects** on the surrounding community (e.g. an increase in property values). Similarly, the growth of incubator firms may generate multiplier effects such as the development of ancillary industries and services around tenant firms. Despite some evidence, little research has been carried out on the indirect effects of incubator programmes. As well, evaluations of

incubator firms based on comparisons with the performance of non-incubator firms often face problems of selectivity bias. Most of the firm data on non-tenant firms (i.e. the control group) are drawn from databases (e.g. Dun and Bradstreet) or from Chamber of Commerce sources which may exclude firms that fail early on – unsuccessful firms do not register with Chambers of Commerce. Such methodological problems notwithstanding, evaluations of the economic impact of business incubators tend to find positive results. One problem, however, is that much of the research on business incubators has not focused specifically on technology incubators, but this may be partly due to problems of definition and because most of them are less than 10 years old.

While incubators have generally been successful, some are more so than others. The Arizona Technology Incubator has a 90 per cent survival of graduate firms, for example. Evidence suggest that the reasons for this depend heavily on “**soft-factors**” such as the selection of tenants, the management and the design and delivery of related services to tenant firms. At the same time, hard factors such as geographical location, industrial specialisation and physical infrastructure do matter. Anecdotal evidence from the United Kingdom suggests proximity to industrial R&D rather than universities is more important for re-locating firms. In Manchester, firms locating at the Biotechnology Park cited the park location near air and land transport routes as a main criterion. Ultimately, technology incubation is part of a longer term investment and the full impact on innovation and job growth and may not appear until several years after a firm has left the incubator. Understanding what makes some technology-based firms emerging from incubators “fast-growing” is necessary for increasing the potential for incubators to contribute to technology development and diffusion. In the future, longitudinal data sets of tenant and non-tenant firms in technology incubators would help shed further light on their impact and ways to improve their performance, including links to the surrounding infrastructure for innovation.

Annex: Selected examples of technology incubators

Australia	In Australia there are currently 63 business incubators operating. Since the mid-1980s several state governments, together with federal support, have established incubators with the main aim of generating jobs. In 1996 the Department of Employment, Education, Training and Youth Affairs launched a programme to provide funding over four years to local communities for the establishment of new business incubators in 60 different regions of Australia, and the enhancement of 30 existing incubators.
Austria	Incubators in Austria are mainly a function of technology and innovation centres. The state of Salzburg regroups six technology and innovation centres including the Salzburg Techno-Z which is specialised in information technologies. In the last five years, more than 800 jobs have been created in these regional technology centres. Many of them have been created by outsourcing from central regions and are remote working and tele-working jobs. In Wiener Neustadt, the <i>Regional Innovations Zentrum (RIZ)</i> Neustadt houses new firms and entrepreneurs in the communications sector, medical and environment technologies. The most important factors in the success of the RIZ is the screening of entrepreneurs and projects followed by the product, the market and financing. Since 1988 the RIZ has helped create 37 firms of which 35 have survived and created 200 jobs, mainly highly skilled.
European Commission	The European Business Innovation Network (EBN) has established a network of over 120 Business Innovation Centres in 17 European countries, including in Central and Eastern Europe. The BICs are mainly instruments for local economic development. A 1995 survey found that private companies are the largest sponsors of BICs followed by regional public sector bodies. In addition to financial support 42 per cent of contributions are made in-kind (e.g. access to equipment and staff) by public research and higher education institutions. Some 78 per cent of BICs provide or broker technology services to client firms. Over half of them have access to seed capital funds while 52 per cent have access to start-up capital funds (EBN, 1996).
Denmark	Between 1986-1992 five science parks were established with close ties to universities. Danish parks are primarily funded by the private sector. The main aim is to promote growth and development of the region's knowledge-based firms and organisations while supporting entrepreneurial activity among researchers. In such a way the science parks act as incubators for creating new technology-based firms. A main weakness of Danish science parks has been the lack of links to sources of venture capital (OECD, <i>Science, Technology and Innovation Policies, Denmark, 1995</i>).
Finland	There are approximately 26 business incubators in Finland and another 18 are planned; of the existing incubators, 10 are technology-based (InnoVest, 1997). The DIO Business Centre, located in the Turku Technology Centre is a technology incubator whose objectives are to promote new companies and create jobs. The DIO Business centre also offers services and facilities to operational units of large firms including Ericsson, Nokia, and Lundbeck. A total of 65 technology companies were established within the incubator between 1989-1995.
France	According to the <i>Agence Nationale pour le Développement et la Création des Entreprises</i> (ANCE), there are some 210 business incubators in France of which 100 are considered "true" incubators (offering facilities and services) as opposed to property-development ventures. In 1993 French incubators had budgets of between FF 200 000 and FF 7 million, and were funded directly or indirectly by local actors (<i>communes, départements, régions and chambres consulaires</i>) as well as private investors. The ANCE estimates that there are 2 500 firms in incubators responsible for the creation of 10 000 jobs. A total of 5 000 firms representing 23 000 jobs had graduated from French incubators and were still in operation.

Germany	Following the creation of the first innovation centre in Berlin in 1983, the number of technology and innovation centres (<i>technologie-und Gründerzentren, TGZ</i>) has increased to around 200, a third of which are concentrated in the new <i>Länder</i> . It is expected this number will rise to nearly 300 by the year 2000. A survey of incubator managers found that on average incubators focused on three main technologies: information and communications, software, and environmental technologies. Between 1983 and 1996 some 6 500 firms had been created in technology and innovation centres of which 82 per cent were new technology-based firms (NTBF), nearly half of which were spin-offs from university research.
Japan	In Japan, technology incubators are a function of innovation centres and science parks. Japanese incubators did not appear until 1989 and in 1994 there were some 45 in operation. Unlike US or European technology incubators, those in Japan do not generally set tenancy limits. Furthermore, Japanese incubators tend to function more as real estate ventures with tenant space. While Japanese incubators do provide a range of office and technical services comparable to incubators in Germany and the United States, a main weakness is the underdevelopment of access to financing, including venture capital and external business linkages.
Israel	Approximately 27 technology incubators have been established in Israel which together employ over 1 000 professionals. In 1996 the Israeli Office of the Chief Scientist had allocated an equivalent of US\$ 32 million to the technology incubator programme. Financial assistance covers 100 per cent of personnel costs and 75 per cent equipment with a cap of US\$ 140 000 for incubator projects for two years. Technology incubators in Israel specifically target R&D entrepreneurs, in particular, recent immigrants. Training is provided to new immigrants in both business and technical skills. As of 31 August 1996, some 280 projects had graduated from incubators of which 58 per cent continued operating.
Italy	In Italy, there are several mechanisms for supporting the incubation and growth of new technology and innovative firms. The National Research Council's <i>Citta Ricerche</i> is a network of services-based consortia grouping innovation centres in Rome, Milan, Genoa, Naples, Pisa and other cities which provide technological, managerial and training services to SMEs. The <i>Promozione e Sviluppo Imprenditorial (SPI)</i> , a finance subsidiary of a state holding company, the Institute for Industrial Reconstruction (IRI) has established a network of 12 mainly property-based business innovation centres (BICs) – with another eight planned – which target new firm creation and SMEs in lagging regions. Many of the BICs, including the BIC in Trieste focus on advanced technologies. In addition, a network of Italian Science and Technology Parks provide support to new technology-based firms.
Korea	Korea's policy towards technology incubators is based on two objectives: technology diffusion and regional technological development. The Ministry of Science and Technology (MOST) recently granted responsibility to the Korean Advanced Institute of Science and Technology (KAIST) for the creation of an incubator comprising 1 600 sq. meters and housing a total of 10 firms. The KAIST's location in the Daeduk Science Town provides the incubator with strong links to 50 government-supported institutions and private laboratories. During 1997-1999, the KAIST plans to expand the incubator into a "high technology center" with 35 000 sq. meters.
Mexico	In Mexico, technology business incubators have been promoted by the federal and local governments since 1990. By 1995 some 15 incubator programmes had been established with another 8 in the planning stage. The majority of incubators are supported by the Conacyt PEIBT programme for technology incubators. Drawing on international experience in this area, the programme has made access to banks and financing an integrated part of its institutional structures.
Netherlands	The Netherlands has a limited experience with technology incubators and science parks in general. Incubators are integrated in the Groningen and Enschede technology parks and provide services to new high technology firms both inside and outside the parks. In 1985 the city of Leiden, in conjunction with the university and chamber of commerce, launched an incubator near the university hospital as a means of commercialising projects conceived by the faculty of medicine. The university provides services to the incubator including access to its chemical waste processing plant, administrative staff and the secondment of the director of the technology transfer centre who helps develop links between tenant firms and public institutions. The Chamber of commerce and the city provide the incubator with an executive officer.

Poland	Like other countries in Central and Eastern Europe, Poland has established business incubators and innovation centres, sometimes in co-operation with international support. Germany is currently sponsoring the establishment of an incubator in Gdansk as part of its TRANSFORM programme. A main goal of incubators in Poland is to increase university-industry relations as illustrated by the establishment of an incubator at the Warsaw Technical University in 1990. The <i>OECD, Review of National Science and Technology Policy, Poland 1995</i> , found that the short-term impact of incubators had been relatively weak. Efforts are underway to improve the planning of incubators and raise the quality of services provided to tenant firms as well as exchange experience among Polish incubators.
United Kingdom	In the United Kingdom technology incubators are generally a function of science parks and technopoles. In 1995 there were an estimated 1 250 firms located in 46 UK science parks employing over 23 000 people. The <i>Enterprise Panel</i> has identified four types of UK incubators. The first concern new and established technopoles such as the Aston Science Park, Warwick University Science Park and the more recent Cranfield Technology Park. The second are sector-specific incubators including the Oxford Centre for Innovation/Oxford Trust, the St. Johns Innovation Centre at Cambridge or the Manchester Bioscience Incubator. The third and fourth categories are general incubators which cover mixed-use enterprises and "building business" incubators such as the Electronic Commerce Centre at the University College London.
United States	The United States has extensive experience with business and technology incubators. The National Business Association estimates there are more than 600 business incubators in the United States and Canada of which 550 are NBIA affiliated. Approximately 30 per cent of them are technology incubators. The research literature on business incubators has found high survival rates of graduate firms, but evidence is mixed on impacts such as job and wealth creation. There is a need for further research, in particular longitudinal data, on the impacts of technology incubators, both in terms of economic and technological development as well as innovation.

REFERENCES

- ALLEN, D. and E. BAZAN (1990), *Value-added contribution of Pennsylvania's Business Incubators to Tenant Firms and Local Economies*, report prepared for the Pennsylvania Department of Commerce, Pennsylvania State University, University Park.
- AGENCE NATIONALE POUR LA CREATION ET LE DEVELOPPEMENT DES ENTREPRISES, (ANCE) (1997), www.ance.asso.fr
- ARBEITSGEMEINSCHAFT DEUTSCHER TECHNOLOGIE-UND GRUNDERZENTREN (ADT) (1997), *Technologie-und Grunderzentren in Deutschland und ihr Beitrag zur Entwicklung technologie-oreirter Unternehmen*, Berlin.
- COOPERS & LYBRAND (1990) "Incubators Are Finding the DNA of Business Success", *Coopers and Lybrand Emerging Business Newsletter*, March-April 1990.
- COUVIDAT, Y. and J. GIUSTI (1991), *Atlas International des Technolpoles*, DATAR, Ministère de la Ville et de L'Aménagement du Territoire, Paris.
- ENTERPRISE PANEL (1995), *Growing Success: A report by the Enterprise Panel*, Securities Institute, London.
- GARDNER, J. and A KENYON (1994), *Business Incubators in Australia – An Evaluation*
- GIBB, J (1985), *Science Parks and Innovation Centres: Their Economic and Social Impact*, European Commission, Proceedings of the Conference held in Berlin, 13-15 February 1985, Elsevier Science Publishers, Amsterdam.
- EUROPEAN BUSINESS AND INNOVATION CENTRE NETWORK (1996), *EC-BIC Observatory, 1995*, Brussels.
- EUROPEAN COMMISSION (1995), European Innovation Monitoring System (EIMS), *Comparative Study of Science Parks in Europe*.
- EUROPEAN COMMISSION (1996), European Innovation Monitoring System (EIMS), *New Technology-Based Firms in Europe*.
- GUY, I. (1996), "New Venture on an Ancient Campus", in *Technovation* 6, June, Elsevier Science Ltd., Oxford.
- GUY, K. *et al.* (1995), *The Evaluation of the Otaniemi Science Park Cluster: Report to Park Promoters*, Technopolis, Innovation Policy Research Associates, United Kingdom.

- MOLNAR L., DePIETRO, and GILLETTE (1996), *Sustaining Economic Growth: the Positive Impact of the Michigan Incubator Industry 1985-1995*, NBIA, Athens, Ohio.
- MOLNAR, L. (1997, forthcoming), *Community Impact of Incubator Investments*, University of Michigan School of Business, A report funded by a grant from the US Department of Commerce, Economic Development Administration.
- MIAN, S. (1996), "Assessing Value-Added Contributions of University Technology Business Incubators To Tenant Firms", *Research Policy* 25, Elsevier Science Publishing, New York.
- MINISTRY OF TRADE AND INDUSTRY OFFICE OF THE CHIEF SCIENTIST (1995), *Technology Incubators in Israel*, MTI, Tel Aviv.
- NATIONAL BUSINESS INCUBATION ASSOCIATION (1995), *10th Anniversary Survey of Business Incubators 1985-1995: A Decade of Success*, NBIA, Athens, Ohio.
- NATIONAL BUSINESS INCUBATION ASSOCIATION (1992), *The State of the Business Incubation Industry, 1991*, NBIA, Athens, Ohio.
- OECD (1992), "Business Incubators and Job Creation", *Innovation and Employment Newsletter*, No. 9, LEED Programme, April, Paris.
- OECD (1996), *Technology, Productivity and Job Creation*, Paris.
- OECD (1997), *Venture Capital and Innovation*, OCDE/GD(96)168, Paris.
- SAN JOSE SOFTWARE BUSINESS CLUSTER (1997), www.sjsbc.org/
- TORNATZKY, L.G. *et al.*, (1996) *The Art and Craft of Technology Business Incubation*, The Southern Technology Council and the National Business Incubation Association.
- US CONGRESS OFFICE OF TECHNOLOGY ASSESSMENT (1995), *Innovation and Commercialisation of Emerging Technologies*.
- WESTHEAD, P. and D.J. STOREY (1994), *An Assessment of Firms Located On and Off Science Parks in the United Kingdom*, HMSO, London.

BUSINESS INCUBATORS IN AUSTRALIA

David Winter, Australia/New Zealand Association of Business Incubators, Australia

Introduction

The Australian and New Zealand Association of Business Incubators acts as a peak body advocating for and resourcing the business incubation industry in Australia and New Zealand. It will come as no surprise therefore that my role today is to give an overview of the development of the industry in Australia. To ensure that my address is meaningful I need to provide a contextual setting in both physical and human terms.

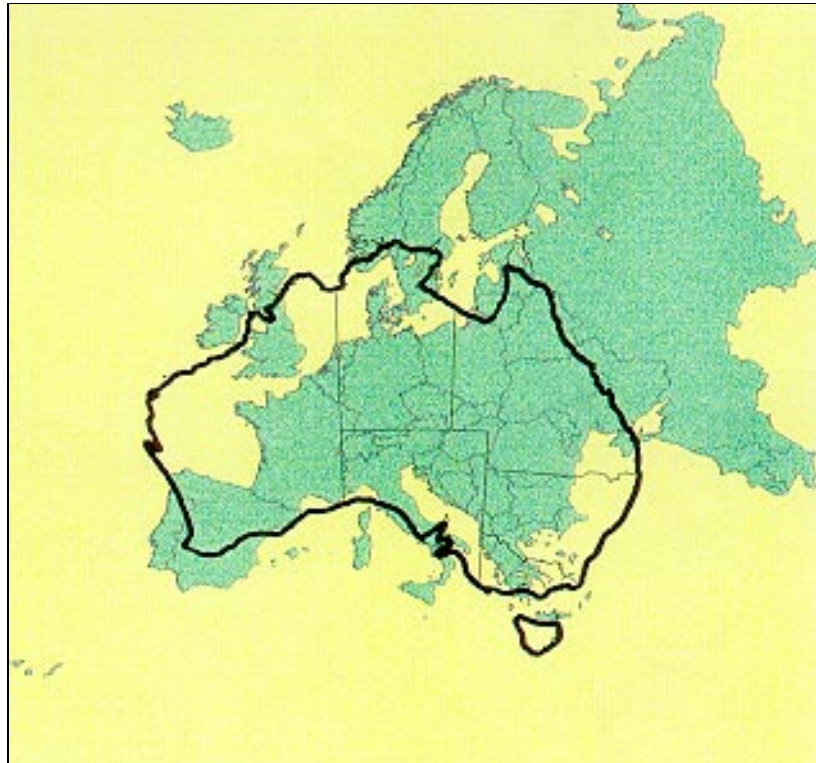
Demographics

The Australian continent covers a vast area, with its people living in a range of environments from sophisticated cities to isolated settlements (see Figure 1). Of particular relevance to this discussion are the Australian population demographics compared to Europe's. In terms of delivering equitable economic development these factors present some special challenges which the business incubation industry in Australia has started to address. Like other developed nations the well-being of the Australian economy is inextricably linked to that of other countries; indeed Australia's economic isolation is gone forever.

Unemployment in Australia peaked in the early 1980s and again in 1993, a year after the United States, when it reached 10.9 per cent. Australia has the third highest unemployment rate of the Group of 7 (G7) countries, trailing behind the United Kingdom, Germany, United States and Japan. Currently the Australian national unemployment rate is 8.7 per cent, which represents 803 000 people. In cash terms, unemployment payments in Australia totalled A\$ 6.6 billion in 1995/96 – around 1.3 per cent of GDP.

Given that in Australia over 50 per cent of workers are now employed in or by small business, our task as the providers of business incubation services is to help mobilise the inherent entrepreneurial spirit of this and coming generations in order to generate new jobs and wealth.

Figure 1. Australia - Europe comparisons



Source: Author.

Business incubation in Australia

The business incubation concept is remarkably simple and finds its roots in the industrial revolution, when tradespeople formed guilds for mutual support and to facilitate the exchange of ideas and techniques. These very human needs are in just as much demand today as they were then. Starting a new business, is for most, a lonely and demanding experience.

The most important service that a business incubator can provide is an encouraging and supportive business environment. A main objective is to build on the very essence of human success, that is drive, enthusiasm and commitment. Technical competence or a good idea is not enough to assure the success of an embryonic venture. The business incubator and its management needs to provide, as part of an overall package:

- ◇ a positive working environment;
- ◇ professional administrative support;
- ◇ readily accessible business advice and mentoring;
- ◇ mechanisms to facilitate the linking of tenants with professional networks and services; and
- ◇ infrastructure to accommodate the special needs of the start up/growing business.

Incubators provide the appropriate rocket fuel to boost business growth, however it is up to the budding entrepreneur to take the first step by lighting the fuse. Generally, the provision of infrastructure assumes greater importance for the more technically-oriented firms. From the financial perspective of the incubator the establishment of specialised work places or the acquisition of industry specific equipment can be a significant drain on fiscal resources.

In addition, capital expended may not be recoverable through rent payments resulting in a dilemma which is not readily solved by a cost benefit analysis driven by cash flow imperatives. The question is, who should take the risk and put up the funds - governments, universities, regional development agencies, big business, venture capitalists, banks, the project proponent etc. etc.

This subject, the developmental financing of specialised technology oriented work spaces, is an important issue that justifies more discussion than time today allows. Fortunately the Australian federal government has recognised the effectiveness, as a wealth creation, economic development and job creation tool, of business incubators and is committing roughly A\$ 8 million per year to facilitate their establishment. This amount when coupled with other funding sources has allowed the Australian business incubator industry to rapidly expand.

To date (1997) there are 63 incubators operating in Australia. This compares to 49 in 1996, 39 in 1994; 40 in 1992 and 17 in existence or being planned in 1988. The number of incubators being established each year is fairly constant at about six per year for the past four years. The incubator industry is maturing with an average of four years of age. This compares to 1992 when only 30 per cent of incubators were more than three years old.

Configuration

In mid 1996 when the Australian/New Zealand Association of Business Incubators undertook an evaluation of the industry and simultaneously documented best practices it was found that incubators were being set up in three streams - embedded, independent and technology - which illustrate the diversity. Analysis between these groups shows differences in factors such as regional area of location, incubator size and provision of services. At that time there were 49 incubators operating in Australia, composed of:

- ◇ 28 **embedded** incubators which are part of a broader organisation, e.g. a regional development organisation;
- ◇ 12 **independent** incubators which stand alone; and
- ◇ 9 industry-specific incubators of which 5 are **technology** incubators.

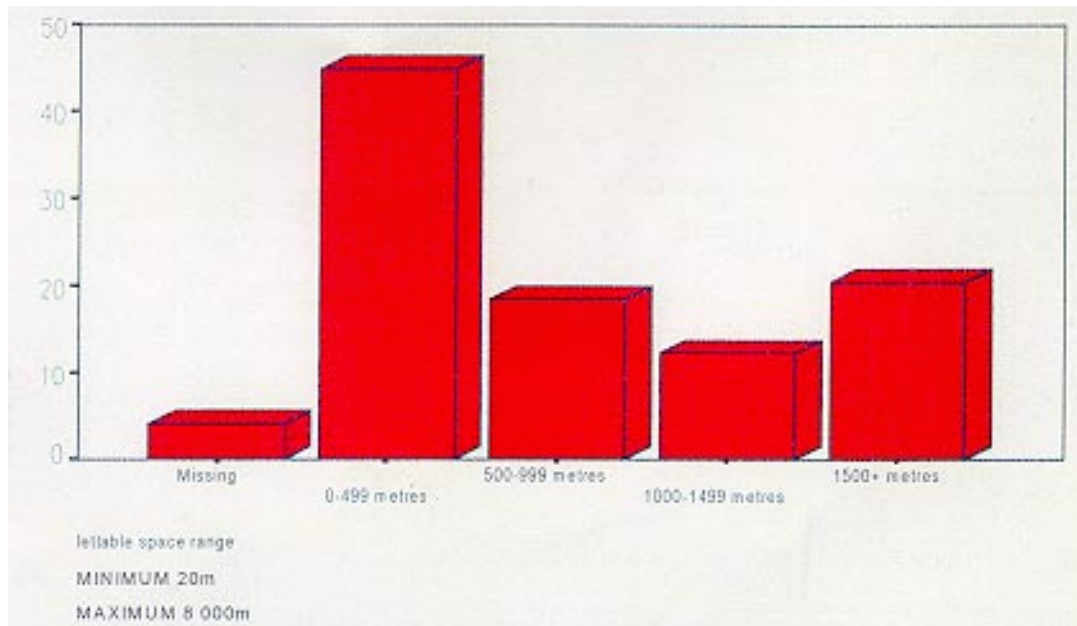
Location

Incubators are located in all states and territories and are present in many regional and metropolitan areas of Australia; 60 per cent are in regional cities or towns. Physically, incubators are located in buildings as diverse as purpose-built facilities to incubators in converted buildings - often recycling unused publicly owned infrastructure. Incubators are also attached to technology parks and/or universities.

Size

Incubators vary widely in size ranging from 20 to 8 000 square metres of rental space. These two figures however are singular extremes. The remaining incubators range between 100-5 000 square metres with nearly 70 per cent of incubators having less than 1 000 metres of lettable space. Figure 2 illustrates the percentages of incubators at various sizes. As one would expect, size of incubators varies according to their location. Broadly speaking, the larger the supporting population the larger the incubator.

Figure 2. Size of incubator by rental space

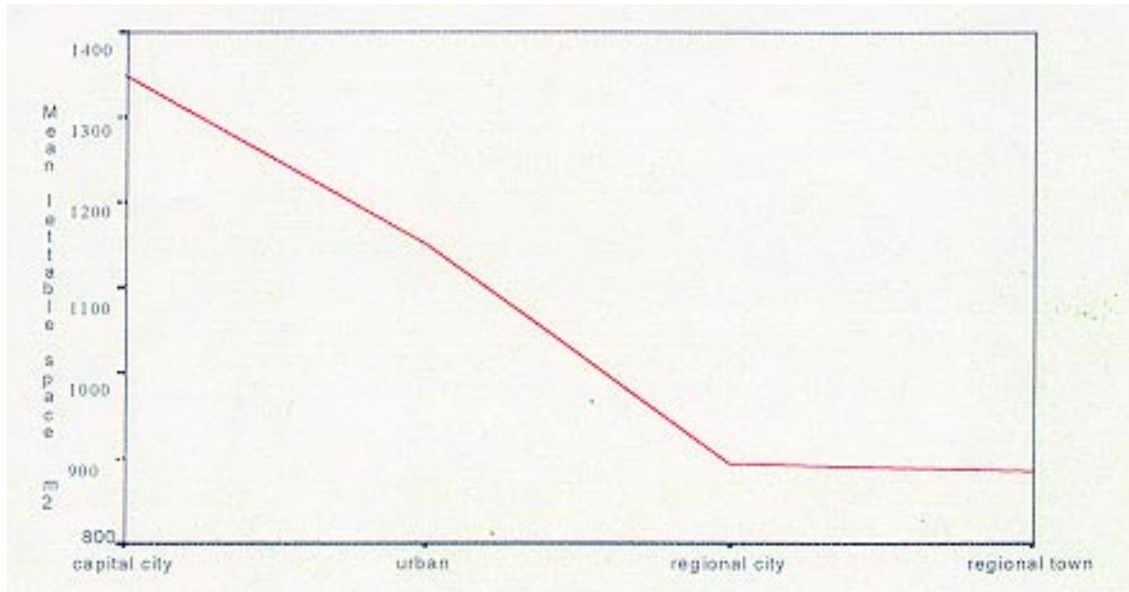


Source: Author.

Figure 3 illustrates the relationship between rental space and regional area. There is also an important relationship between incubator age and area of rental space. Three main points emerge:

- ◇ First, on average incubators older than 5 years are larger than more recent incubators.
- ◇ Second, there was a steady decrease in the average size of incubators from 1991 to 1994. Since 1994 this trend has reversed and incubator size on average is increasing.
- ◇ Third, the trends in size are linked to the regions in which the incubators are being established.

Figure 3. Size of rental area by population centre



Source: Author.

Incubator management

Over 66 per cent of incubators either own their own building or pay a modest rent compared with 20 per cent in 1994. There is remarkable similarity in the management practices among managers from embedded, independent and technology incubators. The majority of incubator programs aim to operate without on-going subsidies. This aim is achieved through one or more of three ways:

- ◇ The proportion of incubators operating from their own building or paying a peppercorn rent has dramatically increased. This is in large part due to local, state or federal government support.
- ◇ Incubator programs with less than 1 500 square metres in rental space are part of a successful larger umbrella organisation which commands considerable community support.
- ◇ Provision of business services which tenants require and which yield a profit.

Incubator business outcomes

Incubators have an impact on their surrounding community in three important ways. They reduce the failure rate of new businesses; increase local economic development; and increase local employment. When these three outcomes are taken together the benefit to local economies is significant and obvious.

Reduction in business failure

An indication of the extent to which incubators are reducing the failure rate of new businesses can be gained by assessing the number of tenant businesses which fail as a proportion of the total number of incubator tenants. This figure can then be compared to the failure rate of businesses outside of incubators.

- ◇ The failure rate for businesses starting up in incubators which have been operating more than five years ranges from 6-9 per cent. This is considerably less than the 32 per cent failure rate for start up business outside of incubators.

This evidence gives credence to the argument that business incubator graduates are ideal recipients of venture capital funds or other patient capital.

Current contribution to local economic development

An indication of the extent to which incubators increase local economic development can be gained by looking at four measures: the total number of tenant businesses within incubators; the total number of incubator graduates; the number of tenant businesses graduating per year; and the annual dollar value of sales and services of the incubator, tenants and graduates.

- ◇ In 1996 a total of 637 businesses operated within 49 incubators. A further 706 businesses have graduated from 45 of these incubators.
- ◇ The estimated annual dollar value of sales and services of the incubator, tenants and graduates is approximately A\$ 238 million.
- ◇ The average number of businesses graduating per incubator per year ranges from 1 to 4.43. On average 12 per cent of incubator businesses graduate each year. For 1995/96 this translates into 76 businesses graduating from incubators.

Current trends and issues

The management of business incubators are continually examining ways to increase their services, contain costs and realise their business development objectives.

Diversification

Successful incubators are now extending beyond in-house development of tenant businesses. They are reaching the wider small business market in their community including businesses operating at home. Examples of assistance offered to external businesses include telephone answering services; small business training in the form of seminars, access to the incubator programs business support network; and the development and marketing of training manuals.

Amalgamation

Some incubators are seeing value in being set up with organisations that have compatible objectives - economic development organisations and other business advisory groups. This gives the combined umbrella organisation more financial stability and security which means that business development can take place in regional areas with small communities and finite resources.

Networking

Australia's large distances create a sense of isolation for regional incubators. This problem is being overcome by incubators in the same region forming networks. The incubators each have different 'catchment populations' which means that the incubators are not directly competing. Steps which have been taken include setting common priorities, establishing regular formal meetings where common problems and ideas can be discussed.

Best practice

The Australian/New Zealand Association of Business Incubators has formulated a set of industry 'best practices' which aim to bring some consistency and quality to the set up and operation of incubators. The production of this document, the insight that it provides and the ability to cross fertilise ideas on "what works" in business incubation is central to the efficient on going development of the business incubation industry in Australia to which the Association is committed.

THE SAINT-NAZAIRE CENTRE FOR LOCAL INITIATIVES

*Frédéric Choloux,
Nantes-Saint-Nazaire Chamber of Commerce and Industry, France*

Background

Saint-Nazaire is located in the west of France in the *département* of *Loire-Atlantique*, which in turn is part of the *Pays de la Loire* region. With some 120 000 inhabitants, it is the second largest city in the *département*, after Nantes. The port of Saint-Nazaire is on the Atlantic Ocean, at the mouth of the Loire, France's longest river. This location naturally led to the development of shipbuilding (in the 19th century) and the construction of seaplanes (between the world wars).

The predominance of large industrial groups

Today, large corporations are predominant in the region. The *Chantiers de l'Atlantique* shipyards (owned by the GEC-Alsthom group), which employ 4 500 people, build ocean liners and cruise ships, and *Aérospatiale* (2 000 employees) manufactures a portion of Airbus. The Donges oil refinery (the Elf-Antar group), with 500 employees, is the largest refinery in France and the third largest company in the Saint-Nazaire employment area.

SMEs concentrated in a single sector

Alongside these large companies, there are a vast number of small SMEs (with fewer than 50 employees), primarily in the metalworking sector. They possess considerable know-how, but have some obvious weaknesses:

- ◇ they are subcontractors and few of them produce real products of their own;
- ◇ few of them have a sales department;
- ◇ few of them have markets outside the region.

In all, it is estimated that two-thirds of local jobs are either directly or indirectly dependent on large industries. The resulting structural instability has led to 17 per cent unemployment, well above the national average.

The response of local actors

Faced with this situation, local actors have given thought to what can be done and have set two priorities:

- ◇ these SMEs must take advantage of their know-how to diversify their activities, while keeping their existing customer base;
- ◇ at the same time, the emergence of new enterprises must be promoted.

These developments should make the local economy less vulnerable to the changing fortunes of the large industrial groups. With this in mind, a number of tools have been introduced over the past 10 years, one being the Centre for Local Initiatives (*Centre d'Initiatives Locales*, or C.I.L.). Others include local business associations and clubs where firms can work together to open up new markets and swap experience. Recently, the Nantes-Saint-Nazaire Chamber of Commerce and Industry launched the “*Nouvelle Donne*” programme, which helps SMEs to think strategically in order to find other ways of using their know-how.

The objectives of the Centre for Local Initiatives

Its objectives are twofold:

- ◇ To promote the emergence of new firms in industry and services. This involves assisting individuals who have a business plan during the start-up period and providing support during the development phase.
- ◇ To assist existing enterprises. This primarily involves financial assistance provided through a capital investment programme created in 1992.

But first and foremost the objective is to help create jobs.

What is the Centre for Local Initiatives?

The characteristic feature is that the Centre combines a number of complementary tools. Established as an association in 1988, it above all reflects the determination of the city’s political and economic actors to join forces in a project aimed at promoting enterprise creation. The City of Saint-Nazaire and the Chamber of Commerce and Industry, and the three main industrial groups (*Chantiers de l’Atlantique*, *Aérospatiale* and *Elf*), are all members of the association.

Tools at the service of enterprises:

The “Créatlantic” incubator

This incubator may provide assistance to new firms for up to two years, which is the maximum period allowed by law in France. After a project has been examined by the Executive Board, a new business may join the incubator and use the physical infrastructure and other services it provides.

This infrastructure allows a fledgling firm to optimise its external and internal costs. The firm has access to all the necessary office equipment (fax, photocopier, E-mail, etc.), but it may also avail itself of our secretarial services to type correspondence or do accounts.

The other services provided are of real value and distinguish us from other business incubators. They include:

- ◇ a monthly internal newsletter that keeps enterprises abreast of new legal, fiscal or labour developments;
- ◇ a quarterly external newsletter that promotes our enterprises;
- ◇ weekly economic monitoring of each firm;
- ◇ a network of skilled advisers who work in close co-operation with the Centre, such as accountants, lawyers and bankers;
- ◇ membership of an Entrepreneurs' Club, which holds monthly evening meetings devoted to specific themes;
- ◇ exchanges and joint initiatives (publication of a directory of new businesses) with other incubators in western France through the "*Pépinières Réseau Ouest*" network.

Preliminary assistance

This fund makes it possible to finance market research or sales prospection prior to start-up.

The Intervention Fund for Local Initiative

This fund lends money to newly established businesses in order to share the risk with a bank.

"Atlantique Initiatives": a capital investment company

This company was set up by the Centre in order to provide a portion of capital for start-ups and for enterprise development or transfers of ownership as well. As a minority shareholder, the company supports projects and entrepreneurs by providing cash, but it may also advise and monitor operations if necessary.

Involvement of local actors

Local actors are actively involved in the Centre's operations. For example, its Chairman and Vice-Chairman are respectively the Chairman of the Chamber of Commerce and Industry and the Mayor of Saint-Nazaire. Representatives of the city, the Chamber of Commerce and the large industrial groups sit on its various review boards. This day-to-day involvement of the founder institutions is important because it shows that they are genuinely interested in small firms and gives credibility to the Centre.

The results achieved by the Centre

After ten years of existence, our various programmes have provided assistance to over 110 projects:

- ◇ more than 75 businesses have gone through the incubator;
- ◇ 25 loans have been made;
- ◇ 40 enterprises have received preliminary assistance;
- ◇ 10 SMEs have been invested in by *Atlantique Initiatives*.

Over 70 of these businesses are still active in the region. Of the firms assisted, 85 per cent ultimately remain in the area. The incubator's success rate has been approximately 70 per cent for the past ten years,

which is above the national average. On average start-ups remain in the incubator for 19 months, so the firms there are renewed every three years. In all, the Centre has so far helped to create some 500 jobs.

Future directions

Based on our day-to-day observation of new businesses, three questions have emerged:

Can the assistance given to new businesses be improved?

In other words, what more can be done to help businesses avoid risks? We must strike a balance so as not to cross the fine line between effective monitoring (advice) and interfering with entrepreneurs' management of their businesses. The more systematic use of operating reports is no doubt a possibility that should be investigated. This is in line with the new standard set by AFNOR (the French Standardisation Association), which requires incubators to sign an agreement with each business.

How can chances of success be improved?

This question is a logical extension of the previous one. It means detecting businesses' problems better. Anticipating problems effectively helps prevent failure.

The products and services of tomorrow have yet to be invented. What role can the Centre play?

The Centre must establish closer relations with technical colleges and laboratories in Saint-Nazaire to help promote the emergence of innovative new firms. An innovation company, which will hold patents for college inventions and exploit or license them, is to be set up in the near future. The Centre will be actively involved in this company through *Atlantique Initiatives*.

By pursuing these goals, the Centre for Local Initiatives will improve its services and become an important actor in the region's economic development.

THE UK EXPERIENCE WITH SCIENCE PARKS AND TECHNOLOGY INCUBATORS

Ian Hamilton Fazey¹, Consultant, United Kingdom

What is the definition of a business innovation centre (BIC)? The term is usually understood to mean a collection of incubator units for small businesses which can draw on centralised facilities for day-to-day operations, coupled with ready access to advice. There is, however, a more down-to-earth, possibly cynical definition. A BIC, according to a recent article in the Financial Times, is little more than a high technology version of a managed workshop.

In the United Kingdom, the same problem of definition applies to science and technology parks, where some BICs are housed. These so-called “parks” are no more than pleasantly designed industrial estates, usually with an elegant pavilion style for most of the buildings. Calling them “parks” is better for marketing the property built upon them or encouraging companies to move in and build their own. One result is that almost every pocket of industrial development outside a UK town centre is now called a “park” of some sort or another, whether prefixed by “science”, “technology” or “business”. Indeed, in the last ten years, at least 200 million square feet (that is about 20 million square metres) of space for offices and light industry have been marketed in these “parks”. To give an idea of how much this comprises, it is more than the total office space available in central London. At the beginning of the 1990s, a survey showed that about 35 per cent of it is occupied by accountants, insurance companies and providers of financial services.

These observations of reality are important because they serve to remind us that when we talk about business innovation centres and science parks, these are euphemisms for managed workspace and industrial estates. BICs and science parks are niches in the property market and although governments, politicians, university vice-chancellors and the people who market them often speak as though BICs and science parks have magic powers, what makes them work - if they work at all - is commerce and profit.

The United Kingdom invented managed workspace in its modern form in 1975, when British Steel formed a subsidiary called British Steel (Industry) - BSI - to create jobs in steel closure areas. BSI created managed workspace, sometimes out of old buildings, sometimes building new ones. BSI also backed many in the UK's network of enterprise agencies, which give advice to small businesses and were pioneered in north-west England, notably in St. Helens, which faced large technological redundancies in its principal glass-making industry.

1. Ian Hamilton Fazey is a British journalist who has written extensively about small and medium-sized enterprises and was a Financial Times correspondent for 10 years to 1996. He has most recently completed a report for the OECD - LEED Programme on Italian business innovation centres entitled, *Italy's National Hatchery: The experience of SPI* (OECD, 1997). This latter report was also presented at the OECD Workshop on Technology Incubators (25 June 1997) but is not republished in this document in order to avoid duplication.

Other institutions, government agencies, local authorities and private companies followed BSI's example of creating managed workspace. The result is that there are now more than 100 managed workspace schemes dotted around Britain. This is now a mature market. About a dozen of these managed workspace schemes are technically BICs in the European Union's understanding of the term: they received EU money to help with set-up costs and are part of the European Business Network (EBN) of BICs promoted by Brussels. BSI, however, the arch practitioner and expert in this field, has little to do with the EBN, the European Union's network of BICs. BSI is an associate member for contact purposes, but considers the European Union's rules for management structure of BICs too prescriptive and constraining. It is simply not always necessary for a BIC to always have a chief executive and supporting directors responsible for marketing, finance and so on, or even a business plan. If companies need specialised advice, the person in charge in any reasonably organised managed workspace centre should be able to direct them where to go. It is not necessary to have it on the spot or be over-sophisticated. Looking at the many companies based in managed workspace in the United Kingdom, they appear remarkably similar and have a similar feel to companies in the BICs in Italy. In Italy, the SPI (Sviluppo e Promozione Imprenditoriale, or Entrepreneurial Development and Promotion) has very good reasons to operate its BICs in a rather more formal way than BSI does in the United Kingdom. These are early days for them, a climate for entrepreneurship has yet to be established in many parts of southern Italy, and BSI used to be more formal before the UK managed workspace market matured.

The point is that it is the climate for doing business that matters to all kinds of small companies - whether high tech, low tech, or even no tech - rather than the technical details of how a BIC is run. The key things needed are a good standard of reasonably priced accommodation and easy access to finance and advice where required. By definition, entrepreneurs succeed or fail mainly through their own efforts; the skills of entrepreneurship can be taught or imparted so that people do not have to reinvent the wheel, but people who need to have their hand held on a day-to-day basis are unlikely to succeed.

Therefore, what has evolved in the United Kingdom, as far as managed workspace is concerned, is a property market. BSI started off in 1975 with similar ideas to those of SPI in Italy. Workshops would be incubators; tenants would be nurtured and would grow; they would move out to bigger premises and their places would be taken by newcomers, ready to be incubated. The reality is that only about a quarter of companies move out. They grow and need bigger premises. The majority stay where they are. Some expand without moving out, often by taking over adjacent workspace when it becomes vacant. The new dynamic is far different from that first envisaged by BSI in the 1970s: it is to sell mature, managed workspace to a property management company - often an insurance company or pension fund - and use the money to build another cluster of managed workspace and start the cycle over again.

The same commercial realities have driven the development of science and technology parks in the United Kingdom. In the United States, science parks - there are more than 200 of them - were driven by universities, usually to exploit ideas within those universities. There has been some of this in the United Kingdom, but science and technology parks are, in the main, part of the commercial property market. The most famous is the Cambridge Science Park, which was founded in 1970 on 120 acres of farmland - about 48 hectares - owned by Trinity College. It is an outstanding success, but not so much because academics have spun out of Cambridge colleges to translate ideas into commercial reality, but because it is associated with one of the world's greatest seats of learning and this cachet has encouraged people to start up high technology businesses there or relocate to the science park from outside. Many businesses have no connection with the university at all. The latest newcomer, as you will have read recently, is going to be Microsoft.

Another highly successful industrial estate of this kind is the Birchwood Technology Park in Warrington, half-way between Manchester and Liverpool. It was built in the late 1970s and early 1980s by Warrington

New Town Development Corporation - which was a government agency - and the NCR Pension Fund. There is no university at Warrington at all, but the park contains the headquarters of British Nuclear Fuels and is adjacent to what used to be called the UK Atomic Energy Authority. This proximity has encouraged scores of small high technology companies and consultancies to set up in the technology park, creating more than 3 000 jobs. Other, blue-chip high technology companies have also set up in the park, not least because it is at the cross roads of the UK motorway system with more than 90 per cent of Britain's population within a half-day's driving time, and is only 20 minutes from Manchester Airport, now the ninth largest in Europe, with scheduled daily connections to most of the world's important destinations, particularly in the United States. When Warrington New Town Development Corporation was wound up ten years ago, property companies moved in with their chequebooks.

There are more than 40 science or technology parks in the United Kingdom now. Many are attached to universities and there are notably successful ones at Warwick, Aston, Coventry, Cranfield and Manchester. Oxford's is at the nearby Abingdon Business Park. It is owned by Standard Life, an insurance company. The Surrey University Science Park at Guildford also houses a good-quality, four-star hotel as part of its infrastructure. Indeed, it is infrastructure like this, together with good restaurants and proximity to an international airport, that many science park developers say is more important than proximity to a university. Where there is a link to research and development, it is to industrial R&D, not blue sky work in universities.

It can be said that with both science parks and incubators, it is commerce and profit that make the world go round, not a driving need for technological innovation for its own sake. The latter happens, but because of market demand, not because of a push from academia or the government to improve competitiveness.

To illustrate: medical scientists at Manchester University want to develop a biosensor that can be used for instantaneous blood analysis by ambulance paramedics confronted with unconscious people. This would save lives because some treatments could be started immediately, rather than having to wait until the patient arrives at the hospital and the lab has done the necessary analysis. But accurate analysis is very difficult in the field because of contaminants. The secret is to use membrane technology to filter out these contaminants. It proved impossible to do the development because the time taken to get approvals in the health sector would mean too long a period with no income stream. The university, however, turned the problem over to MBA students at Manchester Business School. They found that the principles that would make the blood-testing device work, could also be used - in the field - for measuring the ratio of sugar to alcohol in fermenting grapes or brewing beer, or for testing the ripeness of fruit before it is picked so it can have maximum shelf-life in supermarkets. The device is being developed now for these markets. They will provide the income stream needed by venture capitalist backers while it is developed further for the medical market for which it was first envisaged.

Last year in the United Kingdom the government set up an Enterprise Panel to look at technological innovation. It came up with some interesting conclusions which included setting up a national business innovation centre to set a UK pattern for incubating high technology companies. It noted that about 30 incubators were planned or had been set up already, often associated with successful science parks, but it had reservations about the 12 EU-model BICs set up in the United Kingdom at places like Barnsley, in the shut-down Yorkshire coalfields, because they lost impetus after the initial EU funding finished.

This is echoed by the experience of an organisation called Nimtech, the name of which is derived from "New and Improved Technology". Nimtech was set up in north-west England by Unilever, ICI, and Pilkington - with government assistance - in 1986 to act as a broker and clearing house for ideas and projects between nine universities and industry in a region of more than 7 million people. The idea was to

improve technology transfer. Five years later it was about to go bankrupt and a business consultant was brought to try and save it. He said this to me recently: "A government grant is one of the worst things that can happen to you. All it does to an organisation is encourage it to sit back and start delivering statistics. Then, as the money runs out, the principal task becomes one of how to get another grant."

Nimtech stopped trying for more subsidy. Instead, it targeted small and medium-sized businesses which needed to grow but lacked specialised resources to find new technologies and potential markets. Nimtech enrolled more than 100 of them in a network with the universities, charging them all yearly subscriptions. It seems to work. It has now formed a worldwide marketing subsidiary to look for new export markets and venturing opportunities and plans to open a London office to operate on a wider, national basis. Because survival relies on Nimtech making a commercial success of technology transfer and brokering partnerships and joint ventures between its subscribing customers, it is not only surviving, but flourishing as a business in its own right as a result of the entrepreneurial disciplines it has imposed on itself.

There is also a profound change under way in the UK universities. They too have been having problems getting enough government subsidies. This is imposing commercial disciplines on them such as we have never seen before. Many lament the fact that the state can no longer fund universities in the way it used to, but one result is that universities are almost certainly going to have to develop their science parks much more along US lines, so that universities will increasingly become drivers, rather than passengers in a vehicle driven by the property market. The signs are already there. Most have already set up technology transfer companies, for example, and are finding new uses for substantial funds of their own, other than investing them on financial markets.

Bio-incubators are becoming almost fashionable. The UK government is giving £1 million of pump-priming money to no less than eight of them. Last January, Cambridge's Bioscience Innovation Centre announced it intends to raise up to £6 million from a private share placing, accompanied by flotation in the London Stock Exchange's Alternative Investment Market.

The most ambitious project so far, however, is the Manchester Biosciences Incubator, which is to have its own £12 million building attached to Manchester University's School of Biological Sciences, and an exploitation fund expected to total £30 million. The incubator is a concerted attempt by Manchester, backed by a £6 million grant from the European Union, to secure a big share of the fast-growing biotech sector.

In the United Kingdom, this has so far been concentrated in what is known as the bio-triangle of Oxford-Cambridge-London. The project is expected to create more than 900 local jobs over five years as companies expand out of it on to Manchester Science Park and elsewhere. Manchester University is investing nearly £4 million, as well as its portfolio of bioscience patents, but most of the funding will come from the private sector. Merlin Ventures, a specialised venture capital company, is to make a substantial investment, and other potential investors are negotiating with the university.

The incubator will be integrated with the academic activities of what is the largest biological sciences department in a European university, and will have a seed corn fund to support business ideas. The university hopes its own academics will provide most of the ventures for the incubator, although it will also welcome small bioventures from elsewhere, including spin-offs from the drugs industry.

The idea is to bridge what the university calls the discovery gap, so that academics can test the commercial viability of a piece of excellent science - and go back to the lab without losing face if it does not work. If it goes well, there would be further development within the incubator, followed by spin-out to a science park or somewhere else. The new building, which will be able to house 250 scientists, will be

ready in two years. In the meantime, the university will provide laboratory space to run a smaller “virtual incubator”. Coincidentally - or perhaps not - Manchester University is also being helped by the European Union to try and develop another type of incubator.

A disused electrical engineering building has been converted to support young scientists with ideas and nurture them through the pre-business stage of development with no risks to take until they can form viable companies. In a normal BIC they would be expected to start with a business plan, which Professor David Auckland, the man behind the experiment, believes is likely to thwart promise by forcing a company into inflexible objectives too soon. There will be no such early pressure in the Manchester experiment. Instead, it will provide a half-way house for people who as yet have something between an idea and a business but need to carry out a type of technological due diligence before final commitment.

It is being run by a new company owned by the university called Campus Ventures. The units on offer range from single desks to 1 000 sq ft partitioned workshops. Those who occupy them will need no capital, but will be given a “graduate account” by the centre against which their costs will be debited. In the pre-business period there will be no risk attached to the tenants at all, but debits in the graduate account will build up. A compulsory stage in the process is to form a company to take responsibility eventually for the graduate account, but support is good for six to twelve months.

In the second year the university expects some repayment, with final clearance of the graduate account over the next 18 months to two years. The tenants would then be expected to leave for normal commercial premises and operate independently within three years. The capacity of the building will be 30 to 40 budding entrepreneurs at any one time.

The only other compulsory element will be for each new company to give Campus Ventures a 5 per cent non-dilutable stake on formation so that there will be an eventual return if a business succeeds, either through dividends if it stays in its original ownership or through a realisation if it floats or is sold.

In addition to EU backing, the project is being sponsored by Manchester Airport Commercial Ventures, British Nuclear Fuels, The Co-operative Bank, ICL, the regional electricity supply company and Manchester training and enterprise council. Support in kind is coming from the university itself, which is providing the premises rent-free, and Addleshaw Booth, Manchester’s largest corporate law firm, which is giving free legal services. In other words, local industry and commerce is putting up real money. This is not altruism, but enlightened self-interest: it makes long term commercial sense to support initiatives that encourage a more diversified, high tech economy.

These two examples give some idea why Manchester University is a leading contender to house the national business innovation centre proposed by the Enterprise Panel last year. The Enterprise Panel also believes that commerce and profit make the world go round. Its view was very much that any BIC must be part of a wider project, not something that exists in isolation. The commercial approach, rather than heavy subsidy from public funds, gives the BIC involvement in its own success. If its job is to encourage entrepreneurship, it should be entrepreneurial itself in the first place.

Another example is that of Milton Park, a high technology business park in Didcot in Berkshire, near another centre of activity for the UK nuclear industry. It has a BIC, owned and run by MEPC, the property company which developed Milton Park. Although it gets rent from BIC tenants, it provides advisory and support services at no extra charge. It expects to recoup its outlay when companies grow large enough to move out of the BIC into the technology park proper. In other words, it is using the BIC to provide its own customers for tomorrow. This is certainly a new slant on research and development.

ADVANCED TELECOMMUNICATIONS AS A NEW STRATEGY FOR SCIENCE PARKS

Alfred Urban, Salzburg Technology Centre, Austria

Telecommunication as a chance for networking on a regional as well as on an international level

A main objective of Austrian innovation and technology centres' policies is the provision of a communications-based infrastructure that enhances the attractiveness of regions as sites of economic activity. This is very important for future activities towards settling companies in rural regions and for creation of new jobs in these regions. Science park activities must be connected and co-ordinated with telecom initiatives in order to get new synergies for the technology centres. Entrepreneurs in the technology centres are supposed to be able to apply the newest telecom technologies in daily business. Information and communication will become one of the most important competitive factors in many economic branches. World-wide networks offer access to new markets and thereby offer new possibilities in the area of marketing and sales.

Access to international science and research via broadband data highways will be absolutely necessary for science parks. Regional technology and innovation centres in particular must be integrated in national and international networks. Telecom links to patent offices, data bases for standardization and technology brokerage as well as funding institutions and the European research and development programmes are essential for tenants in the centres. A common virtual office must be set up by interconnecting all technology and innovation centres in a greater region. The Austrian technology centres have been practising this for three years and have gained very good connections to national financing funds and federal governments. The time lapse for efficient information flow has been decreased dramatically.

New synergy between science and enterprises by telematic applications

The main aim of the Salzburg telecom initiative was to make a powerful telecommunication infrastructure available to firms and research institutions and thereby provide Salzburg's economy with a decisive competitive advantage. Faster and immediate access to information based on a powerful data network brought a better educational possibility by tele-learning and tele-teaching.

The overcrowded area around the town of Salzburg is supposed to be relieved by the evacuation of electronic data services to southern parts of the country using the broadband link in the state of Salzburg with ATM nodes (asynchronous transfer modus). Numerous telematic applications have been created: tele-publishing, information engineering, multimedia and tele-working. New research institutes have been created in the regional technology parks in the state of Salzburg as a consequence of telematic applications and broadband links with the regional data highway.

The organisation of the future information society brings us smoothly to one of the next important challenges to regional policy, for instance in connection with telecom and regional technology centres. Information can be made available independently of place and time and this allows us to shift business settlement from central and strong economic regions to rural regions. Science and research institutions can be re-located into rural areas. Transport of information instead of people which could relax the traffic situation, relieve the environment and thereby fulfil ecological aims. A requirement for regional technology centres is competitive equality by levelling of differences in tariffs: currently data

communication in the local area is considerably cheaper and affordable whereas long distance communication is very expensive. The alternative data highway, which is provided by the regional Salzburg technology centres, offers a low cost model for data communications on broadband links.

Broadband network between science parks, technology centres and regional innovation centres

The Salzburg Data Highway and Telecommunication Company Limited was established in 1994 as a daughter company of the Salzburg Technology Centre to serve as an infrastructure facility. The aim is to broaden the use of new telecommunication services among companies in Salzburg, particularly to rural companies that are at a disadvantage compared with the economically strong central region of Salzburg.

Five regional innovation centres are established in the state of Salzburg and connected via the data highway. The Salzburg Data Highway offers a country wide broadband network and accompanying services that allow companies to have a connection to international networks. The private ATM back-bone with 18 local nodes is connected to the public ATM server of the Austrian PTT to assure a connection to other Austrian capital cities and also to international ATM networks. Value added services for trade and tourism such as Internet, electronic data interchange, telebanking and online retrieval in data bases and multimedia applications in the graphics and publishing industry demonstrate the success of business settlement in regional technology centres in Salzburg. More than 800 jobs have been created in the last five years in these regional technology centres. Many of them have been created by outsourcing from central regions and are remote working and tele-working jobs.

Video conferencing rooms in the regional technology centres allow direct links to EC offices in Brussels, providing the newest information in European law and funding. The regional technology centres are focal points of the Salzburg Data Highway offering a powerful, reasonably priced, and generally accessible telecommunication infrastructure. Target groups are enterprises, firms, and professional users, which already today need broadband services such as multimedia and graphic data transmission for their work.

Furthermore, the super highway offers value added online services that are data banks (law, technology, business, EC research data bases, stock exchange), information services, agencies and most of all access to Internet at the local tariff. Considering these points the Salzburg Super Data Highway offers international access for Salzburg firms and professional users especially in the regional technology centres as well as an enormous advantage in costs.

The data highway initiative has connected all regional technology centres in Salzburg to the biggest existing computer network in the Salzburg region. All in all there are six innovation technology centres bound together in this regional Techno-Z compound. Additionally, two campus buildings for students and employees exist and all together 15 different buildings were built in six expansion phases and more than 340 students are in 11 research institutes. As many as 940 employees are working in more than 170 companies and more than 40 000 square metres have been rented. Since 1988, telecommunication and telematic applications have been the basis for this rapid expansion.

Connected to this data highway network are technology and innovation consulting offices as well as official European Info Centres and Relay Centres of the European Commission which are located in the state of Salzburg.

Multimedia as a new challenge for the Salzburg Technology Centre

The Salzburg Technology Centre is the largest technology centre in Austria and consists currently of 78 enterprises employing 600 specialists and professionals. More than 300 students study at the University of Salzburg's Institute for Computer Science and a new Polytechnic University for Telecommunication and Multimedia and Art was created last year. These institutions of higher learning are focusing on studies for the information super highway with master programmes in telecommunication engineering, multimedia production and communication, and information economics and management. International broadband links are the basis for the Salzburg Technology Centre now going into a phase of great expansion, nearly doubling its size. Additional business locations for more than 50 companies who wish to use Salzburg's cultural class and international reputation as a meeting place for multimedia production will be available in 1997.

Companies located in the Salzburg Techno-Z can take advantage of the training potential of the Techno-Z Polytech University in co-operation with its telecom research centre and world class audiovideo and media labs as well as broadband international connections. Multimedia and cultural competence have invited the best of high technology firms to seek Salzburg as their European location for production and management using international broad band telecommunication links.

Today in Europe there is no comparable course of education concentrating on the training of technical creative and management orientated specialists for multimedia, online services and other new forms of media in connection with telecommunication. By 1998, 1 000 students are expected at the Techno-Z Information Super Highway Polytechnic University. This will attract new companies to run their business in the Techno-Z Salzburg.

EVALUATING THE IMPACTS OF TECHNOLOGY INCUBATORS

TECHNOLOGY BUSINESS INCUBATION: LEARNING FROM THE US EXPERIENCE

Sarfraz A. Mian, State University of New York at Oswego, United States

Introduction

The rapid evolution of the technology-driven global economy is placing an ever-increasing emphasis on effective development of new technology and its speedy commercialisation into the marketplace. As policy makers at various levels of government grapple with strategies to stimulate such efforts, they are searching for appropriate mechanisms to promote these economic development objectives. One such promising mechanism employed for more than two decades is technology business incubation – a mechanism operationalized through the establishment of incubators. Typically, incubators provide qualifying new start-up firms with building space in physical proximity to other similar tenant firms. The tenant entrepreneurs receive a host of shared services, business advice and financial inputs to provide a nurturing environment for the fledgling new firms.

The incubators whose primary goal is to focus on the development of technology-oriented firms are called technology incubators. The technology incubator concept holds out the possibility of linking technology, know-how, entrepreneurial talent and capital. These incubators are generally established through collaboration among university, industry and government, and are aimed at promoting technology diffusion into the local economy. Most US technology incubators are directly or indirectly associated with universities – the primary source of trained human and intellectual capital – and share common objectives, such as providing a training ground for entrepreneurs and supporting technology-led entrepreneurship based on university research results. Therefore, a majority of US technology incubators are sponsored in full, or in part, by universities and colleges. They are generally incorporated as independent non-profit entities. Other sponsoring organisations include state and local economic development agencies as well as private parties, such as hospitals and research institutes.

This paper, after providing an overview of the emergence of the US technology business incubation industry, examines more than two decades of research on technology incubators (TIs). It specifically addresses the issue of performance assessment and reports on the efforts to develop “best practice” technology incubator programmes. The article concludes with a discussion of the lessons learned from experience in this emerging industry and some associated policy implications.

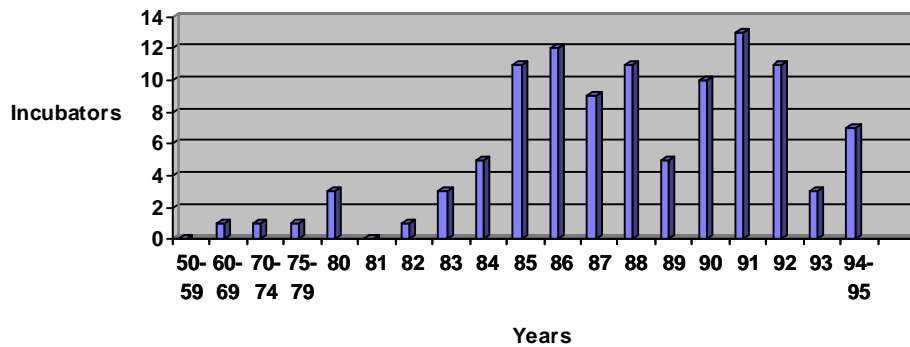
Overview of the US technology business incubation industry

The United States has extensive experience in technology business incubation with facilities spread all across the 50 states. According to the National Business Incubation Association (NBIA), there are more than 500 business incubators operating in North America (including 5 to 6 per cent in Canada and Mexico), occupying roughly 30 million gross square feet of space. These incubators have served 7 795 client firms and launched 4 651 graduates. Approximately 30 per cent of these incubators (around 165) are technology-related, half of which (around 82) are university-affiliated with an average of

14 tenants per incubator (National Business Incubation Association (NBIA), 1995). Another US study (Tornatzky *et al.*, 1996) identified a total of 84 technology incubator programmes in the country, of which only 54 were accessible for the national survey. According to the Association of University Related Research Parks (AURRP), in Arizona, roughly one quarter of the 140 science/research parks in the United States are equipped with technology incubation facilities (around 35).

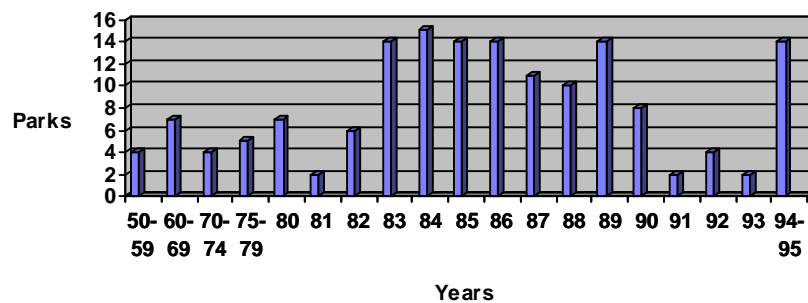
Figure 1 graphically displays the growth of technology incubators by showing the number of North American facilities (around 10 per cent of these are from Canada and Mexico) established by year. More recent data is being compiled by NBIA and AURRP, the results of which will be available by the end of 1997. The graph demonstrates the drastic increase in the establishment of technology incubators in the mid-1980s to the early 1990s. The science/research park followed a similar trend as seen in Figure 2. As shown, during the mid-1980s, there was considerable growth in newly established science/research parks. However, in comparing this graph with the previous one, it becomes apparent that science/research parks were around a bit longer than the technology incubators. Both graphs demonstrate a slowing trend for the 1990s. The available literature relevant to this industry seemed to follow a similar trend – most of the literature was generated in the 1980s. As the industry peaked in the early 1990s, researchers, policy makers, and incubator managers began to focus more on improving the effectiveness of existing incubators rather than the establishment of new facilities. Moreover, the literature suggests that until policy makers are given conclusive feedback on the impact of such programmes on state and local economies, they will be hesitant to subsidise the establishment of similar programmes (Mian, 1997).

Figure 1. Number of North American technology incubators established by year



Source: Author.

Figure 2. Number of North American science/research parks established by year



Source: Author.

Significant US research on technology incubators

Because of the popularity of the business incubation concept in the United States during the 1980s, numerous studies were conducted to assess the emerging incubator industry across the nation, but most of these studies are primarily descriptive in nature (Mian, 1994). A review of the significant research undertaken in the country directly or indirectly related to the subject of technology incubators is provided in Table 1. The table excludes most of the basic descriptive literature, the “how to?” accounts and anecdotal information on the subject of business incubation in general (this information is available from NBIA). As shown, the earlier literature (Allen and Bazan, 1990; Smilor and Gill, 1986; Campbell *et al.*, 1988; and Rice, 1993) did not differentiate technology incubators from other types of incubators, but did include TIs in their study samples. The more recent studies (Mian, 1991; Mian, 1994; Tornatzky *et al.*, 1996; and Culp, 1996), however, exclusively focus on technology incubators. The first two of these are national in scope, while the third provides an in-depth review of a more established TI programme in the United States. It is, therefore, obvious that, to date, only a handful of studies have looked at technology incubators (TIs) in a scientific and systematic manner.

At a macro level these limited number of studies do establish the fact that the US technology incubators are providing a nurturing environment for the start-up and growth of technology-oriented firms. They facilitate technology transfer and hold promise as an innovative tool of technology capturing for regional economic development. In the absence of a well-developed and sound theoretical foundation, the innovation model provides a rationalising theory. This theoretical rationalisation when combined with the limited empirical support described earlier, provides the necessary rationale for the TIs as a viable option for promoting regional economic development.

On a more micro level, however, with the exception of the aforementioned studies, there is very limited work done on technology incubators as such. Consequently, there is no consensus on what makes up the content of the technology incubator’s performance, and the best TI programme management and policy practices. A recent study (Mian, 1997) attempts to fill this gap by addressing the often controversial question of TIs’ performance assessment by providing an integrative model which is summarised in the next section. Similarly, the subject of benchmarking the TI “best practices,” which has received attention recently, is addressed by Mian and others (Tornatzky *et al.*, 1996) and included here.

Performance assessment of technology incubators

As described earlier, despite the steady increase in the number of technology incubators since the early 1980s there has been no single framework available to assess how they are working and thereby improve their effectiveness. This has placed the economic development leaders in the United States in a difficult position. On the one hand, the regions that see a wave of activity sweeping the country and the world feel some pressure to follow suit. On the other hand, experts caution that the jury is still out due to the lack of pertinent experience, and hence, evidence about their usefulness. This is particularly true in light of the numerous questions regarding their impact and organisational self-sustainability. The challenges confronting researchers developing such a framework include:

- ◇ the emerging nature and relatively short life of the TI industry means an absence of longitudinal data;
- ◇ lack of consensus on the type of evaluation criteria to be used; and
- ◇ lack of understanding of the technology incubation process itself.

Table 1. Technology incubator perspective: major US studies

Author(s), year	Research sample	Study context	Key findings/contribution
Allen and Bazan, 1990	70 incubators (TIs 15%, response 66%) 910 firms (response 56%)	Institute of Public Administration, Pennsylvania State University, University Park, Maryland and the US Department of Commerce, Washington DC	This study pointed out the potential of incubators for regional development. It helped to define incubator organisation types based on sponsorship and service categories provided to the tenants. The concept of incubator was described as: a network of organisations providing skills, knowledge and motivation, real estate experience, provision of business and shared services.
Smilor and Gill, 1986	117 incubators (TIs 10%, response 43%) 211 firms (response N.A.)	IC Square Institute, University of Texas at Austin, Texas	The findings of this research supported much of what was already known and provided new data about the age, education and salary of incubator managers. Using the four incubator organisation types identified earlier, the study further identified their measures of success.
Campbell <i>et al.</i> , 1988	13 incubators (TIs 21%, case study) 294 firms (response 55%)	H. Humphrey Institute, University of Minnesota, Minneapolis, Minnesota	In this case study, the features identified as contributing to incubator effectiveness were: low cost developing and operating; and quality management of facilities.
Mian, 1991, 1994	6 incubators (TIs 100%, case study) 150 firms (response 32%)	School of Business & Public Management, George Washington University, Washington DC	As the first TI-focused work, the study supported the assertion that university incubators appear to provide the resource base and environment conducive to the development of technology-based firms. It provided a checklist for successful facilities and developed an assessment framework for TIs.
Rice, 1993	9 incubators (56% TIs, case study) 36 firms (selected)	School of Management, Rensselaer Polytechnic Institute, Troy, New York	The study contended that managerial intervention is the key in incubation support and success is measured by proactive, direct intervention. Factors limiting the effectiveness of direct intervention were identified as the availability of time and the lack of responsiveness of the firms.
Culp, 1996	1 incubator (TI with in-depth case study and surveys) 19 tenant firms (total population 24) and 20 comparable non-tenant firms	Georgia Institute of Technology, City Planning, Dept. Atlanta, Georgia	This study suggests that current theory is insufficient in explaining the phenomenon of technology business incubators, although the innovation theory holds the most promise. Also there has been a low incidence of technology transfer due to various barriers. According to the research, incubator membership did not make a significant difference in the tenant firm performance when compared to similar non-tenant firms.
Tornatzky <i>et al.</i> , 1996	54 incubators (TIs mostly) out of 84 identified through reputational snowballing. Mail questionnaire followed by phone interviews. No firms included	Southern Technology Council, Durham, North Carolina in collaboration with NBIA and ILGARD, Ohio University, Ohio	The findings of this study describe the best practices for each of the following technology incubator domains: management, business planning, finance and capitalisation, research and technology, legal and regulatory, physical infrastructure, markets and products, and structure/operations. Descriptions supported with data provide benchmarking measures in each of the above domains.

Source: Excerpted from Mian, 1996 and updated.

In short, the research on technology incubator performance has been less than comprehensive, and often no more than an extension of the general business incubator studies which are primarily descriptive and anecdotal in nature.

For the first time, Mian (1997) has proposed a comprehensive framework to assess TI's performance in a systematic way (see Figure 3). In an effort to fill the gap in the current literature, this framework provides conceptual clarity by proposing an integrative model for assessing and managing the technology incubator. The model builds upon existing knowledge in three areas relevant to technology incubators: business incubation support in general; the role of higher education; government and private industry's involvement in technology development; and commonly accepted organisational effectiveness approaches. This proposed model for TI's performance assessment is based on the following three sets of variables:

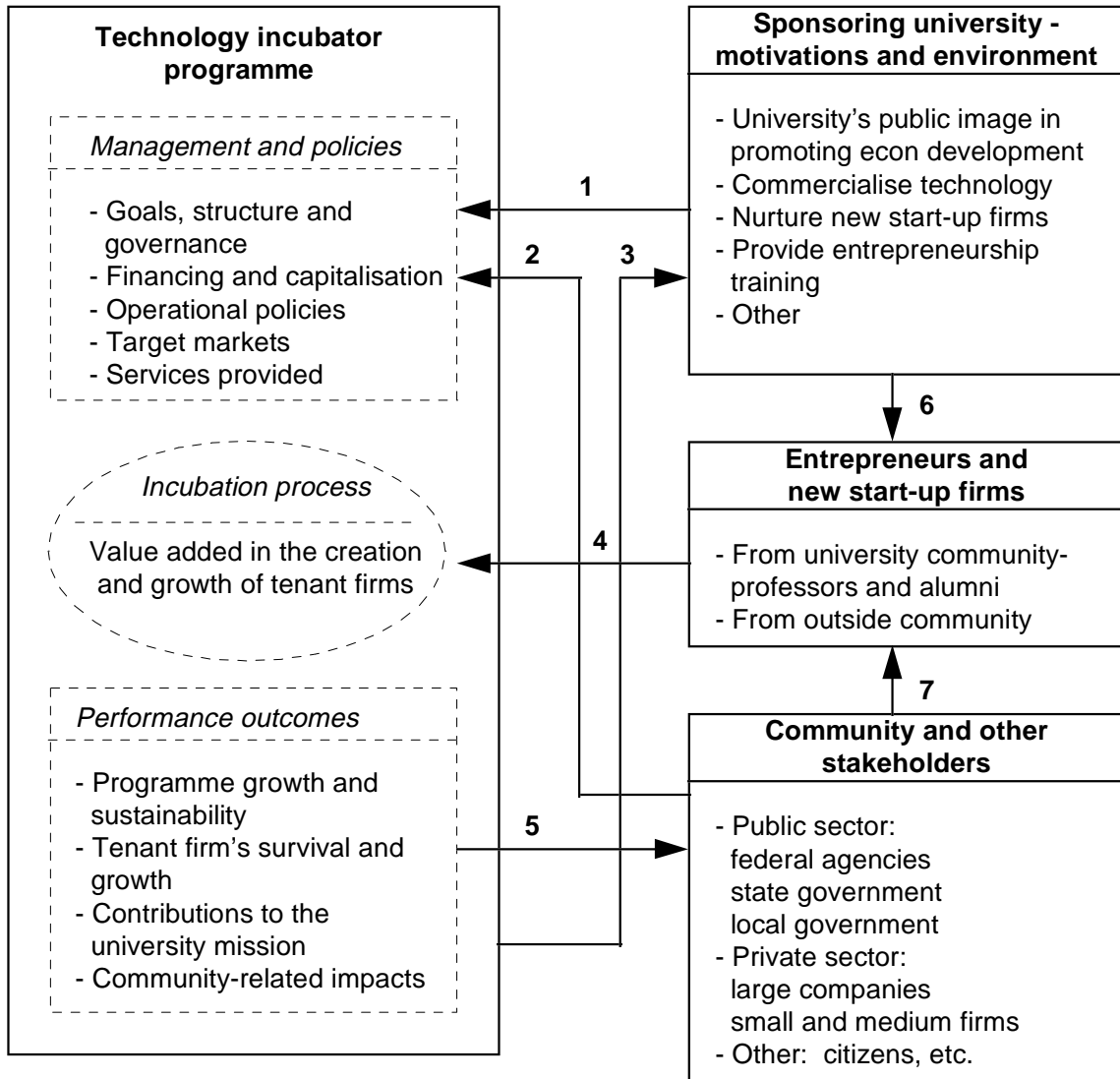
1. *Performance outcomes* – the TI programme's performance outcomes are assessed using four elements: (a) programme sustainability and growth; (b) tenant firms' survival and growth; (c) contribution to the sponsors' (in this case university) mission; (d) community-related impacts.
2. *Management policies and their effectiveness* – an assessment of the TI's management practices and operational policies in light of the programme objectives provides a review of the effective utilisation of resources resulting in the success of the TI programme. The key elements assessed include: (a) goals, organisational structure and governance; (b) financing and capitalisation; (c) operational policies; (d) target markets.
3. *Services and their value added* – a review of the actual provision and their perceived value added to the client firms in the form of: (a) the typical shared office services including rental space and other business assistance services; (b) the university-related inputs, such as student employees, faculty consultants, and the presence of a university's institutional support system around the TI.

These three sets of TI performance assessment variables are conceptualised in Figure 3 and are defined by the TI characteristics drawn from the relevant literature, and proposing a framework that captures most of the key TI performance dimensions (Mian, 1997). The framework provides a systematic and comprehensive approach to the TI performance assessment and is applicable to the TI programmes for which the appropriate data are available. Further, the use of this framework is illustrated through its application to four representative US cases taken from the author's national study of thirty "successful" US TI programmes in operation for at least seven years (Mian, 1991).

Characteristics of best practices in US incubators

An obvious implication of the ever-increasing importance of new technology-based ventures that the newly established technology incubation centres are aimed to spawn, is TIs are to become more effective with a better understanding of their entrepreneurial milieu. This is made possible through learning from successful models, specifically by studying their policies, management practices and the provision and use of services; and applying the experience gained in quality programme development. Significant work has already been accomplished through the respective professional associations to define useful approaches in the form of guidebooks, training programmes, case histories, etc. However, most of this material is directed toward general incubator programmes (available from NBIA). Only a handful of studies (most notably Mian, 1991; Mian, 1994; Culp, 1996; Tornatzky *et al.*, 1996) have focused on technology incubators that are national in scope, the results of which are outlined as follows.

Figure 3. Conceptual model for assessing and managing the performance of technology incubators



Note: Brief description of the loops:

1. University plays leading role in securing resources and provides on-going support.
2. Community and other stakeholders provide funds and volunteer in-kind support.
3. The TI performance is compared against expectations for necessary feedback.
4. Qualified entrepreneurs and new start-up firms move into the TI as tenants.
5. Graduate firms and trained entrepreneurs move within the local industrial base.
6. University serves as a source of new entrepreneurs to be developed in the TI.
7. Entrepreneurs from the outside community seek to locate in the TI as tenants.

Source: Excerpted and adapted from Mian, 1997.

As noted in Table 1, more recent studies conducted during the 1990s allow us to draw important conclusions in the form of US “best practices” in technology incubation. The TI’s salient policy and business-management practices are organised under four key functional domains: management, marketing, finance, and operations (including the provision of services).

Management policies and practices are covered under goals, organisational structure and governance. In terms of goals, TIs seek participation in the regional economic development activities by supporting the development of technology-based firms; providing a laboratory for learning entrepreneurial skills; promoting commercialisation of university technology; and, in some cases, recruiting future tenants for the associated science/research park. A study of the leading US-based TIs with respect to their past accomplishments shows that most of them have made considerable progress in meeting these goals.

Structurally, most of the TIs are non-profit organisations supported by multiple stakeholders drawn from the university, regional and/or state government entities, and private industry. In a number of cases, university foundations have played a prominent role in co-ordinating. Most of the facilities are inside or in close proximity to the university and are surrounded by complementary research and development institutes and related programmes, such as science/research parks.

In the area of governance, most of the US TIs have private sector-dominated boards which provide policy guidance. Typically, the incubator management team has an average staff of four, headed by an incubator manager/director.

Marketing practices of targeted technologies and the type and characteristics of entrepreneurs admitted were the key factors reviewed most often. In terms of targeted technologies, the new and emerging fields including software, informatics, electronics and biotechnology firms, represented the largest number of tenants; however, the relative marketing emphasis varied according to the area/university strengths and/or developmental policies. A majority of technology entrepreneurs were older and better educated than the average entrepreneur in the country. In spite of encouragement through incentives and various technology ferreting initiatives, the participation of university faculty as entrepreneurs has so far been limited.

Financing practices have been studied both from the incubator as well as their client firm perspectives. Whether public or private, most TI programmes have benefited from state grants in one form or another. Those associated with land-grant universities² have received operational subsidies as well. However, none of the TIs (including a large number of those established in the early 1980s) have attained financial self-reliance – a goal of some more successful private university-sponsored TIs. Therefore, TI management has had to spend more time and energy ensuring financial stability than on providing real value-added entrepreneurial advice to their tenants. The support for the provision of easily accessible seed and venture capital from multiple sources has been the hallmark of successful TIs. In the United States, private investors or “angels” have often been described as the best source for early seed capital for emerging technology companies. Most TI tenants have ample opportunity to pursue private venture capital funds. However, the venture capitalists make highly selective investments in young companies they perceive as having a high growth potential. Moreover, a host of state and federal grant programmes are available for which ample guidance and support is provided by the TIs to their technology-oriented tenants. As a result, all successful TIs generally have a high percentage of tenants supported through external funds.

2. Land-grant universities are American institutions of higher education initially given federal aid in 1870s, especially by the land grants, and are supported by government funds. These universities have traditionally emphasised outreach function as part of their mission.

Operational policies of the TIs essentially include: tenant selection policy, graduation policy, tenant performance review procedures, equity/royalty policy, intellectual property policy, and alumni-firm relationship policy. As a general rule, most of the successful TIs have developed elaborate policies and procedures in all of these areas except in intellectual property safeguards where some of the host universities have taken the lead. There are stringent selection/entry criteria applied across the board. Such criteria often include technical and business feasibility assessments combined with the entrepreneur's needs and possible fit with the TI resources. Further, these are often group level admittance decisions. The normal incubation period is three years and is applied with some flexibility, based on each entrepreneur's needs. Tenant performance is regularly monitored, and mentors from the private sector are encouraged to participate along with the incubator manager, to provide necessary feedback to the entrepreneur. Though not widely practised in the United States, equity/royalty holdings in client firms by the TIs is a growing practice levied in the form of "success fees", etc. for which new procedures are being developed. Well-run TI facilities not only stay in contact with their alumni firms (tenant firms which have already graduated) but also involve these firms with the current tenants to provide advice. However, only a few successful TIs have developed formal policies for alumni involvement.

In the provision of *services*, the most successful TIs have been responsive to the client needs and perceived usefulness of the gamut of services often provided through the TI mechanism. The technology-based client firms have consistently given higher ratings to the university-related services/benefits, such as university image; use of student employees and faculty consultants; and access to libraries and laboratories. Therefore, most of the successful TIs provide these services/benefits, depending upon their overall reputation and commitment to technology incubation. Research results on the value-added contribution and, hence, desirability of typical incubator services are mixed. However, most of these typical incubator services, including rent breaks, facilitating networking, business and legal consulting, are available in one form or another to most TI clients.

In summary, it may be noted that there are several areas of improvement suggested by the research dealing with the US "best practices" in technology incubation. The researchers often emphasized the need for greater methodological rigour in study designs and the need for more longitudinal work in future studies dealing with this challenging task of benchmarking the technology incubation practices.

Conclusions, lessons learned and policy implications

Two levels of conclusions are drawn and lessons learned for future policy purposes. These are: (a) *macro* TI industry level, and (b) *micro* TI unit level.

At macro level

1. Based on the past research, it is widely believed in the United States that TIs are providing a nurturing environment for spawning technology-based firms. In this context, the innovation model serves as a rationalising theory with a limited empirical support as well. Therefore, the technology incubator continues to provide a viable tool for US policy makers to promote technology diffusion in the local economy.

2. With the growth of incubators and parks reaching a plateau, TIs may need to position themselves as the gatekeeper and focal point for integration across various complementary technology development support mechanisms, especially those employed for technology transfer and commercialisation purposes. More specifically, TIs and research/science park projects provide a potential for synergy – with the TI acting as a tenant-capturing tool and a bridging mechanism for the park – and the parks providing for TI’s financial sustainability and operational flexibility. More and more US science/research parks are moving toward developing such integrated models. Similarly, TIs need to be better integrated into the ambient innovation environment, such as related training/internship ground, thus, enhancing their capability for drawing resources from the available support structure. Some more successful US TIs have made progress in this direction.

At micro level

1. To be successful, new TIs must arrange infrastructure development grants at the time of project inception. This will promote operational sustainability and free up management time to focus on service quality. Some newer US TIs have followed this strategy.
2. TIs should strive for broad-based support by encouraging stakeholders’ active involvement with tenant entrepreneurs. This will further improve the quality of support to the tenant firms. A good percentage of US TIs already enjoy broad-based support.
3. Unlike the prevailing practice of over-emphasizing the potential for future success in recruitment decisions, TIs need to base entry and service decisions on “needs” and “fit” rather than on success potential only. This will maximise benefits to the region over a longer term. There is a need to adjust the current entry policies in most of the US TIs to achieve this objective.
4. Develop and use comprehensive performance assessment tools which will promote professionalism in the industry. These efforts also need to be enhanced to develop more effective TIs.

REFERENCES

- ALLEN, D. and E. BAZAN (1990), "Value-Added Contribution of Pennsylvania's Business Incubators to Tenant Firms and Local Economies", report prepared for Pennsylvania Department of Commerce (Pennsylvania State University, Pennsylvania).
- CAMPBELL, C., D. BERGE, J. JANUS, and K. OLSEN (1988), *Change Agents in the New Economy: Report on Business Incubation and Economic Development*, University of Minnesota, Minneapolis, Minnesota).
- CULP, R. (1996), "A Test of Business Growth Through Analysis of a Technology Incubator Program", unpublished PhD dissertation (Georgia Institute of Technology, Atlanta, Georgia).
- MIAN, S. (1991), "An Assessment of University-Sponsored Business Incubators in Supporting the Development of New Technology-Based Firms", unpublished PhD dissertation (The George Washington University, Washington, DC).
- MIAN, S. (1994), "US University-Sponsored Technology Incubators: An Overview of Management, Policies, and Performance", *Technovation* 14, pp. 515-528.
- MIAN, S. (1996), "Assessing Value-Added Contributions of University Technology Business Incubators to Tenant Firms", *Research Policy* 25, pp. 325-335.
- MIAN, S. and W. PLOSILA (1997), "Mechanisms for Commercializing University Research: A study of Selected University Programs in the US", paper presented at the Sixth International Conference on Management of Technology, Goteborg, Sweden.
- MIAN, S. (1997), "Assessing and Managing the University Technology Business Incubator: An Integrative Framework", *Journal of Business Venturing* 12, 4, pp. 251-340.
- NATIONAL BUSINESS INCUBATION ASSOCIATION (NBIA) (1995), Athens, Ohio, United States.
- RICE, M. (1993), "Intervention Mechanisms Used to Influence the Critical Success of New Ventures: An Exploratory Study", unpublished PhD dissertation (Rensselaer Polytechnic Institute, Troy, New York).
- SMILOR, R. and M. GILL (1986), *The New Business Incubator: Linking Talent, Technology and Know-How*, Lexington Books, Lexington.
- TORNATZKY, L., Y. BATTS, N. McCREA, M. LEWIS and L. QUITTMAN (1996), *The Art and Craft of Technology Business Incubation*, Southern Technology Council, Durham, North Carolina and NBIA, Athens, Ohio.

GEORGIA'S ADVANCED TECHNOLOGY DEVELOPMENT CENTER: AN ASSESSMENT

Rhonda Culp, University of Southern Mississippi and

*Philip Shapira, Georgia Institute of Technology,
United States*

Introduction

Over the last two to three decades, state and local governments in the United States have focused increased levels of policy attention and resources to the promotion of economic development and employment within their jurisdictions. During this period, the strategies adopted to foster development have changed and evolved. Initially, economic development efforts (particularly in the US South) sought out-of-area branch plants to relocate using such lures as low-cost labour, cheap land, easy road or rail access, and tax incentives for new investments in plant and equipment. These efforts were subsequently extended by more sophisticated initiatives to foster indigenous start-up companies and technology-based industries and services. As part of this extended approach to economic development, technology business incubators have been established in numerous locations in the United States, with about 100 facilities in operation by the mid-1990s (Culp, 1996).

These technology incubators have similarities with general business incubator facilities (of which there are several hundred) in their focus on creating new start-up businesses and jobs, providing shared facilities, and offering management support. But there are important differences, with technology business incubators focusing on companies with more advanced (and often untried) technologies that can be commercialised into marketable products and services. These emerging firms may have needs for research facilities and equipment as well as specialised expertise in management, licensing, marketing, and venture financing. In the United States, technology incubators are often associated with universities, where research and technical facilities are available. Indeed, universities may establish technology incubators as ways of commercialising faculty research.

This paper examines the experience of one of the first technology incubators in the United States – the Advanced Technology Development Centre (ATDC), which was established by the Georgia Institute of Technology in 1980. We consider the history and development of the ATDC and the services offered. This is followed by an assessment of the ATDC's performance, drawing on case studies, interviews, and surveys of ATDC firms.

History and development of the ATDC

The concept for a technology business development centre in Georgia began to take shape in the late 1970s. It was during this decade that the still-emerging stories of successful high-technology based regional growth in "Silicon Valley" in Northern California and "Route 128" in Massachusetts began to be more widely known in other parts of the United States (Castells and Hall, 1994). Georgia – as elsewhere in the South – had experienced an influx of mass-production branch plant industrial facilities since the 1950s, attracted by the region's low labour costs and burgeoning markets. But concerns were growing about the vulnerability of this industrial base to increasing offshore competition. At the same time, Georgia was not perceived as a major location for high technology enterprises, despite the presence of

large research universities and federal installations. Paralleling similar trends throughout the South, where state-aided facilities and programmes to promote high technology firms were rapidly being established, leading officials and influential groups in Georgia began to explore how the state could foster high technology (McMath, 1991). To strengthen Georgia Tech's capabilities to promote high technology businesses within the state, a "Technology Business Development Project" was organised by a group of prominent Georgia Tech alumni, known as the Committee of Twenty. In 1979, this group advocated a new "Technology Business Development Centre" as the focal point of a strategy to foster more high technology firms in the state (Committee of Twenty, 1979).

The idea of a technology development centre was further endorsed in a subsequent study of Georgia's Science, Engineering and Technology Programs, commissioned by the Office of the Governor – and performed by the Georgia Tech Engineering Experiment Station. This study recommended that Georgia Tech should develop, with state support, an "advanced technology development service". This would aid technology business entrepreneurs, help in the recruitment of domestic and foreign advanced technology companies, assist existing industries to expand into high-technology product lines, promote industrial development of alternative energy sources, and provide education in high-technology venture development and management (Georgia Tech Engineering Experiment Station, 1980).

In 1980, with legislative and financial support from the Governor and General Assembly, the Advanced Technology Development Centre (ATDC) was established at Georgia Tech (see Table 1). Four professional staff members were employed to focus on four major programmes: entrepreneurial development, industrial recruitment, education, and venture capital. Space in a former high school on the campus was renovated and, in 1981, the ATDC admitted its first incubator company. In 1984, a new incubator facility (7 710 square metres) was opened at Georgia Tech.

In addition to this Atlanta-based facility, efforts were also made to extend technology incubation services to other parts of the state. With additional state support, the ATDC opened technology business incubators in the eastern city of Augusta, Georgia, in 1987, and Warner Robbins, in the middle part of the state, in 1989. The Augusta centre aimed to promote new start-ups in health-science technologies, drawing on the nearby Medical College of Georgia. However, the clinical nature of research at this college led to few opportunities for start-up companies with marketable health-science products or services. The Augusta facility was subsequently closed in the early 1990s. At Warner Robbins, the ATDC sought to promote aerospace and defence-related spin-offs. Located in a greenfield corporate technology park, progress has been slow, but there are several companies in the Warner Robbins ATDC or located in new adjacent facilities.

In 1996, the ATDC opened a new branch facility, occupying a floor of the new Georgia Centre for Advanced Telecommunications Technologies (GCATT) building. This building, close to the main Georgia Tech campus in Atlanta, was built with state and private funds to promote research, business, and exchange in emerging telecommunications fields. In the GCATT building, ATDC seeks to promote the start-up of new ventures in multimedia, software, and associated communications technologies. A further ATDC branch is scheduled to open in fiscal year 1997-1998 in Thomasville, in the southern part of the state, as part of a new wood products technologies facility.

Table 1. Chronological development of the ATDC programme

Year	Description
1996	ATDC is named Incubator of the Year by the National Business Incubation Association, wins the Tibbitts Award, and graduates two companies.
1996	ATDC at Warner Robins celebrates its 5th Anniversary. ATDC opens its third branch office - the Georgia Centre for Advanced Telecommunications Technology in Atlanta.
1995	ATDC graduates five companies, one of which is the second graduate company of the ATDC/Warner Robins branch.
1994	ATDC graduates two companies, one of which is the first graduate of the ATDC Warner Robins branch.
1994	ATDC recruits two major industry leaders - The Army Environmental Policy Institute and Integrated Device Technology, Inc.
1993	ATDC becomes a part of the newly formed Georgia Tech Economic Development Institute under New Enterprise Development.
1993	ATDC graduates two companies.
1992	ATDC/Augusta centre is closed. Area Chamber of Commerce sponsors South-East Technology Centre.
1992	ATDC establishes the Faculty Research Commercialisation Program to provide initial support for research faculty to convert research technology at the laboratory stage into a prototype of a commercially viable product.
1991	ATDC graduates two companies.
1991	The Middle Georgia Technology Development Centre at Warner Robins is established by ATDC.
1990	ATDC/Augusta broadens focus to include energy and other technologies.
1989	The ATDC graduates five companies.
1989	The ATDC/Warner Robins opens to encourage the development of new defence and aerospace technology firms.
1988	ATDC graduates four companies.
1987	ATDC graduates four companies.
1987	The ATDC/Augusta is formed to focus on the health-science industry.
1987	ATDC graduates first five companies - Digital Transmission Systems, ERDAS, Millimetre Wave Technologies, Sales Technologies, and Theragenics.
1984	Dedication ceremony of ATDC's new 83 000 sq. ft. facility.
1981	ATDC admits first company to the programme. ATDC renovates a portion of the O'Keefe High School building to use as incubator space.
1980	ATDC is established at Georgia Tech. It is staffed with professionals concentrating on four major programme areas: Entrepreneurial Development, Industrial Recruitment, Education, and Venture Capital.
1979	Governor's office commissions a study of the state's Science, Engineering and Technology Programs.

Source: Adapted from information prepared by the Advanced Technology Development Centre, Atlanta, Georgia.

ATDC services

The ATDC operates three main programmes: the Entrepreneurial Services Program; the Faculty Research Commercialisation Program; and the Corporate R&D Support Program. Each of these programmes is summarised below.

The ATDC Entrepreneurial Services Program. The ATDC's central function is to provide "commercialisation assistance to move technology toward the marketplace more rapidly" (ATDC, 1994). The Entrepreneurial Services Program is the ATDC's primary mechanism for performing this function and the majority of funding and staff resources are allocated to it. Under this programme, ATDC offers services to support the growth and development of "early-stage" technology companies. These are companies that are typically less than one year old beyond the conceptual stage of product development. Applications are generated through referrals from other economic development agencies in the state, responses to direct requests for information, and through marketing 15 to 20 application information packets per month have been sent out in response to requests. Companies are admitted into the ATDC incubator based on a staff review of the applicant's growth potential, product marketability, quality of the management team, and the application of new technologies in products, processes, or services (ATDC, 1994). The applicant's technology has to be of a proprietary nature and protected by copyright or patent and the company overall should have a research and development emphasis.

Before entrepreneurs can become members of ATDC, a development plan and strategy and a completed ATDC application form must be presented to and approved by a review committee comprised of ATDC staff members. After this first review, some applicants may be requested to provide additional information or provide a more comprehensive development plan. Should an applicant pass successfully through the first review, a second review is conducted in which the applicant's management team presents a complete development plan before a staff committee. Should an applicant be approved in the second review, a contract is negotiated and the applicant becomes a member. Typically, about 200 application packages are given out each year; approximately one-quarter are returned as formal applications. Of the formal applications, the acceptance rate has been around 20 per cent during the 1988 to 1994 period, or in other words, about one in five applications are approved for ATDC membership.

Entrepreneurs who are members of the ATDC incubator facilities have access to the following entrepreneurial, administrative and facilities services: assistance with business planning, sales and marketing strategies; development of financial sources; intellectual property guidance (for example, patents, copyrights, licenses); staffing guidance; market research; corporate communications assistance; identification of service providers; shared fax, copy, conference rooms, audio and visual equipment, word processing assistance; access to the Georgia Institute of Technology's research facilities and services, including the library, chemistry stockroom, computer centre, student athletic complex, and machine shop; access to faculty and students as consultants, advisors, or employees; and attractive rates on office and laboratory space. Another service is the Corporate Partnering Program. This programme, implemented in 1988, identifies potential corporate partners by matching the resources of large corporations with the needs of the ATDC member companies. These strategic partnerships aim to accelerate the growth of ATDC companies while at the same time benefiting the corporate partners by allowing access to new advanced technologies.

After admission, reviews are conducted by ATDC staff members on an annual basis. Each company is assigned an ATDC Business Management Consultant. This staff member is responsible for working with the companies to address problems which inhibit growth and development. The type of assistance provided depends on the needs of each company; for example, one company may need help with

researching a patent, another may need help gathering market data. Within a three year period after acceptance into the programme, companies are expected to graduate from the programme. These firms typically relocate to other facilities in the area. Graduation is achieved when member firms achieve one or more of the following goals:

- ◇ US\$ 1 million or more annual sales;
- ◇ more than ten employees;
- ◇ more than 5 000 square feet of space needed;
- ◇ acquisition by a larger company; and consistent profitability.

Some companies do not graduate within the three year period due to the long-term nature of their product development process. This includes companies developing biotechnology products which may be undergoing lengthy government testing and approval processes.

The Faculty Research Commercialisation Program. Established in 1991, this programme offers support to faculty members for the conversion of laboratory stage technology into commercially viable products. The programme is available to faculty members from academic institutions that are members of the Georgia Research Alliance – a partnership between state government, six major research universities in Georgia, and private industry (Georgia Research Alliance, 1997). The programme provides financial support, in the form of an ATDC sponsored project. Basic research projects are not eligible for funding: only applied research projects which focus on products or technologies with commercial market potential are considered (ATDC, 1996). Project awards, which range from US\$ 30 000 to US\$ 100 000 per project, can be used for equipment, contract consulting, release time, materials and related expenses. The funds are exempt from university administrative overhead charges. Matching funds for the projects are usually developed with the co-operation of public and private sources. The programme also provides business development support. This includes assistance with project management, marketing, business planning, and licensing. Proposals for support are solicited in the spring of each year and are screened by ATDC staff and external reviewers with expertise in business, venture finance, and the proposed technological area. Review criteria include: scientific and technical innovativeness; probability of market deployment; quality of research personnel; potential for job creation and revenue; availability of corporate matching funds; and likely impact of programme participation. Between 1991 and 1994, the programme funded ten projects. More recently, between five and seven projects have been funded annually. Total funding is US\$ 350 000 a year.

The Corporate R&D Support Program. In addition to supporting early-stage technology companies, the ATDC provides “landing party” assistance to corporate research and development divisions or special product, service or marketing units of established companies that seek access to the faculty and facilities of the Georgia Tech. A landing party usually occupies office and laboratory space in the ATDC incubator facility in Atlanta. There is no formal process for selecting landing party members. Potential corporate members are usually referred to the ATDC by state and other economic development organisations and are accepted as part of ATDC’s mission of helping technology-based corporations that seek to locate or expand in Georgia. The programme offers direct contact with Georgia Tech researchers, access to laboratory equipment, and access to library resources. Through to 1994, 25 companies had participated as landing party members. Current landing parties at ATDC include three corporations engaged in either electronic or multimedia technologies and the US Army’s Environmental Policy Institute.

Organisational structure

The organisational structure of the ATDC has changed through the years. In 1982, the director of ATDC reported to the Vice President for Research at the Georgia Institute of Technology, who then reported directly to the President. By 1994, the ATDC organisation had changed significantly, becoming part of the Georgia Tech Economic Development Institute.

The ATDC now reports directly to the Economic Development Institute director, who in turn reports to the President of the Georgia Institute of Technology. The budget for ATDC has grown throughout the years. In its first year of operation, fiscal year 1981, the budget was US\$ 185 000. The bulk of the ATDC's operating budget has been funded through appropriations from the state legislature. Current funding is about US\$ 1.5 million a year. In 1988, the ATDC first generated enough revenues from its activities to cover the debt service of the facility at the Georgia Tech campus.

Overall measures of performance

The following sections discuss the performance of ATDC, focusing particularly on the entrepreneurial services programme.

More than 100 companies have participated as formal members of the ATDC since 1986. Many other companies have sought information and assistance from ATDC staff without becoming members. Currently, in 1997, there are 49 member companies, comprised of 30 companies at the main ATDC facility, four companies at GCATT, six companies at Warner Robbins, and nine companies who are members "without residence" – mainly firms ATDC is working with while awaiting incubator space. Occupancy rates of the facility have generally been very high, averaging about 95 per cent. The number of members remained fairly constant between 1986 and 1995 (averaging about 35 firms per year), with recent increases in membership attributable to the new GCATT facilities. By 1997, 29 firms had graduated from the ATDC programme. Of these, 22 are still in business, one was acquired and is no longer tracked, two others are no longer tracked for other reasons, and two are no longer in business.

ATDC records were identified to track what happened to firms during the period 1986 through 1995. Over this period, 111 firms had been admitted to ATDC. Of these, 32 were current tenants, 26 had gone out of business before graduating, and two firms were acquired while in the ATDC. Some 24 firms had left the ATDC or dropped out of the programme, usually by mutual consent. There were 27 graduate firms. On this data, excluding the current tenants and counting the acquired firms as successes, the "success rate" was about 40 per cent. This probably underestimates the ATDC success rate, in that a number of the firms that left the ATDC continue to maintain good relationships with the programme.

Another way to calculate a survival rate for ATDC firms is to look at a set of firms at one point in time and then track the status of the same firms five years later. In December 1989, there were 24 member firms and 19 graduate firms according to the ATDC's 1989 Annual Report. Five years later, in December of 1994, 11 of the member firms, or 46 per cent, had gone out of business. Four of the firms graduated, one dropped out, one was acquired, and four were still members. The 19 graduate firms fared much better. Only one firm had failed between 1989 and 1994. Five firms were acquired by other firms several years after graduation. Acquired firms can be considered successes. This data suggests that the riskiest part of the incubation process is the period in the incubator itself. Once graduated, ATDC firms appear to be relatively successful.

In 1996, the ATDC portfolio had grown to 49 member firms and 29 graduate firms (Table 2). Total annual revenues for these 78 companies were US\$ 266 million, with identified employment exceeding 2 100 jobs. The average graduate firm had revenues of US\$ 8.7 million and 66 employees. As expected, the mean for members companies was much smaller – five employees on average, with typical revenues of about US\$ 0.3 million. Employment and company revenues associated with ATDC have doubled since 1990, but in terms of revenues per company or revenues per employee, ATDC graduates have reported rather constant (as opposed to growing) figures since 1990 (i.e. the growth has come from more graduate companies rather than increased average revenues per firm over time). But this may mask the fact that growth among older and larger ATDC graduates is averaged out by a growing number of new, small graduate firms.

Table 2. Summary data on ATDC participating companies

Year	1986	1988	1990	1992	1994	1996
Companies participating in the ATDC programme						
Graduates	-	14	18	18	22	29
Member firms	34	28	25	38	36	49
Total	34	42	43	56	58	78
Identified revenues of participating companies (US\$ million)¹						
Graduates	-	69.2	142.9	186.0	200.0	252.4
Member firms	28	10.4	5.2	9.8	14.0	13.4
Total	28	79.6	148.1	195.8	214.0	265.8
Identified employment in participating companies¹						
Graduates	-	633	1 025	1 294	1 352	1 910
Member firms	327	234	81	157	180	227
Total	327	867	1 106	1 451	1 532	2 137
Average identified employment in participating companies¹						
Graduates		45	57	72	61	66
Member firms	10	8	3	4	5	5
Total	10	21	26	26	26	27
Identified revenues per participating company (US\$ million)¹						
Graduates		4.9	7.9	10.3	9.1	8.7
Member firms	0.8	0.4	0.2	0.3	0.4	0.3
Total	0.8	1.9	3.4	3.5	3.7	3.4
Identified revenues per employee (US\$ thousands)¹						
Graduates		109.3	139.4	143.7	147.9	132.1
Member firms	85.6	44.4	64.2	62.4	77.8	59.0
Total	85.6	91.8	133.9	134.9	139.7	124.4

Note:

1. Several ATDC companies have changed their corporate structure through mergers or acquisitions, making it impossible to continue to track actual revenues and employment data of some ATDC graduates. The data reported here thus *under-estimate* the revenues and employment identified with graduated ATDC companies.

Source: ATDC, 1997.

Additionally, there are significant variations around the means. Some ATDC graduates have been highly successful, for example Mindspring Enterprises, Inc., which has emerged as a major Internet access provider in the US South. This firm now has over 170 employees. Indeed, Mindspring is one of four ATDC graduate companies that have completed initial public offerings, with more than US\$ 46 million raised in subscribed funds (in three cases, ATDC companies are now traded on NASDAQ).

On the face of it, the ATDC appears to represent “good value” from an economic development perspective. For a total state expenditure of under US\$ 20 million since 1981, there are now more than 2 100 jobs in companies associated with the programme. Recently, some US states have offered incentives of several hundred million dollars to attract individual companies with similar total employment. To fully verify and qualify the net economic development of ATDC, studies are needed which compare the performance of ATDC companies with comparable non-member firms.

Customer case studies

Although this paper does not report on a full control group study (but see Culp, 1996), it does present evidence from interviews and surveys conducted with ATDC members and graduates.

Interviews were conducted in 1996 with principals of 19 ATDC members to assess the impact that membership has made on each firm (Culp, 1996). This research approach was qualitative in nature, focusing on the motivations and characteristics of members as well as their involvement with ATDC. Overall, the ATDC membership experience was reported to be positive by a majority of respondents. While the “typical” incubator factors such as business development services were not found to be extremely important to a majority of member firms, there were other benefits of ATDC membership which impacted the firms. The entrepreneurial environment, the facilities (both on-site and at the Georgia Institute of Technology), and the intangible factors such as heightened credibility all emerged as important factors of influence. In some cases, access to student labour and university equipment was valued, although other firms reported difficulties in hiring students or using facilities due to high overhead rates. Table 3 summarises the key ATDC activities and interventions and an aggregate rating of impact for each case.

Why did the principals of the 19 ATDC companies want to become ATDC members? A frequently cited reason was the desire to obtain business development assistance, not surprising since that is usually what is sought from a business incubator. However, once in the ATDC, some members reported that they had not used available ATDC services or that the assistance received had not aided their business development. In other cases, there were principals who reported that ATDC’s assistance had positively helped them.

Another frequently cited motivation for seeking ATDC membership was to be in close proximity to the Georgia Institute of Technology. Since some of the principals were faculty members at the university, a primary benefit of ATDC membership was the close proximity. For four of the companies, the ATDC membership offered a chance to pursue technology licensing or transfer from the university. Two of the companies pursued technology transfer but were not able to do so due to impediments (perceived by the principals as emanating from the university’s licensing organisations). The third company succeeded in securing a technology licensing agreement but reported much difficulty in the process. The fourth company was able to secure a technology transfer agreement with no difficulty. Principals in the third and fourth companies were faculty members – this probably helped in securing a technology transfer agreement.

Table 3. Case Studies: summary of impacts of ATDC on member firms

Company	Sector	Years in ATDC	Key ATDC interventions*	Total impact**
A	Biomedical	7	1,3,4,5	3
B	Electronics	4	5,6	2
C	Software	1	5,6	3
D	Hardware/software	3	5	1
E	Hardware/software	4	1	2
F	Environmental	3	6	1
G	Materials	1	1,2	2
H	Information services	2	5	2
I	Software	3	5	1
J	Software	0.5	1,4,5	3
K	Software	1	1,3,5	3
L	Environmental	1	1,3,5	2
M	Biomedical	6	1	1
N	Information services	2	6	1
O	Biomedical	2	2,5,6	2
P	Electronics	4	3,5	3
Q	Electronics	3	2,6	3
R	Information services	1	2,3,5	2
S	Materials	7	5,6	3

Notes:

* Interventions are of the following types:

- 1 = Business development assistance and special events (n=7)
- 2 = Assistance in technology transfer (n=4)
- 3 = Lenient rental terms (n=5)
- 4 = Assistance in identifying financing (n=2)
- 5 = Heightened credibility factor (n=13)
- 6 = Assistance in accessing facilities at the Georgia Institute of Technology (n=7)

** Total impact was rated as:

- 3 = Definite positive impact (n=10)
- 2 = Somewhat positive impact (n=4)
- 1 = Neutral impact (n=5)
- 0 = Negative impact (n=0)

Source: Culp, 1996.

For many companies, ATDC membership was said to result in heightened credibility. While hard to quantify, there was a “halo” effect of being closely associated with the Georgia Institute of Technology. Most companies reported that this was the primary benefit of ATDC membership. This benefit was viewed as more important than any other benefit of ATDC membership, including business development assistance. Indeed, in cases where principals were most strongly motivated to apply for ATDC membership by their desire to be associated with Georgia Tech, these principals said their expectations regarding membership had been fulfilled. In other words, these principals were not necessarily seeking typical business incubator services. Among those who sought specific services, there were some disappointments.

All except a few of the principals reported that obtaining adequate financial resources was the major impediment to development of their companies. For those principals seeking business development services from the ATDC, it was hoped that financial assistance would be delivered. However, the level of ATDC financial services has been limited to serving as a broker or information intermediary for member companies and potential financiers. While these services have been beneficial for many of the members, it was still not enough to provide a tangible, significant impact on the business development for all firms. At the same time, the association with Georgia Tech and ATDC's links with venture capital firms at least opened some doors for firms that could otherwise have been hard to get into.

In summary, 10 of the 19 member companies reported a *definite positive impact* on their business development resulting from ATDC membership. All of these companies cited the heightened credibility factor as important and some cited the business development assistance as important. Most of these ten companies had principals who were involved and participated in the ATDC programme; some of the principals were associated with the Georgia Institute of Technology, either as faculty or staff members. Four companies reported *some positive impact*, primarily reflected in the heightened credibility factor. For these companies, there was some positive impact on development, for example through business assistance services, but there were also some problems (for example, some of the principals had problems with the physical services such as high prices or lack of laboratory space). Five firms said they had not experienced any impact on business development as a result of ATDC membership. In other words, they had a neutral experience. While none of the companies considered that they had been negatively impacted, these companies reported no gain or perceivable positive benefit from membership. It was interesting to note that in some cases, the principals of these companies were not at all involved with ATDC staff or programmes. In fact, it was stated by a few of the principals that they were not seeking any of the typical business development services but rather the association with the Georgia Institute of Technology. In other words, with the exception of one of these five companies, it was not felt that ATDC membership had been a disadvantage or necessarily a disappointment, rather, the principals were not seeking anything other than a landlord-tenant relationship and/or to be close to the university.

A follow-up mail survey with current members and graduate firms confirmed these findings. Although response was low (13 in total), the factor of heightened credibility of the firm was by far the most frequently cited impact of ATDC membership. Reduced equipment costs and assistance with marketing, management, and time were noted as impacts, but less frequently. Access to qualified employees or shortening of time to market (among the common benefits ascribed to incubators) were barely noted (Table 4).

Conclusions

Overall, the ATDC has established a track record of promoting new high technology start-up companies, some of which have graduated with significant success. ATDC is recognised as one of the most well-established technology incubators, and has won national awards. The cost over nearly two decades has been relatively modest. In a state which has experienced relatively fast employment and population growth, but which has lacked the reputation as a high technology location, many deem the benefits of ATDC, including "perceptual" benefits, to be worth the cost. Most success has been achieved in metropolitan Atlanta, which is the state's most favoured location and which has the advantages of Georgia Tech's research and technological resources. Outside of Atlanta, ATDC has had some success, although results are still limited.

Table 4. Interview surveys with ATDC member firms and graduates

Impacts of participation in ATDC	Current members	Graduate firms	All	Per cent
Heightened credibility of your firm	6	4	10	77%
Cost reductions by reduced equipment costs	2	2	4	31%
Impact on new market position through marketing assistance	3	1	4	31%
Improvement of overall management of firm	2	1	3	23%
Time savings in responding to government regulations	2	1	3	23%
Enhanced access to technological resources	0	2	2	15%
Improvement of financial management of firm	1	1	2	15%
Identification and access to qualified employees	0	1	1	8%
Impact on existing market position through marketing assistance	1	0	1	8%
Impact on new or existing market position by product development assistance	1	0	1	8%
Shortened time to market of primary product	0	1	1	8%
Number of respondents	8	5	13	100%

Source: Culp, 1996.

Would the high technology firms associated with ATDC in Atlanta – and which now employ a couple of thousand workers – have been started without ATDC’s help? It is hard to provide a definitive answer on this point: metropolitan Atlanta had more than 100 000 jobs in technology-related companies in 1996. But most of these high-tech jobs are in large companies, particularly in telecommunications. Despite the technological presence of Georgia Tech (and other research universities), Atlanta has not, until recently, had the infrastructure of finance, management expertise, and entrepreneurial support to create multiple new small start-ups in the fashion of the much admired (but hard to replicate) models of Silicon Valley and Route 128. ATDC has had a role in pioneering improvements in this infrastructure and in beginning to leverage Georgia Tech resources and credibility to aid small start-ups. There is now a sense, particularly in technologies involving media, communications and bio-sciences, that Atlanta is a viable location to start a new technology venture. Here, state and university policy makers hope that ATDC’s experience and its new presence in GCATT – and possibly in other similar facilities in media-related and research complexes in the city and state – could help to foster a round of start-up firms in these emerging technological areas.

From the view of individual firms, ATDC membership generally resulted in a positive impact (in varying degrees) for the majority of member companies interviewed. However, the impacts did not occur primarily by provision of business development services alone. Rather, the primary positive impact of ATDC membership on member companies was the heightened credibility factor generated by an association with a major technological university, sometimes but not always in conjunction with business development services, lenient rental terms, and access to facilities, expertise and students.

REFERENCES

- ADVANCED TECHNOLOGY DEVELOPMENT CENTER (ATDC) (1994), *Annual Report, Fiscal Year 1993-94*, Advanced Technology Development Centre, Atlanta, Georgia.
- ATDC (1996), *Faculty Research Commercialisation Program: FY 1998 Request for Proposals*, Advanced Technology Development Centre, Atlanta, Georgia (available at: http://www.atdc.gatech.edu/ATDC/fcrp_download.html).
- ATDC (1997), *Report Card of Affiliated Companies*.
- CASTLES, M. and P. HALL (1994), *Technopoles of the world: The making of 21st century industrial complexes*, Routledge, London and New York.
- COMMITTEE OF TWENTY (1979), *Status Report on the Technology Business Development Project*, Georgia Institute of Technology, Atlanta, Georgia, 20 November.
- CULP, R. (1996), *A Test of Business Growth Through Analysis of a Technology Business Incubator*, Ph.D. Dissertation, Georgia Institute of Technology, Atlanta, Georgia.
- GEORGIA RESEARCH ALLIANCE (1997), *Georgia Research Alliance Web Site* (<http://www.gra.org>).
- GEORGIA TECH ENGINEERING EXPERIMENT STATION (1980), *State Science, Engineering, and Technology Program*, Atlanta, Georgia: Georgia Institute of Technology, February.
- MCMATH, R.C. (1991), Variations on a theme by Henry Grady: "Technology, modernisation, and social change", in Joe P. Dunn and Howard L. Preston, *The Future South: A Historical Perspective for the Twenty-first Century*, University of Illinois Press, Urbana and Chicago.

TECHNOLOGY CENTRES AND BUSINESS INCUBATORS IN GERMANY

*Bernd Gross, Association of German Technology and Business Incubation Centres,
Germany*

Introduction

Innovation is a motor for social development. Healthy economic development - the key to social prosperity - cannot take place without constant renewal of the technological base. This is a challenge faced by all developed industrialised countries, which are struggling with fundamental changes in their industry structures and with growing unemployment.

Managing innovation as a driving economic factor means ever more rapid translation of the latest research findings into marketable technological products and innovative services. And this aim is closely intertwined with provision of support for small and medium-sized innovative companies.

On this basis, different types of centres for supporting innovation (innovation centres) have been established in many countries, with names such as technology centres, research and technology parks, “technopolises”, business innovation centres and science parks. A central focus of such support is on assisting new technology-oriented companies; consequently, a central role is played by “technology incubators”.

Three important trends and requirements are particularly apparent in the development and activities of technology centres and business incubators:

- ◇ the growing role of small and medium-sized companies, and the need to support start-up firms and promote their growth;
- ◇ the need to promote innovation as one of the most important factors for maintaining economic competitiveness in a global economy;
- ◇ the transition from a society based on traditional industries to one based on services and information.

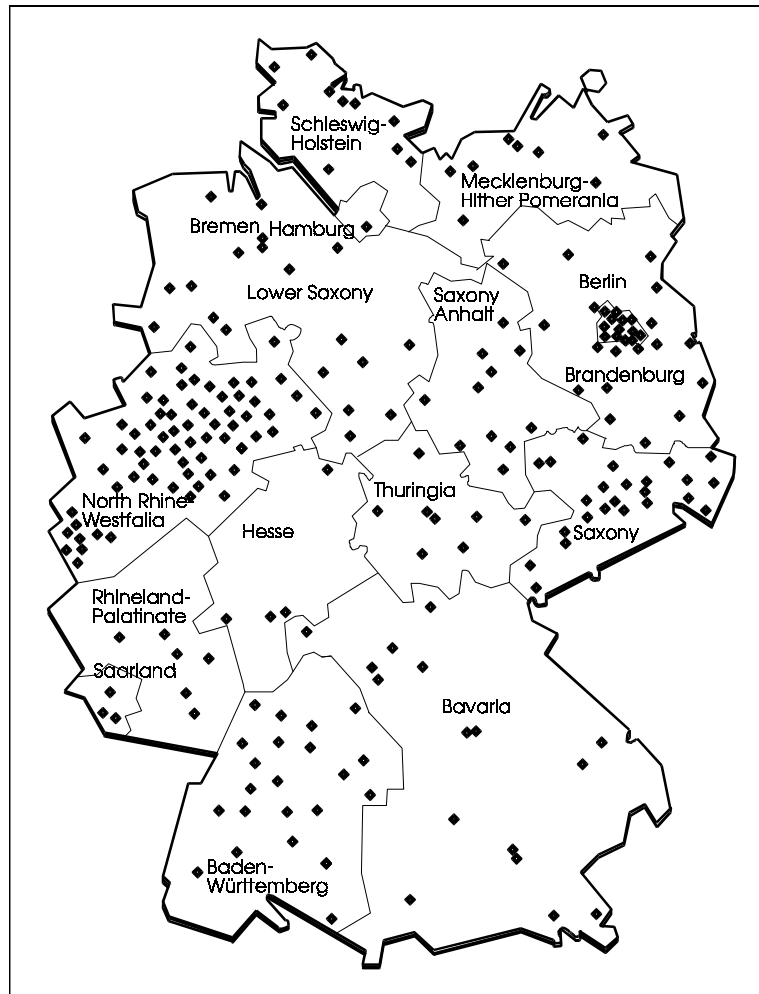
In this light, technology and business incubation centres are complex innovation centres that - each in its own regional environment - support creation of start-up firms and technology transfer and provide the relevant business services. They provide impetus to the economy’s structural transformations and promising new development sites.

The network of technology centres and business incubators in Germany

Germany has high standards of education and research, backed by a powerful network of institutes of higher education and research centres. In 1983, construction of the first technology incubator began with

the aim of enhancing transfer of research findings to industry, and with the help of relevant experience in the United States and some European countries. An extensive network of technology and business incubation centres - one of the foundations of an innovation-oriented economy - has been growing since then (Figure 1).

Figure 1. Technology centres and incubators in Germany 1997



Source: Association of German Technology and Business Incubation Centres (ADT).

The network of technology centres and business incubators has grown continuously and powerfully, supported primarily by regional alliances for innovation, and with the help of consensus between communities, institutes of higher education and research institutes, chambers of industry and commerce and other economic development institutions, savings institutions, banks, etc.

This basic network for innovation now comprises over 200 operational centres. Twenty-two new business incubation centres were opened in 1996 alone.

Overall, the centres represent 5 000 technology-based enterprises, research institutes and innovation-supporting services companies, with a total of 42 000 employees. These organisations are leaders in the innovation competition and are seeds for the industries of the next century. In many cases,

they are already proving to be showcases for German industry - centres that are helping to protect the innovation energy of large industrial companies.

Technology and business incubation centres are effective instruments for regional economic development. Understandably, the various federal *Länder* differ in this regard. Berlin and North Rhine-Westphalia were confronted early on with structural change in their industrial sectors; they began promoting such technology networks ten years ago. North Rhine-Westphalia now has a state-wide network of over 60 centres.

With the aim of supporting smaller companies and start-up firms, Berlin is planning to expand its network from 10 to about 30-40 business incubation centres. Expansion of regional networks of business incubation centres, and of technology parks (which also concentrate capacities), is continuing.

Table 1 shows how distribution of business incubation centres differs by region. In some federal *Länder*, especially North Rhine-Westphalia, the distribution has become so dense that it could be termed as "saturation". In a number of federal *Länder*, such as Bavaria and Hesse, expansion of business incubation centre networks began later but continues apace. Overall, the number of centres in Germany can be expected to increase further. By the early part of the 21st century, a nation-wide network of nearly 300 technology and business incubation centres will be in place to support innovative start-up firms.

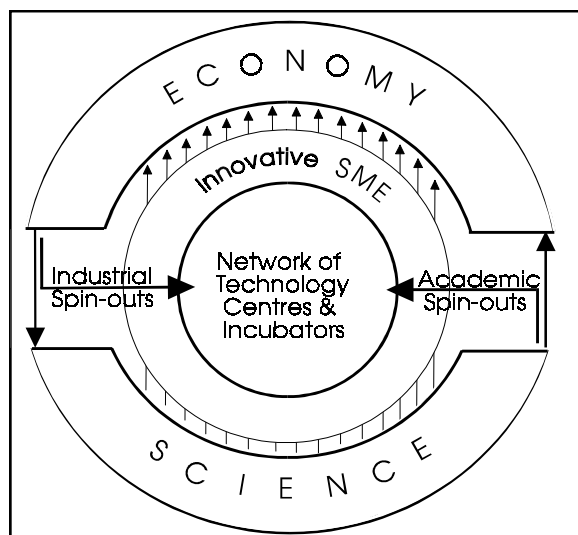
Table 1. **Distribution of business incubation centres by region**

Region/Länder 1996	Number of incubators	Area in 10 000 km ²		Population in millions		Employment in millions	
	A	B	A/B	C	A/C	D	A/D
Baden-Württemberg	19	3.50	5.43	9.8	1.4	4.7	4.04
Bavaria	11	7.00	1.57	11.4	0.96	5.7	1.93
Berlin	12	0.09	133.33	3.4	3.53	1.5	8.00
Brandenburg	13	2.90	4.48	2.5	5.20	1.2	10.83
Hamburg	1	0.08	13.25	1.7	0.59	0.8	1.25
Hesse	4	2.10	1.90	5.7	0.70	2.7	1.48
Mecklenburg-Hither Pomerania	7	2.30	3.04	1.9	3.68	0.9	7.78
Lower Saxony & Bremen	17	4.70	3.62	8	2.13	3.5	4.86
North Rhine-Westphalia	61	3.40	17.94	17.3	3.53	7.4	8.24
Rhineland-Palatinate	7	1.90	3.68	3.7	1.89	1.7	4.12
Saarland	2	0.25	8.00	1	2.00	0.4	5.00
Saxony	20	1.80	11.11	4.7	4.26	2	10.00
Saxony-Anhalt	10	2.00	5.00	2.8	3.57	1.2	8.33
Schleswig-Holstein	8	1.57	5.10	2.6	3.08	1.2	6.67
Thuringia	8	1.60	5.00	2.6	3.08	1	8.00
West Germany	135	24.90	5.42	63.7	2.12	29.3	4.61
East Germany	65	10.80	6.02	15.9	4.09	7	9.29
Germany	200	35.70	5.60	79.7	2.51	36.3	5.51

Source: ADT.

Experience from over a decade has shown that innovation centres have become a recognised instrument in Germany for regional and innovative economic development. In terms of their most important function - helping technology-oriented start-up firms to get established and providing innovative companies with possibilities for growth - innovation centres have been a success, in different ways, within their regional environments. They have also been acclaimed on the supra-regional and international levels.

Figure 2. Conceptual framework for technology centres and business incubators



Source: ADT.

Technology centres and business incubators have become economic factors as infrastructure facilities. As the nodes in networks, they have arisen primarily through regional initiatives, and they are considered living examples of “public-private partnerships”.

They are not an end unto themselves; they are business-oriented infrastructures for innovative start-up firms and developments. The centres have been developed as dedicated, powerful models for technology transfer from science to industry and business, oriented especially to small, innovative companies. Technology incubators can be regarded as SME-based models of technology transfer. Start-ups in general, academic “spin-offs” and companies formed from parts of large industrial companies also play central roles in the centre concept (Figure 2).

The technology centres and business incubators in Germany are an independent variant of the innovation centre concept - one that incorporates international experience in the development of science parks, incubators and “technopolises”. The result is a flexible model that has survived a number of tests, under the special conditions prevailing in Germany, such as the need to provide assistance in structural crises in western Germany or to reshape eastern Germany’s economy and research sector.

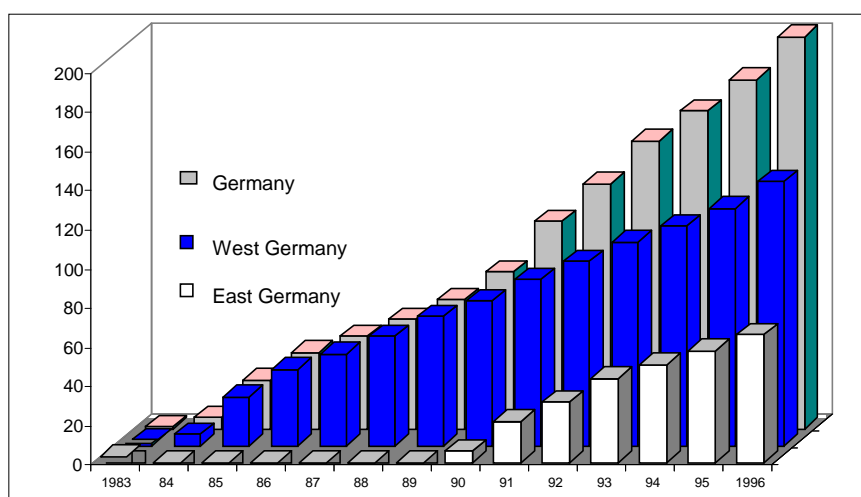
In the coming years, efforts will be focused on giving innovation centres in Germany a more visible profile, using the challenges of the next century’s economic and social developments as a measure. To a considerable extent, the basis for dealing with such challenges will be created through innovation - but only if capable infrastructures and frameworks are in place that enable and help innovative companies to be founded and to grow. Investments in such infrastructures pay off.

Increasingly, Germany's network of technology centres and business incubators is proving to be a source of impetus and a network of future-oriented workshops for industry. The companies involved are extensively active in new and emerging fields of technology development and applications, including such areas as information and computer technology, communications, software development and multimedia, micro-electronics and automation technology, robotics, environmental technology, micro-structure technology, new materials, biotechnology, medical technology etc.

The centres have an average of 25 companies and research institutes, with a total of 200 employees; the average number of employees per company is 8. In the past few years, the total space available for occupancy in the centres has grown by leaps and bounds; it is now over 1.3 million m², this is equivalent to an average of 5 400 m² in rental space per centre. The centres vary widely with regard to size and organisation, however, primarily as a result of regional conditions and resources.

In eastern Germany, the Federal Ministry for Education, Science, Research and Technology has supported construction of technological business incubators. This effort has profited from good co-operation with western German centres that has also created a basis for an intra-German east-west co-operation network.

Figure 3. The development of technology and business incubation centres in Germany (1983-1996)



Source: ADT

In light of the collapse of the eastern German economy and the restructuring of the research sector, these centres have a major role to play in the economic recovery of the various eastern German regions. Historically, eastern Germany has had very few small and medium-sized companies. Consequently, these centres are playing an important role in fostering entrepreneurial approaches in eastern Germany. Eastern Germany now has 65 centres in operation, and its network of centres is twice as dense as that in western Germany.

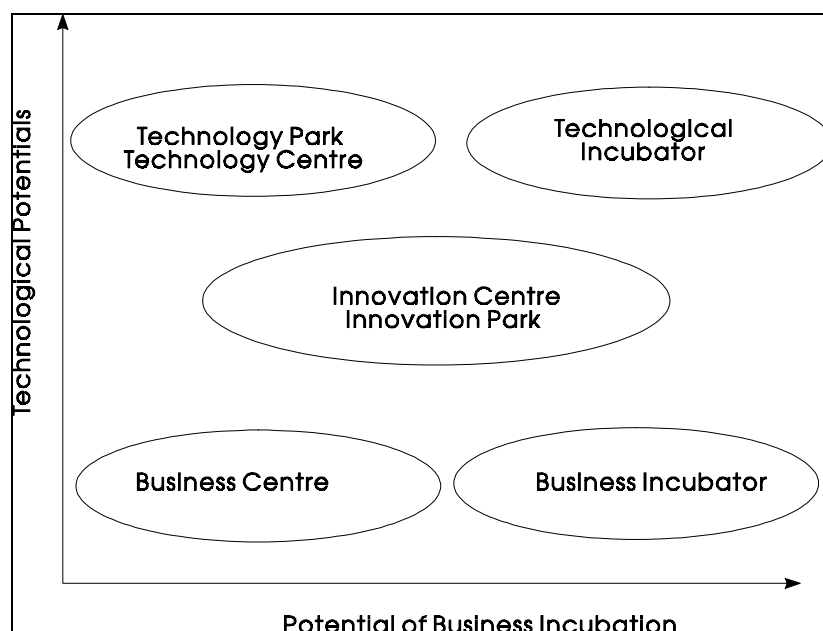
Western Germany has some 135 centres in operation, with a total of 3 200 companies and about 28 000 employees. The 65 active centres in eastern Germany represent over 1 750 companies and 11 600 jobs. The average number of companies per centre is 27 in western Germany; in eastern Germany it is 24. Such differences are disappearing, however.

Now, more than ever, the framework for start-up firms and small innovative companies must be improved. In addition to support programmes, such efforts must include the appropriate tax framework and the creation of the proper infrastructures. Just as the state bears responsibility for building roads and bridges in the public interest, it must also provide the necessary roads and bridges for innovative start-up firms. Such roads and bridges lead directly into the future, and they stimulate private investors to invest in the new innovative firms. Technology incubators and technology parks have proven to be one of the best instruments for attracting investment.

Technology incubators and science and technology parks

In many countries, such as in the United States, France and the United Kingdom, a distinction is made between business incubation centres (incubators) and technology parks (science parks), a distinction that is sometimes manifested through separations of networks and associations.

Figure 4. Combining technological and business potential



Source: ADT.

Germany's concept of technology centres and business incubators is a proven approach in which there are no sharp separations by content or organisation. Basically, Germany's innovation centres are centres that provide support for technology-oriented start-up companies and developments, or technology-oriented business incubation centres. In other words, support of technological developments and applications is closely linked to support for start-up firms. Technology centres and business incubators achieve their aims through this combination, although the specific emphases can vary (Figure 4). An increasing number of business incubation centres in Germany are focusing on assisting start-up firms in general, especially firms in the areas of services and of the crafts. Business incubators in rural or structurally weak regions fall into this category.

In keeping with their core function, innovation centres are business incubation centres for technology-oriented companies. Whereas some centres concentrate primarily on technology companies,

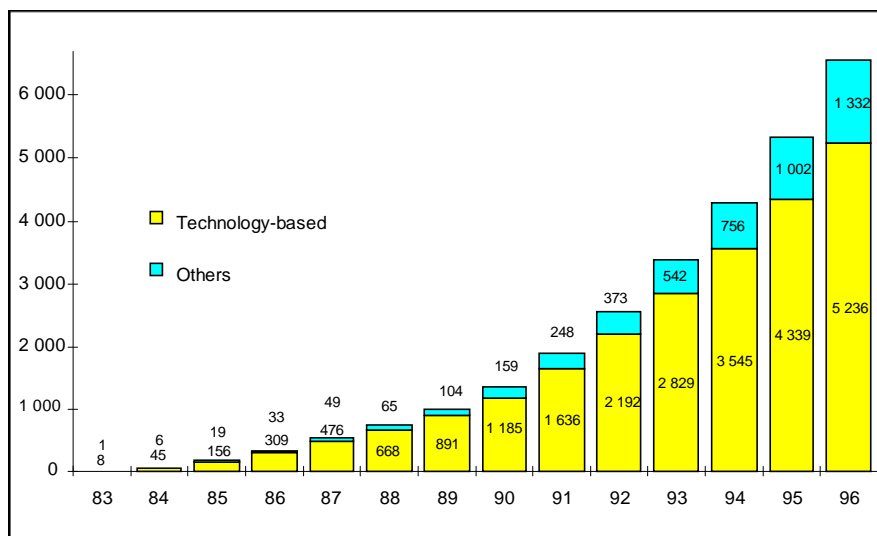
with an orientation to relevant regional requirements and resources, other centres function more as generally oriented business incubation centres. For the network as a whole, the connection between the two tasks is the characteristic feature, however.

If one wishes to stimulate innovation, as a force that spurs economic development, one must concentrate both on developing technology resources and on encouraging company start-ups. Today, more than ever before, the “long-wave” theory of technological innovation is proving its validity: profound technological changes occur not only as a result of scientific revolutions; they depend on entrepreneurial action and go hand-in-hand with “waves” of start-up firms. Support for technological developments and applications is closely linked to support for start-up firms. This is the unity within which technology and business incubation centres achieve their aims. Innovation has two sides: technological innovation and creation of new companies.

In the last few years, the business incubation centres have supported an average of 1 000 company start-ups per year - and this rate is increasing. This growth is being driven by three factors:

- ◇ the centres’ incubator function;
- ◇ expansions of the infrastructure in existing centres;
- ◇ construction of new centres.

Figure 5. Creation of small innovative companies in German incubators (1983-1996)



Source: ADT.

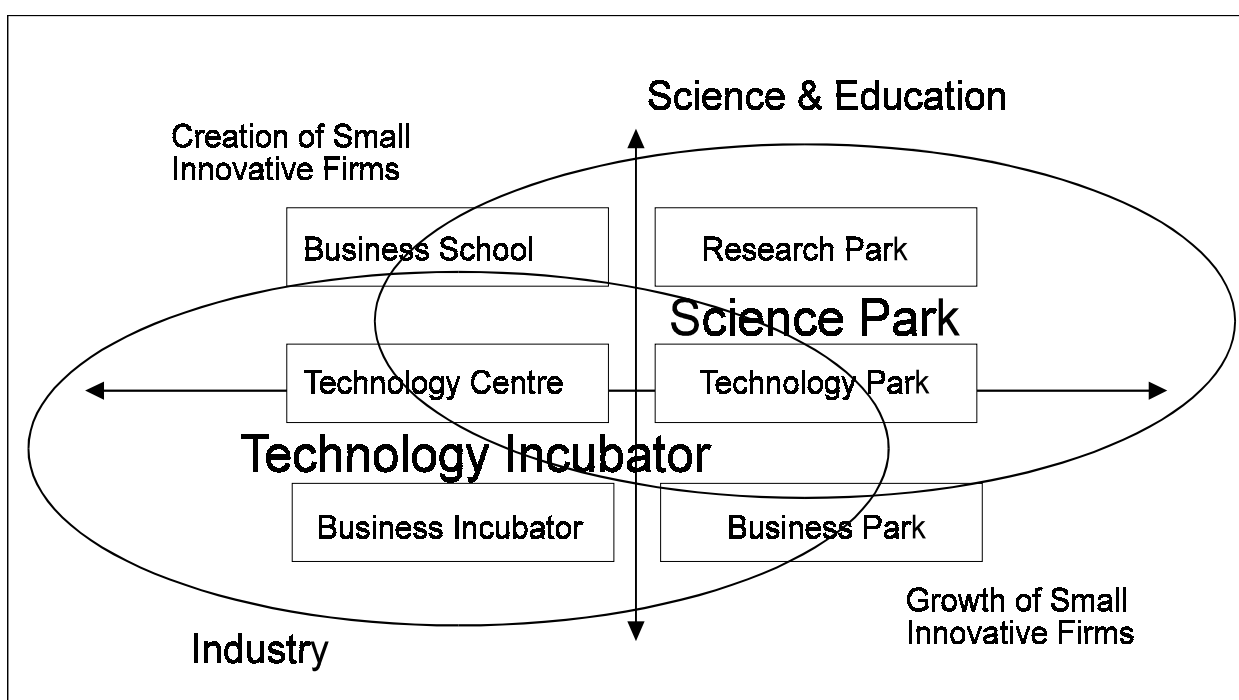
One of a business incubation centre’s basic tasks is to provide support during start-up and the first growth phase. Consequently, limits must be placed on the time start-up firms and young companies can spend within centres. Of the nearly 7 000 companies supported since 1983, over 5 000 are technology-oriented (Figure 5). The success rate for the new companies is remarkable. According to experience to date, only 5-8 per cent of new companies have had to close during their stay within a centre. This success is due primarily to the support provided for preparation of new firms (including a selection process), as well as to on-going support.

As a result, companies started within technology centres and business incubators can be expected to have considerably higher survival chances than other companies. Whereas official statistics (nation-wide)

show that only 50 per cent of companies are still in operation three years after they are started, the technology and business incubation centres have achieved impressive success rates. It is worth mentioning that Germany not only needs to considerably increase the rate at which new firms are created; it must also reduce numbers of insolvencies and ensure that companies achieve long-term stability. The network of technology and business incubation centres is making an outstanding contribution toward this aim, in two regards.

Nearly 2 000 companies have moved out of centres, following limited stays of three to seven years, in order to experience their next growth phase in neighbouring technology, industry or business parks. Often, centres grow together with their companies.

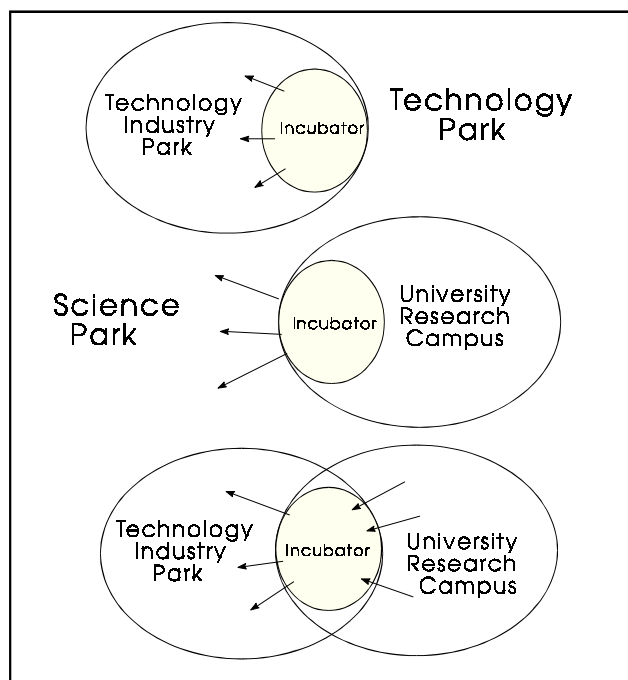
Figure 6. Infrastructure for innovative and technology-based firms



Source: ADT.

A considerable number of technology centres in Germany have grown so large that they could be classified as “technology parks”, even by international standards. Together with nearby universities and institutes of higher education, they then form what is called, around the world, a “science park”. The interrelationship between technology-oriented business incubation centres and science parks has also proven fruitful in Germany, especially with regard to support for academic spin-offs. Incubators can generate highly capable technology, industry and science parks in different ways (Figure 6).

Figure 7. Linkgages between incubators and science/technology parks



Source: ADT.

But not every incubator must be linked to a science park. Germany’s concept of innovation centres has proven to be versatile, flexible and highly effective. In recent years, many incubators have expanded to become technology parks or are planning such a step (Figure 7). This is already true of nearly 50 incubators, or about 25 per cent of all innovation centres. The technology centres in Aachen, Berlin, Karlsruhe, Dortmund and Bochum are such “flagships” (also simply by virtue of their size). Other examples of cities where technology parks are taking shape near business incubation centres include Münster, Erlangen and Kiel.

Assuming that companies that move out of a centre continue growing, later employing about 15 persons (or about twice as many as during their stay in the centre), then the total number of companies involved corresponds to at least 30 000 jobs. If employees of co-operation partners in industry and science are also counted, it can be assumed that the developing network of technology centres, business incubators and technology parks has directly created about 100 000 jobs since 1983.

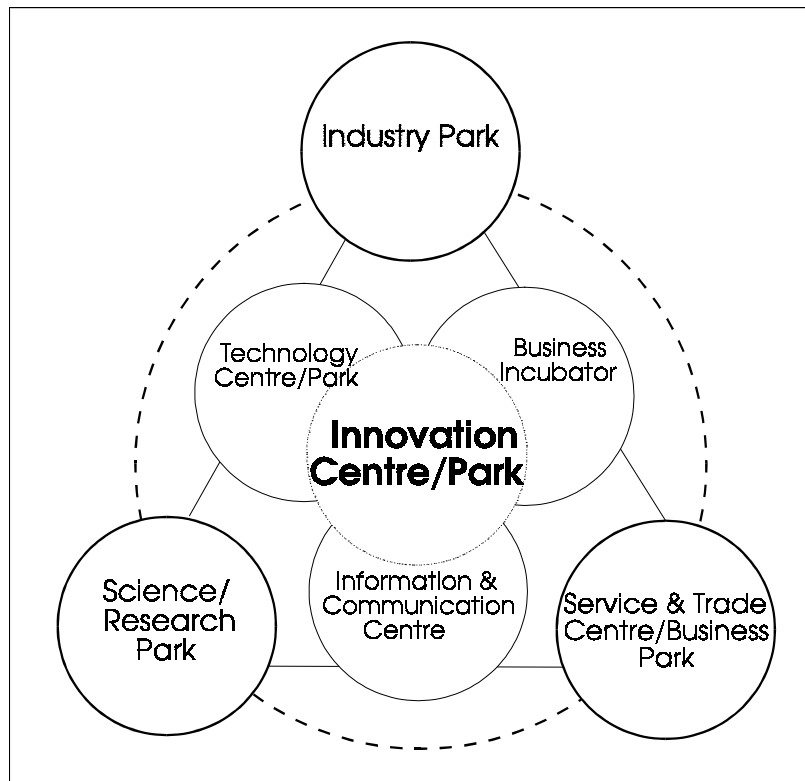
The concept of technology and business incubation centres is continually being refined and adapted to the various regional conditions and global challenges (Figure 8). A central aspect of such efforts is tailoring the centres’ services to the requirements of their tenant companies.

The new tasks of many centres include:

- ◇ creating regional and supra-regional networks of centres and companies;
- ◇ assuming innovation project sponsorships;
- ◇ providing further training and qualification for the relevant region;
- ◇ developing technology “early warning systems” and technology assessments;

- ◇ improving frameworks for innovative regional economic development and enhancing the climate for innovation.

Figure 8. Network interactions of Innovation centres in context



Source: ADT.

Two tasks in particular are being given special emphasis in further qualitative development of the network and are of strategic importance:

- ◇ Technology and business incubation centres not only use modern information and communications technologies to stimulate company start-ups and growth, they are also developing into powerful information nodes for regional economies. Technology centres are bases for a modern information society. As a result, new possibilities are being opened up for networks of co-operation between large and small companies. Many companies in the centres operate in the promising fields of information, computers and communications.

- ◇ Technology and business incubation centres will continue in the future to play an active role in providing financing for technology companies. By providing qualified consulting and support for young companies, they are far more than simply “renters of office space”. In co-operation with savings institutions, banks and insurance companies, they play a significant role in backing new companies. This aspect will become more and more important in the future, since many companies are undercapitalised. Equity participation funds, venture capital and innovation-sharing of business angles are growing in importance.

Technology-based enterprises and academic entrepreneurship

Germany's economic history shows that large industrial companies are often founded through the initiative or active entrepreneurial effort of researchers and technicians. Many well-known companies that have set the pace of technological progress in this century, over the course of many decades, grew out of innovative start-up firms in the 19th century - in the areas of electrical engineering, mechanical engineering and vehicle construction and chemistry.

This group of companies includes, for example, Siemens, AEG, Hoechst, Bayer, BASF and Carl Zeiss. In many cases, the technological implementation of an idea or scientific finding was the driving force, a force which found its expression in entrepreneurial action. New industries have also arisen in connection with scientific revolutions and technological “waves”.

Such new industries manifest themselves first in a wide range of new, small companies, before fast-growing companies begin dominating the market. New technological waves, especially those in information technology and biotechnology, are now occurring in connection with waves of new innovative start-up firms. Traditional companies often find themselves in conflict with start-up firms, which draw much of their innovative power from their flexibility.

In 1983, almost exactly 100 years after the founding of AEG, 14 scientists from Berlin Technical University founded their own companies. A short while later, in 1985, the first German technology and innovation park was established on AEG's decommissioned site in Berlin. Now, after the closing of AEG in Germany last year, some AEG spin-outs can be found in various technology and business incubation centres. Ever since this “birthdate”, support of technology companies and company start-ups emerging from institutes of higher education and non-university research establishments has been one of the most important tasks of technology centres and incubators.

With the aim of improving the framework for technology-oriented start-up firms and companies emerging from the science sector, the Association of German Technology and Business Incubation Centres (ADT), under commission to the Federal Ministry of Education, Science, Research and Technology (BMBF), has been carrying out the ATHENE project (*Ausgründung von Technologieunternehmen aus Hochschul-Einrichtungen und Naturwissenschaftlich-technischen Einrichtungen* - Start-ups of technology companies that have emerged from higher education institutes and scientific establishments). The project, which is scheduled to run until the end of 1997, is aimed at stimulating academic spin-offs and collecting relevant statistics.

Initial research has shown that technology and business incubation centres, in co-operation with institutes of higher education and research centres, exert a driving force in support of academic spin-offs. Technology and business incubation centres are found in the vicinities of 59 universities in Germany, i.e. 76 per cent of this sector's institutions. Other university cities, such as Kassel, Potsdam and Darmstadt, will soon open technology and business incubation centres or are planning to construct centres.

A total of 47 per cent of all technology and business incubation centres are located in cities with higher education institutes and 26 per cent are located in cities with non-university research establishments.

Technology-oriented start-up companies account for 77 per cent of all companies in the business incubators. The corresponding figure for older centres, most of which are located in cities with higher education institutes, is 90 per cent.

Table 2. Tenant firms in technology centres and incubators

Companies in technology centres and incubators	Academic spin-offs	Technology companies
Germany total	49%	77%
Western Germany	47%	79%
Eastern Germany	52%	73%
North Rine-Westphalia	47%	78%
Locations of institutes of higher education	57%	79%
Locations of public research institutes	55%	82%
Locations without higher education and research	34%	68%
Rural regions	44%	65%

Source: ADT.

Since 1990, a total of 4 400 technology companies, 1 500 of them in eastern Germany, have been founded and supported. In 1996 alone, the centres registered 1 200 new companies; of these companies, 890 can be considered technology companies (western Germany: 560, eastern Germany: 330). The number of new companies that have emerged from the science sector, as a percentage of all companies in technology and business incubation centres, is 49 per cent.

Table 3. Incubator firms emerging from the science system

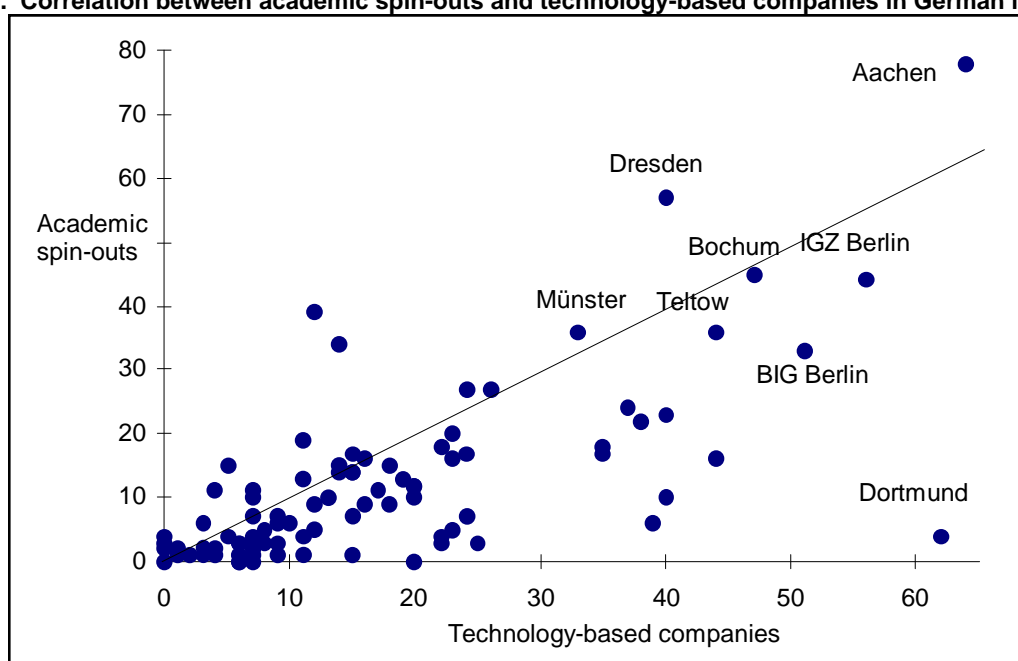
Academic spin-offs in technological incubators	Germany total	Locations of institutes of higher education	Locations of public research institutes	Locations without higher education and research
Academic spin-offs total	49%	57%	55%	34%
from institutes of higher education	26%	35%	32%	12%
from non-university, public research institutes	7%	6%	9%	4%
from institutes of industrial research	7%	7%	9%	6%
others, mixed	10%	9%	6%	11%
non-academic start-ups or spin-outs	51%	43%	45%	66%

Source: ADT.

When this figure is extrapolated to the entire network of technology and business incubation centres, it indicates that there have been 2 350 academic spin-offs. Applied to the entire number of created companies and companies that have moved out (at least partially), this percentage points to a figure of 3 300. Since 1990, the centres have supported about 2 750 academic spin-offs. At 26 per cent, the group of companies that have emerged directly from institutes of higher education is the largest group of academic spin-offs (western Germany: 28 per cent; eastern Germany: 21 per cent).

A number of technology incubators that are either located on a higher education institute's campus or co-operate very closely with institutes of higher education have even higher percentages of academic spin-offs. Prominent among this group are the centres in Aachen, Berlin, Bochum, Chemnitz, Dortmund, Dresden, Karlsruhe and Warne-münde. There have been 7 per cent coming directly from non-university research institutes. These figures are reflected in the qualifications of the employees in the companies. Various recent analyses have agreed that academic employees account for between 50-60 per cent of all employees.

Figure 9. Correlation between academic spin-outs and technology-based companies in German incubators



Source: ADT.

An important reason for the high percentage of technology-oriented companies is found in the many spin-offs from higher education institutes and research establishments; this fact is also reflected in the correlation between academic spin-offs and technology-based enterprises within the technology incubators (Figure 9). Overall, these figures show that most technology and business incubation centres, in keeping with their aims, concentrate on supporting new technology-oriented companies that have emerged from the science sector - and thereby make important contributions to commercial implementation of research findings.

In the technological sector, over 1 000 innovative new companies are founded each year in Germany. Experts maintain that much more must still be done to maintain economic competitiveness and to halt the

dramatic loss of jobs. In spite of positive experiences and a successful development, efforts must still be intensified to stimulate academic entrepreneurship and to profit from experience gained in such fields in other countries.

The network of innovation centres in Europe

Europe now has over 1 000 business incubation centres and technology parks. Together with the associated small companies and research establishments, these centres and parks represent enormous potential for innovation in Europe's future. In many cases, technology and business incubation centres have played a leading role in the process of European integration. Regardless of the differences in terminology from country to country - i.e. regardless whether one must speak of incubation or innovation centres, technology centres, "technopolises" or science parks - all European countries are experiencing similar developments in this area - each with its own differences and diversity.

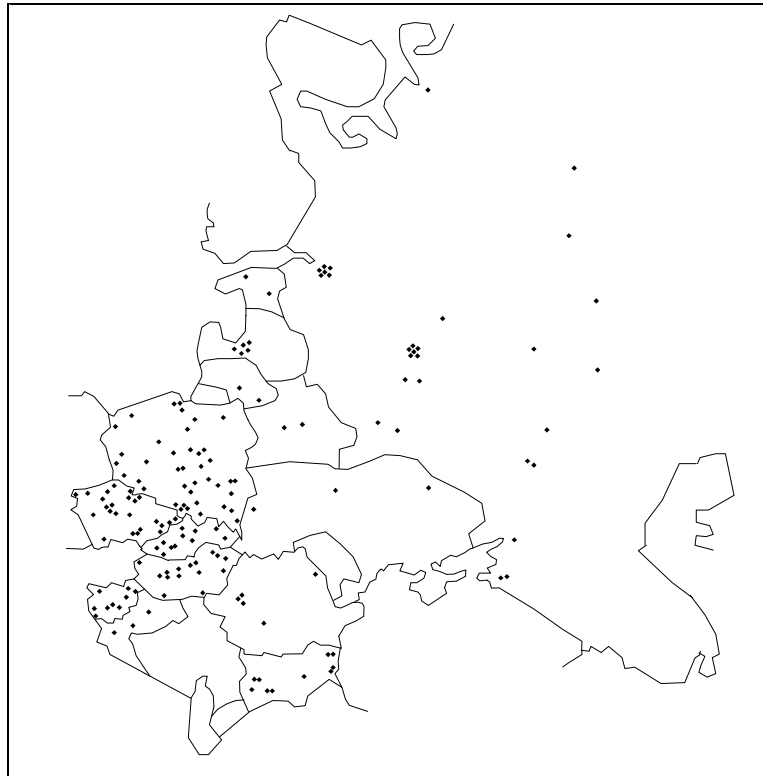
This trend similarity applies to the establishment of smaller business innovation centres (incubators), in order to enhance regional economic development; to the creation of technology parks (science parks), in order to achieve effective transfer of technology from science to business; and to the quantitative and qualitative development of the network. Co-operation within networks is a defining trend.

The entire European network of innovation centres is continuing to grow and now holds broad potential for innovative partnerships between medium-sized companies. It is a network of networks: NICE - Networks of Innovation Centres in Europe. This network includes both regional and national networks and cross-border and international networks. Germany's network of technology and business incubation centres is the largest national network in Europe. This fact, in conjunction with Germany's central European location, means that Germany has special responsibility to help shape co-operation between north and south, and between east and west.

And the western European countries have a special responsibility for the development of eastern Europe's network of innovation centres (Figure 10). This network now comprises about 250 technology and business incubation centres. Often working under very complicated conditions, these centres are making a significant contribution to the development of innovation resources within a market economy, to promotion of the entrepreneurial approach and to the necessary restructuring of large industrial companies and research centres.

Initial experience has shown that business incubation centres are useful instruments of market-oriented structure policy and innovative economic development even in countries undergoing economic transformation. Technology and business incubation centres are thus becoming basic pillars of research, technology and economic co-operation between East and West. German unification has enabled Germany to gather unique experience in using business incubation centres in order to restructure a former state-planned economy, and this experience is now being applied fruitfully to consultation support for eastern European countries.

Figure 10. Innovation centres in central and eastern Europe



Source: ADT.

In the framework of the TRANSFORM consulting programme, the Federal Government is currently supporting 6 pilot projects for establishment of technology centres and business incubators in Eastern Europe, including centres in Russia (Vladimir), Poland (Gdansk), Belarus (Mogilev), Ukraine (Saporoshje), Bulgaria (Sofia) and Latvia (Riga). A further project will be started soon in Kaunas (Lithuania).

Under commission to the Federal Ministry for Economics, the Association of Technology and Business Incubation Centres is carrying out a range of activities to support east-west co-operation between small technology-oriented companies. Similarly, projects for co-operation between science parks and technology incubators in western Europe are being supported by the European Union.

International conferences and bilateral workshops, co-operation projects and the Internet are all contributing to the development of this pan-European network. The network is not an end in itself, however. Its ultimate purpose is to tap potential for innovation, through co-operation in Europe and world-wide, and to jointly create a better, and better co-ordinated, framework for start-up firms, for co-operation and for technology companies' growth.

THE EXPERIENCE OF CATCHING UP AND TRANSITION ECONOMIES

TECHNOLOGY INCUBATORS IN ISRAEL

*Rina Pridor, Technological Incubators, Office of the Chief Scientist
Ministry of Industry and Trade, Tel Aviv, Israel*

Technological Incubators Programme

Background

Israel's economic independence is contingent to a large extent upon the development of its technology based industry. According to this basic belief, the Office of the Chief Scientist of the Ministry of Industry and Trade has formulated and is carrying out an extensive support programme for business incubators aimed at promoting technological entrepreneurship in Israel. The programme, established over the last five years, endeavours to create a tool, that will be used on a continuous basis, to support the first stage of technological entrepreneurship, and to integrate these activities with the very special circumstances, created in Israel, by the recent massive immigration. It provides the support and environment essential for innovative ideas to develop and bloom. Both veteran Israelis and new immigrants are given an unequalled opportunity to transform their concepts into commercial products and viable businesses.

Objectives

Foster starting entrepreneurs possessing innovative technological ideas and help them to develop and commercialise a product

Entrepreneurs taking their first steps are in need of much assistance: financial, professional, administrative, logistic, managerial, and legal. The incubator provides the needed support, in a framework conducive to uninterrupted development work. After the risks inherent in the project are reduced, and the project is more attractive to potential investors and strategic partners, it continues as an independent corporation. If further research and development are required, the company may apply for any of the standard support and assistance programmes provided by the Office of the Chief Scientist.

Implement technological ideas brought by new immigrants

The recent immigration was accompanied by an inflow of technological knowledge and know-how in a variety of fields. Within the incubator framework, new immigrants are given the opportunity to direct their expertise toward commercial applications. The incubator framework expedites the transfer of innovative and advanced technologies to the local technological and commercial environment.

Promote employment of technologically experienced immigrants in their profession

The incubator programme is by no means an employment program, yet it remains one of the most promising avenues for professionally trained new immigrants to work in their designated fields of expertise. They start, initially, on the research and development project teams. In the future, as the projects leave the incubators and expand their activities toward full commercialisation, they continue work on the development, production, and marketing staff of enterprises based on these projects.

The Steering Committee

The technological incubator programme was established and is operated by the Office of the Chief Scientist within the Ministry of Industry and Trade. The policy is determined by the Steering Committee for Technological Incubators, whose members are appointed by the Director General of the Ministry.

Members:

- ◇ Chief Scientist, Ministry of Industry and Trade - Chairperson;
- ◇ a representative of the public, from high-tech industry;
- ◇ the co-ordinator for industrial affairs, Budget Division, Ministry of Finance;
- ◇ the Manager of the Incubator program, Office of the Chief Scientist, Ministry of Industry and Trade.

Functions:

- ◇ set the policy regarding the technological incubator program;
- ◇ set support procedures for the incubator and for the projects run by it;
- ◇ approve financial support to projects, candidates for the incubators, within the approved budget, as per the recommendation of the project committees of the incubators;
- ◇ approve financial support for administrative operations of the incubators within the approved budget;
- ◇ follow-up on the incubators' developments and that of the projects within them;
- ◇ decide upon cessation of support, to an incubator or a project, in case they do not fulfil their function or do not comply with regulations.

The Incubator

Legal obligations

During the incubator stage, the State provides the major part of the project's operating budget. The incubator's management is responsible to the State for professional and efficient management of the projects, including project budgeting and commercialisation. The incubator's management acts as a trustee on behalf of the State, for operating the projects within the incubator.

The agreements and contracts that secure the State's support to the incubator and to the projects are signed by the incubator's management. The budget, for both the administrative management of the incubator and for the individual projects, is transferred by the state to the incubator.

Organisational requirements:

- ◇ The incubator is an independent legal entity, registered as a non-profit organisation.
- ◇ A public entity is involved.
- ◇ Directed by a Board of Directors that sets the policy, consisting of industrialists, business professionals and research professionals serving on a voluntary basis.
- ◇ Projects are examined and approved by a project committee consisting of industrialists, business professionals and research professionals serving on a voluntary basis. The committee also guides, directs and consults the projects during the course of development.
- ◇ The incubator is managed by a salaried General Manager: a professional, with industrial management experience.
- ◇ The incubator is housed in a building with facilities suitable for ten to 20 R&D projects.

Functions:

The function of the incubator is to assist entrepreneurs to successfully complete their projects and turn them into commercially viable ventures. To accomplish this, the incubator provides the projects with the following services:

- ◇ assistance in conducting technological and marketing feasibility studies on the idea and in preparing the R&D plan;
- ◇ assistance in recruiting and organising R&D staff;
- ◇ providing physical facilities suitable for carrying out the project, including plant, equipment and administrative facilities;
- ◇ professional and managerial guidance and direction;
- ◇ secretarial, administrative, maintenance, purchasing, bookkeeping, and legal services;
- ◇ assistance in recruiting investment capital and preparation for commercialisation and marketing.

Areas of activity

There are no preferred areas of specialisation dictated to the technological incubators operating within the programme. A number of incubators have shown a preference for projects that can most benefit from the resources at their disposal - such as association with universities and research institutions. Other incubators find themselves leaning toward a particular technological segment, in accordance with the number of projects sharing a common know-how base. In general, the projects cover the entire range of R&D activities.

The Project

Criteria for approval

THE PROJECT is based on an innovative, technological idea. Its objective is to produce a marketable product, intended for export.

THE INITIATOR is making his first steps as an R&D project entrepreneur.

SCOPE: Approximately five R&D professionals for a period of one to two years.

Legal structure

The project will be established as an independent limited corporation and will operate as a commercial company. An agreement will be signed between the project's initiators and the incubator's management, detailing the rights and obligations of the initiators and the incubator to implement their stated objectives and comply with the requirements as set forth by the government.

The equity ownership in the project's company will be broken down as follows:

- ◇ The initiator – at least 50 per cent.
- ◇ Key employees who are not initiators – at least 10 per cent.
- ◇ The person or persons who contribute additional funding to operate the project (this could be the initiator) – up to 20 per cent.
- ◇ The incubator – up to 20 per cent.

All additional investment required in the future will be open for negotiations, and will dilute the founders' equity ownership, as detailed above, proportionally. Notwithstanding the above, the management of the incubator reserves the right to initially allocate equity ownership to outside investors and/or future strategic partners. In this instance, these shares will be held in trust by the management of the incubator, and the percentage of ownership as detailed above will apply only to the remaining shares issued and not to those held in trust for future investors and/or partners.

Financial government assistance

Incubator projects

A grant of up to NIS 450 000 (US\$ 140 000) per year for up to two years. Total maximum grant per project - up to NIS 900 000 (US\$ 280 000). The actual grant amounts to 85 per cent of the recognised R&D expenses.

Incubator management

A grant of up to NIS 550 000 (US\$ 170 000) per annum, including the salary of the Managing Director of the incubator, operating expenses, expenses associated with sorting and recruiting projects, and expenses associated with starting the projects on the path toward commercialisation.

The actual grant amounts to 100 per cent of recognised expenses.

Non-government support

The government support in establishing and operating the technological incubators is sustained, in many instances, by the following organisations:

- ◇ The Jewish Agency, which has been involved in the technological incubators from the beginning, contributes to the financing of the incubators mainly for housing, equipment and commercial efforts. The Jewish Agency's involvement is mainly in peripheral incubators located in development areas as a part of its general effort to promote regional economic development. The activity involves Jewish communities fostering incubators and contributing professional advice and business networking abroad.
- ◇ Public organisations e.g. the World Zionist Organisation, The Joint and other public funds.
- ◇ Local authorities.
- ◇ Veteran Israeli industries.
- ◇ Research institutes.
- ◇ Private donors.

The Technological Incubator Program today

Funds allocated by the Office of the Chief Scientist

- ◇ 1991 - NIS 3 250 000
- ◇ 1992 - NIS 23 000 000
- ◇ 1993 - NIS 51 000 000
- ◇ 1994 - NIS 80 000 000 (US\$ 26 million)
- ◇ 1995 - NIS 90 000 000 (US\$ 30 million)
- ◇ 1996 - NIS 97 000 000 (US\$ 32 million)

Incubators

Today, 27 incubators are operational throughout Israel, on the following locations: Jerusalem, Tel Aviv, Haifa, Neshet, Beer Sheva, Sde Boker, Dimona, Ofakim, Gush Katif, Arad, Ashkelon, Kiryat Gat, Kiryat Arba, Yavne, Nes Ziona, Netanya, Hadera, Ariel, the Jezre'el Valley, the Jordan Valley, Nazareth, Gush Segev, Kiryat Yam, Katzrin and Kiryat Shmona.

Projects

There are currently 200 projects operating within the 27 technological incubators. Half of them are based on ideas brought by new immigrants. The average number of projects per incubator is 8, with the maximum per incubator currently standing at 11.

Employees

Almost 800 professionals are employed on the projects' staff. About 70 per cent of them are new immigrants. 800 work on projects, which have graduated from the incubator. The majority of the staff are scientists and engineers holding academic degrees.

R&D results

As of 31 August 1996, 280 projects have finished their stay in the incubators. Fifty-eight per cent continue operating independently:

- ◇ 41 per cent produced a viable product and continue work with strategic partners and additional investments. The investments range from US\$ 100 000 to US\$ 5 200 000.
- ◇ 17 per cent are at various stages of negotiations with potential strategic partners or investors, or are continuing work via independent resources (sales, consulting work etc.).
- ◇ 42 per cent were suspended or closed.

Employment and training of immigrant professionals

During the incubator period, new immigrants receive training and guidance, from professional and business aspects. They are exposed to the latest technological developments, in terms of methodology and equipment. As the need arises, they are retrained. There is tremendous improvement in terms of communication skills - both in Hebrew and in English. Experience shows that at the end of the incubator period, the problem of unemployment among this sector is relatively small. In cases where projects were shut down, the majority of the employees found employment in their respective fields, either in industry, or in other projects, in the same incubator framework or with other incubators.

Admission

Presently the 27 incubators are capable of incorporating any new project, suitable for a technological incubator.

Further information

may be obtained from the Administration of the Technological Incubator Program: Tel: 972-3-5103941;
Fax: 972-3-5173734

Written information includes:

- ◇ an updated list of incubators; addresses and contacts in Hebrew and English;
- ◇ a brochure of regulations and procedures related to the technological incubators (in Hebrew);
- ◇ a brochure on the Technological Incubators Program (in Hebrew).

Note:

This summary includes R&D projects operating in the framework of the Technological Incubators Program, and also information about projects, which have already graduated from the program but still are getting certain support from the incubators.

KOREA'S SYSTEM AND POLICY TOWARDS TECHNOLOGY INCUBATORS

*Dal Hwan Lee, S&T Policy Research Division,
Science and Technology Policy Institute (STEPI), Seoul, Korea*

Definitions of Business Incubators (BI) and related concepts

What is an incubator?

As the incubators in medical institutions nurture and take care of prematurely born infants in controlled conditions, the Business Incubator (BI) takes in newly-started small and medium-sized enterprises in their infancy and helps them overcome difficulties and continue to survive, grow and develop.

BI and related concepts

In Korea, such concepts as Technology Incubator (TI), Technology Innovation Center (TIC), and Technology Business Incubator (TBI) are quite similar to the Business Incubator.

- ◇ *Business Incubators (BI)*: Universities, public research institutions, local governments, and private institutions established BIs with the purpose of promoting and supporting small and medium-sized enterprises. BIs host start-ups and provide various benefits and services. The BI is a very effective way of achieving development goals both in the public and the private sectors: it promotes the survival rate of newly started small and medium enterprises, reinforces the application of technological innovations, creates new business and employment, revitalises regional economies and the research functions of universities and research institutes, and, finally, fosters technical manpower.
- ◇ *Technology Incubators (TI)*: The TI's main concern is to bolster the technological development stage. It aims to complete technological ideas or technologies currently under development. Specific activities by TIs include specialists sent as technological guides; joint development; supporting and raising necessary funds; and the provision of support in using machinery and related experiment/instrumentation equipment and computers. In some cases, the TI provides facilities such as office and telegraph/telephone equipment.
- ◇ *Technology Innovation Centres (TIC)*: The TIC conducts research and development (R&D) and technology innovation required by the industrial field, which aims to jointly invest resources into university campuses or research institutions and achieve commercialisation with support from business enterprises or public institutions. As a concept, the TIC is similar to that of the Technology Park; and at the R&D stage to the TI.
- ◇ *Technology Business Incubators (TBI)*: The TBI is a venture of universities, public research institutes, local government, and private institutions to promote and bolster a new technology-intensive enterprise. The TBI is different from the TI or TIC in that it supports the commercialisation of previously developed technology; that is, the start-up activities of

an enterprise. It differs from general BIs in that it concerns technology-intensive or high-tech business.

Types of BIs

By sponsors

- ◇ *Public BIs*: established by government or a local self-governing body with the purpose of revitalising the economy, creating employment, and fostering local economy.
- ◇ *University-affiliated BIs*: Established by a university; contributes to the development of the local community; increases independent power of the university by raising research funds and utilising its benefits; rapidly commercialises the R&D results; practical location for industry-university joint activities.
- ◇ *Private BIs*: Established by private enterprises in order to selectively support prospective small and medium enterprises and to gain capital profits by ownership.
- ◇ *Joint BIs by the private and the public*: Established and operated by the private sector, universities, and public institutions.

By typology

- ◇ *University district BIs*: Utilise the accumulated know-how and equipment of the university, hence suitable for supporting high-tech industry; able to rapidly commercialise the research results by the university.
- ◇ *Urban BIs*: Easy to use at various sites, buildings and equipment; BIs play an important role in revitalising a stagnant local economy, especially in urban centres.
- ◇ *Rural BIs*: Though disadvantageous in that they are distant from much indirect capital, the rural BIs have the advantage of being able to use resources indigenous to those regions; the rural BI revitalises local economy of rural areas and increases income.

By participant business types

- ◇ *Specified BIs*: Take in, support and foster limited kinds of start-up companies; since the space, common facilities and services required by industrial characteristics differ, it is necessary to restrict tenants and have specialists to deal with their requirements.
- ◇ *Non-specified BIs*: Tenants can be any kind of enterprise in diverse industries; provide the minimum common facilities such as office equipment; need professional executives with average administrative capacity.

By organisational structure

- ◇ *Manager-initiated BIs*: Consists of a manager and three or four staff members such as a clerk, a receptionist/typist, and a secretary/receptionist; directly operates only in case of common office works, services supports and general management affairs. As concerns technology, equipment and administrative support, it connects tenants to outside institutions.
- ◇ *Functionally specialised BIs*: Organised by function with a manager and three or four unit departments. If, for example, the departments of planning and management, operation support, and administrative consultation are divided, the direct provision of services to tenants will be diverse. Excessive manpower requirements, however, may cause budget waste and bureaucratic inefficiency in operation. Japan usually takes this organisational form.

General TBI model

TBIs have different characteristics according to the conditions, such as purpose and physical location. However, in any TBI, the three basic elements of investor, operator, and tenant are essential. The three elements can be described as follows:

Investor

- ◇ Starting point to the existence of the TBI.
- ◇ Provides the operator with funds for construction/rent of the building, equipment purchase and operation. Commercial investors occasionally invest directly in a promising tenant company.
- ◇ Public investors gain benefits on a more macro and national economy basis, which leads to revitalising the economy and creating employment. Private investors own equity of promising enterprises and later earn dividends as the stock price rises when the firm is listed.

Operator

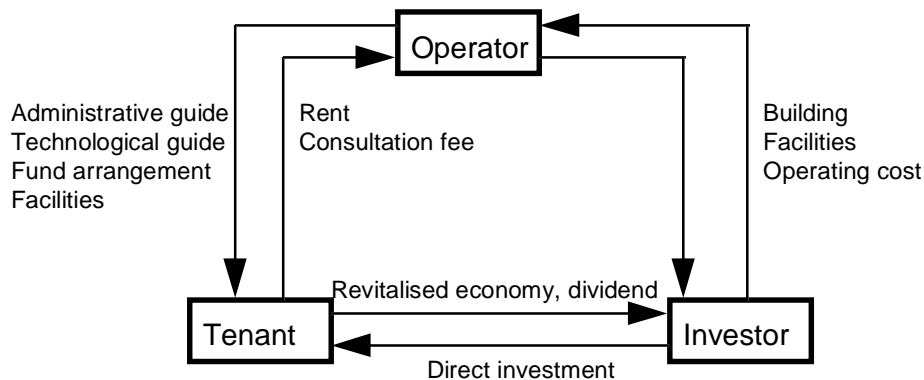
- ◇ Conducts practical operations such as selecting, incubating, and graduating tenants with financial support from the investor. Universities, research institutions or government institutions often assume responsibility due to their non-profit status.
- ◇ Provides common facilities, administrative guides, and funding arrangements for tenant companies but also receives paid rent and consultation fee.
- ◇ In general, the TBI manager assumes all the responsibilities and liabilities. It is essential to appoint a person respected by the government and the fields of banking, science and technology. A TBI manager should have administrative and technical abilities and understand the characteristics of the start-up process and small and medium enterprises.

Tenant

- ◇ Should be technology-intensive small and medium-sized enterprises which belong to the high-tech industry, such as electronics, computer, software, genetic engineering, mechatronics, and precision machinery.
- ◇ Admittance shall be limited to those enterprises who can contribute to the development of national technology and economy and possess excellent technological capacity.
- ◇ Possess ability to take advantages such as administrative guidance, technological guidance, fund arrangement and operational support. Tenant has a responsibility to pay rent, utilities, and consultation fees to the operator but should also share part of the profit in cases where the investor has provided the tenant with capital.

The above is summarised in Figure 1.

Figure 1. General TBI model



Source: Author.

The role of and need for TBIs

The role of TBI

- ◇ Minimises the operating costs of technological business starters through inexpensive rent and common use of office machinery and conference rooms; increases the success rate of small and medium enterprises in the early stages through diverse financial, information, technological, and administrative support including administrative guidance, technological guidance by university/research institute researchers, information exchange among tenants, and venture capital arrangements.
- ◇ Contributes to the revitalisation of local economy: promotes the commercialisation of technology innovations through support for technology-intensive small and medium-sized enterprises.
- ◇ Compared to average BIs, TBIs characteristically contribute more to technological development.

The need for TBI establishment

- ◇ Due to the evasion of technology transfer and grant by advanced countries, more restrictive intellectual property rights, and UR/GR/TR, the need for one's own R&D increases.
- ◇ New technology-intensive business are needed more than ever to promptly commercialise research results and to cope with international competition.
- ◇ On a national basis, it is necessary to anticipate restructuring of technology-intensive industrial structure and the creation of employment while possessing international competitiveness.
- ◇ By reactivating universities with research promotion and support for technology venture creation, the TBI fosters the cultivation of highly qualified labour and research capacity on a long-term basis.
- ◇ From a centralised development system, a shift to the revitalisation of local economy by self-government is required. The TBI provides an important means for this kind of decentralised development system.
- ◇ To survive international competition, it is necessary to build up technology development systems on a national scale. Also, a system of co-operation through networking by the leaders of decentralised local technology development is needed.

Impacts of (T)BIs

Advantages for the TBI tenant enterprises

- ◇ Reduction in the initial investment and operating costs through inexpensive rent and common use of various equipment.
- ◇ The TBIs' administrative, technological, information, and financial support and advice offset the inexperience of new business founders, hence allowing them to concentrate on product and market development.
- ◇ Tenant firms will reduce trial and error by sharing experiences and achieve synergies with other TBI tenant companies through the common use of resources.

All of these advantages help reduce business and investment risks and the increase the possibility for survival and success.

Advantages by investor types

- ◇ *Public investors:* The public (T)BI's main purpose is to create employment and revitalise local economy. Another important purpose is to diversify the local economy and secure the economic base. Employment creation, revenue expansion, maximum use of the unemployed equipment and resources, and revitalisation of stagnant local economy are major advantages of public (T)BIs.
- ◇ *University investors:* Universities can provide outside businessmen with their research results and commercialise them by establishing and operating (T)BIs. They will boost the social contribution of the university by employing university space, technology, facilities, and supporting small and medium enterprises. This will promote the outside notion that

university research can create commercially-viable technology and therefore may reinforce research funding support from the outside. In addition, through the (T)BIs, universities provide opportunities for professors, students, or their graduates to start up their own business.

- ◇ *Private investors*: Private investors can commercially establish and operate (T)BIs and then foster a subcontract business of their own. They can also intensively invest with less risk and costs by selective admission of promising enterprises while revenues from rent will cover some of the operating costs. The corporate social responsibility and corporate image will be promoted.
- ◇ *Joint investors (by private and public sectors)*: Joint investors can seek out more broad ranging and flexible goals. They play a role in economic development with public welfare aspects; but on the other hand they offer investment opportunities to private investors by granting access to the government's technology venture business creation programme, and sometimes concentrate investment on certain high growth industries.

As discussed above, the establishment of (T)BIs can enhance the success rate of newly created small and medium enterprises, and hence contribute to the development of local economy. In addition, it creates an atmosphere that fosters business start-ups, and induces the commercialisation of research results. Another effect of the (T)BI is that it vitalises technology-intensive venture businesses, therefore promoting high level industrial structures and international competitiveness.

Problems in TBI implementation and policy considerations

Domestic/international conditions, differences for TBI implementation

- ◇ There is an important difference between Korea and other advanced countries (especially the United States) as regards the 4Ms (Money, Manpower, Material and Management) which are essential elements for research and venture creation. Therefore, it is necessary to take the difference into account and make TBI establishment and operation planning accordingly.
- ◇ Foreign enterprises are very active and normally engaged in joint research with universities, consigned research, and scholarship donation. However, Korean enterprises have relatively low interest and contribution to these activities.
- ◇ In advanced countries, the concept of local development by organic interconnection among research complexes, technology complexes and university campuses are general. In Korea, technology complexes are usually independent and in most cases they have developed as industrial complexes, which are business centres irrelevant to any university. Only recently has there been a movement to synthesise and interconnect these complexes.
- ◇ In advanced countries, government, particularly local government, is enthusiastic about technology innovations and technology venture through support for universities. In Korea, support by central government is insubstantial and that by local government almost non-existent.

Policy considerations and their implications for TBI implementation

- ◇ In advanced countries the frequency of disused building usage is fairly high, though this differs by TBI types, and in most cases new buildings are used only to create research

complexes. On the other hand, Korea has high sites and construction costs, and few unused buildings. Therefore, Korean alternatives are to use the unemployed buildings in universities and to construct buildings with the sponsorship of outside institutions on the university-owned sites.

- ◇ Funding for the operation and construction of TBIs is covered by outside support at the initial stage. In Korea, some enterprises support universities, however, support from central and local governments is still lacking. A considerable increase in policy funding is urgently needed. In addition, it is desirable to make policy considerations so that the execution of such funding in institutions such as the Small and Medium Industry Promotion Co-operation and Production Technology Research Institute may be interconnected with TBI activities in universities.
- ◇ TBI tenants shall be technology-intensive small and medium enterprises that will respond to the technology innovation demand by industrial field. Also, technology venture funding support for actual production shall be linked to the venture capital company.
- ◇ The TBI, by its nature, requires the active participation of various interested parties such as universities, research institutes, banks, and government and local communities. For the successful operation of the TBI, these parties should share deep understanding and co-operate with each other.
- ◇ Currently, some Korean institutions, including the Ministries of Trade and Industry and of Science and Technology, are operating or planning TBIs. Korea is now confronting the problem of fostering specialists for its effective operation. Therefore, in order to activate TBIs and promote their subsequent nation-wide diffusion, it is urgent that Korea develop specialised programmes to foster TBI specialists.
- ◇ Support for TBIs can be obtained from government, technology/banking enterprises, local self-governing bodies, or research institutions. The contents of support will require the new building construction and operating cost support. The minimal support will consist of operating costs and then the building for tenant enterprises.
- ◇ In the Taeduk Science Town in Korea, TBIs shall be established and operated within a university (KAIST, Korea Advanced Institute of Science and Technology) for diverse purposes. However, universities should operate and interconnect the TBIs to the government sponsored institutions within Taeduk Science Town, and small and medium industry related institutions such as The Small and Medium Industry Promotion Co-operation, Production Technology Research Institute and Korea Productivity Center, and finally to the local self-governing bodies.

Conclusion: essential factors for successful TBIs

- ◇ Competition and co-operation and coalition among nations and business enterprises is a global trend which is critical to achieving international competitiveness. That is to say, co-operation with universities is essential in technology development for corporate international competition.

- ◇ In Korea, much needs to be done to foster a positive attitude and culture towards co-operation/coalition building. Therefore, co-operation between corporate LAC research institutes and universities, or policy measures for promoting co-operation should be directed accordingly. In particular, the role of government-sponsored research institutes in technological support or providing testing equipment/machinery in TBIs is more crucial than ever. Each government research institute should reduce ownership focused resource mobilisation systems and build up usage focused ones.
- ◇ In Korea, TBIs can only survive in the specific environments offered by certain universities. Government and local self-governing communities should provide support for those universities on an experimental basis and expand according to the development of the surroundings. Technology support institutions for small and medium industry in particular should be more actively involved in technology development and venture creation supported through universities.
- ◇ Most Korean universities suffer a lack of capacity for TBI activities due to insufficient support. However, it is necessary to provide support and commitment as a university policy. Professors and researchers in particular should be able to dedicate themselves to the technology development support for domestic enterprises, most of which are encountering difficulties in international competition.
- ◇ Finally, the following are major factors for the successful operation of TBIs, based on examples in other OECD countries:
 - financial support from government/local self-governing bodies;
 - pooling imminent universities and technology venture founders;
 - remarkable incubator managers;
 - financing for tenant enterprises;
 - selection standards for tenant enterprises (business opportunity, technology, personal characteristics of the venture founder);
 - consideration of the diversity of TBI patterns, to select a suitable model for Korean climate (with considerations for cultural factors);
 - considerations for marketing by TBI tenants are required.

TECHNOLOGY INCUBATORS IN RUSSIA AND CENTRAL AND EASTERN EUROPE

Katya Samsonova, Consultant

Introduction

The purpose of this paper is to present an account of some of the recent policy measures to encourage small innovative and technology-based business creation in Russia and Central and Eastern European countries. An attempt was made to look more closely at technology incubators and various financing measures for technology-based firms in the recent years. However, insufficient information and the need to account for many intervening factors, given the present economic situation in these countries, have broadened the focus of this paper to include policies towards small business promotion in general. Technology incubators have not yet become an important policy tool in Russia and other transition economies, but in co-operation with the international community, steps have been taken to introduce them into the framework of economic reforms.

As part of the economic and innovation infrastructure, incubators have multiple stakeholders and pursue different objectives. In general, in the OECD countries four major categories of objectives have been identified by previous research:

- **Economic development:** incubators promote the creation of new firms, and in the case of technology incubators, technology-based firms. New firms create jobs, diversify the industrial base, target depressed regions, build a link between public and private sectors, provide an arena for addressing the problem of regional economic concerns. In each particular case, incubators can take on additional unique economic objectives. In the case of economies in transition, their unique function is to help utilise the huge idle potential of the declining research base of the former state-run science and technology, and create a new market structure of small innovative firms.
- **Technology commercialisation:** the benefits of the formation of the innovative belt around the academic institutions are two-fold. Innovative centres allow technology developed in such institutions to find immediate practical application. In turn, firms associated with the research institutions increase their credibility, prestige and access to a pool of highly qualified university faculty and graduates, libraries, databases and networks. In the case of Russia and other countries in transition, incubators associated with large academic and research organisations help identify potential technologies for commercialisation and co-operation with foreign partners. The reputation and credibility that small dynamic start-ups get from their internationally established hosts is a very important factor in the intergovernmental co-operation programmes. The need to create databases and provide training services also binds many new innovative centres with academic institutions.
- **Property venture/real estate development:** most technology incubators supply facilities at below market rates, that translates into a real estate subsidy to small-firms unable to afford

adequate premises, but having otherwise good chances for survival. Incubators, especially those located in science and technology parks, can also provide those parks with a source of future tenants and maintain high occupancy rates. In the case of the Central and Eastern European countries, there is a large mismatch between the stock of state facilities for innovation and economic needs and financing abilities of the regions. Poorly functioning property markets force many start-up firms to come up with unusual ways of utilising external fixed assets. However, such ingenuity does not promote stability and transparency of operations. Hence, an important role of incubators lies in creating a new explicit market structure of established small businesses, working openly in the formal economy.

- **Entrepreneurship:** this objective is of major importance in eastern Germany, Russia and Central and Eastern European countries, where the economies have been previously dominated by large state-owned firms. Entrepreneurship is increasingly recognised as a critical element in the process of innovation and the creation of technology-based firms. While large firms may create spin-offs, there is some evidence that the growth of new technology-based firms is associated with an increase in entrepreneurial activity. Incubators, in particular those related to the universities can provide useful training ground for entrepreneurs coming from the academic and research institutions, as well as for creating skilled labour force for the local markets. Creating networks of similar firms, and facilitating their links to investors is another valuable contribution of incubators to economic growth.

Issues and policies in promoting small technology firms in Russia

Technology commercialisation

Science and technology in Russia is widely acknowledged to have a huge potential. Much of the scientific knowledge, however, has not yet been commercialised nor even identified by domestic and foreign firms. Foreign companies and investors who have tried to expand on the Russian technological market have found it extremely difficult to identify and access commercially viable technologies and skills. The United States government began working with the Russian government through the Science and Technology Committee of the Gore-Chernomyrdin Commission on soliciting the views of US high-technology industries, and their Russian counterparts on ways to improve technology commercialisation. Given the range of issues and the role of governments in addressing the impediments to technology commercialisation, companies report a need to regularly brief their governments and explore the potential solutions to problems impeding technology commercialisation in Russia. Such briefings can also bring together private firms with similar interests. The Gore-Chernomyrdin Commission acts as a forum for such discussions.

Researchers trying to assess the commercial potential of Russia's technologies face a number of obstacles. Besides the lack of technical and legal information which inhibits the evaluation of technologies, it is difficult to obtain credible information about research organisations and small start-ups budding within them, as well as their areas of specialisation and expertise. According to surveys of US firms, even when information is available, it is often too general for technical and business analyses.

US businesses have suggested the need for information products, such as databases, that would identify the research centres and innovative companies by discipline, specialisation, and researcher. Education and training about technology commercialisation could also have a strong positive impact. Education and training are vital because Russia's relative lack of commercial experience and the non-commercial

orientation of Russian science leads to misperceptions about the nature of the commercialisation process and the value of Russian technologies.

There are two sets of education and training issues: evaluating the commercial potential of technologies and understanding the technology commercialisation process overall. Since research that is excellent from a scientific or technical standpoint is often not commercially valuable, scientists need to understand that a technology must not only be unique and excellent, it must also have an identifiable commercial application and be financially practical to develop. Scientists must also be aware of international practices regarding intellectual property rights, provision of samples, exclusivity, and other standard parts of the technology transfer process. Short-term intensive training courses for scientists and the development of Master's programmes in Technology Management started by some Universities in Russia is a good start, but cannot alone satisfy the high demand throughout the country.

Small business promotion

In European OECD countries about 70 per cent of all innovations are initiated and implemented by small technology businesses (Rothwell, 1991). Most research institutions and universities have technologies that need to be commercialised and small and medium enterprises are playing an important role in providing a link between industry and university-produced research. At the same time, small companies are capitalising on the facilities, libraries, databases, prestige, faculty and student body of the academic and research institutions. In the case of the economies in transition, the state universities and state research centres are experiencing severe financial difficulties following the restructuring of the academies and government research institutes. Setting up or participating in small innovative businesses represents one of the few ways for academic and research personnel to continue productive and dignified professional existence. Needless to say, profitable innovative SMEs can help prevent imminent brain drain and erosion of the domestic intellectual capital base by providing a viable alternative to employment abroad.

In Russia a small business is defined as a self-employed group of individuals or as an individual, organised into an entity, in which authorised capital of public sector bodies, charities, or businesses does not exceed 25 per cent of ownership shares, and the average number of employees is generally between 30-100 employees and does not exceed 60 for scientific and technical firms in particular. As stated in the Russian Federal Program of State Support to Small Businesses, the Russian government relies on small businesses to create jobs, provide the Russian market with competitive products, to contribute to regional development, to provide training for women, youth, handicapped, military people, and promote high technology and innovative businesses.

A number of laws and decrees have been passed to create a favourable environment for small business development in Russia: a Federal Law on State Support for Small Businesses in Russia, adopted in June 1995; a Presidential Decree to create the State Committee for the Support and Development of Small and Medium-sized Businesses, signed in June, 1995; a Presidential Decree on Immediate Measures of State Support for Small Businesses of the Russian Federation signed in April 1996; and a Federal Program of State Support for Small Businesses for 1996-1997, adopted in December 1995.

Among the Program priorities the following are worth special mention: stimulation of investment activities (risk capital funds, leasing development) and innovative and R&D business development. The principal provisions of the Program are: transition from pilot projects to the comprehensive infrastructure development of urban territories; greater emphasis on regional level programmes for funding; a shift from direct SME project support to the establishment of guarantee funds for SME credit lines; transition from

Federal funding to the principle of variety in funding sources; and linking SMEs to large corporations and financial-industrial groups.

According to the initial plan, the cost of the Program was estimated at 883 billion roubles (US\$ 190 million) – 707 billion from the Federal Budget and the remainder from regional and non-budget sources. A multiplier effect is expected to increase the number of SMEs by 1.5 to 2 times. Several other Ministries are also supporting small firms through specific “sectoral” programmes: for example, the State Committee on Industrial Policy is carrying out a programme on innovative business; the Ministry of Economy is implementing a programme on engineering; the Government Commission on Science and Technology is also working on these issues. All of them are dealing with different aspects of SME development through these overlapping initiatives.

The State Committee for the Support and Development of Small and Medium-sized Business (GKRP), created by a Presidential Decree in June 1995, plays a leading role in the implementation of the Federal Program of State Support to the Small Businesses. It also co-ordinates and oversees the Federal Fund for Small Business Support (tentatively: 1997- 200-250 billion roubles, data of US Embassy in Moscow) and executes small business low interest credit programme in all regions of Russia. Policies and programs for small businesses are, for the most part, realised at the regional or local level. By 1997, special administrative bodies or funds designated for the support of small businesses have been created in 50 and 70 subjects of the Federation respectively. Regional SME support programmes began to develop before the Federal Programs on the initiatives of the most dynamic regions. In December 1995, a law was passed, “On a Simplified System of Taxation and Accounting Small Businesses” that allows such businesses to pay only a single tax on their income. Apparently, however, problems at the regional level in the registration and accounting procedures have prevented the vast majority of small businesses from shifting to this system.

The State Committee also develops business relationships with similar organisations abroad to attract foreign direct investment in Russian small businesses. For example, the US Small Business Administration works closely with GKRP within the framework of the Gore-Chernomyrdin Commission, including its Committee on Science and Technology.

The latest programme, “Main Guidelines for SME Development in Russia and Its Support till year 2000” has been prepared on the basis of the 1996-97 SME support Program. The Guidelines focus upon the stimulation of innovative and investment activities, and aim at developing technological entrepreneurship in the formerly “closed” high technology cities such as Arzamas-16, Chelyabinsk-40 and Obninsk.

A network of small business support organisations was created in Russia over the last few years: including GKRP itself, Chambers of Commerce, institutions funded by USAID – 8 regional centres, 144 units for technical support for small and medium-sized businesses, 19 business incubators, among them a technology incubator in Moscow; 23 small business development agencies funded by the European Union’s technical assistance for the CIS programme (TACIS), business training centres (Morozov Project), regional information centres (funded by GKRP and federal/regional funds), and federal employment centres.

Table 1. Trends in Small Business Development in the Russian Federation

	In thousands					
	1992	1993	1994	1995	July 1, 1996	1996
Number of SMEs (end-year)	560.0	865	896.9	877.3	804.7	841.7
Number of workers (yearly average)	7076.7	8630	8479.9	8944.8	5619.0	6269.1

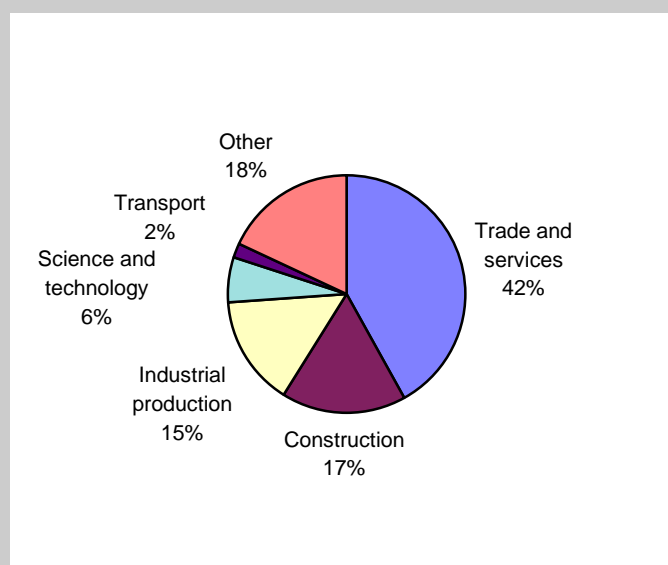
Source: OECD, 1997

Due to a new definition of a “small business” used in the data collection for 1996 in Table 1, these figures are not strictly comparable to previous years. Although the trend in the second half of 1996 was marginally positive, it nevertheless appears that the growth in small business creation and employment slowed down significantly, and may have even stabilised since 1995, with jobs in official small businesses standing at roughly 13 per cent of total employment. This can be compared to an average level of over 50 per cent in OECD and many other transition economies. Because of a large number of unregistered SMEs operating in the Russian “shadow economy,” however, these numbers should be interpreted with caution.

Box 1. Economic Statistics on Russian Small Business Development, as of January 1996

- 300 small businesses registered in Russia, and 1.5 million unregistered small traders;
- small businesses employ about 9 million people, that is 15 per cent of the working population;
- small businesses contributed 12 per cent of GDP and generated 20 per cent of the Russian exports in the first half of 1996;
- Russian small businesses profits constitute 35 per cent of total Russian industry profits;
- approximately 35 per cent of Russian small businesses are offspring of the large Soviet enterprises, the other 65 per cent are newly founded businesses;
- small businesses constitute 60 per cent of all enterprises in Russia:

By industry, per cent:



Source: Goskomstat, 1997.

The creation of small businesses is crucial for the transformation to the market economy and the democratisation of society, which is closely linked to privatisation. The economic transformation of the former state sector, dominated by large firms, to achieve economic efficiency and private initiative can be reached simultaneously by creating an enabling environment for new economic endeavours. For this reason, the development of SMEs is intrinsically bound up with privatisation.

But the recent years appear to be associated with very difficult times for both registered and unregistered small businesses in the Russian Federation. Surveys conducted in 1995 and 1996 found small businesses increasingly frustrated and pessimistic, complaining of liquidity constraints, increasingly scarce bank credit, high and unstable taxation, non-payment by customers, increases in the relative prices of energy inputs and transportation, crime and corruption. Russian SMEs operate in a more difficult overall environment than exists in many other transition economies. A recent comparative study found that it takes, on average, four times as long to set up a new business in Russia as in Poland, and that such businesses are subject to significantly more inspections and other cumbersome regulations. (Frye and Shleifer, 1997).

Crime and corruption are particularly widespread in the SME sector. In a February 1996 survey, supported by OECD, of 887 managers from Russian SMEs throughout the country, 57 and 50 per cent of all managers, respectively, considered "extortion based upon threats of violence" and "extortion by government officials" to be common occurrences. It was mentioned also that the local officials use legal and semi-legal means of extortion, including the manipulation of 40 to 50 tax rates and deductions, and common pressures to make various "voluntary" contributions to municipal funds.

The prime importance of policies at the regional and local levels for small businesses is reflected in a highly uneven development and geographic distribution of small firms throughout the country. According to Goskomstat, the Russian State Committee on Statistics, the city of Moscow accounted for 22 per cent of all small businesses and 19 per cent of small business employment as of 1 January 1997. The corresponding numbers for Saint Petersburg are 10 and 6 per cent respectively. By contrast, 28 regions of the Federation each have less than 4 000 (0.5 per cent of the total) registered small businesses of their territories (OECD, 1997a).

In the sphere of technological innovation the process of privatisation and setting up small high-tech companies is complicated by the difficulty of privatising the inventories of technological capital, that is usually referred to as defining intellectual property rights in the post-communist economies. One of the consequences of weak intellectual property rights for technology commercialisation in Russia is apparent immediately. On one hand, many start-ups face downward instability and even danger of disintegration, due to potential heavy losses in sales. On the other hand, the same missing link in the legislation appears to be a way to cut costs for many innovative firms: generally smaller markets, higher risks and difficulties in sales promotion, make the participation of inventor or designer indispensable for successfully launching products, and the need to have secured rights less pressing. Expenditures involved in securing intellectual property rights are considered unacceptable by many current managers of small technological firms. But it is obvious, that further delay in establishing a stable regime of intellectual property rights protection due the economic consideration mentioned above will hinder the development of small innovative companies in the long run.

Innovative and venture businesses are not registered in the official statistics. Some rough estimates show that about 40 000 innovative firms with 200-300 workers are now functioning in Russia. The sector of dealing with skilled scientific services in the fields of engineering, leasing, consulting is estimated to count about 3-4 000 firms and 20-30 000 workers, that constituted about 2.6 of total full-time employment in 1995.

Financing technology-based firms: the potential of venture capital and technology incubators

Given the economic situation in Russia, applied research experienced a dramatic decrease in state financing. Most industrial enterprises are dealing exclusively with short-term problems of financing their immediate survival and have neither the interest nor the means to pour resources into R&D. Neither do they have the necessary experience in strategic risk management. Many organisations suffer from broken links with the old partners in the former republics. Both industry and research institutions need to re-establish the old and create new efficient networks for regional co-operation, based on market principles. In these circumstances business and technology incubators, especially in their virtual form of “incubator without walls”, could serve as a cost-effective way to help newly created firms grow, as well as generating network externalities among firms linked via computer and telecommunications networks.

Similarly, the experience of OECD countries with the public support for venture capital, especially in the context of underdeveloped private markets, can be useful at this stage of Russia’s economic development. The Russian government has put forward an initiative to set up a venture fund by January 1998. OECD countries employ three main types of government programmes: 1) direct supply of capital to venture firms and small firms; 2) financial incentives for investing in venture capital funds or small firms; and 3) regulations, controlling types of venture capital investors.

The first type of scheme involves the greatest risk. Here capital is provided as equity investments and low-interest loans. The number of such programmes is increasing in the OECD countries. However, financial incentives are more widely used and are intended to stimulate private sector investment. They take the form of tax credits or deductions, loan guarantees taken out by small firms or venture funds.

The venture capital challenges confronting Russia and other economies in transition are significantly greater than those in most OECD countries. Industries in these countries are characterised by a top-heavy business structure and an underdeveloped small and medium enterprise sector. Some aspects of the banking system and capital markets remain underdeveloped and there is often a weak business culture. Fiscal constraints make funding for public programmes difficult. However, most governments are taking steps to address the lack of venture capital. For example, Hungary has enacted a new law to expand the supply of venture capital. In this context, technology incubators are viewed as a useful link in the system of venture financing. Managing a large number of small projects can be costly for venture funds, while an incubator can offer a consolidated package of preselected projects. The management team of an incubator can be delegated some of the responsibilities in handling the oversight of venture capital financing. At the same time, the venture fund is expected to allocate a share of its resources to financing incubator companies at preferred rates.

Prior to 1993 there was no institutional framework or functioning mechanism for providing state financial support to small enterprises in Russia. The situation changed when a number of foundations were created for SME support. The Foundation of Enterprise Support and Competition Development created in 1993, provided low interest loans as its main funding scheme. Direct subsidies were to be avoided and risk capital funds were developed. By mid-1995 the practice of direct project funding had almost disappeared. The major resources were to be directed to initiate special credit lines, piloted in the “Garantia”

programme in the Moscow and Tula regions. Federal Funds contributed 40-50 per cent to the risk capital funds. Risk capital funds are accumulated by the Foundation. The resources are placed into the most reliable instruments (mainly state securities), and reliable banks are selected for the programme. Small enterprise management submits a set of documents to a commercial bank in the region. After reaching a provisional agreement they apply to the regional SME Support Foundation for the loan guarantees or/and partial interest rate compensation. These funds are given to those who are able to back the loan at 30 per cent with their own assets.

In February 1994 the government of the Russian Federation created the Fund for Assistance to Small Innovative Enterprises. Since its creation, some 1 800 business proposals for funding were submitted by small innovative enterprises, 560 of which have obtained the Fund's support and which totalled 134 billion roubles. The Fund accepted projects covering more than 50 regions in Russia.

Given the economic circumstances in Russia today, the Fund is not trying to "actively" manage technological innovations; that is, it does not determine commercialisation priorities for the innovative firms, nor does it influence their organisational structure and financial behaviour through different types of development support. Instead, the Fund focuses its efforts on searching for and selecting firms that have already entered the market for high-tech products. It "passively" manages those firms that have designed the product and have secured intellectual property rights on it, embarked on commercial manufacturing of the product, and have managed to find prospective customers.

The Fund can only work with legal entities, rather than individuals, and provide credit facilities instead of investing in the businesses. The Fund's long-term goals are to develop a system of the most efficient methods of supporting small innovative businesses in Russia and ensure a gradual transition from the passive to active management of technology commercialisation.

At present the Russian market for technological products demands only non capital-intensive products, and small innovative companies only survive if they find niche markets, mainly in the following industries: pharmaceuticals; medical equipment and materials; construction materials; safety, control and diagnostic instruments and systems; technology for environmental control; computer software; food products, and household appliances. Advertising in specialised publications and participation in technical shows are the main mechanisms for promoting such products in the marketplace.

Small technology firms in Russia fall into two roughly equal groups according to the extent they make use of their own funds for technology commercialisation. The first group uses external financing, the premises and equipment of factories and institutions of the Russian Academy of Sciences, Ministry of Education and associated industries. Their own activity is limited to the design, assembly and modification of the final product and mechanisms of swap transactions.

The second group of firms has learned that cutting production costs by avoiding taxes on assets leads to the firm's instability, its low appeal to investors and problems in copyright protection. Such companies acquire fixed assets, either by taking up premises for manufacturing development, or accepting premises and equipment as part of the authorised capital stock contribution from their cofounders.

According to Mr. Bortnik, the general director of the Fund, the conditions for the transition from passive to active technology management in Russia already exist. To better capitalise on the world experience and the existing stock of management skills applicable to Russian markets, there is an urgent need to set up a system of business consulting for small technology-intensive firms. A wide network of technology consulting firms and business/technology incubators should be put in place, with or without international assistance.

International funding

In the interim period, transition economies are obtaining funding for such initiatives from international organisations, such as the European Bank for Reconstruction and Development (EBRD), the Eurasia Foundation, and the Enterprise Funds. The European Union's PHARE program provides early-stage funding for Central and Eastern Europe and its TACIS programme offers similar funding for the former Soviet Union. As these countries are trying to attract private finance, they may also tap into emigrant communities abroad. For example, an important source of venture capital funding in Poland has been the Polish American Enterprise Fund. Along with the money such investments brings comes valuable know-how for building the business community and raising the standards of the financial system. Foreign banks and organisations that are providing lending in this region state that training and building capacity with their local partner is the single most important factor that determines the success or failure of these lending programs.

International programmes that target SMEs in Russia are quite numerous: 156 SME support programmes had been funded by international institutions in Russia as of October 1995. These technical and financial assistance programmes were carried out by 53 donors including governments and international financial organisations. Germany alone sponsored 170 projects worth DM 75 million, 60 per cent of which related to the SME support. TACIS began its support of the SMEs regional agencies network in 1992.

The EU Commission began a number of SME support projects in Russia in 1992. The following list gives an idea of the kinds of projects that were in effect in 1995: Support of the network of SME Development Agencies (24 months, US\$ 4 million); Support for SME Development Agencies and the Business Communication Centres in Moscow and St. Petersburg (12 months, US\$ 900 000), Resource Centre for the network of SME Development Agencies (24 months, US\$ 2 million); Joint Opportunities Programme 24-36 months, US\$ 2.6 million); Joint Venture Opportunity Programme (24-36 months, US\$ 3.9 million); Organisation of a "Partnership" for the NIS (24 months, US\$ 1.8 million).

The USAID started an SME programme in September 1993 with funding of US\$ 40 million, allocated for four years. In total USAID provided US\$ 76.2 million for the Entrepreneurship Development Program in Russia in 1993-1995.

The EBRD established the Foundation for Small Business Support with resources of US\$ 303 million. In 1993, the EBRD launched the "Small Business Find Pilot and Extended Pilot" in Tula, Nizhniy Novgorod and Tomsk regions. Each year the programme is extended to include new regions. Other EBRD programmes aim to encourage the development of regional Venture Funds, and micro-credit systems. The latter grant loans of US\$ 20-30 000 to enterprises with 20 employed workers or less for a period of 6 months.

The Know-How Fund (KHF) has been active in SME support and development since 1990. It offers advisory, training and support services through contracted British consultants. Among others, the fund offers assistance to eight Russian Technoparks, jointly funded by TACIS. Other similar programmes have been initiated by Germany, Switzerland, Japan, Sweden, the Eurasia Foundation, and the Russian American Investment Fund. However, one of the most controversial issues concerns the sustainability of international assistance programmes, e.g. whether SME development agencies in Russia will survive after international donors stop supporting them. International institutions are careful to avoid the Moscow city area, which is more complicated to operate in, in favour of regional projects which often concentrate in the same areas. By and large, the actions of international donors tend to be poorly co-ordinated and there is a lack of continuity between different programmes and stages of the same project.

New infrastructure for innovation

In Russia there are three major groups of institutions for promoting innovation: technology parks, innovation centres, and business/technology incubators. They differ not only by the declared mission, but also by the time period in which the underlying concept was put into practice. The concept of technology parks was the earliest to appear at a time of large state support for science and “research giantism” (large-scale scientific research). Business and technology incubators, linked to higher education and research institutions, as well as to specific industrial and technological clusters are a much more recent phenomenon, being brought to Russia from the West, where they have proved themselves as important tools of technology and innovation policies. Innovation centres are even more recent. They resulted from the appearance of a wide range of small firms which have succeeded to achieve relatively large and stable sales and are looking for adequate office space and transparency in their operations.

According to Professor Nina Fonstein, executive director of the International Business Technology Incubator (IBTI), one of the Russia’s three exclusively “technology” incubators, the country still lacks another important component of the infrastructure for a developed innovation system: institutions that exclusively work on helping firms in the management of science of technology, that can conduct analyses of domestic and foreign experiences, publish the results and organise conferences, and carry out consistent monitoring of the development and practices of small innovative companies.

Technology parks

Long established in the West, the technology parks phenomenon in Russia dates only from the pre-reform days when the notion of technology parks first appeared in 1988 in a paper published in a Russian scientific journal. Moscow University was the first institution to experiment with the concept and St. Petersburg followed shortly thereafter. Around 50 technoparks were created under the auspices of the Ministry of Education but 90 per cent of them never really took off the ground to reach the stage of a developed institution. In 1991 a drop in government financing and changing social priorities forced most of the projects to remain in the planning stage or experience severe financial difficulties. Currently about 26 technoparks are in operation (see Annex). Most of them provide services similar to those of other institutions for supporting innovative firms (i.e. innovation centres, technology incubators) which makes it difficult to differentiate between them. In general, Russian technology parks:

- Provide start-up innovative firms with office space at a below the market rate for a limited time. The space is usually allocated at the business incubator of the given technopark. If the firm survives, it graduates to become a client of an innovation centre which usually hosts small companies that have proven their self-sufficiency.
- Provide firms with consulting services such as auditing, business plan drafting, assistance in raising funding and networking with other firms. Support is also provided for office services such as access to electronic networks (e.g the Internet), etc.

A good example is St. Petersburg State Electrotechnical University that leads and co-ordinates a number of national research programmes: Scientific Instrumentation, Technology Transfer, High Technology Products, Forecasting of Emergencies, Small and Medium Enterprises Incubation and others. The university maintains close links to many research institutions and industrial companies in Russia and abroad, and plays an active role in the numerous science and technology business spin-offs and incubators. The ETU technopark seems to act as a host for a technology incubator – by bringing various

companies and projects in a single building complex, located on campus, and offering its members basic business services, financial investment and training.

Other similar organisations in St.-Petersburg include the Baltic International Technopark and the St. Petersburg Cybernetics Technopolis, which focus on the areas of computer integration and automation, information network and databases, training for experts, and provide assistance in finding a commercial Western partner and other sources of financing.

Business Innovation Centres

Contrary to technology parks, business innovation centres (BICs) are a more recent development. The BICs' goal is to be self-sufficient and help new firms commercialise viable technologies. Innovation centres are being set up in the wake of the emergence of a number of small innovative companies with large and steady sales. Most of them, however, lack adequate office space or their landlords cannot guarantee them stable, reliable and modern facilities. Such firms seek to relocate to premises that would be long-term and convenient enough, but affordable. They re-locate in the innovation centres, because in spite of their sales, they are still unable to rent modern office and production space directly or invest in refurbishing old buildings. The firms are also looking to make their operations more open to public scrutiny and regulation. Locating within the innovation centre is often considered an important commitment to transparency in their further development.

Innovation centres take applications from the independent self-sustaining companies and can be physically located within technology parks. Candidates are required to show a good record of sales from the previous years, and secured intellectual property rights on their products. They are essentially provided with a soft loan for up to 10 years, and in return are expected to guarantee enough steady cash flow to cover monthly utilities expenses. The reconstruction of space in the innovation centre is tailored for previously selected companies and every possible effort is made to guarantee stable long-term agreements for holding office space (for list of BICs see Annex).

Business and technology incubators

Policy makers in Russia are generally aware of technology incubators and their role in technology commercialisation. The need is often voiced to orient more existing business incubators to launching innovative companies. For comparison, according to a US survey by the National Association of Business Incubators, technology-based firms account for about 22 per cent of incubator clients.

Russian business and technology incubators have as their main aim to stimulate industrial restructuring by way of creating a wide range of small and medium firms. They absorb excessive labour force from bankrupt or downsizing former state enterprises, and create a new class of entrepreneurs. It is well understood that business incubators can reduce the risk of starting up a company or making an investment in a new company, create an enabling professional environment for businesses at the beginning of their learning curve. In the current economic climate in Russia, re-establishing broken commercial links and developing new regional markets is seen as another main goal of business incubators. Recently a National Association of Business Incubators (NSBI) was created in Russia in order to facilitate the exchange of information and experience. Twenty-two organisations were among the founders of this Association which brings together successful incubators from the most western parts of Russia to eastern Siberia (see Annex).

As of this date, however, there are only three organisations in Russia that can be classified as exclusive technology incubators: International Business and Technology Incubator (IBTI) in Moscow, one in Nizhnyi Novgorod, and another one in Tomsk, created with the assistance of IBTI. All these incubators are “virtual” incubators or incubators without walls. The traditional type of incubators do not easily accommodate the economic and political realities of Russia today. In order to stabilise the economy by building business bases in various regions of the country, it is important that key scientists and technical personnel remain in their present laboratories and institutes. The large number of firms attempting to establish themselves, usually still inside the parent organisation, and intricacies of their selection, warrant the creation of “virtual” incubators. These incubators are also seen as a cheaper alternative to building costly physical facilities in the current unstable economic environment. The IBTI has offered tutelage over three more prospective regional incubators, but so far the Federal government has not allocated funding for this project. Some regional authorities have volunteered to share the financing burden, but no action has been taken yet.

Case study: International Business and Technology Incubator (IBTI)

In order to maintain this type of decentralisation of technical activities and still provide administrative and financial support as well as business training, a first “virtual” incubator was funded under a multi-year grant from the US Agency for International Development (USAID). The resulting initiative, called the International Business and Technology Incubator (IBTI), is presently located in Moscow on the grounds of the Academy of National Economy (ANE), Russia’s leading graduate business school. The IBTI is managed and operated by Atlas Group, Inc (AG) under a sub-contract from the Virginia Polytechnic Institute and State University (VPI).

The IBTI’s original charter uses part of the USAID grant to fund selected technology projects submitted by the entrepreneurial Russian research institutions and individual scientists and engineers and to support private technology-oriented enterprise development. Through demonstrated performance, the IBTI has gained recognition from various outside sources, including the Russian government, who have also committed to provide additional funding and loan guarantees to a number of IBTI-approved projects. Virginia Polytechnic Institute and State University is the prime contractor under the USAID grant. In this capacity, the Institute provides administrative oversight and selected technical consulting services to the programme.

Atlas Group, Inc. is acting through its corporate headquarters in the suburbs of Washington, DC, and has overall IBTI technical and operational responsibility. Atlas established its operations in Russia in 1991 and has five offices in Moscow and Krasnodar. The company’s management of IBTI operations includes the Moscow-based physical facility as well as the professional and support staff. This staff establishes and implements the methods and procedures for proposal solicitation, evaluation, and sub-grant award recommendation. Experts in specific technical or scientific disciplines augment the IBTI staff when such expertise is needed.

Felix Technology International, Inc. (FTI) is an American-owned affiliate of Atlas Group. The FTI’s staff assists in evaluating the business potential of candidate projects and seeks to form joint ventures and other joint business arrangements with US industry partners and outside funding sources. On the Russian side, the Academy of National Economy hosts the IBTI facility and administers the business development training component of the programme. Curricula and training material are developed jointly between ANE and VPI. The instructional faculty is composed of recognised US and Russian leaders in their respective fields of specialization.

The IBTI activities are carried out in both the US and Russia. The US effort concentrates on proposal review, project selection, business planing and assistance, and serves as a liaison with US industry. The Russian effort centres around the establishment and operation of the IBTI. This unit is staffed entirely by Russian personnel, working under the direction of Nina Fonstein, the IBTI Executive Director.

Requests for innovative projects that can lead to the formation of small businesses within the Russian Federation are solicited through mailings, advertisements in professional publications, and media publicity. Direct contacts with the Russian Government agencies responsible for science and technology also play an important role in generating selected projects.

Applications for funding support are reviewed by members of the IBTI professional staff who make a preliminary determination of technical feasibility and practicality, market potential, investment requirement, and potential profitability. The screening process eliminates proposals that are of no interest, flags areas lacking sufficient information, and identifies potential candidates for support funding.

Successful candidate proposals are then analysed in detail. Technical feasibility and viability are verified by technical experts in the field. Marketability is confirmed through analysis of demand, competition, and niche availability, in both domestic and foreign markets. Financial analysis of cost, investment projections, and such key parameters as return on investment, profitability, cash flow, etc., are performed concurrently. The results of these projections are then utilised in the review of the submitted business plan.

Candidate project applicants gain their business planning skills by attending an intensive business development training programme at the Academy of National Economy. Funding for development and delivery of these courses is included in the USAID grant. IBTI also conducts similar courses for outside groups of Russian engineers, as well as representatives of government, banks and industry. The revenue received from this initiative is used to support and expand IBTI activities.

Upon completion of the above analyses, a “due diligence” investigation of the potential recipient of IBTI funding is conducted. This process is supervised by Russian-born US citizens with experience regarding such issues as ownership, privatisation, financial audits, cost realism, personnel qualifications, and adequacy of facilities.

Proposed projects that remain attractive after undergoing these analyses are presented to an IBTI senior management panel for review and approval of recommendations. Those that are approved are then authorised to receive support funding. Whenever possible, support finding is provided in the form of low-interest loans at attractive interest rates or small grants. IBTI also makes direct equity investments in projects that warrant such action.

The IBTI recognised from the outset that the funding support capacity and authority embodied in the USAID grant is, at best, “seed money” that must be supplemented in order for most projects to mature into viable business entities. As a result, IBTI initiates searches for additional foreign and domestic funding and/or US industry partners for possible joint ventures. IBTI attempts to apply Russian matching funds to critical stages of projects at the level of feasibility verification, proof of concept, or prototype manufacturing. The Western funds are usually introduced as the second level of financing. Identification of such financial support is the responsibility of Fenix Technology International.

Box 2. IBTI activities as of June 1997

Currently the IBTI Incubator has a portfolio of 400 research projects which were reviewed and assessed for their technical novelty and commercial potential. As a result 25 projects have been selected for funding. Each project has been supplied with seed funding of \$25 000. To supplement the seed money, the IBTI has raised additional funds in the form of equity financing from the Federal Fund for Assistance to Small Innovative Firms.

Eight of the 11 completed projects have already been launched in the market, and some have already started making profits. These projects are expected to bring returns of about 40 million US dollars (based on business plans developed jointly with US partners), provided there will be a flow of future investment of 5 million US dollars.

The IBTI is soliciting and receiving proposals from all regions of the Russian Federation. A wide variety of candidate projects are evaluated and considered for support funding since few restrictions on technology and its implications are imposed. The IBTI plans to expand interaction with geographically dispersed incubators. Such incubators are intended to serve the needs of specific regions and municipalities within the Russian Federation. The formation of these incubators is driven by the character of existing facilities and available manpower skills that can survive and grow in a free market economy. The IBTI is being developed into a replicable model to be utilised for the development of regional incubators like the one in Tomsk.

The IBTI also promotes the development of industry-specific incubators. Such incubators are intended to serve the needs of a particular segment of industry or government, which may or may not be targeted for privatisation. In some technologies it is possible that a two-way transfer of technology can be achieved. The IBTI provides oversight and guidance for these incubators as they are formed. The IBTI operations augment ongoing business incubators with the technical procedures and expertise that are missing or inadequate in their current business-oriented support services. These are exemplified by some of the business incubators established under USAID grants in various cities within the Russian Federation (see below - the Morozov Project).

The founders of IBTI believe that while each of these incubators is established to meet a narrower set of objectives, the methodology and infrastructure developed for IBTI can be transferred and scaled to the specific requirements of each such client incubator. To reduce cost and provide ready access to technical speciality experts, it is planned for the IBTI will be the hub of a distributed incubator network. In this capacity, the IBTI provides expert evaluations of candidate projects and funding recommendations.

Spillovers between the development of business and technology incubators: the Morozov Project

As mentioned above, the IBTI shares its expertise and procedures with incubators that are not necessarily concerned with promoting technology firms. The main example in this case is the so called Morozov project – a network of business incubators headquartered in Moscow, with pilot incubators in Tula, Orekhovo-Zuevo, Borovichi, Voronezh, Samara and Perm. The project resulted from the USAID funded participant training programme for business training centres' directors in San Diego, USA in 1994. Each business incubator reflects the specific economic realities of its region, such as military conversion, high technology, agriculture or food processing.

The Morozov project is closely linked to the Austin Technology Incubator (ATI) in the US which provides potential incubator managers with the tools and support to initiate incubator programmes in their communities through participation in training programmes sponsored by the ATI. Participants learn about development of strategic alliances, tenant recruitment and evaluation, facilities management, and the

services sector, such as shared resources, consulting, security. The ATI also assists in development of incubator operations manuals and on-site consulting.

Although most of the business incubators foster non-technology entrepreneurship, the spillover effects are significant. While technology incubators, like the IBTI share their practices with the general business incubators, they themselves indirectly create demand for new small technology firms to provide high-tech products which help develop the business infrastructure. Thus, with the help of Borovichi, a town implementing Morozov's business incubator programme, the city of Novgorod set up a small telephone company to compete with the state enterprise that had a monopoly on the local telephone service. That led to lower prices and better phone coverage for the residents of the city, as well as improved quality of the phone service for the Novgorod Business Park, which, among other businesses, hosts a company that manufactures television sets. The new small private telecommunications company, which produces digital telephones had to submit a business plan for the business incubator competition at Borovechi incubator. At the time it already had 20 clients. Today the company not only competes against Novgorod's former state monopoly, it is also making a profit. Such spillover effects on the local economy resulting from co-operation between business incubators with technology firms, and technology incubators with private businesses, are filling the gaps in the developing infrastructure for private markets.

Experience from Poland, Hungary, and the Czech and Slovak Republics

Business Innovation Centres and Innovation Relay Centres

The German Association of Technology and Business Incubation Centres (ADT) plays a co-ordinating role in maintaining the network of innovation centres in Central and Eastern Europe defined as "an infrastructure-based venture for the establishment and growth of firms". Related goals include the development of innovation in the region, co-operation between researchers and industry; provision of information and technical and management training; and strengthening regional economic development through regional and international networks for information exchange and co-operation between firms.

Europe now has over 1 000 business incubation centres and technology parks, that are united into NICE - Networks of Innovation Centres in Europe. The network includes both regional and national networks, as well as cross-border and international networks. Germany's network of technology and business incubation is the largest national network in Europe. This fact, and the country's central European location, and its experience in German reunification gives Germany a special role in shaping co-operation in this field.

In the framework of its TRANSFORM consulting programme, through the Association of Technology and Business Incubation Centres, the federal government is supporting 6 pilot projects for establishment of technology centres and business incubators in Eastern Europe, including centres in Russia (Vladimir), Poland (Gdansk), Belarus (Mogilev), Ukraine (Saporozhje) and Latvia (Riga) and a new project is underway in Lithuania (Kaunas).

Another group of relevant organisations is the network of Fellow Member of Innovation Relay Centres (FEMIRCs) of the Central and Eastern European countries. It consists of ten centres, many of which involve several local partners. The FEMIRCs began a two year operation on 1 January 1997. Each FEMIRC is paired with an EU Innovation Relay Centre. Poland, Hungary, and the Czech and Slovak Republics each participate in this network (see Annex).

The main objective of the FEMIRC is to contribute to the integration of the CEEC with the European Union by exploiting and developing their industrial potential and by establishing an infrastructure for information and advice on technology transfer and on Community Research and Technological Development (RTD) activities which will facilitate the participation of organisations from CEEC in Community RTD programmes. Each FEMIRC plays an important role as it is expected to become the focal point for information, advice and co-ordination in the geographical area it covers. The relay centres work closely with the national authorities responsible for R&D and industry.

In order to achieve their objectives, the network of FEMIRCs offer their clients the following services:

- information and advice on community RTD activities: electronic networking and databases; assistance in the submission of proposals to Community RTD programmes and search for partners, e.g. guidance/advice to local clients for identifying opportunities in Community programmes; information to interested organisations in the EU on the RTD potential of organisations in the geographical area covered;
- technology transfer and innovation tasks: awareness actions on innovation, such as seminars, conferences, publication of targeted newsletters and brochures, company visits, etc.; assistance on issues like intellectual property and integration of new technologies; training in technology marketing, locally and in the local language; assisting local companies in the definition of their technology requirements, in the identification of external technology suppliers and in the absorption of new technologies (e.g. company visits, technical audits, development of databases after the requirements of local companies, organisation of workshops, seminars, partnering events, participation in exhibitions, direct contact with SMEs and other pertinent players, publication of technology opportunities in relevant media).

Poland

Like other countries in central and eastern Europe, Poland has established business and technology incubators, sometimes in co-operation with international support, as a means to support industrial restructuring and provide research personnel with assistance in starting a business. In addition to small business creation, a main goal of incubators in Poland is to increase university-industry relations as illustrated by the establishment of an incubator at the Warsaw Technical University in 1990 and the New Technology Centre (Table 2). Germany is currently sponsoring the establishment of an incubator in Gdansk as part of its TRANSFORM programme. The *OECD, Review of National Science and Technology Policy, Poland 1995*, found that the short-term impact of incubators had been relatively weak. Efforts are underway to improve the planning of incubators and raise the quality of services provided to tenant firms as well as exchange experience among Polish Incubators.

Table 2. Incubators and technology transfer centres in Poland

Incubator	Type of activity
Enterprise Development Centre at the Warsaw University of Technology	Setting up small enterprises, availability of premises, technical and information services
Incubator Foundation Lodz Centre of Technology Transfer	Setting up small enterprises, transfer of technology from university to practice
Wroclaw Centre of Technology at the Technical University in Wroclaw	Transfer of technology from university to industry
Centre of Technology Transfer at the "MARR" Agency of Regional Development	Setting up new enterprises, development of advanced technologies in the region, restructuring of industry
Centre of Technology Transfer in Gdansk	Setting up new small enterprises, transfer of technology from university to industry
High Technology Park in Poznan	Setting up new small enterprises, transfer of technology from university to industry
Business Incubator in Starachowice Agency of Regional Development	Regional restructuring of industry, providing new jobs
Regional Development Association	Providing new jobs
New Technology Centre in Warsaw	Transfer of technology from university to industry

Source: Wlosinski (1997).

Hungary

Hungary believes that its science and technology parks should play the leading role in the industrial restructuring, solving its employment problems, commercialisation of technologies that would meet European standards, and creation of adequate infrastructure and training facilities. The Hungarian government promotes growth of the science and technology parks with grants and interest-free loans from its economic development funds. These funds support the infrastructure for investments and export marketing. The government also grants corporate tax exemption and facilitates authorisation of new projects. The local municipalities give industrial parks located on their territories temporary tax breaks.

Other networks of innovative firms in Hungary include the Entrepreneurial Incubators Association and Hungarian Association for Innovation. The latter has provided a list of institutions that it considers to be proper technology incubators: Industrial Technology Centre (Budapest), INNOSTART National and Innovation Centre (Budapest), Science and Technology Park (Debrecen), INNOTECH (Budapest), Central Research Institute for Physics (Budapest), TALENT (Szeged), Regional Innovation Centre of Veszprem (Veszprem), Innovation and Technology Transfer Centre of Miskolc, Innonet Innovation and Technological Centre (Gyor).

Czech Republic

In 1990 The Czech Republic established its Society of Science and Technology Parks (SSTP) at the Ministry of the Interior. Members of the Society aim at speeding up the implementation of innovations in manufacturing, technology and services, and turning the STPs into an efficient tool of structural changes in the regions, in active employment policy and the creation of small and medium-sized enterprises. The Society proclaimed the following goals:

- to establish high quality facilities for activities of technologically oriented small and medium-sized innovation companies;
- to accommodate the technology transfer in the broadest sense of the word both on the Czech and international markets;
- to develop educational and training activities aimed at technical creative work and innovation entrepreneurship.

The SSTP regroups three types of institutions for promoting technology and innovative firms: science parks, technology parks, business and innovation centres. They are operated by the R&D institutes, urban authorities, district labour offices, industrial and commercial organisations. Many of them are being started in the border regions, funded by PHARE and other similar programmes. The usual selection of services offered includes: assistance in designing business plans, technological, legal, patent and marketing advisory service, training courses and a standard set of technical and office services, such as telephone, fax, photocopy, computer networks and conference facilities.

One of the oldest members, the Business and Innovation Centre BIC CVUT in Prague was founded in 1991 by the Czech Technical University and the Society of the Science and Technology Parks in order to assist in creation and development of small and medium-sized innovation companies in mechanical, electric and civil engineering – the main fields of research of the University. The selection requirements are a solid business plan, requirements of the region and environmental considerations.

A business and innovation centre in the city of Brno was established within the framework of an EU project for support to small- and medium-sized innovative firms in the region of South Moravia. The centre's main goal is to co-operate with the city of Brno to support business activities of local innovative firms and assist in their co-operation with foreign partners. The projects considered for admission must demonstrate originality and win approval of the business centre incubator council. The Business and Innovation Centre in the city of Plzen is another example of co-operation between the city authorities, the local university and the research organisations. The Incubator has just moved to its new premises with offices and production space in the new developing area of Plzen-Na Borech.

The new wave of privatisation of state companies spurred the growth of a new generation of innovation centres, like the Technology Park INCEL in Prague. The technology park was established on the basis of TESLA – the Research Institute for Communication Technology during the second wave of privatisation. Its goal is to support new private companies in the field of electronics, see them through their growth and introduce them to the market. New emerging companies use the equipment and space of the TESLA that enables them to have access to under-utilised high quality facilities of the former state-run organisation.

Slovak Republic

In the Slovak Republic, the Association of Slovakian Technology Centres regroups 16 members. The FEMIRC Slovakia is part of the network of 62 European Innovation Relay Centres whose goal is to improve the competitiveness of European industry through innovation. The FEMIRC Slovakia aims to improve the competitiveness of Slovak firms and institutes by providing them with better access to European R&D resources and by integrating them into the European technology community. Another institution, the Business and Innovation Centre in Bratislava, combines elements of a business incubator with those of a business consultancy. The BIC provides working space, assistance in financing, computer services, and a regular set of business consultancy services.

The FEMIRC Slovakia was established by three consortium partners: Business and Innovation Centre (BIC) Bratislava Ltd, BIC Group Ltd, and Slovetechnentrum Ltd. BIC Group is a consulting company that is providing comprehensive consultancy for enterprises involved in commercialisation of innovations in the area of overall company analysis, business plans, loans acquisition, restructuring, enterprise development preparation and implementation. It provides assistance in management system innovation, production innovations, product innovations, and business activities innovation.

In the category of production innovations, the company provides assistance in development of the investment plan for obtaining credit; assistance in obtaining credit for the purchase of a new technology; leveraging funding for development of a technology, introduction of new technology. Product innovation is understood as support in leveraging funds for research, development and introduction of the innovated product; and introducing the innovated products in manufacture.

According to the context of work defined for the FEMIRC, the areas of activities are the utilisation of the European R&D results and transnational technology transfer, as well as the participation of the national target groups in the community RTD programmes. The FEMIRC supplies information on the community RTD programme, calls upon the candidates for their proposals, provides assistance in submission of the proposals with the aim to increase the number of successful proposals and to promote international co-operation between the Slovak and EU research and technological development institutions. The FEMIRC disseminates information and promotes the absorption of the community RTD results by communicating them to the potential users of the local industry. This aim is achieved through the element databases such as CORDIS, results and partners are matched according to the international and local requirements. The FEMIRC provides assistance on transnational technology transfer based on the demand and offer of the Slovak industrial companies. Using the European innovation relay centre network and technological databases, the FEMIRC supports technology transfer from the EU to the Slovak industry and vice-versa, from the Slovak RTD institutions to European companies.

Conclusions

Among policy makers in Russia and Central and Eastern Europe, there is an appreciation of the role of business and innovation centres as broadly defined by the German Association of Technology and Business Incubation Centres (ADT): “an infrastructure-based venture for the establishment and growth of firms”. The ADT, along with other European and US institutions, is playing an active role in co-ordinating, expanding and funding the growing networks of knowledge-based ventures. The main goals of such organisations are understood to be: promoting technology commercialisation as part of rebuilding the science and technology management systems and developing the economic potential of the regions and employment creation in the light of privatisation, unemployment in industry and among research personnel, and the drop in funding to state supported research organisations. Perhaps one of the most important contributions of innovation centres and technology incubators is providing technical and

management training, and creating a network that strengthens firm to firm co-operation and information exchange between new firms at their early stages of development.

In the case of Russia, general business incubators are more widespread than technology incubators, but efforts are underway to increase support for the latter. Several factors, however, remain deterrents to starting small businesses, and many technology firms take a long time to legalise or “regularise” their existence. As of today there appears to be only three technology incubators, strictly defined, all of them originating from the USAID grant to set up a model incubator in Moscow. But other types of incubators and innovation centres provide support for technology-based firms. There are attempts to expand the IBTI type of technology incubator but problems with financing even the virtual type of incubators in the regions are an important obstacle. Most financing for regional incubators is in the form of foreign government grants and soft loans. New forms of equity financing are slowly appearing, and there are proposals to create the first Russian venture fund by January 1998.

Technology incubators are expected to provide a good nurturing environment for a large number of small innovative businesses that are growing out of the old system of state-run science. In their virtual form, they could help to rebuild the decentralised research and industry network, by keeping and augmenting the research and economic base in the regions. They can also provide ready-made management teams for the future venture funds. Regardless of the official name of the new infrastructure elements being put in place in these economies by governments, domestic organisations, individuals, and their international partners, the spillover effects of such efforts are very important. There is a growing network of organisations promoting entrepreneurship and efficiency based on solid market principles, and technology incubators have a future role to play.

ANNEX: TECHNOLOGY INCUBATORS AND RELATED INITIATIVES IN RUSSIA

Innovative Technological Centers

Name	Location
Science Park of Moscow State University	Moscow
BIC MGUET	Moscow
Technopark Center	Moscow
IBC New Technologies	Moscow
Science Park "Ismailovo"	Moscow
Center of Cooperation with Innovative Firms at Universities	Moscow
Technology Complex at the Center of Photochemistry	Moscow
ITC of ETU	St. Petersburg
ITC of Regional Fund for Science & Technology of S.P.	St. Petersburg
BIC "Energy and Electrophysics"	St. Petersburg
ITC MUBINT	Yaroslav
Regional ITC "Uralsky"	Ekaterinburg
Vladimir ITC	Vladimir
Tatarstan ITC	Kazan
STP "Novosibirsk"	Novosibirsk

Source: Federal Fund for Assistance to Small Innovative Enterprises.

Technoparks in Russia

Name	Institution	Location
Altai Technopark	Altai State University	Alta, Barnaul
STP Mosecotech-Gang	State Academy of Oil & Gas	Moscow
STP Daltech Park	Far East State Tech. University	Far East, Vladivostok
STP Kazan	Kazan State Tech. University	Kazan
Tatarstan	Kazan State Tech. University	Kazan
STP of Moscow State University	Moscow State University	Moscow
STP Avtoprogress-21	Moscow Academy of Auto & Tractor Design	Moscow
International STP "Technopark in Moskvorechye"	Moscow Institute of Engineering & Physics	Moscow
STP of Zelenograd	Moscow Tech. University of Electronics	Zelenograd, Moscow
Moscow Institute of Energy	MIE	Moscow
STP Novgorod Technopark	Novgorod State University	Novgorod
INEGRO	Obninsk Institute of Atomic Energy	Obninsk
STP Sosnovy Bor	Perm State Tech. University	Perm
STP Karelia Business Incubator	Petrozavodsk State University	Petrozavodsk
STP Aviatechnokon	Samara State Aerospace University	Samara
Technopark v Lesnom	St. Petersburg State Tech. University	St. Petersburg
Technopark ETU	S.P. State University of Electrotechnology	St. Petersburg
Volga Technika	Saratov State Tech. University	Saratov
Volga	Saratov State University	Saratov
Tver STP	Tver State University	Tver
Tomsk International Business Center Technopark	T.S.A. of Control Systems & Radio Electronics	Tomsk
Tula STP	Tula State University	Tula
Ulyanovsk Technopark	Ulyanovsk State Tech. University	Ulyanovsk
STP Uralsky	Ural State Tech. University	Ulyanovsk
Bashkortostan	Ufa University of Aviation	Ufa, Bashkortostan
STP Yaroslavia	Yaroslav State University	Yaroslav

Source: Federal Fund for Assistance to Small Innovative Enterprises.

National Association of Business Incubators: Business Incubators of Morozov Project

Name	Location
Academy of Management & Markets	Moscow
International Business Incubator	Volkhov
Russian Center for Promoting Youth Entrepreneurship	Moscow
SME Fund	Ekaterinburg
Novocherkassk Industry-Humanities College	Novocherkassk
“RITM”	Moscow
Urals Regional Fund “Progress”	Ekaterinburg
“Technopark”	Zarechny
“Partnerstvo”	Orekhovo-Zuevo
Bryansk STP BI	Bryansk
Association “Business Incubator”	Voronezh
Voronezh Regional STP	Voronezh
Irkutsk Youth Business Incubator	Irkutsk
Regional Business Incubator	Obninsk
Omsk Regional Business Incubator	Omsk
Uralsky Business Incubator	Perm
Karelian Innovation Center Business Incubator	Petrozavodsk
Rostov Regional Business Incubator	Rostov-on-Don
Samara Innovation Business Incubator	Samara
Povolzhye Regional Business Center	Saratov
Tula Regional Business Incubator	Tula
Ulyanovsk Business Incubator	Ulyanovsk

Source: Federal Fund for Assistance to Small Innovative Enterprises.

REFERENCES

- IMI Facts and Statistics on Small Business Development in Russia, American Embassy Moscow, January, 1997.
- Proceedings of Technocon '97 (1997), International Conference "Technology Development & Commercialisation: Russian and Global Experience", July, St.Petersburg.
- OECD (1997), "Technology Incubators: Nurturing Small Firms", Background report for the Workshop on Technology Incubators, 25 June, Paris.
- OECD (1994), *Science, Technology and Innovation Policies*, 2 volumes, Federation of Russia.
- OECD (1997a), *Economic Review - Russian Federation*.
- OECD (1997b), forthcoming), *Small Enterprises in Russia: Current Status and Development Policies*.
- Catalogue, Science and Technology Parks in the Czech Republic (1996/97) Society of Science and Technology Parks.
- International Business and Technology Incubator (IBTI, 1997), Information Materials. IBTI, Moscow.
- Federal Fund for Assistance to Small Innovative Enterprises (1997), unpublished data collected from national sources and prepared for the OECD Working Group on Innovation and Technology Policy.
- FRYE, T. and A. SHLEIFER (1997), "The Invisible Hand and the Grabbing Hand", American Economic Review Papers and Proceedings, Vol.87, No.2.
- ROTHWELL, (1991), External Networking and Innovation in Small and Medium-sized Manufacturing Firms", in *Technovation*, Vol.11, No.2.
- WLOSINSKI, W. (1997) unpublished data collected from national sources and prepared for the OECD Working Group on Innovation and Technology Policy.