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High-Tech Centres and Regional Innovation : Some Case Studies in the UK, Germany and Japan

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1. Introduction

In recent years there has been considerable interest in regional development policies which emphasize new technology and innovation. The high-tech centre(HTC) is one of these innovation-oriented regional policies. The emphasis by so many countries around the world on the stimulation of high-tech industry through HTCs and other initiatives is based on the assumption that technological innovation leads to economic growth(Lowe, 1985 ; Simie and Janes, 1986 ; Oakey, 1988 ; Grayson 1992). But the HTC is not a uniform concept. There are a great variety of types and development processes in different countries and regions.

Because the concept is relatively new, even experimental in some areas, there remain unanswered questions and important issues concerning the dynamics of creating and sustaining HTCs that need to be addressed and better understood. The most important issues are how a HTCs are effective as a instrument of regional innovation policy and for stimulating technology-led economic development. This paper highlights these questions and issues in four sections. The first of these outlines the concept of HTCs. The second describes the role of HTC policy as a whole. The third section examines the experience of three countries with different approaches to HTC policy(UK, Germany and Japan). It considers the background and development of HTCs, the extent of public and private sector involvement, and evaluates their effectiveness. Finally, the main characteristics of HTC development in the three countries are compared. In conclusion the results are evaluated and some lessons for the future development of HTCs are highlighted.

2. The Concept of High-tech Centres

Definitions of High-tech Centres(HTC) vary considerably around the world and there are significant variations occur within inividual countries. However, the essential concept is one of spatial development where the interface of research with commerce and industry is encouraged for the better exploitation of advanced technology. We can use the term 'High-tech Centre' in the broadest sense to denote property based development sometimes related to urban redevelopment, which has the objective of facilitating and prompting the growth of high-tech firms through technology transfer and cross fertilisation, in association with a higher education institution (HEI) or a centre of research (Porter, 1991). Two kinds of HTC development have emerged : Science Parks and Technopolises.

A Science Park is a property-based initiative which(UKSPA 1989) :

—has formal links with a university or other higher educational and research institution(HEI) ;

—is designed to encourage the formation and growth of knowledge based businesses and other organizations normally resident on site ;

—has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site.

Within this definition, it is also possible to identity several sub-forms which complement other initiatives designed to stimulate a more productive relationship between industry and academia. Innovation and Incubation Centres are defined as developments within a restricted space in tended primarily for new start-up firms ; Science Parks or Technology Parks are defined as "larger areas of land suitable for knowledge-based firms of different sizes and stages of development, usually, though not necessarily in landscaped surroundings"(Curie, 1985). The planning framework should be sufficiently flexible to permit 'light manufacturing'. Research Parks are defined as being similar to Science Parks but the planning framework is more rigid, permitting only prototype manufacturing(Monck et al, 1988).

The Technopolis concept emphasised the need for a balanced approach to high technology development. Instead of only focusing on technology it involves the creation of new settlements, complete with research parks, new universities, technology cen tres, housing and cultural facilities (Tatuno, 1986). Masser(1991) has pointed out that Technopolises are larger in scale and often linked to the development of infrastructure and facilities on the new town model, whereas Science Parks are more limited in scope. Technopolises also tend to be more production oriented than Science Parks. Technopolises tend to have both national and regional objectives. The national technological objective is to offer to high-tech industries adequate industrial land and an environment suitable for creative research. These resources have become scare in the major metropolitan areas. Consequently the regional technological objective is to promote technological development in less developed areas. For this purpose, physical, scientific and institutional infrastructure is developed in a decentralized pattern by a combination of measures taken at the local and regional levels and by national government(Stohr et al, 1992). A useful distinction between two types of Technopolis can be made according to their focus and activities. Cities with many high-tech production firms but relatively few basic research institutes are Technopolises. Conversely 'Science Cities' are areas dominated by basic research institutes, which have relatively few high-tech production firms. These two terms and the type of communities they represent are not mutually exclusive(Rogers and Dearing, 1990). For example, Silicon Valley in the USA is well established as both a Scienec City and Technopolis. The term Science City applies best to Tsukuba Science City in Japan, which was consciously planned as basic research city. Table 1 summarizes the key features of high-tech centre developments with respect to their nature and physical characteristics and the examples which will be discussed in Section four.

Table 1. Key features of High-tech Centres with respect to their nature and physical characteristics

Types	Physical Characteristics	Focus	Examples
Science Park : Property based initiative			
– Innovation Centre	development within restricted space	mainly intended for start-up firms	BIG, Berlin SP incubator, Manchester
– Science Park	large area of land	R & D(but permit light production)	Cambridge SP Dortmund TP
– Research Park	large area of land	basic R & D(permitting only prototype development)	Surrey Research Park
Technopolis : urban development			
– Science City	Creation of new Settlement(research park, new town)	Basic R & D	Tsukuba, Japan Taedok, Korea
– Technopolis	Creation of new settlement including production activity	High-tech production	Kumamoto, Japan Kwangju, Korea

3. The Roles of High-tech Centre Policy

1) Facilitating Innovation for Indigenous development of new technology

Since the mid to late 1970s, there has been a general trend towards increasing regional(and local) autonomy with respect to economic and industrial development. During the 1980s this trend focused especially on technology or innovation policies, and there has been marked shift from exogenous(top-down) policies to move endogenous(bottom-up) policies. These policies focus on the mobilization and enhancement of regional technological and industrial resources and are often targeted on assisting small-and medium sized enterprises(SME) and on creating new technology based small firms(Rothwell et al, 1989 ; Dodgson et al, 1993). Furthermore, the high risks of development in high-tech R and D activities, the intersectoral nature of new project studies, and the shortened life-cycle of products, have had the result that even large firms are no longer able to generate, on their own, the technical advances necessary for their growth(Mariotti and Ricotto, 1986). They are, therefore, forced to more from the traditional 'in-house' generation of research and development to cooperative procedures with other firms and academic institutions(Perrin, 1991). This change provides local communities with, the opportunity to carry out indigenous development strategies via HTCs which emphasize regionally owned SMEs and the technological expertise in local HEIs(Luger et al, 1991 ; Monck et al, 1988)

It is generally accepted that HTCs can assist in the transfer of technology from academia to industry through consultancy, research contacts, informal contacts and the formation of spin-off companies (UKSPA, 1991 ; Grayson, 1992 ; Lowe, 1985). The main contributions to technology transfer by HTCs arise from their proximity to the HEIs or centres of research, and the encouragement of contacts between these firms and academics by the HTC management. These factors are favourable to the establishment of informal networks, the more effective use of the physical facilities of HEI and the encouragement of spin-off firms in which academics move into the industrial sector. In this way the experience of academic institutions is brought to bear at close range and effectively on industrial operations. An important consideration in the formation and growth of academic spin-off firms is the moral support offered to the scientific entrepreneur in the change from a research or academic environment to industrial one. This support is often delivered in HTCs by incubator/innovation centres designed to provide small units of accommodation with shared services and business advice(Parry, 1992). By these means, the process of spin-off can be encouraged and made more certain, thereby adding to the local industrial structure both quantitatively(although initially the effect will be small) and in terms of diversity of technology which will be an important factor in regional innovation in the long run. Furthermore, by mixing incubator/innovation centres with R and D and high-technology production establishments, innovation capacities may be greatly enhanced. The experience of several HTC developments shows how appropriate territorial structuring helps to extend technological performances far beyond the incubation process(Perrin, 1987). The physical proximity of the R and D, design, prototyping and training aspects of both the HEI and companies in a HTC can greatly improve communication, personal relationships and awareness of the resources available to companies. In this way the ability to work together is much improved and innovative connections may be promoted.

An aggregation of R and D centres, entrepreneurs and HEIs in a HTC can exhibit a certain level of innovation. But it is not until interpersonal communication networks among researchers and entrepreneurs are established that a synergy of innovation will characterise the community, as began to happen in Silicon Valley in the early 1960s. This is the point at which 'critical mass' occurs. It is a point which many HTCs will now be approaching. Therefore, a significant value of the HTC lies in its potential for achieving a synergistic rate of technological innovation through assisting the development of dense communication networks among heterogeneous R and D activities(Dearing et al, 1990).

2) Support for Technology-led economic development and physical development

The widely accepted high-tech centre development strategy assumes that a region's long term economic viability will depend on its ability to generate and sustain a concentration of business capable of developing new products(or processes) that are based on new technology. For regions faced with a high concentration of older, declining manufacturing industries HTCs have been viewed as a tool for facilitating economic restructuring through the incubation of new technology based small and medium-sized enterprises. For other regions whose economies have been performing well, investment in the new innovation capacities of new technology in high-tech centres may represent a long term insurance policy. In either case, a technology led economic development strategy, when successful, almost always leads to more than just employment growth and new business formation(Luger and Goldstein, 1991 ; Grayson, 1993 ; UKSPA 1991 ; Fiedler 1989).

From the empirical evidence that is available, four ways in which HTCs can boost local economic development and increase local innovative capacity can be identified :

a) HTCs can encourage and facilitate the formation and growth of new businesses based upon the research knowledge and expertise available within a HEI or other centre of research(Strub, 1988). The existence of a HTC, in particular a Science Park, near a HEI encourages researchers to consider the commercial exploitation of their research and offers them a location amenable to this process(Dalton, 1992). HTCs can also play an important role in complementing regional business promotion activities both promoting the establishment of new businesses and furthering the growth of existing businesses(Fiedler, 1990).

b) High-tech centres can also act as a catalyst for change in a region, according to Dalton(1991) and Hilpert(1988). They often provide new sources of employment in an area of traditional industries and help to change the image of the area by demonstrating that it can create, attract and support high-tech industry. This effect may extend beyond the HTC because of the opportunities created for existing suppliers to become subcontractors to the new companies, thus widening the benefits and introducing these suppliers to new technologies and skills.

c) HTCs can act as a mechanism to upgrade the technological sophistication and added value of existing industry by providing a location where technical support can be given to local firms which manufacture and market products.

d) HTCs, particularly technopolises, highlight the importance of environmental and infrastructure factors in technology-led economic development(Masser, 1991). In high-tech endeavours, the main resource is highly skilled people. Quality of life has become a main competitive dimension in regional development strategies related to high-tech centre development, because high-tech industries have tended to establish themselves in areas offering a high-quality of life in order to attract and retain these skilled individuals(Similor et al, 1991 ; Oakey, 1989). Therefore active policies to improve quality of life are usually incorporated, when setting up a HTC. As part of such a strategy, an attractive community including housing and cultural facilities can be constructed within the HTC to help attract skilled engineers and scientists from major cities or foreign countries.

In summary, the role of the HTC can be identified as helping to solve regional disparities, improving the general climate for innovation and improving technology transfer between HEIs and industry. It also provides opportunities to upgrade the environment and infrastructure, particularly in the case of comprehensive urban developments. HTC development plays a vital role in bringing together these elements into an integrated strategy and creating the environment that is required to promote local development in terms of technology and the economy.

4. Some Case Studies : The High-tech Centre Policies in the UK, Germany and Japan

1) British Science Parks

(1) Background

The starting point for British science parks was technological development at a few universities such as Cambridge and Heriott-Watt, which drew to some extent upon US experiences. However, the impetus for much science park development has come from local authorities who recognized that the key source of expertise on technological matters was their local universities(Monck et al, 1988 ; Williams, 1986). Many science parks can be said to have been brought about by the economic and social changes that have taken place since the end of the 1970s. The government imposed severe cuts in grants to higher education institutions(HEIs), forcing them to look for new sources of income.

This change prompted a variety of responses including new clubs and committees involving outside bodies, professional support for staff through the establishment of commercial and industrial development bureaus, financial support for commercial ventures to exploit the products of academic research and the establishment of university-based firms (Masser, 1991). There has also been a significant shift in UK government policy since 1979 towards the small firm sector as a whole, backed by the encouragement of the enterprise culture. This change in emphasis has been reflected in many of the economic development initiatives pursued by local authorities, shifts in attitude in HEIs towards enterpreneurship and an improvement in services to small firms (Dalton, 1988).

Another factor that influenced universities to establish science parks was unemployment, both locally and amongst recent graduates. Some universities in the major urban areas felt that it was necessary to make a commitment to the locality and collaborate with local authorities attempting to regenerate such areas. This led to the backing of several science parks in inner city areas by university administrations conscious that their university ought to be seen to be making a clear contribution to the local community(Monck et al, 1988).

(2) Development

There are two clear phases of science parks development in the UK. Phase one was in the early 1970s when Cambridge and Heriott Watt Science Parks were established. Whilst drawing to some extent upon American experience, they were most strongly motivated by technological considerations. The first science park to be developed in the UK was at Heriott-Watt University in Edinburgh in early 1972. The first company in site was Edinburgh Instruments Ltd., a spin-off from the Department of Physics of the University. Heriott-Watt was followed about ten months later by Cambridge Science Park which was set up by Trinity College. Although there were differences in detail, these two institutions independently developed very similar solutions to fit their circumstances. Both these developments were solely the initiatives of higher education institutions and both were established in economically buoyant areas(Dalton, 1988).

The second phase of science park development began in 1982 and was largely a product of changing economic conditions. These science parks differ in various ways from their predecessors. Most were partnerships involving, typically, a higher education institution, a local authority, and a bank. A common objective of these initiatives was to act as a catalysts in changing the industrial structure of their region (Dalton, 1988 ; Monck et al, 1988).

According to the UKSPA(1993), there were 39 parks in operation at the end of 1991, with one more under construction, and a further eighteen parks were at the planning or feasibility-study stage. Science parks in the UK come in all shape and sizes. There are wide variations in management structures and operational practices. Some 30% are in inner city areas and the overall size of site is very small by comparison with their North American counterparts(Masser, 1991). There are only 6 parks with more than 50 tenant firms, 13 parks with 20~50 firms and 20 parks with less than 20 firms. The average employment per tenant firms is 14.5(Massey et al, 1991). All but one of the inner city parks are less than 10 ha in size and only out of town sites extend over more than 20 ha.

Most science parks in the UK are linked to higher education institutions. The findings of Monck et al's survey(1988) show that 34 out of the 52 British universities in existence at that time had set up science parks. A further 3 had ad hoc arrangements for independent companies to locate on their campuses and 4 others were associated with developments elsewhere. Many of the remaining 11 higher education institutions were actively considering establishing science parks. However, few universities have the physical of financial resources to develop science parks independently. The Cambridge and Heriott-Watt Science Parks and the Surrey Research Park are among the few exceptions to the general rule of science park development as a joint initiative involving local authorities, regional development agencies and banks and other private sector organizations. There is some evidence of increasing private sector investment in science park development, particularly since the opening of Belasis Hall Technology Park in 1988. Several of the newest ventures involve private companies including British Nuclear Fuel (Westlake Science Park), TWI Technology(Abingdon Science Park) and British Gas in Loughbourgh(Grayson, 1993).

(3) Public Involvement and Support Mechanisms

Many science parks located in areas of industrial decline were established primarily as a response to the need to regenerate local economies rather than as a means of capitalising on an already vibrant high-tech sector. In these cases the public sector is closely involved in the establishment of science parks. A limited amount of money has been made available for these purposes from public funds, despite the lack of an explicit government policy on science parks. This has enabled development agencies to provide accommodation for indigenous high tech firms and to attract inward investment to the assisted areas of the country. Some of the larger inner city local authorities such as Birmingham and Manchester have played key roles with the help of grant assistance from central government(Monck et al, 1988). The Manchester Science park is a typical case of a publicly supported inner city Science park. The site is owned by the City Council, and Manchester Science Park Limited hold the site on a 125-year lease at a nominal rent on condition that it maintains the site and develops it as a science park. The Science Park Incubator (phase one completed in 1984) was financed by the City Council assisted by Urban Program and European Community funding. Follow-on building(phase two completed in 1989) was developed by the Science Park with bank borrowing supplemented by and Urban Development Grant from central government. Synergy House in phase three, completed in 1992, is financed by the greater Manchester Property Venture Fund(Manchester S.P., 1992).

There is a marked regional variation in public-private investment between the North and South of Britain. Apart from the contribution of host higher education institutions, which for the most part takes the form of land rather than direct financial investment, in the 'southern subelt' only two parks out of nine(Southampton and Kent) had direct public-sector investment. Outside the south only one park out of 29, Heriott-Watt, did not have direct public sector investment. Even there, the Scottish Development Agency later funded an Incubator Unit(Dalton, 1988).

In addition to funding the property development aspects of some science park developments, the government has also provided help for existing and potential tenant firms through a range of initiatives designed to stimulate innovation and the growth of small businesses. Government grants for research and development are particularly attractive to actual and potential science park tenants. These are designed to reduce the time scale for R and D work, limit technical and commercial risks and encourage collaboration between companies. Schemes tailored specially for small firms include SMART(Small Firms Merit Awards), a competition for innovative technologies ; Club R and D, to promote research consortia ; Regional Innovation Grants, for firms with less than 25 employees ; and SPUR(Support for Products Under Research) Schemes, developing new produts and processes which represent a significant technological advance (Grayson, 1993).

(4) Evaluation : Problems and Prospects

A recent study by Massey et al(1992) drew attention to three major problems associated with the British science park development. First, they argue that the development of science parks has not contributed to reducing regional disparities in high tech sectors. Moreover, the distribution of science parks themselves reveals regional disparities in terms of the number of employees and the number of firms(see Table 2). Second, they also claim that lack of production in sciece parks means that they are of little benefit to job creation. Finally they point out that even though the role of academic institutions as the source of research ideas has been emphasised in science parks, there is a relatively low level of academic spin-offs and R and D links. Massey et al conclude that these problems can not be easily solved as long as the basic logic of science park is based on a linear model of innovation : basic research produces applied research which in turn leads to experimental production and ends in initial full production and diffusion.

Table 2. North-South Divide in the Development of Science Parks in Britain

	No. of parks	Area of building(m)	No. of tenants	Buildings : area under construction(m)	Employment
South	10(26%)	194,295(50%)	370(37%)	28,333(55%)	7,171(49%)
North	29(74%)	192,913(50%)	642(63%)	22,995(45%)	7,537(51%)
Total	39	387,208	1,012	51,328	14,708

Source : Massey et al, 1992, p. 54

The findings of the UK Science Park Association(UKSPA) challenge these conclusions. It is argued that, far from being based on an outdated linear notion of innovation, the science park plays an important role in a complex interactive model by stimulating contacts between academics and the market as well as contributing to the diffusion of technological innovations throughout industry as a whole (UKSPS, 1991 ; Grayson, 1993). Monck et al(1988) have also studied the 'value-added' by British science parks. The findings of their survey show that 60% of firms in science parks had informal links with academics and that 20% of firms were either academic based or had academic founders. In the eyes of these firms the value attached to these links was often greater than originally expected. The multiplier effects of science parks in their local economy were also found to be greater than those of small firms in general. This is because local economies are likely to benefit considerably from the concentration of professional employment (Masser, 1991). This survey also showed that 60% of science park firms subcontracted some of thier production to other firms in the areas. This accounted for 15 % of the total output of firms in science parks.

In summary, British science parks should not be seen as a recipe for technology led economic growth. Even in Cambridge, the successful and internationally recognized science park is not itself the principal cause of the remarkable development of the Cambridge economy in the 1980s(Segal, 1988 ; Keeble, 1988). Furthermore there are important differences between science parks such as Cambridge and those situated in some of the older industrial areas in the north of England and

Scotland which face problems in attracting high tech industry and have little potential for developing their indigenous industrial structures. In these areas, Science park creation is often regarded as an instrument of government regional policy rather than as a commercial venture (Masser, 1991). However, as the work of Monck et al shows, there are important strengths in the science park concept in terms of value added to the local economy. In the UK, economic circumstances have encouraged higher education institutions to strengthen their links with local communities and seek ways to facilitate technology transfer. The science park is an important instrument in such a process whose benefits will be reaped in the longer rather than the short term.

2) German Innovation Centres and Science Parks

(1) Background

The initial model for German high-tech centres(HTC) came from the USA. However the German concept of innovation centres(Technologiezeutrum or Grunderzentrum) is good example of the modification of the science park concept to fit national circumstances. The main impetus for science park development in Germany has come from regional and local authorities which see science parks as a useful means of counteracting the effects of economic decline(Meyer, 1988 ; Fiedler, 1988).

Public policy has emphasized the importance of technology transfer programmes directed at the small firm sector, because small and medium have traditionally played an important part in German economic growth. During the 1980s there has been enhanced public support for centres that perform industrially relevant R and D on the one hand, and for mechanisms that convey appropriate know-how to potential industrial end users on the other. The rapid growth of innovation centres and science parks is the product of these efforts. In particular, they are expected to release the innovative potential of small and medium sized firms, and encourage bottom up regional development, specially in those areas which do not already have a significant high tech industrial presence. The role of academic spin-off firms is seen as particularly important in this context(Rothwel et al, 1992).

In addition, an important aspect of regional technology policy in Germany has been the encouragement of linkages between academic institutions and industry. This includes the following programs, which aim to install technology transfer units within higher education institutions (Shimank et al, 1987) : technology transfer offices at universities, initiated by central government ; regional technology transfer institutions established by regional government(ministry of commerce in state government) ; and the Frauenhofer Society, a national technology transfer institution which has strong regional representation and acts as a mechanism for bridging the gap between scientific research and industry. These technology transfer centres played an important role in the establishment of innovation centres and science parks in local areas, because of their support for spin-offs from HEI and the linkage between HEI and SMEs.

(2) Development

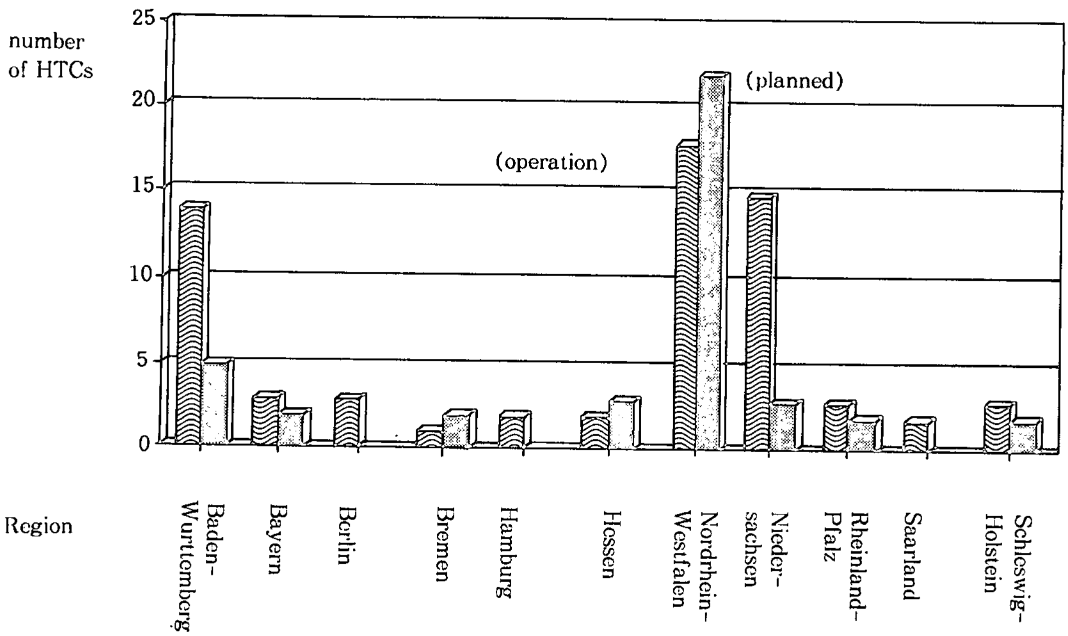
As in the UK, there has been a rapid growth in Germany in the number of innovation centres and science parks, since the launch of the Berlin Centre for Innovation and New Enterprise(BIG) in 1983. By the end of 1990 there were 90 centres operating Germany including 6 centres in the former East Germany(Fiedler et al, 1991). The primary role of Germany HTCs is to promote the establishment and development of new companies. In this respect, science parks and innovation centres are part of a broader drive towards the improvement of regional economic performance. Stech-wehr (1990) defined two types of development :

– Innovation Centres, which concentrate on firms at the establishment and start-up stages. A typical feature of innovation centres is that admission to the centre is only granted to new or recently established firms and they are obliged to leave the centre after a fixed period of time. It may, therefore, be useful to incorporate this kind of centre into a broader structure, e.g. a technology or industrial park in the vicinity to ensure that the company concerned remains in the support network. Most innovation centres have been created by rehabilitation old industrial buildings.

Technology or Science Parks, which focus on specific kinds of technology rather than on the type of company. The creation of closer links with research institutions or universities is of critical concern. In order to create a 'critical mass' of R and D and production in a specific field of technology, these aim to integrate public research institutes, the research departments of large business, small and medium enterprises and innovative start-up companies.

Figure 1 shows the distribution of HTCs in Germany. There is a strong concentration of HTCs in areas of traditional industry, like Nordrhein Westfalen and Baden-Wuttenberg. These HTCs have three main aims(Henschel-Neumann, 1988 ; Meyer 1988) : promoting start up firms ; creating (qualified) jobs in the region : and translating research findings into practice(technology transfer). As in Britain, science parks and innovation centres in Germany come in all shape and sizes and there are

Figure 1. The Distribution of High-tech Centres in Germany



Source : Steckwehr, 1990, p.10

wide variations in management structures and operational practices. There are only 15 centers with more than 35 firms and 20 centres with less than 10 firms. The average employment per tenant is only 7.5(Sternberg, 1989).

Most HTCs in Germany are linked to HEIs. Sternberg(1990) shows that a university or technical college exists in 71% of the centres. However this leaves 29% with no nearby centres of research with which they can establish contacts. In 1990 these centres catered for 2,080 companies employing 18,400 people and total building investment amounted for 980 million Deutsher Mark. The total lettable area of innovation centres in Germany is 657,000 square meter. Some 88 percent of this area has been occupied by firms and 12 percent remains available to let. About 23 percent of the total area is used by start-up firms and 9% by R and D labs of HEIs or large companies.(Fiedler, 1991)

Although public sector funding for HTCs was the norm in the early years. There is now a trend towards profit oriented centres prompted by private sector firms rather than by the public authorities. Examples include the Stuttgart Business Park set up by companies in the information technology and telecommunication sectors, St. Georgen and the Hamburg Technology Centre. However, these are still the exception in Germany, where public sector funding remains dominant.

(3) Public Involvement and Support Mechanisms

The development of HTCs in Germany is closely tied to regional and local government priorities. The dominant role of local authorities can be seen from the fact that they own half of the buildings or land in HTCs in Germany. A high proportion of funding for such developments comes from the public sector, both for infrastructure development and for operational costs. According to Sternberg(1989), in 25 out 31 centres local authorities are one of the sponsors and in 12 centeres they are the main sponsors. There has been little involvement from universities in the establishment of HTCs except in cases where they are established on a university campus(e. g. Dortmund).

The Berlin Centre for Innovation and New Enterprise(BIG) and the Dortmund Technology Centre/Park illustrate two different funding mechanisms in Germany as well as two different development concept. BIG is an example of strong public sector involvement. It was funded solely by the city government to stimulate the establishment of new firms in high-tech or information based production and also to support innovation within existing local firms. The City invested 7.89 million DM to buy and rehabilitate an old factory. The role of the HEI was confined to consultation prior to development and participation via an advisory committee. After 8 years of successful development at BIG, further expansion of its area has been necessary. In 1991 the city made a further investment of 17 million DM for the second phase of development, which includes a technology park to give more flexibility in high-tech production(BIG, 1991). Dortmund Technology Centre(DTC) has developed differently. Unlike most other German HTCs, it was initiated by the university. DTC was set up under a joint venture agreement between the city of Dormund(26%), the Chamber of Commerce and Industry(24%), the University (22%), Local Banks(10%) and others(10%). The Centre offers laboratory and office space for lease to firms wishing to engage in R and D co-operation with university researchers. Demand for space in the centre rapidly exceeded capacity, and it has already expanded twice(Wegener, 1992). In addition, an area of 37 ha adjacent to DTC has been designated as a Technology Park to accommodate new arrivals such as subsidiaries and the R and D labs of large firms. Many of the new firms in the Dortmund Technology Park are soft ware and consulting companies founded by graduates of the university(Stadt Dortmund, 1991).

After their establishment, many German high-tech centres benefit from additional financial support. Examples include state government subsidizes to cover operating losses(e. g. Baden Wuttenberg), and direct rent subsidises for firms wishing to locate in such a centre(e. g. Nordrehein Westfalen). An altenative used by several local authorities is to charge the centre a low rent so that it can offer premises at lower charge. BIG is such an example. Its rent range from only 8.0～16.0 DM per square meter which is considerably cheaper than similar property elsewhere in the city.

There are a number of central government schemes designed to nurture indigenous technology based firms in Germany. The TOU(Technology-oriented enterprise) program is aimed at technology-based new businesses. It offers grants, loans and guarantees and is one of the most important government instruments for simulating, spin-off activities from HEIs who found firms in German HTCs(Rothwell et al, 1991).

(4) Evaluation : problems and prospects

A major issue of current concern is the growing number of innovation centres and science parks in the pipeline in Germany. This given rise to fears that the quality of applicants for these centres will be diluted (Rothwell, 1989).

Furthermore, as the centres become increasingly dependent on profits for their viability, there is a corresponding decline in the concept of promotion within the centre itself. However, this is by no means signifies that regional and economic policy consideration and the promotion of new firms are no longer an important area of HTC's work.

There are several study results evaluating innovation centres and science parks in Germany as instruments of regional innovation policy as well as of technology-led economic development. Results are available in terms of supporting start-up firms, value added to the local economy, in particular in the area of traditional industry, and their multiplier effects. The evidence for breeding start-up firms through the mechanism of innovation centres shows that 46% of total tenant firms in the centres are start-up firms. Most of these firms claim that an innovation centre is also evidence for successful graduate firms(Fiedler et al, 1991). 240 firms employing 21,000 people have moved out of the centers to continue their activities after a fixed term as an tenant(generally 5 years). The size of graduate firms gives some measure of their success. Their average size is 28.5 employees, which is some 3 times the average firm size in German innovation centres(9.5 employees).

Sternberg(1989) has examined the value added by innovation centres. The findings of his survey show that 74% of firms in the centres had intensive links with HELs or centres of research and that they regarded these link as very important for their operation and development. He also found that 40% of firms had close links with other firms within the centre for exchange of information. In particular, centres adjacent to national R and D centres and local HELs have an extremely high contact intensity(e. g. Stuttgart, Hamburg, Hannover, Heidelberg and Dortmund). In these cases the value attached to these links were often much greater than originally expected.

The multiplier effects of innovation centres or science parks on their local economy have also been found to be greater than that for small firms in general. This is because the local economy benefits from the concentration of highly-qualified professional employment in the centre. According to Sternberg(1990), the majority of the enterprises in innovation centres are working in applied R and D(87%) and 24.6% of firms are spin-offs from universities or centres of research. This survey also shows that sales in the local area accounted for 38% of the total output of firms in the centres.

In terms of image boosting it was found that strong efforts to use innovation centres/science parks as a regional innovation policy had been made in areas of traditional industry(Fiedler et al, 1991). 40 % of total centres are located in a single region(Nordrhein Westfalia) which sets a high priority under its new economic policy to solving problems of regional decline. If the region of Baden Wuttenberg is added, the percentage of such centres would be increased to some 70%. These two regions have adopted similar policies intended to boost their image by high-tech development and giving incentives for development by providing support to firms. This situation has some similarities with British experiences.

It should be note that most German HTCs are still relatively young and any indicators of their success or failure must be treated with caution. In particular, it must be borne in mind that, although centre-based firms are said to be more successful than average, they have also had greater opportunities for subsidy and to be accepted on parks, they have often had to endure a rigorous application procedure. In addition, once located in a centre, these companies have often been able to obtain venture finance from various financial institutions more easily than firms located elsewhere.

In summary, then, as in Britain, German innovation centres and science parks are only one of a number of factors that many facilitate technology-led economic development. However, although the actual employment effects of a centre may be small, their spin-offs for the region may be substantial. They have also contributed a great deal to dispelling the negative image of declining regions and giving them a fresh progressive appeal.

3) Japan's Technopolis Program

(1) Background

Japan has undergone rapid urbanisation since the Second World War, resulting in the concentration of population in the core areas, the Tokyo/Nagoya/Osaka region that forms Japan's industrial heartland. Since the early 1960s, a number of attempts have been made to shift development to peripheral regions, for example, New Industrial Cities as growth poles(Abe and Alden, 1988;Masser, 1988). More recently, there have been a number of urban and regional technology-led developments with a bias towards peripheral regions. The technopolis programme is the best known of these development Policies (Masser, 1990 : Edgington, 1989).

There were several good reasons in favour of a decentralised technology policy and technopolis programme(Fujita, 1988, Kawashima et al, 1988) : the local dynamism which several local communities had developed to attract high-tech industry(e.g. Silicon Island in Kyushu), the increasing trend of highly qualified Japanses academics to return to their area of origin in search of a pleasant environment and also to fulfil the traditional Shinto obligation : and the movement of population in recent years back to local regions centred around local nuclear cities(MITI, 1985). Earlier experience with the development of new towns with industrial parks to promote regional development in peripheral areas also gave useful experience for regional innovation policy(Masser, 1990).

As in Britain and Germany, Japan's model of high-tech regional development was based on a few unique experiences of high-tech growth in the USA. Although Japan was not the first country to copy the experience of high-tech centres in the USA, its effort is particularly comprehensive and therefore must be viewed as the most concerted attempt to create new centres of industrial innovation. The importance of Japan's technopolis policy lies as much in the way that it gives a new dimension to growth pole and new town ideas and in the procedures used by central government in Japan to stimulate local efforts, as in technology policy itself(Masser, 1991).

(2) Development

The development of Japan's technology policy can be divided into three distinct phases(Kawashima et. al, 1988;Edgington, 1989). These are government support for Tsukuba Science City, which was constructed in the early 1970s to improve the nation's R and D efforts, and the technopolis program initiated by MITI in the early 1980s and the Research Cores.

Japan's Science City, Tsukuba, brings together several national development policy initiatives over the last 30 years. This plan aimed to decentralize government functions from Tokyo and promote higher levels of research and education activities in the Tsukuba Academic New Town(size 4000 ha)(Glasmeier, 1989;Iwami, 1992). In 1970, the Tsukuba Science City Act designated six neighbouring municipalities to form the Science City. The Science City was planned around the concept of creating a pleasant environment in which scientists could live and work(Taketoski, 1985). In 1989, Tsukuba had a daytime population of 162,189. Recent projections suggest that the population may double within 15 years. About 45% of Japan's national researchers work in this city which contains 33 percent of Japan's national research facilities, supported by 40 % of the nation's R and D budget. 45 national R and D labs and institutes, along with 2 universities, operate in Tsukuba. As the largest R and D centre in Japan, Tsukuba is effectively a national technopolis (Iwamil, 1992).

The second policy phase begin in 1993 when a regionalized technology policy was introduced by the Technopolis Law. The technopolis programme seeks to promote industrial development by raising the technological level of local businesses and establishing new high-tech industry, encouraging R and D to ensure sustained regional development : and creating attractive communities in which people can live and work (MITI, 1984;Tatsuno, 1986; Glameiet, 1988).

Originally, it was envisaged that only two or three model technopolises would be constructed throughout Japan. However, the proposals aroused such interest that 40 out of 47 Japanese prefectures put in bids for designation and intense lobbying took place on their behalf prior to the enactment of the 1983 Technopolis Law (Tatsuno, 1986). Since 1983, 26 sites throughout the whole country have been designated by MITI as technopolises. Most of these are located in peripheral areas of Japan such as Hokaido, Tohoku, Kyushu and Shikoku(Edignington, 1993).

To qualify for technopolis designation, a region must meet certain criteria(MITI, 1988). It must be an area where industries are not excessively concentrated, and which lies in the vicinity of a mother city with a population of at least 150,000. There must be at least one university providing courses in high technology within the proposed site and it must also be an area where there are already enough local enterprises to provide the nucleus of entrepreneurial skills for the project. Finally the locality must have good access to the national rail and international air transport network. Not all the technopolis areas meet these requirements. Some are much smaller than the deal population(for example Hakodate(60,000), and Kumamoto(86,000), whilst other are much larger than this(Kakubohayato : 505,077, Aomor, 287,000). Some areas have a high concentration of high-tech industries(Kumamoto, Hamamasu). However, each technopolis has focused its plan based an existing leading industry in the region and has used on going new town and industrial park projects. There are also three other conditions, which technopolis sites must satisfy to achieve MITI designation(MITI 1988 : Masser 1990). First, they must show that they have clear goals for local industrial development based on advanced technology. In other words, they must identify those indigenous strengths which are likely to provide the most fruitful breeding ground for technological innovation. For example, the Niche-Harima Technopolis has started frontier research on new ceramics, the Kibikogen Technopolis began research to upgrade the food industry through bio-technology, and Nagaoka is based on the field of mechatronics and new materials which builds on skills developed locally in precision engineering and material science(MITI, 1988). Secondly, a technopolis site must make provision for the basic infrastucture and urban facilities that are required for economic development. This includes housing and urban services as well as public utilities and infrastructure. In fact several cities have taken advantage of on-going new town developments in their area, such as Akita New town, Miyazaki Science City, Nagaoke New Town and Kamo Science City in Hiroshima. Finally, a site must demonstrate that a local high technology promotion organisation is to be established, which brings together both public and private sector institutions and academic bodies to co-ordinate development programmes and provide the necessary service facilities for firms wishing to locate in the technopolis area. Most host prefectures established technology promotion organisations for their technopolises, consisting of representatives from industry, universities and local government.

In 1986, MITI developed the concept of the Research Core to overcome the problems of technology transfer which have been experienced at both Tsukuba Science City and some technopolises in peripheral regions. The Research Core is intended to induce the exchange of research findings with the private sector and assist production innovation, new software, information processing and related industries. To maximize the opportunities for technology transfer in technopolises, each Research Core has an incubator containing joint venture research facilities and training components. The Research Core is thus an attempt to correct the initial weakness of technopolises in technology transfer. 28 locations were proposed in 1986. Most Research Cores are planned to be on technopolis sites(Edgington, 1989 ; Kawashima et al, 1988).

Key features of Japanese High-tech Centre development are summarized in Table 3.

Table 3. The Development of High-tech Centre in Japan

period	General Features	Examples
1963～1979	Science City – basic R & D – initiative of central government	Tusukuba (45km from Tokyo)
1980～1990	Technopolises – research and production – local and central government collaboration – bottom-up effort at local level	25 sites in peripheral regions e. g. Kumamoto, Nagaoka Miyazaki etc

period	General Features	Examples
1985～	Research cores – incubation for SMEs – local initiatives – mainly sited in technopolises	28 Cores planned e. g. Kumamoto Creative Area(Core), Nagaoka Techno-Intelligent Core Miyazaki Sun-tech Park etc

(3) Public Involvement and Support Mechanisms

The technopolis program has been developed with the active involvement of regional and local authorities, which have reponsibility for infrastructure development financed mainly by locally levied technopolis taxes(Nishimoto, 1986). Central government assistance is normally limited to about one third of the infrastructure costs. However, central government also offer a range of tax incentives including a special depreciation allowance, low interest loans and other forms of assistance to encourage companies to locate in the new technopolises. For example, MITI Subsidises frontier-type R and D through the Small and Medium Business Agency and it provides local industry with funds for technological advance through the National Academy of Industry and Technology. For industries, locating in technopolises, MITI provides industrial relocation promotion incentives (MITI, 1984), The Ministry of Construction provides the hard infrastructure necessary for the technopolis such as roads and highways connecting the technopolis with the mother city. This Ministry is also involved in major projects in some technopolises including Nagaoka New Town Park and the Biotech Forest in Kumamoto technopolis.

In several cases private sector involvement is encouraged through the Private Investment Law(1986) which promotes public-private partnerships in infrastructure development through preferential tax and loan provisions. Host prefectures at technopolis sites are also developing their own programme for supporting R and D activities and technology transfer. In addition to technology promotion organisations established prior to the designation of technopolis sites, host prefectures, are developing their own on line information network based on a system connecting the three big cities with the technopolis areas.

In summary, then, Japanses technopolises are joint operations, systematically planned at the local level but co-ordinated and supported by central government.

(4) Evaluation : Problems and Prospects

Although the Japanese technopolis program is based on regional innovation policy to stimulate local efforts in technological innovation, it is not certain how far it will succeed in the aim of dece-ntralizing the Japanese economy and promoting regional growth. R and D remains highly concentrated in core regional academic institutions and in particular most private sector R and D is still concentrated in the three big cities(Koba-yashi, 1982 ; Fujita, 1989). It has also proved difficult to attract enough highly skilled personnel from the major centres despite the relatively high quality resi-dential and working environments characteristic of technopolises (Tatsuno, 1986 ; Masser, 1990). Furthermore, the local effects of high-tech industries have often been less than might be expected because of the degree to which they are export oriented. Consequently, local linkages may not be extensively developed and the spin-off effects of new technology on the local economy may therefore be limited.(Glasmeier, 1988)

Nevertheless, there is some evidence for the successful development of technopolises in terms of technology led economic development. The analysis undertaken by Sthor et al(1992) seems to indicate a positive initial record of technopolis development from the viewpoints of broadening high-tech development in peripheral regions, upgrading productivity, and reducing interregional disparities in technology-based economic development. Sthor et al's survey showed that 14 of the technopolises which replied to his questionnaire had a share of high-tech manufacturing plants slightly above the national average and were exceeded only by the metropolitan area of Tokyo. Osaka and Nagoya had substantially lower shares than most technopolis areas.

Some of the problems associated with the lack of spin-off activities and key personel may be solved by the efforts of host prefectures and the government by creating an innovative environment through the Research Exchange Promotion Act, Research Cores and the information network system(Dearing, 1990; Fujita, 1988). The return home phenomenon and local efforts to encourage it also bode well for the future(Kumamoto Prefecture Reoport, 1988).

In particular the 'do it yourself' dimension is the most interesting feature of programme, providing a stimulus for bottom up efforts at the local level. The process of technopolis designation and implementaion, has played a vital role in bringing together various elements into an integrated strategy and creating the institutional framework that is required to promote technological innovation(Stohr, 1985; Masser, 1990). Consequently many of the areas which follow these development mechanisms show prospects of stimulating their local economies.

5. Evaluation

1) Comparison of International Experiences

There are many unique features in the experiences of the three countries considered that limit the scope for generalization.

Nevertheless, a number of conclusions can be drawn from the analysis which highlight some important issues in high-tech centre(HTC) development. We will summarize and compare the main features of HTC approaches in the three countries under five headings : background, development features, nature of industrial and technological development, public sector involvement, and impact on localeconomic development.

(1) Background

There are important differences in the motivation for establishing HTCs in these three countries, although in all cases HTC development has occurred in the context of the economic and social changes that have taken place since the 1970s. Whereas British and German science parks/innovation centres were motivated by the need of HEIs to transfer technology to SMEs, in Japan the need for decentralisation from major cities was the crucial factor behind the technopolis programs. Thus European science park development grew out of locally-based considerations whereas East Asian HTCs were initially developed to meet national and regional policy needs.

There are both similarities and differences between the establishment of science parks and innovation centres in the UK and Germany. In both countries, policy has emphasised the importance of technology transfer programs directed at SMEs, because they are seen as playing an important part in local economic development. Many universities have also developed spin-off activities and closer links with industry. However it is of interest that, in Germany, it was the successful development of technology transfer centres at the universities supported by central government that gave the impetus for local authorities to establish innovation centres, whereas in Britain cuts in central government grants to higher education institutions prompted a variety of responses including the setting up of science parks and collaboration with local authorities wishing to regenerate industry.

In contrast, Japanese approaches are dominated by pressure towards regional decentralisation in countries where congestion, the deterioration of the living environment and spiralling land prices in the major cities have become a treat to future economic growth. In Japan there had already been government support for local dynamism and local economic development.

Table 4. Comparison of Background Factors for the Establishment of HTC

	UK	Germany	Japan
background factors	– motivated by technological considerations – Importance of technology transfer to SEMs		– need for regional decentralisation of R & D and high-tech industries
actions	– property led development	expansion of technology transfer centres	supplementary support for local dynamism

(2) Development features

Marked contrasts exist between approaches in the three countries in terms of the development of HTCs and their main objectives. The British and German approaches are characterised by small scale property-led development within the existing urban framework. In Germany, the initial development was the innovation centre, built up by rehabilitating old properties. To ensure that successful companies remained integrated in the existing network, they were provided with a science/technology park in the immediate vicinity. The concept of a mixture between incubation and light industry was evident at an early stage. The physical proximity to HEIs in Germany is not crucial because of the availability of land and strong incentives by local authorities. In contrast, siting British science parks adjacent to universities was seen as a way of improving the exploitation of academic research and encouraging academic entrepreneurship. Later science parks were enthusiastically taken up by local authorities as a means of boosting local economies, but the university-led basic research and development activities remained as a main concern. Thus, a property-based initiative close to a place of learning and providing high quality units in a pleasant environment, are important features of British Science Parks. Many examples maintain a site density of less than 25% to foster this

Table 5. Comparison of Development Features

	UK	Germany	Japan
nature of development	small scale property led development within an existing urban framework		comprehensive urban development
locational feature	proximity to HEIs	inner city area	proximity to mother city and university (peripheral region)
types-initial stage	science park : green field campus style e.g. Cam bridge Heriott-Wattin 1973	innovation centre : rehabilitation of old properties e.g.BTC, Berlin in 1983	Science city : new town development e. g. Tsukuba in 1972

	UK	Germany	Japan
types-development	science park(innovation centre)	integration of science parks and innovation centres	technopolis(mixture of research park and industrial parks including town)
stage in operation	39 in 1992	84 in 1991(6 East Germany)	26 under development in 1992

prestigious image.

Japanese technopolis programmes are based on comprehensive urban development which involves the creation of new settlements complete with research parks, new universities, technology centres, housing and urban facilities. From the outset the new town model was very much in the mind of the planners and they also saw the programme as an instrument for promoting the decentralisation of activities from major metropolitan areas.

There are also importance differences between technopolis and science park approaches in terms of their operation. The technopolis program requires a long term investment strategy in terms of basic infrastructures, housing and urban services. Science parks and innovation centres are viewed much more in terms of short term returns on investment in property(masser, 1991). Because of this science parks have lower risks and a greater ability to respond to changing circumstances than technopolises. As a result, there is no inherent limit to the number of Science Parks that could be developed to meet specialised needs.

(3) Nature of industrial and technological development

There are major differences between the two approaches in terms of the nature of industrial and technological development. The main thrust of the Japanese technopolis is to promote manufacturing production, whereas science parks and innovation centre in the UK and Germany are primarily concerned with basic research and development activities(Masser, 1991;Oh, 1992;Fiedler, 1988). There is also a difference between British science parks, which see themselves essentially as research parks, and explicitly exclude manufacturing activities from their premises(Parry, 1990;Masser 1991), and many German Innovation Centres which often permit light industries where they relate to the translation of scientific knowledge into new products (Miebach, 1992).

The national Science City in Tsukuba in Japan had a major focus on basic research in public R and D entres in the early stages, but they later established technology parks in the vicinity to provide a location for high-tech industry to exploit the findings of the R

Table 6. Comparison of Nature of Technological and Industrial Development

	UK	Germany	Japan
main trust	– basic research and development activities		– basic R & D(national Science City) – Promoting technology manufacturing industries (technopolises)
nature of development	– excludes manufacturing activity	permits light industries	to balance R & D and production(by Research Cores)
reasons for this development	to keep the prestigious image of park adjacent to HEI	to support a variety of activitics SMEs in locality	to solve the problems of technology transfer

and D. The technopolis programme also emphasises links between research and production technology transfer. At a later stage of development the Research Cores in Japan serve mainly as incubators for SMEs and to overcome the problems of technology transfer experienced by both Tsukuba Science City and Technopolises in peripheral areas. To maximise the opportunities for technology transfer in local areas, each Japanese research core has an incubator which has much in common with the innovation centre in Germany or some science parks in the UK.

(4) Public Sector Involvement and Support Mechanisms

The role of government and the local authorities varies substantially between the science park/innovation centre approach and technopolis programmes. In the UK and Germany there has been no direct intervention from central government to promote high-tech centres and the proliferation of centres reflects local r ather than national efforts(Masser, 1991; Fiedler, 1989). It is only in the peripheral regions in the UK that central government, through regional agencies, has regarded science park development as an extension of its traditional property development activities. Most British science parks are partnerships involving typically a higher education institution a local authority and some financial institutions. In Germany, on the other hand, local authorities(city government) are the main sponsors for the development of innovation centres or science parks, and there is only limited university involvement except for a few establishments on university campuses.

Central government has been central to the development of technopolises in Japan. The national Science Cities were established by central government initiatives. The real strength of the Japanese programme lies in the ways used by central government to stimulate local efforts.

Table 7. Comparison of Public Sector Involvement

	UK	Germany	Japan
role of central government	no direct intervention from central government except		essential for development
role of central government	regional agencies involved in property development in peripheral regions	support for technology transfer centres prior to their establishment	MITI : close involvement in monitoring the implementation process
role of local authority	partner	main sponsor	initiative for development
public support for the centre	mainly support for innovation	financial support for operation including sudsidizing lower rent	support for innovation (subsidizing frontier type R & D) information network
investment strategy	short term investment strategy in terms of accommodation		long term investment strategy in terms of infrastructure

MITI in Japan has been critical in shaping the proposals submitted for designation and it was also been closely involved in monitoring the implementation of each technopolis(Masser, 1990;Fujita, 1988). However, there is a strong 'do it yourself' dimension to technology policy that provides a stimulus for bottom up efforts at the local level.

In addition to funding the property development aspects of high-tech centre, there are different approaches within the four countries to providing help both for the centre itself and for the tenant firms.

The British approach is focused on support for innovation, particularly for SMEs, whereas German Centres benefit from a range of financial support for everything from start-up costs to ongoing operational subsidies such as subsidising the rents of tenant firms or charging the centre itself a low rent through regional support. The Japanese government has also provided a range of financial assistance for the development of technoplises e.g. subsidising frontier type R and D, industrial relocation incentives and urban facilities. In addition to these, Japanese technopolises have provided support for the development of an information network and a Technology Promotion Centre for better communication between researchers to achieve a critical mass of research activity.

(5) Impacts on local economic development

There are also important differences in the likely impacts of the hign-tech centres in the four countries. The emphasis that is being given to the creation of institutions for promoting technology transfer and stimulating local efforts in technopolis programmes is likely to have a more direct impact on future technological and economic developments than the establishment of science parks(Masser, 1991). In particular Japanese technopolis developments seem to be most successful in broadening high-tech development in peripheral areas, upgrading productivity there and reducing and in part inverting inter-regional disparities in technology based economic development(Stohr etal, 1992). However, problems such as a lack of spin-off activities from HEIs and local R and D centres and attracting key personnel to the area remain in Japan.

The British science parks and the German innovation centres and science parks show that the symbolic value of high-tech centres as a visible sign of local commitment to the promotion of new technology can be dismissed in terms of potential impact on local economic development(Masser, 1991; Wegener, 1992). In the major conurbation the principal economic contribution of science parks or innovation centes may bring employment and new industrial activity into areas which have deteriorated through the decline traditional industries often with a consequent lose of working population. There are important strength science parks and innovation centres in terms of the value added to local economy through links HEIs or R and D centres in local areas and technology trasfer. Firms graduating from innovation centre. Germany illustrate the successful development of a local high-tech base through links between HEIs and R and D centres.

Table 8. Comparison of High-tech Centres in Terms of Impact

	UK	Germany	Japan
impact on local development	symbolic value of HTC(value added to local economy in areas of traditional industry)		direct impact on development
	strengthen HEI's link to local community	successful establishment of new high-SEMs	– breeding hightech development in peripheral areas – Upgrading productivity – reducing and inverting existing interregional disparities
problem and main issues	reinforced, not reduced, regional disparities in hightech industries	dilution of the quality of firms in HTCs	lack of spin-off activity from HEIs
	little benefit to job creation because of lack of manufacturing	decline in the concept of promotion of technology	attracting key personnel

There are several problems with the development of science park approaches in both countries. Whilst the number of Parks in the pipeline is growing, there are fears that the quality of applicant firms for location on these science parks will be diluted. As science parks become increasingly conscious of economic objectives, there is also a corresponding decline in the concept of promotion in the centre itself.

2) Conclusion : Some Lessons for Future Development

In this paper, some experiences with high-tech centres(HTC) have been evaluated with respect to their effectiveness as a regional innovation policy and their potential for achieving technology-led economic development. The experiences of three countries(the UK, Germany and Japan) have been evaluated. Different approaches to high-tech centre development have been found to have particular strengths in particular circumstances.

An initial conclusion of this review is that High-tech centres can be valuable as an instrument of regional innovation policy as well of technology-led economic development. Evidence considered in this study suggests that high-tech centres support start-up firms and their development after the incubation stage, that they add value to the local economy, in particular in areas of traditional industry, and that they have marked multiplier effects. However, hign-tech centres are only one of a number of factors that may lead to technology-led local economic development.

Although the actual employment effect of high-tech centres is small, their spin-offs may well be substantial. They certainly have contributed much to dispelling the negative image of declining regions and giving them a fresh appeal. In particular, there are important strengths in the high-tech centre concept in terms of value added to the local economy. Economic circumstances have encouraged higher education institutions and centres of research to strengthen their links with local communities and seek ways to facilitate technology transfer. The high-tech centre is an important instrument in such a process whose benefits will be reaped in the longer rather than the short term.

There are also a number of development lessons that can be learnt from the international experiences which are of value to High-tech centre planners in local as well as in central government. First, High-tech centres should focus on the development of a locality's indigenous industry. Fostering SMEs through an incubation policy is the crucial to this end. The initial policies of science parks in European countries, and the more recent approach to technopolis policies elsewhere, demonstrate the importance of breeding SMEs. The experiences in Eastern Asia point to the problems of achieving technology transfer between incoming branch plants, however high-tech, and local firms, when SMEs are not fostered through incubation policies. Therefore, and important consideration in achieving spin-offs is the assistance offered to scientific entrepreneurs to change from a research or academic environment to an industrial one. This incentive is enhanced if a high-tech centre contains an incubator/innovation centre. By mixing SMEs with R and D and high-tech production establishments, innovation capacities may be further enhanced.

Second, the differences of approaches between science parks and technopolises show their strengths in particular circumstances. The presence of some manufacturing on high-tech centres may reinforce their favourable effects. However, science park sites are generally too small and unsuited to large scale production while planning constraints actually forbid manufacturing in many cases. Mass production does not fit the prestigious image of many science parks. The emphasis that the technopolis concept gives to the creation of institutions for promoting technology transfer and stimulating local efforts by encouraging manufacturing industries and associated R and D may well have a much more direct impact on future innovation and regional development than the establishment of science parks. On the other hand, science parks have lower risks and a greater ability to respond to changing circumstances and are not intended to be industrial estates. Technopolises require a long term investment strategy in terms of comprehensive urban development, whereas science park success depends more on short term returns on investment in property and the symbolic value of a prestigious high-tech development. In this sense technopolises can succeed only in the right combination of circumstances including close co-operation between local and central government. It must also be borne in mind that the technopolis and science park approaches have different impacts because they have different aims and are designed to fit different circumstances. Whereas science parks focus on the local economy and are established without substantial government funding, technopolis are part of costly national decentralisation policies as well as aiming to boost regional innovation and economic development.

Third, an aggregation of R and D centres, entrepreneurs and HEIs in a high-tech centre can prompt only a certain degree of innovation. But it is not until interpersonal and inter organisational communication networks among researchers and entrepreneurs are established that a synergy of innovation will be established in the community. Therefore, it is necessary to assist the development of communication networks among R and D activities. On-line information networks connecting High-tech centres and major cities, or technology promotion organisations as a communication node for researchers, are examples of these approaches.

Fourth, evidence from international experiences shows that successful high-tech centres are those which capitalise on existing locational behaviour. The critical factors for their development are the role of a high-grade university, the location of a variety of research facilities and the attractiveness of the area to highly-qualified workers and entrepreneurs as a place to live and work. Easy access to major cities by the transportation network is also crucial. In areas without these conditions for growth, it is difficult to see a high-tech centre having any major impact on the local economy, although long term subsidising from the public sector may enable them to survive as small, specialised property developments.

Although unique in many respects, there are many lessons that can be learnt from these aspects of international experiences which are of considerable importance to local and central governments wishing to enhance their indigenous technological potential through high technology spatial development strategies.

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