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A review of the infrastructure, governance, business support and services in market led science and technology parks as a framework for the planning and development of science and technology parks in different country cultures

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Innovation and business country culture in relation to the development and success of STPs

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A review of the infrastructure, governance, business support and services in market led and policy led science and technology parks as a framework for the planning and development of science and technology parks in different country cultures.

Abstract

There is worldwide interest in the development of science and technology parks (STPs). Today in addition to those in Europe and the USA there are strong science park movements in South America, India, and China and interest from a number of Western Asian and African countries. Clearly there are differences between these countries which will affect the development of STPs.

In all definitions of science parks there are at least two common themes. One refers to real estate and the other reflects the intention to support the creation and growth of existing and new knowledge based businesses, which is part of an interest in extracting wealth from technology.

However, the characterisation of science parks in these definitions hides a number of real differences in the science park models that have been developed. This difference reflects the prevailing economic, technology and social conditions of the locations in which these have been developed.

This paper looks to identify the differences in the nature of different science and technology park models against both the level of scientific competence at a regional and national level and land value.

To do this the paper reviews some of the development strategies, structures for governance, and innovation strategies that have been put in place for science and technology parks.

The conclusions of this paper is that science parks have evolved into a wide range of land use models and, the extent of the business development support services continues to increase as a mainstream science park activity but to be really effective these sites need to integrate into a effective innovation systems.

This paper attempts to provide a background of detail against which those either planning or running parks can consider their developments.

Introduction

There are few if any countries in the world that are either not actively engaged in either planning or creating science parks. Measures of the level of this interest include the rising number of members of science park related associations, stronger interest by organisations such as UNESCO in helping developing countries to better understand how science parks operate, a significant increase in the number of international missions which are part of a discovery phase for those now considering these projects and an increasing number of references to science parks as part of wider innovation systems related to economic development.

Despite the history of science parks stretching back to the 1950s there are still a number of enduring questions that are raised about their development and operation. The most common of these questions relate to their planning, physical development and capital funding; operational matters, tenant related issues; and performance of the park in terms of there economic impact.

The uncertainties about science parks arise from two differences when compared with other forms of property development.

The first is that parks are projects which usually bring together stakeholders that include government and politicians, a host (university or research centre) and business interests all of which groups have different aims and ambitions for these projects. These interests can range from economic development at one extreme to unbridled profit seeking at another. These differences represent a number of gaol conflicts that need to be reconciled.

The second difference is that parks are often planned against of the widely varying economic conditions and scientific competence of the region in which this model of land use is proposed. To put this in context science parks have been built in regions which vary from those where 30% of a country's R&D spend occurs and land values are sufficient to support all the costs of the project to those where the R&D spend is less that 2% and land values do not even support building costs yet they were originally conceived to support technology transfer.

Given these large differences the combinations of answers to these questions relate very much to the prevailing conditions in the country or region in which science parks are being considered. Of these conditions those three which have the greatest significance in terms of the costs to the promoters of these sites relate to:

- Real estate component of any project, i.e., land acquisition and building costs.
- The cost of both creating, managing and sustaining the background of scientific competence of the region where a park is planned or in operation.
- Setting up strategies which are necessary to support entrepreneurs trying to capitalise on this investment.

The paper explores these questions in relation to science parks with the view to setting out ideas that may be of value to both those contemplating the development of a park or for those already actively engaged in the science park movement.

Physical development strategies – land value to incubation led

Science parks have emerged as a brand of real estate development over the last 50 years. Over this time they have acquired added significance because of the increasing level of interest by governments in economic development and by business in the opportunity these sites provide for access to business support, technology and skills.

This interest is accelerating with both increasing global competition and the emergence of new ideas on how best to deliver soft and hard infrastructure to maintain a regional competitive advantage.

Based on these drivers it is suggested that it is no coincidence that over this period these projects have moved from being locally promoted projects to become, in many countries, an element in their respective national innovation programmes.

This shift has been a significant influence on the evolution of parks from being nearly exclusively motivated by interest in real estate to sites that are explicitly instruments of economic development that fulfil this role

This shift to an economic development role has encouraged governments to take a greater role in their planning, funding and development.

This broader investor base has made it possible to:

- Decreases the risks for local investors and increase the type, scale and scope of sites which are developed under the title of science, or science and technology parks – *risk and diversity of sites.*
- Achieve significantly greater scale of sites that have been brought forward as part of wider regional urban planning projects – *scale and density of sites.*
- Increase the number of funding regimes that can be used to promote and develop science parks which in turn has made it possible for science parks to be developed in areas with lower land values and lower scientific competence than the early sites – *funding and development, public - private and public - university partnerships.*
- Fund business incubation and additional business support services to change the dynamics of science park development from a real estate focus – *Incubation and added tenant services*
- Integrate these parks into wider innovation systems by implementing policies to help them support national innovation systems – *science parks and regional or national innovation systems.*

Risk and diversity of sites

A historical view of the development of science parks suggests that the initial interest in these developments was stimulated by local interests and stakeholders taking a parochial view and championing these projects.

The level of risk which could be tolerated by the early promoters such as universities meant that the development of science parks was nearly always restricted to areas where either land values could support debt associated with the development or a land sale could realise sufficient funds to enable the construction of the incubators and support some of the activities that focus on economic development.

From a period in the mid 1980s rapidly increasing international competition encouraged governments to engage with the science park movement which in turn:

- Had an influence on the types and locations of sites that come forward for development as science parks because of the ability of government to step in to counter market failures by taking the financial risk, supporting these projects with other infrastructure and take a more patient view in terms of measuring the return on capital.
- Encouraged local governments to consider bringing forward their own land as sites for parks.

- Encouraged planning authorities to approve the change of use for a science park on university land holdings, which if the land had been held purely by commercial interests, may not have been granted permission.

The types of sites which the engagement of government enabled included:

- So called 'green field' sites that were next to a university, e.g., Surrey Research Park (UK) where the University's ownership helped overcome significant barriers to secure planning permission for the site which would not have happened if the land had been in private ownership.
- Recycled redundant industrial sites, e.g., Coventry Science Park (UK) which is located on a major site previously owned by Rolls Royce as an industrial plant and Aston Science Park (UK).
- Redundant military complexes.
- Redundant commercial research facilities, e.g., Kent Science Park (UK) in Sittingbourne which was a redundant Shell Research Centre that was successfully promoted and re-launched as a science park.
- Redundant academic buildings, e.g., National Physical Laboratory (UK), where there is a redundant building on the site of one of the worlds leading academic physical measurement centres that is now being promoted as an incubator.
- Sites that came to the market with the shifting pattern of government expenditure on science and technology, e.g., Harwell Science Park (UK).
- Sites that have been planned to drive the transfer of excess intellectual capacity associated with a government installation, such as a nuclear power facility, to the private sector as part of a 'privatisation' regime by government, e.g., Westlakes Science Park (UK) fulfils this role associated with the Windscale nuclear installation.
- Sites associated with defence research, e.g., Porton Down and Malvern Science Parks (UK), which are now fully operational sites adjacent to Ministry of Defence research centres.
- Zones or districts in cities allocated for redevelopment because they have lost their focus on a particular industry or trade (Barcelona@22, Spain).

What has also followed from this increased investment is that some business parks now want to re-brand their image by adding small business centres and calling themselves science parks, e.g., Milton Park Cambridge, UK.

Scale and density of sites

One of the most dramatic changes to the science park movement following the involvement of government in the development of science parks and the wider recognition by urban planners in the potential of these developments to stimulate economic development has been the scale and density of some of the more recent developments that have emerged.

The changing dynamics of global business has also affected a number of cities. Some of these are responding to this change by establishing districts to which they ascribe the title science park. Associated with the governance of these science or knowledge zones there is a raft of officials which are aimed at co-ordinating business development services in order to both attract foreign direct investment and support new technology based firms.

The increase in the scale of some science park developments has brought some forward as mixed use projects which include housing, hotels, leisure and other facilities. Also the recognition of the potential of science parks has prompted the development of new zones/towns of development associated with nodes of international communication such as airports. In these locations the intellectual or knowledge base element has been planned around a new research institute or university. With both the 'baby boom' in many developing countries that started more than 20 years ago and with many more people aspiring to higher education there is now an expanding demand for higher education which provides an opportunity for seeding a new science parks associated with this kind of investment. An example is Mubarak City of Science and Technology (MuCSAT, in Borg el Arab, Egypt).

City centre initiatives such as Barcelona@22 (Spain), the Coventry Science Park (UK) and Maryland BioPark (US) are all a reflection of the recognition of the changing needs of the property sector to provide added value services for companies that are addressing markets that are more competitive than in historic times, they face the challenge of new platform technologies that can remove their market very quickly (digital photography undermined silver halide and Polaroid technology very quickly) and they need access to different resources that include knowledge intensive business services if they are to improve their chances of innovation.

An interesting footnote to this brief review of real estate related issues is that in parallel to the widening interests of science parks there has been a change in the densities of people that they accommodate as they have evolved from real estate initiatives to be part of national innovation systems.

These range from relatively low density occupation on early parks where it was normal for between 500 and 7,500 people to be engaged in high value development, through densities of 50 to 60,000 people on larger mixed use park that offer housing, retail and in some cases leisure, to densities of up to 1.5 million people where 'parks' are based in cities that have adopted policies aimed at increasing their engagement with science and technology business.

Funding and development

One of the factors that influenced the early development of science parks was the value of real estate income. Before the contribution made by science parks to economic development was recognised, which brought with it the interest of government and their substantial resources, the early science parks relied on their intrinsic land value or the inherent worth of their existing buildings on which to base their projects.

This strategy relied on attracting large companies to these early science parks where the proceeds from the purchase of land funded early development.

This was particularly the case in the United States where early parks offered a "campus-like" environment and mainly focussed on attracting (recruiting) large companies to their sites in order to set up specialist facilities, while providing little if any business assistance or services[1].

Examples of successful European parks that were able to fund their own development through land sale strategies, albeit with the benefit of having been granted zoning or planning permission on relatively low cost land, included Cambridge Science Park in the UK which recruited Knapp Pharmaceuticals, the Surrey Research Park (UK) which recruited BOC, Research Park Triangle (US) with IBM as an anchor tenant and Sophia Antipolis in France that recruited Air France.

This trend continued on parks in areas with high land values and where the combined elements of convenience for international connections and scientific excellence attracted substantial research facilities to these sites. Two examples of these investments are the

[1] Batelle Technology Partnership Practice October 2007, Characteristics and trends in North American Research Parks: 21st Directions

Sharpe Research Laboratory on the Oxford Science Park (1992) and the Borax Research facility in Surrey (1994).

Today finding mobile capital looking to invest in corporate research centres in locations other than those with an outstanding track record is very difficult although not impossible; however, if this is pursued as a strategy the pedigree of an area has to be very substantial and marketing has to be extremely selective. It is understood that Technia in Kuopio Finland is adopting this strategy in which they are focussing their marketing attention on companies that have a match to their scientific competence.

A more common opportunity today in terms of attracting mobile capital for research facilities is to provide space to accommodate small specialist parts of large companies.

Public - private and public - university partnerships

In contrast to parks planned and developed in higher value locations a number were built in less prosperous areas and these had to develop more creative ways of financing the physical building and infrastructure. This was only made possible by forming partnerships between government, higher education and business.

Two early examples in the UK of where there was a public / private partnership was the Warwick Science Park where the incubation facilities were subsidised by Barclays bank which acted as a corporate sponsor and Aston Science Park where the initial core of the Park was created around a refurbished industrial building the costs were funded by Birmingham's City Council and Lloyds Bank.

The high profile achieved by some of the early parks that focussed on business incubation and the promotion of business incubation in the European Union through its BIC (Business Incubation Centres) organisation prompted a significant increase in interest in these projects and the associated services they offered. Continuing economic decline in some parts of Europe encouraged significant public investment in business incubation. This public investment again widened the number of sites that could be developed as the private sector funding for incubators began to reduce as many potential donors recognised the need to reduce their costs.

Incubation and tenant related services

The recognition of the increasing contribution to economic growth and competitiveness made by those engaged in the knowledge economy has encouraged a third wave of science parks. Evidence across Europe[2] and the US[1] has shown that science parks are now placing greater emphasis on supporting incubation and entrepreneurship to grow a future tenant base.

Empirical data from the Surrey Research Park shows that just under 40% of the 45 companies on the Park (total number of companies on whole site is 140) that are not in the business incubator known as the Surrey Technology Centre, emerged from this building[3].

Over the last 20 years much has been learnt about the needs of entrepreneurs as they form and develop new companies. This steady improvement has encouraged a number of new elements and services to be offered on science parks as part of the support for business formation and its subsequent growth.

Examples of these the types of facilities now being actively pursues include:

[2] United Nations Economic Commission for Europe 2007, Creating a conducive environment for higher competitiveness and effective national innovation systems. Lessons learned from the experience of UNECE countries. United Nations, New York and Geneva 2007 ISBN 979-92-1-116982-9

[3] Parry M 2008, perse comm.

- Pre and full incubation: a number of parks have also created formal pre-incubation programmes which assist those with technologies that have commercial potential to build a business plan that can either attract equity, grant money, or loans in order to progress, e.g., pre-incubator centre that has been created in the UK known as SET Squared which is based on the science parks in Surrey, Southampton, Bristol and Bath.
- Creating and servicing grow on space to encourage companies to move out of business incubators.
- Providing ready made operational laboratories for biotechnology companies
- Centres with substantial investments in scientific equipment to support companies needing to continue to invest in science based research.
- Specialist facilities such as advanced manufacturing centres

The provision of these facilities passes the risk of the capital costs of these items from the tenant base to a central funding body. In addition it also increases the size of the market for these sites and can result in attracting many high risk companies that are working on speculative commercialisation programmes.

The experience of those engaged in business incubation is that they develop an initial pioneer or foundation phase when they are first established which involves providing the infrastructure or building which has associated management strategies that include tenant selection policies and incubation programmes, which are run by appropriate staff to support the programme and strategies to move companies out of the centre.

To deliver this incubators require effective management, support for companies that include the following:

- Mentoring and coaching associated with pre and business incubation.
- Establishing early stage financing programmes including proof of concept funding and seed capital.
- Business planning, advice and training services.
- Access to ideas that can be achieved by forming links with relevant qualified people already in markets or experts on emerging markets that are driven by innovation.

An interesting question remains over the intensity, costs for and provision of these services.

In locations where land values are high there are often both a number of innovative business services and retired people with extensive business experience already in the community to whom support services can be ‘out sourced’. This strategy helps to keep fixed costs low and enable these services to be used selectively and avoid the “one size fits all model” of providing services. However, where the business community in the locality surrounding a park is not well developed it is necessary to provide support services as a direct cost on the centre. This requires direct local subsidy unless there is in place a national business support service that is already in place which can provide support.

Offsetting the risk of accommodating high risk companies can be achieved in a number of way of which one is by increasing the cost of occupation with the view that one winner can pay for the failures (not recommended), offering flexible occupancy contacts so those that fail or grow fast can leave a centre easily, and/or providing business support programmes that deal with real commercial issues that are encountered while companies build a revenue or asset base that can make them self sustaining.

Evidence from the US[1] and the UK also indicates that in some cases science and research parks are focussed on particular niche areas of activity. Examples of such facilities are the

Advanced Manufacturing Centre in Sheffield (UK) which has focussed on aerospace engineering and other advanced manufacturing activities, which has as a partner the Boeing Corporation, and the Maryland BioCentre in Baltimore US.

Variations to niche centres that might be applicable in developing countries include the following:

- Incubators that target for example horticulture, textiles, handicrafts or an 'open sector' for relevant technologies for local needs.
- A new idea that is developing are export business incubators[4] which are focussed on developing export led growth, based on best practice for export led economies.
- 'Returner' centres that attract back talented and qualified nationals that have been educated abroad and see the opportunity to continue there career at home working on appropriate business opportunities. These centres are already in operation in China and India.

The growth in the number of companies formed in these innovation centres also prompted many of the parks to also provide "grow-on space" in which to accommodate those companies that graduated to a more independent property options.

To accommodate this growth it is important to understand the barriers that companies graduating from incubators face as they move to larger building and a more independent phase of development.

Examples of major barriers to the ability to move companies to larger premises, assuming they are available on a site are:

- A lack of broadband capacity at affordable rate. To overcome this some park operators have installed a "point of presence" on their site to provide highly competitive band width which then reduces one more of the barriers of entry for many companies wanting to grow but are reluctant to buy high capacity bandwidth direct from commercial providers because of their demands for long contracts for high prices.
- Access to laboratories: providing these is very costly; however, modular systems are now being produced that can be provided as independent system built units to meet specific needs of growing biotechnology companies.

Government policy changes

In many countries legislation that prevents or limits the ability of universities to engage with business has proved to be a barrier to forming links between higher education and business. Recognition of this has resulted in some countries altering legislation to enable closer links. However, it is important to recognise that changing legislation without creating a funding stream or incentives to support links this will continue to limit the potential interaction between higher education and business.

In addition to these changes to the physical development of science parks legislation was passed in the UK which separated the government Ministry of Defence into a part that was concerned with commercialising technology and that part that remained part of government and was active in defence technologies that are crucial to national defence.

In the UK the legislation laid the foundation for the Regional Development Agencies that were charged with creating Regional Economic Strategies and it was made a requirement for

[4] Allen, J., 2008 Perse Comm.

universities to engage in the added role of engaging with business and the community for economic development. These development agencies are now also a channel for economic development.

Evolving funding structures

The initial wave of science parks were in the majority funded as market led projects in which financial returns justified the initial investments. This included both the re-use of refurbished buildings and new build projects. However, accepting some of the high risk tenants attracted to many early parks was made possible because even for those that managed to cover building costs with rents they often operated on land that had been granted to them at low land values so were able to take the added risk of dealing with new companies with no trading record.

This review of science parks shows that there is no particular land use formula that has been used to establish science parks. However, it is clear that with the involvement of government in these projects the funding of science parks has begun to diverge from applying simple real estate based site analysis (NPV and residual valuations), which drove land sales or whether to build a park or not, towards putting business plans into a broader context. This context looks at the economic development potential of these investments and the potential of doing this in parallel with altering national policies that increased the number of sites that were regarded as having potential as a science park.

The experience of the market for science parks is that most operate in locations where the commercial market are not able to make the necessary returns on the property investment needed for these project to justify making the investment. The market failure has required partnerships between the public and private sector to instigate these developments and a number of commercial arrangements have been adopted for creating science parks.

Other examples include where the public sector has set up a property company that is state funded in the initial phase to commence development but when it has reached sufficient momentum to raise and support bank finance or attract equity partners the public sector has either sold its share or in other cases simply remained partner but reduced its risk.

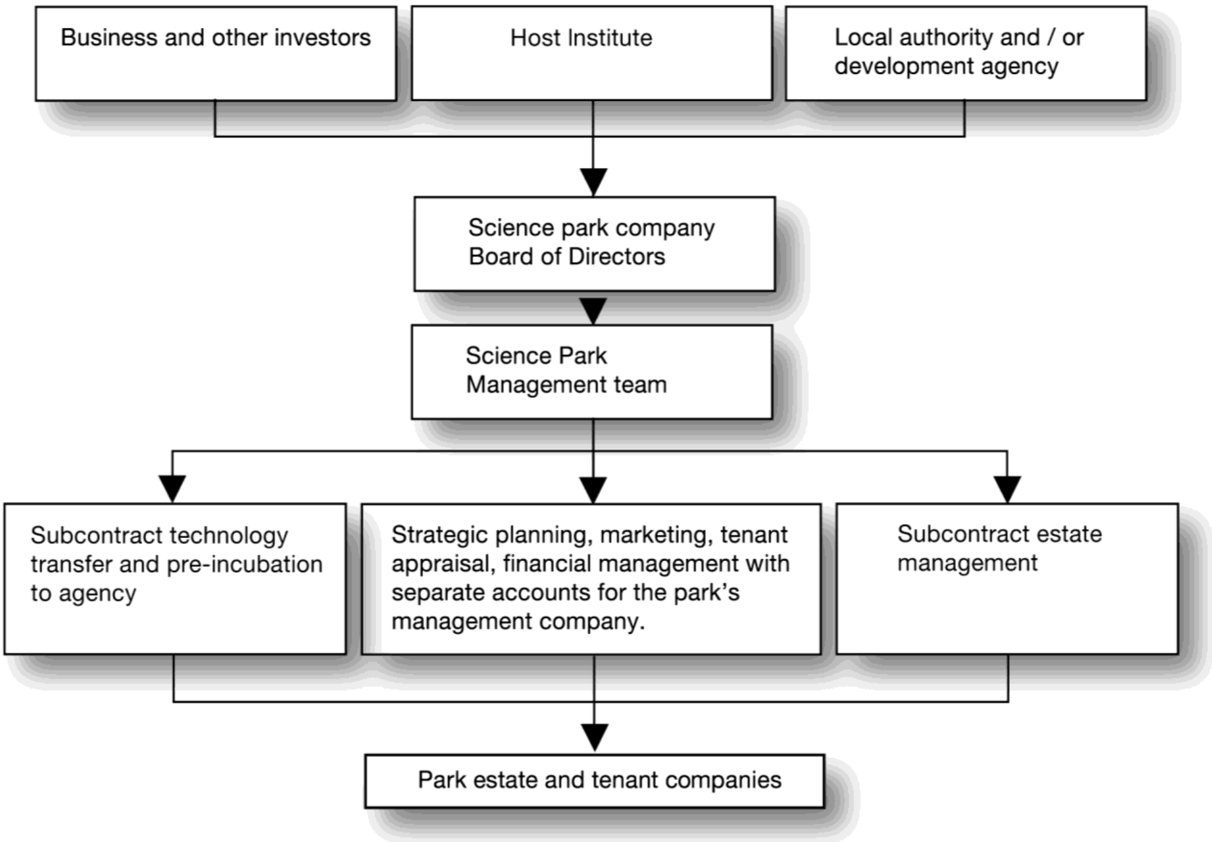
An exit route for early funders is a flotation of the projects on a stock market. However, the experience of those that have gone down this route is that it is necessary to create a single investment vehicle that operates a number of parks which create the asset base that looks for funding on the stock market e.g., Technopolis in Finland is an example of such a vehicle. If this is considered as a model it is important to structure the management and ownership of the organisation to enable this exit.

Other examples are where science parks have been adopted as central to a national strategy to redirect a part of a national economy such as the cases in Singapore, Qatar and Dubai. In these examples the investment in real estate investment is colossal but is allied to substantial investments in supporting science and technology, education and tax incentives that together are aimed at attracting technology business that can set a firm foundation for the future.

Governance and management

The most commonly adopted structure for science parks is shown in figure 1.

Figure 1- Characterisation of a Joint Venture management structure - after[5] Rowe 2006



This structure allows for the engagement of a number of partners to take varying degrees of control and opportunity to invest in a project. It allows for the land to be vested in the company, the governance gives control to varying partners and allows for partners to be rewarded should the venture succeed.

In this arrangement services can be either provided directly or indirectly to the tenant companies either through the company or via a subcontract.

A number of questions arise in this kind of structure which relate to the payment to the non investing partners. For example if a university makes no investment in the park, although its engagement is essential to create the park, how can the institution be rewarded for this commitment? Obviously if a project is successful and the land value rises ownership of this land can help the university's balance sheet. In addition to this opportunity other benefits might include public relations, the potential for securing research contracts with tenants, creating working relationships which help students find placements for either industrial professional training years or if they are on entrepreneurship in technology courses.

Performance

[5] Rowe D., Interface with the University or Centre of Technology. Chapter 3 in The planning development and operation of science parks, Edited by Malcolm Parry, UKSPA 2006.ISBN 1-871786-14-2

One of the responses to these various sets of conditions is to try to focus national investment in those ways that have the most beneficial economic impact. There is little in the way of published hard comparative data that supports the hypothesis that science parks have a beneficial economic effect. However, there is a wealth of qualitative reports that have been reviewed[6] that provide evidence to support the view that science parks are effective in supporting business development and a broadly based study on performance of companies on science parks[7] compared with matched companies not on parks produced some statistically significant results about the performance of science parks in a national context.

The results of this study**Error! Bookmark not defined.** indicated that parks in locations, that are endowed with a good supply of science and technology, i.e., high scientific competence and have good linkages between this science and technology base and the demand side of business, demonstrated the highest levels of success measured by rate of tenant company growth, the level of qualification of their employees and the numbers of innovative services they launch when compared with matched companies not on science parks.

Managing technology transfer, IP and links with business

There have also been a number of improvements to the management structures within host organisations in order to both develop links between tenant companies and host organisations for business support and for transferring technology into tenant companies. In the case of the Association of University Research and Industrial Liaison Office (AURIL) in the UK it has developed a range of training programmes for its members to improve the way the interface between business and universities operate and to improve the management of IP.

In a number of business schools MBA programmes students are encouraged to take an active role in working with small companies on their science park as part of creating linkages.

Science parks and innovation

The acceleration in the need for all economies, including those able to offer low cost labour, to strive to add value to economic activities added significant impetus to the whole debate about knowledge production and its use.

Out of this came a number of new initiatives on both the supply side of knowledge production, the demand side of knowledge utilisation by business and ways of improving the interface between these two parts of the equation.

Today it is recognised that this process relies on economy wide knowledge flows. This means the creation, diffusion and use of the knowledge. Recognition of the importance of these three components of innovation in stimulating growth and competitiveness has prompted most governments to try to create environments that are conducive to building the relationship that enable this knowledge flows.

Attempts to do this have included traditional innovation policies which focussed on increasing the supply of R&D but this has now largely been rejected as inadequate. A second wave of innovation policies looked to build on the systems for collaboration and the concept of the economies that emerge from the successful development of clusters. A third model which is now being developed is where there is effective co-ordination and integration of policy in which there are no conflicting goals. In essence the complexity and dynamism of the current

[6] Parry M. 2006, The performance of science and research parks. Chapter 10 in The planning development and operation of science parks, Edited by Malcolm Parry, UKSPA 2006.ISBN 1-871786-14-2

[7] UKSPA 2003, Evaluation of the past and the future economic contribution of the UK Science Park movement, published by the UKSPA in conjunction with the Small Business Service.

innovation-driven economy do not need a grand system design in innovation policy, but challenge governments to explore new directions for innovation governance and for governments to adapt and learn more profoundly than before[8].

The understanding of this relationship is continuously improving, but at the same time, the increasingly global competition, rapid technological advances and emerging new strategies at the firm and country levels makes this understanding only tentative and often obsolete. This means that there needs to be a continuous reanalysis of the established common wisdoms in both policy and enterprise strategy[9]

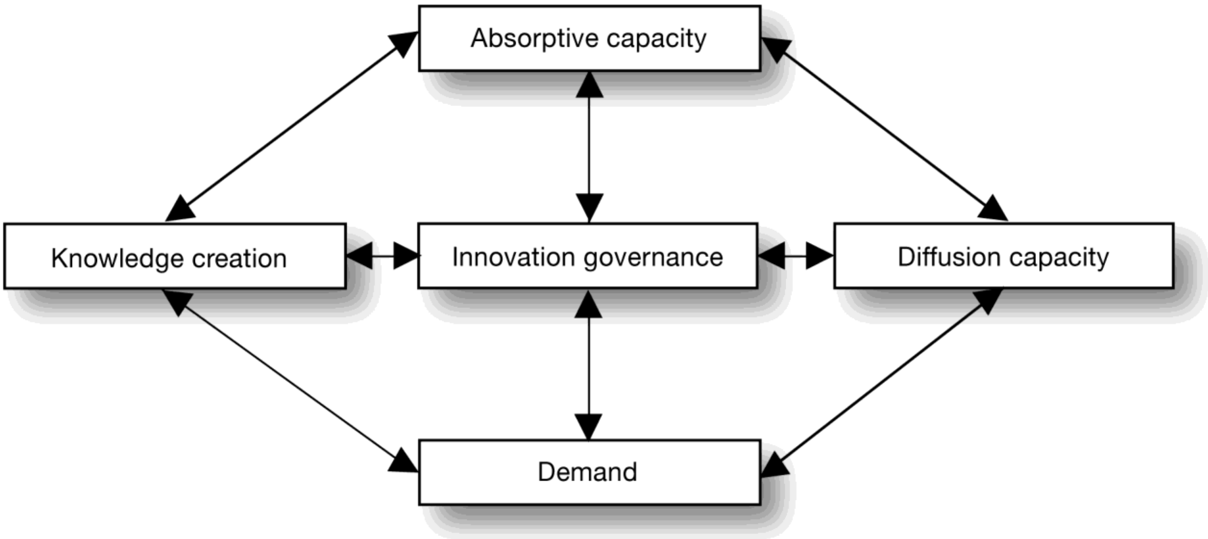
The early adoption of incubation by science parks has given them a significant level of experience in how to operate at this interface and it is clear that they have been able to adapt to the changing needs of their tenant base and encourage these tenants to have continuous interaction with their suppliers, customers, buyers and external organisations such as universities or research and development organisations[10].

At its highest level the relationship between knowledge generation and its utilisation as part of the innovation process has been characterised in a diagram[11] that defines the relationship between knowledge creation, the demand for this, the capacity for this to diffuse into the commercial and business sector and how much of this is absorbed into new products and services and the overall relationship of how this is managed.

This diagrammatic representation of the national innovative capacity (figure 1) is useful as it sets out a framework against which scores can be recorded in building up the background data for developing a business plan for a science park. By scoring each linkage it is possible to make an assessment of the scope, scale and timeframe for any necessary investment.

[8] OECD (2002) Dynamism National Innovation Systems, Paris OECD – Page 14
[9] UN 2007, Creating a conducive environment for higher competitiveness and effective national innovation systems – lessons learnt from the experiences of UNECE Countries, Page viii – UN 2007 ISBN 979-92-1-116982-9.
[10] UN 2007, Creating a conducive environment for higher competitiveness and effective national innovation systems – lessons learnt from the experiences of UNECE Countries, Page 1 – UN 2007 ISBN 979-92-1-116982-9
[11] UN 2007 Figure 1 – Creating a conducive environment for higher competitiveness and effective national innovation systems – lessons learnt from the experiences of UNECE Countries Page 42 – UN 2007 ISBN 979-92-1-116982-9

Figure 1 – Characterisation of a National Innovation System



After UN[11]

An added nuance to these relationships is that they can be refined in relation to particular sectors rather than more generic linkages.

It is suggested that such a system could be overlaid on any industrial sector including those noted in the section of this paper relating to niche incubators, with a great deal less investment than trying to create cumbersome arrangements across whole sets of institutions.

The theory behind these investments is that the greatest impact on economic development occurs when the relationships characterised in Figure 1 are intact and working well. However, there is a view that over reliance on policies that build these characteristics into an economy is not always effective.

In essence it[12] is essential to have an additional layer of enterprise without which, whatever other strengths and weaknesses, little if any progress can be achieved which means that without also dealing with weaknesses in the firms and the organisational capabilities there will be a reduction in the effectiveness of the policies that are in place to create the linkages noted in figure 1.

Innovation governance

At the heart of this process are the governance structure which motivate and drive the concerted efforts at many level in many different organisations, including interfaces with the business sector and society at large towards effective performance[13].

The need for effective governance of innovation continues to grow because a significant proportion of the knowledge generation capacity in any country takes place in the public sector in higher education and government laboratories but needs to be move into a commercial framework to be exploited. This requires liberal economic policies and business support that allow such IP assets to find a home in the commercial sector.

[12] UN 2007 Figure 1 – Creating a conducive environment for higher competitiveness and effective national innovation systems – lessons learnt from the experiences of UNECE Countries Page 25 – UN 2007 ISBN 979-92-1-116982-9

[13] OECD (2002) Dynamism National Innovation Systems, Paris OECD

Market failure in terms of early stage funding for market evaluation and proof of concept are examples where there is a much needed input from government to overcome a significant barrier to technology transfer and an matter in which immediate government action is required.

Good governance allows connections to be created which might include technology users to engage in the development of policy. One simple strategy as an example is to create science and technology boards comprising appropriate representatives of business, the public sector and higher education in defining both the content of knowledge creation and policies that define the interface between these three sectors. It is important that if such a board is created it does not focus on science and technology policy to the exclusion of developing innovation policies.

The five generic institutions that need to be assembled in considering governance of innovation include:

- Governments (national and regional) – they set policy directions
- Private enterprises: clusters and business federations and associations
- Universities and related institutions that provide skills and knowledge
- Bridging institutions which include public laboratories, technology transfer organisations, operational clusters and business consultant
- Other public an private organisations that play a role in the national innovation system, e.g., patent offices, financial intermediaries, training organisations and standards agencies.

It is essential that there is a facilitation mechanism that draws these together and creates the appropriate set of forums (fora) in which the dialogue can take place and they have sufficient authority and funding to pay for and implement the linkages.

It is suggested that as an initial step in considering innovation governance is an audit of the categories of activities noted in below is undertaken with the objective of populating this with details of the institutions or policies that are active in either a nation or region on which attention is being focussed in relation to an innovation system and any associated strategy for the development of science parks.

An 'innovation' audit

- Research and Innovation Funding: which includes national research councils, any super national funding bodies (e.g., EU Framework Programme) and which can include aid agencies and charities that support R&D?
- Networks: which include networks that have knowledge transfer as their focus, trade bodies or organisations which might include a national R&D or industrial research organisation.
- Government: which might include ministries or departments that focus on business, enterprise and regulatory reform, the environment, food and rural affairs, innovation, universities and skills, health, science and innovation, defence and regional development?
- Physical Infrastructure: which includes existing science parks, incubators and clusters or science cities?

- Technology Transfer Associations: in the UK these include the University Companies Association, Association of Independent Research and Technology Organisations, and the Association for University Research and Industry Links and associated technology transfer offices.
- Business Support: which includes, accountants, designers, higher education institutions, intellectual property professionals, lawyers, learning and skills council, marketing and media, regulatory authorities, sector skills council, and those engaged in skills training.
- Industry: industrial councils, research and technology organisations, consultancies, companies, inventors and entrepreneurs.
- Learned Societies:
- Research base in the country: which include innovative academics, business schools, public sector research establishment, large science facilities, university-based laboratories, universities and corporate labs
- Finance: including any venture capital and business angel community, proof of concept funds, an alternative stock market and banks.
- Standards: including any standards laboratories, national laboratories, standards agencies and national IP registration organisations.

Careful mapping of these activities onto a region or country can help to develop a clear understanding of those areas with the greatest potential impact taking account of their location and the skills and technology base in which they operate. This process can also tease out ideas of where added investment is needed to build and support innovation capacity.

Knowledge creation

Knowledge generation involves a large set of activities, which go beyond R&D. These include incremental improvements in products and production techniques, software, design and marketing and active use of new knowledge and new technologies developed elsewhere should all be considered as knowledge generating activities.

Despite this, traditional indicators of innovation performance are heavily biased toward investments in scientific and technological invention and thus do not capture innovation in sectors like services. Moreover, even within those sectors that they do represent, traditional indicators poorly reflect the true level of innovative activity. Recognition of 'hidden innovation' has important implication for those engaged in the development of science parks as it helps to understand that the range of tenants that might be interested in parks is wider than those recognised by investors in these sites and for the types of support provided to tenant companies.

This broader view of innovation also has implications considering wider indicators for supporting innovation such as investments in formal R&D or patents awarded and have important policy implications[14]. Hidden innovation is often more about absorbing ideas than creating new ones and this process is affected by non-innovation policies which include the way companies face their markets, suppliers and the skills base they develop internally.

It is well understood that innovations can influence performance across a number of sectors which include those in relation to products and services, production processes, new markets,

[14] NESTA 2006 "The innovation gap: why policy needs to reflect the realities of innovation in the UK? London: National Endowment for Science, Technology and the Arts. Research Report October 2006

new organisations and new inputs. It is also important to recognise that innovation is relative in that they need not be new to the world but may be commercially successful ideas as they are new to a market. Of course the product may not have the longevity in the market if the innovation is already in the public domain in another market but it still has potential in a defined area.

The regional conditions most conducive to innovation include a large number of qualified customers with a high demand for new products and a high willingness to pay for these. In addition a good and ready supply of highly educated labour, a supply of knowledge intensive business services and better opportunities for firms to pursue innovative activities.

Suggestions for ways that the supply of knowledge intensive business services can be increased include providing good quality well equipped offices, ensure there is a high speed broadband service, improve access to good international air connections and secure the education of the critical labour categories[15].

Linkages

The linkages between the various element in the national innovation system has been recognised as an important ingredient in supporting innovation; however, over reliance on building these linkages may miss an important nuance in the mix of activities.

These details include:

- Research alone is insufficient to create innovation.
- Problem solving plays an important role in innovation and so knowledge creation linked to demand for solutions has greater potential for innovation that pure research.
- Users of technology are often more important sources of innovation than pure research which means that in additions to links to R&D activities linkages to suppliers and customers is as important.
- The linkages between R&D and production are complex. One aspect of this complexity is that those engaged in R&D also have problem solving skills which are important in innovation.
- Open innovation which creates markets for innovative small companies rather than reliance on internal generation of innovation by large companies is an important driver of innovation.

To assist in this process it is important to develop arenas, create meeting places and organise events in which customers and suppliers, entrepreneurs, inventors and researches can interact.

There is clearly a role for science parks in this activity.

Absorptive capacity

The absorptive capacity denotes all activities that contribute to the successful absorption and adoption of technologies either new or known to the firm and to the country.

[15] Karlsson C, 2008, Perse Comm – Creating supportive framework conditions for enhancing the innovative capacity of firms.

The evolution of architecture of businesses in developed countries towards more horizontal structures that operate in complex supply chains that interact in order to gain efficiency and to innovate has helped many of these companies to increase their absorptive capacity.

In contrast many developing countries are still dominated by businesses that are hierarchical in their management structures (Taylorist in nature) which tends to limit this capacity. Science parks are likely to have little impact on changing this absorptive capacity in large domestic companies but by locating next to business schools which teach more modern management practices than those defined by Taylor in the early 1900s then there is greater chance of innovation emerging from the companies on these sites.

This suggests that

- Models for business need to be evolve to a more open arrangement to better facilitate learning.
- Companies need to try to achieve higher levels of skills and qualifications in their respective workforces.
- R&D function in companies needs to be recognised as not only serving the process of product development but it also enhances the capacity of companies to recognise changes in the market place and technologies that are being developed that could have a beneficial influence on their own products.

Diffusion capacity

It is clear that the diffusion of good ideas through an economy or specific industrial sectors is valuable for companies to maintain a competitive advantage. Recognition of this need to facilitate the diffusion of new knowledge through the economy has prompted those engaged in setting out policies to support this process to develop protocols that focused on different forms of partnerships through which to create the connections that support this diffusion. In R&D, this requires different forms of public-private partnerships, which promote knowledge circulation and matching of business needs and R&D expertise. Examples of these in the UK include a host of knowledge transfer partnerships; however, other important linkages include connections between:

- Foreign and local firms (direct, vertical and horizontal linkages)
- Large and small firms
- Small firms in clusters
- Research technology organisation (RTO) and industry

Of these there is a view[16] the biggest weaknesses are the poor linkages between large and small firms with SMEs being the weakest part of the innovation system. Clearly with the focus by science and technology parks on supporting the formation, development and growth of SMEs they can play an important role in helping to make connections.

Two examples of how this can done include developing an innovation advisory service as part of a science park outreach programme which connects companies across a region include small medium and large and through "technology connect programmes" in which large company technology scouts are encouraged to meet new innovative companies in business incubators.

[16] UN 2007 Figure 1 – Creating a conducive environment for higher competitiveness and effective national innovation systems – lessons learnt from the experiences of UNECE Countries Page 55 – UN 2007 ISBN 979-92-1-116982-9

Innovation based competitiveness

The experiences of many developing and emerging market economies in the world demonstrate that macroeconomic and business environment factors alone may not be sufficient to promote innovation, competitiveness and growth.

An issue that is still open for discussion is whether the business environment is a more important determinant of innovation than some specific innovation policy mechanisms. A current mainstream wisdom is that the business environment is essential to innovative behaviour through a stable macroeconomic framework, tightness of incentives and remedy of market failures only in areas where the incidence of market failures seems to be widely accepted.

Science parks are an attempt to address some of these market failures. Parks do this by degree. Those founded on high land values generally only have to deal with market failures in relation to business support, early stage funding, short term contracts for accommodation to enable growth and easy access to skills and technology. In contrast other science parks that are located in low value locations with low land values and depressed economic conditions they have to substitute for a much wider range of market failures. Science park development strategies to do this include creating broader mixed uses that bring in a potential customers base, include a wider range of facilities and services. Examples of some of these facilities that might be of value include rapid prototyping equipment, broadband services or other services to assist in the formation and growth of companies.

Demand

The factors that influence the demand for technology at the macro and micro levels are numerous. The factors that influence the supply side of technology are relatively better understood than demand side factors. However it is generally accepted that there are a number of broad components that affect the demand for technology which include: macroeconomic framework or the systemic nature of technology, the business environment and the need to maintain a competitive advantage, competition policy which includes minimising monopolies that inhibit competition and as a consequence innovation, financial systems which restrict or act as a barrier to investment, the strength of the IPR protection regime and public procurement policies that drive business investment in innovation to meet demand by government.

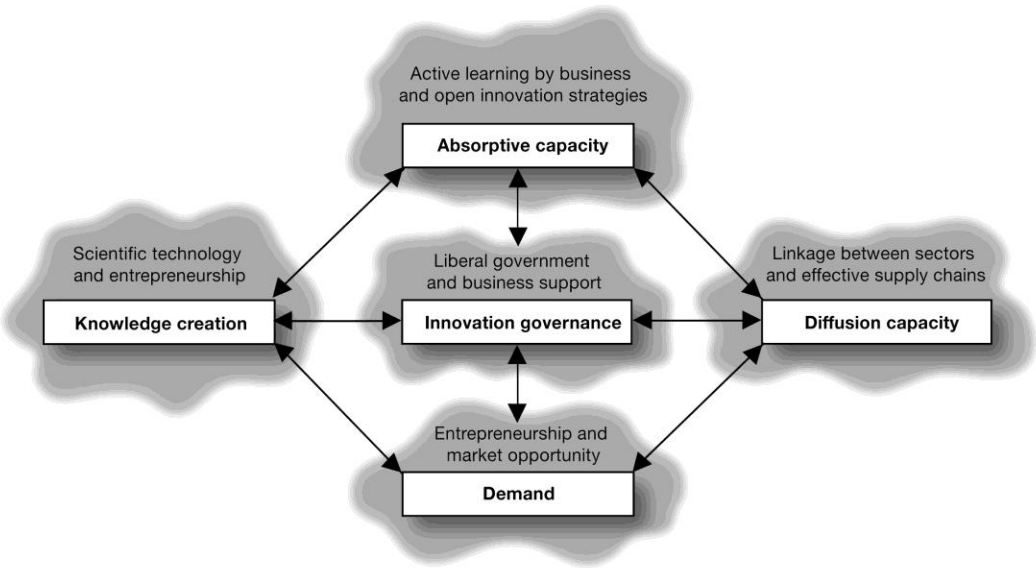
Science parks and innovation systems

Experience of those engaged in the science park movement has shown that each of the components characterised in figure 1 that make up an innovation system has a context and it is this context that is critical in helping to create the right environment to increase the chance of success.

The context of science parks in this process is that contrary to their name they are not about science alone, in fact they are about enterprise and this enterprise includes commercialising analytical knowledge (science), driving synthetic knowledge up the value chain (engineering) and commercialising symbolic knowledge (content). Examples of these respectively include stem cells, satellite engineering and computer games.

The context for the other elements that comprise innovation is shown in figure 2.

This enterprise and the related mechanism are shown in figure 2



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To build the kind of environment that provides the context to such an innovation system is difficult and is particularly so when it is being attempted across a large area. It is suggested that one of the values of science parks is that they are locations at which it is possible to pioneer and test policies and models to create an effective innovative environment.

As a starting point it is suggested that initial science parks are located in or close to a city. Cities provide functional regions in which economic activity is dense and therefore potentially open to change.

Most markets or customer networks for the majority of companies is within such a functional region and usually very often the one in which they are located. The conditions in these functional regions which are conducive to innovation include demand which is in effect a large number of qualified customers with a willingness to pay for a new product. To supply this demand it helps to have access to a highly educated labour force, new ideas or products and services that are either developed locally or imported.

From this initial local market it is possible to widen this in the case of some companies to exports where a particular competitive edge is recognised.

Science parks can play a role in bringing partnerships together to achieve these conditions by:

- Encouraging their host organisations to increase the supply of entrepreneurs through training. It has been suggested that every university course should offer course on entrepreneurship which is either voluntary or obligatory.
- Create a spirit of entrepreneurship in the host organisation.
- Provide the right physical infrastructure to support company formation and growth, e.g., pre and full incubation and grow on space.
- Create a supportive framework that helps companies build their ideas.

To achieve this it is necessary to work with a range of partners which includes government if legislation is required to remove bureaucratic obstacles to progress, to encourage government to create markets for innovative products by both removing barriers to competition and to modernise government by buying technological systems to improve performance.

Summary

This paper is broad ranging in the issues it has considered. The premise behind this was that science parks are not fixed institutions but rather agents for change that have themselves to evolve to support this process.

The funding of science parks has moved from being predominately land value based to a regime where they are valued for their role in economic development.

This has required parks to develop a range of soft services to support the high capital costs of construction and in some cases land acquisition. These include business incubation and then the integration of this into an innovation system.

Research carried out in the UK has shown the science parks have been successful in addressing this and some of lessons of incubation can be developed for use in developing economies.

Bibliography