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South Africa's National System of Innovation and Cluster Formation in the ICT Sector

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Abstract

The paper is made up of two distinct sections. The first section provides an outline and overview of the post-apartheid South African National System of Innovation, while the second section specifically focuses on two cluster initiatives in the South African information and communication technology (ICT) sector. Since South Africa's transition to a democracy in 1994 the science and technology system has been overhauled and reorganised within the framework of a National System of Innovation (NSI). The establishment of a Department of Arts, Culture, Science and Technology (subsequently split to create a more specialised Department of Science and Technology or DST) has provided a driving force for these changes.

The 1996 White Paper on Science and Technology outlined the NSI and led to the enactment of various articles of legislation, which guided the establishment of institutions and mechanisms in support of the NSI, which have provided the basis for the growth and enhancement of the science and technology system. The business sector performs the majority of R&D and innovation in the country and has shown real growth in its level of expenditure on these activities over the last decade. Both the DST and the Department of Trade and Industry (DTI) have supported several cluster orientated development and innovation initiatives. Science parks and incubators have been introduced with varying success as cluster-based technology development centres. An Innovation Fund for large near-market projects and a Technology and Human Resources for Industry Programme (THRIP) are two key R&D and innovation funds (provided by DST and DTI respectively) geared to encouraging inter-sectoral and inter-institutional collaboration.

In the latter part of the paper, we look at the clustering dynamics of the ICT sector in South Africa, in particular the centripetal forces fostering spatial agglomeration. We focus our analysis on two regional (i.e. Western Cape and Gauteng Provinces) ICT cluster case studies which illustrate a clear and intensifying concentration tendency of ICT-related production and R&D, viz. the Bandwidth Barn (a product of the Cape IT Initiative [CITI]) and the Innovation Hub (a component of the Blue IQ project).

SECTION I

1. New policy framework in South Africa

Since the advent of democracy in South Africa in 1994 there have been major policy changes in all areas of the economy and society including the science and technology (S&T) and innovation system. Prior to 1994 the S&T system was largely autonomous and government funds were mostly provided through a system of large national programmes. Anticipation of democratic change in the early 1990's led to intensified debates within the Mass Democratic Movement concerning the future of science and technology and its implications for society. Perhaps the most significant event was the International Development Research Centre (IDRC) review of and report on the S&T system and policy in South Africa (IDRC, 1993).

The first democratic cabinet in 1994 included the appointment of a Minister of Arts, Culture, Science and Technology. Further, a new Department of Arts, Culture, Science and Technology (DACST) was established. The DACST immediately set about producing consultative policy documents such as the *Green Paper on Science and Technology* which led to the publication of the *White Paper on Science and Technology* in 1996. The White Paper was based on the concept of a National System of Innovation with an emphasis on linkages and overcoming the fragmentation and duplication of the past. The White Paper also set the scene for changing the institutional landscape and it proposed reviews of all the major science and technology institutions. Further, the White Paper provided recommendations for a new advisory body, the National Advisory Council on Innovation (NACI) and an enlarged and reinvigorated research-funding agency (the National Research Foundation). Moreover, the White Paper introduced new support measures for Innovation such as the Innovation Fund, laid the groundwork for new strategies (e.g. the National Biotechnology Strategy) and initiated the development of numerous new policy documents and instruments over the coming years.

In 2002 the DACST split into two departments, one for Science and Technology (DST) and the other for Arts and Culture (DAC), both reporting to the same Minister but allowing the two respective Director-Generals to focus on more specific portfolios. The DST released South Africa's National Research and Development Strategy in 2002, which laid out more specific plans for developing the research component of the National System of Innovation. The strongly indicator-based strategy rests on the three pillars: (a) innovation, (b) science, engineering and technology human resources development and transformation, and (c) creating an effective government S&T system. It also plans new technology platforms such as in ICT and biotechnology and advocates an increase in the knowledge intensity of resource-based sectors. There is also a strong emphasis on science and technology for poverty reduction and a focus on enhancing basic research in areas where South Africa has important natural or knowledge advantages such as astronomy, biodiversity, human paleontology and indigenous knowledge.

2. Funding of research and innovation

Table 1: Research Support programmes and funds in South Africa

Fund and agency	Purpose	Total Fund value (US\$ million)
Innovation Fund (Department of Science and Technology through the National Research Foundation)	Medium to large scale technological innovation projects promoting cross-sectoral collaboration	\$24 million
Lead Programme Fund (Department of Science and Technology and National Research Foundation)	Medium-sized international collaboration S&T projects	\$3.4 million over three years
Regional Science and Technology Programme (Department of Science and Technology)	Priority areas in S&T co-operation with partners in SADC and Africa	\$1.8 million over three years
The GODISA Programme (Department of Science and Technology, EU funding, Department of Trade and Industry and Department of Labour)	Enhancement of technological innovation of SMMEs – establishment of pilot centres	\$6.2 million
National Research Foundation (funded by the Department of Science and Technology)	Grants and bursaries for researchers and research teams, student support and institutional support and international funding	\$26 million
Technology and Human Resources for Industry Programme (THRIP) (National Research Foundation and Department of Trade and Industry)	Collaboration between industry and higher education in research and technology development and transfer of people	\$46 million (including industry contributions)
Water Research Commission	Water research in strategic areas	\$10 million
Partnership and Industrial Innovation (PII) (Department of Trade and Industry)	Large private sector research projects in priority areas aimed at technological innovation	Variable
Support Programme for Industrial Innovation (SPII) (Industrial Development Corporation and Department of Trade and Industry)	Matching scheme to support technology development in manufacturing industries plus feasibility study support	\$12 million

In support of these policies and strategies, previous sources of funding have been strengthened and new funds have been established for R&D and Innovation support in South Africa. Most of these funds are specifically aimed at encouraging inter- and intra-sectoral collaboration and the development of research and innovation capacity. Some of the main funds and agencies are listed in Table 1.

3. R&D performance

The HSRC Knowledge Management Group recently completed a national R&D survey on behalf of the Department of Science and Technology (DST, 2004). Further R&D surveys and innovation surveys will be undertaken by the Group on behalf of the Department in support of the indicator based National R&D Strategy. The results from the survey indicate that the country spent about R7.5 billion Rand (or PPP US\$1.5 billion) in 2001/02. This represents about 0.76% of GDP, an improvement on the 0.69% recorded in 1997/98. There are 33,897 full time equivalent (FTE) R&D personnel in the country, including 8,661 FTE researchers. Total researchers comprise 1.9 per 1000 of the FTE labour force and women researchers account for 35.3% of all researchers. Higher education institutions account for about 25% of all R&D performed while industry performs just over half of all R&D.

4. Innovation performance

The University of Pretoria and Eindhoven University of Technology of the Netherlands recently published the results of an innovation survey covering the three-year period 1998-2000 (University of Pretoria and Eindhoven University of Technology, 2003). The survey covered the manufacturing and services sector and was based on the third Community Innovation Survey (CIS) of the European Union, but modified and expanded for the South African situation. They received 617 completed survey forms from the 7,039 firms targeted in the survey. Of these respondents, 44% reported that had produced technological innovations in 1998-2000, comparable to most developed nations in Europe. About 32% of new products and services innovation was undertaken with external partners. A lower figure was obtained for partnerships for process innovations where 18% of firms reported external partners. Innovative South African firms are more likely to co-operate with foreign partners than South African partners and 18% of innovating firms co-operate with South African partners versus 26% with partners outside South Africa, mostly in Europe. Firms attributed 30% of sales in 2000 to improved products and services, thus indicating that the benefits of innovation are being harnessed by industry.

5. Cluster Initiatives in South Africa

Soon after 1994 the Department of Trade and Industry (DTI) launched a series of cluster studies, which were mainly funded by the European Union. Numerous meetings, training sessions and workshops were held around the country. Strong interest was generated in industry, academia and government but, similar to some other well-intentioned initiatives early in South Africa's democracy, changes in agendas and strategies of government led to the curtailment of the cluster studies. However, the initiative served to stimulate interest and thinking about clusters and innovation in economic research and planning as well as in other policy documents. Various other specific cluster initiatives have been launched including a wine industry cluster, tourism cluster, jewellery industry cluster, floriculture industry cluster and the automotive industry cluster. A few of these clusters, such as the wine industry cluster, are driven by a strong R&D base. However, all of the

abovementioned cluster initiatives are aimed at improving innovation and creating new opportunities in their respective sectors.

The DTI's *Integrated Manufacturing Strategy* supports partnerships and clusters in manufacturing sectors with an emphasis on research and innovation. The Department of Science and Technology launched its *National Advanced Technology Manufacturing Strategy* in 2003. This strategy complements the National R&D Strategy and the DTI's *Integrated manufacturing Strategy*, and will be implemented through sector and technology innovation centers – with a focus on seven sectors: automotive, cultural and craft, clothing and textiles, metals and minerals, chemicals, aerospace and capital goods. In addition, within these sectors there are eight technology focus areas: advanced materials, product technologies, production technologies, logistics, cleaner production technologies, ICT in manufacturing plus the cross-cutters of SME development and SQUAM (standards, quality assurance, accreditation and metrology).

There have been various science park initiatives in South Africa. Some of these did not end up the way they were originally intended and in some cases became industrial real estate locations or specialist retail outlets. Science parks and targeted, specifically located clusters need the buy-in of government and industry and careful planning in all aspects of their initial development. Some of the present parks (particularly the Innovation Hub) have better prospects of success in the long-term because of this commitment on the part of government and industry.

South Africa has emerged from the slump in R&D and innovation activity of the early 1990s and the numerous new policies aimed at invigorating and transforming the R&D and innovation system, combined with a range of support measures to foster R&D and innovation appear to be paying off. Throughout these initiatives there is an emphasis on partnerships and collaboration which is leading to a suitable environment for cluster development in certain sectors. The ICT sector is one in which clusters are developing and two examples of this make up the balance of this paper.

SECTION II

6. ICT Cluster Formation in South African

6.1 Background

Both the production and use of ICT are unevenly distributed across countries and regions. While this is typical of emerging and fast evolving technologies, there are particularly significant spatial differences in the patterns of ICT production. Traditional explanations for these differences include distinct factor endowments, technologies and policies. Regions with originally similar characteristics may develop in very different directions. Hence, the *locational patterns* of ICT cannot be explained in terms of factor endowments and policy regimes only. The tendency of particularly knowledge-driven industries to cluster geographically has been recognised in policy-making. In this section of the paper we look at the clustering dynamics of the ICT sector in South Africa. In particular, we

focus our analysis on two regional (i.e. Western Cape and Gauteng Provinces) ICT cluster case studies which illustrate a clear and intensifying concentration tendency of ICT-related production and R&D, viz. the Bandwidth Barn (a flagship project of the Cape IT Initiative [CITI]) and the Innovation Hub (a component of the Blue IQ project).

There are a number of reasons for the emergence of clusters within the South African ICT sector:

- A shortening of the product life cycle (i.e., a need for shared knowledge development);
- The minimisation of R&D and production costs;
- The need for system integration in a converging market,
- Concentration on core competencies and the contracting out of peripheral activities;
- An increased say in standardisation processes; and
- The availability of social capital – this refers to the complex of local institutions and trust relationships between local actors within a region.

Proximity to university laboratories and other research centres provides firms located in innovative clusters with easier access to scientific expertise and research results, thus, facilitating transfer of research into commercial applications (Jaffe, 1989; Acs *et al.*, 1992, 1994). Furthermore, firms located in a science park benefit from agglomeration economies, due to the fact that numerous high technology enterprises are clustered in a relatively small area, especially if they operate in the same sector, or in closely connected sectors. The networking opportunities of tenant firms are also widened, basically for the same reason. Finally, the park acts as a bridging institution providing tenant firms with suitable accommodation on flexible terms and technical and business services which are particularly valuable to new high-growth enterprises. We can use Castells & Hall's (1994) concept of *technopoles* to describe the Blue IQ and CITI initiatives. Castells & Hall (1994:8) argue that the technopole concept refers to "various deliberate attempts to plan and promote within one concentrated area, technologically innovative, industrial-related production".

6.2 Policy Context

Policy-makers in South Africa have come up with measures to stimulate innovation and entrepreneurship in the ICT sector. Inspired by the vision and experiences with new business development and cluster formation in Silicon Valley (the region between San Francisco and San José), Route 128 (Boston), Silicon Plateau (Bangalore, India), Hsinchu Science Park (Taiwan) and the Multimedia Super Corridor (Malaysia), they seek to create indigenous technopoles in South Africa.

The South African Government has recognised that it is not possible to exploit the ICT revolution effectively without a strong local ICT sector, including the multinationals, locally owned companies, and especially black empowerment enterprises (SAITIS, 2000; DACST, 1999). Cabinet has identified the ICT sector as one of the key growth sectors in

South Africa, and the telecommunications sector as a key enabling sector. Key objectives of Government's ICT sector strategy include: significant improvements in employment, growth, empowerment, SME development, exports and investments (DACST, 1999).

The Department of Trade and Industry (DTI) (SAITIS, 2000; DTI, 2002) has identified eight key success factors for a national ICT sector strategy:

1. Developing human capacity: skills and knowledge;
2. Cost effective and ubiquitous ICT network infrastructure;
3. Sustainable growth of the domestic ICT industry;
4. Strong content and application development for domestic and international markets;
5. Rapid diffusion and adoption of ICTs through the economy;
6. Government: a model user of ICTs;
7. Enhanced innovation and R&D capabilities; and
8. Proactive, co-ordinated and transparent policy and implementation processes.

The objective of the DTI (2002) *ICT cluster strategic Plan* is to: (i) develop new industries as a national policy, and (ii) develop a milieu of innovation. Castells & Hall (1994:9) define a milieu of innovation as "social, institutional, organisational, economic and territorial structures that create the conditions for the continuous generation of synergy,...both for the units of production that are part of the milieu and for the milieu as a whole".

The DTI already runs several innovation support programmes, most notably Support Programme for Industrial Innovation (SPII), Technology and Human Resources for Industry Programme (THRIP) and Partners in Innovation (PII). These programmes, and the Innovation Fund managed by the DST, must be effectively marketed in the ICT sector, and must be sufficiently well resourced to meet the demand. The DTI can also support the further investigation by NACI of the possible application of a tax incentive for R&D and innovation, including the ICT sector. Further, the DTI must assist the ICT and electronics sectors in marketing their capabilities internationally through focused investment and export marketing programmes undertaken by the DTI with its partners in the South African Electro-Technical Export Council and the private sector in general.

6.3 The Innovation Hub

In March 2001, in a bold bid to position Gauteng (which is South Africa's wealthiest province) as South Africa's 'Smart Province', the Gauteng Provincial Government launched an initiative called Blue IQ. The Innovation Hub is part of the Gauteng Government's R1.7 billion Blue IQ project, under the auspices of the Strategic Economic Infrastructure Investment Programme (SEIIP). Blue IQ is Gauteng Province's high-tech industrial promotion agency. The Innovation Hub's vision is to "create a unique space where high-tech entrepreneurs, businesses, education, research and venture capital can

meet, network and prosper” (Innovation Hub, 2003). The 11 Blue IQ projects are focused on three sectors:

- *Smart industries*, i.e. the Innovation Hub and Gautrain Rapid Rail Link.
- *High value-added manufacturing*, i.e. Gauteng Automotive Cluster; Wadeville Alrode Industrial Corridor; Johannesburg International Airport (JIA) Freezone; and City Deep Terminal
- *Tourism*, i.e. Cradle of Humankind World Heritage Site; Constitution Hill; Newtown; Dinokeng; and Kliptown.

The Blue IQ initiative aims to: create an environment in which smart industries – in the ICT and bio-medical sectors can thrive; shift Gauteng’s manufacturing sector away from traditional heavy industry into more sophisticated, high value-added production; and develop business tourism in order to capitalise on Gauteng’s status as South Africa’s commercial and financial hub.

The Innovation Hub is a full member of the International Association of Science Parks (IASP).¹ The Business Incubator at the Hub is a member of the National Business Incubators Association (NBIA) in the US, which seeks to provide professionals worldwide with information, education, advocacy and networking resources for early-stage companies. The Innovation Hub consists of:

- A high-tech incubator;
- An entrepreneur/innovator development programme, including the recently launched Coach Lab where postgraduate students are mentored to work on industry projects;
- Initiatives targeting empowerment; and
- Alliances with world-class academic and research institutions.

The Innovation Hub is being developed to:

- Establish a high-tech hub in Gauteng;
- Develop an infrastructure to implement and stimulate high-tech business in a conducive and mutually beneficial environment; and
- House other essential components such as incubators, venture capital funders and professional service suppliers, to form the basis for a world-class ‘innovation corridor’ in the province.

The Innovation Hub is South Africa’s first science park and is a joint initiative between the Gauteng provincial government and the Southern Education and Research Alliance (SERA), an alliance between the University of Pretoria and the Council for Scientific and Industrial Research (CSIR). Construction started in October 2003 (and is expected to be finished later this year) with the objective of creating South Africa’s own ‘Silicon Valley’. The R300 million Hub is located in Pretoria and is being built around the concept of technological convergence. The sectors that are being targeted include

¹ The Innovation Hub is the only full member in Africa.

biosciences and biotechnology, ICT, electronics, aerospace, advanced materials, and advanced manufacturing sectors such as automotive, defence and defence spin-offs. The Hub is positioned adjacent to the University of Pretoria and directly to the east of the Hub – just across the N1 highway – lies the CSIR. Hence the Innovation Hub is situated on a ‘knowledge axis’, and is therefore deemed to be at the centre of knowledge and information. Pretoria is only 60km by freeway from South Africa’s commercial capital, Johannesburg. Furthermore, the Gautrain Rapid Rail Link, another Blue IQ project, is set to link Pretoria, Johannesburg and Johannesburg International Airport by 2006.

The provincial government sees the hub as: (i) creating a unique location in Gauteng Province where high-tech industry, academia and entrepreneurs will be able to meet and work together; (ii) better positioning the province as a globally-competitive knowledge economy; (iii) a catalyst to enhance the innovative and growth capacity of high-tech companies and to improve productivity and technology; (iv) an incubator for high-tech start-ups; and (v) promoting black economic empowerment by acting as an incubator for innovative black start-up companies.

Processes and outputs of the Innovation Hub are benchmarked on a continual basis, against international best practice. The objectives of the incubator are:

- To facilitate the accelerated growth and sustainable development of technologically innovative start-up companies;
- To position the Innovation Hub incubator as the prime location for technologically innovative start-up companies; and
- To be a leader in South African best practice incubation.

Facilities and services offered by the incubator include:

- Flexible leases and a variety of office sizes;
- Reception and secretarial support;
- Sophisticated ICT infrastructure for the guaranteed supply of unlimited connectivity and high bandwidth;
- Management advisory and mentoring services, including structured training programmes focused at the developmental needs of the new venture;
- Business support services (financial, legal, administrative);
- Access to business networks and markets;
- Assistance in finding suitable black economic empowerment partners;
- Assistance with obtaining venture capital or financing;
- Assistance in accessing technical expertise;
- Entrepreneurship development and education;
- Participation in a high-tech cluster with access to like-minded people, i.e. being part of an entrepreneurial, innovative community;
- Being part of an established brand, viz: the Innovation Hub;
- Market visibility by means of corporate advertising (marketing support);
- A research interface; and
- Technological support.

The incubation programme is made up of three phases: (i) *pre-incubation phase* which lasts for about six months and makes sure that the start-up has a good business plan and has tested the market with its product; (ii) the *incubation phase* lasts between 3-4 years; and (iii) the *associate stage* is the final phase of the programme, and is like a year-long 'after care' stage. The incubation programme has already produced success stories such as Expertron, a start-up which invented a new information security solution product – concluding a 30% shareholding deal with Grintek, and has been granted a lucrative contract for the product by the ERP.com group. Another start-up Naledi3d Factory, successfully established an interactive virtual reality development facility in Uganda.

6.4 The Bandwidth Barn

The Bandwidth Barn is the pioneer project of the Cape Information Technology Initiative (CITI), a not-for-profit promotion agency for the ICT industry in the Western Cape. The Cape IT Initiative (CITI) is a non-profit public-private partnership funded by the Western Cape Province and City of Cape Town governments, as well as more than 40 corporate members including UUNET, Microsoft, Telkom and other national, regional and local businesses. CITI promotes the development of the Knowledge Economy in the Western Cape Province of South Africa and acts as the marketing agency for the Western Cape IT sector. CITI's intention is to grow the Western Cape into an international ICT hub, creating jobs and building the regional economy. The Bandwidth Barn offers entrepreneurs the facilities, bandwidth, mentorship, support and networking required to grow young businesses and foster innovation. The overall aim of the Bandwidth Barn is to facilitate the creation of jobs (social goal) and wealth (economic goal) through ICT, and to make the region more attractive for direct foreign investment (economic goal).

The Barn was financed by a million Rand sponsorship from the DTI's Sector Partnership Fund (SPF) and it received a multi-million Rand sponsorship from UUNET SA, the largest carrier of Internet traffic in Africa. The Barn is located in Cape Town's central business district, in close proximity to three major universities, i.e. University of Cape Town, Stellenbosch University and the University of the Western Cape – all of which graduate computer engineers. The objectives of the Barn are to:

- Serve as a focus point for IT entrepreneurship in the Western Cape and to bring the benefits of 'clustering' to the budding ICT sector in Cape Town;
- Provide fast 24/7 Internet connectivity (ADSL) to high-tech start-ups;
- Provide small ICT businesses with affordable office rentals, shared office facilities to reduce overhead costs for services like Internet connectivity, telephone and reception;
- Provide incubation for start-up ICT entrepreneurs in the Western Cape;
- Provide a supportive networked community to create synergies;
- Create a network of strongly interdependent firms and specialised suppliers, knowledge producing agents (education institutions, research bodies, engineering companies), bridging institutions (brokers, consultants) and customers, and to link together in a value-adding production chain.

The Barn is a unique incubation model where the stability of anchor tenants is coupled with a dynamic and evolving set of small companies. The Barn aims to remove the barriers that impede small start-ups, i.e.:

- The cost of high quality Internet access;
- The difficulty of finding premises and the requirement to sign long-term leases;
- The cost of reception and PBX services; and
- The isolation of operating on one's own.

One Barn success story is the black empowerment company, *Liquid Thought*, which is an e-business consulting service. The company is three years old, employs 10 people and its turnover is likely to exceed R10 million by the end of the 2003 financial year. Zulfiq Isaacs, the MD of Liquid Thought, had this to say:

The Barn was critical to our success. Clustering enables you to reduce overheads by sharing the cost of Internet access and other infrastructure, it quickly raised our profile in the marketplace and created networking opportunities. Most importantly, we were able to partner other companies with different skills to create joint projects (CITI, 2003).

CITI has formed the 'Cape Lab' initiative to help teach entrepreneurs about international markets and to forge links with peer organisations like *Enterprise Island* in the UK and *Enterprise Ireland* in the Republic of Ireland to help address this issue. CITI envisions the Western Cape duplicating India's success in attracting offshore software development projects and international software support centres. Further, the Bandwidth Barn has been actively involved in local and provincial ICT initiatives (e.g. the Cape Online e-Government Strategy) and in policy-making organisations such as the Internet Service Providers Association (ISPA), the Internet Society of South Africa (ISOC SA), ICANN, etc.

6.5 Common Features

The geographical structure of the Bandwidth Barn and the Innovation Hub are concentrated, with a multitude of linkages between core firms, their spin-offs and local subcontractors, world-class universities and research centres, and local/regional authorities. Some key common features characterising this specific production model can be identified, namely:

- The geographical proximity of small and medium sized firms;
- A spatial development where the interface of research with commerce and industry is encouraged for the better exploitation of technology;
- A dense network of inter-firm relationships, in which the firms co-operate and compete at the same time;
- A dense network of social relationships, based mainly on face-to-face contact, which is inter-connected with the system of economic relationships;
- The presence within the area of complementary competencies and skills;

- Facilitating the creation and growth of innovation-based companies through incubation and spin-off processes, and provide other value-added services together with high quality space and facilities;
- Creating a culture of innovation where the physical infrastructure stimulates the cross-fertilisation of ideas and the flow of knowledge and technology to create the 'buzz' that comes with shared exploits, innovation and dynamic social interaction; and
- A high degree of specialisation of both the firms and the workforce.

Both the Barn and the Innovation Hub are not-for-profit incubators and the owners do not hold equity in their tenants. They have close links to each other and often network and share resources. CITI and the Innovation Hub have strengthened existing ties through an informal partnership that is aimed at consolidating the activities of both parties for the greater benefit of the ICT sector nationally. This includes sharing knowledge resources, such as ICT guest speakers and information on high-profile international delegations to South Africa.

The two case studies clearly underline the importance of local and regional policies in promoting ICT clustering dynamics. Focusing merely on national policies is insufficient. Further, the close proximity to centres of teaching and research is particularly favourable for the creation and growth of knowledge-based businesses. Both the Bandwidth Barn and the Innovation Hub are innovative clusters which (i) have formal operational links with centres of knowledge creation, such as universities and research centres; (ii) are designed to encourage the formation and growth of innovative businesses; and (iii) have a management function which is actively engaged in the transfer of technology and business skills to 'on-park' located small high-tech firms. The objectives of the two technology incubator programmes are to: (i) provide a mechanism for the commercialisation and transfer of technology; (ii) promote the concept of growth through innovation and application of technology; (iii) support economic development strategies for small business development; and (iv) encourage growth from within local economies.

6.6 Concluding Remarks

Despite the fact that the cost of transmitting information has declined tremendously and has become largely invariant of distance, the importance of location to innovation and production remains. The primary reasons for this are benefits that the proximity of others generates to the firms in the area, i.e. *Marshallian* externalities (Marshall, 1920). Firms located in the area of a specialised cluster of firms may benefit from knowledge spillovers: information concerning new applications or other innovative practices may spread faster among the firms that are located geographically closer to each other. As the two case studies have revealed, there are other factors fostering spatial agglomeration such as the availability of skilled labour, good infrastructure, and supporting institutions, e.g. universities and research centres.

Both the Innovation Hub and Bandwidth Barn are examples of innovation being driven in an institutional way. Both of these clusters are still at a very early stage of development,

therefore it is difficult to critically assess their success. That said, international experience suggests that few incubators succeed, and those that do are driven by experienced, hard-core entrepreneurs (Colombo & Delmastro, 2002:1103). Ultimately, the success of the Innovation Hub and the Bandwidth Barn will be determined by how much venture capital experience and business experience that the people running them have. Finally, innovative clusters must be strategic, properly managed and implemented, without becoming bogged down in politics and bureaucracy.

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SECTION I

1. New policy framework in South Africa

Since the advent of democracy in South Africa in 1994 there have been major policy changes in all areas of the economy and society including the science and technology (S&T) and innovation system. Prior to 1994 the S&T system was largely autonomous and government funds were mostly provided through a system of large national programmes. Anticipation of democratic change in the early 1990's led to intensified debates within the Mass Democratic Movement concerning the future of science and technology and its implications for society. Perhaps the most significant event was the International Development Research Centre (IDRC) review of and report on the S&T system and policy in South Africa (IDRC, 1993).

The first democratic cabinet in 1994 included the appointment of a Minister of Arts, Culture, Science and Technology. Further, a new Department of Arts, Culture, Science and Technology (DACST) was established. The DACST immediately set about producing consultative policy documents such as the *Green Paper on Science and Technology* which led to the publication of the *White Paper on Science and Technology* in 1996. The White Paper was based on the concept of a National System of Innovation with an emphasis on linkages and overcoming the fragmentation and duplication of the past. The White Paper also set the scene for changing the institutional landscape and it proposed reviews of all the major science and technology institutions. Further, the White Paper provided recommendations for a new advisory body, the National Advisory Council on Innovation (NACI) and an enlarged and reinvigorated research-funding agency (the National Research Foundation). Moreover, the White Paper introduced new support measures for Innovation such as the Innovation Fund, laid the groundwork for new strategies (e.g. the National Biotechnology Strategy) and initiated the development of numerous new policy documents and instruments over the coming years.

In 2002 the DACST split into two departments, one for Science and Technology (DST) and the other for Arts and Culture (DAC), both reporting to the same Minister but allowing the two respective Director-Generals to focus on more specific portfolios. The DST released South Africa's National Research and Development Strategy in 2002, which laid out more specific plans for developing the research component of the National System of Innovation. The strongly indicator-based strategy rests on the three pillars: (a) innovation, (b) science, engineering and technology human resources development and transformation, and (c) creating an effective government S&T system. It also plans new technology platforms such as in ICT and biotechnology and advocates an increase in the knowledge intensity of resource-based sectors. There is also a strong emphasis on science and technology for poverty reduction and a focus on enhancing basic research in areas where South Africa has important natural or knowledge advantages such as astronomy, biodiversity, human paleontology and indigenous knowledge.

2. Funding of research and innovation

Table 1: Research Support programmes and funds in South Africa

Fund and agency	Purpose	Total Fund value (US\$ million)
Innovation Fund (Department of Science and Technology through the National Research Foundation)	Medium to large scale technological innovation projects promoting cross-sectoral collaboration	\$24 million
Lead Programme Fund (Department of Science and Technology and National Research Foundation)	Medium-sized international collaboration S&T projects	\$3.4 million over three years
Regional Science and Technology Programme (Department of Science and Technology)	Priority areas in S&T co-operation with partners in SADC and Africa	\$1.8 million over three years
The GODISA Programme (Department of Science and Technology, EU funding, Department of Trade and Industry and Department of Labour)	Enhancement of technological innovation of SMMEs – establishment of pilot centres	\$6.2 million
National Research Foundation (funded by the Department of Science and Technology)	Grants and bursaries for researchers and research teams, student support and institutional support and international funding	\$26 million
Technology and Human Resources for Industry Programme (THRIP) (National Research Foundation and Department of Trade and Industry)	Collaboration between industry and higher education in research and technology development and transfer of people	\$46 million (including industry contributions)
Water Research Commission	Water research in strategic areas	\$10 million
Partnership and Industrial Innovation (PII) (Department of Trade and Industry)	Large private sector research projects in priority areas aimed at technological innovation	Variable
Support Programme for Industrial Innovation (SPII) (Industrial Development Corporation and Department of Trade and Industry)	Matching scheme to support technology development in manufacturing industries plus feasibility study support	\$12 million

In support of these policies and strategies, previous sources of funding have been strengthened and new funds have been established for R&D and Innovation support in South Africa. Most of these funds are specifically aimed at encouraging inter- and intra-sectoral collaboration and the development of research and innovation capacity. Some of the main funds and agencies are listed in Table 1.

3. R&D performance

The HSRC Knowledge Management Group recently completed a national R&D survey on behalf of the Department of Science and Technology (DST, 2004). Further R&D surveys and innovation surveys will be undertaken by the Group on behalf of the Department in support of the indicator based National R&D Strategy. The results from the survey indicate that the country spent about R7.5 billion Rand (or PPP US\$1.5 billion) in 2001/02. This represents about 0.76% of GDP, an improvement on the 0.69% recorded in 1997/98. There are 33,897 full time equivalent (FTE) R&D personnel in the country, including 8,661 FTE researchers. Total researchers comprise 1.9 per 1000 of the FTE labour force and women researchers account for 35.3% of all researchers. Higher education institutions account for about 25% of all R&D performed while industry performs just over half of all R&D.

4. Innovation performance

The University of Pretoria and Eindhoven University of Technology of the Netherlands recently published the results of an innovation survey covering the three-year period 1998-2000 (University of Pretoria and Eindhoven University of Technology, 2003). The survey covered the manufacturing and services sector and was based on the third Community Innovation Survey (CIS) of the European Union, but modified and expanded for the South African situation. They received 617 completed survey forms from the 7,039 firms targeted in the survey. Of these respondents, 44% reported that had produced technological innovations in 1998-2000, comparable to most developed nations in Europe. About 32% of new products and services innovation was undertaken with external partners. A lower figure was obtained for partnerships for process innovations where 18% of firms reported external partners. Innovative South African firms are more likely to co-operate with foreign partners than South African partners and 18% of innovating firms co-operate with South African partners versus 26% with partners outside South Africa, mostly in Europe. Firms attributed 30% of sales in 2000 to improved products and services, thus indicating that the benefits of innovation are being harnessed by industry.

5. Cluster Initiatives in South Africa

Soon after 1994 the Department of Trade and Industry (DTI) launched a series of cluster studies, which were mainly funded by the European Union. Numerous meetings, training sessions and workshops were held around the country. Strong interest was generated in industry, academia and government but, similar to some other well-intentioned initiatives early in South Africa's democracy, changes in agendas and strategies of government led to the curtailment of the cluster studies. However, the initiative served to stimulate interest and thinking about clusters and innovation in economic research and planning as well as in other policy documents. Various other specific cluster initiatives have been launched including a wine industry cluster, tourism cluster, jewellery industry cluster, floriculture industry cluster and the automotive industry cluster. A few of these clusters, such as the wine industry cluster, are driven by a strong R&D base. However, all of the

abovementioned cluster initiatives are aimed at improving innovation and creating new opportunities in their respective sectors.

The DTI's *Integrated Manufacturing Strategy* supports partnerships and clusters in manufacturing sectors with an emphasis on research and innovation. The Department of Science and Technology launched its *National Advanced Technology Manufacturing Strategy* in 2003. This strategy complements the National R&D Strategy and the DTI's Integrated manufacturing Strategy, and will be implemented through sector and technology innovation centers – with a focus on seven sectors: automotive, cultural and craft, clothing and textiles, metals and minerals, chemicals, aerospace and capital goods. In addition, within these sectors there are eight technology focus areas: advanced materials, product technologies, production technologies, logistics, cleaner production technologies, ICT in manufacturing plus the cross-cutters of SME development and SQUAM (standards, quality assurance, accreditation and metrology).

There have been various science park initiatives in South Africa. Some of these did not end up the way they were originally intended and in some cases became industrial real estate locations or specialist retail outlets. Science parks and targeted, specifically located clusters need the buy-in of government and industry and careful planning in all aspects of their initial development. Some of the present parks (particularly the Innovation Hub) have better prospects of success in the long-term because of this commitment on the part of government and industry.

South Africa has emerged from the slump in R&D and innovation activity of the early 1990s and the numerous new policies aimed at invigorating and transforming the R&D and innovation system, combined with a range of support measures to foster R&D and innovation appear to be paying off. Throughout these initiatives there is an emphasis on partnerships and collaboration which is leading to a suitable environment for cluster development in certain sectors. The ICT sector is one in which clusters are developing and two examples of this make up the balance of this paper.

SECTION II

6. ICT Cluster Formation in South African

6.1 Background

Both the production and use of ICT are unevenly distributed across countries and regions. While this is typical of emerging and fast evolving technologies, there are particularly significant spatial differences in the patterns of ICT production. Traditional explanations for these differences include distinct factor endowments, technologies and policies. Regions with originally similar characteristics may develop in very different directions. Hence, the *locational patterns* of ICT cannot be explained in terms of factor endowments and policy regimes only. The tendency of particularly knowledge-driven industries to cluster geographically has been recognised in policy-making. In this section of the paper we look at the clustering dynamics of the ICT sector in South Africa. In particular, we

focus our analysis on two regional (i.e. Western Cape and Gauteng Provinces) ICT cluster case studies which illustrate a clear and intensifying concentration tendency of ICT-related production and R&D, viz. the Bandwidth Barn (a flagship project of the Cape IT Initiative [CITI]) and the Innovation Hub (a component of the Blue IQ project).

There are a number of reasons for the emergence of clusters within the South African ICT sector:

- A shortening of the product life cycle (i.e., a need for shared knowledge development);
- The minimisation of R&D and production costs;
- The need for system integration in a converging market,
- Concentration on core competencies and the contracting out of peripheral activities;
- An increased say in standardisation processes; and
- The availability of social capital – this refers to the complex of local institutions and trust relationships between local actors within a region.

Proximity to university laboratories and other research centres provides firms located in innovative clusters with easier access to scientific expertise and research results, thus, facilitating transfer of research into commercial applications (Jaffe, 1989; Acs *et al.*, 1992, 1994). Furthermore, firms located in a science park benefit from agglomeration economies, due to the fact that numerous high technology enterprises are clustered in a relatively small area, especially if they operate in the same sector, or in closely connected sectors. The networking opportunities of tenant firms are also widened, basically for the same reason. Finally, the park acts as a bridging institution providing tenant firms with suitable accommodation on flexible terms and technical and business services which are particularly valuable to new high-growth enterprises. We can use Castells & Hall's (1994) concept of *technopoles* to describe the Blue IQ and CITI initiatives. Castells & Hall (1994:8) argue that the technopole concept refers to "various deliberate attempts to plan and promote within one concentrated area, technologically innovative, industrial-related production".

6.2 Policy Context

Policy-makers in South Africa have come up with measures to stimulate innovation and entrepreneurship in the ICT sector. Inspired by the vision and experiences with new business development and cluster formation in Silicon Valley (the region between San Francisco and San José), Route 128 (Boston), Silicon Plateau (Bangalore, India), Hsinchu Science Park (Taiwan) and the Multimedia Super Corridor (Malaysia), they seek to create indigenous technopoles in South Africa.

The South African Government has recognised that it is not possible to exploit the ICT revolution effectively without a strong local ICT sector, including the multinationals, locally owned companies, and especially black empowerment enterprises (SAITIS, 2000; DACST, 1999). Cabinet has identified the ICT sector as one of the key growth sectors in

South Africa, and the telecommunications sector as a key enabling sector. Key objectives of Government's ICT sector strategy include: significant improvements in employment, growth, empowerment, SME development, exports and investments (DACST, 1999).

The Department of Trade and Industry (DTI) (SAITIS, 2000; DTI, 2002) has identified eight key success factors for a national ICT sector strategy:

1. Developing human capacity: skills and knowledge;
2. Cost effective and ubiquitous ICT network infrastructure;
3. Sustainable growth of the domestic ICT industry;
4. Strong content and application development for domestic and international markets;
5. Rapid diffusion and adoption of ICTs through the economy;
6. Government: a model user of ICTs;
7. Enhanced innovation and R&D capabilities; and
8. Proactive, co-ordinated and transparent policy and implementation processes.

The objective of the DTI (2002) *ICT cluster strategic Plan* is to: (i) develop new industries as a national policy, and (ii) develop a milieu of innovation. Castells & Hall (1994:9) define a milieu of innovation as "social, institutional, organisational, economic and territorial structures that create the conditions for the continuous generation of synergy,...both for the units of production that are part of the milieu and for the milieu as a whole".

The DTI already runs several innovation support programmes, most notably Support Programme for Industrial Innovation (SPII), Technology and Human Resources for Industry Programme (THRIP) and Partners in Innovation (PII). These programmes, and the Innovation Fund managed by the DST, must be effectively marketed in the ICT sector, and must be sufficiently well resourced to meet the demand. The DTI can also support the further investigation by NACI of the possible application of a tax incentive for R&D and innovation, including the ICT sector. Further, the DTI must assist the ICT and electronics sectors in marketing their capabilities internationally through focused investment and export marketing programmes undertaken by the DTI with its partners in the South African Electro-Technical Export Council and the private sector in general.

6.3 The Innovation Hub

In March 2001, in a bold bid to position Gauteng (which is South Africa's wealthiest province) as South Africa's 'Smart Province', the Gauteng Provincial Government launched an initiative called Blue IQ. The Innovation Hub is part of the Gauteng Government's R1.7 billion Blue IQ project, under the auspices of the Strategic Economic Infrastructure Investment Programme (SEIIP). Blue IQ is Gauteng Province's high-tech industrial promotion agency. The Innovation Hub's vision is to "create a unique space where high-tech entrepreneurs, businesses, education, research and venture capital can

meet, network and prosper” (Innovation Hub, 2003). The 11 Blue IQ projects are focused on three sectors:

- *Smart industries*, i.e. the Innovation Hub and Gautrain Rapid Rail Link.
- *High value-added manufacturing*, i.e. Gauteng Automotive Cluster; Wadeville Alrode Industrial Corridor; Johannesburg International Airport (JIA) Freezone; and City Deep Terminal
- *Tourism*, i.e. Cradle of Humankind World Heritage Site; Constitution Hill; Newtown; Dinokeng; and Kliptown.

The Blue IQ initiative aims to: create an environment in which smart industries – in the ICT and bio-medical sectors can thrive; shift Gauteng’s manufacturing sector away from traditional heavy industry into more sophisticated, high value-added production; and develop business tourism in order to capitalise on Gauteng’s status as South Africa’s commercial and financial hub.

The Innovation Hub is a full member of the International Association of Science Parks (IASP).¹ The Business Incubator at the Hub is a member of the National Business Incubators Association (NBIA) in the US, which seeks to provide professionals worldwide with information, education, advocacy and networking resources for early-stage companies. The Innovation Hub consists of:

- A high-tech incubator;
- An entrepreneur/innovator development programme, including the recently launched Coach Lab where postgraduate students are mentored to work on industry projects;
- Initiatives targeting empowerment; and
- Alliances with world-class academic and research institutions.

The Innovation Hub is being developed to:

- Establish a high-tech hub in Gauteng;
- Develop an infrastructure to implement and stimulate high-tech business in a conducive and mutually beneficial environment; and
- House other essential components such as incubators, venture capital funders and professional service suppliers, to form the basis for a world-class ‘innovation corridor’ in the province.

The Innovation Hub is South Africa’s first science park and is a joint initiative between the Gauteng provincial government and the Southern Education and Research Alliance (SERA), an alliance between the University of Pretoria and the Council for Scientific and Industrial Research (CSIR). Construction started in October 2003 (and is expected to be finished later this year) with the objective of creating South Africa’s own ‘Silicon Valley’. The R300 million Hub is located in Pretoria and is being built around the concept of technological convergence. The sectors that are being targeted include

¹ The Innovation Hub is the only full member in Africa.

biosciences and biotechnology, ICT, electronics, aerospace, advanced materials, and advanced manufacturing sectors such as automotive, defence and defence spin-offs. The Hub is positioned adjacent to the University of Pretoria and directly to the east of the Hub – just across the N1 highway – lies the CSIR. Hence the Innovation Hub is situated on a ‘knowledge axis’, and is therefore deemed to be at the centre of knowledge and information. Pretoria is only 60km by freeway from South Africa’s commercial capital, Johannesburg. Furthermore, the Gautrain Rapid Rail Link, another Blue IQ project, is set to link Pretoria, Johannesburg and Johannesburg International Airport by 2006.

The provincial government sees the hub as: (i) creating a unique location in Gauteng Province where high-tech industry, academia and entrepreneurs will be able to meet and work together; (ii) better positioning the province as a globally-competitive knowledge economy; (iii) a catalyst to enhance the innovative and growth capacity of high-tech companies and to improve productivity and technology; (iv) an incubator for high-tech start-ups; and (v) promoting black economic empowerment by acting as an incubator for innovative black start-up companies.

Processes and outputs of the Innovation Hub are benchmarked on a continual basis, against international best practice. The objectives of the incubator are:

- To facilitate the accelerated growth and sustainable development of technologically innovative start-up companies;
- To position the Innovation Hub incubator as the prime location for technologically innovative start-up companies; and
- To be a leader in South African best practice incubation.

Facilities and services offered by the incubator include:

- Flexible leases and a variety of office sizes;
- Reception and secretarial support;
- Sophisticated ICT infrastructure for the guaranteed supply of unlimited connectivity and high bandwidth;
- Management advisory and mentoring services, including structured training programmes focused at the developmental needs of the new venture;
- Business support services (financial, legal, administrative);
- Access to business networks and markets;
- Assistance in finding suitable black economic empowerment partners;
- Assistance with obtaining venture capital or financing;
- Assistance in accessing technical expertise;
- Entrepreneurship development and education;
- Participation in a high-tech cluster with access to like-minded people, i.e. being part of an entrepreneurial, innovative community;
- Being part of an established brand, viz: the Innovation Hub;
- Market visibility by means of corporate advertising (marketing support);
- A research interface; and
- Technological support.

The incubation programme is made up of three phases: (i) *pre-incubation phase* which lasts for about six months and makes sure that the start-up has a good business plan and has tested the market with its product; (ii) the *incubation phase* lasts between 3-4 years; and (iii) the *associate stage* is the final phase of the programme, and is like a year-long 'after care' stage. The incubation programme has already produced success stories such as Expertron, a start-up which invented a new information security solution product – concluding a 30% shareholding deal with Grintek, and has been granted a lucrative contract for the product by the ERP.com group. Another start-up Naledi3d Factory, successfully established an interactive virtual reality development facility in Uganda.

6.4 The Bandwidth Barn

The Bandwidth Barn is the pioneer project of the Cape Information Technology Initiative (CITI), a not-for-profit promotion agency for the ICT industry in the Western Cape. The Cape IT Initiative (CITI) is a non-profit public-private partnership funded by the Western Cape Province and City of Cape Town governments, as well as more than 40 corporate members including UUNET, Microsoft, Telkom and other national, regional and local businesses. CITI promotes the development of the Knowledge Economy in the Western Cape Province of South Africa and acts as the marketing agency for the Western Cape IT sector. CITI's intention is to grow the Western Cape into an international ICT hub, creating jobs and building the regional economy. The Bandwidth Barn offers entrepreneurs the facilities, bandwidth, mentorship, support and networking required to grow young businesses and foster innovation. The overall aim of the Bandwidth Barn is to facilitate the creation of jobs (social goal) and wealth (economic goal) through ICT, and to make the region more attractive for direct foreign investment (economic goal).

The Barn was financed by a million Rand sponsorship from the DTI's Sector Partnership Fund (SPF) and it received a multi-million Rand sponsorship from UUNET SA, the largest carrier of Internet traffic in Africa. The Barn is located in Cape Town's central business district, in close proximity to three major universities, i.e. University of Cape Town, Stellenbosch University and the University of the Western Cape – all of which graduate computer engineers. The objectives of the Barn are to:

- Serve as a focus point for IT entrepreneurship in the Western Cape and to bring the benefits of 'clustering' to the budding ICT sector in Cape Town;
- Provide fast 24/7 Internet connectivity (ADSL) to high-tech start-ups;
- Provide small ICT businesses with affordable office rentals, shared office facilities to reduce overhead costs for services like Internet connectivity, telephone and reception;
- Provide incubation for start-up ICT entrepreneurs in the Western Cape;
- Provide a supportive networked community to create synergies;
- Create a network of strongly interdependent firms and specialised suppliers, knowledge producing agents (education institutions, research bodies, engineering companies), bridging institutions (brokers, consultants) and customers, and to link together in a value-adding production chain.

The Barn is a unique incubation model where the stability of anchor tenants is coupled with a dynamic and evolving set of small companies. The Barn aims to remove the barriers that impede small start-ups, i.e.:

- The cost of high quality Internet access;
- The difficulty of finding premises and the requirement to sign long-term leases;
- The cost of reception and PBX services; and
- The isolation of operating on one's own.

One Barn success story is the black empowerment company, *Liquid Thought*, which is an e-business consulting service. The company is three years old, employs 10 people and its turnover is likely to exceed R10 million by the end of the 2003 financial year. Zulfiq Isaacs, the MD of Liquid Thought, had this to say:

The Barn was critical to our success. Clustering enables you to reduce overheads by sharing the cost of Internet access and other infrastructure, it quickly raised our profile in the marketplace and created networking opportunities. Most importantly, we were able to partner other companies with different skills to create joint projects (CITI, 2003).

CITI has formed the 'Cape Lab' initiative to help teach entrepreneurs about international markets and to forge links with peer organisations like *Enterprise Island* in the UK and *Enterprise Ireland* in the Republic of Ireland to help address this issue. CITI envisions the Western Cape duplicating India's success in attracting offshore software development projects and international software support centres. Further, the Bandwidth Barn has been actively involved in local and provincial ICT initiatives (e.g. the Cape Online e-Government Strategy) and in policy-making organisations such as the Internet Service Providers Association (ISPA), the Internet Society of South Africa (ISOC SA), ICANN, etc.

6.5 Common Features

The geographical structure of the Bandwidth Barn and the Innovation Hub are concentrated, with a multitude of linkages between core firms, their spin-offs and local subcontractors, world-class universities and research centres, and local/regional authorities. Some key common features characterising this specific production model can be identified, namely:

- The geographical proximity of small and medium sized firms;
- A spatial development where the interface of research with commerce and industry is encouraged for the better exploitation of technology;
- A dense network of inter-firm relationships, in which the firms co-operate and compete at the same time;
- A dense network of social relationships, based mainly on face-to-face contact, which is inter-connected with the system of economic relationships;
- The presence within the area of complementary competencies and skills;

- Facilitating the creation and growth of innovation-based companies through incubation and spin-off processes, and provide other value-added services together with high quality space and facilities;
- Creating a culture of innovation where the physical infrastructure stimulates the cross-fertilisation of ideas and the flow of knowledge and technology to create the 'buzz' that comes with shared exploits, innovation and dynamic social interaction; and
- A high degree of specialisation of both the firms and the workforce.

Both the Barn and the Innovation Hub are not-for-profit incubators and the owners do not hold equity in their tenants. They have close links to each other and often network and share resources. CITI and the Innovation Hub have strengthened existing ties through an informal partnership that is aimed at consolidating the activities of both parties for the greater benefit of the ICT sector nationally. This includes sharing knowledge resources, such as ICT guest speakers and information on high-profile international delegations to South Africa.

The two case studies clearly underline the importance of local and regional policies in promoting ICT clustering dynamics. Focusing merely on national policies is insufficient. Further, the close proximity to centres of teaching and research is particularly favourable for the creation and growth of knowledge-based businesses. Both the Bandwidth Barn and the Innovation Hub are innovative clusters which (i) have formal operational links with centres of knowledge creation, such as universities and research centres; (ii) are designed to encourage the formation and growth of innovative businesses; and (iii) have a management function which is actively engaged in the transfer of technology and business skills to 'on-park' located small high-tech firms. The objectives of the two technology incubator programmes are to: (i) provide a mechanism for the commercialisation and transfer of technology; (ii) promote the concept of growth through innovation and application of technology; (iii) support economic development strategies for small business development; and (iv) encourage growth from within local economies.

6.6 Concluding Remarks

Despite the fact that the cost of transmitting information has declined tremendously and has become largely invariant of distance, the importance of location to innovation and production remains. The primary reasons for this are benefits that the proximity of others generates to the firms in the area, i.e. *Marshallian* externalities (Marshall, 1920). Firms located in the area of a specialised cluster of firms may benefit from knowledge spillovers: information concerning new applications or other innovative practices may spread faster among the firms that are located geographically closer to each other. As the two case studies have revealed, there are other factors fostering spatial agglomeration such as the availability of skilled labour, good infrastructure, and supporting institutions, e.g. universities and research centres.

Both the Innovation Hub and Bandwidth Barn are examples of innovation being driven in an institutional way. Both of these clusters are still at a very early stage of development,

therefore it is difficult to critically assess their success. That said, international experience suggests that few incubators succeed, and those that do are driven by experienced, hard-core entrepreneurs (Colombo & Delmastro, 2002:1103). Ultimately, the success of the Innovation Hub and the Bandwidth Barn will be determined by how much venture capital experience and business experience that the people running them have. Finally, innovative clusters must be strategic, properly managed and implemented, without becoming bogged down in politics and bureaucracy.

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