INTRODUCTION

1.1 Background

Developing technologies in the field of manufacturing have an impact on industrial location, servicing and the architectural design framework, which in some cases result in the decaying of industrial sites. Rehabilitation of old industrial buildings indicates the commitment towards conservation of architectural heritage and recognition of manufacturing traditions. Rehabilitation of old industrial buildings for the purpose of accommodating activities of technological innovation realises the need to revitalise decaying industrial sites and promote innovation for industrial manufacturing.

The rehabilitation of old industrial buildings is now an established approach (Eley and Worthington, 1984:3), acting as a tool for preserving the heritage from the industrial building era (Marsh, 1983:3). There is a need for further analysis and evaluation of both private and public owned old industrial buildings in South Africa, which if rehabilitated could revitalise local economies. Rehabilitation of old industrial building can also be an essential ingredient in sustaining a healthy economy because a healthy and sustainable economy relies on the efficiency of the working environment.

This study investigates the rehabilitation assessment of the Pretoria State Garage for the purpose of accommodating the Pretoria Technology Park. The rehabilitation process and the technology park programming and planning address the physical form and the intellectual context of the project respectively. The rehabilitating assessment of the State Garage recognizes the potential re-use of existing structures by new industrial and commercial activities, which are vital to community growth. The site contains obsolete and redundant buildings that are structurally sound and could be converted into a major opportunity to attract business through providing inexpensive commercial and industrial spaces.

The technology park development methodology is incorporated to complement the rehabilitation assessment of the Pretoria Technology Park. It is significant for the establishment of a technology transfer network, design specifications and macro-planning strategies of the park. The design of the park should fit within the existing physical forms of the State Garage and offer intellectual (know-how) and physical infrastructure to tenant companies.

1.2 Scope of Project

1.2.1 Relevance of the study

The rehabilitation assessment will benefit the revival process of the State Garage and also provide intellectual framework for the sustainability of the State Garage. Pretoria and specifically the southwest quadrant will also maintain one of its historically significant sites that once contributed to the socio-economic sector of the city.

The establishment of the Pretoria Technology Park will contribute to the innovation program for small and medium sized enterprises and enhance links between institutions of higher education, research and manufacturing industries.

1.2.2 Problem context

The two issues relating to the salvation of the Pretoria State Garage buildings and the establishment of a sustainable technology park inform the study.

1. Pretoria contains a considerable surplus of obsolete and abandoned buildings and sites, which, in most cases, are relegated to positions of obscurity due to highly preferred new construction. The Pretoria State Garage in Pretoria stands obsolete and consequently redundant due to a shift in the field of industrial manufacturing. The current use and architectural composition of buildings on site does not promote any sustainable activity or development that can salvage the site from possible demolition. The challenge lies in the architectural fitting process of the site for possible use by the Pretoria Technology Park, which is anticipated to restore and innovate the industrial manufacturing tradition of the site. The location of the site is also ideal because of its proximity to the target group (small and medium companies already in the vicinity).

2. A number of science and technology parks were initiated in South Africa, including Pretoria, without success as compared to similar developments in Europe, Asia and United States of America. The sustainability of the Pretoria Technology Park relies highly on the park's relevance to local technology supply and demands to research communities and user groups respectively. As a result it is important to develop a methodology for the establishment of a locally appropriate size and type of park that can also fit within the existing physical forms of the Pretoria State Garage.

1.2.3 Statement of the problem

This study proposes the development of the Pretoria Technology Park, which incorporates the development of an operational framework that is to be fitted within the existing site of the Pretoria State Garage.

1.2.4 Limitations of the study

This study is limited to the rehabilitation assessment of the Pretoria State Garage, which incorporates the technology park development methodology for the Pretoria Technology Park.

- The Pretoria Technology Park development methodology focuses on the establishment of a technology transfer centre for local small and medium sized enterprises in the manufacturing sector. It is assumed that the park is small and will be situated in areas with an industrial history that is oriented towards providing technology innovation to small and medium sized companies.
- This study does not conduct the actual survey of the local technology demand and supply but relies on the already existing statistics and programs from the Department of Trade and Industry, University of Pretoria and CSIR.
- The assessment for the rehabilitation analyses the architectural, cultural and spatial qualities of the Pretoria State Garage and its capacity to accommodate the Pretoria Technology Park.
- Issues relating to cost, implementation and technical aspects of building rehabilitation are not covered.

1.2.5 Objectives of the study

There are three main objectives that are based on the three main areas of concern in the study: programming and planning of the Pretoria Technology Park, rehabilitation assessment of the Pretoria State Garage and the fit process.

1.2.5.1 Programming and planning of the Pretoria Technology Park

This section describes and analyses basic characteristics of local productive systems promoting research and development for the purpose of establishing a technology transfer mechanism for the Pretoria Technology Park. It also investigates precedents from European science parks that are relevant to this establishment.

1.2.5.2 Rehabilitation assessment of the Pretoria State Garage

The rehabilitation assessment explores the history and the architecture, including industrial, socio-cultural and spatial values, of the Pretoria State Garage.

1.2.5.3 Fit process

This process analyses and compares specific dimensions and spatial demands of both the Pretoria State Garage and the Pretoria Technology Park respectively for the purpose of mutual fitting.

1.2.6 Study layout

Part one introduces and investigates significant precedents of European and South African science parks. Selected parks are investigated according to their operational principles, location and relevance, size, land use and image (architectural and landscapes) among others.

Part two implements the technology park development methodology for the establishment of the technology park's strategic planning and consequently its size and type. This evolves through three stages dealing with:

- Description and analysis of local technology supply, demand and transfer of Pretoria.
- Description of strategic development and planning of the park.
- Determination of the type of park.

Part three reviews different aspects of building rehabilitation assessment of the Pretoria State Garage and explores its capacity to accommodate Pretoria Technology Park building scheme. This includes proposals for the demolition of unwanted structures and elements, investigating the long-term resilience of buildings to be retained, assessing negative physical features and establishing a preliminary planning and programming of the site. The process is completed with the fitting process (comparative analysis) between the proposed building scheme of the Pretoria Technology Park and the rehabilitation capacity of the existing buildings of the State Garage.

1.3 Definition of terms and concepts

1.3.1 Science park

According to the United Kingdom Science Park Association (UKSPA, 1988:i), a science park is a property initiative which:

- has formal operational links with a university or other Higher Educational Institution, or major centre of research;

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

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

The term '*science park*' may be used to include initiatives called by other names such as Research Park, Innovation Centre, High Technology Development and Technology Park, where they meet the essential criteria set above (UKSPA, 1988; Van Dierdonck, Debackere and Rappa, 1991:110). In this study the term '*science park*' is used to include all the above.

There is a clear distinction between science and business park. A park is a place, generally within a town or a city, reserved for sports, leisure and pleasure. Business is associated with transaction, concentrated efforts and commerce. Business park may be a single cell, dedicated to one client, or multi-cell, subsuming different clients and architecture within an overall master plan. It may be devoted to one theme, such as scientific research, as in a science park, or it may be an administrative village, as on office park, or it may be flexible, combining speculative business building with a shared amenity building for a separate workforce (Phillips, 1993:6).

The term '*technology park*' is characterised by an environment whereby tenant companies are actively involved in trade applications in the area of high technology and particularly in production and business activities (Komninos, 1993:110). The establishment of the Pretoria Technology Park focuses mainly on upgrading the local manufacturing industry.

Science parks are uniquely positioned to encourage and facilitate start-ups and growth of new technology-based firms. They have been recognised as important institutions for industrial innovation and technology transfer, provision of public research and development, start-up finance, consultation, marketing and other services to technology based firms (Komninos, Merciev and Tosi, 1996:50).

Science parks are the results of co-ordinated initiatives from government authorities, academic institutions and businesses, for new research and development activities. Those initiatives have emerged and proved science parks to be an important organ for technological restructuring and support for industrial high-tech manufacturing.

According to Van Dierdonck and Hysman (1992:1) there are three main objectives of science parks:

1. *Technology transfer*: This process focuses on the transfer of technology from basic research at universities to commercial products.
2. *Regional development*: Science parks stimulate regional development through the revitalisation process of depressed areas and increase of average income.
3. *Urbanisation*: Science parks promote clustering of similar types of companies for reasons of environmental impact (noise and pollution) and facilitate with infrastructure for companies.

Massey and Wield (1992:11) state that besides the three popular concepts described by the UKSPA (1988), there is a fourth concept based on the assumption about what the science park characteristics will lead to, based on the aims mentioned by the park managers and sponsors. They identified a set of four key elements expected from science parks to those working to set them up:

1. The creation of employment
2. The establishment of new firms
3. The facilitation of links between host academic institutions and park firms (including the start-up of firms by academics)
4. The generation of firms with a high level of technology at the leading edge.

In their investigation, Massey and Wield (1992:15) indicated that the effects postulated by the popular science park concept have not happened and indeed in some cases where the outcomes do look positive the underlying processes are not those postulated by the model. Due to the doubt cast on

popular science park concept, they suggested an alternative conceptualisation with three main elements:

- First, the particular model of scientific investigation and innovation on which science parks are based is a linear model- beginning with academic research and leading eventually to commercial production.
- Second, science parks are based on particular spatial characteristics located close to academy, away from physical production, in exclusively high status locations.
- Third, science park are property development, but with very different results in different places.

Komninos (1993:117) describes science parks as a zone of co-operation between research, industry and training, engaged in the following activities:

- Physical infrastructure that accommodates research laboratories, research councils, light industrial units, companies rendering services (market research, counselling on management, technology and financing), administrative services and technology transfer.
- Increasing the relevance of applied industrial research and joint contract between research institutions and industry.
- Production of prototypes.
- Provision of specialised services to companies.
- Nurture of start-up new-technology based firms and provision of accommodation and finance.
- Provision of educational and training schemes.
- Cultural and refreshment services can be provided depending on the site.

The role of science parks in economic development has been recognised and recommended. Much of the credit should be taken by the public sector, which initiated most of the programmes. Yet the private sector has been slow to recognise the growing opportunities offered by the success of parks and tenant companies alike (Sunman, 1988:ix). In addition Gower and Harris (1994:24) assert that it is evident that science parks may seem to be achieving success against the notably very similar property sectors such as business parks.

1.3.2 Technological innovation and innovative companies

Technological innovation is a process that involves research and development leading to the first commercial introduction of new technologies (Mansfield et al. 1982: 5) and is usually stimulated by

perceived production and marketing problems and needs than by technological opportunities (Bruun, 1980: 204). Innovative companies are companies that are susceptible to diffusion of technological innovations and depend on that for profit and survival. Small companies seem to be more flexible and innovative at a lower cost (Hesketh, 1996:252).

1.3.3 Start-up companies

Start-ups are companies usually created by researchers in an effort to transfer technology from institutions of higher learning to the manufacturing sector or commercialisation of academic research.

1.3.4 Incubators

Incubators provide accommodation and common administrative services to newly founded technology firms and start-up companies stemming from researchers involved in the park.

1.3.5 Innovation financing

Innovation financing (as part of the risk capital) provides funds to new start-ups companies by strengthening their equity base and increases their chances for long-term survival. This funding is provided to innovative companies that are already accepted by the incubator management. Initial funding for the establishment of a science or technology park comes mainly from the public sector (government, local authorities and universities) and often followed by corporate groups such as banks and research institutions.

1.3.6 Small and medium sized companies

There are many definitions of small and medium companies worldwide. In South Africa, measures used are usually based on elements such as the number of employees, turnover, value of assets and even the amount of electricity consumed. Employment seems to be the preferred measure with firms of less than twenty to thirty employees being regarded as small. Following success, firms grow, employ more people and raise more capital and delegate significant authority to at least one subordinate, which results in the medium category (Hesketh, 1996:251).

1.3.7 High technology manufacturing

Manufacturing is the act of making something through deliberate processing from raw material to the desired object, usually with the use of machinery. This act encompasses several functions that must be strategically planned, organised, scheduled, controlled and terminated (Badiru, 1996:1).

There is a lack of common accepted definition of the high technology sector. Burke and Dowling (1987:5), for the purpose of their research, concluded that high technology industries are identified by a high percentage of research and development funds invested in the companies and above average number of scientists, engineers, professionals, and technical personnel employed as a percentage of total employees. Badiru (1996:2) defines high technology as a concept of utilising new developments in electronics, data processing, and physical materials innovatively to generate products or services.

Burke and Dowling (1987:5) use the term '*advanced technology*' in describing policies and programmes that do not focus exclusively on particular industries, but extend to the application of new technologies to all existing industries. As a result, high technology manufacturing involves the source, product design and final product of the new technologies.

1.3.8 Rehabilitation

The term 'rehabilitation' is not yet well defined to a particular process in architecture. Lowry (1981:422) observes that the term rehabilitation has been used in general to describe the efforts related to extending useful life of existing buildings, although the methodology may be applicable equally to conservation and recycling. Various definitions on rehabilitation of old buildings exist from a number of authors, which will be discussed in order to highlight the common values from each.

Firstly, rehabilitation recognises old buildings as potential resources, which through the rehabilitation process often provide cheaper and more appropriate premises for new and growing firms. Rehabilitation involves new uses that can halt decay and rejuvenate whole neighbourhoods while at the same time maintaining a sense of time and place (Eley and Worthington, 1984:3).

Rehabilitation, as defined in different contexts, is viewed as an integral part of other processes such as conservation. Sheppard (1980:601) describes rehabilitation in the context of conservation, which goes beyond the notion of preserving functionally redundant buildings. He describes conservation as

a comprehensive process that encompasses all different ways and means to preserve, use, protect and consolidate existing buildings, neighbourhoods or ensembles. As a result conservation can involve any of the three following means: *recycling, rehabilitation or reconstruction.*

- *Recycling,* which is defined as the process of converting an old building to new uses usually involving a re-organisation of the building within an existing envelope. Its purpose is to make an old structure viable, contemporary and relevant, and re-integrate it in its environment.

- *Rehabilitation,* as a social act dealing with the renovation of an existing building for the purpose of extending its life, its uses and its social role. The original function is maintained, and if modified, it is done only to a certain extent. Rehabilitation involves the improvement of both the physical condition of the building and the well being of its principal occupants.

- *Reconstruction* deals with the process of creating or repairing past artefacts in a historically, faithful manner. It has an archaeological and scientific basis and is done for symbolic, sentimental, didactic or scholarly reasons.

Nelson (1982:7) refers to rehabilitation as a process of returning a property to a state of utility through repair or alteration that makes it possible for an efficient contemporary use while preserving those portions and features of the building that are significant to its historical, architectural and cultural values. Smith (1980:134) states that rehabilitation together with restoration was noticeable during the seventies as two other treatment trends parallel to renovation development for older housing. He urges that neither renovation nor rehabilitation properly describe what it entails. He argues that rehabilitation should be defined as a repair and improvement of buildings to satisfy basic health and safety standards. This brings rehabilitation as fundamentally concerned with the life support system of a unit, such as plumbing, electrical wiring, heating and structural integrity. In conclusion he refers to restoration as concerned with the replication or reconstruction of original period architecture and usually is limited to buildings formally designated as historically significant.

Smith (1980:383) defines restoration as a design process that moves backward, to recapture the form and detailing of an earlier period in a site's history, while rehabilitation moves forward to provide an essential contemporary solution to new functional requirement. He recommends that it must be admitted that rehabilitation is simply a technical or utilitarian issue. The physical modification involved in rehabilitation and adaptive re-use can be solely on technical assessments of existing site

conditions. These conditions include, in the case of buildings, such factors as floors and surface coverage, structured bearing capacities, means of egress, condition of the building envelope, and the mechanical and electrical system capacities.

Rehabilitation involves either new users or existing occupants fitted in existing buildings (Lowry, 1981:421). Existing buildings may be old or new. Lion (1982:1) suggests that the distinction between the old and the new should be defined by the period of the Second World War because of the significant changes in building material and techniques from the pre-war period. Rehabilitation includes all those situations where a building is altered physically to improve space utility or to accommodate major new functions of the existing occupants. Rehabilitation may be explained in the following categories:

- An old building receiving renovation to upgrade the building systems or visual alterations to fit the existing occupant.
- An old building receiving major functional alterations, occasionally including visual alteration, to accommodate new tenants.
- A new building receiving visual alteration, and usually of minor nature, to house existing tenants.
- A new building receiving functional alteration to accommodate new tenants.

The rehabilitation process involves the infrastructure of the existing buildings and the identity of the previous or existing occupants. Words such as property and building site are preferred rather than buildings as to take into account the full range of both physical and tangible resources- the land, the buildings and the rights and obligations associated with real property.

Rehabilitation encompasses other activities involved in other processes as highlighted above. The purpose of this study is not to redefine the term 'rehabilitation' but to identify common values from each of the above-mentioned definitions. It is therefore essential to formulate a coherent and systematic rehabilitation methodology, which incorporates the following:

- Existing buildings and new or existing occupants.
- Investigation of the old building's historical, architectural and cultural values.
- Provision of essential contemporary solution to new functional requirements.

1.3.9 Literature review

This section covers two main areas of the study: development of the Pretoria Technology Park and the rehabilitation assessment of the Pretoria State Garage.

1. Development of the Pretoria Technology Park

Sources reviewed throughout this section are in both electronic and print formats. Information pertaining to the history of science parks (especially European parks) is mainly sourced from electronically due to the unavailability of relevant prints in South African libraries. Most sources used during the development methodology are by Komninos, the initial tutor to the candidate in this particular field of study. Komninos is a professor of Urban and Regional Innovation in the Faculty of Engineering, Aristotle University of Thessaloniki and a consultant for the European Union in the same field.

2. Rehabilitation assessment

A variety of sources were reviewed during this section including those by Bidwell (1977) for the assessment of negative physical features of brickwork and Worthington (1984 and 1997) and partners (Eley and Worthington) dealing with the rehabilitation of industrial buildings. Unfortunately the owner of the site, Department of Public works, failed to produce any historic material that would have enriched this assessment process.

1.3.10 Conclusion

The two programmes of rehabilitation and science park constitute the core of this study, and moreover their mutual incorporation in the programme. Broader definitions of both rehabilitation and science park are certainly embraced and elaborated on, as this coherent approach will be implemented in this study.

The definition of science park will abide with the UKSPA (1988:i) criteria and in addition to that the alternative conceptualisation of Massey and Wield (1992:15), which prioritises location proximity and result of productivity, based on the park's district location.

High technology manufacturing is a trend defined by international role players in the field of technology, which must embrace local relevance. Small and medium enterprises are defined locally

according to the nature of their contribution to local economies. This study will not define further the two terms and only refer to their role, which is integral to science park planning and programming.

PART ONE

2. SCIENCE PARKS

2.1 History of Science Parks

The global economic crisis of the second half of the 1970's led most industrial nations to reconsider, correct and adjust their industrial policies to the New World market demands. The economic future of most countries depended to a large degree on their ability to create new products and processes and to make these commercially viable. A growing interest for technological change could be noticed in most industrial countries. There was a strong emphasis in economic policies on technological change or innovation that was accompanied and supported by scientific research.

The original basis for the idea of science parks came from the United States of America- from Stanford University and Silicon Valley in the San Francisco Bay area and Boston-Cambridge and Route 128 on the east coast (Massey & Wield, 1992:10). The first Science Park was built in 1946 on the Stanford University campus. It offered production facilities to new mobile technology based firms. It was not until the 1960's that science parks developed in the United State burgeoned, with over one hundred science parks operating by the middle of the decade. Science parks in the United States, however, are quite different in form from those in the United Kingdom. The average area of United State science parks is over 500 acres while in the United Kingdom an average size is less than 50 acres (Gower & Harris, 1994:25).

Historically successful science parks in the United States, science parks related to the Universities of Stanford, MIT and North Caroline, had great influence on the initial science park programme in Britain. It was during the beginning of the seventies that the idea of science parks spread to Great Britain where two universities established parks of their own: Cambridge Science Park of Trinity College Cambridge (1972) and Heriot-Watt University Research Park of Heriot-Watt University (1972) (UKSPA, vol. 1- Property 1988:84).

Significant science park developments in the European Union and the history of science parks in South Africa are discussed as precedents to the architectural manifestation and the development methodology of the Pretoria Technology Park. However, descriptions are limited to their general contribution to the development of science parks and also architectural and operational elements that are relevant to the establishment of the Pretoria Technology Park.

2.2 Science parks in Europe

Descriptions of science parks in this section will cover areas relevant to the study and distinctive to the park described. European science parks developed in two distinctive phases. The first phase was experimental developing during the early seventies. During this era only a few science parks were established as a result of joint efforts from universities, local authorities and firms. The following four science parks are the first to be developed during the first phase, with Cambridge Science Park and Sophia Antipolis becoming prominent international role players:

- *Cambridge Science Park* of Trinity College Cambridge (1970) in Britain
- *Heriot-Watt University Research Park* of Heriot-Watt University (1972) in Britain
- *Sophia Antipolis* (1972) in France
- *Haasrode* (1972) in Belgium

The second phase dates to the beginning of the eighties during which much progress was made with at least a hundred science parks built (Komninos, 1993:71-85). This phase reflects the success and influence of the preceding phase, and it is characterised by a variety of science parks, which addresses issues of technological innovation to local and multinational/international companies.

This section focuses on parks from both the first and the second phases that played prominent role in shaping the future of science parks in Europe and relevant to the establishment of the Pretoria Technology Park. The following precedents are briefly introduced and consequently referred to analytically in the text for a comprehensive interpretation and relevance to the establishment of the Pretoria Technology Park:

- Cambridge Science Park in Britain.
- Sofia Antipolis in France.
- Berliner Innovations und Grunderzentrum (BIG) in Germany.
- Thessaloniki Technology Park in Greece.

2.2.1 Cambridge Science Park: *Cambridge Phenomena*

Britain holds a prominent position in the European Union with a larger number of science parks. The Cambridge Science Park is the first science park to be established in Britain and Europe during the early 1970's in Cambridge by Trinity College (figure 1). The park originally covered 28 acres and was later extended in five consecutive phases, eventually covering an area of about 130 acres. Its major area of activities involve scientific research related to industrial production, light industrial

production, accommodation for business councillors collaborating with the academic and scientific personnel, and accompanying common services to the park. From 1973 to 1986 the park accommodated 68 companies with employment capacity of 1900 people. In December 1999 the park accommodated 64 companies employing about 4000 people (www.cambridge-science-park.com). The Cambridge success, the so-called *Cambridge Phenomena*, was accredited to the park's high quality architectural and natural environment and successful marketing strategies (Komninos, 1993:72).

Since the establishment of the Cambridge Science Park the number of science parks in operation in the United Kingdom grew from three in 1982 to forty-five in 1993 (Table 1). As a result UKSPA was established with the primary objective of during the late eighties of promoting awareness and understanding of science parks. Investment has continued in an upward direction; £564 million invested and earmarked for investment 1993 and the number of science park tenants rose from 301 in 1985 to 1188 in 1993 (Gower and Harris, 1994:24).

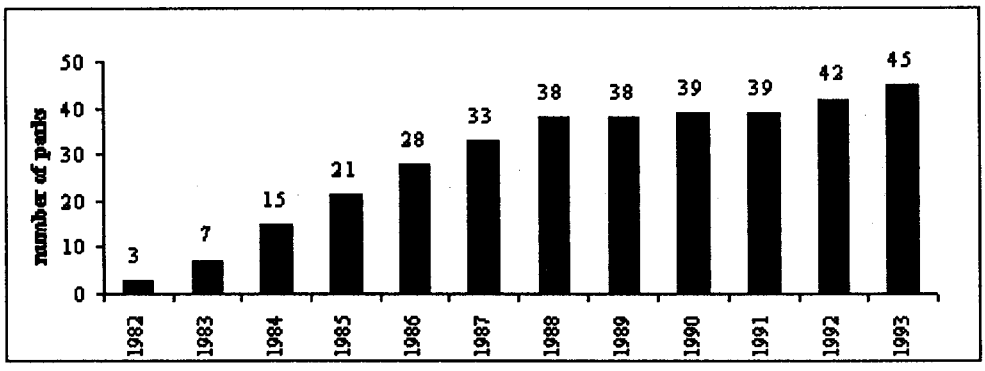


Table 1: The number of science parks in the UK from 1982 to 1993 (source: Gower and Harris, 1994:24)

The British public sector contributed to the creation of British science parks covering 62% of the total cost. At the beginning of 1988 the total investment capital on science parks development programme reached £ 296 million and with an added £ 167 million for another two-year programme for property extension and building of new science parks. The government based organisations, under the Department of Trade, Industry and Labour, spent 21% of their GDP developing eighteen science parks. Local authorities of large urban areas, under the general local development programmes sponsored by the Department of Environmental Affairs, covered 11% of investment, contributing to the creation of nine science parks. The private sector put forward the development of six parks and covered 8% of the total cost (Rowe, 1988:ix). The British science park program succeeded as a result of co-ordination between different government departments, local authorities, universities and the private sector. A similar strategic co-ordination, with the public sector playing a catalyst role, could benefit the South African science park program.

Figure 1: General view of Cambridge Science Park (source: http://www.cambridge-science-park.com)

2.2.2 Sophia Antipolis

Sophia Antipolis is located in a remote area, 12 miles from Nice, France. In 1987 Sophia Antipolis covered 5683 acres with 3700 acres preserved for natural vegetation, 370 acres offered for residential accommodation and 1600 acres for accommodating advanced technology activities such as research, development centres, engineering consultants and data processing centres (figure 2). Most buildings are two-storey high and designed to resemble the futuristic architectural style.

Sophia Antipolis is divided into four main areas of excellence:

- Computer science, electronics, robotics and telecommunication.
- Medical science, chemistry and biology.
- Research and training
- Natural sciences.

There is a significant increase in the number of firms with over a thousand companies and approximately a hundred new companies move in every year. Sophia Antipolis currently accommodates 1164 companies, 20530 engineers and technicians, and 5000 researchers and students (http://www.sophia-antipolis.net) as compared to a total of 1200 jobs in 1987 (http://www.etud.insa-tise.fr).

The Sophia Antipolis initiative became a prototype to the so-called Technopole phenomenon in France. This unique approach was developed in two forms: La Technopole and Le Technopole. La Technopole are developed at a large urban scale actively involved in high-tech development schemes such as the Sophia Antipolis. The main objective for this programme is to upgrade high-tech production standards to become competitive within the common European market. La Technopole phenomenon becomes a model for any similar initiative specifically in the Gauteng Region, which has the highest per capita income, number of scientists and institutions of higher learning in South Africa.

Le Technopole are parks developed at a smaller scale as technology parks or innovation centres. The main function of these initiatives is to act as incubators for high-tech companies and as instruments for technology transfer, which is similar to the Pretoria Technology Park.

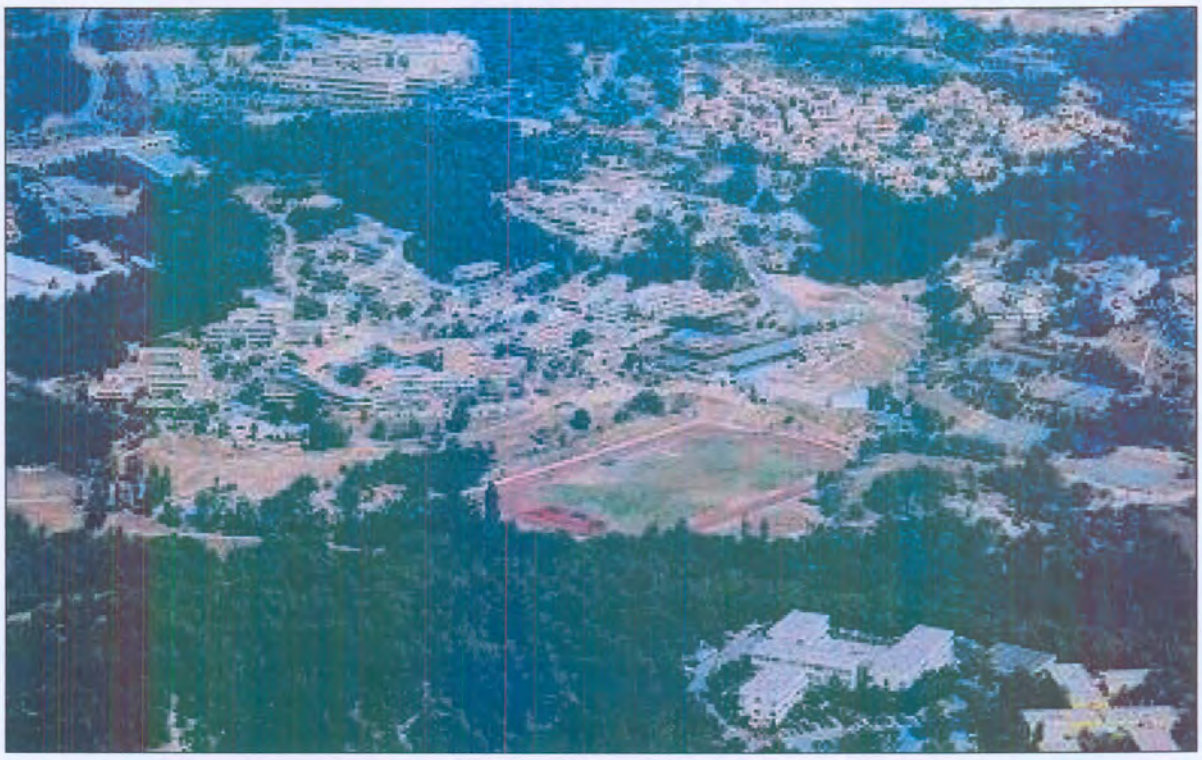


Figure 2: General view of Sophia Antipolis (Source: http://www.etud.insa-tise.fr)

2.2.3 Berliner Innovations und Grunderzentrum (BIG)

Berliner Innovations und Grunderzentrum (Berlin Innovation and Business Incubation Centre) is located in the heart of Berlin, in an area surrounded by old buildings (figure 3). BIG is accommodated together with TIG in the 1887-1905 Allgemeine Elektrizitats-Gesellschaft (AEG) machinery production plant and are both managed by the Innovation and Management Centre Berlin Ltd. (IZBM). Included on site are the 1909 Turbine Factory buildings designed by Peter Behrens. Fletcher (1975:1264) describes the site as good industrial architecture solely by meticulous organisation of the structure and materials, without recourse to ornament. The BIG was established in 1983 as the first German technology and business incubation centre. These AEG rehabilitated building structures currently accommodate over sixty companies and fifteen research institutes of the Technical University of Berlin (TUB) and the Fraunhofer Gesellschaft (FHG). The site offers a total area of 96,000 square meters of business and office space that can be rented at reasonable low prices (http://www.big.izbm.de).

Figure 3: Berliner Innovations und Grunderzentrum (Source: http://www.big.izbm.de)

BIG, in partnership with TIG, specialises in the fields of information and communication technology, multimedia, electronics, laser technology and photonics, measurement technology and analysis, automation technology, biotechnology, medical technology, laser technik, quality control, engineering services and other related fields. Required information on the architectural rehabilitation process of this significant precedent could not be available.

Following the establishment of the Berliner Innovations und Grunderzentrum (BIG) six centres for high-tech firms and new establishment had been established at the end of 1984. Up to the middle of 1985 ten other centres were erected. Most parks were initiated, financed or co-financed by local authorities. These parks are used as instruments for local economic promotion. Private agencies are employed to manage the parks. Due to limited funds and time constrains local authorities often make

use of vacant industrial buildings d AEG industrial site in Berlin (Komninos, 1993:77).

2.2.4 Thessaloniki Technology Parks

In 1990 the Chemical Process Engineering Research Institute (CPERI) established the Thessaloniki Technology Park (figure 4). The park is located in Thermi, fifteen kilometres east of Thessaloniki and the main campus of the Aristotle University of Thessaloniki. This initiative followed the 1989 Greece government call to develop a science park program. The government geared up a general technopole and innovation program, which aimed at resolving the crisis in the field of research and development. The program was based on three hypotheses (Komninos, 1993:215):

- That the Greek research and development has the potentials for re-orientation and sustainability towards high-tech activities for local market as well as to reduce imports.
- That strengthening of research activities and industrial high technology can be achieved through creation of technopoles and restructuring of Greek industrial centres.
- That for such a purpose, legislation should play a leading role, than transformation being conducted by the functions of the market, which usually do not lead towards qualitative development of productivity.

As a result four technology parks including the Thessaloniki Technology Park were developed in Greece and are all members of the International Association of Science Parks.

The Thessaloniki Technology Park promotes the following activities (http://www.techpath.gr):

- *Regional development* through increased competitiveness of local industry mainly in the areas of chemical technology, material technology, food and beverage, textiles and energy and environment.
- *Technology transfer* between local industries and higher educational institutions.
- *Contract research* that links industries to local universities for joint ventures.
- *International technology transfer* between Greece, United States, Eastern Europe, and the Balkans.
- *Contract education* between local industries and international research and technology organisations.

The park is divided into three main operational centres: administration/conference centre, incubator, and laboratory units. These centres constitute basic components of the technology park.

Figure 4: Thessaloniki Technology Park (Source: http://www.mercury.techpath.gr)

Administration/Conference Centre

This centre (1425m²) provides technology transfer services in the following areas:

- *Dissemination of information* in the areas of information technology, telecommunications, system automation, environment, agro industrial, food and beverage, materials and energy.
- *Research-Industrial liaison* through analysis of technology demands of companies, regional technology demands, and assessment and exploitation of research results.
- *Analytical services* using measurements, testing and quality control.
- *Research and technology development programs through* preparation of proposals, project management, implementation of technology development projects and partner searches.
- *Consulting* in the areas of technology auditing, intellectual property rights, system automation, technology brokerage, quality assurance and energy.
- *Financial and business services* in terms of funding, investment, joint ventures and assessment of investments, technology adaptation and new products
- *Education and training in the areas of business executives' further education and graduate placement.*

Incubator

This centre was designed to accommodate twelve start-up and tenant companies in 1200m² building block, but presently accommodates fifteen.

Laboratories

This centre composes of two laboratory units: Unit I (3024m²) that accommodates bench type laboratories for CPERI research purposes; and unit II (1850m²) that accommodates specialised experimental unit including pilot plants.

2.3 Typologies of European Science Parks

The Western European experience shows that most parks, initiated by public authorities, universities and industry, are orientated towards strengthening bonds between the academic and business environment. Most science parks have common characteristics: typological and functional collaboration with a university or a higher educational or research institution.

European science parks can be classified according to size and production activities (Komninos, 1993:140):

1. Large sized parks located in areas with a traditional industrial past. Their location is aimed at innovation in traditional production and also the establishment of big high-tech companies.
2. Large sized parks located in areas without any industrial past. They are aimed at attracting well-established technology companies with high specialisation capacity in production.
3. Small sized parks situated in areas with an industrial history. They are orientated towards diverse high-tech demands of small and medium sized companies.
4. Small sized parks located in areas without any industrial history, orientated towards high-tech small and medium sized companies and specialised research activities.

Most small sized science parks such as the Thessaloniki Technology Park provide innovation to local small and medium enterprises by means of technology transfer mechanism, while large parks such as Sophia Antipolis attract small and medium enterprises and well-established high-tech businesses and research departments of multinational companies. A number of multinational companies have selected Sophia Antipolis to establish their European headquarters.

2.4 European science parks and the built environment

Both the Cambridge Science Park and the Sophia Antipolis are prominent in the development of the science park built environment. The landscape of the Cambridge Science Park is shaped in an irregular 'Y' shape surrounding three lakes linked by footpath, which is based on a spine road

looping around (figure 1). The landscape plan is developing in three phases, each running concurrently with the park's development and extensions. The two roads and disused railway line to the south determine the boundaries of the park. A plantation of mixed conifer and deciduous shelter some parts of the park though obscuring some of the building views from afar. Some sites have nature reserve characters like hawthorn hedge with rabbit burrows, which happen to be the original habitats of the site before conversion into a park. Much attention was given to the landscape design, which would retain the natural morphology and wildness and minimise artificial interventions, particularly on lakes (Shinn, 1986:32-34).

The evident success of the Sophia Antipolis is highly attributable to the park's built environment, which embraces futuristic high-tech structures and well designed landscapes and contains well preserved buildings and ruins from the 16th century and the Roman era (figure 5). This kind of environment has appealed, in conjunction with research and development activities, to both local and multinational companies (http://www.alpes-azur.com).

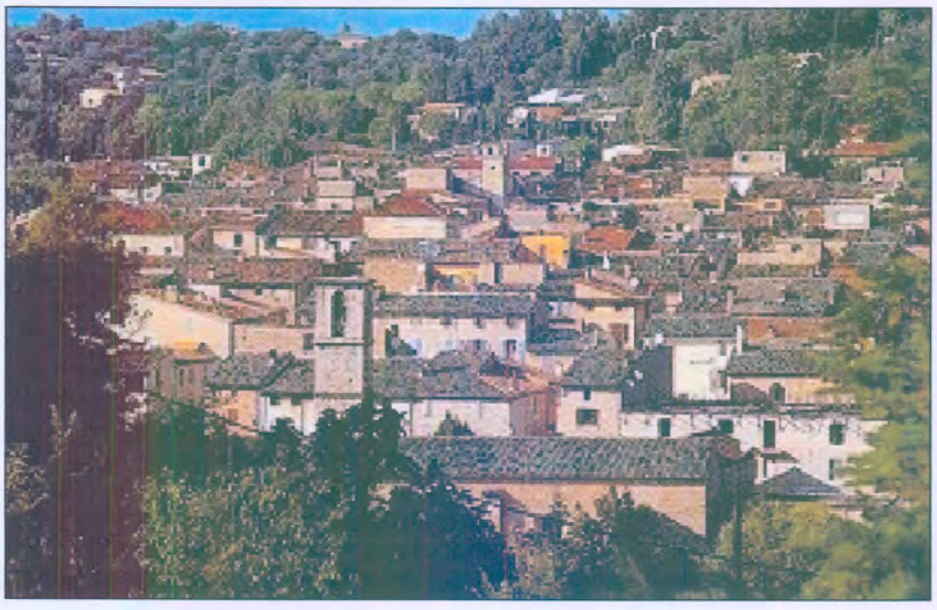


Figure 5: 16th century and Roman era architecture at Sophia Antipolis (Source: http://www.etud.insa-tise.fr)

2.5 Science Parks in South Africa

Stellenbosch Technopark is the first South African science park developed by the Stellenbosch municipality in collaboration with the University of Stellenbosch. This high technology park initiative covered approximately 148 acres. The development was initially aimed at accommodating over a hundred companies, including foreign companies that are involved in high technology

developments. The University of Witwatersrand and the University of Pretoria followed the Stellenbosch initiative by developing the Highveld and the Persequor Technology Parks respectively. The former is located within the boundaries of both the Midrand and the Centurion municipalities while the latter is located in Pretoria East between the CSIR and the University of Pretoria. The Highveld Technology Park was unsuccessful. This is warranted by a number of reasons, one of them being that there was lack of research personnel from the university working close to the development (Els, 1989: 22). Since Els's report in 1989 little has been mentioned of the developments in the above-mentioned programmes.

In South Africa institutions of higher education initiate science park programmes. This includes the newly initiated science park by the Technikon Free State.

2.5.1 Science Park of the Technikon Free State

The Science Park of the Technikon Free State is one of the emerging programmes that transpire success. It is the first South Africa science park to register with the International Organisation of Science Parks (IASP). It is one of the three registered IASP members in Africa together with Technopole de Dakar in Senegal and Parc Technologique in Tunis. The following services are offered by a number of expertise centres operating with academic faculties of the technikon (http://www.tofs.ac.za):

- Supplementary health services
- Environmental monitoring
- Rapid prototyping, manufacturing and testing of mechanical products
- Electronic design and manufacture
- Fibrinogen Unit
- Aspects of hospitality management and tourism
- Health and Environmental Research and Development

2.5.2 Perseqour Technology Park

The site is located west of the CSIR and covers approximately 148 acres. Twenty-seven landowners occupy 17246 m² of the site. It comprises of 25 stands their sizes ranging from 3447 m² to 11519 m² (figure 6). The park was established in 1989 with the aim of providing state owned enterprises, the principal figure being ARMSCOR, with military high-tech equipment. After a few years the

University of Pretoria decided to sell land, on site, to private companies with the aim of maintaining rental income.

Companies on the park specialise in variety of activities such as:

- Courier services
- Provision and installation of office equipment
- Engineering, design and manufacturing
- Accounting services and computer hardware and software installation
- Technologies in the field of communication electronic warfare, spectrum monitoring, mining electronic system and security
- Project management
- Multimedia
- Techno-economics
- Pharmaceutics

There are plans to re-establish the Perseqour Technology Park as a science park. The Gauteng Premier, Mbhazima Shilowa, officially announced this initiative on 15th February 2000, as part of the Innovation Corridor forming alliance between the University of Pretoria and the CSIR. This initiative was later named SERA (Southern Education and Research Alliance), which was allocated a 60-hectare site between the University of Pretoria and the CSIR. This initiative will link business, education and research to create, nurture and grow technology-led businesses in South Africa (University of Pretoria, 2000:1).

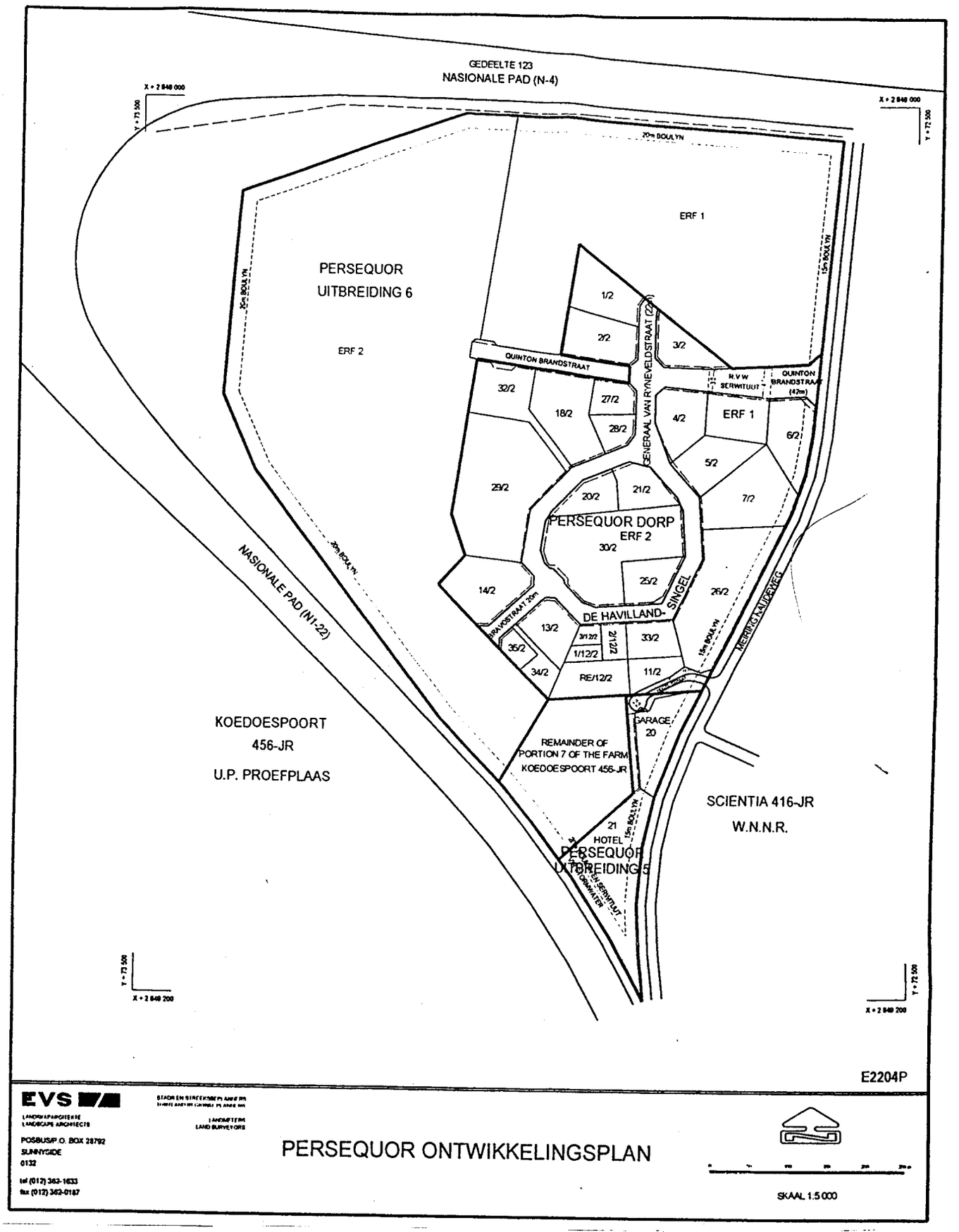


Figure 6: Persequor Technology Park Development Plan (Source: EVS Landscape Architects)

2.6 Conclusion

In Europe, governments, local authorities and universities together with local industries initiated most science parks with the main objective of strengthening bonds between academic research and business. Most parks have permanent links established with at least one higher educational institution and encourage start-up companies. Though South Africa was slow in recognising the role played by science parks, most science park programmes already developed were hampered by political instabilities and subsequent reduction of financial assistance from the government. New hope was born with the announcement of SERA, which aims at upgrading the innovation programme in the Gauteng Region and the South African industry. A lesson from the European experience is that science parks were established with the aim of uplifting local companies (especially small parks) and offering intellectual and physical infrastructure of international standards to tenant companies.

Large parks such as the Sophia Antipolis attract mainly multinational companies by offering architecturally intimate spaces and competitive high-tech environments. Occasionally, internationally competitive companies get involved in the development of science parks, which enhances the image of the parks. These parks become centres of excellence dealing with technological innovation and transfer for various industrial sectors. Unlike large parks, small parks such as the Thessaloniki Technology Park can only focus on particular industrial activities usually associated with light industrial manufacturing.

Basic land use program of developed science parks comprises of (see diagram 1):

- Administration centre that includes technology transfer unit and financing offices
- Research (innovation) laboratories
- Accommodation for start-up (incubator) and technology firms
- Zones for socio-economic activities (conference, arts and exhibition halls, banks (ATM), post, restaurants/cafeteria, etc.)
- Parking

Large parks usually include residential and recreational facilities and reserve spaces for future expansions. Most parks are landscaped to enhance their image while their building coefficient is low.

An investigation and consideration of the diverse European examples offers valuable knowledge and experience that can be utilised in South Africa's diverse nature of universities and local industries, towards a successful implementation of science and technology park initiatives.

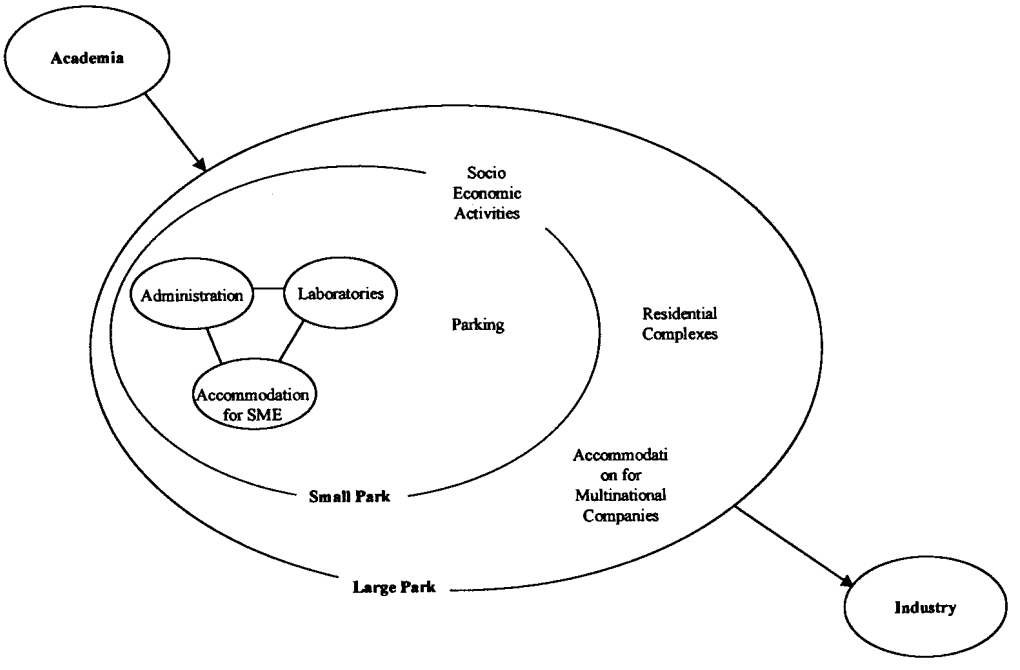


Diagram 1: Elements and structure of a Science/Technology Park

PART TWO

3. ESTABLISHMENT OF THE PRETORIA TECHNOLOGY PARK

Sustainable development of the Pretoria Technology Park relies on the relevance and efficiency of its development methodology to local business and research communities. The development methodology aims at establishing the park's strategic planning and the type of a technology park. Consequently, different centres are established to provide accommodation and services to park's major activities. Each centre is defined according to its spatial characteristics and design specifications. These demand certain architectural qualities from the existing physical forms of the Pretoria State Garage, which will ultimately determine the appropriateness of the rehabilitation fitting process.

The development methodology of the Pretoria Technology Park should involve four stages (Komninos, 1993:135):

- The first stage is concerned with the description and analysis of the area and concentrate on local supply, demand and technology transfer.
- The second stage is concerned with the description of strategic development of the park in relation to real business needs of the region and the capabilities of local scientific and research community.
- The third stage, which is the most important, describes the choices as strategy and model of the park.
- The fourth stage is concerned with the carrying-out of the program involving introduction of legislation and administrative organs of the park. This is related to the implementation programme and not covered in this study.

3.1 Description and analysis of the Gauteng Region

The analysis and description of the region is based on the objectives of the interested groups. Van Dierdonck and Hysman (1992) classify those groups interested according to their objectives into the following four categories:

- Objectives of regional development office, government and politicians
- Objectives of university, institutions of higher education and research centres
- Objectives of local industry
- Objectives of new firms

3.1.1 Objectives of regional development office, government and politicians

Objectives of the regional development office, government and politicians focus mainly on the development of the area and urbanisation. The public sector mainly provides funding.

Development of the area

This section focuses on the following objectives:

- *Creation of job opportunities in the region*. Unemployment remains a major challenge for private and public sector in South Africa. In 1994 unemployment in the Gauteng region was 28.7% as compared to the national average of 32.7% (Provincial Statistic: 1995). Attention is also given to the creation of jobs for special groups such as woman, people with a low level of education and prevention of emigration of people with a high level of education.

- *Increase the average income*. The Gauteng Gross Geographical product per Capita is the highest of all provinces with the rate of R19261 to national average of R8704 (Provincial Statistic: 1995). Though measures of the Human Development Index indicate that the Gauteng Region occupies the 52nd position scoring 0,820 on the high human development mean of 0,886 (Human Development Index for the RSA, 1981and 1991).

- *Development of the infrastructure* that will benefit the overall image of the designated region.

- *Implementation of industrial defensive strategy* through revitalisation of zones with existing old industrial by attracting high-tech industry.

- *Implementation of industrial offensive strategy*, which stimulates the development of a region with a low degree of industrialisation.

Urbanisation

Urbanisation focuses on the zoning of different groups of companies for reason of common infrastructure to deal with issues of pollution, noise, logistics and interactions. The zone in which the Pretoria State Garage is located is characterised by museums and office buildings. Buildings, such as

the former SA mint, that used to house industrial functions in the area are being constantly transformed into museums, which are currently underachieving.

Supporting organisations

The public sector and local authorities in order to carry out a mandate to meet the above-mentioned objectives should create the supporting organisations. The South African Department of Trade and Industry (DTI), as part of its strategy, has formed the following partnership programmes for the promotion of technology in South Africa's manufacturing industry:

- Support Programme for Industrial Innovation (SPII). This program provides incentives for the development of innovative products and processes, administered by the Industrial Development Corporation of SA Limited (IDC). It is designed to promote technology development in manufacturing industries in South Africa through support for innovation of competitive products and/or processes (Support Programme for Industrial Innovation, 1997).

- The Technology and Human Resources for Industry Programme (THRIP) managed by Foundation for Research Development (FRD) and guided by a board comprising representatives from industry, government, higher education, labour and science councils. This program supports science, engineering and technology research collaboration focused on addressing the technology needs of the participating firms. THRIP also encourages and supports the development and the mobility of research personnel and students among participating organisations (THRIP, 1997).

3.1.2 Objectives of university, institutions of higher education and research centres

The objectives of the universities, institutes of higher education and research section focuses on the technology transfer, scientific aspects, financial aspects and marketing.

Technology transfer

Technology is transferred from institutions of higher learning to the manufacturing sector through exchange of researchers and personnel. This exposes researchers and personnel to the manufacturing sector, which will possibly result in the creation of spin-offs and commercialisation of academic research.

Scientific aspects

The link between the institutions of higher learning and the manufacturing sector will increase the industrial relevance of university research and give academic research access to leading-edge research and development of park firms.

Financial aspects

Institutions of higher education benefit through links with the manufacturing sector in terms of:

- Income that is generated through investment in the manufacturing sector.
- Expensive equipment donated by companies.
- Usage of the facilities belonging to the research park firms.
- Employment and consultation opportunities for academic staff and students in the manufacturing sector.

Marketing

Relevance of the academic research to the manufacturing sector improves the marketing image of the academic institutions.

Supporting organisations

Both the University of Pretoria and the CSIR are two prominent organisations that are capable of establishing required partnership with the Pretoria Technology Park in order to develop. Both organisations have the capacity to render engineering and management support to the park. The link between the two institutions and the park will provide the opportunity to exchange ideas on the relevance of academic intellectual capacity to local industries.

3.1.3 Objectives of local industry

The involvement of local industries in the science park projects benefit industry in terms of the following:

- Increase in the number of suppliers or potential clients.

- Increase in the number of inhabitants in the region and their average income.
- Synergy with new firms.
- Possible location of subsidiaries of existing companies.
- Improvement of the image of the area.

3.1.4 Objectives of new firms

This section indicates a number of ways in which new firms on the park benefit from the objectives of the industrial park, availability of services and the presence of the university on the park.

Objectives of an industry park

- High-tech image.
- Synergy between firms.
- Accessible and attractive location of the science park.
- Living facilities in the area such as housing, cultural activities, schools and recreation.
- Upgrading the degree of education of people in the area.
- Provision of financial support.

Presence of services

- Financial services.
- Consultation and training facilities concerning finance, accounting, marketing and personnel.
- Common services such as secretarial, reception and possibility for group meetings.

Presence of university:

- Availability of external scientific and technological resources.
- Recruitment opportunities.
- Access to post-graduate education programmes at the university.
- Academic environment.
- Academic amenities.
- Network opportunities.

3.2 Description of strategic development

Strategic development of the park should relate to real needs of local manufacturing companies and technology supply capabilities of local scientific and research communities. It involves:

- Macro-planning strategies and
- Type of a technology park

3.2.1 *Macro-planning strategies*

Macro planning strategies focus on systems of local technology supply, transfer and demands. This is most significant to the establishment of a relevant technology park to the user group. The actual survey to measure the value of this section can be conducted in a separate study and focus exhaustively in topics to be discussed below, including target groups in the region. As a result, the following topics are discussed in general according to the concerns and framework established by relevant government departments such as the Department of Trade and Industry, user groups, institutions of higher learning and research (such as the University of Pretoria and the CSIR in this regard).

1. Local technology supply

Analysis of local technology supply systems identifies applied research activities and potentials for technology applications to companies stemming from non-company research centres. Small and medium sized companies are turning more and more to external sources for technology in order to develop their technological capacity. Technology support from local research and development institutes and universities plays a prominent role in applied industrial technology development. Within this context, the investigation of technology supply focuses on regional research and development potential and the collaboration between research institutes and industrial firms.

- The University of Pretoria has the capacity for rendering technology support and innovation to the industry. The Faculty of Engineering is the largest in the country with different fields of specialisation: Agricultural, Computer, Civil, Chemical, Electrical, Electronic, Industrial, Technology Innovation, Mechanical, Metallurgical, Mining Engineering, and Engineering and Technology Management. The faculty regards its ties with industry as one of its unique characteristics and aims at keeping expertise relevant by regarding the need of industry as top priority.

- The CSIR as government and business technology partner renders scientific and technological services to industries in the fields of Bio/Chemical, Building and Construction, Defence, Water, Environment and Forestry, Food, Information and Communications, Manufacturing and Materials, Mining, Roads and Transport and Textiles.

2. *Local technology demand*

Analysis of regional and local technology demands determines the basic orientations of the region and its innovation capacity. The manufacturing and services sectors have important needs for innovation. Pretoria, like the rest of South Africa, compared to the complex global market demands with its mixed First and Third World characteristics lacks competitive technological infrastructure and resources when compared to international industrialised nations. South Africa was rated eleventh out of fifteen newly emerging industrial countries in 1993 World Competitiveness Report (Whiteside, 1996:265).

South Africa industries need technology know-how in most fields of engineering: research, manufacturing, management, marketing, design, training, production, and quality assurance. This is evident from the disappointing results of the development strategies of South Africa (Unger, 1996:172). Recent initiatives such as the Innovation Hub by SERA show a growing need for technological innovation in the country.

3. *Local technology transfer*

The University of Pretoria plays a prominent role in terms of technology transfer in the region. The Pretoria Technology Park will benefit from the link with the University of Pretoria, since the university collaborates with local and international companies such as SASOL, AEGI, ISCOR, CSIR, SAA, Eskom, Alcatel and Nokia.

The most important field for every innovation system is technology transfer. This should follow the linear model by Massy and Wield (1992:15) that product development starts with academic research, which eventually leads to the final product. According to Badiru (1996:28) the question of technology transfer has to address and overcome, at least, the following issues:

- The nature of technologies to be transferred.
- Parties subjected to technology transfer.

- Clarification of the objectives of technology transfer.
- The financial implications of acquiring required technology.
- The similarities, differences, advantages and disadvantages of the new technology as compared to the previous technologies.
- The ability of the local infrastructure to sustain technology transfer process.
- Flexible macro-planning strategies that will accommodate future technological changes.

3.2.2 Type of a technology park

The Pretoria Technology Park aims to facilitate the local small and medium enterprises in the manufacturing sector and services of Pretoria and the Gauteng Region. This is warranted by both international and local trends of industrial competitiveness. This urges manufacturing industries to appreciate the value of integrating their operations, which includes interested groups like the universities and research institutions.

Following is a list of supporting co-operative actions of subsystems, which serve to counterbalance the weakness at certain points during the integration process (Badiru, 1996:5):

- Manufacturing system.
- Management system.
- Quality information system.
- Financial information system.
- Marketing information system.
- Inventory information system.
- Personnel information system.
- Production information system.
- Design and engineering systems.
- Management information system.

These systems are consequently accommodated in different centres of the park in accordance to the nature of their operations and objectives of the park. Recent developments in innovation policy and criticism of science parks functioning show that technology transfer is the key element in science park planning and operation (Komninos *et al,* 1996:50). As a result, these systems will be integrated around the park's main objective of technology transfer.

3.3 Description of centres and services of the Pretoria Technology Park

The main objective of this section is to propose a technology transfer mechanism for the Pretoria Technology Park that will facilitate the local manufacturing sector. It is imperative that the organisation and management of a technology park, in order to address issues of technology transfer, be organised around four centres dealing with technology transfer, provision of technology services, support of new start-ups and innovation financing (Komninos *et al,* 1996:51). The similar nature of operations and spatial requirements in the centres for technology transfer and innovation financing suggest that they be accommodated in the central management building for efficiency. As a result the general layout of the park is divided into a management centre, technology building and incubator building.

The description of centres and services of Pretoria Technology Park is based on the software program of the Science Park of the Technical University of Crete by Komninos *et al* (1996) and the Fix Technology Park by Setshedi (1998). This relation is warranted by the fact that all three projects are orientated towards establishing a technology park that responds to the innovation demands for small and medium enterprises. Space and design specifications relating to the centres and services discussed below are discussed in section 3.4, which includes centre for socio-economic activities and a museum.

3.3.1 Management centre

This centre comprises of technology transfer and innovation financing units that provide technology transfer and innovation financing services to tenant companies respectively.

3.3.1.1. Technology transfer unit

This centre is a major institution and tool for technology transfer. Badiru (1996:30) describes duties of this centre as "triple technology transfer modes" focusing in: transfer of complete technological products, transfer of technology procedures and transfer of technology concepts, theories and ideas.

- *Transfer of complete technological products*, whereby a fully developed product is transferred from a technology source for utilization at a technology target. With very little product development effort carried out at the target point, information about the operations of the product is fed back to the source so that necessary product enhancement can be carried out.

- *Transfer of technology procedures and guidelines*, in this the technology transfer mode, procedures and guidelines are transferred from the technology source to the technology target. The technology blueprints are implemented locally to generate the desired products. The use of local raw materials and manpower is encouraged for the local production.

- *Transfer of technology concepts, theories and ideas*. This strategy involves the transfer of the basic concepts, theories and ideas associated with a technology. The transferred elements can then be enhanced, modified or customized within local constrains to generate new technological products. The local modifications and enhancements have the potential to generate an identical technology, a new related technology, or a new set of technology concepts, theories and ideas.

The centre for technology transfer consists of three different services (Setshedi, 1998:22 and Komninos *et al*, 1996:53):

1. *Industrial liaison office*

The industrial liaison office develops technological corporation and networks between participating organizations such as the University of Pretoria, CSIR and other research institutions, tenant companies, including local and international retailers and producers. This technological co-operation develops networks to identify a particular industrial sector such as manufacturing that can benefit a considerable geographical area and establishes technology structures that will benefit the typology of local generic technologies.

2. *Observatory and information office*

The observatory and information services provide information on technological development to those parties involved in production practices and policy making. This unit operates on double information interface. Firstly, a structure investigating information on technology issues of great importance to large companies and small and medium sized companies. Secondly, a structure diffusing information to all park parties concerning a wide range of issues related to specific small and medium sized companies, policies and programs of technological development.

3. *Career advisory office*

This office focuses mainly on the link and co-operation between the higher education institutions and the business sector. This unit is responsible for initiating programs for training scientists, graduates and students according to market needs. It supplies firms with information concerning graduate qualifications and specialization, provided by higher educational institutions and supply of information to higher education institutions for the trends of the labour market and to promote the absorption of graduates of firms.

The unit focuses on the two areas of labour market demand for graduates and relevance of qualifications. This is set-up through a creation of a consulting office for students and graduates, the publication of informative prospectuses for post-graduate studies and career possibilities, meetings, and the realization of annual studies on trends of labour market.

3.3.1.2. Innovation financing unit

This unit provides innovation funding to newly founded business and start-ups in forms of seed and venture capitals (Komninos *et al*, 1996:60). Levy (1996:11) states that:
"South Africa's banks, owned by the country's major business groups, skew their activities to large enterprises within their own business stable, and neglect small firms", and that "a common factor criticism is that the banks tend to discriminate against business borrowers other than white".
Most start-up firms require loans that banks evaluate according to their risk levels and transaction costs and also that they vary in making loans to start-ups, young firms and small firms. In most cases the banks would require collateral that will amount to 100 percent of the value of the loans. The South African Department of Trade and Industry, in partnership with THRIP and SPII, has established incentive and funding schemes to assist small and medium innovative enterprises.

1. *Seed capital service*

This unit embraces the incubator concept by providing finance support to high technology start-ups. The unit offers financial support provided that the intellectual property schemes meet the required criteria for innovation.

2. *Venture capital service*

The venture capital service complements the seed capital service by providing the following services:

- Formation of the fund on an equity basis, in co-operation with existing financial institutions and schemes.
- Formation of an upraising unit for innovative projects.
- Unit for information of small and medium sized companies on the financial capabilities of the scheme and comparative advantages.
- Design of the exit routes, always in co-operation with the financial institution or bank involved and withdrawal from the individual projects.

3.3.2 Technology building

This centre is the second principal component after the centre for technology transfer. It offers advanced technology services and applications that are required by small and medium sized companies, which are not widely accessible in the market and internally. Advanced technological services are basically related to research, manufacturing, production, design and quality assurance.

As a result, services provided by this centre to tenant companies are grouped in the following categories:

- Business services
- Multimedia services
- Telecommunication services
- Systems and automation services
- Quality analysis and certification services

1. Quality analysis and certification services

The services will co-ordinate a number of dispersed and non-organized initiatives in the field of quality analysis and control, and certification in the fields of industrial quality, engineering and production sectors. Certification issued through this unit is vital for competitive marketing of products, locally and internationally. A co-operative network is established to promote the co-use of equipment by interested organizations.

2. Business services

South African companies need various technological services and inputs such as technical, financial, training and marketing, which are necessary components of small and medium sized companies. The

business service is designed to provide the most essential services for small and medium sized companies and start-ups.

The business service unit focuses in the following areas:

- Technological evaluation of new proposals for products and firms (analysis of technology based discoveries inventions, technical feasibility and marketing).
- Protection of intellectual property, model protection, registration of trademarks and licensing royalties.
- Design of development plans involving business plan preparation, build and testing of prototypes, user questionnaires and product improvement.
- Marketing, which involves choice of marketing route, design of marketing strategy, new venture plans and establishment.

3. Multimedia services

The purpose of the service is to develop expertise in areas that have been identified as critical to the development of software for the marketing and promotion of local activities. The service will be based on a range of multimedia platforms, applications and peripherals and will invite interested parties from the software and related industries to view and develop relevant applications. The service will also offer consultation on the suitability of multimedia for different applications and help companies to select multimedia platforms or applications.

4. Telecommunication services

Telecommunication networks will play a significant role in the operation and competitiveness of the park due to its increasing integration to the international market. Efficiency can be achieved by dividing the telecommunication system into different field of specialisation in developing networks and integration (transmission networks, data transfer, storage and processing network).

5. Systems and automation services

Industrial modernisation and company competitiveness are directly related with process automation and dynamically aided by system analysis and design. The laboratories can support active collaboration with national and international institutions in research, development and applications.

3.3.3 Incubator building

The incubator building provides accommodation to start-up companies and technology based firms in their early stage of growth. An evaluation committee is required to monitor acceptance of tenant companies into this centre. Deirdonck and Huysman (1992:22) establish a system of evaluation criteria, which take into consideration the following parameters:

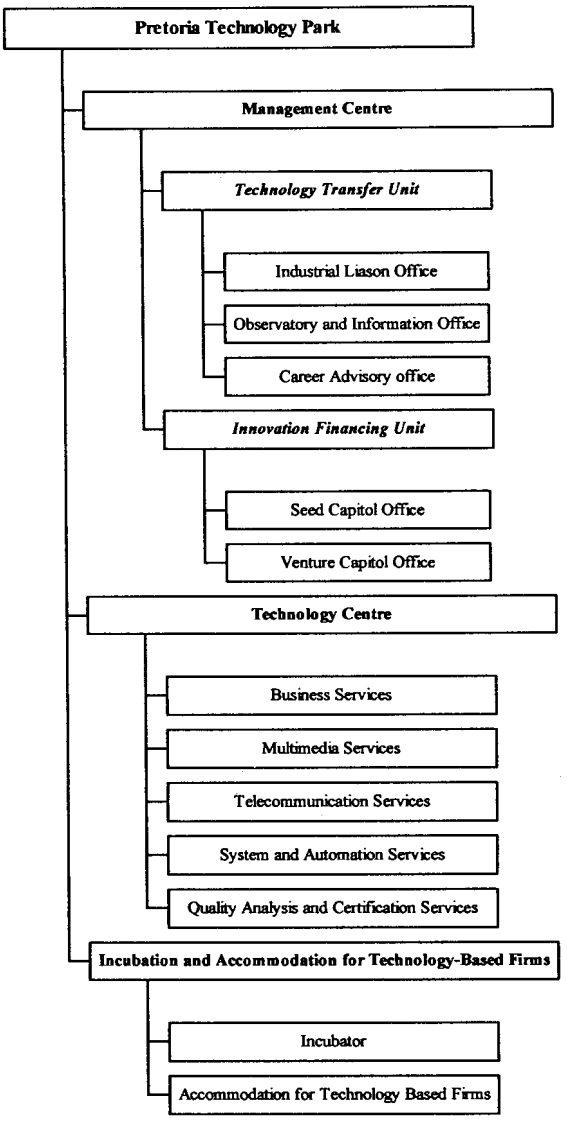
- Research and development effort of company, measured by percentage of turnover devoted to research and development, number of patents, and percentage of employees who are qualified scientist or engineers.
- Collaboration between tenants and university or whether it is to be establishment in the future.
- Active character of company in the high-tech field for which the university partner is recognised as having an outstanding position.
- Possible synergism with the existing firms.
- Multiplicatory character of functions of the company.

This centre provides common services to tenants such as:

- Secretarial support
- Marketing services
- Financial advice
- Professional continuing training programs
- Information on intellectual property rights and patents
- Internet and Integrated Service Digital Network (ISDN) services
- Access to international databases

These are similar services provided by the incubator of the Thessaloniki Technology Park that accommodates about fifteen small and medium companies since its establishment in 1990 (http://mercury.techpath.gr).

Diagram 2: Pretoria Technology Park Centres



3.4 Pretoria Technology Park space and design specifications

This section complements section 3.3 dealing with descriptions of centres and services. A complete science park usually includes technology transfer orientated administration, research institutes and laboratories, accommodation and services provided for start-up companies, accommodation for selected companies and common services such as post, banks, lecture rooms, restaurants, exhibition and seminar halls. Basic characteristic for science park design is a layout program for land use, basic buildings and installations. Land use and building program includes (Komninos, 1993:141 and Setshedi: 1998:21):

- *Central building* – which consists of office space for administrative personnel and park committees; technology transfer services, innovation financing services, services for projection-communication-advertisement, seminar and exhibition halls, cafeteria, restaurant and accompanying services such as post, banks and pavilions.
- *Incubator* – which accommodates start-up companies with common use spaces for incubator's administrative personnel and installation of selected companies.
- *Technology building* –for research institutes and laboratories.
- *Parking space* – from one space for every two persons.
- *Landscapes*- average of 50% coverage of park space.

Due to various requirements of tenants to be located on the park, Southern (1988:52) provides a summary of main factors influencing decision-making:

- The prestige, which the site offers, and its overall image.
- The type of accommodation provided.
- Car parking.
- The availability of premises and the access to the nearby higher educational institutions.

Southern (1988:53) also provides a description of the overall impression that the park should ideally make for immediate and favourable impact on the visitor:

- A visible and attractive entrance.
- Well-designed and maintained landscapes.
- Adequate parking, which should ideally be landscaped or hidden from main approach roads.
- Clear sign posting.

In *The building and its cartilage* Southern (1988:53) summarises the building envelope as according to specific requirements of occupiers as follows:

- *Density and building form.* The building form is normally a one or two storey with occupier's normal preference of single storey with own front door.
- *Expansion space* to cater for fast expanding companies.
- *Building material* can vary, but brick and tile have figured strongly, and quality cladding has been used at a number of locations.
- *The building module and fenestration.* The module is generally 1:1 or 2:1 and its average depth should allow people access to windows and natural light.
- *Entrances.* Occupiers have a preference for entrances, which are immediately noticeable to visitors.
- *Internal height.* A minimal internal floor-to-ceiling height of 3m (10 feet) meets most needs; a void of around 60 to 90cm will accommodate the majority of services required by occupiers.
- *Heating and services* that offer the flexibility to alter or add to a system.
- *Internal finishes.* Floors are normally finished to dust free concrete to enable the occupier to choose his final finish, which is often, vinyl/ceramic tiles or carpets. Walls are often plastered and suspended ceilings are normally included in most speculative schemes. Internal partitions should be capable of easy adaptation.

Miller (1988:32) states that developers prefer the English conventional developer's specifications building, which seem to be equally suitable with very few exceptions that users can be accommodated in a regular 1.5 meter grid with the conventional 13.5 meter wall to wall interior.

3.4.1 Space description

The space descriptions reflect the amount of space required for each activity. Specific space characteristics should meet the park's long-term development of requirements and a complete product definition. Science park design specifications should allow for flexibility when fitted within a rehabilitated property. Space planning should first provide required square meters for each component. Growth is also a major component of building design that should be incorporated in the planning process. This could either be approached through centralising or providing space for growth in one area, or decentralising space for growth among existing departmental parameters (Rayfield, 1994:91). The space description of supporting areas will be determined by their role in facilitating the main units and the availability of accommodation space. Salata (1983:9) quotes Ronald Ward and

Partners stating that there is no such thing as a standard office, but dimensions that have been traditionally accepted. This is relevant to space planning and dimensions for building rehabilitation. Ancillary areas usually cover approximately 30% of the building space and house activities, which attract people and bring income to the park. Following (see Table 2) are the square meters of basic technology park spaces and necessary ancillary areas. These surface areas are similar to those of the Thessaloniki Technology Park (Setshedi, 1998).

1. Management centre

Technology transfer unit

- Industrial liaison office - liaison service: 250-300 m²
- Technology observatory - information service: 250-300 m²
- Career advisory unit - counselling service: 250-300 m²

Innovation financing unit

- Seed capital service: 250-300 m²
- Venture capital service: 250-300 m²

Ancillary Areas

The surface area of ancillary spaces cannot be predetermined but depends on the availability of the remaining spaces and are usually located where space is available. Most of these activities can be located along significant pedestrian intersections.

- Exhibition hall: 80 m²
- Conference hall (50-150 seats): 200 m²
- Reception: 20 m²
- Lecture rooms (100m²x2): 200 m²
- Library: 100 m²
- Amenities: 60 m²

The total area requested for the accommodation of the management centre equals to 2160 m², which is 465 m² more than the total area of the Thessaloniki Technology Park's Administration and Conference Centre.

2. Technology building

- Business service: 300-400 m²
- Multimedia service: 300-400 m²
- Telecommunication service: 300-400 m²
- Systems and automation service: 300-400 m²
- Quality analysis and certification service: 300-400 m²

Ancillary areas

- Special library: 100 m²
- Reception: 20 m²
- Amenities: 60 m²

All areas of this centre including circulation add up to 2180 m² as compared to 1850 m² of the specialised experimental unit (excluding two CPERI laboratories that occupy 3024 m²) of the Thessaloniki Technology Park.

3. Incubator building

Special attention is required to buildings accommodating start-ups and selected companies. Komninos (1993:93) describes incubators as rectangular buildings with one to two storeys, divided into units of 30-250m². A basic criterion in designing incubators is flexibility, which caters for further subdivisions and alterations. Accommodation is also needed to house tenant companies ranging from 80m² to 300m², which do not necessarily have to be accommodated in the same building as the incubator

Administrative and ancillary areas

- Manager office space: 50-100 m²
- Cafeteria/lounge (50-150 people): 80-180 m²
- Reception: 20 m²

The total area for both the incubation space and accommodation for technology-based firms can range from 1000 m² to 2000 m² each depending on the tenancy demand.

4. Museum and centre for socio-economic activities

The museum will display historic artefacts and events relating to the site. The centre for socio-economic requires:

- amenities (60 m²)
- pavilions (100 m²)
- amphitheatre for 150 people (200 m²)
- parking (to be relocated to the site south of the Pretoria State Garage),
- banks (including ATM machines covering about 50 m²)

The total area for this section amounts to 410 m².

Defining approximate areas needed for different spaces offers an insight into the shapes and sizes required for accommodating the Pretoria Technology Park activities. This is a preliminary stage, which will be taken into consideration during the rehabilitation assessment and the fitting process of the State Garage buildings. As a result the Pretoria Technology Park requires approximately 10250 m² (see Table 2) for its functions as compared to a total of 7499 m² of the Thessaloniki Technology Park. These surfaces might change depending on the availability of space within the existing forms of the State Garage buildings but still confirms that the Pretoria State Garage is a small science park located in an area with an industrial past, like BIG.

Centre	Area in m²	Total area per centre
Management centre		
1. Technology transfer unit		
- Industrial liaison office	300	
- Observatory and information services	300	
- Career advisory office	300	
2. Innovation Financing Unit		
- Seed capital service	300	
- Venture capital service	300	
- Ancillary spaces	520	
Total area		2160
Technology building		
- Business service	400	
- Multimedia service	400	
- Telecommunication service	400	
- Systems and automation service	400	
- Quality analysis and certification service	400	
- Ancillary spaces	180	
Total area		2180
Incubator	2000	2000
Accommodation for tenant companies	2000	2000
Museum	1500	1500
Centre for socio-economic activities	410	410
Total area (for the technology park)		**10250**

Table 2: Required surfaces for the Pretoria Technology Park

3.5 Market research for alternative locations for the Pretoria Technology Park

Pretoria like most South African cities dating from the second half of the eighteenth century shows signs of decay. One of the major elements of market research is the selection of a positive environment that appeals to all the parties involved. It is useful to judge right at the outset whether a building site is likely to be capable of re-use, and for what. That evaluation is vital as to determine, from the outset the difference between success and failure. The main factors affecting market are *location, configuration and condition* (Department of Environment, 1987:8), though factors such as *financing, timing, ownership* and *function* play decisive roles (Theron, 1981:427).

- *Location* refers to the parts of the country or type of neighbourhood in which a building site stands, but also alternatives of area to different types of use and possible expansion. Deirdonck and Huysman (1992:23) suggest that for the evaluation of the location the following should be taken into consideration: access to transport ways, housing in the area, degree of education of people in the area, entrepreneurial attitude of people in the area and presence of venture capital.

- *Configuration* refers to the shape and the size of the building, which is very important. Natural light-distance from the windows determines how building can be re-used. The two main considerations are the depth of the building and the ceiling heights.

- *Building condition* is the most variable in building re-use. The longer a building is left empty, the greater and more expensive will be the work required.

The ideal location for the Pretoria Technology Park lies in its proximity to the main campus of the University of Pretoria. A site that meets this demand is apparently not available within the main campus of the University of Pretoria and the surrounding area. It is therefore necessary to allocate a site within the vicinity of the city of Pretoria. The Pretoria State Garage was initially chosen and because it contains a surplus of obsolete buildings that can provide suitable accommodation for the park. Both the Marabastad and the Asiatic Bazaar areas and the Pretoria West industrial sites are identified as possible alternative locations after the Pretoria State Garage (figure 7).

3.5.1 Pretoria State Garage

The Pretoria State Garage (figure 7 and 8) lies in the southwest quadrant of Pretoria Central and has the kind of distinct and boundaries that create an identifiable neighbourhood:

- Potgieter Street and the new Tshwane Mail Centre to the west, which was built on the site of the former South African Railways good yard.
- African Window museum on the rehabilitated former South African Mint property to the east.
- Minnaar Street and railway lines to the south.

The site is situated in a quadrant intensively characterised by museum buildings of monumental and architectural significance such as the African Window (former South African Mint), Transvaal Museum, Fire station, Loreto convent, Land Bank and City Hall. Instead of looking at this site for public uses like museum and galleries, it is efficient to look at the site and its new use as an effort towards re-adaptation and continuation of its original industrial functions. The site covers approximately 7.5 acres with the adjacent vacant site (across Minnaar Street to the south) covering approximately one acre.

The Pretoria State Garage is an industrial site comprising of stores, workshops and offices spaces. Le Roux (1993:22 and 57) describes the site as:

- Economically viable and requires rehabilitation.
- Physically good for restoration.
- Typologically important.

Figure 7: Aerial photo of the southwest quadrant of Pretoria (source: Tshwane Municipality)

3.5.2 Marabastad and Asiatic Bazaar

Marabastad became the first African settlement in Pretoria, which came into existence in August 1888. The settlement was named after Chief Maraba who had served as a translator for the Landlord of Pretoria. It was evacuated in 1940 as a result of the reallocation processes of the then Local Authorities (Freidman, 1994:25). The ***Asiatic Bazaar*** is situated south of Marabastad. It was also established in the late 19th century, for the settlement of the growing Indian population in Pretoria (Freidman, 1994:37).

Marabastad (figure 8) is characterised by a fine-grained urban fabric with distinct zones (not legally defined), that affords a convenient way to describe the area (Meyer *et al.* 1999:45):

- *The Asiatic Bazaar* is located within DF Malan West, Struben Street, Steenhoven Spruit Street and the railway line. The area is the main Indian trading area and part of the Central Business District of Pretoria. It has been in existence for almost a hundred years and is predominantly occupied by retailers and wholesalers. The area comprises of undeveloped pieces of land, with limited entertainment and religious activities. The western part, formally housing schools, comprises of filling station, government buildings and vacant land.

- The *Belle Ombre Station Precinct* is located east of township Asiatic Bazaar Extension 1 and north of Boom Street. The area comprises of the Belle Ombre Train Station, bus terminal, and Boom Street Taxi Rank.

- The *eastern and southern-eastern quadrant* is an area situated south of the Belle Ombre Station Precinct and east/south-east of the Asiatic Bazaar. It was traditionally designated for 'white' Central Business District or inner city of Pretoria. This area is of a mixed-use zone made up of businesses, light industries, high-rise buildings, flats and vacant properties.

- The *southern and southwestern quadrant* is an area situated south of the Asiatic Bazaar. It comprises of municipal depots and workshops to the south of Struben Street and the Heroes`Acre Cemetery and a national monument on the northern side of Church Street. There is also a tennis club located to the northeast of the cemetery.

The present picture of the area reflects an immediate need for redevelopment. Marabastad constitutes of properties that hold historic, typological, architectural and social context (Le Roux, 1991:19):

- Buildings with outstanding qualities which can easily be restored
- Buildings conserved or to be conserved within their typological context
- Properties to be redeveloped for complete image of the area.
- Present/previous shopping malls or squares which through redevelopment can assist the total image of the area.
- Small new buildings, which already contribute to a better image of the area.

3.5.3 Pretoria West

Pretoria West (figure 8) was laid out in 1892 after the 1890 establishment of the residential areas of Arcadia, Sunnyside and Les Marais and later followed by Muckleneuk, Mayville and Goedehoop in 1893, 1896 and 1897 respectively.

In 1909 the first factory was erected in Pretoria West. During the 1950s various areas, including Pretoria West, a portion of the farm Daspoort 319-JR, industrial townships Koedoespoort, portions of Hermanstad, Silverton and Booysens, as well as a number of stands in Pretoria Central were zoned for industrial purposes (Rossouw, 1984:12).

As a result of the uncoordinated nature of earlier development, industrial development in Pretoria was initially scattered in and around the city.

Apart from smaller industrial areas, industrial development within the municipality area of Pretoria was, at the end of 1979, predominantly concentrated in a few areas (Rossouw, 1984:30):

- The Booysen-Daspoort-Hermanstad-Zandfontein area to the north-west of the city centre
- The Pretoria North area.
- The Koedoespoort-Silverton-Waltloo-Crysler Park area to the northeast of the city.
- Certain parts of Pretoria Central.
- The Pretoria West industrial area which links up with the ISCOR works.

The three sites offer competitive spaces with common characteristics but also significant variations that will influence the ultimate selection. The selection of the Pretoria State Garage is based upon the following considerations:

- The Pretoria State Garage is an industrial type building that is consistent with the general Pretoria Technology Park building configuration requirements. The site offers minimal accommodation space for the park. Its buildings are in physically good condition and provide the rehabilitation process with the least renovation cost and high future returns. This is a major advantage as compared to the other two sites, which are relatively larger and possibly require more expenditure for renovation.
- The site is located within a singular 7.5 acres block, which requires minimal urban re-zoning intervention as compared to alternative sites. This study focuses specifically on the rehabilitation of an existing property in order to accommodate a technology park that is actively involved in trade activities rather than urban zoning.
- The site is confined to one building block, which offers the advantage of better control and accessibility.

The Pretoria State Garage site has a potential to retain and continue with the traditional manufacturing character of the southwest quadrant of the city. Its building configuration offers competitive spaces suitable specifically for the Pretoria Technology Park and for possible future extensions and alterations. This excludes zones for housing or large recreational sites for sports and cultural activities, which might need to be included in the two alternative sites.

The above-defined characteristics thus should, for possible implementation, conform to the criteria set by local urban design regulations, which will address issues such as land use, typology and forms of buildings, zoning, development phases and town planning (Komninos, 1996:237).

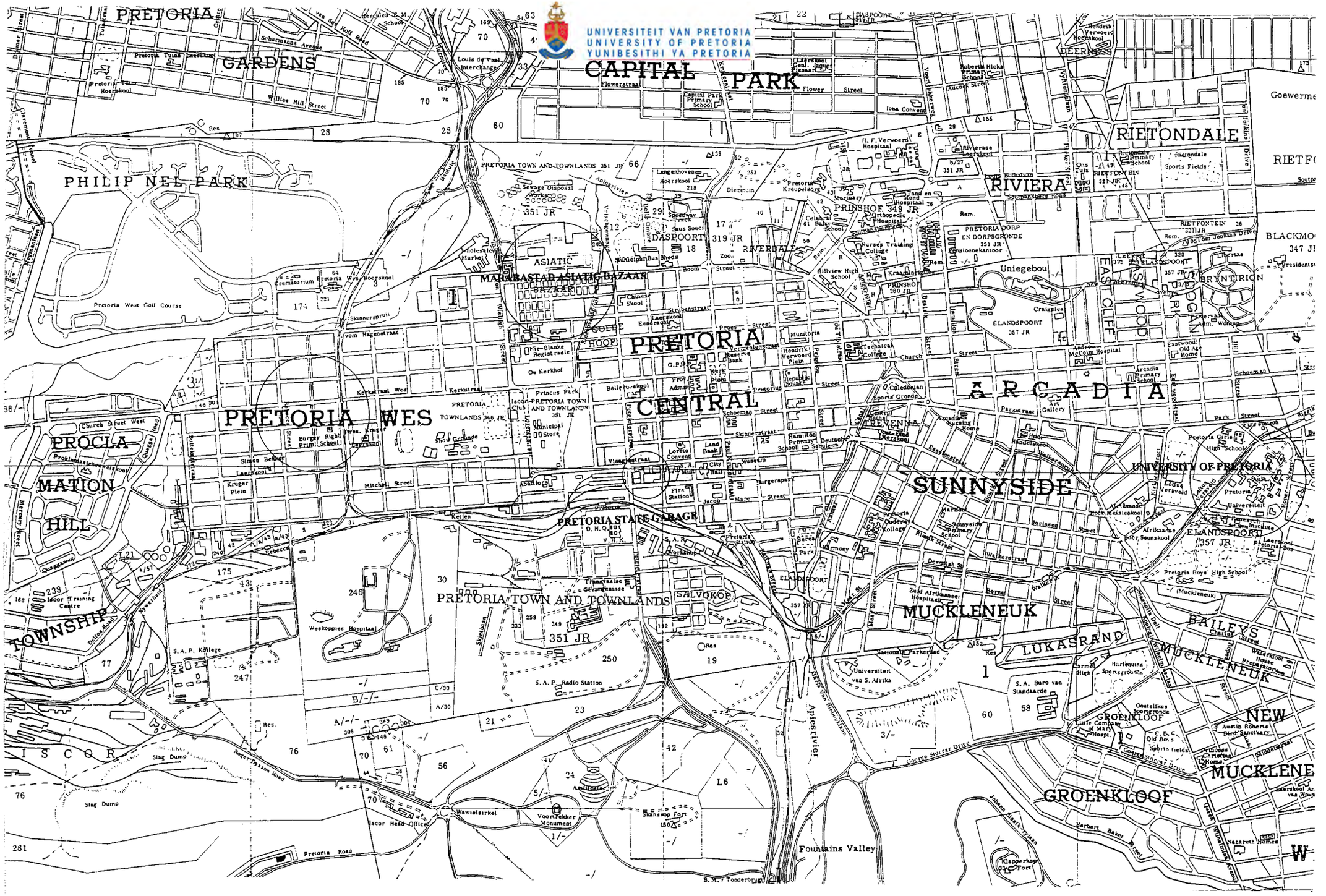


Figure 8: Pretoria City Plan (Source:Tshwane Municipality)

3.6 Conclusion

This section consequently establishes a preliminary corporate network involving major role players in an effort to promote technology transfer. This network emerges as an establishment meant to address issues of technology transfer in the manufacturing sector in Pretoria. Most technology parks are unique in their orientation because of the role they play in addressing technological issues unique to their respective regions. The Pretoria Technology Park's unique character is based on its objective to provide technological innovation to the local manufacturing industry. This industry is divided into two distinct groups, one from the well-established high tech industry and another from the traditional manufacturing companies in the previously disadvantaged communities. The uniqueness of this initiative is based on the ability to bridge the gap between the two industries and provide with technological innovations that will make both industries competitive.

Another study can be carried out in order to investigate the full potential of the Pretoria West and the Marabastad and Asian Bazaar sites in accommodation similar initiatives. The two sites are likely to incorporate residential zones and accompanying services such as banks, posts, transportation and sporting and recreational facilities. This would have a positive and revival impact to the land-use planning in the respective areas.