SWP 11/89   DEFINING A SCIENCE PARK

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The first part of this paper discusses whether the Science Parks are a topic worthy of study in terms of being either a new and/or a recent growth phenomenon. The second part outlines the reasons for the existence of the Science Parks and presents the relationship between "triggers", sponsors and aim(s). The third part discusses the confusion surrounding the defining of the Science Parks and presents a summary of the literature by grouping the attributes of the Science Parks and related locations (Research Parks, Innovation Centres, Technology Parks and Business Parks). The last part of this paper presents the results of empirical research assessing the accuracy of the literature findings.

SCIENCE PARKS: A NEW AND/OR A RECENT GROWTH PHENOMENON ?

Science Parks are not a new phenomenon. The first Science-based Park was established in 1951 in the USA (Stanford Industrial Park) and 1972 in the UK (Cambridge Science Park). Nevertheless, this paper argues that the Science Parks are still a subject worthy of investigation as recent findings have provided evidence of their rapid growth characteristics. For example:

1.The number of operational locations in the UK has increased from 2 before 1982 to 33 in 1987 (Monck et al (1988,80)). Furthermore, this total had increased to 38 by

Sept. 1988 (Broadhurst 1988). The number of firms sited on UK locations have increased from 412 to 642 between Dec 1986 - Feb 1988 with employment increasing from 6,311 to 7,642 (Rowe (1988)).   By Sept. 1988 these totals had increased to 730 firms with 8,900 employed (Broadhurst 1988).

2.The number of Technopoles in France have increased from 3 to 8 between 1980 - 1985 with employment totaling 10,000 (Sunman (1986,11)).

3.The number of Innovation Centres in West Germany have increased from 0 to 18 between 1980 - 1985 with 300 firms employing 3,000 (Sunman and Lowe (1986,3)).

4.In 1964 the Research Triangle Park, USA had 5 firms employing 765 staff. By 1981 it had 35 firms employing 20,000 (Crompton (1984,46)).

REASONS FOR THE EXISTENCE OF THE SCIENCE PARKS.

"TRIGGERS".

A survey of the literature (table 1) identified 6 potential "triggers" which it is suggested have led to the general existence of the Science Parks. A "trigger" is defined as the reason for the initial consideration of a Science Park.

The most commonly identified "triggers" include university / industry linkages, regional unemployment and

UGC reductions.

Table 1 The "Triggers" of a Science Park

	University Industry Linkages	Regional Unemployment	UGC Reductions	Gain experience of high-tech firms	Bandwaggon Effect	Image
Allen (1986,33,34)		YES	YES			
Caulcott (1987,89)		YES				
Currie (1985,6,28,35)		YES	YES			
Jones and Dickson (1985,33)			YES			
HOCBP (1983,3)	YES					
Lowe (1985,4,35,36)	YES					
Monck et al (1988,3,77-79)	YES	YES	YES		YES	
Rowe (1987)				YES		YES
Segal (1982,8)						
Segal Quince W (1985,19,35)	YES					
Segal (1986,19)			YES			
Shattock (1985,143)		YES				
Storey (1987,36)						
Taylor (1984,74)	YES					

"To gain experience of high-technology firms" is the desire or willingness of the sponsor(s) to understand the high-technology firms' growth and consequent funding requirements. Keeble and Kelly (1986,89) found that new technology based firms exhibit a faster rate of growth

compared with other small firms. Bullock (1985,2) considers the life-cycle of a high-technology firm in terms of a "hardening" process. An example is a firm developing from a software consultancy to a hardware manufacturer. The desire to join the "bandwaggon" is the willingness of the sponsor(s) to initiate a Science Park as a response to the existence and/or growth of other locations. For example, a University may be "pushed" into considering a Science Park development as a response to a near "neighbour" possessing one. Sir Frederick Crawford (Aston), Mike Shattock (Warwick) and Tony Pender (English Estates) were influenced by the experience of the United States as well as the Bursar of Trinity College whom had established the Cambridge Science Park (Monck et al 1988,79). "Image" is defined as the "cosmetic" effect sponsor(s) may obtain by being associated with a Science Park. For example, it may improve the high-technology image of a major clearing bank (Rowe 1987).

An analysis of the literature suggests that the "triggers" have a time dimension and consequently may relate to particular economic circumstances. For example, the desire for linkages between Universities and Industry may have been "triggered" by a Wilson Government circular (1966) requesting closer cooperation between the two. This was called "the forging of the White Hot Technological Revolution" (Taylor (1984,74)). Another time "trigger" may

be (1979) for increasing regional unemployment. For example, the unemployment rates in the West Midlands (Aston and Warwick Science Parks) and Strathclyde (West of Scotland Science Park) stood at 16.5% and 17.1% respectively by 1982 (Shattock (1985,143)). Allen (1986,33) discusses the need for Clwyd (Newtech Science Park and Innovation Centre) to revitalise the industrial infrastructure of the region as a response to various closures including Shotton Steelworks and Courtaulds which had left 19% unemployed. A further time "trigger" may be (1981) for University Grants Committee (UGC) reductions. In 1981 it was announced that some of the newer technical Universities (Aston, Bradford, Salford) would suffer grant support reductions of up to 44 percent (Jones and Dickson (1985,33)). At the University of Keele the UGC allocations in 1986/87 had decreased in real terms by 35.7% compared with 1980/81 (THES 13/6/86). This paper suggests that the "bandwaggon" effect is likely to be a recent "trigger" as a response to the recent rapid growth of other locations.

SPONSORS.

The survey identified 6 groups of sponsors of the Science Parks. These include Regional Development Agencies (RDA's), Local Government, University / HEI, Private firms, Banks and Property Developers (UKSPA,1988). The prime sponsor is defined as the body whom initially proposed /

considered the location. The earliest locations, for example, Cambridge Science Park (1972) and Heriot-Watt Research Park (1972) have only single sponsors and are University based initiatives (UKSPA,1988). However, of the 31 operational locations opened between 1982-1987, 23 (74%) have mixed sponsors (UKSPA,1988).

AIMS.

Table 2 The Aims of the Science Parks

Types of Objectives	Economic							Social	Economic and Social			
	Technology Transfer	Change Industrial Infrasructure	Employment Generation	Company formation Growth	Financial Return on Land	University Active Role In Commun	University Improve Image	University linkages with La/HEI	Academic spin-offs	Change University Culture	Enterprise Culture	Improve Academic Courses
Baker (1982,5)	Yes											
Bolton (1987,80)			yes									
Bond (1985,130)		YES										
Crompton (1982,46)				yes		yes						
Currie (1985,4,35-38)		YES		yes	yes	yes						yes
Dalton (1985,233,235)										yes		yes
Danilov (1967,78)			yes									
Debenham TC (1983,1)		YES										
DTI/Shell (1982,46)	yes											
Henneberry (1984,306)				yes								
Lowe (1984,4,8,27)	yes	YES							yes			
Lowe (1985,32,111,112)		YES			yes				yes	yes		
Macdonald (1987,32)									yes			
Monck (1985,125)						yes				yes		
Monck (1986,2,5,12,14)				yes			yes					
Monck (1987,11)			YES									
Monck et al (1988,167,168,247)	yes	YES	yes						yes			
Nicholl (1986)						yes						
Oakey (1984,56,155)			YES							yes		
OECD (1984,8,9,51)	yes											
Roberts and Weiner (1968,78)										yes		
Rimmer (1986,55,56)				yes								
Rowe (1986,41)	yes											
Segal (1982,16)					yes							yes

The literature suggests that the Science Parks may have a wide variety of aims (table 2). In order to simplify the literature findings, this paper classifies the aim(s) as economic and/or social. For example, technology transfer, changing the industrial infrastructure and providing a financial return on the land are economic objectives. On the other hand, the University / HEI being seen to play a more active role in the local community is a social aim and this may be particularly important at a time of high local unemployment. Academic spin-offs are classified as being both economic and social aims. For example, it may provide additional income and employment opportunities (economic aims) as well as fulfilling the personal ambition of the academic (social aim).

From the literature a number of hypotheses are developed by relating the "triggers" to the sponsors and the aim(s) to the "triggers" and sponsors.

Hypotheses Relating "Triggers" to Sponsors. This paper argues that the "triggers" can be related to particular sponsors. For example:

1.The desire to achieve linkages between the Universities and Industry and UGC reductions are "triggers" for the University / HEI (table 3).

2.Regional unemployment is a "trigger" for the Regional Development Agencies, Local Government and Property

Developers (English Estates).

3.The desire "to gain experience of high-technology firms" is a "trigger" for the Private firms (Prudential) and the major clearing banks.

4.The "bandwaggon" effect and the desire to improve "image" are "triggers" for all sponsors.

Table 3 Relating "Triggers" to Sponsors

Sponsors	Regional Development Agencies	Local Government	University Polytechnic HEI	Private Firms	Banks	Property Developers
Triggers						
University-industry links			YES			
Regional unemployment	YES	YES				YES
UGC reductions			YES			
Gain experience of high-tech firms				YES	YES	
Bandwaggon effect	YES	YES	YES	YES	YES	YES
Image	YES	YES	YES	YES	YES	YES

Hypotheses Relating Aim(s) to "Triggers" and Sponsors. This paper suggests that the aim(s) of the Science Parks can be related to the "triggers" and sponsors. For example, the aim of a particular location would be a change in the industrial infrastructure if its "trigger" was increasing regional unemployment. Its sponsors would be either one or a combination of Regional Development Agencies, Local

Government and Property Developers (English Estates).
Broadhurst (1988) related the aim(s) of the Science Parks to
sponsors and argues that the aims of a particular location
would be property development and technology transfer if its
sponsor was a University / HEI.

The relationship between "triggers", sponsors and
aim(s) is shown by the "effectiveness" loop (figure 1).

Figure 1 The "Effectiveness" Loop.

"Triggers"
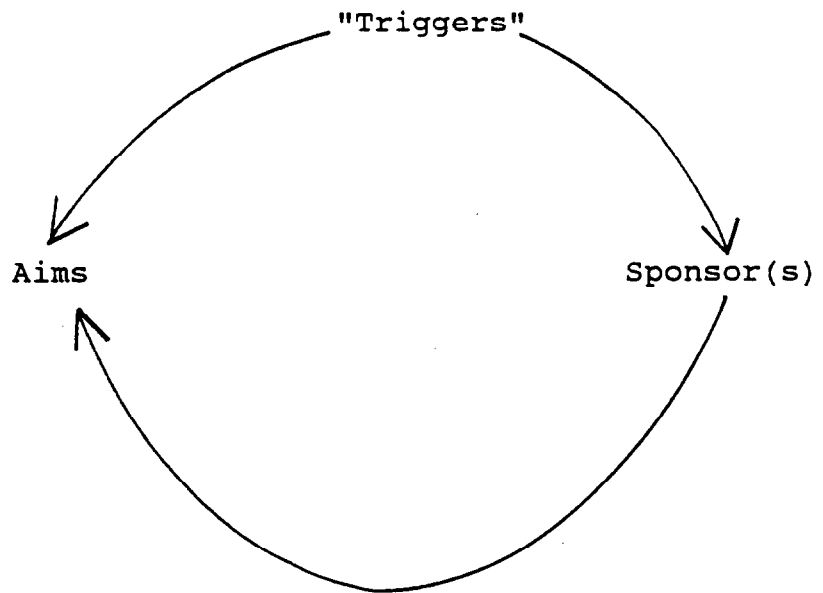
Aims   Sponsor(s)

S = f(T).

A = f(S).

A = f(T).

where -

        S = Sponsors

        f = function of

        T = "Trigger"

        A = Aim(s)

The figure shows that the sponsors are a function of

"triggers" and the aim(s) are a function of both sponsors and "triggers". Consequently, it is concluded that in order to understand the "effectiveness" loop it is necessary to :

1. Identify the "triggers". (and relate to -)
2. Identify the prime sponsors. (and relate to -)
3. Identify the aim(s).

However, a particular methodological problem found for any empirical study is that 23 of the 33 operational locations have mixed rather than single sponsors (UKSPA Feb 1988). Consequently, individual locations may have more than one aim and it may not be possible to apply the "effectiveness" loop. Furthermore, where locations have mixed sponsors it may be difficult to identify the prime sponsor ie. the sponsor whom initially proposed / considered the location. In addition, the initial time "trigger" may be "hidden" as there may be a long gestation period between the initial consideration of a Science Park and the time needed to become fully operational. For example, at Surrey Research Park the initial idea was conceived in 1979 but it took five years before construction on phase 1 began (Parry 1988).

This paper concludes that the Science Parks are a topic worthy of further investigation in terms of being a recent growth phenomenon and having a wide variety of economic

ble 4 The Comparison of a Science Park related Locations
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|	Spectrum of Schemes	Research Park	Research Centre	Science Centre	Innovation Centre	Technology Park	Technopark	Business Park	High Technology Development	High Technology Estate	Industrial Estate	Real Estate Development
ompton (1984,9)										YES		
oss (1982,434)											YES	
rrie (1985,1)												YES
I/Shell (1982,42)		YES				YES	YES					
nneberry (1984,27)	YES											
use of Commons Paper(1983,7)										YES		
cdonald (1987,25)		YES	YES	YES	YES	YES						
nck et al (1988,62)		YES				YES	YES	YES				
reton Smith (1984,5)										YES		
rry (1982,3)										YES		
oks (1988,58)								YES				
gal (1982,4)		YES				YES	YES					
omson (1984,76)											YES	
SPA (1986,1)		YES			YES				YES			

and/or social aim(s). The next part attempts to establish the total population of the Science Parks in the UK by the defining of the Science Parks.

REVIEWING SCIENCE PARK DEFINITIONS: IS THERE CONFUSION ?

From a survey of the literature a total of 83 definitions of the Science Parks and related locations were found. Table 4 presents a summary of the 83 where the term Science Park has been used interchangeably with related locations. For example, it has been compared as a Research Park, Research Centre, Science Centre and Technology Park (Macdonald (1987,25)). Table 5 shows that the 41 members of the United Kingdom Science Park Association (UKSPA Feb 1988) classify themselves (in their title) according to 15 different names ranging from a Science Park to a Research Park, Innovation Park, Technopark, House, Centre and Technology Enterprise Centre.

Table 5 The UKSPA Classification of Locations
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	Total
Science Park	14
Research Park	3
Innovation Park	3
Technopark	1
Technology Park	3
Research Centre	3
Innovation Centre	2
Technology Centre	4
Technology Enterprise Centre	1
Business Technology Centre	1
Technology Exchange	1
Centre	2
House	1
Industry Link	1
Business Enterprises LTD	1
	==
	41
	==

Source (UKSPA Feb 1988).
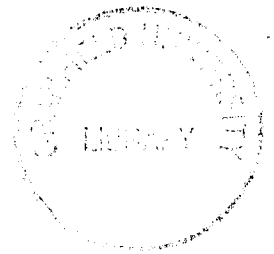
WHY IS THERE CONFUSION ?

It has been suggested that confusion has arisen because there is no widely accepted definition of a Science Park (Macdonald (1987,25)) and the term does not exist in planning law (Tweddle (1980,254)). Sanders concluded at the 3rd UKSPA Conference (Feb 1988) -

"my main message today is that there is no single solution in the provision or definition of Science Parks".

The term may have been confused because it combines all the best images for property development (Bullock (1983,9)). This paper suggests that the words "Science" and "Park" may signify a synergistic association between the needs of Science-based industry and skilled labour and consequently may act as a "pull" factor attracting firms and labour to a particular location. Consequently, it is likely that the term will continue to be abused (House of Commons Background Paper (1983,7)).

As there was confusion in the literature it was necessary to construct a definition in order to define a sampling frame of the Science Parks. This would enable a sample to be chosen for the purpose of a wider study investigating networking.

CONSTRUCTING A DEFINITION.

In order to simplify the literature findings a definition was constructed from the grouping of the Science Park

attributes.   Attributes were grouped according to: the
physical attributes of buildings and land; the managerial
attributes of management, sponsors and rules and regulations
governing the operation of the location; and firm
attributes.   As the literature review also identified the
attributes of related locations (Research Parks ,
Innovation Centres, Technology Parks and Business Parks),
the findings for all locations were compared to find any
overlaps and distinct differences.

Physical Attributes.   Tables 6-7 present a summary of the
literature which has mentioned the physical property
attributes of buildings and land.

Table 6 The Building Attributes of a Science Park
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	Physical Property Development	Mixed use premises	Enables changing Property requirements
Carter and Watts (1984,4)		YES	
Debenham TC (1983,16,20,24)		YES	YES
Eul (1984,51)		YES	YES
Henneberry (1984,25,27)	YES		
Herring Son Daw (1984,19,26)		YES	
Macdonald (1987,25)	YES		
NDCF (1983,8)		YES	
Segal (1982,3)	YES		
Taylor (1984,75)			
Worthington (1984,61)		YES	YES

The building attributes are mainly a physical property development which caters for mixed uses under the same roof. The National Development Control Forum (1983,8) suggests that it is important that buildings allow for mixed use activities as the amount of floorspace allocated to research, development, production and storage can change cyclically. Furthermore, the buildings should facilitate changing property requirements as 19 percent of all Science Park firms expanded their property during 1985-1986. In addition, 61 percent of expanded firms had a 300 percent property expansion (Monck et al (1988,97)).

Land attributes include a location with land which is on or within close proximity to a University / HEI and has a low density (low ratio of buildings to land). The ratio of buildings to land at Cambridge Science Park is approximately 1:6 compared with 1:2 on a conventional industrial estate (Segal Quince Wicksteed (1985,42)). Furthermore, the literature suggests that the locations are usually situated in an attractive park-like environment and have a high quality of design and landscaping. The layout should take advantage of the natural amenities of the site - trees, ponds and hedgerows (Herring Son and Daw (1982,27)). In addition, Currie (1985) suggests that the location must have the potential for expansion. Tweddle (1980,255) argues that a Science Park should not be less than 150 acres for it to be able to give maximum benefit. However, locations are

much smaller than this. For example, Aston and Warwick Science Park locations are 22 and 42 acres respectively (Financial Times Surveys 1983-1987).

Table 7 The Land Attributes of a Science Park
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	On or close proximity to University	Low Density	Attractive Park-like Environment	Quality of Design Landscape	Potential for expansion
Brook (1982,180)		YES		YES	
Crompton (1984,9)	YES	YES		YES	
Currie (1985,1,12,29,41)	YES			YES	YES
Dalton (1985,233)			YES		
Debenham TC (1983,7,20,98)				YES	
DTI/Shell (1982,6,50)	YES	YES	YES	YES	
Eul (1985,164,167)	YES	YES	YES		
Henneberry(1984,25)		YES	YES	YES	
Lowe (1984,13,18,24,35)	YES	YES			YES
Macdonald (1987,25)	YES				
NDCF (1983,4)	YES				
Salesbury (1984,13)		YES		YES	
Segal (1982,3,13)	YES	YES	YES	YES	
Segal Quince W (1985,42,176)	YES	YES	YES		
Taylor (1984,75)	YES				
Trinity College (1983,19)	YES	YES		YES	
Tweddle (1983,35)	YES	YES		YES	
Tweddle (1984,38)	YES	YES	YES	YES	
Worthington (1982,38)	YES				

<u>Managerial Attributes</u>.   The managerial attributes mentioned in the literature include management, sponsors and rules and regulations governing the operation of the location.

The literature suggests that the management is engaged in a variety of functions which include providing managerial support to firms and supervising building works (Shattock (1985,144)).   The management of individual locations vary in terms of whether they are on-site or off-site, size (number of support staff), skills (whether for instance, marketing and financial planning assistance is provided) and the availability of venture capital (Science Park brochures). There is overall agreement that locations have single or mixed sponsors and operational links with a University / HEI (table 8).

Table 9 suggests the variety of rules and regulations attributes governing the operation of the location to be a selective entry criteria which may include an assessment of the technological content of the firms' products (Monck (1985,129)).   Other attributes may be flexible planning permission allowing mixed use activities.   Flexible tenancies (short, medium and long term) are especially important in view of the firms' changing property requirements.   Eul (1985) suggests that on a Science Park location, conventional production and office activities are excluded.

Table 8 The Sponsors
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	Mixed Sponsors	Operational links with Univ./HEI	University related development	Private	Central Government	Local Authorities	Development Agencies
Carter and Watts (1984,3)		YES					
Currie (1985,1,17,33,38)		YES	YES	YES	YES		
Debenham TC (1983,20)		YES					
DTI/Shell (1982,6)		YES					
Eul (1985,164)		YES					
Henneberry (1984,25)		YES					
Herring Son Daw (1984,19)		YES					
Lowe (1984,13,31)		YES					
Monck (1986,6)				YES			
Monck et al (1988,84-87)				YES	YES	YES	YES
Moreton Smith (1984,5)			YES				
NDCF (1983,4)		YES					
Parry (1982,3)		YES					
Planning (1982,9)		YES					
Rowe (1988,2)				YES			
Salesbury (1984,13)		YES					
Segal (1982,3)		YES					
Taylor (1984,75)		YES					
Trinity College (1983,19)		YES					
Tweddle (1983,35)		YES					
Tweddle (1984,38)		YES					
Worthington (1982,38)		YES					
UKSPA (1986,1)	YES	YES					

Table 9 The Rules and Regulations Attributes on a Science Park

	Selective entry criteria	Flex. Planning permission mixed use	Flexible tenancies	Conventional production excluded
Carter and Watts (1984,31)			YES	
Currie (1985,1,2,12)		YES		
Eul (1985,51,164)		YES	YES	YES
Henneberry (1984,25,50)		YES		YES
Lowe (1984,50)	YES			
Monck (1985,127,129)	YES	YES		
Monck (1986,7)			YES	

Firm Attributes.

Table 10 presents a summary of the literature which has identified the attributes of firms.

Table 10 The Firm Attributes of a Science Park

	Collection of high-technology firms	At all stages of development	Caters for the starter firm	A high level of research	A low level of manufacturing
Brook (1982,180)				YES	
Carter and Watts (1984,3)		YES	YES		
Crompton (1984,9)	YES				
Currie (1985,1)		YES			
Herring Son and Daw (1984,19)				YES	YES
Lowe (1984,13)	YES				
Moreton Smith (1984,5)				YES	YES
Parry (1982,3)					YES
Trinity College (1983,19)	YES				
Tweddle (1983,35)	YES				
Tweddle (1984,38)	YES				

It is clear from the table that the attributes consist of a collection of high-technology firms which are at all stages of development. Monck et al (1988,129)) defines high-technology in terms of all firms located on Science Parks even though Monck (1986,11) found that 10 percent of firms provide financial and business services. Henneberry (1974,26) defines high-technology in terms of the industrial classification of firm activities. These classifications include Scientific and Industrial Instruments, Electrical Engineering and other Professional and Scientific Services. The stage of development of firms range from an independent single site company to a subsidiary or branch of a UK company and a unit, department or subsidiary of a University (Monck (1987,8)). Furthermore, the location may cater especially for the starter firm. This may be shown by the provision of incubator facilities such as communal telephone answering and typing services. Moreton Smith (1984,5) suggests that firms may undertake a high level of research and a low level of manufacturing.

The following analysis presents a summary of the literature which has identified the attributes of related developments, for example, Research Parks, Innovation Centres, Technology Parks, and Business Parks. Owing to a lack of data it was not possible to use the same groupings as were used for the Science Parks.

DEFINING A RESEARCH PARK

Table 11 presents a summary of the literature which has identified the attributes of a Research Park. It is observed that there are overlaps with the Science Parks particularly with regard to the land attributes. A Research Park may also be on or within close proximity to a University / HEI and have a low ratio of buildings to land. Furthermore, it may be situated in an attractive park-like environment which has a high quality of design and landscaping.

DEFINING AN INNOVATION CENTRE.

From the literature findings (table 12) it is observed that overlaps with the Science Parks may include the location being on or within close proximity to a University / HEI and flexible tenancies. However, distinct differences may be that an Innovation Centre is situated in an Industrial Building and is a development within a restricted space which consequently offers limited opportunity for expansion. Furthermore, there may be more emphasis than firms located in Science Parks upon the development of inventions into commercial products.

Table 12 The Attributes of an Innovation Centre
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	Industrial Building	On or close proximity to University	Within a restricted space	Limited for expansion	Flexible tenancies	Caters for the starter firm	Devel. of inven. into a commer. product
Currie (1985,1)			YES	YES		YES	
Debenham T C (1983,16)	YES	YES				YES	YES
Eul (1984,52)						YES	YES
Eul (1985,163)		YES			YES		
Lowe (1984,16)							Yes
Monck et al (1988,69)						YES	
Taylor (1984,75)		YES					YES
Worthington (1982,37)	YES	YES				YES	

DEFINING A TECHNOLOGY PARK.

In a Technology Park academic involvement may not be essential and there may be more emphasis on production as the entry criteria may allow small and medium sized manufacturing units. However, from table 13 it is observed that overlaps may occur with the land attributes and both may have a collection of high-technology firms which need mixed use activity premises.

Table 13 The Attributes of a Technology Park
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	Mixed use premises	On or close proximity to University	High quality of design and landscaping	Collection of high-technology firms	Emphasis on production	Academic involvement not essential	Campus li› atmospher‹
Debenham T C (1983,20)		YES	YES	YES	YES		
Lowe (1984,15)	YES				YES	YES	
Lowe (1985,31)	YES				YES	YES	
SRI/GLC (1980,16,157)				YES	YES		YES

DEFINING A BUSINESS PARK.

From table 14 it is observed that similarities with the Science Parks may include a location of low density which allows for mixed use activities. However, distinct differences may be that a Business Park is not required to be on or within close proximity to an academic institution and may allow mass production activities. Furthermore, there may be no on-site research and development facilities.

Table 14 The Attributes of a Business Park
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	Mixed use premises	Low Density	Not close proximity to University	Mass production	No research or development facility
Debenham T C (1983,20)	YES		YES		
Eul (1985,164)		YES		YES	YES
Lowe (1984,18)	YES		YES		
Thomson (1985,75)	YES				
Worthington (1985,75)	YES		YES		

CONCLUSIONS FROM THE LITERATURE REVIEW.

This paper concludes that there is general agreement in the literature as to the similarity in the attributes of the Science Parks as compared with related locations despite the confusion in the names. However, owing to a lack of data the classification of attributes relating to Research Parks, Innovation Centres, Technology Parks and Business Parks was

less exhaustive than that for the Science Parks.

For the purposes of this research a Science Park is defined as a physical property development which has mixed use premises and enables changing property requirements. It is on or within close proximity to a University / HEI and is of low density (low ratio of buildings to land). It is situated in an attractive park-like environment and has a high quality of design and landscaping. A Science Park has the potential for expansion. It has a management which is engaged in a wide variety of functions and has single or mixed sponsors. A Science Park contains a collection of high-technology firms which are at all stages of development. It caters for the starter firm. Firms on Science Parks undertake a high level of research and a low level of manufacturing.

The next part of this paper attempts to assess the accuracy of the constructed definition by a comparison with actual locations.

EMPIRICAL RESEARCH.

The purpose of the empirical research was to answer the following research questions.

1.Is the definition of the Science Parks constructed by the grouping of the Science Park attributes found from the

literature review accurate with a comparison of actual locations ? Conversely, are there distinct differences between locations possessing some or all of the attributes ?

2.Are there any similarities and distinct differences between the Science Parks and related locations (Research Parks, Innovation centres, Technology Parks and Business Parks) possessing some or all of the attributes ?

METHODOLOGY.

1.A questionnaire was constructed from the grouping of attributes identified from the literature survey. Questions were predominantly closed-ended. For example, did the location have the particular attribute or not ?

2.A postal survey was conducted of the 33 operational members of the United Kingdom Science Park Association (UKSPA Feb 1988). Postal questionnaires were sent to the persons designated as contact points by UKSPA. Their titles range from Science Park Director, Managing Director, Marketing Director and General Manager, Chief Executive, Executive Director, Senior Bursar and Acting Chief Estates Surveyor.

3.A follow-up postal survey was undertaken of the locations whom had not replied.

4.In order to analyse the data, locations with similar titles were grouped. For example, a Research Park was grouped with a Research Centre and an Innovation Park was

grouped with an Innovation Centre. Finally, a Technology Park was grouped with a Technopark, Technology Centre, Technology Enterprise Centre, Business Technology Centre and Enterprise Centre.

5.The chi-square statistical technique was used to analyse the data. In order to apply the technique the data was grouped.

FINDINGS.

1.Response Rate. 27 completed questionnaires were returned representing an 82 percent response rate. However, 1 reply included data relating to a second location which was at the advanced planning stage. A further location informed the researcher that the University had discontinued its Science Park venture. Consequently, 29 out of 34 possible responses were received representing an 85 percent actual response. 24 replies indicated that they wished to have feedback of the results.

Table 15 shows the number of replies received.

Table 15 The Number of responses from each Location
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	Total
	=====
Science Park	12
Research Park	4
Innovation Park	1
Technopark	1
Technology Park	1
Research Centre	3
Innovation Centre	2
Technology Centre	2
Technology Enterprise Centre	1
Business Technology Centre	1
Technology Exchange	0
Centre	0
House	0
Industry Link	0
Business Enterprises LTD	0
Enterprise Centre	1

Although only 3 locations classified themselves (in their title) as a Research Park (table 5), 4 gave this classification. This may be as a result of the study asking for the term which most appropriately described their location rather than for its actual title. The location at the advanced planning stage was described as a new term - an Enterprise Centre. As no replies were received from locations classifying themselves as Business Parks, a comparison could not be made with the literature findings.

2.Similarities within the Science Park locations. Table 16 compares the attributes identified within the Science Park locations. The table shows a high level of agreement in terms of the Science Parks having the attributes identified from the literature survey.

Table 16 Science Park Attributes compared with related Locations
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	Science Park		Research Park		Innovation Centre		Technology Park	
	YES	%	YES	%	YES	%	YES	%
A Physical Property Development?	10	90.9	7	100.0	3	100.0	7	100.0
Mixed use activities?	10	90.9	2	28.6	3	100.0	7	100.0
Changing property requirements?	10	90.9	6	85.7	2	66.7	5	71.4
On or close proximity to University?	11	100.0	7	100.0	3	100.0	6	85.7
Low Density?	11	100.0	7	100.0	3	100.0	5	71.4
Attractive Park-like environment?	10	90.9	7	100.0	3	100.0	6	85.7
High quality of design?	11	100.0	7	100.0	3	100.0	7	100.0
Potential for expansion?	10	90.9	7	100.0	2	66.7	4	57.1
Manangement has variety of functions?	10	90.9	6	85.7	3	100.0	5	71.4
Mixed Sponsors?	8	72.7	3	42.9	2	66.7	4	57.1
Operational links with University?	10	90.9	7	100.0	3	100.0	7	100.0
Selective entry criteria?	11	100.0	7	100.0	3	100.0	7	100.0
Flexible planning permission?	7	63.6	2	28.6	2	66.7	6	85.7
Flexible tenancies?	11	100.0	7	100.0	2	66.7	5	71.4
Conventional production excluded?	8	72.7	7	100.0	2	66.7	2	28.6
Collection of high-technology firms?	11	100.0	7	100.0	3	100.0	7	100.0
Firms at all stages of development?	11	100.0	6	85.7	2	66.7	6	85.7
Caters for especially the starter firm?	4	36.4	3	42.9	2	66.7	5	71.4
High level of research?	10	90.9	7	100.0	2	66.7	5	71.4
Low level of manufacturing?	9	81.8	3	42.9	2	66.7	4	57.1

10-11 (90.9%-100%) locations indicated that they had 15 out of the 20 attributes. Individual replies clarified these findings. For example, 1 location claimed that it was on or within close proximity to a University / HEI as it was within 150 metres of the Science and Technology Laboratories. Furthermore, the location was situated in an attractive park-like environment as it was set in woodland with a pond at the rear. Its selective entry criteria included all applications being vetted for financial, commercial, legal and technical conditions. Another location added that its flexible tenancies included 21 years with 3 year break-clauses. However, shorter tenancies were allowed subject to a premium. 1 reply clarified a collection of high-technology firms in terms of having firms in the biotechnology and instrumentation activities. Nevertheless, only 4 (36.4%) locations indicated that they catered especially for the starter firm and only 7 (63.6%) indicated that they had flexible planning permission allowing mixed use activities. 8 (72.7%) indicated that they had mixed sponsors and that conventional production was excluded.

3. <u>Similarities within related locations</u>. Tables 17-19 compare the attributes identified within related locations. From table 17 it is observed that there is almost total agreement between Research Parks and Research Centres

Table 17 Research Park Attributes
================================

	Research Park		Research Centre	
	YES	NO	YES	NO
A Physical Property Development?	4	0	3	0
On or close proximity to University?	4	0	3	0
Low Density?	4	0	3	0
Attractive Park-like environment?	4	0	3	0
High quality of design?	4	0	3	0
University key role in management?	4	0	3	0
Leading-edge activities?	4	0	2	1
Collection of high-technology firms?	4	0	3	0

N = 7

Table 18 Innovation Centre Attributes
===

	Innovation Park		Innovation Centre	
	YES	NO	YES	NO
Industrial Building?	1	0	2	0
On or close proximity to University?	1	0	2	0
Within a restricted space?	0	1	2	0
Flexible tenancies?	1	0	1	1
Caters for especially the starter firm?	1	0	1	1
Invention into product?	1	0	2	0

N = 3

Table 19 Technology Park Attributes
=====================================

	Technopark		Technology Park		Technology Centre		Technology Enterprise Centre		Business Technology Centre		Enterprise Centre	
	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
Mixed use activities?	1	0	1	0	2	0	1	0	1	0	1	0
On or close proximity to University?	1	0	0	1	2	0	1	0	1	0	1	0
High quality of design?	1	0	1	0	2	0	1	0	1	0	1	0
Collection of high-technology firms?	1	0	1	0	2	0	1	0	1	0	1	0
Emphasis on production?	1	0	0	1	1	1	0	1	0	1	1	0
Academic involvement not essential?	0	1	0	1	0	2	0	1	0	1	0	1

N = 7

possessing the attributes identified from the literature survey. For example, all 7 locations indicated that they had 7 (88%) out of the 8 attributes. However, 1 (13%) Research Centre indicated that its firms did not engage in leading-edge activities. All 3 Innovation Parks and Innovation Centres indicated that they were industrial building developments which were on or within close proximity to a University / HEI and emphasised the development of inventions into commercial products. 1 (33%) Innovation Park claimed that it was not a development within a restricted space whereas the 2 (67%) Innovation Centres were (table 18). Although the literature suggested that with Technology Parks academic involvement was not essential, all 7 locations did not agree. Furthermore, 4 (57%) claimed that within their locations there was not emphasis on production. All 7 concluded that they had a location of high quality design, collection of high-technology firms and allowed mixed use activities (table 19).

4.<u>Overlaps between Science Parks and Related locations</u>. From table 16 it can be seen that overlaps occur between Science Parks and related locations. For example, there is total agreement amongst all locations having a number of attributes including a high quality of design, selective entry criteria and a collection of high-technology firms.

All 7 Research Parks have 12 (60%) of the Science Park attributes. All 3 Innovation Centres have 10 (50%) of the attributes and 2 (67%) have the remaining 10. However, only 5 (29%) Technology Parks indicated that conventional production was excluded. Table 20 indicates that there is not a significant variation between the Science Parks and related developments having the grouped attributes of the Science Parks (X^2 = 0.181 at 6 degrees of freedom and the 5% level of significance).

Table 20 Grouped Science Park Attributes compared with Related locations
==

	Science Park	Research Park	Innovation Centre	Technology Park	Total
Physical	83	50	22	47	202
Managerial	65	39	17	36	157
Firm	45	26	11	27	109
Total	193	115	50	110	468

5.<u>Differences between related locations and Science Parks</u>. Tables 21-22 compare the suggested differences found in the literature review between related locations and the Science Parks.

Table 21 Differences between an Innovation Centre and a Science Park
==

	Innovation Centre			Science Park			
	YES	%	NO	YES	%	NO	NO ANSWER
Industrial Building?	3	100.0	0	3	27.3	7	1
Within a restricted space?	2	66.7	1	6	54.5	5	0
Invention into product?	3	100.0	0	9	81.8	1	1
Total number of locations	3			11			

From the findings (table 21) it is observed that there is a difference between the Science Parks and Innovation Centres being a development within an industrial building. Only 3 (27%) of the Science Park locations claimed that they were compared with all 3 Innovation Centres. However, it is observed that further overlaps exist as 6 (54%) Science Parks regard themselves as developments within a restricted space compared with 2 (67%) Innovation Centres. Furthermore, 9 (82%) Science Parks claimed that there was emphasis within their locations upon the development of inventions into commercial products compared with all 3 of Innovation Centre locations.

From table 22 it is observed that there is a difference between Science Parks and Technology Parks concerning whether there is emphasis within locations upon production ? Only 1 (9%) Science Park claimed that there was emphasis on production compared with 3 (43%) Technology Parks. However, both types of location agreed that academic involvement was essential with only 1 (9%) Science Park disagreeing.

Table 22 Differences between a Technology Park and a Science Park
==

	Technology Park				Science Park				
	YES	%	NO	%	YES	%	NO	%	NO ANSWER
Academic involvement not essential?	0	0.0	7	100.0	1	9.1	10	90.9	0
Emphasis on production?	3	42.9	4	57.1	1	9.1	9	81.8	1
Total number of locations	7				11				

CONCLUSIONS.

This paper concludes that the grouped attributes of the Science Parks and related locations identified from the literature survey are very similar to the characteristics of the actual locations. It is concluded that confusion in the literature concerning the interchangeability of using the term Science Park with related locations (Research Parks, Innovation Centres, and Technology Parks) is explained by finding a considerable number of similar attributes between locations. Furthermore, the suggested literature differences between related locations and Science Parks were not supported by many of the actual findings. Consequently, it is concluded that a Science Park should be defined in terms of a broad spectrum of locations rather than one which has rigid boundaries. 4 replies specifically commented that they regarded the UKSPA definition as the most appropriate. It too defines a Science Park in terms of a broad spectrum of developments. Consequently, for the purpose of determining a sample of the Science Parks for the wider study investigating networks, the total population of Science Parks consists of the 33 operational members of the United Kingdom Science Park Association (Feb. 1988).

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