The Potential for a British Technopole: A Study of Hertfordshire

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ABSTRACT

With the recent years of recession having taken their toll on the British economy many theorists have turned their attention increasingly towards the historical thinking of a Russian economist Kondratieff and subsequent writings of current economic thinkers. Kondratieff created Long Wave Theory, whereby product or process innovation leads to economic growth in fifty year cycles. We are presently at the end of the Fourth Wave, based on a Post-Fordist society characterised by computers and electronics. A potential Fifth Wave is on the way.

Current thinking focuses on the importance of innovation as a stimulant to economic growth. The concern for the planner is to stimulate localised or regional economic growth. The concentration of innovative activity is best seen in technopole regions where high-technology firms, typified by research and development activities, cluster together. Successful planned technopole regions can be found in mainland Europe, but not so far in Britain, despite clusters of high-technology firms. One such region in Britain is Hertfordshire which, according to location quotient scores, has a large high-technology presence, historically based on the declining defence industry.

This research will analyse the potential for Hertfordshire to become a British technopole region in the future. A Weberian "Ideal Type" analysis will be conducted using theoretical models, and two successful European examples to assess whether Hertfordshire has both the necessary elements for it to function as a technopole, and whether inter-firm and institutional relationships are strong enough to allow this to happen. The two European examples are Cité Scientifique, Ile-de-France Sud, in France and Baden-Württemburg in Germany. Both are known technopole regions and exhibit networking activities as integral to their success.
ACKNOWLEDGEMENTS

I would like to thank the many people who have made valuable contributions to this research, in both an academic and an advisory capacity. There are others who have had a supportive role.

I would like to thank James Simmie, my supervisor, for reading and re-reading drafts of this thesis and for his important academic help. I would also like to thank my family for supporting me throughout these two years, providing both financial support and encouragement. There are also the contributors to this research, who play an active role in the activities of Hertfordshire, and who took the time to assist me.

Finally, there are my colleagues on the MPhil course. All the hours of mutual complaining, stress and abuse were inspirational. That is what friends are for.
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"The information technology revolution is not a one-off conversion. It has, like the steam engine, raised the pace of technological change for a generation, creating a need for more flexible small-batch production systems, a better educated more innovative workforce, and more creative, individualistic management. Growth will come in new products, knowledge-intensive products, more differentiated than mass produced with more of their value in design... In the high-technology industry, whoever pioneers production will have a decisive influence on future patterns of trade, with others finding it hard to catch up."


**Technopole**

A technopole is a city or sub-region which is the location for a concentration of both the inventive and the innovative elements of the innovation chain.

**High-Technology Firm**

Firms involved in the provision of goods or services which are dependent upon the application or development of new technology or knowledge.
CHAPTER ONE: INTRODUCTION

1.1 Innovation, Networking and the Competitiveness of Firms

To be competitive is one of the golden rules within industry. It is the foundation on which a market share is built, and on which long-term profitability depends. It is no longer sufficient to produce an ordinary product and apply a good marketing campaign, hoping that sales will take care of themselves. It is not just the strategies of firms that are important, but also the role that national/regional circumstances play in the competitive success of firms. Porter’s ideas about nations can be reduced to a regional level:

"Creating competitive advantage in sophisticated industries demands improvement and innovation - finding better ways to compete and exploiting them globally, and relentlessly upgrading the firms' products and processes. Nations [regions] succeed in industries if their national [regional] circumstances provide an environment that supports this sort of behaviour. Creating advantage requires insight into new ways of competing and the willingness to take risks and to invest in implementing them. Nations [regions] succeed where the national [regional] environment uniquely enables firms to perceive new strategies for competing in an industry. Nations [regions] succeed where local circumstances provide an impetus for firms to pursue such strategies early and aggressively."

Porter (1990, p. 67-68)

With the ever diminishing life cycles of new products, and the accelerating pace of technological change, commercial industry has had to look for new ways of maintaining its competitiveness. As Akio Morita (1992) said:

"The key to competitiveness in a borderless, 'high tech' world does not lie beneath the microscope lens of the laboratory scientist, but on the drawing
boards and computer screens of electrical engineers, software developers and design experts."

(The First United Kingdom Innovation Lecture 1992, p. 4)

One such way has been to enter into partnerships, as the above quote implies, and to co-operate with other firms within the same industrial sector, thereby overcoming the shortfall of in-house expertise. Perhaps a barrier to this phenomenon in the UK might be the traditional ideals of company loyalty and production secrecy. Akio Morita, the Chairman of the Board of the Sony Corporation believes that we, as a nation, tend to revere scientists far too much at the expense of the real dynamos of innovation, the engineers. It is our concentration on the 'invention' side of the technology process that hinders our partnership potential between suppliers and sales and marketing firms, the 'innovation' process. Such co-operation has been taking place within the electronics industry of Silicon Valley, California for many years. It is, therefore, a barrier that can be overcome. Industrial partnerships have been particularly prominent within high-technology industrial sectors, like the electronics industry, and are becoming more prevalent within the pharmaceutical sector.

Having stated that inter-firm co-operation and partnerships are likely to occur within the high-technology industrial sector, it would be prudent to investigate whether such activity is prevalent within a high-technology agglomeration. A little known agglomeration in the UK is Hertfordshire, one of the home counties north of London.

The following research puts forward a Weberian “Ideal Type” analysis of Hertfordshire, in the light of two prominent European technopole examples, and the ideal technopole models suggested by theorists. The potential of Hertfordshire as a British technopole region will be evaluated. Secondly, due to the integral part that networking plays within the two European regions, in the form of inter-firm collaboration and institutional support, such activities will also be examined in Hertfordshire.
1.2 Why Choose Hertfordshire?

Hertfordshire was chosen primarily as it has the highest location quotient value for the concentration of high-technology employment in the country. The location quotient is a numerical method of showing the concentration of an industrial sector within a certain location. The value given to a location shows the concentration of employees in the industrial sector under scrutiny, when compared to a national average (given the base score of 1.0). With a high-technology employment score of 3.6, Hertfordshire is well above the average.

Hertfordshire has been described as "one of the leading centres of high-technology in Europe. Two branches of high-technology, in particular, have located in the area: aerospace and pharmaceuticals." (Hart 1993). Although Hertfordshire has this high concentration of high-technology employment, it is not widely recognised as a high-technology location. This could prove to be a significant factor when asking firms about their activities within the county. Many opportunities for inter-firm research could be overlooked simply for the fact that possible partnerships were not known to be in the vicinity. An empirical background to the county will be discussed in chapter four, focusing in particular on the significant presence of research and development plants of the two afore-mentioned industries that have located in the county.

1.3 The Essential Elements of a Technopole Region

The first part of this research uses the Weberian concept of "Ideal Type" which looks at the position of an object being studied when compared to an "ideal" position, in this case how close Hertfordshire comes to the model of a successful technopole and its component parts. Hertfordshire will also be compared to the standing of the two European examples. The essential elements of a successful technopole include business support institutions, educational establishments, firms disposed toward innovative activity, (such as research and development), and a state targeted policy supporting industrial research.
1.4 Definitions for Networking Activity

As well as looking at the representation of the infrastructure, necessary for the county to be realistically considered as a British technopole, it will also be necessary to define networking activities within the high-technology industry on a series of levels. These range from everyday unconscious decisions, whereby workers talk to friends as part of an everyday routine, to specific conscious decisions to work with different firms, subcontracting various activities. The latter is primarily due to much needed expertise being unavailable in-house, so resulting in them being subcontracted to specialist firms within the vicinity.

The following table (1.1), focused on inter and intra-firm relationships, illustrates the example of research and development activities characteristic of the high-technology sector. Equally important to a local/regional scale economy are the networking elements of supply chains, customer contacts and advice.

<table>
<thead>
<tr>
<th>Level</th>
<th>Activity</th>
<th>Contact</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Conversation</td>
<td>Colleague/Friend</td>
<td>In-House</td>
</tr>
<tr>
<td>Level 2</td>
<td>In-House Research</td>
<td>Research Dept. Staff</td>
<td>In-House</td>
</tr>
<tr>
<td></td>
<td>(Formal)</td>
<td></td>
<td>(Same Site)</td>
</tr>
<tr>
<td>Level 3</td>
<td>In-House Research</td>
<td>Research Dept. Staff</td>
<td>Different Branch</td>
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<tr>
<td></td>
<td>(Formal)</td>
<td></td>
<td>(Locality)</td>
</tr>
<tr>
<td>Level 4</td>
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<td>Research Dept. Staff</td>
<td>Different Branch</td>
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<tr>
<td></td>
<td>(Formal)</td>
<td></td>
<td>(Elsewhere)</td>
</tr>
<tr>
<td>Level 5</td>
<td>Subcontracted Research</td>
<td>Research Partner</td>
<td>Locality</td>
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<tr>
<td></td>
<td>(Formal)</td>
<td></td>
<td></td>
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<tr>
<td>Level 6</td>
<td>Subcontracted Research</td>
<td>Research Partner</td>
<td>National</td>
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<tr>
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<td>(Formal)</td>
<td></td>
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<tr>
<td>Level 7</td>
<td>Subcontracted Research</td>
<td>Research Partner</td>
<td>European/Global</td>
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<td>(Formal)</td>
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Table 1.1 Different Levels of Research and Development Activities

Having split the definitions into different levels does not necessarily mean that level 7 is infinitely more important than level 1, just because the latter is an informal sharing of ideas under the guise of social interaction. Many of the best contacts arise through
informal conversations. In some ways the seven levels of definition could be seen as progressive, where an idea begins as a casual discussion, developing into a multifaceted product or process innovation, requiring subcontracted specialist research. Level 4 can be equally important as level 7 with large firms having a global research and development network of their own, sometimes spending more than individual countries.

1.5 Networks as a Spatial Phenomenon

Networking is above all a spatial phenomenon, which is why it is important to us as planners, when looking at ways of creating economic development. Networking generally has a global reputation associated with the functions of multinationals, but there is also an important close region or location-specific networking characteristic, which I will show during this research. Particular region-specific examples of networking within the high-tech industry can be found in France and Germany, as well as the better known case of Silicon Valley. It is the two European examples that will be looked at in more detail, and used as comparisons for Hertfordshire.

One question that is common when discussing such activity is why should locality matter when technology is forever reducing the time-space continuum? The answer is complex. Whilst much communication is conducted at the end of a telephone line or a computer keyboard, for many businesses everyday face-to-face contact is necessary, involving suppliers and contractors. This tacit user-producer relationship is the lifeblood of successful product and process innovations within the industry. It is not only a way of cutting costs, but also facilitates the continual feedback of ideas leading to a phenomenon given numerous titles such as design coupling, co-makership and upstream management, whereby users of a product have an integral part to play in its design and manufacture. There is also the presence of local business support institutions and local educational facilities, to be considered.

The major problem is how to evaluate and measure these networks of activity. Many people would not describe such activity as a conscious decision, with contacts and
arrangements forming part of their everyday routine. Networking could be described
as a “buzzword”, created by academia and governments alike, in an effort to quantify
working routines. However, in terms of public policy formation and efforts to help
firms benefit from interaction, this process should be quantified in some way to see
where help is needed. This becomes more significant in the light of European funding
programmes which, in most cases, specify partnerships between firms in order for
projects to win financial assistance. Networking on a regional, or, in this case, a
county-wide scale, can be discovered by identifying the frequency and reason for
contacts between firms and the business support and educational infrastructure in the
area. Inter-firm contact must also be investigated.

Bennett and Krebs (1994) attempted to measure local economic partnerships within
the EC-LED A (EC Local Economic Development Agency). They started by setting
out the primary actors within these partnerships. Then, by assessing the strength and
importance of their interaction, the authors built up a kind of matrix diagram showing
strength of linkages through the thickness of lines on the page. This method has a lot
of positive points as relationships can be clearly seen through their graphical
representation. However, there are cautionary points to be regarded when employing
this method, namely a clear and simple measurement system must be employed so that
results are easily comparable and clear to the reader. I will, therefore, utilise some of
these methods in my research findings.

1.6 The Implications for the Planner

The planning implications of this research lie in the realms of local/regional economic
development. The economic base of the region is of vital importance to the planner.
The reasons for this are threefold. Firstly, and importantly for the planner, there is the
question of land use. Large greenfield sites are highly desired by industry. The
location of large multinational firms can also prove to be a significant economic
magnet for a region, creating spin-off firms, and a boost to the service sector of the
area. Secondly, the economic activity of the region determines the employment
structure, therefore affecting unemployment levels, spending power and what is
known as the multiplier effect. Thirdly, the economic base of a region affects the educational infrastructure in terms of institutions that might be located there. In the case of Hertfordshire, schooling was targeted to the needs of local industry.

In this research I intend to show the importance of attracting and keeping innovative firms for the local/regional economy. By planning an integrated infrastructure of support and opportunity the success of innovative firms can disperse across the economy creating highly desired economic growth, something that has been at a premium in the recent years of recession. Planning for industry is a fundamental need and the lifeblood of a successful regional economy.

1.7 Thesis Structure

This introduction has given a brief outline of the area of research to be investigated and the case studies to be examined. Key concepts are also defined. It sets out in diagrammatic form a definition of networking solely for the purpose of this research. I do believe, however, that it covers all the major areas of activity. This chapter has also set out the key discussions to be covered in more detail in the following text.

The next chapter looks at the empirical justification for this research. It covers the theoretical arguments about why innovation is a key concept of capitalist economies. Beginning with Long Wave theory by Russian economist Kondratieff, and following the continuing arguments by successive theorists such as Schumpeter and Mensch, it examines the role of innovation within the economy.

The second part of the chapter reviews the plethora of literature available on the process of networking. This review gives definitions and applies the process to concepts of flexible specialisation and focuses particularly on networking activities within research and development (R & D), a trademark of the high-technology industrial sector. Two principal theoretical models are set out which will be used to criticise the position of Hertfordshire. Finally, the spatial constraints of the concept of networking are reiterated, stressing their importance in this study.
The third chapter sets out the two hypotheses, which will be investigated in this research, and the relevant methodology. It also sets out the sample frame and the caveats which existed due to the nature of the research.

There then follow the case studies of this research, setting out its spatial and industrial focus. The academic beliefs and economic theories are compared to reality, with a look at the possibilities for the planner or economic development officer to influence economic regeneration on a small spatial scale. The case study area of Hertfordshire is compared to the two European examples to see if there are lessons to be learned. This enables the identification of the primary actors influencing the transition from an idea to a marketable concept. If innovation is the key to economic success in the capitalist economy, any way to influence its location and its effects must be seriously considered.

The final chapter contains the conclusions of this research and their implications for the planner or local economic development officer in terms of creating a viable and successful economy based upon the high-technology industry.
CHAPTER TWO: BACKGROUND THEORY

2.1 Background Economic Theory

With the economy becoming increasingly unpredictable, and with the existence of a major recessionary period spanning both the middle-to-late 1980s and the early 1990s, economists are looking at ways of deregulating economic activity, and freeing markets. A recurring interest in the discursive argument about the value of Kondratieff Waves, and the successive works by Schumpeter and Mensch, is gaining importance. Emerging from this debate is the widespread belief that technology and innovation could be the key to the next Kondratieff Wave, (assuming that it will appear in some shape or form), and the key, therefore, to new economic growth. If this were the case, then the careful planning of innovative regions, termed technopoles, could facilitate planned regional economic growth.

2.1.1 Kondratieff and Schumpeter

Both Kondratieff and Schumpeter saw long waves as an "internal regulator" of capitalist development. Development in this case meant a qualititative change in production as a result of what they called "technical innovation". These technical innovations appeared in clusters of "frantic entrepreneurial activity" followed closely by periods of consolidation whereby there was no immediate need for new innovations to be sought. This sporadic activity created Kondratieff's cycles of capitalist development, involving periods of boom and depression, (Marshall 1987, p. 30). A good description of the four Kondratieff Waves can be found in Hall and Preston (1989), showing not only the innovations occurring and the related industries but also how these interacted with the socio-political environment at the time, (see table 2.1, p. 19). The boom periods spawned secondary innovations and perhaps provide the link between the two concepts of product and process innovation. It is apparent from table 2.1 that, as Marshall says, these cycles can be matched with the major innovations of the past three centuries, beginning with the Industrial Revolution in the 1780s and continuing up until the internal combustion engine in the 1930s. We
are now in the fourth Kondratieff concerning microcomputers, a full fifty years after Schumpeter’s writings, with a possible fifth one on the way.

<table>
<thead>
<tr>
<th>Date</th>
<th>First Wave</th>
<th>Second Wave</th>
<th>Third Wave</th>
<th>Fourth Wave</th>
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</thead>
<tbody>
<tr>
<td>1787-1845</td>
<td>1846-1895</td>
<td>1896-1947</td>
<td>1948-2000(?)</td>
<td>Transistor, Computer, CIT</td>
</tr>
<tr>
<td>Key Innovation</td>
<td>Power Loom; Puddling</td>
<td>Bessemer Steel; Steamship</td>
<td>Alternating Current; Electric Light; Automobile</td>
<td>Electronics, Computers, Communications, Aerospace, Producer Services</td>
</tr>
<tr>
<td>Key Industries</td>
<td>Cotton, Iron</td>
<td>Steel, Machine Tools, Ships</td>
<td>Cars, Electrical Engineering, Chemicals</td>
<td>Mix of large Fordist and small subcontracted factories, Multinationals</td>
</tr>
<tr>
<td>Industrial Organisation</td>
<td>Small factories, Laissez-faire</td>
<td>Large factories, Capital Concentration, Joint Stock Company</td>
<td>Giant factories, Fordism, Cartels, Finance Capital</td>
<td>Mix of large Fordist and small subcontracted factories, Multinationals</td>
</tr>
<tr>
<td>Labour</td>
<td>Machine minders</td>
<td>Craft Labour</td>
<td>Deskilling</td>
<td>Bipolar</td>
</tr>
<tr>
<td>Geography</td>
<td>Migration to towns</td>
<td>Growth of towns on coalfields</td>
<td>Conurbations</td>
<td>Suburbanisation, Deurbanisation, New Industrial Regions</td>
</tr>
<tr>
<td>International</td>
<td>Britain; Workshop of the world</td>
<td>Germany, US competition, Capital export</td>
<td>USA, German leadership; Colonisation</td>
<td>US hegemony, Japan challenge, Rise of NICs, NIDL</td>
</tr>
<tr>
<td>Historical</td>
<td>European Wars, Railways</td>
<td>Opening up of N. America, Global transport and communication</td>
<td>World Wars, Mass consumption, Great Depression</td>
<td>Cold War and Space Wars, Global village, Mass consumption</td>
</tr>
<tr>
<td>Role of State</td>
<td>Minimal army/police</td>
<td>Early imperialism</td>
<td>Advanced imperialism; Science and education</td>
<td>Welfare state; Warfare state; Organised R &amp; D</td>
</tr>
</tbody>
</table>

**Table 2.1 The Chronology of Kondratieff’s Waves**

Inevitably such theoretical analysis encompassing a group of different writers; Kondratieff, Schumpeter and Mensch, among others, will involve conflicts of opinion.
Even Schumpeter, who resurrected the forgotten writings of Kondratieff, had his disagreements. Kondratieff had put the cycles of innovative activity down to an economic need, whereby an advance in technology was demanded either to cut costs (process innovation), or to make a more complicated product (product innovation). Once this innovative need had been satisfied, there was no longer any incentive to continue experimenting, until the next crisis. Schumpeter, on the other hand, looked on innovative clustering as a result of mass production reducing profit margins and exclusive production rights.

Innovative clustering is not a spatial but a temporal phenomenon. Schumpeter talked of entrepreneurial innovations occurring at roughly the same time due to new technological opportunities. In turn these spawned secondary products and of course new process innovations. At this point it is necessary to make a distinction between product and process innovation. Product innovation is, as it sounds, an advance in, or a completely new product or good. A particularly successful example, having mentioned the Chairman of Sony in my introduction, is the Sony Walkman. This product took the idea of stereo music systems and created a new concept in portable music. It was a simple product innovation but has proved hugely successful. Advances in the product also reflect new technology. Process innovation, on the other hand, is an advance in the making of such products. A good example is the shift from human manual labour to robotic production lines such as occurred in the car industry. It is perhaps also necessary at this point to clear up another distinction, that between invention and innovation, as the two can easily be confused. George et al (1991, p. 232) define the difference as follows:

"Invention is the production of new knowledge in the form of a new product or method of production. Innovation covers the whole range of activities that are needed to translate a new idea into commercial practice for the first time. They include the further... development and refinement of an idea before the stage of commercial application can be reached... The innovation stage also includes identifying the market for a new product, investing in the..."
capital goods needed for production and distribution, and raising the funds for that investment.”

2.1.2 Mensch

Mensch became the second person to resurrect the theory of long waves. Interest had waned due to the post-war boom periods of industrial production. Mensch was far more critical than Schumpeter. His main research was focused on the innovative clustering, using statistical analysis. He found that innovatory activity tends to change its focus from entrepreneurship to consolidation and improvement as boom periods are experienced. However, as depression begins to deepen, then entrepreneurial innovation once more becomes dominant.

It seems that as more research is conducted, attention is becoming focused further away from the reasoning for innovation and more toward the nature of innovative activity and its effect on the economy. The desire to accelerate and direct the diffusion of innovation is the new priority. Freeman et al. (1982) analysed Mensch’s work and found him very subjective. They put forward their own four stage model of technology diffusion:

I. the depression phase of a Kondratieff in which embryonic and experimental features of a new industry/technology begin to appear in competition with the declining sectors whose development lay in an earlier wave; [proximity to an educational institute is important at this stage]

II. the boom period of the ensuing expansionary Kondratieff in which the new industry/technology becomes a leading sector with substantial employment growth and secondary effects on other industries and services; [production process becomes more standardised and the market location becomes more significant in price competition]
III. The stagflationary turning point where the former rapid growth of the sector gives way to consolidation and rationalisation involving intensive competition, increasing capital concentration and slower employment growth; [labour costs become very important and production shifts to less developed countries, company concentration and firm take-overs occur]

IV. The ensuing depressionary wave with a slowdown in output and investment, falling employment levels and over-capacity.

The additions in [ ] are taken from Hassink (1992, p. 23)

A further criticism, levelled at Schumpeter, is that he overemphasises technological factors at the expense of the wider socio-political and cultural context within which these developments are taking place, (Hassink 1992, p. 24). He also neglects the spatial aspect of why firms in some locations innovate more than others, a key question if one is looking for ways to encourage regional economic restructuring through innovation.

2.1.3 Mandel and Forrester

A few of the theorists have addressed the varying intensity in capital goods production. Mandel sees the industrial cycle as the acceleration and deceleration of capital accumulation. In a boom period, over-investment occurs, causing a decreasing rate of profit return. Conversely in times of depression, under-investment occurs, only to increase as profit levels rise. Innovative activity is made possible by the presence of this under-invested capital reserve.

Delbeke (1981, p. 250) criticises Mandel for his overemphasis on the supply side of the economy and argues that the demand for goods is equally important. He does, however, consider Mandel’s analysis of the spread of innovation to be important:
"Although Mandel does not investigate thoroughly the pressures that generate innovation, the distinction between the effects of technological innovation in the capital goods sector and the spin-off in the other sectors is extremely important."

(Delbeke 1981, p. 251)

Forrester, like Mandel, looks at the economic effects of innovative activity. His two pillars of theory are based firstly on the multiplier effect, whereby innovations spread from one part of the economy to another spawning new products, and secondly, the capital investment fluctuations as described by Mandel. Forrester, however, includes a temporal factor in his analysis. As well as lags in the construction of industrial production, he also addresses the idea of "bootstraps". This is a situation where some of the production factors of a firm are redirected to acquire capital equipment. This means that instead of new capital investment, money is redistributed within the production process. These factors, Forrester argues, create the fifty-year cycle identified by Kondratieff.

Delbeke (1981, p. 252) again, is also critical of Forrester. He argues that the continuous role of innovative activity, which is constantly changing and updating, is neglected. Instead of revitalising some past innovation as Forrester would have us believe, perhaps new invention might be preferred. He also, like Mandel, does not pay enough attention to the demand factor.

2.2 Thoughts on Policy and Current Technopoles

A technopole is a spatial concept, described as the location containing both the inventive and innovative elements of the innovation chain. The spatial scale is limited to a city or sub-region. Gibson and Smilor (1990) put forward a definition which hints at the potential importance of networking activities:
"A modern technopole is one that interactively links technology commercialisation with private and public sectors to spur economic development and promote technological diversification."

The background economic theory indicates that technopole planning can be an important tool of economic and regional policy for the state. New innovations will supposedly lead to new products and therefore to new job growth, as was the historical case of the development of the textile industry in Lancashire. Unfortunately, at the same time, we must also consider that new innovations can lead to new methods of production, which can cause the rationalisation of industry and the loss of jobs. For the purpose of this research I will acknowledge both outcomes, but hold the view that the high-tech industry and its large R & D component is an important asset to attract, and accommodate, in terms of establishing a viable regional economy in this time of recession.

The concern of policy, therefore, is to enable and at the same time to direct, this innovative activity, in this case within the high-tech industry. The high-tech industry as discussed by Hall and Markusen (1985, p. 146), has tended to have different locational factors from the predominant secondary industrial sector in the North. The pattern of military influence and the desire for highly skilled labour led the high-tech sector to the southern part of the UK. One of the most important points to note is that this new growth has not and will not take place in the traditional industrial regions, a point stressed by Hall.

The lack of growth in these traditional regions can be seen as a consequence of the traditional labour relations inherent in these areas, as well as the type of labour pool that is in existence. Tyneside, for example, has traditionally been a shipbuilding area providing heavy manual labour suitable for that industry, but not the highly educated workforce desired by the R & D departments, in particular of the large pharmaceutical companies to be found in Hertfordshire. It is a problem that perhaps needs more recognition by the state policy makers. The UK has a major problem at the moment because science subjects are being shunned in our education system, leading to a
shortage of highly qualified science graduates desired by the high-technology sector. A second point is that, with the demise of the Cold War, the previously dominant defence oriented market, of great importance to Hertfordshire in the past, has had to be redressed. A defence-led industrial policy is no longer appropriate or satisfactory. A new focus has to be found, and this new focus could be the innovative potential of the UK high-technology sector.

Hall and Markusen (1985, p. 149), look at the problem of policy making in this more recent light. They recognise the weak government policy of growth areas around the South East but, highlight the conflicting action of the Green Belt policy still in effect. They also point out that one of the more important locations, Cambridge, has been largely ignored. In concluding their policy chapter, Hall and Markusen argue that an effective policy needs to address a multitude of factors encompassing education, defence strategy, and regional economic growth. Above all, they argue that a long term strategy should be employed.

In 1988 the DTI argued that innovation was essential for the UK to continue to compete in world markets. It would make sense then for the state to have a policy approach enabling firms engaged in research and development to have the best start possible. Both the Conservative and Labour parties published policy statements to this effect at the start of the 1990s, recognising the fact that innovation is linked to economic growth.

Simmie (1994, p. 13), draws on the concept of Smilor's Technopolis Wheel (1988) showing the "elements which need to be spatially concentrated in a complete technopole". It is these factors that need to be addressed when creating a successful policy linking innovation and economic growth. By this I mean ensuring a desirable labour force, by forging links with educational establishments, ensuring an adequate infrastructure (such as a network of functional information and resource sharing), so that firms will be attracted to an area. It is this model that I will use to assess the potential of Hertfordshire as a British technopole. Simmie argues that the UK innovation policy basically revolved around defence spending, as in the USA. He also
points out the discrepancy in educational links between universities and innovative activities, with the UK not faring very well. An interesting role model mentioned by several authors is the MITI in Japan which has had a great deal of success in bringing different firms together, in similar and conflicting industrial sectors, as a means for collaborative problem solving. There are several pertinent and essential questions posed by Simmie at the end of his article (1994, p. 18). The inevitable demise of the defence industry and the future role of the educational establishments in particular must be addressed.

Another aspect of technopole planning policy is looked at by Malecki and Nijkamp (1988, p. 384). Networking between firms and the local business support institutions is a vital prerequisite if the presence of educational establishments in the vicinity are to be used to their full potential. Much of this depends on the willingness of firms to collaborate and the type of industrial activities in an area. The existing industrial mix and the supply of workers is one such factor, perhaps explaining why the traditional industrial regions are rejected. In their research Bruno and Tyebjee (1982) cite twelve factors "as being essential for the environment for entrepreneurship". These twelve factors are set out below:

1. venture capital availability
2. presence of experienced entrepreneurs
3. technically skilled labour force
4. accessibility to suppliers
5. accessibility to customers or new markets
6. favourable governmental policies
7. proximity to universities
8. availability of land or facilities
9. accessibility to transportation
10. receptive population
11. availability of supporting services
12. attractive living conditions
Within these, both the educational links and government policy involving locational incentives feature strongly. All the factors above represent a relatively small spatial scale. In terms of a regional strategy the incubator theory mentioned by Malecki and Nijkamp seems to be important. This is the process whereby larger firms or locations spawn new firms that subsequently move to a similar or neighbouring location, helpful for creating a regional innovative network.

Malecki and Nijkamp (1988) also look at policies already in existence, oriented to high-tech firms. The educational and science park policies seem to be rather flimsy. Much is directed at ensuring that small firms do not fold and that graduates might choose to work in the vicinity of a large educational establishment, when the reality is that many are highly mobile and are willing to work anywhere. With the poor reputation that the industrial UK has, many, especially scientists, would probably choose to work abroad. Despite the conclusion that some good can come out of a high-tech policy, even if it is a by-product, Malecki and Nijkamp have their doubts about the success of policy alone. They argue that the infrastructure, and even tradition, is such that a multi-focused policy approach is needed if it is to have a significant effect. This is something that has happened in the two European examples that will be examined later.

Cooke (1985) sets out a prescriptive agenda for what he calls an “innovation-based regional policy”. He rues the diminution of the qualitative aspect of grant aided firms, arguing that quantity not quality has taken precedence. Cooke too, like Hall, points out the lack of innovation potential of the more traditional industrial and disadvantaged regions. He argues that for these regions to become successful again, either the more traditional industries must be re-vitalised or policy should concentrate on the high-technology industry. Hall suggests that the spatial pattern of industry has shifted, perhaps permanently and that new regions, such as the M4 corridor and the Western Crescent will now become dominant.

There seem to be many major examples of European technopole planning, as well as the success of Japan, to which the UK can be compared. The Japanese example is of
course slightly different because of the absence of a defence-led research policy. The two comparative regions for Hertfordshire have been chosen for their similarities, in terms of economic structure, geography and infrastructure. There is also the spatial issue of inter-firm and institutional networking which plays an integral part to their success.

The first example of Cité Scientifique in the Ile-de-France region of France has several similarities to Hertfordshire. It is close to the national capital, being on the southern fringe of Paris, characterised by new town developments and has been shaped by decentralisation from the capital. The region also has the same high-technology concentration in similar industrial sectors, much of this initially based on defence. The second example of the Baden-Württemburg region of Germany also has a similar economic base characterised by high-technology industry and a dense institutional network of business support with which Hertfordshire can be compared. Another factor that makes these two regions good comparable examples is that they are successful technopoles and exhibit the collaboration and co-operation identified by theorists as being integral to technopole success. Hertfordshire can, therefore, be compared to successful examples which comply to an extent on theoretical ideals. Both of these regions will be discussed in detail in the research chapter.

2.3 The Spatial Significance

I began this chapter by putting forward the proposition that technology and innovation could be the key to the next Kondratieff Wave, and, therefore, the key to economic growth. It was then indicated that this activity could be instigated by the careful planning of technopoles, facilitating regional economic growth. It is this spatial scale that is an important concept behind this research.

It can be seen empirically that the four Kondratieff Waves that have occurred so far, have been instigated at a small geographical scale, spreading gradually as new technological opportunities take hold. The first two Kondratieff Waves were geographically limited to the areas of raw materials (i.e. coalfields), necessary for the
production of iron and steel and shipbuilding. There then followed the US dominance of car production centred on the Fordist mode of production, which was again limited initially to a small geographical scale. Finally, the fourth Kondratieff, introducing the high-technology revolution of electronics and computers, was centred on the region of what was to become known as Silicon Valley in California.

Looking back at the twelve factors put forward by Bruno and Tyebjee (1982) the spatial scale is fundamental, stressing the accessibility to suppliers and customers, the proximity to universities and business support services. Hertfordshire, as I will elaborate in the following chapters, has the majority of the twelve factors and so under this definition could be labelled a technopole. Network activity should be well provided for. Malecki and Nijkamp (1988, p. 387) conclude from various studies regarding a successful information centre policy for innovative firms that specific local conditions have to be fulfilled:

1. availability of research institutes acting as seedbeds for new activity
2. availability of a high-skill labour force
3. government support for R & D activities of starting firms
4. availability of spatially discriminating venture capital
5. availability of a stimulating and innovative entrepreneurial climate
6. availability of inexpensive buildings for starting firms

These conditions are fundamentally spatial in nature and are inherently conducive to the networking process. Conditions such as research institutes acting as seedbeds for new activity, and a stimulating and innovative entrepreneurial climate, indicate close education-industry links and a spatial climate in which inter-firm co-operation and strategic alliances are a common feature. If Hertfordshire can be categorised as a technopole then the above factors should be in evidence. Therefore, networking in some form should also be taking place at this small spatial scale.
2.4 Definitions of Networking

There are several definitions of networking in the sense of research alliances and cooperation, as opposed to the more common computer oriented term based on the internet system. Rank Xerox looked at the phenomenon in terms of spawning new companies, or incubator firms:

"a system of work in which [workers] leave their parent company to found their own business, which then contracts to provide specialised services to the parent company, among other clients."

Aldrich and Glinow (1992, p. 125), also see networking as a system of personal contacts and development infrastructure. They define business development as involving value creation through mobilising resources, in response to opportunity. Their central proposition is that:

"...to add value, the people who are involved must create linkages or relationships between components of the process, in short, they must become involved in social networks."

2.5 Theoretical Perceptions of the Integral Part Networking Plays within Models of Innovation

There are many models created by theorists demonstrating the stages of innovative activity from the first shoots of a new idea, right through to the commercialised end product. One of the clearest definitions of the innovation process is given by Mackintosh (1994) as follows:

"New Idea + Commercial Exploitation"

The crucial distinction is that innovation covers the whole process of translating a new idea into commercial practice, and is not simply the generation of a new idea, thought
of as invention. Turner and Williams (1983) offered a model of what they describe as successful technological innovation which must embrace the whole process of invention and research through design, development planning and promotion to production, sale and use. The crucial parts of the model, (figure 2.1), are the feedback loops at each stage of the process. It is this range of communication that allows the model to progress at each level.

Figure 2.1 Turner and Williams’ Model of Technical Innovation

At the beginning, an identification of need is made by observing the market and questioning potential customers. User-supplier relationships have taken their first tentative steps. Secondly, the designer begins to formulate ideas as to how this need may be satisfied. Turner and Williams make the point that this first idea is not going to be the final solution. A long process of experiments and evaluation will be repeated until a connection is achieved between the creative idea and its practical application. This process of design-coupling or upstream management or any one of
several other labels is fundamental if the end product is going to be a commercially viable entity. The commercial realisation is integral to the definition of innovation given earlier.

Networking, in the form of feedback loops, allows for continual refinement and correction of products. The model even inserts a networking stage labelled *communication* as the prerequisite to *production*. The feedback loops are fundamental to the model and include not only user-supplier relationships but also in-house contacts, relating to everything from finance to marketing.

A second interesting model of innovative activity is put forward by Peters (1988), (figure 2.2), and focuses on the activities within the firm. He sets out his ideas for pursuing fast-paced innovation by adapting the work ethics of the firm. This newly adaptive firm will have a *Corporate Capacity for Innovation*, which he describes as a climate in which innovation is expected from everyone.

Peters’s argument for his newly adaptive firm is that in the past innovation was driven by centrally controlled research and development with big projects being the norm. He argues that such projects tended to be science driven and not customer driven. Recently, however, markets have become more diverse and changes in technology have accelerated causing *product and service development to turn on its head* allowing new competitors to appear. Therefore, for the firm to remain competitive Peters sets out a new strategy of innovation which he says is *marked by an explosive number of lightning-fast small starts that match the environments turbulence*. The guiding premise for his model is Application-Orientated Small Starts. In this new climate, expectant of innovation, in-house networking is vital. This he identifies in four key strategies which include the need for *"team product development"*. He argues that firms must be prepared to take ideas from any source, including competitors, and stresses the need for *systematic word-of-mouth marketing*. The academic buzz-word for this process is, of course, "networking".
The Guiding Premise

The Four Key Strategies

Management Tactics to Encourage Innovation

The New Look Firm

1-1: Invest in Applications-Oriented Small Stanzs

1-2: Pursue Team Product/Service Development

1-3: Encourage Pilots of Everything

1-4: Practice "Creative Swiping"

1-5: Make Word-of-Mouth Marketing Systematic

1-6: Support Committed Champions

1-7: "Model" Innovation/
  Practice Purposeful Impatience

1-8: Support Fast Failures

1-9: Set Quantitative Innovation Goals

1-10: Create a Corporate Capacity for Innovation

Figure 2.2 Peters' Model for Pursuing Fast-Paced Innovation

The third model is of the innovation chain created by Roberts (1989), (seen in figure 2.3), although it is more of a continuous process than a chain. It is a flexible model in which innovation can begin either with basic research, proposed by most linear models, or with customer demands. As in the previous two examples, this model draws attention to the interdependence of all stages of the process, demonstrated by the feedback loops. All stages of the development process are included from the
Figure 2.3 Roberts' Model of the Innovation Chain

- Basic Research
- Strategic Research
- Applied Research
- Manufacturing
- Development (Design for Manufacture)
- Selling
- Installation and Servicing
- Customer
- Marketing
initial idea to the commercialisation of the final product. As Simmie (1993) argues, if one is looking at the importance of innovation (in relation to economic prosperity), research should consider R & D expenditure and outputs (patents), as well as the production and subsequent diffusion of commercially viable products. This of course brings into focus all of the elements within the definition of innovation and the communication aspect of the whole process - networking in the form of user-supplier relationships, in-house and interfirm collaboration.

The three iterative models illustrated include all of the elements within Mackintosh's definition. They also all agree on the significance of communication, or networking, to the progression from an abstract idea all the way through to a commercially viable product. Even if the end product is not a successfully commercialised entity, the collaboration, whether in-house or between different firms, will have created a valuable bond for future activities.

2.6 Network Theory

Chesnais (1985) argued that technology transactions could not be satisfactorily dealt with in markets, and this has therefore pushed interfirm agreements to the forefront of corporate strategy. Indeed Cooke and Morgan (1994) make the criticism that present organisational theory does not adequately consider the network relations between firms and public or quasi-public intermediary agencies, this being especially important for SMEs.

Cooke and Morgan (1993) base their definitions of networking within and between firms on a table compiled by Boyer, which gives a synoptic presentation of the principles behind organisational forms of production, from Fordism through the intermediary period right up to flexible specialisation and the Post-Fordist era. Interfirm networking is given three main definitions:

• Close and long lasting ties between producers and users capture learning by using effects.
This has become critical in that technological change is constantly speeding up, products have shorter life cycles and markets are becoming more demanding. In products where strong tacit knowledge is required then close producer-user relations are of great importance. As Lundvall (1988) points out, learning-by-using can instigate further new products. He continues by saying that:

"Such bilateral network arrangements, with their exclusive two-way channels of informational trading and tacit knowledge transfer, appear to be assuming more importance in corporate strategy."

- Networking and joint ventures as a method for reaping both specialisation and co-ordination gains.

- Long run and co-operative subcontracting as far as possible in order to promote joint technical innovations.

The ever increasing technological changes in the market have convinced firms that they need to specialise to a greater extent, and so they sub-contract parts of the production process to others who specialise in a single part of the process. It has changed the whole production philosophy, in that contrary to the atmosphere of mistrust, a new air of co-operation, and as Lascelles and Dale (1989) term, a co-makership philosophy is establishing itself.

2.7 Networking and Flexible Specialisation

Wickham Skinner (1983), makes the connection between advancing technology and the methods of industrial organisation, (quoted in Piore and Sabel 1984, p. 262):

"We've seen shorter product life cycles, more productive proliferation, smaller order quantities. Now the new technologies, microprocessor based, have the ability to 'think', to react, to be flexible, to handle short runs, to handle product proliferation, to move an organisation much more quickly..."
Piore and Sabel identify four types of flexible specialisation; regional conglomerations, federated enterprises, small independent enterprises, solar firms. The first, regional conglomeration, relies on a sense of community for its cohesion, and institutions such as trade associations and unions to provide communal purchasing of raw materials and information. The second type of flexible specialisation is that of federated enterprises. Again, there is a strong sense of community holding firms together in a common interest. The final two are organised in terms of firms and subcontractors. This is particularly relevant to the high-tech industry as solar firms rely on the subcontractors for advice on design and production problems. This is because they do not make their products in their entirety, in-house.

A second idea explained by Piore and Sabel (1984, p. 270), is the encouragement of competition within a system of flexible specialisation. The recognition of common interests and mutual obligations does not rule out some form of power hierarchy. An example within the high-tech industry is given:

"A manufacturer of a component for the IBM personal computer knows that if the market grows too large, IBM will manufacture that component in-house; he or she will therefore have to shift attention to some other piece of equipment - unless it proves possible to outrun the giant competitor in the race for cost-cutting innovations."

Therefore, there is a constant search for new product and process innovations due to the subcontracting nature of flexible specialisation. It is particularly important for the smaller firms as losing a contract, such as the aforementioned example, can result in bankruptcy. This competition for cost-cutting innovation is not limited to subcontractors either, foreign competition and large corporate competition also intensify the process. Many Japanese firms and IBM reward innovation ideas among workers, further intensifying the whole process.

At a microeconomic scale, flexible specialisation places a stronger emphasis on the worker, and the level of innovative input and intellectual participation in the work
process, at all levels. It brings into focus the relationships between industry and educational establishments, something that is taken very seriously at the new technopole created at the University of Limerick in the Republic of Ireland. In Palo Alto California, universities have always been the source of workers, new innovatory research and the *organising centres of intellectual communities for the employees in the industry*. This critical intellectual networking is eloquently explained by Piore and Sabel (op cit. p. 287):

"...engineers and scientists employed in separate, often competing enterprises can share ideas, seek advice, and come to respect one another for the creativity and elegance of their innovations...the high-tech professionals have not only a common language, which accelerates the diffusion of ideas, but also a common set of standards - regarding the 'right' way to make money applying technology in the market. Thus, the university campus is like the corner café where Italian artisans solve one another's problems and share - or steal one another's ideas: a place where Proudhon might have taken Marx to show him where co-operation and competition meet."

### 2.8 Networks within R & D

Within R & D the networks formed between firms are used to minimise risks, share costs, and to increase the ability to respond quickly to new market opportunities. As Angel (1994) notes, there is a lack of research on the prevalence of such co-operation, or the *significance of emerging linkage relations for the location of production and for attendant processes of regional growth and development*. He concentrates his research on the linkages within the semiconductor sector of high-tech industry. He sees flexibility and innovation as becoming central to all aspects of both the organisation and geography of production systems. He cites research by Saxenian (1991) which argues that the prevalence of local collaborative linkages has a marked qualitative contribution to the profitability and innovative dynamism of high-tech firms.
Angel concludes his research by suggesting that firms are starting to establish closer relationships with their suppliers, enabling an increased information exchange and collaborative technology development programmes. However, he does not overemphasise the importance of locational agglomeration. A lot of linkages exist between large firms and contractors. Within the semiconductor industry the increased flows of information are the major advantage, whereby customers:

"...provide detailed forecasts regarding volume and type of product demand, provide early access to the specifications of next generation technologies and communicate their assessment of the strengths and weaknesses of suppliers."

(Angel 1994, p. 198)

Angel finishes by saying that strong collaboration, involving a commitment to work together in the long term, providing financial and technical assistance, is perhaps not so attractive to firms who are wary about combining their economic fortunes. It is the small firms that would participate in the majority, being the most economically vulnerable.

In an article entitled The Network Paradigm Cooke and Morgan (1993) investigate the networking activity between firms in the high-tech sector. They set out this paradigm as being different from both markets and hierarchies because:

"in network modes of resource allocation, transactions occur neither through discrete exchanges nor by administrative fiat, but through networks of individuals or institutions engaged in reciprocal, preferential, mutually supportive actions. Networks can be complex: they involve neither the explicit criteria of the market, nor the well-organised routines of the hierarchy...In network forms of resource allocation, individual units exist not by themselves, but in relation to other units...Benefits and burdens come to be shared...Complementarity and accommodation are the cornerstones of successful production networks."

(Powell 1990, p. 78)
The article looks at networks both from an organisational aspect and from a spatial dimension in terms of regional development. Networks, according to Chesnais (1988), can overcome the imperfections of the market and the rigidities of the vertically integrated hierarchy, therefore creating networking as the new corporate strategy.

The two aspects of networking are addressed in turn, looking first at connections within and between firms. The intrafirm arrangements have come to the forefront due to the ever-shortening life cycle of products, placing ever-increasing value on the commercialisation side of the enterprise. In terms of inter-firm agreements, much work has been done on the flexible firm and the Post-Fordist era. Producer-user relations are becoming more crucial due to the shorter life cycle of products and improving technology. Tacit knowledge transfer is now more important. The immediate feedback of information to the producer is essential.

The spatial element of networking theory is, according to Cooke and Morgan, increasing in value. Spatial proximity is becoming more important when considering such factors as economies of time. Maillot and Vasserot (1988) draw attention to the importance of regional context:

"If the relationships between public and private organisations concerning business services, finance, innovation, and training are co-operative then the overall performance of firms situated in such a regional milieu is better than it would otherwise be."

It is the SMEs that would benefit most, being able to meet the needs of their customers in respect to technology, product quality and the training of their workforce. A question mark must be raised over the heads of the large multinationals present in such a region. How much do they consider or even rely on the public-private interfaces described above? Do they have their own in-house people to deal with such matters?
Cooke and Morgan (op cit. p. 562) conclude by identifying the key elements of a networked region. It is perhaps these elements by which one should judge the effectiveness of a region under investigation. The five elements put forward are:

- public and private industrial support institutions
- high grade labour market intelligence and vocational training
- the rapid diffusion of technology transfer
- a high degree of interfirm networking
- receptive firms disposed towards innovation

There are still a number of problems that have to be overcome, even if most of the above elements are present within a region. There is the inherent mistrust and company loyalty to be reduced, so that subcontracting and the transfer of tacit knowledge can be implemented. Product and process innovations are closely guarded, especially within the pharmaceutical industry, where patents are markedly short, (starting at the beginning of the development process and not when the product goes onto the market).

A good example of successful networking can be seen in Japan, instigated by MITI, which tracks linkages and encourages co-operation between firms. It created *Inter-Industrial Networks for Technological Activities [INTAC]* and by 1986 almost 1000 of these had been created. They have flexible structures and encourage personal interaction and the sharing of resources to evolve naturally, so as not to create false relationships. The problem of secrecy has also been addressed with membership being limited to one or two firms from individual industrial sectors, thereby greatly diversifying the information being transferred (Cutler 1984, Eager 1985).

2.9 A Summary of the Spatial Importance of Networking

As I have shown, networking is becoming increasingly significant in the future corporate strategies of firms. It is most apparent within the high-technology industry which undertakes a great deal of research and development activity. With such a high
degree of importance placed on the creation of new product and process innovations research expertise is at a premium. Firms no longer have the full range of facilities in-house and so have to subcontract certain activities to smaller specialist firms within the vicinity.

Networking is affected by spatial constraints, at least where most SMEs are concerned. Multinationals have a wider range of options, due to their larger size, but even world leaders need to employ specialist research firms, as I will show. Such subcontracted research will also be spatially constrained in terms of convenience and accessibility.

These spatial constraints can primarily be shown by the agglomeration of similar enterprises within the same area, usually based on an educational presence. The major historical example is that of Silicon Valley, where the university spawned new firms from its research departments, as well as attracting new research laboratories to the area. It was a spatial meeting of like-minded research experts/enthusiasts. An environment of investigation and research interest was created, combined with the necessary facilities, contacts and potential initial markets.

The second spatial constraint is that of proximity to potential partners, customers and markets. The smaller scale SMEs need to be near to their customers for obvious functional reasons. It is a logistical decision for a firm to be near its market. In the case of the Malaysian Rubber Producers’ Research Association in Hertfordshire, the obvious location would have been in Malaysia, near to the source of the primary raw product. However, the need to be in close contact and proximity to customers, (firms like Pirelli), and the European market, proved to be a greater need.

A third spatial constraint concerns human resources. A lot of technology transfer is in the form of human capital. Workers carry a lot of functional information, such as methods of applying for funding contracts or specific personal contacts, inside their heads. This worker knowledge is often a personal store of information like a tacit product knowledge. To gain the benefits of this knowledge, interaction with the
person in question is vital. Such workers often move between firms or create their own, winning subcontracted research work on the basis of specific expertise and personal reputation. To gain the maximum benefits from these personal contacts and reputation the new firm needs to be in the same area. In this way a network is created in a particular location.

Perhaps a final less significant spatial constraint is that of address. Similar to the science park phenomenon of recent years, address can be very influential in obtaining contracts. An address quoting a business complex or established educational institution can be a good recommendation. As with the Silicon Valley example, an address close to Bell Laboratories or Stanford was a reasonable set of credentials.

2.10 Summary and Conclusions

- The economic debate about the value of Kondratieff Waves, named after the Russian Economist, has led to the widespread belief that technology and innovation could be the key to future Waves.

- Theories have progressed from the reasoning for innovation and its temporal characteristics, more toward the nature of innovative activity itself and its effect on the economy - very important in this time of the fluctuating success of the capitalist economy.

- A technopole is a city or sub-region which is the location for a concentration of both the inventive and the innovative elements of the innovation chain. If innovation and technology are so important, the careful planning of innovative regions, termed technopoles, could facilitate planned regional economic growth.

- In 1988 the DTI argued that innovation was essential for the UK to continue to compete in world markets, a prime way to facilitate innovationary activity is to create technopoles, evident in other European countries.
• The French example of Ile-de-France (Cité Scientifique) has exhibited a state-led decentralisation of industry, supplemented by a large educational presence. Continuing technology policy and networking activities have led to the region functioning as an integrated successful technopolitan development. The German region of Baden-Württemburg is an example of a successful technopole, exhibiting innovation policies addressing finance and technology-transfer issues. Considerable networking is evident on a regional scale.

• Using these two European examples, in conjunction with the theoretical concept of Smilor’s Technopolis Wheel, the potential for Hertfordshire to become a British technopole region can be assessed. The subsidiary question of networking activities within these regions will also be addressed.

• Rapid technological change and shorter product life cycles increase the importance of tacit knowledge transfer and closer user-producer relations.

• Greater specialisation is required in-house, with knowledge gaps being subcontracted out to specialist firms, creating a new air of co-operation, termed a co-makership philosophy.

• The new era of flexible specialisation brings into focus the relationship between industry and educational establishments.

• Cooke and Morgan put forward five core elements of a networked region; public and private industrial support institutions, high grade labour market intelligence and vocational training, rapid diffusion of technology transfer, high degree of interfirm networking, receptive firms disposed towards innovation.
CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Background Literature

There is a plethora of articles and books on the subject of economic development and theories of the importance of innovation to future economic growth. There also many articles written about the spatial importance of networking activities. There are several successful examples across the world that can be used to compare with Hertfordshire. I have chosen the two European examples of Cité Scientifique and Baden-Württemburg as there are many similarities that can be analysed, and also because networking plays an integral part in their success.

Therefore, I will look at Hertfordshire in the context of these two European examples. The premier hypothesis will examine the necessary elements of a technopole region and how far these are represented in Hertfordshire. The successes and failures will be identified concluding with the standing that Hertfordshire has in relation to a successful technopole model (taken from the profusion of literature on the subject), and the successful technopole in reality. The second subsidiary hypothesis will look at a spatial phenomenon identified in the two contrasting examples, and how important a role this networking plays in Hertfordshire. Two null hypotheses can be identified for the purpose of this research.

3.2 Hypothesis One

_Hertfordshire, as the prime British high-technology location, (using the location quotient identification), does not possess the potential to become a successful technopole in the same way as the two European examples._

This hypothesis identifies the component parts of the region and compares their density and integration on a scale relative to both Cité Scientifique and Baden-Württemburg, already established as successful European technopole regions.
In order to investigate this hypothesis, the business support institutions and the educational presence in the county will need to be identified and their effectiveness evaluated. An examination of the state approach is also needed to relate the situation of the county to the wider national outlook. If Hertfordshire is the prime location for the high-technology industry in the UK then does state policy identify it as such?

The presence of both the educational and business support institutions will then be compared to the two European examples and the success that they have had over the last decade. Possible reasons for any discrepancies will be identified and suggestions for its amelioration will be given in the context of my research findings.

3.3 Hypothesis Two

**Hertfordshire, as the prime British high-technology location does not exhibit a network of subcontracting and collaboration, especially focused on the research and development activities within the county.**

This second, and subsequent hypothesis focuses on a particular spatial element of the success of the two European examples, their networks of collaboration and subcontracting. For Hertfordshire to be successful it needs not only to have the infrastructure of business support and educational establishments but also the necessary levels of integration and contacts between the different elements. Research and development plays a big part in the high-technology industry, its success becoming more and more reliant on inter-firm collaboration due to the increasing specialisation of new research.

The spatial element of economic activity is important to the planner if regional economic regeneration is to be addressed. This hypothesis will be examined by creating a picture of the contact between firms and the business support institutions and educational establishments, and the reasons for this contact to occur. Inter-firm contact will also be examined to see whether firms in the same industrial sector can collaborate at a local/region specific level.
If Hertfordshire does not exhibit such a dense network of activity then ways of improving this situation must be examined. A case study of the pharmaceutical presence within the county is offered for a number of reasons. Firstly, it is one of the most successful industrial sectors in the UK, and is continuing to grow in terms of research and development investment, more than even the USA and Japan. Figures to illustrate this can be seen in the research contained in chapter four. Secondly it is the prime industry in Hertfordshire now that the defence sector is in decline, highlighted by the huge job losses recently at British Aerospace in Stevenage. Finally, Hertfordshire boasts the presence of the big four companies; Glaxo, SmithKline Beecham, Roche and Merck and Co.

3.4 Methodology

The first hypothesis takes the form of a Weberian “Ideal Type” analysis, briefly described in the introduction. This places the case studies in contrast to a model situation examining the discrepancies and the similarities. For this first part of the research Smilor’s Technopolis Wheel, containing all the elements for a successful technopole, will be set as the “ideal” with which to compare the relative positions of Hertfordshire and the two European examples, already established as successful technopoles.

The networking research had to be designed to cover all of the possible nodes of a technopole network, which have been identified in the review of existing literature in the previous chapter. As I briefly explained in the introduction, there is a fundamental hurdle to overcome in the measurement of network activity. There has to be a distinction between the everyday greetings of colleagues at work, and the conscious interactions between contacts from different firms. It is particularly difficult when questioning people about their activities, to get them to consider the implications of such inter-firm interactions, unless it has a quantifiable outcome.

Perhaps one of the most recognisable forms of inter-firm co-operation in tangible terms, is evident in the ball-park of EU funding programmes. This will have to be
addressed briefly, in relation to the current research, any further investigation would create a whole new research project on its own merits. The vast majority of these funding programmes require cross-border partnerships within the European Union. It is a different spatial scale but needs to be addressed.

The first method of research was a three-part postal questionnaire. This involved questionnaires to a wide sample of firms across the county in order to investigate whether there is a general environment of co-operation and collaboration. The sample of firms questioned was chosen using a combination of two classifications which categorises according to primary activities. These classifications were the SIC definitions and those of the CBI, in association with the business directory publisher, Kompass. The wider survey sample was restricted to high-technology and supply firms, primarily in the New Towns within the county; Hatfield, Hemel Hempstead, Stevenage and Welwyn Garden City, as well as Hertford, Hitchin, Letchworth and St. Albans. The survey sample size was 103 in order to get as large a response as possible. The end response rate percentage was 60% (62), quite good for a postal survey. I chose to look at the New Towns as they can be cited as one of the many similarities between Hertfordshire and the French technopole example.

The second survey involved questionnaires to the various county business support institutions such as the Chamber of Commerce and Business Link at St. Albans.

The final survey was focused on a particular industrial sector within the county. The pharmaceutical industry has a large presence within the county, dominated by the major multinationals; Glaxo, SmithKline Beecham, Roche and Merck, Sharp Dohme and Co. There is also a significant number of SMEs. The questionnaire survey aimed to find out just how much this industrial sector, steeped in research and development activities, accommodates interfirm and institutional collaboration in a bid to become market leaders.

The second method of research was in the form of semi-structured interviews. These were conducted with representatives of some of the business support institutions
within the county, and some of the firms involved in the case studies, firstly to augment the information obtained from the questionnaire survey, and secondly, to gather more detailed and firm-specific information.

3.5 The Sample

The sample of firms was chosen from the SIC classifications and that of the CBI. The sample included the research and design classification (94000) from the SIC, which is the core part of the high-technology industrial sector. However, I decided to take a wider view of the economy as well, using the CBI classification. This CBI classification used was primarily based on electronic and precision equipment firms (37-38), supplemented by chemical firms (31-32), engineering subcontractors (48), and those offering research and technical services (84-85).

The business support institutions were also questioned, generating a picture of the economic infrastructure of the county to compare to Smilor's necessary elements of a technopole. This will establish just how far Hertfordshire meets the recommendations for operating as a successful technopole, and how far it measures up to the already established French and German regions.

The pharmaceutical sector was chosen as the case study for reasons mentioned earlier in the chapter and for the dominant future economic position that I believe will emerge. The pharmaceutical sector, in my opinion, represents the major industrial influence within the county, due to the decline in defence contracts that formally dominated the area. The pharmaceutical industry is also becoming recognised as one that is being forced to subcontract and create inter-firm alliances due to the advance in, and change in nature of, future drug products. The sample frame was taken from the ABPI Directory of Members and augmented by the International Directory of Pharmaceutical Companies (1991), which provides names and addresses county by county for the UK, as well as the holding company. The sample frame consisted of 37 pharmaceutical firms within the county of Hertfordshire, many as subsidiaries of much
larger multinational pharmaceutical corporations. SmithKline Beecham, in particular, had several holding interests within the county.

3.6 The Caveats of the Research

There are of course the inevitable practical problems that occur with any research project of a reasonable size. In addition to this, there are problems specific to the nature of this particular subject matter.

The practical problems concern the response rate from the sample questioned. There has to be a compromise between ensuring a reasonable response rate and the cost of the survey. To ensure a better response rate from the postal survey an SAE was included, facilitating a reply. This proved to be quite successful as a response rate of 60% was achieved.

A second practical problem is finding a suitable respondent who would be able to give an appropriate answer that could be used. It is a distinct disadvantage when dealing with people in business that they are usually very busy and, therefore, often unobtainable.

There were practical problems of definition when looking at the networking aspect of this research. The research had to be carefully constructed to elicit information which would expose network activity and allow it to be measured. There was an initial problem that respondents sometimes confused the issue under investigation with the more common computer networks such as internet. Once this distinction had been cleared up responses became very useful.

3.7 Summary and Conclusions

- Hertfordshire, (due to its location quotient score), will be analysed in the light of a plethora of technopole and networking theory. A Weberian "Ideal Type" analysis will be used to examine the position of Hertfordshire when compared to Smilor's
Technopolis Wheel and the established regions of Cité Scientifique in France, and Baden-Württemburg in Germany.

- Two hypotheses will be used for this research looking at the potential of Hertfordshire to become a successful technopole, (if it is not already), and whether it exhibits one of the successful factors of European technopoles, intense region-specific networking between all the necessary elements.

- Three different groups will be surveyed; a wide survey of firms, the business support and educational institutions, and a case study of the pharmaceutical industrial sector.
CHAPTER FOUR: HERTFORDSHIRE: A THEORETICAL AND A EUROPEAN COMPARISON

The beginning of this chapter will set out a brief analysis of the theoretical model of Smilor et al. (1988). This will be used to assess the potential for Hertfordshire to function as a technopole. Secondly, as a preliminary to my research findings, a short historical and industrial background of Hertfordshire will provide the context of this study. The industrial approach adopted by the county until the Structure Plan is reviewed in the year 2011 is also described. There then follows the contemporary research of my first hypothesis, focusing on the elements theoretically described as necessary for a technopole.

To allow my findings in Hertfordshire to be put into context with reality, and not just a theoretical situation which may prove unreasonable, two successful European technopole regions will also be analysed at a comparative level. The regions of Cité Scientifique in France and Baden-Württemburg in Germany have already proved their success and so can provide a real life 'yardstick' for the potential of Hertfordshire as a British technopole region.

Finally, my second subsidiary hypothesis looks at the networking activities within Hertfordshire. It has been proved that inter-firm and institutional collaboration is an integral part in the success of the two European technopoles. If Hertfordshire is to become equally successful then it should also exhibit some level of networking.

4.1 Smilor's Technopolis Wheel

The Technopolis Wheel developed by Smilor et al. (1988) shows seven major groups of elements which, when spatially concentrated, should interact to generate self-propulsive economic growth. The seven elements can be seen in the diagram (figure 4.1). The elements coincide with education, business support institutions and state policy, as well as the firms themselves.
In the following analysis, I will compare the elements present in Hertfordshire and the two established European regions to those put forward by Smilor in the model. The comparative position that each area occupies in relation to the model will give a clear indication of how successful that region is, or could be, as a technopole.

4.2 Hertfordshire

Hertfordshire is the closest that Britain has come to a concentrated technopole region, basing this description on the clustering of high-technology industrial activities, and research and development plants. If it is the best example that we can offer then how does it measure up to established and renowned technopole regions of our European counterparts?
4.2.1 An Historical Overview

From as early as the 1930s Hertfordshire was a base for engineering and electrical manufacturing, specifically with the aircraft centres at Hatfield. Hertfordshire as a county is probably most famous for its New Town development during the 1950s-1960s. These New Towns; Hatfield, Hemel Hempstead, Stevenage and Welwyn Garden City were all built as model locations in which the decentralising population of London could be housed and work as a self-sufficient community. Areas were set aside for industry on purpose built sites well away from the residential zones. It was supposedly a planning dream to be able to create purpose built towns in the more recent post war era.

Such New Towns were greatly attractive to industry in its out-migration from London as an outdated and expensive industrial capital city. Many firms inherently influenced by defence contracts migrated westwards, into what has now been termed the Western Crescent, and northwards into Hertfordshire. These new locations were chosen due to the residence of military training bases such as that at Aldershot. The other major attractions of the area, apart from the conducive environmental features located in the heart of the Green Belt, are of course the exceptional transport links; road, rail and air all being adequately represented, ideal for moving goods to different parts of the country and the world.

Until recently, Hertfordshire has been dominated by the UK defence industry with firms such as British Aerospace and GEC Marconi in residence, to name but a few. Reacting to this influential presence of the high-tech defence industry, and due to the attractive environment provided by a county in the Green Belt, firms in the high-tech sector began to cluster in this location, locating not only their headquarters but also the more prestigious Research and Development facilities.
Transport Links

Environment

Figure 4.2
Hertfordshire's Assets
4.2.2 The Hertfordshire Economy Today

Today with the decline in the post Cold War defence contracts, Hertfordshire can no longer rely on the guaranteed defence market to sustain and underpin its industrial activities. The county now has one of the highest growth rates in unemployment in the South East, along with Surrey. In fact, the unemployment level reached a high of 10% (44,000) in 1993. In recent years British Aerospace at Hatfield has closed down followed by further huge job losses (600+) at the Stevenage plant. With the continuing defence sector job losses and the concern about filling vacancies in the expanding pharmaceutical sector employment is a big issue in the county.

One of the major problems facing Hertfordshire today, apart from the end of Cold War contracts, is that it is dominated by several large firms, especially in the pharmaceutical sector, which, if it became an issue, would probably have no real allegiance to the county. These firms are huge multinationals in nature and could close their Hertfordshire based branch plants and relocate elsewhere, where rents are cheaper. The one major exception to this is the new Glaxo Medicines Research Centre recently completed in Stevenage. It is a multi-million pound development that represents a serious commitment to this location. Indeed, Glaxo is now instigating a take-over of the fellow research company, Wellcome, to become one of the major UK multinationals. It is these firms in the pharmaceutical sector which, I believe, have taken over the mantle of the county’s leading light for industrial activity. It is, therefore, these firms which should be seen as the manufacturing and research base of the county, and as such should receive adequate attention.

4.2.3 Hertfordshire as a Focus for the High-Tech Industry

Hertfordshire has been chosen as the focus of this research as it has the highest location quotient score for high-tech industry within the UK, (as I described briefly in the introduction). The location quotient is a measure of the number of jobs within different industrial sectors in certain locations, in this case by county. The number of jobs within the sector being studied is compared in ratio form to the number of jobs
across the whole country. The number generated is then compared to the national average. An average score is considered to be equal to one. Therefore, scores above one are believed to indicate a greater concentration of jobs in the sector, in the location being studied. Hertfordshire has a score of 3.6 when its high-tech employment is compared to the rest of the country. It is, therefore, well above average.

The high-tech sector has traditionally been the source of major R & D activities. The defence industry instigated the clustering of high-tech firms and research and development activities, and has now been superseded by the pharmaceutical sector, again a “hot-bed” of R & D activities. The common employee profile attracted is of highly skilled, well paid graduates. This of course justifies strong links to educational institutions, at the very least for potential recruitment, or maybe joint research projects. Whether this actually happens in the Hertfordshire locality, or is less locationally specific, needs to be addressed.

It is this high profile presence of research and development establishments that makes Hertfordshire a prime candidate for networking activities. As well as the multi-million pound Glaxo development at Stevenage other research institutes can be found. Establishments such as Crosfield, the Building Research Institute and the Malaysian Rubber Producers’ Research Association also reside in Hertfordshire. There must be good reason for them to have stayed in the county, even if the original decision for location is now irrelevant. To illustrate my point, Glaxo originally settled in Hertfordshire due to its founder having a liking for the place. More recently, however, such multi-million pound investment has to be based on factors involving infrastructure, communication and markets.

In the case of the Malaysian Rubber Producers’ Research Association, location was decided by the presence of research partners and the potential market for its research, involving companies like Dunlop and Pirelli. With a network of contacts in the vicinity, Hertfordshire was an ideal location in which to settle.
4.2.4 An Industrial Strategy for Hertfordshire

Hertfordshire is currently seen as a “restraint” county not in the business of promoting big development, but rather preserving its image as a green county, offering an attractive environment for the highly skilled workforce which is required by the high-tech industry.

The county has two major problems as I have outlined briefly. The first is the phenomenon of overheating caused by the boom period of the 1980s, which primarily affected the service sector domination of the South East. The second problem concerns the sizes of firms within the county. The majority of firms in Hertfordshire are of a small size (90%), employing fewer than 50 employees, with a further 3% employing more than 100 employees but accounting for 44% of total employment in the county (Bright Green briefing paper 1993). These large, dominant firms include the afore-mentioned pharmaceutical giants.

Because of this huge skew in economic activity within the county, a pro-active approach is needed, and indeed has been adopted. The county’s Partnership for Prosperity initiative is a case in point. It was created to unite service-providing organisations in order to form a working partnership on Hertfordshire’s changing economic structure. Founder members included the County Council, the Chamber of Commerce, the DTI and the DOE. This is a good base on which to build a workable network of industrial activity within the county.

The Bright Green Strategy looks at the county’s activities from a number of viewpoints including; business space, industrial characteristics and the quality of life factor provided by a county in the Green Belt. As the briefing paper says:

"...a vision which combines the forces directed towards a post-mass production and environmentally sustainable economy and which places emphasis of quality of life issues is most likely to maximise Hertfordshire’s
The **KISS Strategy** (Knowledge Innovation Skills Service), that has evolved from the Bright Green paper emphasises these networks of industrial support and the overwhelming presence of research and development activities within the county. **Knowledge** refers to the industrial support institutions, aiding firms in their bids for European funding as well as other functional support. **Innovation** refers to the research and development presence in the county. Innovation is seen as the key to future economic prosperity, looking not only at product innovation but also such things as user-producer relationships. **Skills** refers to the need for *life-long* learning reinforcing the need for strong links between industry and education. Finally, **Services** refers to the dominant sector of industry, involving the subcontracting out of research and business activities.

### 4.3 Hypothesis One

This hypothesis will be investigated in three parts, forming a detailed comparison of Hertfordshire with the two European examples. A brief overview of the situation was given in chapter two. This will be continued in the light of this research. The presence and, more importantly, the function of the business support institutions will be examined, followed by a similar look at the educational presence in the county. Lastly, the effects and influence of state policy will be examined, particularly important as Hertfordshire has been greatly influenced by the Cold War defence contracts in the past. Reference will be made to the ideal model put forward by Smilor et al. (1988), as to the elements of a successful technopole.

#### 4.3.1 The Business Support Institutions

The principal “business support institutions” within the county can be identified as follows; the County Council, the Chamber of Commerce and Business Link. Their
activities will be examined briefly and their effectiveness as a whole will be compared with their counterparts in the two European examples.

The County Council, or more specifically the Economic Development Department of the County Council, has attempted over the last few years to take a very proactive role in ameliorating the economic disparity within the county, left by the folding of the Cold War defence contracts, which guaranteed many firms within the county a reliable market for their products. Much research has been commissioned in order to discover the strengths of the county and in particular the effect of European funding programmes designed to help research and development projects. As I explained earlier the Bright Green Industrial Strategy was adopted. The Partnership for Prosperity scheme was also proposed.

The county is described as a “green and verdant county north of London”, and as such was allowed a laissez-faire policy of economic planning for many years. The defence contracts provided guaranteed markets for firms such as British Aerospace, Lucas, and GEC Marconi. The Green Belt was to be preserved in an attempt to keep the type of environment desired by highly skilled workers employed within the high-technology industrial sector. It therefore came as a significant shock when unemployment rose from 2.5% (1989) to 9.6% in 1993, Mort and Woolley (1994, p. 58). It was a shock to the arrogant complacency of the county. The laissez-faire approach was no longer good enough.

The Partnership for Prosperity scheme adopted a three point strategy. This was as follows:

- Raise education and training standards
- Promote the development of key sites
- Attract local and inward investment

According to the Economic Development officer at Hertfordshire County Council, this scheme has been very successful, achieving a succession of joint ventures.
Education has been addressed by focusing on the young people of the county in an effort to raise their skill level, particularly important given the nature of much of the prominent industrial activity within the county. As well as this, the former British Aerospace defence site at Hatfield has seen a £50 million investment. It is currently under consideration for a "waste-to-energy" site where waste disposal is used to generate electricity. The single regeneration budget has also increased to £5.5 million. Business Link Hertfordshire has also been set up, which I will examine later.

The Bright Green Strategy is being used as the action plan for Hertfordshire up to the year 2011, until the Structure Plan is reviewed. I have already mentioned the quality of the environment in the county. The Green Belt is important, and is obviously protected, but the complacency of the "our green county is full to new economic activity", at a time when many regions are clamouring for new economic activities to bless them with their presence, has disappeared. Now this environmental concern lies alongside a strategy for an improved educational presence and an increased concern for business competitiveness.

This improved business competitiveness identifies three main avenues of approach; innovation, business support and fair and open markets. The innovation element ties in with the justification for this research. Innovation is seen to promote faster growth and with Hertfordshire's research and development presence, the county is looking to maximise the potential of the multiplier effect. The key idea is that to maximise the potential of the multiplier effect in Hertfordshire's favour a local network of contacts and collaboration must be in place. Otherwise the significant multinational firms present in the county will maximise the multiplier effect but on a national or international level.

The instigation of the national program of Business Link is a recent addition to the business support infrastructure. It was created in January 1994 as a one-stop-shop network and is funded nationally by the DTI and the network of TECs. It has three main objectives. These are as follows:
• To be a first point of business contact
• To maintain a standard of access and quality
• To improve the growth and competitiveness of firms

The idea behind its creation is to eliminate the customer confusion about the plethora of potential business support institutions which supposedly exist for firms, creating a single point of business contact. For the county of Hertfordshire, this would be Business Link in St. Albans. It would recognise the fact of global competition, especially in the light of the multinationals present in the county. Hertfordshire has to be internationally competitive if its resident research and development establishments are to remain in the county and are to remain successful.

Business Link co-ordinates the business support activities and works in partnership with the County Council, Chamber of Commerce, the TEC and the University of Hertfordshire in an effort to target business support, primarily for the SME population of the county. The size of targeted firms is between 10-250 employees. Its role is both proactive and reactive depending on the needs of different firms. Certain groups are targeted in the county, specifically the manufacturing presence.

The Hertfordshire Chamber of Commerce and Industry, as with all local/region specific Chambers, is made up of representatives of industry and other business support institutions. Members are not, however, restricted to Hertfordshire. Members come from all sectors of the economy. There also existed a Hertfordshire Chamber of Trade and Commerce but this is now defunct. One of the important functions of the Chamber is to aid firms within the county with the exporting of their goods. An Export Association is run in conjunction with the Chamber providing export documentation.

4.3.2 The Educational Establishments

Within this category of investigation it is also necessary to include those research establishments present in the county. This is because Hertfordshire does not have
quite the density or depth of an educational presence when compared to the two European examples. The main educational establishments can be seen as the Hertfordshire TEC (Training and Enterprise Council), the University of Hertfordshire, Hatfield University, and several further education colleges. It should be noted that there are only two universities (both recently upgraded from polytechnic status), compared to the multitude of top-level establishments in both Cité Scientifique and Baden-Württemburg.

The Hertfordshire TEC is very important to Hertfordshire, as is the complete national network of similar TECs in other regions. Described in Hertfordshire, your county (1992), Hertfordshire TEC:

"...aims to change attitudes to training and enterprise, develop employment skills, maximise labour resources and promote business development. It provides a range of services to individuals and companies, including the government's Employment Training, Youth Training, Enterprise Allowance and Business Growth Training schemes. The TEC also works in partnership with other agencies to provide training and enterprise services in the county."


The TEC was set up in 1980 by a group of senior executives in local industry in response to a government initiative, and is part of a national network. It is funded by government funds and local sponsorship. The TEC helps and advises on training, with specific courses for the high-technology sector such as the management of design and applied manufacturing technology.

The second establishment is the University of Hertfordshire, present in the county for more than two decades, although only recently upgraded to university status along with the many top level polytechnics in this country. The university is a multi campus establishment with different schools of study across the county, at St. Albans and Hatfield for example. It has historically provided education related to the aerospace industry, but is still significant to many economic sectors of the Hertfordshire
There is quite a strong scientific representation, particularly at postgraduate level. Much of this science, however, concerns the natural sciences, more applicable to biotechnology than the chemistry and physics of laboratory technicians in the pharmaceutical industry. It is relevant, however, for the new genetics-based areas of research into which the industry is moving. Glaxo, for example, has many bio-technology relationships in the USA. The university also has several limited companies which carry out various subcontracted work for local companies. The other education establishments in the county include Hatfield University and the further education colleges which all have close relationships with the university.

The research establishments in the county include the Malaysian Rubber Producers' Research Association, the Building Research Establishment and Rothhampstead Experimental Research Station. The first, the Malaysian Rubber Producers' Research Association is a Malaysian interest, located in Hertfordshire due to the greater need to be close to its European market and not the rubber producing region of Malaysia. Current research projects are as diverse as looking at rubber bearings to make buildings earthquake proof and designing new rubber moulding for racing car engines. Both projects have been involved in the European funding programmes. The Building Research Establishment is exactly as it sounds, researching new building materials and designs. It too has been involved in the European research programmes.

4.3.3 Recent State Policy and its Current Aids to Innovation

The Cold War commitment to defence spending has obviously been the dominant factor of state policy for many years, that is until now. However, this legacy will still continue for a few years to come. Figures from the EC Statistical Office 1987 (PSI 1991, p. 226), show that about half of government funded research and development is devoted to defence, leaving far smaller proportions for universities and industry.
<table>
<thead>
<tr>
<th></th>
<th>Britain</th>
<th>Germany</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defence</td>
<td>48.4</td>
<td>12.7</td>
<td>34.2</td>
</tr>
<tr>
<td>Universities</td>
<td>16.5</td>
<td>29.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Industry</td>
<td>9.0</td>
<td>15.6</td>
<td>10.7</td>
</tr>
<tr>
<td>Energy</td>
<td>3.7</td>
<td>8.8</td>
<td>6.7</td>
</tr>
<tr>
<td>Other</td>
<td>22.4</td>
<td>33.0</td>
<td>36.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Table 4.1** Government Funding of Research and Development (figures as % of total)

It is this defence spending that has created a successful high-technology sector within Hertfordshire on the backs of British Aerospace, GEC Marconi and Lucas.

The DTI, (Department of Trade and Industry), is the primary tool of regional government policy for industry. It has a particular section devoted to the high-technology sector, focusing on *Innovation, Technology and Change*, with its own "Innovation Enquiry Line", among other initiatives. The DTI visualises innovation as:

"**Innovation - the commercial application of knowledge or techniques in new ways or for new purposes - is important in every business. It is not necessarily about thinking up new things in the first place but about exploiting opportunities profitably and ahead of competitors.**"

(Innovation, Technology and Change 1992)

From this definition the DTI set out the following:

- managing change to allow new ideas, new technology or new opportunities for improvement to flourish.
- improving your application of skills and technologies to processes, products or services to increase profits or competitive advantage.
- improving many small aspects of research and development, design, production and marketing as well as thinking about step changes.
- adopting and adapting other people’s ideas to improve your competitive advantage.
• that every business can innovate - not just the “high-tech” (sic) ones.

Taking these five initiatives as a platform, the DTI produced three types of help directed at a range of firms, from SMEs to multinationals.

The first type of help is consultancy services. This is split into two sections, the first giving help with introducing or improving the use of new technology, and the second focusing on solving the problems that arise with the day-to-day uses of technology.

The second type of help is the DTI’s technology transfer services. This is carried out by the DTI by:

• offering direct help through specific programmes.
• supporting the development of Regional Technology Centres (RTCs).
• assisting the development of Europe-wide programmes.
• providing specific help through its Research Agencies.
• assisting groups of UK experts to visit overseas countries to study new technologies.
• supplying information about technological advances overseas.

The regional Technology Centres are in fact the regional DTI offices, perhaps a misleading pseudonym. There are four DTI Research Agencies providing scientific and technical services on a fee paying basis. There is currently one in Hertfordshire, the Warren Spring Laboratory, Stevenage.

Finally, there are the grants for research and development. Most of these, as with the European funding, involve collaboration between different firms or between firms and educational or research establishments. However the DTI recognises that SMEs may be working with few resources and may prefer to work independently so tailors some grants accordingly. One of the primary objects of the grants, therefore, is not to encourage collaboration as in Europe, but to improve the competitiveness of the firm.
4.4 Cité Scientifique Ile-de-France Sud, France

Several authors have described and compared the French example, mainly due to the proximity and comparability of Britain and France. Cooke (1985) looks at regional innovation policy in France 1961-1976. He states that innovation policy in France is not a recent phenomenon. It was guided by two different agencies set up in the late 1950s, early 1960s; the Délégation Général à la Recherche Scientifique et Technique (DGRST) and the Délégation à l'Aménagement du Territoire et à l'Action Régionale (DATAR), the latter being the French regional planning agency. The innovation policy concentrated initially on the decentralisation of key public sector industries from the capital. This was intended to create economic growth in the Ile-de-France region, South of Paris. First to be decentralised were the government chemical and atomic research laboratories, to be followed by others in the private sector.

The most obvious example of technopolitan development is the Ile-de-France region, (Decoster and Tabaries 1993). In particular the South Ile-de-France Scientific City (Cité Scientifique Ile-de-France Sud) is a good case study area, where high technology parks and economic activity zones have been created. Cité Scientifique is located in the Ile-de-France region’s southern axis, formed by the three new towns of St-Quentin-en-Yvelines, Evry and Melun-Sénart, and the north west of the département of Essonne from Saclay-Orsay to Massy. It is here that there is the highest concentration of scientific activity, so significant that a local structure plan has been proposed to establish the Saclay Plateau area as a technopole.

Pecqueur and Rouzier (1991) believe that the South Ile-de-France technopole has the fundamental properties essential for the development of a “technological district”. This is explained by Decoster and Tabaries as:

“...a dense and diversified industrial structure made up of small and medium-sized firms (SMEs) and numerous large enterprises, and a local business ‘milieu’, situated in a large urban agglomeration which provides high-level
Figure 4.3 The Ile-de-France Region
Paris and Cité Scientifique [Below]
tertiary and urban services."  

(Op. cit p. 83) 

However, it is stated that there are said to be deficiencies in terms of transport and communication links, something not experienced by Hertfordshire, but not perceived as a major problem by the authors. The bid for a new Eurostar station will probably alleviate this situation. There is also said to be a character deficiency created by over-suburbanisation and the presence of university campuses. In my opinion, the educational presence is an integral part of the functioning of the region and, therefore, should be seen as an advantage.

At least 20% of the employment in the region is made up of industrial design activities. The employment characteristics and spatial structure are determined by the dominant presence of the large establishments and large firms in the region, despite the wide SME economic base. The South Paris scientific agglomeration has a very specific range of activities according to the authors:

"...is strongly specialised in activities involved in the production of special equipment (automatic industrial equipment, medical equipment, aerospace equipment, instruments, apparatuses) that combine different technologies such as optics, electronics, hydraulic engineering and mechanical engineering."

(Op. cit p. 85) 

The region has a fairly recent industrial history, dating back only to the 1960s. It began with a period of decentralisation from the capital, Paris, and continued with an economic polarisation around the high-technology presence. The economic base has been strengthened by the agglomeration of SMEs innovating in specific market niches and the reorganisation of large industrial groups spawning subsidiaries. Continued growth has occurred as a result of the dualistic pressure of decentralisation from Paris and incentive from DATAR. The region’s successful image has also had an effect encouraging the influx and creation of many educational institutions.
The economic polarisation around the high-technology industrial sector was initiated by large decentralised production and research establishments which are sources of knowledge, founders of firms, human resources and know-how as well as a market for high-technology. The South Ile-de-France region, like Hertfordshire, has large electronics firms and aeronautical and telecommunications establishments, as well as many SME service and industrial firms. These SMEs were attracted to the area by several factors including the image of the region, the significant educational presence, the skilled labour pool and the quality of the environment.

The region has a very large research concentration, particularly in the public sector, originating from the decentralisation of various establishments in the late 1950s. Such establishments included the Centre of Nuclear Research (Centre d’Etudes Nucléaires) and the National Centre of Scientific Research (Centre National de la Recherche Scientifique). At the same time the Orsay university complex was created. Subsequent public research decentralisation continued, to be joined by some private sector representation and a multitude of educational establishments. Crucial factors necessary for successful networking activity to occur were beginning to cluster together. Particular research areas of importance and excellence have emerged and include mechanical engineering, biotechnology and computing.

Large national technological programmes exist in France which have directed and shaped the scientific potential of the region, according to Decoster and Tabariés (op. cit 1993). In particular the relationships between public research and industry have been addressed through the creation of large sectoral research organisations (CEN - the nuclear sector, CNET - telecommunications, and CNES - space research). Some similarities to the industrial presence in Hertfordshire can be seen. The major partners to the public research organisations have been the large firms, leading to extensive networking within the region:

"In the last few years...there has been a very important development in these laboratories of industrial collaboration and the emergence of locally-rooted partnerships. This phenomenon has particularly characterised university
research teams because of the links that their role in education gives them with the world of industry and because of their lack of resources...Various studies have shown that geographically localised networks have been created in the South Ile-de-France between innovative firms and between firms and research centres creating a complex of economic and technological interdependencies, incubator phenomena and synergies. In the Ile-de-France innovation system technological collaboration networks are dominated by multinational firms and large specific-purpose research centres.”

(Op. cit p. 92-93)

Hertfordshire too, has its share of multinationals and research establishments. However, the educational presence in the county is not as extensive.

It might be prudent at this point to elaborate on a particularly successful networking example within the region, for reasons of comparison with Hertfordshire. The Saclay Nuclear Research Centre (Centre d'Etudes Nucléaires - CEN) has close relations with many public research centres in the region and a long tradition of subcontracting and more recently a policy of technology transfer by means of spin-offs and partnerships. As a result, local economic development and the local innovative milieu have been strengthened. Information is provided for other firms in the same or similar industrial sectors and technical co-operation occurs through new firm formation, research contracts or the granting of licences. At present the CEN is establishing links between itself and the universities in the region by transferring their research teams from Saclay to the universities.

The region also has an institutional support framework. Set up around 1985, the Regional Centres for Innovation and Technology Transfer (Centres Régionaux pour l'Innovation et le Transfert de Technologie - CRITT) help SMEs to innovate by linking them with a research centre and finding finance. Placed throughout the region they diffuse the positive effects of the innovative environment that has been created, in order to widen and strengthen the networks of activity.
Decoster (1993), in another paper, expresses concern about the diminishing status of regions outside these new growth technopoles, i.e. the older, traditional industrial areas, a concern similarly expressed by Hall. She argues that more attention should be paid to the diffusion of this growth dynamic from these technopoles into other areas, especially within the region concerned.

4.5 Baden-Württemburg, Germany

Baden-Württemburg in Germany is a second European example that can be studied. Unlike the French example and Hertfordshire in the UK, Baden-Württemburg has a long history of industrial support, dating back to the 19th Century. Detailed by Hassink (1992), the innovation policies of this region are split into several categories; financial incentives, economic development organisations, technology transfer and technology centres. Their spatial scale of influence can be seen below:

<table>
<thead>
<tr>
<th>Financial Incentives</th>
<th>Level of Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>technology policy</td>
<td>#</td>
</tr>
<tr>
<td>Econ. Devt. Organisations</td>
<td>#</td>
</tr>
<tr>
<td>consultancy offices</td>
<td>#</td>
</tr>
<tr>
<td>chamber of commerce</td>
<td>#</td>
</tr>
<tr>
<td>Technology Transfer</td>
<td></td>
</tr>
<tr>
<td>Steinbeis Foundation</td>
<td>#</td>
</tr>
<tr>
<td>Technology Centres</td>
<td>#</td>
</tr>
<tr>
<td>see map</td>
<td>#</td>
</tr>
</tbody>
</table>

Table 4.2 The Spatial Scale of Baden-Württemburg’s Innovation Policies

The networking activities within the region are of vital importance:

"Embedded in the framework of the federal and European technology policy, Baden-Württemburg’s technology policy measures apply to fields in which organisational and spatial proximity are essential. Therefore the support of small and medium-sized enterprises and technology transfer are of major importance. Baden-Württemburg has developed an innovation consultancy
Figure 4.4 The Baden-Württemburg Region of Germany
network that has been used as a model by other states in Western Germany."

(Grotz 1989, quoted in Hassink op. cit p. 106)

4.5.1 Financial Incentives

Because the general federal technology policy did not address the specific regional economic problems, Baden-Württemburg created its own technology policy programme. This programme was supported by three financial pillars:

- support for the public research infrastructure
- technology transfer (discussed in part 2.5.3)
- technological aid schemes focused on individual firms

The technology aid schemes covered everything from help for businesses to start-up, to support for the use of modern technologies and business development. The decision was taken to use the State Credit Bank of Baden-Württemburg as the central organisation, creating a user-friendly framework of financial support for local firms. The Federal Government also has a large input with the Government Commissioner for Technology Transfer, evaluating the suitability and progress of all financial applications.

4.5.2 Economic Development Organisations

Technology transfer has become the core of technology policy within Baden-Württemburg as the region thrives on the diffusion of new technology rather than its development. This situation has necessitated a technology transfer network spread over the whole state. Again, this network can be divided into three groups:

- consultancy offices managed by economic organisations
- technology centres
- consultancy and transfer centres
The consultancy offices concentrate on general economic advice, and are managed by such economic organisations as the Chamber of Commerce. They play an integral part in constructing networks of experts and SMEs as well as lobbying to attract further research centres.

The Chamber of Commerce is particularly effective as it is German policy for all firms to be a financial member creating close economic links. The Chamber of Commerce is seen as an integral part of the region providing information on technology and cooperation, solving business problems, and advising on financial assistance and the available research centres in the region. A whole network of contacts has developed consisting of public research centres, technology transfer centres, consultancy firms and other firms within the region. A particularly successful activity has been the development of a database of possible contacts and supply and demand needs, and the presence of Innovation Consultants paid by the Ministry of Economic Affairs and Technology of Baden-Württemburg and the Chamber of Commerce.
4.5.3 Technology Transfer

The technology transfer centres are based on links with the educational and research presence within the region. The educational presence, as in the French example, is massive. It consists of nine universities, fourteen Fraunhofer Institutes, three "Grossforschungsinstitute", ten industrial co-operative research institutions and six institutes of applied research. Such a list rather puts the educational elements of Hertfordshire to shame. All technology transfer centres are linked to the polytechnics of the region.

The Steinbeis Foundation is considered the most important organisation for technology transfer in Baden-Württemburg, (Charbit et al. 1991). The Foundation was created in 1971 so it has had two decades to develop and expand the technology transfer between firms and knowledge centres. The polytechnics are integral to this process. The rate of growth of the Foundation is an indicator of its success. The Government Commissioner for Technology Transfer is also the chairman of the Foundation giving it some influence over state policy decisions. The Foundation has taken both a proactive and reactive stance on the creation of transfer centres in an attempt to produce a comprehensive spatial coverage of the region. These centres have three main activities:

- general consultancy services
- technology consultancy
- research and development

The managers of these centres are generally professors at the local polytechnics, selected, among other requirements for reputation. There are currently 98 centres connected to polytechnics, their growth attributed to increasing specialisation and new professors wanting additional centres of their own. All activities are overseen by a headquarters in Stuttgart, additionally advising with general advice on financial aid both within and outside the region. The spread of the transfer centres and the Chamber of Commerce consultancies can be seen on the map, (figure 4.6).
Figure 4.6 The Steinbeis Network in Baden-Württemburg

4.54 Technology Centres

Support for these centres is part of the official technology policy of Baden-Württemburg. A system of spin-offs from the educational and research establishments of the region are expected to speed up technology transfer, with centres helping local authorities to create localised economic development. Main effects of the schemes have intensified the concentration of highly skilled jobs, but have also allowed suppliers in the region to become more innovative. Mikus and Mitsch (1986) have described the conditions for a successful centre:
• availability of knowledge centres
• high density of firms (sufficient demand)
• specialisation of firms in the centre in research fields that are well represented in the regional production structure, in institutions of higher education and in research centres

In other words research conducted by firms should be comparable to that being undertaken by the educational establishments in the vicinity so that possible collaboration could occur.

Cooke and Morgan (1993) have also looked at this region, finding some striking similarities with Hertfordshire in England. Just as in Hertfordshire, there is a combination of large multinational firms and a large, dynamic population of SMEs. In Baden-Württemburg the large firms include Daimler-Benz, Porsche, Bosch and Hewlett-Packard. Hertfordshire can even boast large firms of the same sector, Glaxo and Smithkline Beecham, both of which are multinational pharmaceutical companies.

In Baden-Württemburg, although these large firms have many dealings outside the region or Germany itself, a large proportion of suppliers can be found within the region. It remains to be seen if the same can be said of the relationship between Hertfordshire and its pharmaceutical residents.

In conclusion then, the policies of the region appear to be quite successful. Aid is mostly directed at the smaller size range of firms (SMEs), and although the urban areas dominate, the rural areas are beginning to attract more help and jobs. Many firms benefit from the technology transfer network, increasing their innovativeness. External knowledge plays an important part with relationships between universities and polytechnics very strong. Research and development activities can be subcontracted to specialist personnel, enabling an optimisation of firm development. The region seems to have struck a good balance between firm size and activity, with many of the SMEs also benefiting from the presence of the large multinationals. In
turn the multinationals will be inclined to remain in the region to maximise their benefits from a large supply base.

There is, however, a note of caution when evaluating these policies, voiced by Cooke and Morgan (1990, p. 31) when they say:

"Public policy in Baden-Württemburg appears so successful because it aims to help firms which are willing and, above all, able to help themselves."

This means that if a technopole is to have a chance to establish a successful network of producer-user relationships, including such things as training and education, vital to the high-tech industry, then companies must be prepared to strike up such alliances. At the end of the day it is for their own benefit, as can be seen in Baden-Württemburg.

4.6 A Comparison between Hertfordshire and Other European Technopoles

At first glance there seem to be several similarities between Hertfordshire and the examples of Baden-Württemburg in Germany and the Cité Scientifique in France. There are five main categories of comparison that can be identified.

Firstly, the type of firms resident in the three regions can be compared. All three have a broad economic base of SMEs which accompany a significant presence of multinational firms. In Hertfordshire, as I have detailed earlier, the economic base of the county has large representation within the pharmaceutical, aerospace and electronics sectors. In France, Cité Scientifique also has a significant representation of biotechnology and pharmaceutical, aerospace and electronic firms. Baden-Württemburg is in a similar situation. The comparative situation can be seen in table 4.3.
<table>
<thead>
<tr>
<th>Industrial Sector</th>
<th>Examples of Multinationals</th>
<th>State Industry, State Establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hertfordshire</td>
<td>Aerospace, Electronics, Pharmaceuticals</td>
<td>Warren Spring Laboratory (relocating)</td>
</tr>
<tr>
<td>Cité Scientifique</td>
<td>Aerospace, Electronics, Data Processing, Telecommunications</td>
<td>CEN, CNET, CNES</td>
</tr>
<tr>
<td>Baden-Württemburg</td>
<td>Electronics, Automotive Industry,</td>
<td>Max-Plank Institutes, Fraunhofer Societies</td>
</tr>
</tbody>
</table>

Table 4.3 The Comparative Economic Situation in the Three Regions

The second area of comparison is the relative success and density of business support institutions such as the Chamber of Commerce and the County Council in Hertfordshire. Cité Scientifique has the regional centres for innovation and technology transfer (CRITT) which help SMEs to innovate by linking them to research centres and finding them financial help. Decoster and Tabariés (1993, p. 99) view the situation as a problem of a *surfeit of institutional actors*, which include the regional prefecture, Cité Scientifique itself and the DRIRE (Direction Régionale de l’Industrie, a la Recherche et a l’Environnement - regional directorate of industry, research and the environment). They have, however, combined to create an initiative designed to help firms start up. This includes a practical course for potential founders of firms. There is also the DGRST and the DATAR which have encouraged the decentralisation of government research laboratories, and those in the private sector, to the region.

In Baden-Württemburg there is also a large institutional influence, perhaps the largest of the three regions being examined. Specific institutions have been created in the region purely for the purpose of aiding high-technology firms in a technopole environment. To illustrate this the Steinbeis Foundation, which could be called an overseer of regional technology networks, ‘controls’ a Ministry of Economic Affairs...
and Technology of Baden-Württemburg and a special Government Commissioner for Technology Transfer. It is probably unthinkable that such a position would be created at such a high level in the UK. The comparative situation can be seen in table 4.4.

<table>
<thead>
<tr>
<th>Hertfordshire</th>
<th>DTI, Business Link, TEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>County Council, Chamber of Commerce</td>
</tr>
<tr>
<td>Cité Scientifique</td>
<td>DATAR, DGSRT, DRIRE</td>
</tr>
<tr>
<td></td>
<td>CRITT</td>
</tr>
<tr>
<td>Baden-Württemburg</td>
<td>Steinbeis Foundation, Technology Centres</td>
</tr>
<tr>
<td></td>
<td>Chambers of Commerce</td>
</tr>
</tbody>
</table>

**Table 4.4** A Summary of the Business Support Infrastructure in the Three Regions

The third area of comparison that can be made is between the educational and research presence in the regions. Cité Scientifique has a multitude of educational establishments, as I have described in an earlier chapter. The Orsay university complex is a particular example. The educational components of the region are so important that the CEN at Saclay moved its research teams from Saclay to the universities of South Ile-de-France. Educational establishments were included in the decentralisation process during the infancy of the region, alongside the government research institutions and some from the private sector. These included vocational and technical centres and grandes écoles (**SUPELEC, Ecole Polytechnique, Ecole National Supérieure des Industries Agro-alimentaires, Ecole National Supérieure des Techniques Avancés and the Ecole Centrale**), (op. cit p. 91).

The state of Baden-Württemburg in Germany also has a multitude of educational establishments, numbering up to forty-two at the highest level of further education (including nine universities and fourteen Fraunhofer Institutes). The links between industry and education are again very strong and spatially diverse. Firms see the act of subcontracting research to such educational establishments or research/technology
transfer centres as a means of *optimising development*. It is something that is encouraged at all levels of policy implementation and economic activity, no matter how big or small the firm is.

Hertfordshire is deficient in this particular area. There are not renowned university establishments within the county, although some would argue that Cambridge and London are only a short distance away. There seems to be a large gap in this sector of the potential components of a technopole. The educational institutions are not an integral part of the potential technopole environment presumed to exist in Hertfordshire, (if the location quotient scores are to be used as a tentative indication). In terms of research, there are several public sector research establishments and also some in the private sector, most of which have university contacts outside the county, unlike the other two European examples. A comparison can be seen in table 4.5.

<table>
<thead>
<tr>
<th>Hertfordshire</th>
<th>Education</th>
<th>Training / Vocational</th>
<th>Research Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>University of Hertfordshire, Hatfield University, Other</td>
<td>Further Education Colleges TEC</td>
<td>MRPRA, Crosfield, BRE, Rothampstead, Warren Spring Labs (relocating)</td>
</tr>
<tr>
<td>Cité Scientifique</td>
<td>Orsay University Complex, Ecole Polytechnique, Ecole Centrale</td>
<td>SUPELEC, Ecole National Supérieure des Industries Agro-alimentaires Ecole National Supérieure des Techniques Avancés</td>
<td>CEN, CNES, CNET, Centre National de la Recherche Scientifique</td>
</tr>
<tr>
<td>Baden-Württemburg</td>
<td>9 Universities 14 Fraunhofer Institutes Polytechnics</td>
<td>Polytechnics</td>
<td>3 Grossforschungsinstitute 10 Industrial Co-operative Research Institutions 6 Institutes of Applied Research</td>
</tr>
</tbody>
</table>

Table 4.5 A Summary of the Educational and Research Presence in Each Region

The fourth area of comparison is the existence and effects of policy implementation. This seems to be a major area of disparity. In the last thirty years there have been
national technological policies influencing industrial sectors and their supply chains within the Cité Scientifique region. Much of this, as in Hertfordshire, revolved around the defence sector, involving aerospace, defence electronics and communications. However, there was no real policy for technopolitan development in the area. It was led by the 1965 Structure Plan for the region and the activities of DATAR. At present, the public authorities in France are faced with a dichotomy. Do they create a non-targeted policy aimed at all firms to increase the intensity of the milieu, while at the same time diffusing the technology within, or, do they create a targeted policy aimed at specific firms in the region? The inclination is to strengthen and consolidate the networks within the region before seeking to diffuse the technology potential.

There are two poles of industrial policy in existence. Both France and the UK, (and the USA), adopt a “mission-oriented” policy. The government decides where to target money, and attempts to pick future industrial winners. At present the high-technology sector, characterised by its innovative potential is thought to be the key to future economic growth. The French strategy of technopole specialisation could prove very risky if industrial sectors were to collapse. The policy of concentrating different industries in different technopole regions could benefit from such specialisation but may be in trouble if the bottom drops out of particular markets. Germany and Japan, on the other hand, adopt a “diffusion-oriented” policy. This creates a situation of widespread capacity to adapt to any future industrial changes that might occur. In this way any new comparative advantage can be achieved without a complete about-face in industrial activities. Educational links are a significant part of this diffusion-oriented policy.

In Germany, policy development has been reviewed and re-oriented over a period of about fifteen years. Once R & D potential had been increased, policy was centred on strengthening the networks that evolved. Only when this had been achieved and there was a framework of potential for the SME population did policy re-address specific technology development and its international standing. Baden-Württemburg had a mass of state input creating a whole framework of financial and technology transfer
opportunities for the SME economic base in the region. This intervention was a co-
ordinated response and is overseen by the Steinbeis Foundation.

In Hertfordshire economic activity was dominated by the Cold War initiatives in the
defence industry. Because of this dependence on a guaranteed market, Hertfordshire
could afford to adopt a highly selective policy of economic development. This was
created in order to preserve the Green Belt environment desired by highly prized
research and development branch plants, including British Aerospace and GEC
Marconi. Today, however, with the Cold War almost a fading memory the county
has had to reappraise its economic situation and address rising unemployment. State
policy has been full of good intentions but has not been as specifically targeted as that
of either France of Germany. At present a hopeful look at European research funding
is filling the void. Programmes such as KONVER attempt to reorganise the defence
sector but for Hertfordshire it is maybe too late. At the time of writing, British
Aerospace has announced huge job losses at its Stevenage plant. The comparative
past and present situation can be seen in table 4.6 below.

<table>
<thead>
<tr>
<th>Historical Position</th>
<th>Present</th>
<th>State Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hertfordshire</td>
<td>Cold War Contracts</td>
<td>“Partnership for Prosperity” “Bright green” KONVER</td>
</tr>
<tr>
<td>Cité Scientifique</td>
<td>DATAR decentralisation</td>
<td>Structure Plan designation as technopole</td>
</tr>
<tr>
<td>Baden-Württemburg</td>
<td>Long history of industrial support from 19th Century</td>
<td>Increasing density of Steinbeis network</td>
</tr>
</tbody>
</table>

Table 4.6 Comparative Policy Approaches in the Three Regions

The final area of comparison is concerned with the networking that takes place within
each region. It can be seen that great attention has been paid to this aspect of
technopole activity both in France and Germany. State institutions and educational
establishments have been encouraged through a plethora of policy guidance, financial incentives and research opportunities to interact and collaborate with both the SME population and the multinational presence in the respective regions. The firms themselves have been very receptive to such activities. Public research institutions moved their research teams to educational establishments, in the French example, creating a multi-faceted approach to problem solving. Technology transfer is also a key issue.

It still remains to be seen how Hertfordshire, as the UK's prime technopole candidate, compares with the European examples in terms of functioning on a region-specific scale. Inter-firm and institutional networking plays a fundamental part in their success. The next part of this research project (section 4.8 onwards), therefore, attempts to do just this, looking at the connections between the SMEs, multinational and the various business support and educational bodies. It is a traditional British characteristic to be reserved and secretive about industrial activities. There is not only an industrial barrier to be overcome but inherent cultural phenomena to be reversed. How much collaboration is going on within the county? Regional networking seems to be a European prerequisite within technopoles. Hertfordshire is rapidly losing its defence security and needs to do something that will secure and intensify the innovative milieux that currently reside within its borders.

4.7 Smilor's Hertfordshire

Smilor's Technopolis Wheel, illustrated at the beginning of the chapter, showed the seven major groups of institutions which are required, in theory, to interact within a technopole. Put together they should generate self-propulsive economic growth (Simmie 1994). The following version of Smilor's Technopolis Wheel is constructed in relation to the situation in Hertfordshire, (figure 4.7).

It is easier to describe each segment in turn beginning with large corporations. It is true that there are headquarters within the county, most having decentralised from the capital, London. It is also true that there are a lot of the marketing divisions in the
county. The reason for this is the extremely good communication links to the rest of the country and also more importantly to Europe via the airports and ports. For many of the big multinationals, especially the American ones, these facilities act as the European headquarters for marketing and administrative operations. Secondly, as with Smilor's Wheel, research and development activities exist in the county. None are more influential than the Glaxo Research Campus at Stevenage. The large corporations are also major employers as I pointed out earlier in the chapter, particularly in the pharmaceutical sector. This skew is becoming increasingly prominent due to the huge job losses being experienced by the defence industry at the time of writing.

In terms of the small companies the diverse SME population is equally important as the large corporations. Within the county there are corporation spin-offs. In the pharmaceutical sector SmithKline Beecham has some local subsidiaries. I have also included the subsidiary service sector and the potential for a bio-technology presence, something that is lacking in this country as a whole, but would have a ready-made market.

In the next segment, re-labelled "The European Union", I have put the prominent European Funding Programmes, which require cross-union collaboration, in an attempt to unite, or at least improve the relationship between the economic activities of the member states. The second segment contains the KONVER programme.

State Government includes the educational support, although it is not as prominent as in the two European comparisons. Much of this educational support originates from the activities of the DTI, including the relocating Warren Spring Laboratories in Stevenage. Also under the heading of state government I have put funding programmes, such as Eureka (a collaborative European initiative separate from the EC funding programmes) and SMART (a DTI initiative to improve the competitiveness of SMEs for the benefit of the national economy). The other segment contains the decline in defence spending. This is something that has a great affect on the county.
Figure 4.7 Smilor's Hertfordshire

*Local Government* contains the county council and local government, but also the two economic approaches adopted by the county council, the Partnership for Prosperity and the Bright Green Industrial Strategy. Finally, there are the assets of the county, similar to the original contents described by Smilor. These assets include the attractive environment of a county in the Green Belt, the excellent transport and communication links, and perhaps the cheaper rates when compared to those in London.
The final sector Education was labelled "university" by Smilor. However, in the case of Hertfordshire there is only two universities in the county. It would be better to take a broad view including further education establishments, the TEC, private and public research establishments. "Other" refers to the locational influence of the nearby universities of London, Oxford and Cambridge. All these I have described earlier in the chapter.

A surface analysis of the comparative situation between Hertfordshire and the "Ideal Type", Smilor's Technopolis Wheel, reveals that Hertfordshire has the majority of the elements for it to become a fully functioning technopole and to generate self-propulsive economic growth. However, it is not just a question of having a representative in each segment of the wheel, but the quantity and more importantly the quality of each element. Yes, Hertfordshire has a university element, but it is not an Oxford or a Cambridge, primarily in terms of academic standing. Secondly, the European Union funding programmes are attempting to fill the void left by the declining defence sector, while at the same time promoting research on a Europe-wide scale. European help, such as the KONVER programme, is primarily occupied with consolidating the existing high-technology standing of the county rather than generating its expansion and promotion. A few steps backward must be taken before the leap forward into recognised technopoli standing can be achieved. The concern and proactive stance of the county is shown by the local government sector which contains the current policies, such as 'Bright Green'.

4.8 Hypothesis Two

This second hypothesis will be split into four parts, following the different elements of the county and the extent to which they communicate with each other, and the extent to which they form necessary links and partnerships for the purpose of producing commercial gains. The links between firms, the business support institutions, and the educational establishments, will be examined, as well as the inter-firm collaboration within the county. Finally, the activities of the pharmaceutical sector within the county will be briefly described. The networking activities of the county will then be
criticised in light of the key elements for a networked region identified by Cooke and Morgan (1993) and Malecki and Nijkamp (1988).

4.8.1 Contact with Business Support and Educational Institutions

One of the questions that I asked the sample of firms questioned in Hertfordshire was the frequency and reason for contact with various business support institutions and educational establishments. These include the Chamber of Commerce, County Council, the TECs, the University of Hertfordshire and other various higher education establishments. The University of Hertfordshire is not one of the traditional breed of universities, being promoted in the recent transformations of polytechnics to universities. As a result, it perhaps does not have the reputation or "pulling power" of older, more renowned, seats of learning, such as reside in the regions of Ile-de-France or Baden-Württemburg. Many people in the county might argue otherwise. Glaxo, a major employer and major investor in the county, cites London, Oxford and Cambridge as the relevant universities to the county, due to their locational proximity. Perhaps, therefore, Hertfordshire does not need the "pulling power" of a recognised university institution to draw investment into the county if the three mentioned above are already fulfilling that function.

The first thing to notice about the results is that firms have not only more contact with education, but such contact occurs on a far more regular basis. There are several reasons for firms to liaise with educational facilities within the county. Firstly, the affiliation to life-long learning advocated by the Bright Green Report (1993) is reflected in the philosophy of local firms. Regular training of new and existing employees is cited as a reason for contacting the University of Hertfordshire and other higher education colleges. For the last twenty years the university has offered short refresher or training courses to local businesses. There is also a lot of interaction between the university and the other higher education colleges. The University of Hertfordshire has a close relationship with four colleges enabling students to undertake compatible courses by means of a points system.

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Figure 4.8 Frequency of Contact with Institutions in Hertfordshire
A second reason for liaising with the educational presence in the county is as an integral part of the teaching process itself. Two firms in particular, dominated by research and development, take a leading part in lectures and coursework, reinforcing education-industry relations. Marconi and the FIRA (Furniture Industry Research Association) both teach at the colleges. The FIRA has about 12 colleges/universities as members, not just in Hertfordshire. In return they are able to use some of the facilities at the University of Hertfordshire.

The frequency of contact with the educational establishments tends to be on a weekly or monthly basis, compared to the more sporadic quarterly or annual liaisons with the County Council or Chamber of Commerce in St. Albans. The need for contact with the Chamber of Commerce can be explained by the fact that the firms who responded positively generally have an active role, i.e. a member of the firm is a board member or has another functional role within the Chamber. Other reasons for contact are cited as marketing or help in the successful exporting of goods. The reasons for contacting the County Council tends to be to ask advice. This can range from advice about planning, local rates, mainly functional help with one-off issues, explaining the sporadic relationship. It does, however, act as a word of warning for the economic development department, active in the Partnership for Prosperity, whose good intentions are maybe surplus to local need.

There was also a negative contact option in the questionnaire, which proved to be the most common response for both the County Council and the Chamber of Commerce. This can perhaps be explained in the context of the level of contact of firms in Baden-Württemburg with the local Chamber of Commerce and other local scale state apparatus.

In Baden-Württemburg a study was made of the information sources firms contacted to find out about technological aid schemes. SMEs in particular, as in Hertfordshire, have big problems in collecting information due to a lack of expertise and manpower. Becher and Weibert (1990, quoted in Hassink 1992, p. 124) explain:
Figure 4.9 Reasons Given for Contacting Institutions in Hertfordshire
"Firms that eventually make use of the aid schemes are usually guided by their own bank or credit institution along the path from initial information to successful application. Economic organisations, such as the chambers of commerce, are only significant with regard to the provision of initial information about the schemes."

The sources of technological aid in Baden-Württemberg were shown in figure 4.5 on page 75. The state banks came out best, as the most helpful. They seem to be willing to help SMEs in what would be seen as a high risk investment in the UK.

I have already cited some of the reasons for contact. However, some trends have emerged. The educational establishments seem to fulfil a multi-functional role, providing everything from advice to training existing and potential employees and, as expected, research facilities. The same can be said for the TECs, although firms saw them in a more advisory position. If advice can be supplied by these other bodies, then unless it is within the specific remit of the County Council, there is no need for the County Council to be contacted, except for further contact information. As Hassink says, about the situation in Baden-Württemburg (op. cit 1992, p. 125):

"The importance of the chambers of commerce in the technology transfer network, however, has been decreasing. These organisations, which are not concentrated on a specific industry or field, find it increasingly difficult to help firms. This is because of the growing specialisation of the economy and the more complicated technical questions of the companies."

This local government apparatus fulfils a general information-providing role while more technical questions can be answered or passed on to a specialist by the DTI technology transfer schemes.
4.8.2 Contact Between Firms in Hertfordshire

There is a reasonable amount of contact between the wider survey of firms in the chosen towns of Hertfordshire (St. Albans, Letchworth and Hertford in addition to the four New Towns). However, the type of firms which are networking, and the hierarchical level of this contact, follows a definite trend. In terms of research and development there is very little inter-firm collaboration, at least within the county. Most of the subcontracting occurs at a group level, i.e. to firms owned by the same parent company. One particular exception to the rule is Marconi Instruments who subcontract work to the research centres of GEC Marconi in Borehamwood.

Another subcontracting trend focuses on the research and development into new computer software by electronics and computer specialist firms within the area. As I said in the preceding chapter, a computer company (Applied Digital Devices Ltd) attempted with several other like-minded companies to set up a local network, based on a central office, to provide marketing, advertising and administrative assistance for the local computer trade companies in the locality. The main problem proved to be money, and not the more common industrial reservedness of associating with the competition.

A further reason that was cited more than once was the subcontracting of selective research to the University of Hertfordshire. Although not a firm as such, the University could emerge in the future as an integral part of the networking activities in the locality, just as a similar educational presence in the two European examples has done. Admittedly they have had a great deal of help at state level, particularly in France, which has not been forthcoming in the case of Hertfordshire, see table 4.5 earlier in the chapter. Some of the research that was subcontracted played some part in the education of the students, another interesting point to be discussed. In the now famous case of Silicon Valley in the USA, and also in France and Germany, research emanated from the university establishments from the outset and was not a coursework requirement. The research was instigated by creative scientists, for example in the Bell Laboratories, outside the confines of the firm.
Figure 4.10 Contact Between Firms in Hertfordshire
The level of contact between the firms surveyed in Hertfordshire also reflects a particular trend. There were only four responses from the wider survey of firms collaborating at a research department level. Most of the interaction occurring was for, and with, the supply level of firms. The supply of goods was the predominant reason given for dealing with other firms in the locality. As a consequence, many of the contacts, cited by the firms who responded, perform a supply function. Only two of the respondents cited that their contacts in Hertfordshire are incubator firms. One was set up for business purposes and the other is a subsidiary of a training centre to train their own staff. Many of the firms questioned had never heard of the term and are only small sized SMEs so do not have the resources to create such subsidiaries even if they want to.

There is also some interaction among the managerial levels of different firms in the county. Some of this is accounted for by the existence of Regional Trade or Business Groups and the Chamber of Commerce in St. Albans. Some of this contact can also be attributed to the fact that some SMEs employ few employees, meaning that management is a hands-on position i.e. the Company Director is also an integral part of the labour force.

The networking of activities in Hertfordshire has been limited in the past by the absence of a co-ordinating institution, provided by the state in both of the European examples, and targeted to particular needs. With the introduction of Business Link, which is beginning to find its feet after its first year in operation, collaboration between the industrial support institution and the economic base of the county can be co-ordinated and targeted towards alleviating the deficiencies. In this way, the doubling of responsibilities and confusion over which role to play can be removed. The innovative firms within the county seem keen to increase their collaborative activities, especially with the European funding programmes becoming more effective. With a central institution, like the Steinbeis Foundation, everything can be co-ordinated and contact will be increased.
4.9 A Case Study of the Pharmaceutical Industry

Why pick the pharmaceutical industry as a case study within Hertfordshire? Within the UK it is the sector that has experienced the biggest growth in R & D spending, increasing some 11% between 1992 and 1993, with some companies increasing their spending by 25% (Financial Times 17/6/94). Indeed the UK Pharmaceutical industry is seen as “central to the country’s R & D effort”, spending 31.8% of all industrial R & D in Britain. The share of the business expenditure in the UK attributed to R & D pharmaceutical research has risen from 5.38% (1973) to 13.81% (1990), which is considerably more than in both the USA and Japan. The following table illustrates the dominance of the pharmaceutical sector in the top ten ranked firms in the UK by research and development expenditure:

<table>
<thead>
<tr>
<th>Company</th>
<th>Current R &amp; D Spend (£'000)</th>
<th>Sales (£M)</th>
<th>R &amp; D as % of Sales</th>
<th>Previous R &amp; D 1992 (£'000)</th>
<th>- R &amp; D - 1991 (£'000)</th>
<th>Spend 1990 (£'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glaxo</td>
<td>739,000</td>
<td>4,930</td>
<td>14.99</td>
<td>595,000</td>
<td>475,000</td>
<td>399,000</td>
</tr>
<tr>
<td>SmithKline Beecham</td>
<td>575,000</td>
<td>6,164</td>
<td>9.33</td>
<td>478,000</td>
<td>432,000</td>
<td>393,000</td>
</tr>
<tr>
<td>Shell</td>
<td>529,000</td>
<td>83,748</td>
<td>0.63</td>
<td>499,000</td>
<td>472,000</td>
<td>473,000</td>
</tr>
<tr>
<td>Unilever</td>
<td>518,000</td>
<td>27,863</td>
<td>1.86</td>
<td>461,000</td>
<td>426,000</td>
<td>408,000</td>
</tr>
<tr>
<td>Zeneca</td>
<td>490,000</td>
<td>4,440</td>
<td>11.04</td>
<td>458,000</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>General Electric</td>
<td>398,000</td>
<td>5,612</td>
<td>7.09</td>
<td>417,000</td>
<td>435,000</td>
<td>390,000</td>
</tr>
<tr>
<td>Wellcome</td>
<td>325,500</td>
<td>2,041</td>
<td>15.95</td>
<td>254,000</td>
<td>229,700</td>
<td>221,200</td>
</tr>
<tr>
<td>Rolls-Royce</td>
<td>253,000</td>
<td>3,518</td>
<td>7.19</td>
<td>229,000</td>
<td>216,000</td>
<td>237,000</td>
</tr>
<tr>
<td>BP</td>
<td>237,000</td>
<td>34,950</td>
<td>0.68</td>
<td>315,000</td>
<td>308,000</td>
<td>329,000</td>
</tr>
<tr>
<td>BT</td>
<td>233,000</td>
<td>13,242</td>
<td>1.76</td>
<td>240,000</td>
<td>243,000</td>
<td>228,000</td>
</tr>
</tbody>
</table>

(Financial Times 17/6/94)

Table 4.7 The Top Ten Firms in the UK Ranked by R & D Expenditure

The top two companies are cited as Glaxo and SmithKline Beecham, and both of them are located in Hertfordshire. Glaxo originally resided in the county due to historical reasons, but has now got a solid financial commitment in the form of its recently completed £1000M research campus in Stevenage, (the figure depends on who you talk to). This has underlined the firm’s commitment to the county for the
foreseeable future. SmithKline Beecham and several of its subsidiaries are also present in Hertfordshire, in Welwyn, giving Hertfordshire the two top spenders as cited above. Two other big names in the pharmaceutical sector can also be found in the county, Roche, and Merck, Dohme & Co. With the decline of the Cold War leading to a reduction in defence contracts, pharmaceuticals, one of the few industries at which the UK excels, is now the cornerstone of a UK industrial resurrection. Despite this encouraging picture, Glaxo, the UK’s top R & D spender, is only ranked 42nd in the world, overshadowed by many companies, chiefly from the USA, Japan and Germany. Zeneca (the drugs arm of ICI) and Wellcome are also British drug manufacturers, and can be found in the table.

"Add together these individual companies and you have a uniquely successful British industry. Five of the world’s best-selling drugs come from Britain, led by Glaxo’s ulcer treatment Zantac. Exports are fast approaching £4 billion, creating a surplus over imports of nearly £2 billion. British companies, led by Glaxo, have even managed to make inroads into Japan: the world’s second largest drug market, but also one of the most difficult to break into for foreign companies."

(The Guardian 24/1/95)

Speculative questions are continually being asked as to why this particular British industrial sector is so successful on a global scale. Vague answers such as the following have been suggested:

"The trouble is we don’t really know. Pharmaceuticals is the sort of post-Fordist industry Britons ought to have a natural talent for. It employs thousands of our best brains on research and development without the burden of having to work on heavy production lines... And maybe governments’ preoccupation in the 1960s and 1970s with problem industries, such as cars and electronics, prevented them meddling in pharmaceuticals, leaving Glaxo, Wellcome and their competitors to get on with growing into world-class companies."

(The Guardian 24/1/95)
Other ideas have been suggested such as the strong homebase of the NHS in the UK and government research money being historically well-spent. One of these factors, the support of the NHS is being curtailed, as it is in the USA, with doctors being advised to prescribe cheaper non-branded products. R & D within the pharmaceutical industry is of vital importance. Companies continually strive to find a breakthrough product to combat well known medical conditions. Strategies have, in recent years, changed due to the nature of the patents available on these revolutionary drug discoveries. Instead of patents beginning once the product enters the commercial market, they begin instead as the research process starts. Therefore, only a few years exist between the drug being on the market, and cheaper non-branded substitutes becoming available. Most patents last a maximum of twenty-five years. As a result, large drug manufacturers have now turned away from the development of drugs which provide little advance over existing treatments, to concentrate on major medical breakthroughs against such things as cancer, arthritis and the HIV virus.

It is now widely accepted that no one company has the resources to research every avenue. The head of R & D at SmithKline Beecham is quoted as saying that:

"The industry recognises that technological self-sufficiency is no longer attainable...[and] must be strengthened by alliances"

(FT 17/6/94)

Many alliances have been with smaller bio-technology companies for in-depth expertise. However, it is not necessarily classed as R & D expenditure, instead being attributed to investment spending. Perhaps the one factor that makes the pharmaceutical industry slightly different from other sectors is that replacement discoveries must be sought and capitalised upon before the existing patents on commercial products expire, leaving the flood gates open for cheaper copies. It is a situation that is currently facing Glaxo, who is battling to extend the patent on the revolutionary ulcer drug Zantac. The patent is due to expire in 1997, and would result in the destruction of a guaranteed income upon which the company has relied for many years.
Hertfordshire has the perfect opportunity, therefore, to change its industrial focus from a declining industrial sector to an existing and expanding sector, perpetuating the trend of high R & D expenditure and the need for human resources. It was always a worry that a long over-dependence on defence contracts could mean the decline of the county as a high-tech research base. Instead, the pharmaceutical companies can now take precedence. The advantage that Hertfordshire has, is that the big spenders are already in residence, committing themselves for the near future, giving the county time to capitalise on their presence.

As I have hinted above, the pharmaceutical industry is increasingly coming to rely on inter-firm alliances. The complex nature of research demands a wide range of expertise which can only be subcontracted into a company. The high-tech industry is traditionally one of alliances and networking. It should follow then that Hertfordshire, as a high-tech concentration (according to the location quotient score), will exhibit such characteristics. It should also follow that the pharmaceutical industry, increasingly reliant on research alliances, would conduct such activities within its ranks in Hertfordshire. If it does not, then the county should investigate ways of encouraging firms like Glaxo and SmithKline to utilise both the human resources and strong base of SMEs available.

4.9.1 Glaxo

"Glaxo is an integrated research-based group of companies whose corporate purpose is to create, discover, develop, manufacture and market throughout the world safe, effective medicines of the highest quality which will bring benefit to patients through improved longevity and quality of life, and to society in general through economic value."

(Glaxo Annual Report 1994 p. 2)

As I have described, Glaxo is the biggest R & D spender within the UK. It is also one of the biggest pharmaceutical companies in the world. The company has a long history, dating back over a hundred years, emphasising an innovatory approach to
drug discovery based fundamentally on their strong R & D activities. After a brief period of depression during the 1970s, in which Glaxo was the subject of a failed hostile take-over bid by SmithKline Beecham, Glaxo released the anti-ulcer drug Zantac onto the commercial market. With successful marketing it has now become the biggest selling prescription drug in the world.

However, the high profits gained from drugs such as Zantac rely heavily on the short-life patents attached to them. In the case of Zantac the patent is due to expire, allowing cheaper non-branded products to compete in the open market. This will obviously make a significant reduction to Glaxo’s profits. The company has always maintained the position that their anti-ulcer drug will not be the main focus of the company’s activities, as their commitment to R & D will always introduce new innovative drugs to the market.

Glaxo’s route to the top was based on a very ‘un-British’ strategy of doing things. Instead of diversifying into unknown territory as most of its competitors were doing, Glaxo sold off everything except its prescription drug operation. Secondly, Glaxo concentrated on becoming a global drug presence. Finally, Glaxo poured millions of pounds into research even in the knowledge that it would not pay off for more than a decade, traditionally a Japanese investment strategy.

In the company’s Annual Report the Deputy Chairman, in his opening remarks, makes special reference to the Medicines Research Centre at Stevenage. He describes it as being:

"...central to the drive to bring forward new and better medicines of value. It has been expressly designed and equipped to encourage a dynamic multi-disciplinary research culture which can best harness the biological revolution in drug design."

(Op cit. p. 7)

Accordingly, Glaxo continues to invest heavily in research and development with £185M, out of a total capital expenditure of £260M in 1994 alone, being spent on the
Centre at Stevenage. With Glaxo’s commitment to R & D being so central to its operations, the Centre at Stevenage is likely to be the hub of a considerable amount of the company’s future major research. The 95 acre site, opened by the Queen on the 19th April 1995, costing between £700 - £1000 million will place Stevenage, and therefore Hertfordshire, as a significant actor to the company’s R & D activities.

Glaxo, like most other pharmaceutical companies, also has a commitment to networking within the industry. As the Deputy Chairman says:

"...we recognise that pharmaceutical companies cannot be self-sufficient in terms of the science and technology needed for success. Alliances and collaborations with academic institutions and smaller biotechnology companies are of great significance in exploring the new knowledge effectively. Glaxo made an early start in putting such a network together and other link-ups will follow."  

(Op cit. p. 7)

It remains to be seen whether such alliances for a multinational company are spread around the world, independent of any one location, or whether a major investment like the Research Centre at Stevenage will have any influence over companies in the vicinity.

4.9.2 SmithKline Beecham

Another big R & D spender, it also has a branch plant in Hertfordshire. It focuses its main research on Over-the-Counter products (OTC) and can be associated with many common products, from toothpaste to cold remedies. In 1972 Beecham, the British side of the now joint SmithKline Beecham company, attempted a take-over of Glaxo and was blocked by the British Government. The reason given was a fear that reduced spending on research and development would occur. One of the attractive qualities of Glaxo, it was thought at the time, was its network of overseas contacts. Since then the company’s history has been a list of take-overs culminating with the major merger with the U.S. SmithKline Beckman Corporation.
In terms of drug development, the ulcer remedy *Tagamet* was superseded by Glaxo, eroding its expected market share. The OTC market is a very lucrative part of the industry. In the UK we spend around £200 million a year on painkillers alone. In addition, the OTC market is a way to extend the life of drugs which have seen their patent expire. As well as its vast compendium of OTC products, the company has developed drugs for both schizophrenia and bacterial infections common in late-stage AIDS patients, slipping into the gene-oriented drug market based upon the emerging importance of bio-technology.

SmithKline Beecham owns some minor research interests in the county, admittedly in one location but under different corporate names. These are quoted in the directory of the ABPI (Association of the British Pharmaceutical Industry). The company, therefore, has some SME interests in the county. It is unlikely that any collaboration with rivals such as Glaxo will take place but the huge new investment by its rival might increase the desire for SmithKline to remain in the county simply for the reason for the pharmaceutical supply and marketing firms that will probably be attracted to the area now that Glaxo has made such a long term commitment.

4.9.3 The Pharmaceutical Industry in the County

A survey of the pharmaceutical firms was conducted in a similar way to the wider survey described in the methodology chapter. Questions were again asked about contact with the various institutions within the county and also the nature of the research and development conducted at the branch in Hertfordshire. The pharmaceutical sector employs around 10,000 people within the county and has an influential presence.

I have just outlined two of the major pharmaceutical employers in the county, Glaxo and SmithKline Beecham. The latter has a number of subsidiaries in Hertfordshire representing the diversity of interests of the company. Glaxo, on the other hand, is set to become an even greater international force in the pharmaceutical sector as it
instigates the take-over of Wellcome, another giant in pharmaceutical research and development.

The brief survey of the pharmaceutical presence within the county revealed that as well as the big four firms, there is some evidence of other multinational subsidiaries and SMEs. The directory of the Association of the British Pharmaceutical Industry 1994-1995 gives ten firms, not including the Glaxo facility, within the county. Table 4.8 shows that the majority of these are listed as companies with interests in medical and dental speciality products (MS).

<table>
<thead>
<tr>
<th>Firm</th>
<th>B</th>
<th>MS</th>
<th>GM</th>
<th>E</th>
</tr>
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<tbody>
<tr>
<td>Astra</td>
<td></td>
<td>#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beecham Research Labs</td>
<td></td>
<td>#</td>
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</tr>
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<td>Bencard</td>
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<tr>
<td>Du Pont</td>
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<td></td>
</tr>
<tr>
<td>Merck, Sharp &amp; Dohme</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>William Ransom &amp; son</td>
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<td>SKB</td>
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Table 4.8 ABPI Listed firms in Hertfordshire

Other definitions are (B) companies with interests in bio-technologically derived medicines and pharmaceutical materials which are intended for human use, (GM) companies with interests in generic medicines, pharmaceutical chemicals and materials which are intended for human use and (E) companies engaged in export.

As well as these firms, other firms in the county could be identified by using the International Directory of Pharmaceutical Companies. These were also questioned on their major research and development activities and the function of their branch in the county. Many of the European firms used the branch in Hertfordshire principally as a marketing location, although some research and development is conducted at the site, (Serono and Sanofi, a Swiss firm and French firm respectively). Non-European multinational firms use Hertfordshire as a European business headquarters (Du Pont).
There appears to be no local scale subcontracting of research and development services. Most is done at group level on the one site, or on an international scale reflecting the nationality of the holding company. Any subcontracting that occurs is in the nature of the supply of materials or data. The need for contact with customers is also a serious consideration. Managerial contact between firms is as a result of involvement with the Chamber of Commerce activities and some pharmaceutical management seminars.

The reasons and regularity of contact with the various establishments within the county, the same as for the wider survey can be seen in the graphs (figures 4.8, 4.9 and 4.10).

There are also some interesting answers as to views about ideal network situations for the pharmaceutical industry. The nature of competition and commercial sensitivity is a concern. Du Pont Pharmaceuticals UK Ltd put forward the idea of a network, functioning as a kind of public relations and marketing forum, as opposed to a means for trading:

"Inter-firm co-operation [would be] of value if [it involved] raising the acceptability of pharmaceutical companies in the local environment."

Glaxo, the largest pharmaceutical presence in the county, can be singled out as a separate entity. In terms of collaboration with educational establishments, Hertfordshire suffers due to its deficiency. Glaxo has identified the universities of London, Oxford and Cambridge:

"One recent initiative is the Glaxo Institute for Applied Pharmacology at Cambridge where Glaxo scientists work alongside academics and research students on applied research and pharmacology."

(Glaxo Key Facts 1994, p. 7)
Such large firms, therefore, do need good relations with the world of education. If Hertfordshire had recognised establishments collaboration would probably occur on a local scale. In fact, Glaxo’s continued commitment to the county is partly due to the proximity of the three universities already identified.

At the time of writing, possibly one of the biggest events in the pharmaceutical industry’s history is about to take place, which could have a far reaching significance for Hertfordshire. Glaxo is in the process of taking over fellow competitor Wellcome, to become the biggest pharmaceutical giant in the world, valued at around £28 billion on the Stock Exchange - more than IBM and four times GEC, Britain’s biggest engineering group, (The Guardian 24/1/95).

The view from Glaxo is that it would create a group that could cope with the growing pressures on the industry. This refers to the increasing costs of speculative research and development, the short patent life of medicines under pressure from cheaper non-branded products, and above all the cutbacks in global spending on health-care by governments (particularly the UK and the USA). It has led the industry to conclude that the answer to all of these problems is to become bigger and, where possible, either collaborate or buy out your competitors.

The take-over will bring great benefits to Glaxo in terms of increasing its global market share from a miserly 3.9%, (remember Glaxo is a leading drug company), to 6.3% of the world market. No other company enjoys more than 3.9% of the market at the moment. All the above problems can be solved by collaboration. The take-over will give Glaxo a strong global position with sufficient scale and breadth for strong research and development, and continued investment in new technologies to maintain a strong pipeline of new drugs, (The Guardian 24/1/95). Combine this with Glaxo’s network of bio-technology firms in the USA and you have significant world-beating potential. For Hertfordshire to ameliorate this fact, and encourage the creation and incubation of small bio-technology firms, it would need a change of attitude by everyone from the venture capitalist to the scientist.
The bio-technology question is very important for the pharmaceutical industry and could be an ambitious path to technopole success, but is perhaps one option to consider. As Sir Richard Sykes, Deputy Chairman and Chief Executive of Glaxo Wellcome, stated about the industry and his company:

"In the past, the pharmaceutical industry was a self-sufficient industry. It would be driven by medicinal chemistry... That is not the way the industry operates today or will operate in the future. Why? Because today the whole process is being driven by modern biology and by modern technology. This is the age of biology... leading us to a greater understanding of the underlying mechanisms of disease."

(The Goldring Audit Channel Four 7/5/95)

In the Goldring Audit documentary, an in-depth analysis of the workings of the pharmaceutical industry was presented. The future of the industry was seen to be heading towards the realm of the small bio-technology firms and strategic alliances between large and small firms. As Mary Goldring says, the big names are being forced to subcontract gene research instead of pouring money into new technologies as they would for their own traditional chemical drugs.

Sir Richard Sykes describes the position taken by his company:

"When you think about the research going on today to understand the basic mechanics of disease, then a very small part of that research can be carried out within the pharmaceutical company. Most of that research is being carried out in universities, in academic institutions and in biotechnology companies. So the research, whether its fundamental research... whether its technical development, most of that work is going on outside the pharmaceutical industry... In our case, we formed collaborations and strategic alliances with universities, with academic institutions and with small bio-technology companies so we can take advantage of that knowledge, and
those new developing technologies... to help us better produce medicines of value...”

(Op. cit 7/5/95)

The trouble is that 60% of small bio-technology firms are in the USA, with the UK only having a poor 5%. If this is the future of the pharmaceutical industry then the UK is going to have difficulty maintaining its dominant position. Indeed the UK government is desperate to create such firms. There are four main reasons for this bio-technology void in the UK. Firstly, unlike the Americans, our scientists are shy of the business world, preferring to stay in the security of the university environment. The USA openly encourages scientists to commercialise their research. Secondly, and a discrepancy between the UK and Germany, the existence and availability of venture capital for such small firm creation is absent. Baden-Württemburg greatly benefits from the support of the state credit institutions who play an integral part in the success of the wide SME base of the region, and the inter-firm collaboration. 96% of bio-technology work over here is commissioned in the USA. It does not harm our companies but it should worry us in terms of the lack of facilities in this country.

David Owen, the Industrial Collaboration Director from the Medical Research Council, reveals the implications of this absence for the UK economy:

"Dealing with US companies is very helpful if it facilitates bringing useful healthcare products back to the UK, but not particularly useful in terms of using that technology to create jobs and opportunities in the UK."

(Op. cit 7/5/95)

The implications for Hertfordshire are becoming clear. With Glaxo committed to its huge research and development budget, its take-over of Wellcome will see a rationalisation of all such activities. Research branches of Wellcome in South London (Beckenham) will almost certainly be amalgamated into the new Medicines Research Campus at Stevenage, something that is of extreme concern to the London Borough of Bromley. The two firms have been researching similar product development and so will combine their expertise to good effect. Much of this research concentrates on
Figure 4.11 Glaxo’s Global R & D Network
potential Aids related drug development, perhaps the most important area of research at the present time. Stevenage looks set to become the European centre of the world’s leading drug manufacturer.

Equally important for Hertfordshire during the next decade, is the fact that research is becoming more targeted. Technology to develop new drugs has decreased in both scale and expense. A consequence of this is that:

"Barriers to entry are falling, and small laboratories are setting up, with their eye on creating just one or two drugs. Big groups are finding it hard to hold onto some of its brightest people. Instead, those scientists are spinning off into their own companies where they have more freedom, and the prospect of wealth if their discoveries are successful."

(Financial Times 24/1/95)

This is the ideal time for Hertfordshire to capitalise on the historical presence of Glaxo, cemented by its huge recent investment, and other leading pharmaceutical competitors also present in the county, and to try and create the ideal environment for these new spin-offs expected to emerge over the next few years. Indeed, the merger of Glaxo and Wellcome may well be the catalyst. The proposed rationalisation of the two companies’ research may well make many scientific personnel superfluous. Encouragement and financial help to set up subsidiaries may well stop them drifting abroad. The research and development presence is much sought after. Almost one in six people in the industry in Europe are employed in research and development, with spending in the UK currently at around £4 million a day, Glaxo itself spends over £350 million a year.

One of the major problems facing the pharmaceutical industry in the county is a reflection of society as a whole. There is, put simply, a shortage of science personnel. The UK pharmaceutical industry requires around 2,000 graduates a year, but the total number of science graduates is continually falling. Within Hertfordshire, this problem is going to become particularly acute in the light of Glaxo’s new Research Campus
development. As the Association of the British Pharmaceutical Industry stated in 1990:

"The continuing search for new medicines and the export drive of Britain's pharmaceutical industry... face major challenges because of the growing shortage of talented UK science graduates. Over the next five years the number of graduates is expected to remain static as a result of demographic changes and a declining uptake of science courses while demand for graduates increases in the industry"

(Quoted in Hart 1993, p. 65)

In a study in 1991 by PAEC it was found that 180 new science technicians were required by the big four pharmaceutical firms in Hertfordshire to cover replacement and expansion, in the following year. Today with the new Glaxo Campus this figure is going to be considerably larger. Concern has already been expressed by the firm in this respect.

4.10 Hertfordshire and the Key Elements of a Networked Region

Cooke and Morgan (1993) put forward their five requirements for a successful technopole, taking a slightly different focus of approach to that of Smilor. They identify their key elements of a networked region. Their five requirements were as follows:

• public and private industrial support institutions
• high grade labour market intelligence and vocational training
• the rapid diffusion of technology transfer
• a high degree of interfirm networking
• receptive firms disposed towards innovation

The first key element identifies the support institutions which should interact consistently with the firms within the county. In the case of Hertfordshire the major
institutions have tried to take a proactive role, with schemes such as the *Partnership for Prosperity* which has already been described. The TEC was rated well in the survey of firms. There is, however, the danger that the County Council is trying to accomplish more than is logistically possible in its position. The intention to become involved in promoting and aiding firms to successfully apply to the European funding programmes is one such issue. There is the danger of over-complicating the county’s resources, duplicating efforts and confusing firms as to who is the best point of contact for specific problems. Some of the County Council’s efforts are perhaps inhibiting the success of the one-stop shop, Business Link. The Chamber of Commerce also has a key role to play with regard to its export expertise, considering the number of multinationals and the nature of the high-technology dominated economic base of the county.

The problem lies more with the government attitude towards research and development and the relative public support institutions. The paper by Jeremy Howells (1994) is particularly enlightening. Compounded by the Tory attitude to privatisation, the British government cut its support for research and development during the last decade and a half. Government expenditure on research and development fell by 17.9% in real terms between 1985 and 1991 (from £4965 million to £4075 million; Cabinet Office 1993, taken from Howells 1994, p.4). At the same time spending in other countries was on the increase. The following table shows the UK growth in total research and development expenditure compared with major competitors in the period 1985-1991:

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<tbody>
<tr>
<td>UK</td>
<td>11.9</td>
<td>146.9</td>
<td>6.6</td>
<td>2.27</td>
<td>2.08</td>
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<tr>
<td>Germany</td>
<td>22.1</td>
<td>179.7</td>
<td>10.3</td>
<td>2.72</td>
<td>2.58</td>
</tr>
<tr>
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<td>183.9</td>
<td>10.6</td>
<td>2.25</td>
<td>2.42</td>
</tr>
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<td>Japan</td>
<td>42.9</td>
<td>208.2</td>
<td>13.0</td>
<td>2.58</td>
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</tr>
<tr>
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<td>98.0</td>
<td>154.1</td>
<td>7.5</td>
<td>2.93</td>
<td>2.78</td>
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GERD (Gross Expenditure on R & D), PPP (Purchasing Power Parity) (Op. cit. p. 6)

*Table 4.9 UK Growth in R & D Expenditure and its Competitors*
As you can see from the table, UK expenditure is significantly below that of the other countries. The growth index is also well below that of the others. Notice the figures of both France and Germany, the two countries in which successful examples of technopoles and networking have been illustrated. The most interesting figure is in the last column, spending as a percentage of GDP. The UK comes almost half a percent below the poorest of the other four.

This fall in expenditure is predicted to fall even further, by another 4.3% between 1992 and 1996. Government research agencies have suffered to the extent that much research is now contracted out whilst external sources of funding have increased. The Warren Spring Laboratory, mentioned earlier, is now going to merge with AEA Technology thus moving out of the county of Hertfordshire.

It is this non-commitment to research and development that could be a major barrier to Hertfordshire becoming a UK technopole in the same genre as Cité Scientifique and Baden-Württemburg. Both of these latter examples exhibit considerable state support in all elements identified by Cooke and Morgan.

The second key element concerns the quality of the labour pool within the county, and the opportunities for the labour force to switch between different sectors of the county's economy. In respect to the pharmaceutical sector this key element has proved to be a particular problem. Hart (1993, p. 63) has identified the concerns expressed by the industry:

"At a seminar involving the pharmaceutical firms, the county council and the TEC, a senior manager in Glaxo Group Research's Human Resources Department, stated that the staffing of their new research campus at Stevenage could be problematic. In particular there was a problem with finding people with good A' Levels and post doctoral qualifications in chemistry. He felt that this was because in the past Stevenage schools had been more concerned with engineering than with science to provide recruits for British Aerospace."
As Hart continues, it is not sufficient for the county to have a highly qualified labour pool, but as Cooke and Morgan show, it is the vocational training that is needed. However, the county has most definitely suffered simply because it was good at the vocational training of its up and coming workforce. Years of preparing young people for the defence industry has led to a shortage of skills for the other significant sectors within the county. The county has been defeated by its own success and complacency based on defence. Hart calls it the “pinnacle problem” - the more skilled workers are, the further up the occupational ladder they go - the less likely it is that they can simply move from one branch of high-technology to another:

"In many ways the problem isn't one of training in a narrow sense - it is one of education in a wider sense and the concomitant ability to learn new skills." (Op. cit, p.65)

The important part of the element, therefore, is the nature of the vocational training. Too much, or too narrow an approach can be more destructive than constructive. This problem of over-specialisation in the high-technology sector can be illustrated by the following graph (HMSO 1990, p. 22), (figure 4.12):

![Graph showing Graduate Recruits (1988) in the Private Sector](image)

**Figure 4.12** Graduate Recruits in the Private Sector and the Specialism Required

114
As you can see, the amount of specialisation in research and development is very high when compared to other sectors of employment. This also applies equally to the engineering profession which encompasses the remainder of the defence sector.

The third element is concentrated in the realm of the DTI and its technology transfer services, as outlined earlier. Technology transfer between the large pharmaceutical firms in the county is unlikely to occur, especially when the recent trend has been towards amalgamation and take-over (the Glaxo deal being the latest example). However, at the level of SMEs, increased technology transfer is likely to continue. As I described earlier, research establishments such as MRPRA, the Building Research Establishment and the FIRA all conduct contracted research for clients involving new and innovative technology. This will inevitably filter down through the relevant industrial sectors. With the DTI’s targeted technology transfer services such as Biotechnology Means Business, and Manufacturing Intelligence, firms can identify their needs and deficiencies. However, such services are on a national level.

The fourth element concerns the amount of networking within the region and, therefore, the second hypothesis of this research. There is, as I have shown, a significant amount of networking on a supply level basis, similar to the situation in Baden-Württemburg. The amount of networking in the arena of research and development is open to debate. Many firms are secretive, especially in the pharmaceutical industry, regarding what they are researching and with whom, for the simple reason of industrial espionage. A greater amount of networking occurs at a group level, not necessarily within the county. Hertfordshire may be a significant location for research and development sites, but, this is either contained within the site or, is collaborated by researchers in the same firms across the world.

Networking with educational establishments within the county is centred on interactive teaching rather than pure research. Local firms are contacted to conduct seminars and practical projects and lectures. High level research is conducted with the more prominent universities of Oxford, Cambridge and London. Hatfield
University does, however, have the HERTIS facility which provides a commercial and technical information service free to firms.

The fifth, and final, element identifies the need for receptive firms disposed towards innovation. This element is certainly present within the county. If Hertfordshire’s location quotient rating is still to be believed, (something that I will question in the following chapter), then Hertfordshire has more than its fair share of innovative firms. The Census of Employment data, (using the definition of research and development employees as those within enterprises based on specific returns), and quoted in Howells (1994, pp. 17-18), shows the highest absolute and relative concentrations of research and development by local labour market area (LLMA). The first table of absolute concentrations looks simply at the total employment figures.

London features as the top area in terms of total employment despite the huge employment decrease in the last decade. The two Hertfordshire work areas of Welwyn, and Hertford and Ware, both feature in the top ten primarily due to the pharmaceutical presence.

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<tr>
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<td>+ 959</td>
</tr>
<tr>
<td>Thurso</td>
<td>1742</td>
<td>2392</td>
<td>- 650</td>
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Table 4.10 Employment Figures for Local Labour Market Areas

The second table of relative employment uses the location quotient scores in which the county of Hertfordshire as a whole came out top with a score of 3.6. This time the two Hertfordshire areas feature more strongly in the table and show huge
employment increases over the last decade, particularly in the context of overall decline.

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<td>+389</td>
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Table 4.11 Location Quotient Scores

Looking at the two tables above it is obvious that two work areas of Hertfordshire have a large concentration of research and development activities, and therefore fulfil the criteria of receptive firms disposed towards innovation. As Howells says in his article, and as I have shown, much of this is due to the pharmaceutical industrial sector within the county.

The question, then, is not one of whether these firms are present within the county but how far the facilities within the county act as an enabler to innovative activity, and whether this leads to the localised networking successfully nurtured by both the French and the German examples.

4.11 Some Thoughts on Ideal Networks for Hertfordshire

Contained in the three surveys was a chance for respondents to describe a theoretical situation of networking activities that would be desired within the county. In response to the question “briefly describe your perception of an ideal network for the high-technology industry”, many interesting ideas were put forward. Several firms expressed the need to link firms specialising in the progressive elements of the whole
production process, from the initial research and development right through to the marketing of the final product, in order to realise any possible commercial benefits. This relates back to the definition of innovation given by I. Mackintosh in chapter two. ELE International, an electronic firm offered this suggestion for an ideal network:

"...a strong research and development company linked to a manufacturing company, linked to a strong sales and marketing company"

The financial aspect was also a common response subject. A few respondents think that money is a serious consideration. *If information costs money no-one will buy.* In my opinion, this is a key reflection of UK industrial culture. The above quote can be taken as meaning that because information is 'an intangible', firms will be reluctant to spend valuable financial resources on something that is very difficult to measure and quantify. Another multinational, Berner Ross International, thinks that ideas are seldom practical or cost effective. Networks were theoretically sound, but in terms of cost or functional feasibility they are not possible in terms of the density and size that would be required to achieve the results desired. Along the same lines, there is concern about the commercial expectations involved in research and innovation. Eastman Chemical (UK), a company involved in the marketing and production of chemical products, say that an ideal network would be best where:

"Research and design groups should have partnership relations which are above commercial pressures."

This is shared by a couple of firms who suggest that networking should take place at a data exchange level only, which implies independent working practices and the sharing of run-of-the-mill information only. There is this undercurrent of reservedness and confidentiality, inherent in the UK industrial culture. The absence of commercial pressures is, however, a good idea taking the competitive edge out of inter-firm relationships and the need for single corporate loyalty. If intellectual property is not
at stake, firms may be more willing to share ideas and help each other with collective problem solving.

Further concern is expressed about the ability of SMEs to find contacts in the marketplace who have similar interests and technologies. A suggestion about creating a forum to put similar firms in contact with one another is linked with the suggestion for a forum focused on particular niches in the market, oriented towards specific technologies. The business support institutions currently in existence primarily point towards the European market and the European funding lottery (Business Link), and an attempt at alleviating the poor educational presence in the county. Such forums would have to be created by the firms themselves, and as such would probably function better as a result.

There is also a feeling that the computer network ('internet') is a great advantage, enabling firms on the system, both nationally and internationally, to communicate easily. One respondent says that he has often had technical assistance from sources as diverse as UK universities and Australian firms delivered right to his desk through the computer system. This tends to dispel the importance of a regional, local scale network. However he continues by describing an attempt by a large group of small computer firms to set up a local, physical network of personal contacts, not through the medium of a computer screen. The idea involved creating a central office which would provide marketing, advertising and administration services in return for the small companies supplying their professional expertise. The scheme failed for financial reasons. It does, however, reinforce the idea that networks at a local/regional scale are necessary, and indeed wanted by firms.

4.12 Hertfordshire Compared to the Ideal Type

Hertfordshire compares itself reasonably well in regard to the Ideal Type position represented by Smilor's Technopolis Wheel. The concerted effort to capitalise on the high-technology representation in the county, creating a co-ordinated business support infrastructure, has come very late in the context of similar European regions,
as I have shown. However, it shows signs of promise, attracting European funding to reduce the negative impact of the declining defence industry, and to develop its technology infrastructure. Firms within the county have also responded well to approaching Fourth Framework of European funding. There is also scope to develop and intensify the pharmaceutical presence as I have advocated earlier in the chapter. The Ideal Type position of the Technopolis Wheel is only a guiding light, used in this research to apply some measurement to the elements of a successful technopolis and the three examples. If Hertfordshire continues its efforts progress will be made. Both of the European comparisons took over a decade to reach their current positions. They are now faced with the dilemma of how to maintain their economic success for the future.

4.13 Summary and Conclusions

- Hertfordshire has historically been a location for high-technology industry from as early as the 1930s. This was reinforced by government research establishments and lucrative defence contracts being located in the county, to be near the military bases north of London and in the Western Crescent.

- Hertfordshire has a wealth of attractions to the high-technology sector including good transport links, conducive environmental features and the existing firms in residence. These have attracted prestigious research and development plants of large firms.

- Several problems face the county at the moment including one of the highest growth rates in unemployment in the South East, and a large skew towards a small number of very large firms. The decline in defence spending is also becoming a serious economic problem for the county.

A location quotient score of 3.6 makes Hertfordshire the highest concentration of high-technology in the country, with the large research and development presence reinforcing this categorisation.
Both Hertfordshire County Council and consultants have identified the need for networking activities within the county to strengthen and reinforce the industrial structure already present.

All the theoretical factors are present within the county to enable effective networking activities to take place. More importantly, business support institutions have recognised the significance of its industrial structure and the need for concerted communication as an enabler for successful research and development activities.

The comparison between Hertfordshire and Cité Scientifique and Baden-Württemburg has highlighted many similarities. An influential factor, however, seems to be the time period involved in each case. Germany has developed its policies and integrated regional network of activity over a period of fifteen years, while the French example has also been created by concerted action on behalf of both the state and the private sector over a number of years. Hertfordshire has all the prerequisites for an effective high-technology networked region but has not had the concerted policy focus in the past.
CHAPTER FIVE: CONCLUSIONS

5.1 Summary

- Hertfordshire is not currently acting as a technopole. However, it must be taken into account that both of the two European comparisons have built upon decades of targeted policy and intensification of the innovation networks present in each region.

- Hertfordshire has the potential to become a successful British technopole, exhibiting the majority of the critical elements adhered to in theoretical models and in comparison to the two European examples. Business Link is the key to the future, destined to take on the role of the Steinbeis Foundation.

- Hertfordshire's networking experiences illustrates the infancy of the region as a dedicated technopole. However, the defence industry utilised a subcontracted network of suppliers, also demonstrated by other industrial sectors in the county. Institutional collaboration is provided for by Business Link.

- The British attitude to the sciences is an inherent problem now being addressed by the government and scientific governing bodies. Years of neglect towards the sciences need to be reversed if Britain is to reach the standards set by our European colleagues.

- Regional economic planning is evidently an important consideration, affecting factors such as unemployment, land use and spending power. A significant void that needs to be filled at present is the lack of place marketing, something being addressed by Stevenage at the moment. Hertfordshire is not renowned for its high-technology presence. The two European regions in comparison are widely recognised as successful technopoles.
• The future for Hertfordshire as a potential technopole is relatively bright, despite the huge employment losses inflicted by defence cuts. The Bright Green Strategy has been officially adopted, Business Link was created last year (January 1994), and the Partnership for Prosperity is reasonably successful.

5.2 Is Hertfordshire Acting as a Technopole?

It is difficult to state categorically whether Hertfordshire is currently acting as a technopole, or not, as each technopole region has its own characteristics and specialisms. However, it is possible to identify whether the region exhibits core activities seen in technopole regions throughout the world. This is where my second hypothesis comes to the fore. For Hertfordshire to act as a technopole it is not only necessary for the elements identified by Smilor et al. to be present, but for them to act as a whole and not in isolation. The key idea behind the Technopolis Wheel is that a combination of all the necessary elements of a technopole will generate self-propulsive economic growth. They cannot do this individually. High-technology firms need the educational inputs, while the region as a whole needs the organisational inputs of the business support institutions to diffuse these activities. There are then the subsidiary levels of activity such as the spin-off or incubator firms and the service sector, all of which support the economy of the region in question. An illustration of this interdependence is the situation in Hertfordshire, which has greatly suffered from a lack of targeted state support, despite having the majority of the elements that Smilor et al. include in the Technopolis Wheel.

The second important point is that Hertfordshire adopted a laissez-faire approach for many years, unlike the technopole regions of Europe used as comparisons in this research. To keep the experiences of Hertfordshire in some sort of context, the relatively short-term concern to build upon the county’s high-technology industrial agglomeration must be kept in mind. Both Cité Scientifique and Baden-Württemburg have consolidated over a decade of targeted state policy and industrial ambition. This research has looked at the current situation in the county and based on this, the prospects for Hertfordshire in the future.
5.3 Hertfordshire’s Potential as a British Technopole

Taking a simple overview of the county, it can be said that Hertfordshire does have the necessary elements for it to become a potentially successful British technopole. However, on closer inspection there is a lot of thought and development which needs to be applied to this basic infrastructure. The education element within the county is a complicated question. It does not have the standing, or arguably the need, to compete with the nearby universities of London, Oxford or Cambridge which have been cited as providing good locational pulling power. If firms like Glaxo will build on their historical presence, and locate at Stevenage to be central to all three, then perhaps a university presence is already catered for. However, without this distinct educational presence contained within the county boundary there is never going to be this over-powering environment of research and innovation such as exists in the French and German examples. There is always going to be the need to look outside the county for additional expertise. The recent government policies have merely made the situation more spatially diverse.

Attention, therefore, could be better concentrated on redirecting the focus of school age training away from the traditional defence industry towards a new sector. I would argue that this could reasonably become the pharmaceutical sector. Instead of grooming school leavers for an engineering career at British Aerospace, more attention could be devoted to sciences such as physics and chemistry creating some of the much sought after laboratory technicians for Glaxo and its pharmaceutical competitors. The relatively strong presence of the natural sciences at the University of Hertfordshire could improve a poor biotechnology representation within the county and, therefore, allow Glaxo to form some of its biotechnology relationships outside the USA. Hertfordshire has proven success in targeting school leavers for its local industries. There is no reason why it should not be equally successful with a different focus. At the moment, according to Goldring (1995):

"The translation of pure science into workable industrial processes, in other words development, is a key part of any high-tech country's industrial base."
It would be an ambitious strategy for Hertfordshire to contemplate attracting biotechnology firms, but few exist in this country, (Cambridge has an Australian funded SME). The advantage for the would-be venture capitalists is that a market already exists within the county. Such a process of development would intensify the collaboration between firms within the county and would also be of great benefit for the UK economy as a whole. Government support would be forthcoming as it too wants to fill this void. Perhaps this is too ambitious, but it is an interesting thought to contemplate. Nothing can be lost by generating new ideas.

In terms of the business support institutions in Hertfordshire the proactive role of the County Council’s economic development department is a creditable element. It does, however, need to be wary of spreading itself too thinly and confusing the idea of the one-stop shop provided by Business Link at St. Albans. Firms still do not have a clear idea of where to go for specific help, especially for European funding for innovation. Business Link should become the key destination. Its role appears to be very similar to that of the Steinbeis Foundation in Baden-Württemburg, co-ordinating the actions of other business support institutions within the region. With Business Link co-ordinating and targeting policy and technological aid there is a bright future for the high-technology population of Hertfordshire. However, the density and scale of these actions need to be intensified over the next few years.

The Innovation and Technology Advisor at Business Link said that he often finds himself isolated in his position due a lack of business development infrastructure. If future policies and actions can be developed along the lines of the intense network created by the Steinbeis Foundation then the feeling of isolation will become less of a problem. The Chamber of Commerce is a stalwart of the business community, and as such it will always have specific functions to fulfil. There is only scope, I would argue, for increasing the membership of local firms and widening expertise to complement the much needed help with export licenses, for example. It is never
going to be as effective as the German equivalent unless membership can be made compulsory in Britain, as it is there.

The TEC is also a relatively new and useful addition to the range of business support institutions. Its role in-between the traditional educational establishments like the universities and polytechnics, and in-house training, will strengthen the commitment to life-long learning adhered to in the Bright Green Strategy. It is also a co-sponsor of Business Link, in conjunction with the DTI, ensuring close links between the three.

The county, or indeed the DTI Eastern Region, as I described in the previous chapter does not have anything like the density of specialist coverage of technology transfer or innovation facilities of the two European examples. As well as the equivalent institutions to the DTI, the two European examples have additional and powerful institutions specifically targeted at the high-technology industry, i.e. the CRITTs in France and the Steinbeis Foundation in Germany. It is this solid commitment to a regional policy of aiding innovative activity that has developed over recent decades to provide the dense networks of activity crucial to the regions’ success.

5.4 Hertfordshire’s Networking Experience

The networking experiences formed the second part of this research and, as I have shown with the comparative examples in Europe, are seen to be integral to the function of a technopole region. Networking activities are obviously limited to the infrastructure and economic base of the area under scrutiny. Hertfordshire’s limited localised presence of educational establishments extended the research collaboration to facilities outside the county which might otherwise have been more centralised. However, this is not a significant problem with the three establishments, London, Oxford and Cambridge, forming a triangular pulling power centred on the county.

The extent of inter-firm collaboration is concentrated on the supply function of firms rather than the more specialist research functions. Research, at least with the multinationals in the county, tends to rely on group level collaboration keeping
research methods and trade secrets in-house. Some of this group level collaboration does, however, occur within the county where different branches are situated in the locality. Examples such as GEC Marconi and Marconi Instruments, and the smaller subsidiaries of SmithKline Beecham illustrate this.

Discrepancies with the two European examples occur at state level and with the individual characteristics of each region. In the Ile-de-France region of France the decentralisation and subsequent concentration of state industry, such as the nuclear sector (CEN), has also increased the networking density of Cité Scientifique. The Steinbeis Foundation is one such institution which does not really have an international equivalent, but is crucial to the success of Baden-Württemburg. In this context the comparison becomes more a question of looking at something to be encouraged.

Finally, with regard to the business support institutions Business Link should be developed along the lines of the Steinbeis Foundation, as I have already said, and therefore, could become equally successful. If Hertfordshire continues to be guided by the European funding programmes which also promote collaboration, although at an international level, Business Link may become more significant. Hertfordshire County Council, however, needs to be wary of clouding its one-stop-shop position.

The TEC is also integral to the future success of the county with its “Bright Green” commitment to life-long learning, and the transition from grooming the younger generations for the defence market to a new county industrial focus, such as the pharmaceutical sector which I have advocated in this research. The co-ordination of activities by Business Link is a recent step in the right direction and shows the new commitment to bringing the business support infrastructure closer together improving the chances of innovative firms in the marketplace. The attitude that innovation leads to economic growth appears to have filtered down from a theoretical to a grassroots level.
Figures 5.1 A Diagrammatic Summary of the Networking Activities in Hertfordshire
In the light of the article by Bennett and Krebs to which I referred in the introduction, the institutional relationships and networking collaboration can be represented in a graphical form with the thicker lines illustrating a stronger link between the two institutions, the first matrix of figures 5.1, (p. 128). I have placed Business Link in St Albans at the centre because I believe that it has the potential and the status to fulfil a central role in the county, acting as a unifying force for the high-technology activities of the county.

The second diagram, (figures 5.1), shows the collaborative situation in respect to the firms of the county. This diagram reflects the basic table that I put forward in the introduction, illustrating the different levels of inter-firm co-operation.

5.5 The British Attitude to the Sciences

A relatively new addition to the British calendar has just finished (March 1995). The need to have a British Science Week reflects the growing concern that we have about the state of our industry, and our ability to compete on a global scale with both our fellow Europeans and Japan, and the NICs (Newly Industrialising Countries) of Asia. Attention is not just directed at our industry but also at more serious matters of a global concern:

"One third of the public still believes the sun goes round the Earth - and two thirds do not know how long the orbit takes. This ignorance is not confined to the man in the street. Parliamentary surveys have shown MPs completely confused over the causes of the three main environmental threats: acid rain, the hole in the ozone layer, and global warming."

(The Guardian: Comment 27/3/95)

As the article goes on to confirm, there is a substantial self-interest behind the merriment of Science Week. The President of the British Scientific Association believes that a public ignorance allows research budgets to be cut without the rigmarole of protest associated with both health-care cuts and education cuts. A
comment by the Science Minister, David Hunt, is unlikely to be directed at the UK in the near future:

"The nation that embraces science and technology most willingly and most effectively will be the winners in tomorrow's world."

(Op. cit, 27/3/95)

Future government science policy is to have a rethink. At the launch of Science Week it was announced that a panel of six Nobel prize winners would help to shape Britain's scientific future. Meetings are set to include leading scientists across the country. However, it is not simply a case of deciding the best way to generate scientific expertise, starting with remedying the poor scientific representation in our schools, although this is an urgent consideration. There is also the significant problem of creating a global competitiveness for the British high-technology industry. The commercial part of Mackintosh's definition of innovation is therefore suffering. There are some exceptions. In the recent Prince of Wales Awards for Innovation, the winning company was JCB who had re-invented an existing product, the tractor. It was networking between the company and the market, involving co-makership, which had led to the commercial success. The company had set out from the start to listen to the market so that commercial success could be more easily guaranteed. It was this co-makership, the final product and its commercial success (0% to 10% of the market in two years), which had won the award.

The President of the British Scientific Association recently advocated that:

"Scientists have paid too little attention in the past to celebrating their successes or communicating the excitement which scientific research can generate. At last they are learning how to sell themselves."

(Op. cit, 27/3/95)
The most important molecule on the planet pulled into Euston Station in London yesterday to form the centrepiece of a genetics exhibition that is expected to be visited by 400,000 rail travellers, writes Roger Highfield, Science Editor.

The 15ft model of the DNA molecule, which holds the instructions to make every protein in the human body, will be used in the exhibition about developments in genetics. "We want to give people the information so that they can make up their own minds about the ethical issues arising from genetic engineering," said Ms Mary Rice, of the Medical Research Council, which organised the event with the Wellcome Trust.

Figure 5.2 The Quest for Scientific Recognition During Science Week
Even out of the panel of Nobel prize winners, two of the most recent British scientific successes left for the USA where presumably they were better appreciated and accommodated. Akio Morita pointed out that we do not hold scientists in as high regard as many other leading innovative countries around the world. This is something that filters down to credit institutions who are unwilling to finance long-term scientific research projects. One of the major foundations of the success of Baden-Württemburg has been the responsiveness of the credit institutions who not only make finances available but are also the principal source of complementary funding schemes such as technological aid programmes for the region.

Until the British attitude towards science improves, the high-technology sector and Hertfordshire as a potential technopole, will face barriers of a decreasing labour pool of skilled scientists, government cut-backs and therefore a lack of competitiveness of British high-technology firms.

5.6 The Planning Implications of this Research

The key question to be answered is what are the implications for the planner if Hertfordshire is to become a future successful British Technopole? The first objective is to build on the current assets of the county and not to try to achieve too much too soon. The decline in the defence market is a big economic blow to the county but, as I have shown and according to many, the decision of Glaxo to locate their prestigious research and development centre at Stevenage is the beginning of a new era in Hertfordshire's economic history. The county has a significant chance to create a new industrial focus, the pharmaceutical sector.

As I indicated in the previous chapter, the Glaxo centre is made all the more significant due to the take-over of fellow drug giant Wellcome to create the biggest drug manufacturing firm in the world, Glaxo Wellcome. As well as the implications for the service and supply sectors in Hertfordshire of such a big new development, there is the possibility of spin-off firms being established due to the amalgamation of two large firms. Some highly skilled labour is bound to become superfluous and so
may create spin-off firms. If this process can be accommodated by the county then these new firms may well locate in the county and feed from the larger firms, strengthening the SME economic base of the county. Importantly at the moment, the planner has the opportunity to create new industrial space without eating into the Green Belt due to the vacation of large sites such as the former British Aerospace site.

One concern of the pharmaceutical industry was its environmental acceptance by the public. With the Glaxo site locating in the *green and verdant county* of Hertfordshire this concern can be diminished. The Glaxo site is aesthetically very good and with technology rapidly advancing there is no longer this image akin to the industrial wastelands of Eastern Europe. Hertfordshire must build on the relationship between successful *British* industry and a top grade environment for the skilled workers required.

Planning policy in the future should look towards intensifying the business support institutions in the county and consolidating the basically sound economic base. High-technology industry is the county’s strength, in the form of both SMEs and multinationals. High-technology industry requires facilities for technology transfer and research centres. Business Link could be the British equivalent of the Steinbeis Foundation in Baden-Württemburg. The county planners need to provide a dense environment conducive to innovative networking, something that at the moment falls short of the two European examples. The lack of state support and the regions invisibility as a high-technology agglomeration are the primary problems.

Above all a long-term outlook must be adopted, something that the British do notoriously badly. The economy is finally emerging from recession, but it will be many years before another boom period. If Hertfordshire can generate the potential for industrial collaboration, seen as the way forward, then the good days of the defence-led market can be re-created. Success for the two European technopoles that I have addressed has not been an overnight phenomenon. Hertfordshire too must build gradually and intensify its infrastructure allowing firms such as Glaxo Wellcome
to generate a secondary economy and multiplier spending effect. An important underlying tenet is that nothing can be achieved overnight. Just as pharmaceutical firms must invest and plan for the future, so must the planner. The things that we do now rarely have an immediate effect. It will take many years to discover whether what we are doing is right. By then it will be too late for regrets. However, at the same time we cannot do nothing. Investment in the future is the key to success, as the Japanese have proved. One of the pressing priorities for the planner, and one that can have short term effects, is the increasing trend of place marketing. Success breeds success.

5.7 The Future

Future economic trends are notoriously difficult to predict accurately. This research began by looking at the relevance of Kondratieff’s Long Wave Theory to the modern capitalist economy. The notion that innovation has empirically been the key to new waves of economic growth has been widely discussed by different economists. In the case of Hertfordshire, its industrial success has rested jointly on innovative activity and state influenced contracts for the defence industry. Now that the defence factor has been significantly curtailed, the future success of the county is going to become increasingly more reliant on the innovative presence of the high-technology sector.

For this high-technology sector to continue in the same successful vein as the defence-led market, attention must be paid to the established successful examples of similar technopole locations, i.e. Cité Scientifique and the German region of Baden-Württemburg for the purpose of this research. The key factors to emerge from these examples were:

- a significant innovative SME and multinational presence
- an educational and business support infrastructure
- regional scale networking activities
An important factor to be remembered when comparing the three examples is that Hertfordshire has had its high-technology economy for many years but, in terms of becoming a successful technopole, it has long been in the shadow of the defence industry. Only now is this shadow being lifted, forcing the county to contemplate its economic future in the light of escalating unemployment. The other two examples have worked for many years at becoming a recognised technopolis, combining specific state policy with a purposeful educational presence. Innovative industrial activity has built up gradually reinforcing the role of each factor and increasing the depth and density of the innovation network within the region in question.

The Bright Green Strategy for Hertfordshire was officially launched this month illustrating this British lag behind Europe in recognising the importance of our high-technology sector and the regions in which they agglomerate:

"Hertfordshire County Council's new strategy - entitled Bright Green - is one of the first in the country to combine environmental sustainability with the development of knowledge-based industries such as pharmaceuticals, defence and information technology."

(Planning Week 13/4/95, p. 4)

It is this question of marketability that is becoming crucial to the successful future of such regions. Both Cité Scientifique and Baden-Württemburg advertise the fact that they are successful technopole regions. The advertisement for one of the major credit banks integral to the success of Baden-Württemburg appeared in a British newspaper, (figure 5.3). Hertfordshire is hardly recognised as a high-technology agglomeration by the firms who reside in the county. Hertfordshire has many of the elements favourable to its future success as a British technopole, including a green and spacious environment long recognised as desired by a highly skilled labour force.

If Hertfordshire can instigate a good marketing campaign, a significant step along the road to self-propulsive economic growth could be achieved. Firms like Glaxo are world leaders in their industrial sector and as such can have immense "pulling power".
In Baden-Württemberg, we know all about bull markets.

And bear markets, too, come to that. In turbulent times, L-Bank’s credit quality and liquidity forge firm foundations for innovative issues.

L-Bank is the bank of the State of Baden-Württemberg, an economic powerhouse of a state, even by German standards. The wealth of blue-chip corporations based in Baden-Württemberg includes names that any state would be proud to call its own. The close ties between bank and state make for effective synergies. Baden-Württemberg is the force that underpins the credit quality that has won the bank its triple Triple-A rating. In return, as state development agency, L-Bank assists the state with its public sector commitments — targeted infrastructural improvements, promotion of trade and industry, funding for residential construction programs and family support, to name but a few. Oh, and the promotion of agriculture, of course. Which brings us back to those bull markets. L-Bank, Schlossplatz 10/12, D-76113 Karlsruhe, Germany. Telephone INT 721/150-0.

Figure 5.3 Publicity for the Financial Underpinning of Baden-Württemburg
With large sites becoming vacant due to the exodus of the defence industry the county is finding that space is becoming available without encroaching on its precious green environment. The Bright Green Report might be the initial step of recognition of the innovative industrial presence within the county to those outside the area. The marketability of the county is very good. It has exceptional transport links, proximity to the capital, London, an attractive environment and an established high-technology presence upon which to build. It also has a proactive basic infrastructure conducive to future industrial success, not reliant upon the guaranteed defence market. The potential for Hertfordshire to become a successful British technopole is already in existence and with some patient nurturing over the long-term period it can be realised.


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MPhil Thesis Questionnaire: Networking within the Pharmaceutical Industry

ABOUT YOUR COMPANY

Name of firm: ________________________________________________

No of employees: 1-10 [ ] 10-20 [ ] 20-30 [ ] 30-40 [ ] 40-50 [ ]

50-100 [ ] 100 + [ ] 500 + (specify) ________________

Is your company: public [ ] private [ ] part of a group [ ]

If part of a group, please explain ________________________________________________

__________________________________________________________________________

Main function of firm in Hertfordshire: _____________________________________________

__________________________________________________________________________

% turnover spent on R & D: (approx) _____________________________________________

What are your main types of current R & D activity? __________________________________

__________________________________________________________________________

Do you subcontract your R&D activities to other firms in the area? YES/NO

If YES, please explain _________________________________________________________

__________________________________________________________________________

NETWORKING ACTIVITY

How regular is your contact with: (please tick)

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<th>EDUCATIONAL INSTITUTIONS</th>
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If other please specify: _________________________________________________________

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What is the reason for this contact, if it exists: (please tick)

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If other please specify (e.g., technology transfer/diffusion)

Do you have any contact with other firms in Hertfordshire? YES/NO

If YES...

[1] AT WHAT LEVEL? Managerial [ ] Research [ ] Supply [ ]

Other (specify)


Other (specify)

[3] FOR WHAT REASON?

Has your firm instigated any networking with other firms in Hertfordshire? (such as creating incubator outlets or research groups, if so please specify)

If not in Hertfordshire somewhere else (where)?

Have you undertaken any joint research projects with other firms in the area? (Such as design coupling, if so please specify)

Briefly describe your perception of an ideal network (in terms of subcontracting, inter-firm cooperation ...) for high-tech industry

PLEASE RETURN THE COMPLETED QUESTIONNAIRE IN THE ENVELOPE PROVIDED. THANK YOU FOR YOUR HELP.
**MPhil Thesis Questionnaire: Networking in the High-Tech Industry**

**ABOUT YOUR INSTITUTION**

Name of institution: ________________________________________________

Who is represented on your board of directors (in terms of firms/councils/etc.) (if applicable) _______________________________________

Primary functions of institution:

Business Advice [ ] Employee Training [ ] Financial Help [ ]

Liaisons between different parties [ ] *(please explain)*

Other [ ] *(explain)*

How is this institution financed?

Main clients:

Would you describe your role as primarily:

Proactive [ ] Reactive [ ]

If proactive, explain ____________________________________________

**NETWORKING ACTIVITIES**

Do you think that Hertfordshire capitalises on its intense concentration of high-tech industry? Yes [ ] No [ ]

If No, what could/should be done? __________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

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In your experience are the high-tech firms within Hertfordshire willing to cooperate with each other?

YES [ ] ...in terms of:
R & D [ ] European Funding Bids [ ] Subcontracting services [ ]
Other [ ] (explain) _____________________________________________

NO [ ] ...could you suggest reasons why you think not?

__________________________________________________________________

Do you think that your institution has strengthened links between companies in Hertfordshire? Yes [ ] No [ ]
If Yes, in what way... ___________________________________________________________________

In your opinion, how important is the presence of the pharmaceutical companies in Hertfordshire? _____________________

__________________________________________________________________

Do you think that multinationals such as Glaxo and Smithkline are too large to worry about networking with smaller companies, (such as biotechnology companies) within Hertfordshire?
YES [ ] ...why? ___________________________________________________________________

NO [ ] ...does any take place that you know of? ____________________________________________

Briefly describe your perception of an ideal network for high-tech industry: ___________________________________________________________________

PLEASE RETURN THE COMPLETED QUESTIONNAIRE IN THE ENVELOPE PROVIDED. THANK YOU FOR YOUR HELP.