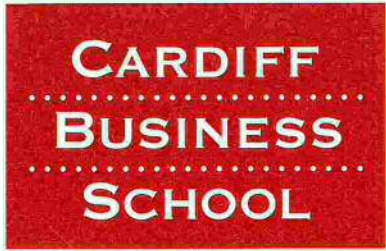


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Notes for Contributors

Authors should send papers for potential publication in the *Welsh Economic Review* to the Editor at the address given below, preferably via e-mail in a Word for Windows format. Papers are welcome on any topic that would be of general interest to the readership, and should be written in a style suitable for non-specialist readers. Papers should be approximately 3,000-4,000 words and any graphs or figures should be accompanied by the underlying data to allow reproduction.

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WERU Conference 2001

In May 2001, the Welsh Economy Research Unit held its 9th annual conference. The conference theme was *Wales HQ? Learning, Economic Autonomy and Regional Development*. Following the conference, speakers were invited to provide a summary of their presentations for this *Review*. Those received are published below. A wide range of issues were debated during the conference, and WERU would like to thank all conference speakers and delegates for their participation. Special thanks go to Sarah Dickins, journalist and broadcaster, who was Chairperson for the day.

Wales Today - Recent Industry Developments and Issues of External Control

Max Munday, Director, Welsh Economy Research Unit, Cardiff Business School.

Introduction

The purpose of this article is to provide a brief review of recent industry developments in the Welsh economy. In particular, the article will summarise recent industry 'gains and losses' in Wales, and relate these changes to issues of external control. Expected developments in Welsh industries in the first part of new Millennium will also be outlined, as will factors affecting Welsh prospects in period to 2010.

Gains and Losses

The year to April 2001 has not been a particularly happy one for Welsh industry. Contributing to falling business confidence has been uncertainty about economic conditions at the national and global level, particularly fears of a slowdown in world growth following problems in the US and Japan, and a slowdown of growth in industrial production in the Eurozone.

In Wales there have been several specific developments that are affecting current regional economic prospects. First, parts of the Asian-owned consumer electronics sector have switched production to central and eastern Europe, particularly mature technology products, resulting in around 2000 redundancies. Second, Corus announced extensive redundancies in February 2001. Steel and electronics have not been the only sectors damaged by recent developments. Textiles, automotive component production, and general engineering have also seen extensive redundancies through the year. In the year to April 2001, an estimated 10,000 redundancies have been announced, comprising, some 2-3% of Welsh manufacturing employment.

On a more positive note, Wales has continued to gain inward investments in some selected sectors of manufacturing and in services. In manufacturing, inward investment either created or safeguarded jobs at firms such as Mollertech (Caerphilly) Toyota (Deeside), Ford (Bridgend), BAE (Broughton), and Wireless Systems International (Cwmbran). In services, there were also major investments announced/completed in financial and

business services and communications sectors. During 2000-01, One to One (Merthyr), Pearl Assurance (Cardiff), Lloyds TSB (Bridgend) and On Line Finance (Caerphilly) made investments, with call centres continuing to dominate new employment provision.

In spite of new inward investment, manufacturing employment losses have outweighed manufacturing gains in 2000-01. Several factors explain recent industry losses:

1. Globalisation trends in industries with large economies of scale, resulting in consolidation on an international scale - (particularly in motor vehicles, steel and electronics).
2. Globalisation accelerating specialisation and transfer abroad of uneconomic activities - in the case of Wales this has been seen in the transfer of electronics, textiles and automotive output to Central and Eastern Europe, and North Africa.
3. Cross border merger and acquisition activity leading to rationalisation and restructuring at the regional level - partly a response to 1 & 2 above - has hit sectors as diverse as utilities, financial services and manufacturing in Wales.
4. The strength of Sterling (or weakness of the Euro). It is worth noting that in 2000 around 70% of Welsh overseas exports went to the European Union (HM Customs estimate). Wales is very exposed to adverse currency movements, and a prolonged slowdown in the Eurozone.
5. Productivity improvements (particularly in the chemicals and mechanical engineering sectors).

Plenty of press coverage has been given to the 'currency' factor, but rather less has been given to points 1 & 2 above. The factors that made Wales the winning UK location for inward investment during the late 1980s are exactly those factors that make areas of

Central and Eastern and Southern Europe so attractive today.

Recent Losses and External Control

The role of externally controlled firms in the recent round of job losses, has added further fuel to the regional debate on the longer-term value of externally-owned manufacturing to Wales. Generally, external control is read as overseas control, but the concept could equally be applied to Welsh based enterprises controlled from other areas of the UK.

Perversely, at a time when political structures in Wales are becoming more devolved, an increasing amount of industry activity is becoming externally controlled. Why does this matter? The arguments are well-rehearsed in the regional economics literature. Differences in operational scope mean that externally controlled firms usually have access to a wider set of opportunities than their indigenous counterparts. This might mean that such firms are better able to move production capacity quickly, and can purchase globally not locally - indeed it is these very factors that help explain their competitiveness. However, this flexibility implies costs for the host region. Externally controlled firms set goals at an international level, taking less account of the local economic context in their decision-making. Furthermore, externally headquartered firms may be less embedded in their local economies compared to their indigenous counterparts, creating fewer indirect economic benefits as a result of their presence. This is most often seen in the comparatively low local purchasing propensities of foreign-owned firms in Wales. However, more generally, externally controlled plants may also not have the breadth of functions of their locally controlled counterparts. This has implications for earnings, occupational diversity, and employment opportunities, but is also tied to the Wales 'R&D problem' and fears of a continuation of a low skills equilibrium in the region. The latest figures on R&D in Wales show that business enterprise R&D for manufactured products as a percentage

of manufacturing value added was just 1.4%, compared to a UK average 5.1%. This problem is present in elements of externally controlled manufacturing activities, but most evident in sectors such as financial services and utilities, where there has been a gradual 'hollowing out' of HQ functions in the recent past.

While there are well established arguments concerning the disadvantages of external control in the regional economy, it is important to examine another side of the debate. First, what would have happened to the Welsh economy without the involvement of foreign capital in the 1980s, when

there were few alternatives in terms of indigenous capital to fill the void left by manufacturing losses? Foreign-owned manufacturing can then be connected to significant employment creation in Wales. Second, foreign-owned manufacturers generally pay higher wages, are comparatively productive and are associated with knowledge and competitive spillovers into the domestic sector (Table 1).

Defining the precise costs and benefits associated with external control is always complex. It is also difficult to comment on trends in external control in Wales. One indicator is trends in overseas control of Welsh

manufacturing (there is little data available to comment on external ownership in services). Table 2 shows that the influence of the foreign sector has grown in employment terms across most manufacturing sectors between 1974 and 1998, with particularly large increases in electronics.

The growth of foreign involvement should also be set in the context of what has happened to the domestically controlled sector. For example, between 1981-1997 employment in foreign-owned manufacturing increased by 17%, whilst employment in domestic manufacturing in Wales fell by 12%. Some of this change in the foreign and

Table 1 Labour Productivity, Salaries, and Total Value Added (including indirect) per Direct Employee (1995) UK and Foreign-Owned Manufacturing Firms in Wales

Sector	Sales per Employee (£000s)		Gross Salaries (£000s)		VA/employee (£000s)	
	UK	FO	UK	FO	UK	FO
Rubber etc	69.8	87.1	16.6	19.7	38.1	49.6
Metals	103.0	221.7	20.7	23.4	43.9	120.6
Engineering	52.7	78.7	17.7	21.6	29.8	36.6
Electronics	58.8	110.7	16.0	19.0	31.8	48.7
Transport Equip. etc	90.2	128.9	20.0	22.8	40.3	69.1
Average	81.4	126.5	18.7	20.9		

Source: Brand et al., (2000). Assessing the impact of Foreign Manufacturing on Regional Economies, *Regional Studies* 34 pp. 343-55

Table 2 Employment (000's) in Overseas Manufacturing; Wales 1974 & 1998

Sector	SIC 92	1974 Employment (Plants)		1998 Employment (Plants)	
Food & drink	15-16	2.0	(4)	4.5	(24)
Textiles	17-18	1.0	(5)	1.1	(9)
Wood, wood products, printing etc	20-22	1.3	(10)	4.0	(23)
Chemicals	24	6.4	(15)	8.6	(56)
Rubber and plastics	25	1.3	(5)	4.4	(36)
Non-metallic minerals	26/23	0.0		3.0	(16)
Basic metals etc	27-28	10.5	(23)	5.4	(39)
Mech Engineering	29	5.9	(21)	5.4	(31)
Electrical, Electronics etc	30-33	13.0	(18)	24.1	(64)
Motor vehicles	34	7.6	(11)	11.5	(33)
Other transport	35	0.0		2.2	(5)
Other manufacturing	36	3.8	(15)	1.3	(12)
Total	15-36	52.8	(127)	75.5	(348)

Notes: Derived from Welsh Economic Trends, 1977 & Digest of Welsh Statistics 1999. Some figures for 1974 are estimated. Figures in brackets for 1974 are for companies, in 1998 they are for plants.

domestic sector results from cross border mergers and acquisitions. Analysis of Census of Production data shows slower overall growth of gross value added in domestic sector manufacturing compared to the foreign sector (Table 3).

In summary, foreign controlled firms currently account for an estimated one third of Welsh manufacturing employment, and 45% of Welsh manufacturing output. If one assesses

(see Industrial Production section of this *Welsh Economic Review*). The manufacturing index for Wales has fallen dramatically since the middle of last year, with particularly steep falls in electronics, basic metals, textiles and chemicals.

The manufacturing redundancies announced during 2000-01 contribute to the longer term forecast loss of manufacturing employment in Wales up to 2005 (Table 4). Fastest growth in the

considered. These factors can be summarised as follows:

- How far the region will continue to attract foreign manufacturing and services investment. There is an increasingly competitive location marketing environment, marked by expected EU enlargement, and the continued cost competitiveness of countries in central and eastern Europe.

Table 3 Growth in Manufacturing GVA by Sector: Foreign and Domestic Sector, Wales 1984-1997

Sector	Foreign Sector	Domestic Sector
Food and drink	304%	139%
Printing, paper and publishing	170%	255%
Chemicals	130%	-33%
Rubber and plastics	442%	357%
Non-metallic mineral products	110%	-18%
Basic metals	126%	149%
Mechanical engineering	328%	77%
Electronics	263%	103%
Overall	205%	118%

Source: Census of Production, PA1002.

Table 4 Growth in Employment and GVA by Broad Sector (per cent per annum)

	1995-00 Emp	2000-05 Emp	2000-05 GVA
Agriculture, forestry, fishing	-3.9	-0.7	1.6
Mining/quarrying	4.2	-4.5	-3.0
Manufacturing	-0.8	-2.4	1.9
Electricity, Gas & Water	-16.9	-1.2	0.6
Construction	6.9	-2.0	1.2
Distribution, Hotels and Catering	0.1	0.6	1.6
Transport & Communications	0.3	1.7	4.1
Financial and business services	3.8	2.2	2.6
Government & other	0.6	1.2	2.7
Total Wales	0.8	0.3	2.1

Source: Cambridge Econometrics, 2001.

'external' to mean foreign control, then there has been a steady increase in external ownership with foreign capital making a stronger contribution to Welsh economic prospects through time.

Recent Manufacturing Losses and Economic Prospects

Returning to the scale of recent losses, then how far are events starting to show through in the statistical indicators, and what are broad sector prospects? The problems of Welsh manufacturing are evident in the Welsh Index of Production

period 2000-05 is forecast to occur in financial and business services and in transport and communications.

In conclusion, and in the wake of recent manufacturing losses, and falling business confidence, it is very difficult to see the Welsh economy closing on performance targets set in terms of reducing the GDP gap with the rest of the UK. The health of the global economy remains the key factor affecting Welsh economic prospects. However, there is also a series of more local factors which need to be

- The efficiency with which EU Objective 1 funds can be used to address economic problems in industrial south Wales, west and north west Wales, to allow these areas to play a full role in regional economic development processes.

- How far employment currently being created in financial and business services and the communications sector in south east Wales is vulnerable to improvements in information technology, and further

restructuring and consolidation in the largest service providers.

- How far Wales can retain value added locally, other than wages. There are still challenges to be met in terms of improving the regional linkages of UK and foreign firms operating in Wales, and substituting imports, while also acting to increase the diversity of functions within firms.
- The extent to which Cardiff can build upon a new political and physical infrastructure, and compete with other regional centres to attract high quality employment in the fastest growing national sectors.
- The degree to which the National Assembly can develop a coherent set of policies, in close conjunction with its main regional partners, to address the underlying local economy problems such as low activity rates, low earnings and a poor record in innovation, and new firm formation.

A National Garden for Regional Regeneration

Charles Stirton, Director, National Botanic Garden of Wales

Introduction

Why is it a novel idea that botanic gardens can help facilitate regional economic regeneration? I hope to convince you that the newly established National Botanic Garden of Wales (Garden of Wales) is doing just that. I imagine that few would put botanic gardens on their top list of economic priorities. Yet, the newly established National Botanic Garden of Wales is already impacting on its hinterland and on Wales generally. I will share with you the exciting development and will underline its future potential impact through working in partnership with others.

The Garden

The National Botanic Garden of Wales opened its gates on the 24th May 2000. For many the opening was a significant cultural experience. The Garden is the first national garden of the third millennium, and the first national institution created under the new devolved National Assembly for Wales. It is also the first botanic garden to be built in the United Kingdom for over two centuries, and possibly one of the very few of the 1,846 botanic gardens in the world to be built on the principles of sustainable development. It is one of 28 millennial landmark projects in the United Kingdom. The £43.6 million

project has taken a decade to build from inception to opening and achieved 243,000 visitors in its first year, (40% above target).

The new garden is being established in the 18th century parkland of Middleton Hall in Carmarthenshire, midway between Swansea, Carmarthen and Llanelli in South West Wales, in an area that is virtually free of pollution. Set in an estate of 568 acres (230 hectares), it lies on the edge of the Towy valley, with spectacular views across one of the most beautiful valleys of agricultural Wales that is rich in ancient monuments (Dryslywn and Dinefwr Castles) and historic gardens. The recently restored Aberglasney Gardens is only a few miles away. The Garden lies in a rural area only a few miles from the industrial, urban south. Invisible to the park, the M4 intersection is a few miles from the Garden's southern tip, where the National Assembly has built a special grade separated interchange on the A48 (an extension of the M4) providing easy access to the Garden. The Garden enjoys a varied topography, a necklace of lakes, a range of microclimates, rich wildlife, and the added benefit of established woodlands and wild meadows.

What are Botanic Gardens?

Botanic gardens are institutions holding named and documented collections of living and preserved plants and plant parts for the purposes of scientific research, conservation, display and education. They are also important tourist attractions welcoming annually some 150 million visitors worldwide. Gardens are living museums and may contain significant architecture, libraries and dried plant collections. Latterly, they have begun to be important centres for environmental education; many with nature reserves and conservation programmes. They have always been key mediators in the introduction of economically important plants.

Gardens are defined by their purpose, content and landscape. In the past much of the garden design in Europe has been driven by various "schools" or by utilitarian imperatives. The emphasis has been placed on the quality and content of the landscapes, vistas, botanical research, and the plant collections. These influences are reflected in numerous well-known and loved gardens around the globe. Yet visitors or "customers" have rarely been at the heart of the development of botanic gardens over the last few centuries. It is heartening that over the last three decades there has been a steady shift in the way in which botanic gardens are relating to their visitors and

their community. If this trend continues, Gardens of the 21st Century will become more aligned with the cultures and social needs of the areas within which they exist or are linked to. They will also become economic regenerators or integral components of the local economy.

Building a new type of Botanic Garden

The opportunities and pressures facing the building of new gardens are very different from those of their predecessors. In the past the resources of the world were thought of as being infinite, whether privately, commonly or imperially owned. The scientific focus was on exploration, discovery, collection, description, and cataloguing. There were also large translocations of economically important plants around the globe, from colony to colony.

Today's world is very different. Just ten years on from the Earth Summit in Rio there are nearly one billion more people on earth - all demanding a share of the planet's space and resources. We live in a world of considerable environmental concern, finite resources, new pests and diseases, rapid climate change, globalisation, and acute interdependencies. Over the last decade there has also been a shift in approach to ownership of genetic resources. National sovereignty rights on genetic material are now enshrined in international law. All these elements influence what a modern botanic garden might aspire to be and what collections it may decide to hold.

Drivers and influences

There have been many overt and subtle influences on the building of the Garden of Wales and in the shaping of its style, content and direction. Key to these are Welsh devolution and a new National Assembly, the Rio Earth Summit and the Biodiversity Convention, Agenda 21, sustainable development, climate change, the global biodiversity crisis and assisted regional economic regeneration for Wales. Certain policy directives favouring organic land management, a GMO-free Wales, social inclusion, community outreach, and lifelong learning have also influenced the project. Each has offered an opportunity to be innovative.

It is against this background, that the Garden of Wales has slowly transformed its aspirations from an estate restoration project, to a new outward-looking national institution. Some key drivers for design and operation have been: sustainable development and recycling leading to a preferred future; Welsh culture and hospitality within an international context; local sourcing

(77% shop, 64% restaurant, Taste of Wales; 80% of plants sold); opening much of behind the scenes to our visitors; and an innovative and entrepreneurial culture.

Mission

The Garden's mission is "to develop a viable world class botanic garden dedicated to the research and conservation of biodiversity and its sustainable utilisation, to lifelong learning and to the enjoyment of the visitor". The mission focuses on science, education and the visitor experience. These are the planks that enable the Garden of Wales to contribute to regional regeneration.

Benefits

What benefits has the Garden of Wales brought to its region and to Wales?

- Major new all year premier tourist attraction
- New tourist product called "Premier Gardens of Wales"
- New short and long-term jobs
- New benefits and opportunities for local communities
- Part restoration of an historic landscape site
- Promotion and harnessing of new businesses
- Facilitator for new inward investment
- New champion for sustainable living, and water and energy conservation
- New site to further develop Wales as an enduring image around culture, innovation, heritage and environmental best practice
- Model for building new types of 21st century organisations
- New centre for Life Long Learning
- New scientific institution
- New centre for entrepreneurship and innovation

Challenges facing West Wales and the Garden's response

West Wales has suffered for some time from declining GDP, declining agricultural and tourism sectors, and a lack of significant inward investment. The low rate of inward investment in West Wales creates new opportunities to focus on the creation of new small sustainable local businesses. The suffering and changing agricultural sector creates opportunities for agricultural diversification. A declining traditional tourism sector enables a shift to more sustainable ecotourism and cultural tourism. West Wales is in transition, and the Garden is contributing to all these dimensions.

The following examples show how we are rising to these challenges.

- **Biotechnium.** As part of the challenge to create new jobs and businesses, the Garden has created a new Biosciences Business Incubator with support from the WDA, Europe and the Millennium Commission. The Centre opens in July 2002 and will promote the growth of indigenous SME's through corporate venturing, commercialisation of University based science, and from start-ups from the government and charitable sectors. Biotechnium is part of the WDA driven Technium Consortium of sectorally-based business incubators that are being established in Wales. The Garden's £3 million incubator will provide flexible office and laboratory space for up to 48 potential entrepreneurs (contact: rgriffiths@gardenofwales.org.uk). The Garden will run its own science programme in the Centre. Both these initiatives harness existing and new financial resources and talent and will act as a magnet to attract scientists of international repute, attract skilled professionals back to Wales, and will increase public/European funding for science in Wales.
- **Premier Garden of Wales.** This new tourist consortium brings together 12 of Wales's finest gardens. The Consortium markets the Garden's both in the UK and abroad. The Garden of Wales works closely with the Welsh Historic Gardens Trust and hosts their web site (See www.gardenofwales.org.uk).
- **Great Glasshouse icon.** This magnificent award-winning signature building designed by Lord Foster & Partners, with its radical Kathryn Gustafson landscape, is raising the international profile of the Garden and of Wales.
- **Principality LifeLong Learning Centre.** This new learning Centre received over 10,000 learners in its first year. Our aim is to help people become part of a learning society, stretch their horizons, and reduce social exclusion. We believe that Gardens can provide bridges for volunteers to get back into full time work, or to transfer their life skills to new generations.

Conclusion

New gardens face many challenges. Perhaps the greatest is to do things differently, and to work closely with all stakeholders. We are trying to do this by being outward-looking (centripetal) instead of inward-looking (centrifugal). It can be achieved by asking, "What can we do for our community and

environment"? We have begun this process by sourcing building materials and artisans locally, breaking up large contracts into smaller contracts to level the playing field for local contractors, by selling locally produced crafts and foods (300 local businesses sourced in our shop), and outsourcing operations such as catering, plant sales, cleaning, maintenance, and security. It is a challenging time for new gardens. They need to be flexible, quality-driven, innovative, enterprising, responsible, responsive, ethical, proactive, and centres of best practice in employment and environmental standards. Increasingly they need to pay particular attention to the needs of their customers, ensuring they have a memorable visitor experience.

We are only part way there. There are no short cuts. It is a long term investment that requires dedicated all-Wales partners and needs further infrastructure and running cost investment.

The garden is already a successful tourism project. It is the most visited garden in Wales. The platform and building blocks for science, sustainable development and education are being put in place. Now we need the partnership and additional resources to make it work for the betterment of the people and environment of Wales.

The Garden of Wales is a turning point for Carmarthenshire, now re-branded the "Garden County of Wales", and is showing that Gardens can indeed play a role in economic regeneration.

Entrepreneurship in the Fens: Some Lessons from Cambridge

Peter Hiscocks; Director of the Cambridge Entrepreneurship Centre

Introduction and Purpose

There has been an astonishing renaissance of enterprise and new business ventures in Cambridge and the surrounding region during the past twenty years. In fact, such a significant level of change has occurred that it has encouraged a number of investigators to examine "what has happened" and "what caused or enabled these things to happen". As a result we are able to suggest some tentative and outline characteristics that may be interesting and relevant to other regions that are looking to stimulate economic growth.

From this you should not believe that Cambridge has a "formula for success" or that there was a carefully researched

and excellently executed plan that led to the current results. There have also been many mistakes and not a few significant failures. However, overall Cambridge has been highly successful at growing new businesses and some of the factors that have led to this success are likely to be of interest to others. A key point for this discussion is the 'role of the University of Cambridge'. To what extent has the University been a part of this change and what is its role going forward.

The aim of this paper is to put forward these ideas for discussion and consideration rather than "showing how clever Cambridge has been".

Importance of Enterprise and Entrepreneurship

There has been an increasing awareness in recent years that new business ventures started through enterprise and entrepreneurship are critical elements in the growth of modern economies. Traditionally, entrepreneurship has been seen as a method for job creation in small new firms and self-employment. However, this view often focuses on keeping people off the dole through the establishment of low value-added operations or 'life-style businesses'; it underestimates the potential economic significance of entrepreneurship and ignores its social and cultural role.

In modern economies where innovation is of such importance in building sustainable competitive advantage, entrepreneurship has a more significant role. In the Cambridge region we have noticed the following key benefits arising from the growth of new 'knowledge intensive' businesses:

- Significant employment opportunities.
- High value-added products and services.
- High salaries and wages.
- Focus on skills growth and knowledge development in the work-force.
- Innovation orientation, providing resilience to competitive and market changes.
- Global business perspective and high export percentage of revenues.
- Clusters of competitive firms in the same industry encouraging innovation, skills growth through training and employment and mobility between firms.
- Wealth creation for owners who then recycle some of this as active 'business angels'.
- Wealth creation for employees through share option schemes, especially people joining ventures early.

Entrepreneurship is also of increasing importance for the University of Cambridge. The start-up and spin-out of new business ventures from the University not only provides a way to apply and exploit the considerable knowledge base of the University but it also gives alternative career opportunities and challenges for people who would otherwise be 'stuck' in an academic position with little chance for change.

Cambridge Past Performance in Establishing New Business Ventures

Looking at what is happening today, there is often a readiness to assume that things have always been thus. This is certainly not the case in terms of the Cambridge hi-tech business situation. Historically, the principal industries of the Cambridge region have been agriculture, leatherworks, and a small glass industry in the nineteenth century: There was no tradition of industry, manufacturing or hi-tech ventures until the late 1970's. The exceptions were the foundation of Cambridge Instruments by the son of Charles Darwin in the nineteenth century, and Pye Ltd, the electronics company, in the mid twentieth century.

The defining characteristic of the Cambridge region has been the University that was founded in 1209 and that has been one of the most highly respected centres for teaching and research in the world. Indeed,

Cambridge has such a record in terms of scientific and engineering discoveries and inventions (see Table 1 below for a sample of some of the best known) that it is tempting to assume that the current success of Cambridge in terms of new business ventures must derive directly from this research base. Whilst it is certain that the University of Cambridge has had an influence on the growth of hi-tech firms in the region, they have not all 'spun-out' from the University.

Until about 1970, only about a handful of new business ventures in Cambridge had 'spun-out' from research at the University. Obviously having a great centre of learning and research is useful, but on its own it will not cause new business ventures to be created. The next sections will look at the current performance of new business ventures in Cambridge, and then at some 'critical success factors'.

Current Performance from New Ventures in Cambridge

The level of hi-tech new business start-ups in the Cambridge region is the highest in the UK and the second highest in Europe (behind Munich). Figure 1 shows how the number of hi-tech new firms has grown rapidly over the past thirty years from less than 40 businesses in 1970 to over 1550 in 2001. The rapid growth in the number of hi-tech or, as we prefer to call them, knowledge intensive companies, has produced a considerable growth in employment in this sector so that it is

Table 5: Cambridge University - Great Scientific & Technological Advances

1600:	Dr William Gilbert - Science of navigation, map making
1687:	Isaac Newton - 'Principia Mathematica' - fundamentals of nuclear physics, laws of gravity
1704:	First chair of astronomy - leading to first public observatory
1812:	Charles Babbage - first 'calculating machine' - heralded invention of modern computers
1873:	James Clark Maxwell - 'Treatise on Electricity and Magnetism'
1887:	JJ Thomson - Cavendish Labs - discovered the electron - hence telephones, radio, television and computers
1915:	Lawrence and WH Bragg - X-ray diffraction
1929:	Frederick Gowland Hopkins - vitamins
1932:	Cockcroft, Walton and Rutherford - Atom first split
1933:	Paul Dirac - Quantum Theory and Position Emission Topography
1934:	Frank Whittle - work on jet propulsion
1941:	First jet flight
1949:	Maurice Wilkes - EDSAC (Electronic Delay Storage Automatic Calculator)
1953:	Crick and Watson - discovered structure of DNA
1958:	Frederick Sanger - insulin construction
1960:	Charles Oatley - first Scanning Electron Microscope
1962:	Max Perutz & John Kendrew - 3 dimensional structure of proteins
1968:	Anthony Hewish and Jocelyn Bell - discovery of 'pulsars' in astrophysics
1982:	Aaron Klug - molecular biology - viruses and RNA
1985:	Cesar Milstein - monoclonal antibodies

the second largest type of employer in the region, providing about 45,000 jobs. Firms are typically small to medium sized; the average number of employees per firm is less than twenty, and there are few that employ more than 500. The numbers employed in this sector are certainly a major contributor to the extremely low level of unemployment in Cambridge and the surrounding region, which is running currently at about 1.5%. These knowledge intensive businesses also tend to have a high level of export sales in their business operations, averaging at about 60% of revenues.

It has been noticed that the growth in numbers of these new businesses in Cambridge has been concentrated in certain industry sectors, notably software, computer chips and related hardware, telecoms, and biotech. These have been named as 'clusters' recently, and are seen to be a major contributor to the success of the growth of knowledge intensive businesses within a particular region. A number of studies have been carried-out on the importance of clusters and the mechanism by which they support new business creation.

Most of the knowledge intensive business activities in the Cambridge region focus on design and development; little manufacturing is carried-out by many of these new businesses, with revenues coming from licences and royalties or from sub-contracting the manufacture to third-parties or collaborators.

If we look at the performance of the University in 'spinning-out' new companies during the past 30 years, at first glance it is poor. The official figures for businesses that have been spun-out from the University, and in which the University still owns shares, is about 30 companies – only one a year over this

period. However, a more careful analysis of the new business ventures in the Cambridge region shows that a far greater number have been set-up by Cambridge alumni, either directly after leaving the University or within a few years – this number is nearer 300 companies. Furthermore, surveys of knowledge-intensive companies in the Cambridge region have shown that about 90% of these firms have some ties with the University in terms of active project collaboration, sponsored research, student projects, active recruitment, etc.

The value that these new businesses represent to the Cambridge and regional economy is difficult to quantify. However, in terms of 'sale value' or market capitalisation (where relevant) the value of these businesses is in the order of £30 to £40 billion. Furthermore, some 2,000 plus new millionaires have been created who not only increase local spending but, in many cases, are keen business angels investing their capital back into new knowledge intensive business ventures. It must be remembered that all this is new, incremental economic growth and wealth that did not exist before the creation of these businesses and that would not have happened without the formation of these new businesses.

Critical Success Factors

The recent and dramatic change in the economy in the Cambridge region during the past thirty years has caused many people to ask why it happened and what were the main factors for this change. Of course, with twenty-twenty hindsight it is easy to make up reasons (and somewhat difficult to be proved wrong) but this is an important question, and so we have tried to get to the bottom of what really caused this to happen, and what were the things that really mattered. One thing we came across quite early was a set of criteria

that had been developed by Prof. Gibbons of Stanford University when he had looked at this issue as regards Stanford and Silicon Valley. His list of ten requirements for the establishment of a high-tech region is given below:

- Universities and centres of academic excellence
- Entrepreneurs with marketable ideas and products
- Business angels and established seed funds
- Sources of early stage venture capital
- Core of successful large companies
- Quality management teams and talent
- Supportive infrastructure
- Affordable space for growing businesses
- Access to capital markets
- Attractive living environment and accommodation

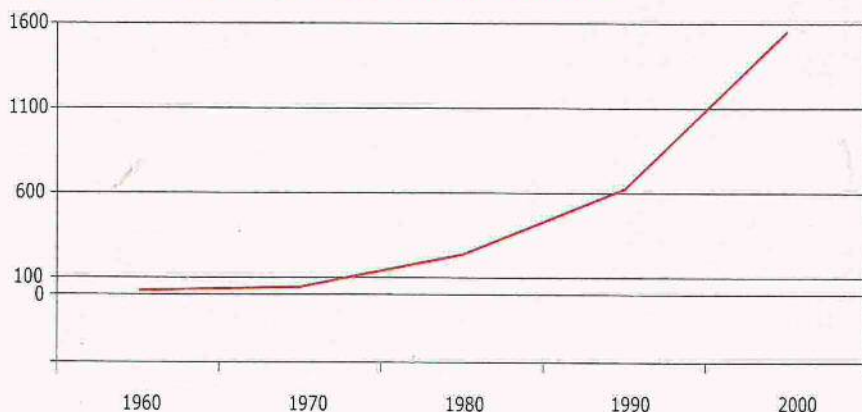
Source : Gibbons - *Stanford University* 1998

When we compared this list with Cambridge we realised that some of these factor fitted with Cambridge, but not all of them. For example, Cambridge does not have a core of successful large companies, it does not have quality management teams and, in the early days at least, did not have a supportive infrastructure (and there are many that would say that it still does not today). Furthermore, there were some factors that we felt were critical to us in Cambridge that Gibbons did not mention including:

- business networking infrastructure
- leadership committed to enterprise and entrepreneurship
- some early successes that are well publicised
- building and supporting a culture of enterprise and entrepreneurship
- (within universities) having suitable intellectual property policies
- providing access for all to teaching and training in enterprise studies

The outcome of these studies was that we realised that there is no one single factor that will guarantee success as a region for hi-tech new business ventures – no single silver bullet that will guarantee success. Rather, there are a number of factors that have to be in place for the development of successful hi-tech cluster to happen. We have borrowed a phrase first coined by David Gill, Head of Innovation at HSBC, who had also noticed this characteristic; we call it a 'golden chain' of factors that are 'linked' to each other and integrated to achieve the environment that will encourage and support new hi-tech business ventures. We think that the exact nature of these factors – or critical

Figure 1: Number of High-Tech firms in Cambridge



success factors – will probably be different for different regions but the ones that we think are most important are:

- Building an entrepreneurial culture – celebrating successes
- Having a significant local research oriented knowledge-base i.e. a good research university
- Building a venture capital community including early stage funding
- Establishing some form of business network that will support cluster development
- Providing practical management teaching to build skills and confidence in the option of starting a new business
- Providing a supportive infrastructure, including business regulations and planning consent

It should be noticed that the growth of the knowledge intensive businesses in the Cambridge region happened as a result of individual endeavours and private finance; there was virtually no local or central government planning or finance involved.

The Changing Role of the University of Cambridge

Historically, the University of Cambridge has been ambivalent, almost discouraging, of the exploitation of ideas and knowledge developed by its researchers and academics. That has now changed. The University is now committed to the development, application and exploitation of its knowledge base to support and assist the economy and communities. In practice this means that, at one level there is active support and encouragement for research contracts and other links with major corporates, and at another level there is support and encouragement for the spin-outs of new business ventures based on the knowledge-base of the University.

An important part in the support for new business ventures has been the establishment of the University of Cambridge Entrepreneurship Centre. This new department has the mission of:

1. building an entrepreneurial culture within the University of Cambridge
2. providing teaching, development and support for the people that will make new business ventures successful

To achieve this the Entrepreneurship Centre has three main activities:

1. teaching and training to inspire, build skills and embed through training

2. advice, support and mentoring for new business ventures
3. research into new best practice in establishing new businesses

The Centre was established in May 2000 and expects to increase considerably the number of new businesses spinning-out and starting-up from the University.

Wales HQ? Pharmaceuticals: tough medicine for Wales?

Roger Jones; Penn Pharmaceuticals

Whereas Wales has been wonderfully effective in attracting targeted industries in the electronics and automotive sectors, comparable success in the Pharmaceutical sector has proved to be elusive. Indeed with the departure of Warner-Lambert in Pontypool, employment in this sector in Wales has declined significantly over the past 20 years.

Why this lack of success? Why this decline? The answer probably lies in prioritisation. If you spread your resource too thinly then you will fail at everything. However with the decline in British automotive manufacturing, and the turbulent nature of the electronics/digital communications sector, perhaps the time is ripe to re-evaluate the contribution that Pharmaceuticals manufacturing could make to the economy of Wales.

One of the industrial sectors where British companies still perform well is in the Research and Development of new Pharmaceuticals. During the past decade it has been estimated that approximately half of the "blockbusters" in terms of new drugs originated from UK intellectual property. There is no doubt that this is a sector where British technology is truly world class. It is said that the industry is alive and well and living in Southeast England where it contributes to the skewed distribution of prosperity.

Could one of the big players be attracted to Wales in the first few years of the new millennium? The answer is probably not. There is still a considerable amount of consolidation taking place and research budgets running at about 15% of turnover are felt by the financiers to be capable of rationalisation and the proceeds returned to shareholders. It must be said that not everyone agrees with this view, but the consequences of cutting Research and Development spending will not be felt for another ten years, so that the perpetrators of the crime will be long retired or otherwise distanced from their action.

However this may not be the doomsday scenario that it might appear to be at first glance. The industry is characterised by high profit margins and a price inelastic demand. Consolidation may result in inefficiencies which specialised service providers can remedy. In product areas of high margins this can lead to unique opportunities for those specialised service providers. This is one area open to Welsh investment.

Another opportunity is based on the competitive pressures that the industry is subjected to on expiration of patents. This provides opportunities for new entrants. For example it is South African influenced companies that dominate the generic drug market in UK at present. Who is to say that Indian or Brazilian companies will not be the major players in five years time. Now is the time to be looking for them since they will need a UK base from which to operate.

Yet another opening by which viable start-ups may be introduced to Wales is by looking at inefficiencies in manufacturing locations already established, and then offering solutions to self-evident problems. A good example of this approach may be seen in the Irish Republic. The Irish Government in the 1970's targeted Pharmaceutical companies. Once Research and Development expenses have been written off, the patent owning company with costs of say 5 can sell the product for 100. This level of margin, if transparent, will attract price controls and taxation. Ireland passed legislation which enabled companies investing in the Republic to remit tax-free a proportion of the margin to any tax haven of the companies choice. This was very attractive to trans-national companies. They were now able to manufacture the drug substance in Ireland and transfer price that product to a high priced market such as USA or Japan at a price of say 50 where the cost is 5. The margin of 45 is removed to a tax haven, and now the base price in the high priced market is 50 plus, manufacturing and marketing costs reducing the profit margins in these markets to manageable proportions on which local taxes are then payable.

Ireland understood this very well and attracted dozens of major companies. They were less interested in the skills and R&D infrastructure. The consequence is a dynamic but overheated sector. The reality is that the advantages of the "profits black hole" far outweigh the labour market consequences. With wage inflation running at above 10%, and loss of operating efficiencies due to labour

churning, there is an opportunity for Wales to help the expansion of the Irish Pharmaceutical industry by providing services and labour in Wales. After all much of the product transits through UK. We would not be competing with Ireland since we could never offer the taxation incentives, but we could develop a viable long-term industry in a sector we had aspirations to foster.

In this short article we have deliberately addressed the "How?" question before the "Why?" since the conventional wisdom is that Pharmaceuticals are just too difficult. Let us now look at the "Why?" to determine if the benefits exceed the risks.

There are at least seven to consider.

1. The industry is potentially very large.
2. It is characterised by high margins. It seems more logical to attract companies that make high profits than one where margins are constantly squeezed such as automotive engineering.
3. It is characterised by being refractory to sudden change. Manufacturing is regulated globally. Once approval has been given, it is not without risks and considerable time delay to seek to relocate a manufacturing site. Therefore change is gradual.
4. The industry uses a high level of skills. If we intend to keep the most talented people in Wales we have to find work that uses a high level of skills. This ultimately leads to high salaries and wages which puts money into the economy, and provides the multipliers which are the basis of successful economies.
5. The industry turns indigenous intellectual property into wealth. If we are to establish institutions to capitalise on the intellectual capacity of a nation, then it is necessary to have a vehicle with which to effect the change. Otherwise, the control of the process is in the hands of others.
6. The industry spins out other service industries. Therefore a strong manufacturing base will develop a range of specialised service providers.
7. The products of the industry are high in value and low in volume - ideal for countries where difficulties with transport infrastructure present problems with almost every other kind of product.

Having considered the "How" and "Why" we should look at the "when". There are real opportunities to develop the Irish support option which are available now, and which may not be there in five years

time, perhaps due to a downturn in the Irish economy.

This will give Wales plenty to shoot at in the short term and by involvement in the pharmaceutical industry we will climb onto the learning curve and develop other opportunities.

Home Grown Expertise Holds the Key to New Prosperity in Wales

Pat Jones, Director of ELWa's Knowledge Exploitation Fund

The days when Wales could rely on the helping hand of overseas inward investment for its economic stability are numbered. For a quarter of a century investment totalling more than £13 billion from Europe, the Far East and North America has, to a large extent, provided the backbone of Wales' progress. But the economic landscape of the 21st Century will see a far greater role for home-grown enterprises whose ideas and innovative products will provide the mix for a new era of success and commercial achievement.

Wales is now turning to a greatly under-used resource - the knowledge, expertise and world-beating research and development already available within its universities and colleges. Wealth creation levels are struggling at around 80 per cent of the UK average, and both Eastern Europe and Asia are competing more strongly for our "lower tech" jobs so the country has only one real option for the future.

As outlined clearly in the National Assembly's BetterWales.com strategy, it is now vital to move towards the higher value-added industries and generate more knowledge-led businesses turning out sophisticated, world beating, products and services - products such as specialist semiconductors, smart automotive systems or leading edge software.

Moreover, there is growing realisation of the need to nurture more entrepreneurs - those energetic and visionary individuals with the ability to establish this new wave of innovative, high wealth creating and sustainable enterprises. It is now recognised that much of the knowledge upon which Wales could begin to build such businesses already exists on the campuses of further and higher education institutions.

In addition, many of the young people with the personal attributes to turn this entrepreneurial dream into reality are also to be found within these same institutions. To unlock these major

resources and put them to work in the economy, a new £43 million initiative - known as the Knowledge Exploitation Fund (KEF) was launched in 2001, which enables further and higher education institutions greatly to expand their commercial activities and build new collaborative links with industry.

The Fund represents an intensive four-year investment in the profitable application of knowledge and the development of human potential. It will provide new facilities and build new skills to enable institutions to work with businesses to boost the long-term wealth of Wales. KEF is a solution made in Wales to address the circumstances of Wales. Unlike knowledge exploitation initiatives elsewhere, it embraces both higher and further education.

KEF aims to revolutionise the outlook of further and higher education and open up the technological and human resources of these sectors for the benefit of the economy, creating a strong spirit of entrepreneurship in the academic world. Ultimately, it is hoped that KEF's economic impact on Wales will rival that of the past 25 years of inward investment, offering excellent value for the £34 million invested by the National Assembly and £8.8 million from Europe.

Already universities and further education colleges have become far more commercially aware in recent years. For example, acoustic technology experts at Bangor University worked with a local company to make nearly 5,000 damaged recordings of Welsh historical music commercially usable, and neighbouring Coleg Menai's Food Technology Centre helped a manufacturer in their area to create an entirely new and profitable range of convenience foods.

The Centre for Intelligent Systems at the University of Wales, Aberystwyth, has developed a major reputation for creating problem-solving software which has helped firms ranging from small and medium enterprises to multi-nationals. Their world-renowned expertise in artificial intelligence and robotics has proved a real asset for the automotive industry in particular.

Further education colleges have also been working with local industry to provide customised training, and in some cases whole workforce development programmes. For example the South East Wales Education for Industry Consortium (SWEFIC) involves eight FE colleges in developing and delivering multi-media training for the engineering and electronics sectors.

KEF will provide the funds and support to ensure this kind of industry-focused initiative spreads throughout Wales, providing intellectual nourishment from institutions to local businesses. To achieve this, KEF has appointed a new network of Entrepreneurship Champions - one in every institution across Wales. Their mission is to drive the programme forward, forge the necessary partnerships, influence the curriculum and ultimately achieve a far-reaching culture change. These champions will be the key contacts for ambitious businesses wishing to take advantage of the fund.

The Fund, which will be split equally between further and higher education, has four main objectives:

- to give businesses greater access to the knowledge and resources of the institutions
- to accelerate the commercial exploitation of research and development work and other expertise in the institutions
- to help staff in further and higher education to respond to the needs of industry, particularly the needs of small and medium sized companies.
- to support the development of entrepreneurship in universities and colleges

In short, firms with good ideas will have more opportunities to develop those ideas in conjunction with highly qualified academics, and young people with entrepreneurial flair will be helped to develop the right skills to turn their talents into dynamic businesses.

The KEF team will work closely with the WDA to ensure maximum impact from joint initiatives such as university Centres of Excellence for Technology Innovation and Collaboration (CETICs), and other major new initiatives such as Finance Wales and the Agri-Food Partnership. KEF lays heavy emphasis upon meeting the growing need to raise the skills of the current workforce. In particular, the Fund will focus strongly upon the small and medium sized enterprise sector from which the bulk of job creation is expected to come in the years ahead.

As well as training support, academia will be enabled to invest in new equipment, technology centres and incubator facilities, which can be used jointly by local SMEs and the college or university concerned. A good example of this kind of shared resource is the

appointment of a highly qualified formulation chemist and a team of specialists to the Wales Centre for Printing and Coating at the University of Wales, Swansea. Thanks to KEF, the Centre led by Dr Tim Claypole will now be able to target hundreds of small printing firms that make up the bulk of the printing industry in Wales, and offer them access to the latest equipment available at the University. The targets set for the KEF programme for the initial phase underline its ambitious nature and the huge potential benefits which success can bring.

KEF funding in the first 24 months is aiming to:

- Provide expertise from HE or FE to 3,300 Welsh companies
- Train 7,000 employees in specialised skills
- Provide entrepreneurship training to 10,000 students and 570 lecturers
- Enable 840 new business start-ups
- Grant 200 entrepreneurship scholarships to help students or recent graduates establish commercial enterprises

A big acceleration in the current programme of technology transfer is also expected, with the Fund helping to:

- Stimulate 100 new collaborative projects between institutions and SMEs
- Register 15 new patents from academic research
- Support 10 new incubator units or technology resource centres where fledgling hi-tech enterprises can draw upon academic expertise.

One of the most important aspects of the KEF project is the assistance it will provide for both intellectual property and technology audits. Universities and FE colleges need to assess their current knowledge and resources to decide how best to exploit them in the future.

It is estimated that royalties resulting from intellectual property developed by Welsh higher education institutions currently amounts to only £500,000 a year (1998/1999). With support from the new Fund, more intellectual property will be commercially exploited, increasing the return to the institutions and improving the growth of the Welsh economy.

The establishment of the Knowledge Exploitation Fund by the Welsh Further and Higher Education Funding Councils coincides with the advent of ELWa, the

new body charged with bringing about a revolution in Post-16 education and training in Wales. ELWa, Education and Learning Wales, contains a Higher Education Council, covering universities and other higher education and a National Council which will be responsible for further education, work-based training and, from April 2002, sixth-form funding also.

It aims to make Wales a learning country where knowledge and ideas form the basis of prosperity and a high quality of life. Among its key objectives is to be responsive to the needs of business and to help firms develop high level skills which will underpin a sophisticated 21st century international economy.

KEF will play a very significant part in the achievement of this mission. However it is essential that the institutions seize this opportunity and bring forward high calibre projects, either alone or in collaboration with partners. There are particularly strong opportunities for institutions located in the Objective One areas of Wales, for which two thirds of the total funding has been earmarked.

Wales has long relied on investment from outside to sustain its economy, but it has become clear in recent years that this investment can no longer be taken for granted. Now the focus is switching to this major alternative resource which is located on campuses across the country. The Knowledge Exploitation Fund will facilitate investment in our intellectual resources and assist in laying the foundations for a prosperous new century.

If you are a company - particularly a small and growing enterprise - KEF presents an opening to bring the knowledge base of the academic world into your office or factory. Working with colleges or universities you can apply new expertise to develop new products or processes, develop staff, access hi-tech equipment or strengthen your management team. KEF exists to assist innovation at all levels. More information about the Fund is available on the new KEF website kef-wales.org.uk, or by contacting the Entrepreneurship Champion for your local university or college.