IASP International Association of Science Parks and Areas of Innovation

32nd IASP World Conference on
Science Parks and Areas of Innovation 2015

Beijing, China

Science and Technology Parks, Areas of Innovation, government, universities, civil society and business – where are they going in the innovation race and what should S&TPs be doing to help anchor innovation in a region?

Plenary Session 2 :

Science parks and the new industries: business models and entrepreneurial profiles

Author :

Malcolm Parry

Surrey Research Park, UK

Hosted by:

中关村 Z-Park ZHONGGUANCUN SCIENCE PARK

Science and Technology Parks, Areas of Innovation, government, universities, civil society and business – where are they going in the innovation race and what should S&TPs be doing to help anchor innovation in a region?

Executive summary

Innovation has always been a major force in social and economic change. Its importance to business in gaining a competitive advantage and to governments in resolving economic, social and environmental challenges has attracted significant levels of investment and has been the focus of public policy and many theories about creating the optimum conditions for the process to thrive.

Recent thinking about the optimum conditions is that in addition to the roles of government, businesses and universities, labour and financial institutions should be added as important stakeholders because of the relevance of entrepreneurs and the role of micro-technology companies and SMEs in the open innovation model.

This paper reviews both the historic and current UK policies and thinking in relation supporting innovation from the particular perspective of Science and Technology Parks (S&TPs) and Areas of Innovation (AIs).

The innovation race

Innovation as a process and the resulting innovations have always been important influences on driving social and economic change which has over time created competitive advantages for some countries, regions, cities and companies and destroyed others.

The tensions between creative and destructive elements of innovation have been recognised since the 1940s[1] with examples today of where these tensions have changed an AI such as Chicago from a prosperous city to one with significant challenges and influenced the fortunes of companies such as Eastman Kodak which was the inventor of digital cameras in 1973 but did not capitalise on this and today is a much smaller company.

Recognition of the risks of failing to innovate has prompted most governments to plan, develop and implement initiatives that can help to raise their national and regional innovation capacity and create Area of Innovation (AI) which by definition produce high levels of innovation. Most modern businesses also recognise that to maintain their competitive advantage they must also address this issue from both a market and management perspective.

To understand the challenges of innovation some background research[2] published in 2013 looked at over 50 years' worth of research and identified a number of key principles that underpin its processes and outcomes. The impact of this research has been to influence UK policy to try to improve the innovation environment.

The findings included:

· It is business not government that drives innovation. This has led to a drive to create high numbers of new technology businesses.

· Innovation is most effective where it is not linear and comes from distributed or community-based models in which a number of stakeholders collaborate. This relies on networks and these are most effective when they draw in external resources. This has led to the promulgation of many programmes that are aimed at creating the linkages for knowledge exchange.

· There are a number of classifications for innovation which can vary from being radical, which in some instances is disruptive to business, society and government, through to incremental which results in progressive changes. Another classification spans original innovation which is based on inventions without precedent, innovation which is based on the recombination of existing technologies while a third category reflects its incremental nature and is concerned with refinement of existing technology to generally increase efficiency.

· Most innovation is either incremental or involves in the recombination of technology and respectively is based on adaptations of existing elements, products and technologies or involves new combinations of existing elements, bodies of knowledge or technology. These levels of innovation have been a major driver of efficiency in large companies to maintain their share value; however, with accelerating rate and cost of change many large companies are looking to secure access to innovation through the open innovation model.

· Most large companies are risk averse so they do not try to drive radical innovation through to the market because the impact it has is unknowable and they have a strong interest in protecting their existing investment. This means there is an important role for micro technology firms (MTFs) and small and medium sized enterprises (SMEs) in driving this process. The current trend is to support enterprise that can help to

1. Schumpeter, J. A. (1943). Capitalism, Socialism, and Democracy (6th ed.). Routledge. pp. 81–84.
2. Technology Strategy Board 2013 https://www.innovateuk.org/innovation-research

fuel this type of relationship.

· Innovation occurs across whole economic systems which means that innovation programmes should not just concentrate on the technology sector. In the UK a number of programmes have been developed to attempt to spread the value of innovation into wider sections of society.

· Firms vary in their emphasis on product and process innovation according to the life-stage of a technology which means there needs to be a variety of support programmes to suit different stages of development. To achieve this some firms are looking to universities and other external institutions to help support this need for innovation.

· Innovation is a 'sticky' activity in which geography matters. Innovation investments and outputs are still concentrated in particular global centres, allowing leading actors to congregate, mingle and compete. This means policy has to work on building this 'sticky' environment and this has implications for AI and STP's.

· Businesses need to build advanced organisational practices to manage the innovation process effectively. Some have two separate groups responsible for activity with one exploring creative and radical new ideas and the other looking to exploit and develop incremental improvements of existing ideas, processes and products. This requires effective education including continued professional development programmes as well as other business education programmes to help companies develop and adopt practices that drive innovation.

The importance of innovation in achieving social and economic objectives has also prompted the OECD[3] [4] to set out some of the building blocks for the process and indicators that can be used to monitor innovation and complement them with indicators from other domains.

These include:

• Access to education to develop basic scientific skills and then provide the opportunity to build on these through to tertiary education all of which help to empower people to become opportunity led entrepreneurs[5]. Educational standards can be assessed.

• Supporting the development of a dynamic business sector especially SMEs and new and young micro technology firms (MTF). All of these help translate knowledge and ideas into jobs and wealth and often exploit opportunities that are too nebulous for large companies to pursue. This also needs to be supported by government policies that drive entrepreneurial effort. This process is characterised by the formation and extinguish rate of companies, the availability of debt and equity finance, and a policy environment that determines for example market regulations, ease of company formation and personal taxation structure all of which can be either major barriers or incentives to growth depending on how these impact technology, market and company growth[6].

• Investment in innovation which includes: business investment in R&D which can be either direct or indirect to gain market share which in turn is influenced by publicly funded support programmes; public procurement to support innovation which may be relevant in, for example, defence, the environment or health and may also be influenced by government and private investment in for example broadband and other forms of infrastructure.

3. OECD 2010 Measuring Innovation – A New Perspective http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/measuring-innovation_9789264059474-en#page91

4. The OECD Innovation Strategy: getting ahead for tomorrow. OECD 2010. http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/the-oecd-innovation-strategy_9789264083479-en#page5

5. Opportunity led entrepreneurs are different from those that are necessity and this differentiations is an important distinction.

6. Parry M., Technology, market and company journeys: how can we help them succeed? Paper presented to the IASP Annual Conference, Copenhagen 2011.

• Effective scientific collaboration at regional, national and international levels; this requires making public sector research available to business via IP, supporting the formation of spin offs, encouraging joint research between business and universities, promoting training and education for business, consultancy and contract work, and making it simpler for staff mobility in terms of informal co-operation by researchers across the business / public sector boundary. Science is vital to innovation because of the capacity of scientific research to discover and understand step changes in knowledge which can lead to disruptive changes.

Innovation and policy

The 'invention to innovation' path that has prevailed over the last 300 years has been characterised by a series of waves that continue to emerge and decline as disruptive technologies upset the status quo and following incremental innovations build momentum in the changed environment.
These waves are consistently characterised by shortening product development cycles and in many instances changes to supply chains, improved access to increasingly large markets and a total reliance on innovation.

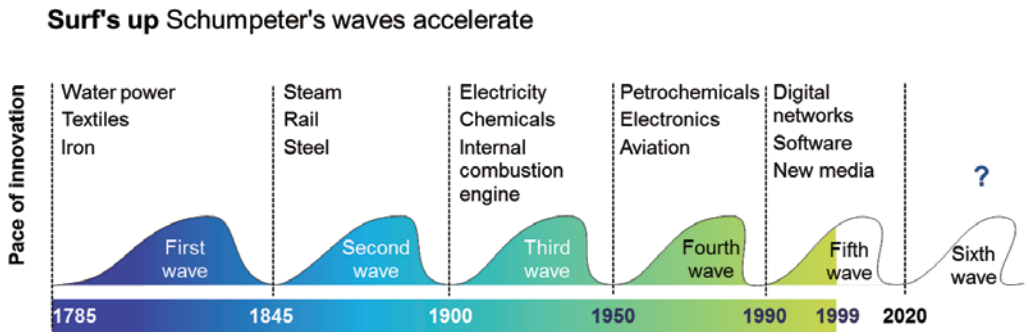

Figure 1: Surf's up – Schumpeter's waves accelerate[7]

The early waves tended to be driven by lone inventors. In some cases these early innovations resulted in the formation of large industrial companies that perfected efficiency of production and as a result achieved market domination in the first half of the 20th Century which many retained up to the late 1970s or even later; however, with this domination came large size and the burden of internal bureaucracy began to hamper their capacity to innovate.

As the digital engineering wave moves forward to what is predicted to be its end, there is a view that a sixth wave from 2020 to 2040 will be dominated by health and life science, green growth and low carbon technologies. Other predictions are more granular and work done for the European Cluster Observatory[8] note the importance of emerging industries which include: the creative industries[9]; eco industries; experience

7. The Economist's special survey "Innovation in Industry" (20 February 1999)
8. Extension of the European Cluster Observatory December 2012: Promoting better policies to develop world clusters in Europe. WP2 Methodology Report. Cluster-specific framework conditions for world class clusters with emerging industries Contract N° 71/PP/ENT/CIP/11/N04C031. Prepared by: Kristina Dervojeda , PwC Netherlands, Fabian Nagtegaal, PwC Netherlands, Diederik Verzijl, PwC Netherlands, Mark Lengton, PwC Netherlands
9. Higgins P., Cunningham S., Bakhshi H., NESTA 2008. Beyond the Creative Industries: Mapping the creative economy in the UK.

industries; maritime industries; mobile service industries; mobility industries, and personalised medicine; however, it is also clear that technology convergence will have a major impact in the process and this may alter the dynamics of these waves and enable some to be extended.

To exploit these sectors there needs to be: the necessary science dominated research infrastructure; technology to develop this; engineering capacity to turn this into applications; the market that may or may not already exist; and the human resources to be in place to enable the transitions.

Because business in risk averse it is important that governments take the risk in these early stages of developing these technologies and fund the basic research that is necessary to try to establish the precursors knowledge as well as fund work on applications and demonstrators that will help to attract investors and commercial interests which, if successful, can convert the technology back into revenue[10].

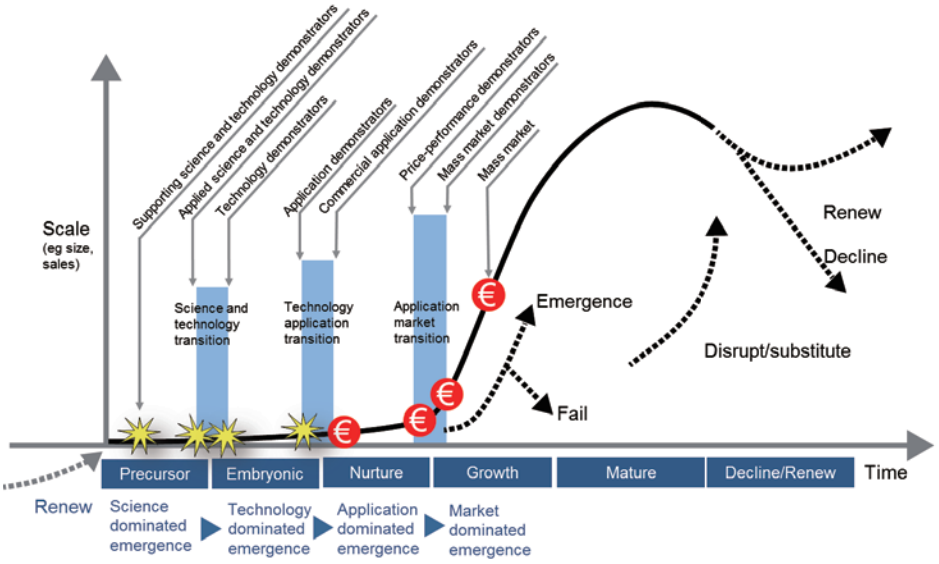

Figure 2 - A framework for mapping industrial emergence – after Phaal et al[11]

It is clear that the formation, growth and longevity of these waves are constrained and path dependent by a number of boundaries that include access to resources, scientific understanding, supporting technology, systems that are necessary for development, services that are available to support the development, products that can help push or pull the innovation, business competence and the presence of markets.
A better understanding of these boundaries has prompted most governments to take an active role in trying to mould what are thought to be the most influential fiscal and social policies necessary to widen the boundaries

10. Mazzucato M., The Entrepreneurial State: debunking Public vs. Private Myths 2013. Anthem Press.
11. R. Phaal , E. O'Sullivan , M. Routley , S. Ford , D. Probert. A framework for mapping industrial emergence. Technological Forecasting and Social Change, Volume 78, Issue 2, 2011, 217 - 230

to this path to effect positive changes.

The influence of government

In the 1950s in the UK and other parts of the Europe and the USA these policies focussed on R&D and assumed that the commercialisation process would occur automatically by following a linear pattern of technology push.

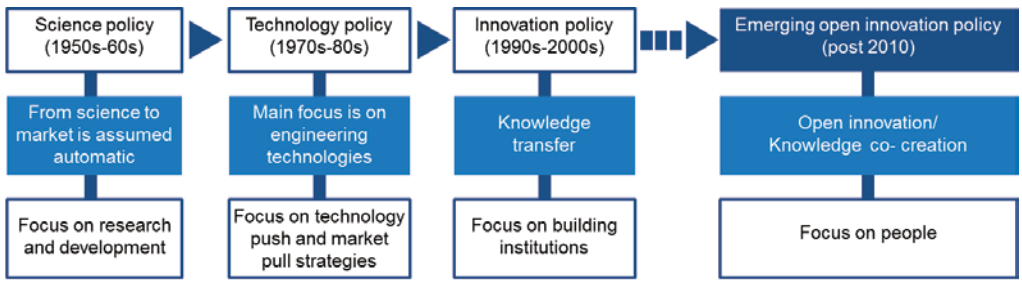

Figure 3 Strategic policy interventions in the UK to encourage innovation - after Andersen[12]

In the 1970 and 80s the commitment to R&D was strengthened by the addition of technology policies which were more focussed on engineering solutions and were built around technology push and market pull to drive innovation.

In the 1990s the need to accelerate the rate of innovation in order that, for example, the UK could maintain its competitive position in globalising markets led to further policy refinement. These changes in the UK focussed on Knowledge Transfer and on putting in place new institutions to achieve this transfer as well as improving those already in existence. Examples of this institution building include funding the professionalisation of university technology transfer activities; creating a bid based system that was open to universities to secure funds for supporting technology commercialisation; and in 1997 the government placed an obligation on universities to extend their role in teaching and research to include community development and to achieve this provided funding for this through what was known as the Higher Education Innovation Fund (HEIF).

The relationships between business, government and universities that have been the focus of the interventions that have been seen as important drives of innovation have been described by the metaphor of the 'triple helix'[13]. In 2014 an the UK's National Centre for Universities and Business (NCUB) suggested adding both labour and financial market institutions to the relationship and suggested more work was needed to understand how the means and patterns of connections operate on the basis that the more intense the connectivity, the more successful universities would be anchors for innovation and their regions by being smart innovation partners for companies.
In the second half of the 20th Century both the ease of access to financial market institutions for equity in the form of venture capital (VC) and the development of a number of technologies which enabled the growth of

12. 2013 Andersen B., Silva M., Levy C. Nov 2013 Collaborate to Innovate. Big Innovation Centre
13. Etzkowitz H 2002 The Triple Helix of University – Industry – Government, Working Paper 2002-11, Stockholm: Institutet för studier av utbildung och forskning (SYSTER). 2002

global markets have spread the opportunity for innovation to many more entrepreneurs and with that the open innovation and co-working strategies have developed. The result is that since 2002 there has been an increase in the number technology based start-up companies in the UK and this has led to increased competition in many technology markets. This competitive environment has prompted a new trend of building stronger relationships between funding institutions, such as VC and other equity modules such as Angel and Crowd funding, and labour institutions that in particular encourage entrepreneurs and entrepreneurship, in order to support the formation of equity backed entrepreneurial led start-up companies.

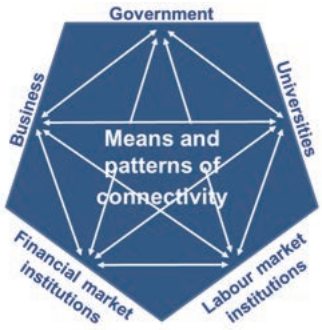

Figure 4: The Innovation Pentangle (after NCUB[14])

The policy framework and associated government programmes in the UK which operate in the "pentangle" include both EU and UK initiatives which focus on enabling the engagement of entrepreneurs and capital in this relationship with the particular purpose of driving the formation and growth of MTFs and SMEs.

The current major EU SME policy instrument to support innovation is Horizon 2020. The intention of this is to enable companies that are EU-based or established in a country associated to Horizon 2020 to secure EU funding and support for innovation projects that will help them grow and expand their activities into other countries – in Europe and beyond.

The majority of the UK's national programmes have been established by the UK innovation agency 'Innovate UK'. The principles behind Innovate UK's programmes are: to provide bid based funding available to support the development and testing of innovations particularly by using business of all sizes but in some instance exclusively using the commercial, technical and marketing skills of SMEs; to improve access to knowledge programmes which are focussed on fostering networks that encourage innovation; and offering support and advice for those companies seeking to drive innovation.

The Innovate UK programmes which provide funding for innovation are extensively used by many companies on UK S&TPs to support innovation. Although there is no quantitative data available on this the significant experience of developing the Surrey Research Park, the operation of its Surrey Incubation programme and its Surrey Angel Investor Club provides clear evidence of the importance of the government funding programmes to support the early stages of innovation across technology readiness levels 1 to 6. Many of the companies on the site have used government funded programmes to demonstrate a potential market for a viable product or service.

The main national technology focussed InnovateUK initiatives include:

- Innovation Vouchers which are currently valued at £5K allow companies to purchase technology advice from an external expert.
- Launchpad funding awards of up to £100K are aimed at early stage SMEs in the high tech sector in specific locations in the UK and are linked into a local cluster and can provide matched funding.
- Eurostars is a collaborative programme for R&D active SMEs that have traded for 12 months as well as

14. National Centre for Universities and Business 2014. State of the Relationship Report

other restrictions.

• Collaborative R&D programme can fund between £25K and £5m to test and develop a new product, process or service. Applicants need to be a UK business or research organisation, work in science, engineering or technology industries and work with a research partner or other business on the funded project. Each of these programmes is based on a different theme such as the recent one on wearable technologies.

• The Catalysts programme is run jointly by Innovate UK and the Research Councils for funding research and development which focuses on a specific priority area and aims to help take projects from research to as close to commercial viability as possible. Current Catalysts cover: agri-tech, biomedical, energy, and industry biotechnology.

• SMART is a grant scheme which offers funding to SMEs carrying out R&D which offers potentially significant rewards and that could stimulate UK economic growth. In this programme three types of grant are available for proof of market, proof of concept and development of prototype.

• The Small Business Research Initiative (SBRI) is a well-established process to connect public sector challenges with innovative ideas from industry by supporting companies to generate economic growth and enabling improvement in achieving government objectives.

• Seven 'Catapults', which are physical centres with associated technical know-how, have been established. These operate in the middle levels of technology readiness and provide services that address market failures, which in particular impact heavily on capital investment by firms, and tend to pay off over longer timescales. Currently these are focussed on Cell Therapy, High Value Manufacturing, Offshore Renewable Energy, Satellite Applications, Digital, Transport Systems and Future Cities. These are a form of R&D funding which focus on translational infrastructure in specific priority areas and aim to help take projects from research to commercial viability and cover a number of technologies from biotechnology to space technology. A review of these Catapult Centres[15] has emphasised that the criteria for choosing the themes for the investment model in individual centres is that a large global market exists for the technology on which they individually focus, the quality the UK lead in that technology and the necessary absorptive capacity to commercially exploit the output in the UK.

The Innovate UK programmes concerned with access to knowledge programmes include:

•Knowledge Transfer Network which is run under the brand of "_Connect" and links business, entrepreneurs, academics and funders to develop innovations.

• The Enterprise Europe network helps SMEs gain access to business opportunities in the EU.

• The Knowledge Transfer Partnerships which are aimed at creating business-university links. This programme has been running for over 35 years and has proved to be highly valuable in supporting SMEs gain access to qualified staff.

The UK government has also introduced a number of fiscal measures such as its Patent Box option in April 2013 that provides qualifying companies with the benefit of reducing their corporation tax currently from 23% to 10% when the profits arise from the exploitation of patents over which they have exclusive rights and if they are qualifying companies. The IP profession has concluded that that there is a slow but positive take up on it, and over time it is expected that more companies to take advantage of it but there has been a small increase in the number of patent applications from SMEs.

The UK government has also established an R&D tax credit programme. This now gives 300% for qualifying R&D and cash-back for loss making SMEs as an incentive to invest in R&D.

15. Review of the Catapult network – recommendations on the future shape, scope and ambition of the programme. Dr Hermann Hauser. Nov 2014 Department for Business, Innovation and Skills. https://www.catapult.org.uk/documents/2155693/2268412/Review+of+the+Catapult+network/55b57ced-b38f-4477-97a1-9d75f2b1c853?version=1.0

In 2015 the government merged its business coaching Growth Accelerator programme with the Manufacturing Advisory Service to create the Business Growth Service. The Growth Accelerator is a fee based but subsidised programme that is aimed at providing tailored mentoring to businesses to accelerate growth. The elements of the programme that can be accessed include access to finance, business development, innovation, leadership and management and then joining a "growth community" network that lets companies connect with an elite group of business leaders.

The particular programme that focusses on innovation uses experts to help companies using this part of the programme to:

- Understand how to convert ideas into business value.
- Create new or improved products and services.
- Commercialise products, services and business models.
- Identify, protect and monetise intellectual property (IP).
- Embed an innovative and entrepreneurial culture.
- Create successful partnerships and collaborations.
- Spark creativity in companies.

This process involves a combination of master classes and one-to–one mentoring, and expert coaching from practitioners with a background in innovation, and allows a company's management team to attend relevant master classes. The scope of these classes includes an introduction to creative thinking and problem solving, when to apply these techniques and practical tips on how to do this.

The Business Growth Service also provides master class based advice on how to identify the right source of R&D grant funding available to support innovation as well as effective strategies to making successful application for these funding streams.
These programmes are focussed on the central area characterised in figure 5. It is clear that the entrepreneurs and SMEs are critical in developing AIs.

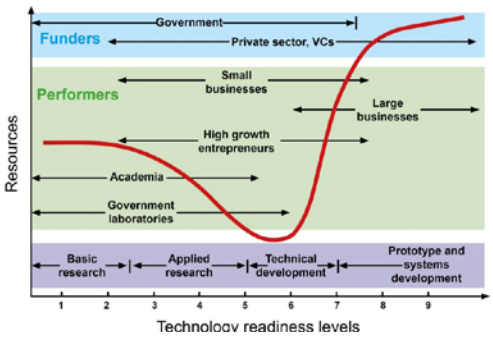

Figure 5 – after Coyle[16]

An additional role for entrepreneurs has also emerged from the idea of Smart Specialisation as driver for developing AIs.

16. P.E. Coyle The Missing Middle – Presentation to NDIA Science and Technology Division May 2011

Addressing the issue of specialisation of R&D and innovation is particularly crucial for regions that are not leaders in any of the major science or technology domains.

One argument that has been promoted is to increase the intensity of knowledge investments in for example HE, vocational training, public and private R&D, and to do this across several frontier technology research fields but this usually means a thin spread of investment in many technologies.

A new idea being promoted which comes from the US[17] and has been adopted by the EU is to encourage investment in programs that will complement the region's other productive assets to create future capability and interregional comparative advantage.

This is not a top-down industrial policy or a search for smart specialisation through a foresight programme but is concerned with an entrepreneurial process of discovery to reveal what a region does best in terms of science and technology. This relies on a learning process by entrepreneurs to discover the research and innovation domains in which a region can hope to excel. In this learning process, entrepreneurial actors are likely to play leading roles in discovering promising areas of future specialisation, not least because the needed adaptations to local skills, materials, environmental conditions, and market access conditions are unlikely to be able to draw on codified, publicly shared knowledge, and instead will entail gathering localized information and the formation of social capital assets.

Two good working examples of this process are the development of a major computer games cluster on the Surrey Research Park over the last 20 years and the emergence of the Tech City Cluster in London[18] in which entrepreneur led technology based companies have stimulated a response from universities to the needs to support these clusters with skills and technology.

Universities in the innovation race

Since the publication of the Dearing Report[19] the government has commissioned a number of additional reports on university-business collaboration and how these could be improved in order to drive innovation[20] [21] [22] all of which have concluded that effective and judicious engagement between universities and a range of stakeholder communities with business and industry being prominent among them[23] and critical to building AIs. However, one of the major challenges for nearly all governments has been to encourage the whole of their university sector to engage in economic development. To do this successfully has required overcoming

17. Foray D., David P. A., and Hall B. Smart Specialisation – The Concept. Knowledge Economists Policy Brief No.9 June 2009 http://ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm
18. Parry M.J., 2013 City centre and urban edge parks – what lessons can be learnt from each other? IASP Annual Conference, Recife 2013.
19. Dearing, R. National Committee of Inquiry into Higher Education, UK, 1997. http://www.educationengland.org.uk/documents/dearing1997/dearing1997.html
20. Lambert, R. The Lambert Review of Business-University Collaboration, UK, 2003. http://webarchive.nationalarchives.gov.uk/20130129110402/http://www.hm-treasury.gov.uk/media/9/0/lambert_review_final_450.pdf
21. Wilson, T. A Review of Business-University Collaboration. February 2012. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32383/12-610-wilson-review-business-university-collaboration.pdf
22. Witty, A. Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth 2013. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249720/bis-13-1241-encouraging-a-british-invention-revolution-andrew-witty-review-R1.pdf

the most obvious drag factor of integrating the aims, purpose and activities of these heterogeneous organisations with the uniformity of purpose and ambition of the more homogeneous nature of individual businesses. Despite much progress this remains a problem with very many initiatives being established to overcome this change.

In the last two years university research has also been pushed a long way towards measurable economic contribution through the Research Excellence Framework (REF) programme and this shift in the emphasis of university research goes a long way towards measurable economic contribution where traditionally it has not been part of the research process.

The UK Research Councils now require all submissions for research to demonstrate how the results will contribute to society and the economy.

In talking to the UK Councils they have indicated that at the design stage of any proposed research it is important to consider how the work will engage with national priorities, policies and/or commercial interests and to do this they have emphasised that collaboration with industrial users or policy makers at an early stage in designing research to identify likely benefits and define impact is likely to be more successful in securing funding.

As a consequence of this demand for demonstrating impact universities are now recruiting impact officers to help them develop and prepare impact pathways for their research bids in anticipation of the Research Excellence Framework 2020. Also in the spirit of helping young researchers the University of Surrey has trialled and is now deploying across all of its PhD students a requirement of preparing a research impact pathway which is presented to an industry panel. This has proved a success.

To try to further develop and better understand the ways that this can be made more effective the UK government has sponsored the National Centre for Universities and Business to develop, promote, and support collaboration between universities and business across the UK. The aim of this Centre is to find practical ways of harnessing the talent being developed in the UK's universities, and the UK's strength in ground breaking research and development, for the benefit of the nation's economy.

Current initiatives to aid crossing the heterogeneous-homogeneous interface include:

- Providing universities with the opportunity to bid for government funding and other support to encourage the formation of spin-out companies. Examples include the UK Challenge Fund such as the Oxford Isis Fund which is also open to private sector investors and the Oxford Invention Funds.
- Offering bid based funding to universities through the UK's Higher Education Funding Council's Higher Education Innovation Fund (HEIF). This funding allows individual universities to create bespoke programmes to support the third function of community development by the HE sector in the UK.
- Professionalising Tech Transfer (TT) activities through such organisations as the Association for University Research and Industry links (AURIL[24]) in the UK and AUTM in the USA and the international Alliance of Technology Transfer Professionals (ATTP). In the case of AURIL their training is focussed on Knowledge Exchange /Transfer (KE), Facilitating Life Long Learning, Employer Engagement, and Public and Community Engagement.
- Access to R&D funds through the Research Councils but all bids must demonstrate impact with up to 25%

23. Witty A., Universities and Business: the moment of opportunity and the Arrow of Research 2014. In the Business Growth Benefits of Higher Education. Greenaway D. and Rudd C. D. Palgrave Macmillan.
24. http://www.auril.org.uk/ProfessionalDevelopment/tabid/1151/Default.aspx

of the scoring allocated to this element of the R&D outputs.

• Important informal changes that are also helping to improve the employability of graduates are taking place in HE in the UK. The increase in the cost of student fees means that students are choosing more career-focussed courses, and on the supply side, universities are overhauling their courses to ensure to ensure employability skills and work-related learning are built into these[25].

• Supporting a stronger skills base include: business sponsorship of students; tailoring courses to business needs; developing University Technical College partnerships where a university sponsor and local employers develop the curriculum for 14 to 19 year olds and creating interfaces with business such as the ingenuity programme at Nottingham University which is aimed at SMEs; and establishing S&TPs and supporting AIs.

• Strengthening a university's sector focus by incentivising senior staff to champion these technologies with companies active in the sector.

• Moving university-business relationships up the 'Value-Chain' by universities moving from having transactional engagement with business to a model based on strategic partnerships to provide a more supportive long term working relationship with companies and help influence the innovation process. This can encourage more productive discussions around future research and skills requirement as well as R&D. To achieve this one strategy is to appoint key account managers and better targeting of resources such as working with industry and business association. If successful this relationship helps universities to not only continue with basic R&D but also move the outputs up the value chain to help industry and business gain a competitive advantage.

• Making universities more accessible to business of all sizes so they are 'easy to do business with'. Most universities have worked on the principle that they gain most by working with large corporations; however, some of the most innovative companies are much smaller with some being SMEs. Working with these smaller companies is more difficult than larger companies. To close the gap and work with smaller companies needs new internal structures and rewards systems and the companies need to understand the benefits they gain through this interaction.

Part of widening the level of engagement with SMEs is to improve the relationships with these companies through two-way access to a full-spectrum of partnership information including partner capabilities, working along the supply chain of large corporations, developing company innovation roadmaps, developing research and education portfolios for skills and future research needs, agreeing to unencumbered IP from the outputs of research, and seeking, through collaboration, sources of third-party funding through Innovate UK funding programmes.

• Using Catapult Centres to address the UK's technology readiness gap where there is deliberate link created between R&D generators and R&D users.

• Encouraging universities to increase their visibility to large parts of the business community in terms of the generation of innovation which means overcoming this lack of prominence in this process by working harder at changing this perception.

• Encouraging university research, including PhD students to increase its impact. A practical activity to encourage and document this impact is through 'Pathways to Impact' where details are provided to a university's key business partners that also allows for easy access to its government funded research portfolio and unencumbered IP derived from this research.

• Delivering high level, employment relevant skills and entrepreneurship by developing a Knowledge Exchange strategy that can lead to directly accessing the skills requirements for strategic partners is to offer a wider ranging service for companies which range through research and innovation, through to formal postgraduate award-bearing programmes, to extensive 'just in time' cpd/executive education.

25. Cridland J. Business and Higher Education 2014. In The Business Growth Benefits of Higher Education. Greenaway D. and Rudd C. D. Palgrave Macmillan.

To be successful in this requires a deep knowledge of the skills requirements in the chosen sectors in which a university has specialised and to draw together parts of their curriculum to enable undergraduates to link their specialist studies with business education.

• Facilitating university/business collaboration through simple commercial arrangements: there have been a number of these iterations of standard contracts to better enable and lower the cost of organising transactions between universities and business. The Lambert Toolkit[26] has been developed as one these iterations to try to standardise the contracts and processes of university/business links. In 2013 a report by the Big Innovation Centre[27] highlighted that in addition to contracts a range of soft skills need to be developed in cementing business – university relations.

• There is evidence in a 2015[28] report from HEFCE that the subject studied is influential in terms of the business started: studying engineering, art and design related subjects particularly lead to enterprise pathways. One of the suggestions is the lower market entry costs in arts and design and some computing/ software development. This echoes findings reported in 1999 about drivers for the development of the Surrey Research Park[29].

• Supporting student start-ups: a 2015 report also concluded that a tentative return on investment (ROI) gross annual value of £2.7bn p.a. of student start-ups and spin-outs emerging from English HEIs in 2013. This suggests student incubation programmes are important[30].

• Improving access to their institutions, in particular to the facilities and equipment they house, by creating repositories of the infrastructure available for use by external partners.

• Many HEIs are restructuring internally to help raise the efficiency and effectiveness of their KE activities. However, internal restructuring can cause disruptions in the short term.

S&TPs anchoring innovation in a region and internationalisation

In the UK there has also been a strong independent non policy led interest in innovation and entrepreneurship by universities that have built over 140 S&TPs and incubators that accommodate over 4,100 companies that collectively provide more than 61,000 jobs.

Experience has shown[31] that where S&TPs are successful they make a significant contribution to the regional economy and establish themselves as part of AI.

The model for these has been to offer space and service for incubation, business acceleration and larger units for either specialist parts of large companies or single site technology companies. This process is characterised in Figure 6.

It is also clear that the private sector is also now establishing private centre that provide some of features

26. https://www.gov.uk/lambert-toolkit

27. Andersen B., De Silva M., and Levy C. 2013 Collaborate to innovate How business can work with universities to generate knowledge and drive innovation. November 2013.

28. Research to Assess the Nature and Annual Value of Student Start-Ups March 2015. A report prepared by Public and Corporate Economic Consultants www.pacec.co.uk on behalf of HEFCE

29. Parry, M. and Russell, P. The Planning, development and operation of science parks: UKSPA 1999

30. 'Knowledge exchange performance and the impact of HEIF in the English higher education sector', a report by Tomas Coates Ulrichsen for HEFCE April 2014

31. Parry M., 2014 Tenant companies – the lessons for the planning, development and management of science and technology parks from an analysis of 29 years of data on tenant companies on the Surrey Research Park. Paper presented to the IASP 2014 Annual Conference Quatar.

the university led incubators offer. These co-working spaces provide entrepreneurs with access to similar minded individuals through membership of these centres and in cities some of these centres are establishing informal relationships with universities to create relevant business education programmes[32].

S&TPs also have an important role in supporting smart specialisation and internationalisation should firmly sit on the S&TP agenda. S&TPs are ideally placed to contribute, enhance and facilitate smart specialisation and commercial innovation. As such, international links are exceptionally important to innovation in the UK and the UK attracts more inward investment for R&D than any other country in the EU.

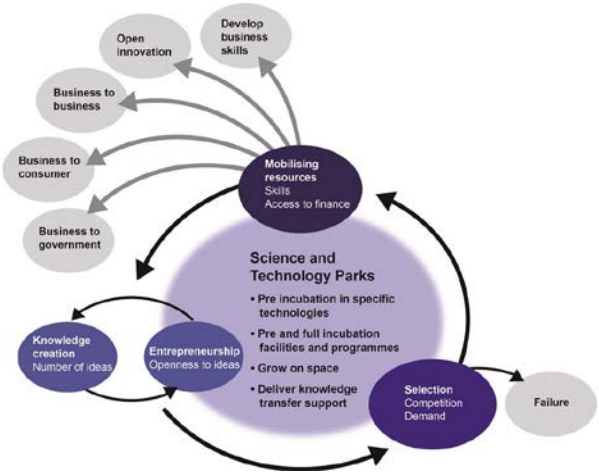

Figure 6: the S&TP incubation model

Science Parks and other innovation locations have a crucial role to play. Companies don't just choose countries to locate their R&D and other activities – they choose places. A place with the right kind of premises, a flexible and supportive business environment and collocation with synergetic businesses and service companies can all play an important part in the investment decision-making process. And if a company is looking for proximity to a world-class research organisation for collaboration on cutting-edge innovation, then UKSPA S&TPs should be able to access resources and be well connected to deliver, both through collaboration with their Universities and Research Institutes.

UKTI (UK Trade & Investment) has joined with Science Parks at many events, recognising that the UK's strength in science and innovation are big opportunities for both inward investment and trade. UKTI have developed the UKTI Innovation Gateway which is focused on cross-sector inward investment opportunities in the area of science & innovation, as well as the potential for trade opportunities.

Business – building an open innovation environment

Companies join the innovation curve (Figure 2) at different stages in this cycle and some fail but there needs to be momentum to achieve growth which gives strength to the argument for developing effective forms of interface between generators and consumers of technology that can help to support the creation of companies that take the risk of push technologies across these transitions.

Part of the path dependency in this process has emerged as the open innovation model of development which has been become widely adopted by business. In this relationship there is a process of risk sharing which between companies of different sizes reflect differences in their appetite for risk, their capacity for execution and their need for supportive environments of incubation.

32. Parry M., 2013. Title City centre and urban edge parks – what lessons can be learnt from each other? IASP Annual Conference Proceedings, Recife 2013.

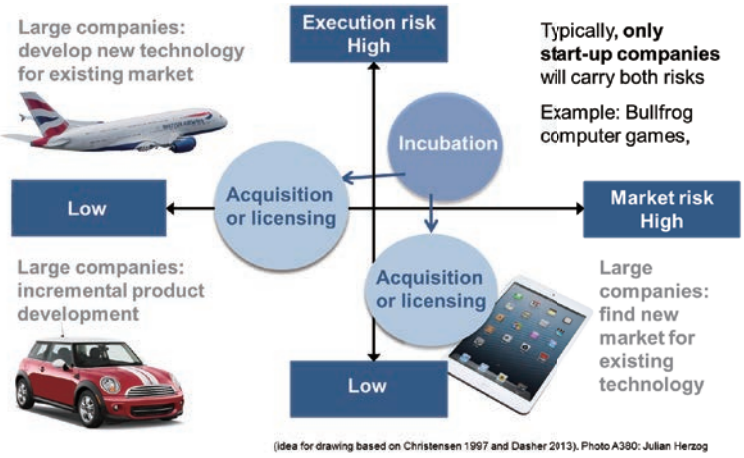

Figure 7: Market and execution risk matrix[33]

Fundamental to the process are companies that are trying to push and pull ideas into the market. These operate somewhere on this market/ execution risk matrix. In this large companies dominate three quadrants of these relationships. Typically those in the low market risk and high execution risk they develop new technology for existing markets such as aircraft. Those in the low execution risk and low market risk tend to work on incremental product development which is common in the car industry and typically large corporations. Companies in the high market risk and low execution risk area tend to find new markets for existing technology and this is typified by the Ipod, Iphone I pad range of products all of which products rely for much of their functionality on technology that has its origins in government funded research. In contrast only one quadrant is dominated by startup companies. This high execution and high market risk area is commonly the area in which game changing or disruptive innovation predominantly occurs.

It is also clear from these classic waves of innovation that over time, industries tend towards a size distribution of firms in which a relatively small number of businesses account for a disproportionate share of activity. However, to increase the chance of any company coming to dominate a sector there needs to be many that start. This is exemplified in the history of browsers where many companies entered the market but today this is dominated by just a few such as Firefox, Internet Explorer, Google Chrome and Safari.

It is also clear that the bureaucracy and cost of innovation that starts and drives waves has hampered large corporations from the necessary continuous process of maintaining their competitive position so are now looking to MTF and SMEs for a source of some of their innovation.

As a consequence the cost and burden of bureaucracy that hampers their own innovation capacity has led them to develop other wider reaching innovation strategies. Big company practice of open innovation is demonstrated by the acquisition of Motorola Mobility by Google in 2011 for $12.5bn which was about meeting the company's strategy for the mobile communications. In 2011 Google also made 24 start-up acquisitions in businesses that it expected to be critical within two years or so. Technologies it acquired covered E-commerce,

33. Perse Comm. Richard Dasher Stanford University – presentation to the WTA Innovation Forum, Daejon 2013

social network and mobile business enhancements, online video and audio content distribution, non-text content distribution (voice and image recognition) and infrastructure security. In addition Google Ventures raised its fund size to $300m in 2013 and made a number of minority investments in start-up companies that it anticipated were in technologies 3 to 7 years from market[34].

Summary

The innovation race is unending. The importance of the process to economic development has been recognised by government and by business. The result of this recognition has been changes in public policy to support both the process and the final stakeholder in the main relationship that drives this which comprises all of the knowledge generation institutions but in particular those that form the research base of the country and particularly the universities.

The already recognised relationship between universities, business and government in driving innovation has now been argued to need the additional partners of the labour and finance institutions. These additions reflect the increasing importance in the entrepreneur and funding arrangements that support entrepreneurial in leading innovation. Business has responded with creating an open innovation model for acquiring and implementing innovation, government has created an innovation agency and funded through this and other initiatives a wide range of innovation programmes and universities have seen the need to change their processes because they recognise the imperative of remaining relevant to the innovation race.

The consequence of these changes in the UK has proved to help it maintains its competitive position
To help anchor innovation in a region S&TPs should:

- Formulate an argument that has clear evidence to support public policy and investment in S&TPs.
- This argument should include research and an evidence base that clearly shows how businesses on S&TPs gain positional and competitive advantage for their regions / sectors.
- The policies in place can support businesses as they respond to the impacts of any disruptive change.
- Be clear that it is business, not governments that drive the creation of innovative high technology businesses, and that S&TPs provide the environment for growth.
- Be recognised as stimulating effective scientific collaboration at regional, national and international levels – noting the importance of emerging industries.
- Be aware that innovation is a “sticky” activity in which geography matters – provide the environment and services that allow players to congregate, mingle and compete.
- Create effective networks on the S&TP that enable stakeholders to collaborate, and draw on external resources to operate effectively.
- Be active in stimulating Open Innovation with large companies who are looking to secure access to innovation through the open innovation model.
- Be aware that there is an important role for micro and medium sized business to be proactively driving open innovation -it’s not a one way street.
- Recognise that provision of CPD programmes are critical to help companies develop and adopt practices that drive innovation.
- Note that in the UK there is also a strong independent non-policy led interest in innovation and entrepreneurship by Universities offering space and services for incubation, business and acceleration and growth.

34. Perse Comm. Richard Dasher Stanford University – presentation to the WTA Innovation Forum, Daejon 2013