SCIENTIFIC_GENERICS

Study of Science and Innovation Campus Options

SEEDA

16th October 2006

Jeremy Klein
Antony Hurden

Scientific Generics Limited
Harston Mill
Harston
Cambridge CB2 5GG

A Generics Group company

CONTENTS

EXECUTIVE SUMMARY

This study was commissioned to assess and characterise the demand for the Science and Innovation Campus concept included in the draft RES and to flesh out the concept.

We interviewed in-depth nine large companies that from their profiles might reasonably be expected to be participants in a Science and Innovation Campus.

We found that there was no single problem with respect to the organisation and sourcing of R&D which would be answered by a single form of Science and Innovation Campus. Instead, these businesses are entering external R&D activities and relationships for three main purposes and each of these suggests a different 'flavour' of Science and Innovation Campus.

The first is a **content-based** Science and Innovation Campus. Here the participating companies are seeking expertise or facilities. Large companies typically think globally and compare UK options against those in other countries. There is relatively little that an RDA can do to create new centres of excellence, though it would be possible to promote those that do exist more aggressively as national or global class institutions.

The second is a **context-based** Science and Innovation Campus. Here the participating companies gain access to an environment which would stretch them beyond their current boundaries in order to stimulate innovation. Rather than be dependent on global class facilities or expertise, it is more important that companies can work effectively with local universities. An RDA can contribute by encouraging an effective 'best practice' model among universities in the region.

The final is a **collaboration-based** Science and Innovation Campus. Here the participating companies work together to solve a problem of mutual interest, possibly because industry structure dictates innovation across a common interface. The nature of the collaboration would need to be determined by the participants but an RDA can contribute by offering these collaborative teams a 'home' and thereby improve on the virtual teams which have become the typical model in the UK. Where similar entities have been formed in the UK and elsewhere they have generally been in the IT/telecoms area, reflecting the inherently multi-sectoral nature of these technologies.

If it is intended to concentrate on large companies then SEEDA should not seek merely 'to satisfy existing demand' for the reason that there is no strongly voiced coherent demand to satisfy. Instead, an imaginative and specific concept could be put forward by SEEDA in order to stimulate and focus demand. In designing such a scheme two elements were suggested by our interviews

- One element is **content**. Large companies will be responsive to national centres of excellence in key future fields. These cannot be quickly created from scratch, but could conceivably be formed by combining existing departments and centres of excellence.

- Another element is **collaboration**, reflecting the increasing structural necessity to collaborate across industries and technologies. There are many existing 'virtual' collaborations such as the DTI's Technology Programme that could possibly be made more effective if they had a physical 'home'.

To further refine the concept we recommend turning from structures towards the specialism(s) of the science and innovation campuses. Possibilities include:

- identifying existing regional departments and centres of excellence that could be transformed into a national centre of excellence
- technology convergence (eg health informatics)
- emerging cross-disciplinary themes (eg 'homeland security')
- collaboration within or across supply chains, where there is a structural need for collaboration (eg telecoms)
- providing a context for collaboration between a large company and its smaller suppliers
- reflecting the themes of existing programmes such as the DTI's technology programme which has already spawned the creation of industry-based collaborations.

This research has been confined to large companies so we recommend that the needs of medium-sized companies be researched too.

1 TERMS OF REFERENCE

The draft RES contains the following statement:

> SEEDA will work with businesses, universities, other leading research institutions and central government departments to encourage and stimulate the establishment of new Science and Innovation Campuses in the region, drawing together all of the elements needed to maximise the economic and societal benefits of the region's world class science, engineering and technology base and business strengths. These campuses will build on internationally recognised regional research groups and provide business with new opportunities to develop new and innovative knowledge based products and services needed to compete in the global marketplace.
>
> The Campuses will seek to address the gap left by the demise of many large corporate research and development laboratories and capitalise on the trend towards greater business to business collaboration particularly at the pre-competitive research and development stage of new product development. Building on international best practise, these Campuses will provide a space, and access to specialist scientific instrumentation and facilities, where businesses and academics can research and rapidly develop new products and services to address current and emerging market needs. They will a provide focal points for business clusters and knowledge transfer networks together with training, innovation and enterprise services. Consultancy and technology brokerage services will also be provided for smaller firms.
>
> To progress this vision SEEDA will continue to work closely with the Central Laboratory for the Research Councils to establish the Harwell Science and Innovation Campus particularly with respect to promoting business engagement with the project and the establishment of new advanced and accredited courses for instrument engineers. Significant opportunities are also presented to revitalise the economy of Ashford through plans by Imperial College of Science Technology and Medicine to establish a new research centre at their Wye campus. SEEDA will work with partners to establish at least one further Science and Innovation Campus in the South East, and will work with the London and East of England Development Agencies to extend this approach across the Greater South East.

This description is not sufficiently detailed for a network of campuses to be funded and implemented. As a next step towards this SEEDA commissioned Scientific Generics to establish the demand for the scheme in order to flesh out the concept and develop the proposition further.

2 METHODOLOGY

The core of our study has been in-depth interviews with a selection of companies that might be expected to be participants in a Science and Innovation Campus. The targets were large companies' because these are seen as:

- The natural target for the Science and Innovation Campus, reflecting the scale of thinking behind the concept
- A key sector in the south east
- More significant in total employment terms for the south east than SMEs,
- Able to give the relatively long term commitments required
- Relatively underprovided for by government and regional 'initiatives', which have focused more on the needs of SMEs and startups.

The companies interviewed are listed below.

'Aerospace Company'

'Medical device company'

'Mobile telecoms operator #1'

'Magnet company'

'Electronic equipment company'

'Agrochemical company'

'Mobile telecoms operator #2'

'Aeroengine company'

'Financial services company'

The interviews followed the following general format.

1 We first introduced the Science and Innovation Campus concept as described in the RES.
2 We then explored the ways in which R&D/innovation is organised in the company, including the locations of facilities, external relationships.
3 We asked about problems and issues in R&D and unmet needs
4 We finally revisited the Science and Innovation Campus concept in the light of the company's R&D activities and discussed was in which the concept could be relevant and useful to them.

The interviews were analysed to identify recurring themes that would help define the shape of a Science and Innovation Campus.

3 RESULTS

3.1 R&D Context

All the companies we interviewed had clear policies on research. They were able to describe:

- The topics they were researching, and the business benefits of this research
- What they do in-house, and what they do externally
- If done externally, where are doing it and why.

It is worth noting that the clarity and purposefulness we uncovered was quite different from the situation ten to fifteen years ago where corporate R&D centres were often regarded as costly 'black holes' with questionable business relevance.

3.2 Current patterns of external R&D

The Science and Innovation Campus concept is a form of *external* R&D. The starting point for our analysis of findings is the type of external R&D activities and relationships in existence.

We found that most of the companies were engaged in external R&D activities and relationships. These are listed in Table 1.

It is notable from this table that there are many types of relationship in existence. In order to make sense of these we considered the motivation in each case – what the companies were seeking to achieve. We were able to discern broadly three types of motivation: *content*, *context*, or *collaboration*. These types of motivation, which are described below, lead to different considerations in deciding with how to outsource, and with whom. The motivations are also listed in Table 1. Of the sample of companies we spoke to, four were looking for content, two were looking for context and one was looking for collaboration.

Table 1. External R&D relationships identified during the interviews

Company	Example external R&D relationships	Motivation
'Financial services company'	• None in the UK but uses Indian resources for development because it is more cost-effective • At Sussex University the company sponsors a masters course in IT to develop technology leaders for the business of the future, rather than training analysts which is a short-term issue • Chose Sussex for closeness to UK HQ and good credentials and willingness to partner plus creativeness • Control of IP through variation on Sussex's terms of business • SEEDA has a valuable role in providing the single point of contact for the University. SEEDA makes all the contacts into the University so the company does not have to deal with difficult communications into the University	Context
'Aerospace Company'	• Large companies have a large product and R&D portfolio and they need a balanced research portfolio. It works with EPSRC to put footprints down to define broad research areas • The **best teams** don't exist in a **single** university for big projects. Need to form a network with the company as project manager. The company has **Strategic** partners who have breadth of knowledge and can co-ordinate development teams made up from **in-depth** partners. The company adopts a systems approach to managing such projects. • Seconding academics into primary site of technology exploitation often leads to compromises	Content
'Medical device company'	• Labs in New York, Munich, Bangalore, Shanghai to provide relevant research in cost-effective ways • Association with Stanford – this brings good PR to both them and Stanford, but the true commercial benefit is less clear. Research funding is not directly beneficial. • Co-location with universities and hospitals	Context

Company	Example external R&D relationships	Motivation
	e.g. Munich, brings rapid product development as user feedback is more direct. • Distinction in relationships shows national characteristics: UK is good at idea creation and invention, but it needs Japan and US to innovate and take to market. India is good a creative thinking by coming at a problem 'sideways'.	
'Mobile telecoms operator #1'	• Research at various UK centres: Surrey (radio), Imperial (computing), Kings College and UCL, Coventry (automotive, more pragmatic than Warwick), Cambridge, Leeds, City University (location) • Coventry's pragmatic approach leads to WiFi in car in a realistic way • University experiments facilitate skills training for employees – but needs market input • Parent company has done more R&D than anywhere else in Europe through FP6 & 7 projects. The DTI attitude is anti-EU projects so this ripples down to how the UK approaches EU projects and funding.	Content
'Magnet company'	• Deal with Oxford, Cambridge and Imperial. Strong entrepreneurial networks – many investors with a strong technology interest • Has a high level of PhD staff to keep at leading edge of research and technology. Industrialise from these people • Outsources about 15% of R&D • Does not see itself as a regional company (despite the name), fewer than 1/3 business comes from within Oxford • Their reputation encourages academics to approach company directly • Cambridge academic researcher has noted that the company has coped with the model of growing beyond a staff level of 150 by engaging in spin-outs	
'Aeroengine company'	• Universal Technology Centres (UTCs) in the UK at Birmingham, Cambridge, Cranfield, Imperial, Loughborough, Manchester, Nottingham, Oxford, Sheffield, Southampton, Strathclyde, Surrey, Sussex, Wales, York – bringing in	Content

Company	Example external R&D relationships	Motivation
	expertise from established centres. These are long term commitments, that are secure and build relationships. • Some of these have been in place fro some time and have mutually supported each other in keeping ahead of the game. Draw on specific expertise. The company will help them develop a suite of facilities, e.g. tat Sussex to build large suite of facilities to study rotating flow. Surrey has developed from former company person moving there for research which built up to UTC. • Some activities in China, Singapore, Japan • Does a lot of research in-house. TRL 1-4 done at universities, TRL 4-6 done in-house, TRL 6-9 Research and product development. • Secondments and will bring academics in-house to get specific short-term work completed.	
'Electronic equipment company'	• Sandwich course placements and short student projects • Close relationships with Bath and Cambridge universities • External materials testing houses	Content
'Agrochemical company'	• Even big universities have only a partial fit to 'Agrochemical company's business. But are beginning to set up a strategic partnership with a university to address non-core work. • In India, there are plenty of good chemists at lower cost than UK. Have built new lab in Goa to recruit this talent and control it within the company and direct it towards business needs.	Content
'Mobile telecoms operator #2'	• Research done in half a dozen centres across the globe • Takes students for summer work • EPSRC applications • Board of Mobile VCE which cuts across the country: Edinburgh, Bristol, Surrey. Led by University but guided by industry.	Collaboration

3.2.1 'Content'

Some companies outsource because they can define the problem in very specific terms and they want access to excellent capabilities or facilities that they cannot cost-effectively match in-house. For example, one company has long-term relationships with 27 university departments to undertake research in defined leading edge areas (through their University Technology Centres 'UTC's). Content-based externalisation is possible and likely when companies know exactly the problems they want to have solved.

Externalising in search of **content** hinges on finding the specific skills or facilities a company needs. The degree of excellence required is dependent on circumstances: in some cases a company will look for the best place in the world; in other cases lesser capability will be adequate and the choice will be made on grounds of cost or convenience. The large companies we spoke to are typically looking for high levels of capability and are prepared to search globally to find it and then to develop long-term relationships to support the company's business goals.

3.2.2 'Context'

When the form of the company problem is much less specific, then the company can only set the context in which they want a solution. One way to address such a problem is to use cross-disciplinary skills they cannot afford to retain in-house, or sources of new ideas and innovation they think could not be generated within the narrow confines of their own staff base. As an example, 'Mobile telecoms operator #1' sees that multi-skilled teams can deliver a solution into a new business sector in a way that is not possible with their current skills. Bringing together healthcare and telecoms experts would begin to identify business solutions in health telematics. Context-based externalisation is likely when companies are not able to define the problems they want solved with certainty, and want a space within which future opportunities can emerge.

Externalising in search of **context** is mainly dependent on a company coming to a workable arrangement with a conveniently-situated provider. Companies are likely to come to arrangements with local universities where possible. For example, 'Financial services company' has a good relationship with Sussex University, but Sussex is not pre-eminent in the fields of IT that interest them. Rather, the university is very conveniently situated and there is an excellent working relationship that addresses the specific business needs of the company. Plus, the general strength of the University, itself, is a benefit.

3.2.3 'Collaboration'

In some circumstances a problem cannot be solved by a single organisation, so collaboration is a solution.

Collaboration can be required for a number of reasons:

- Scale or complexity. Sometimes problems are simply too big to be solved by one company alone. Some of the work on the human genome fell into this category
- Access to funding. There is public support for collaborative research – eg the UK's Technology Programme and the EU's Framework Programme.
- Shared interfaces. In an increasingly networked world it is unsurprising that collaboration and forms of 'open innovation' are becoming prevalent. Some companies will work with other companies in their supply chain in order to achieve standardisation across interfaces and interworking. This occurs in industries such as telecoms where a shared market and supply chain often acts as the glue between application areas and therefore demand collaboration across interfaces.

Externalising in search of **collaboration** is a dependent on agreeing who to collaborate with and finding a form of collaboration such as a European Union Framework Programme that will work for all parties. These arrangements rarely involve new facilities or shared space; they are more likely to involve virtual teams with periodic meetings to bring the researchers together.

3.3 Issues and problems in external R&D

Overall the companies we interviewed had established ways of sourcing most of their R&D and innovation, and there were no *serious* unmet needs in evidence. Nevertheless interviewees did describe problems and express needs and we have listed these in Table 2. Again, there is little consistency between interviewees.

Table 2. 'Wish list' of external R&D identified during the interviews

Company	Wish list
'Financial services company'	• Using the university as a safe environment for brainstorming, and as catalysts to be entrepreneurial • Value being able to tap into entrepreneurial thinking at Sussex. This can be a trigger to creative thinking • Need to develop future technology leaders
'Aerospace Company'	• RDAs seek to link local universities to local businesses. But, if local university is not excellent, this puts local businesses at a disadvantage. RDA

Company	Wish list
	should focus on connecting companies to the best (in the UK) rather than the region • Refer to the recent report which suggests how the Research Councils can improve with a better understanding of technology transfer (http://www.dti.gov.uk/files/file32802.pdf) • The UK is a "small problem" culture. Research Councils address problems with budgets around £300k to £500k over a 3 to 5 year timescale. RAE scores dictate some of this behaviour. Breakthrough thinking needs a different model • Allow people to move between organisations without harm to academic career • Large scale projects to create demonstrators of sufficient size to bring significant economic impact • Get industry to look 5, 10, 20 years into the future – technology forecasting to set seeds. These lead to a requirements document that will be business drivers for research and technical challenges • Industry should give academics a **relevance** for their research • Allow flexibility in the research programme to allow disruptive ideas to emerge within the 'relevance footprint'.
'Medical device company'	• Need to have high intellectual calibre • Willingness to collaborate
'Mobile telecoms operator #1'	• National centres of excellence • Cross disciplinary e.g. wireless-centred healthcare, transport telematics, social networking, mobile TV • Able to look to the future and answer questions like "how do we address the digital economy of the future?" • Sector focus that can be multi-skilled • Telecoms is a global business that leads to an increasing need to collaborate
'Magnet company'	• Help with planning issues which can obstruct business growth • Needs strong regional centre of excellence – this needs strong regional support • National NMR facility (e.g. the Diamond synchrotron, or similar facilities in Japan and France) • Coherent UK science policy (e.g. as in Taiwan) • Government procurement policy could support high-

Company	Wish list
	tech UK companies. SEEDA should be seeking to influence Treasury thinking.
'Aeroengine company'	• Things stall at the TRL 4-6 when things get expensive and need to demonstrate pull from the market. Need to create 'vehicles' to get money for this process. • Would welcome ways to identify small technology suppliers
'Electronic equipment company'	• IP is difficult with external parties
'Agrochemical company'	• Secure research into design of molecules and how they work. Want to be certain that there is no leakage of IP. • Co-creation innovation between univs and industry • Access to funding • Access to non-core technologies • Would SEEDA support partnerships similar to Imperial College and Wye College in Canterbury? • Need to have strength in technical competence
'Mobile telecoms operator #2'	• Think globally, not regionally. Regional boundaries are artificial and silly • Bring in bigger universities (SEEDA excludes big universities such as Cambridge, UCL, Imperial) • Need to control IP so do research in-house

It is possible to discern a small number of common issues:

- Externalising for **content** is made difficult by the challenge of locating the right expertise from within the UK university system. The lack of national centres of excellence was mentioned by several people, and the regionalisation agenda (set by national Government) was seen as exacerbating the problem by encouraging the formation of regional centres below critical mass. There was some demand for national centres of excellence. Difficulties of dealing with universities such as contractual problems and the difference of pace between universities and industry were noted.
- IP was mentioned several times as a source of difficulty in external relationships.

Most of the unmet needs were therefore 'nice to haves' rather than critical weaknesses.

3.4 Response to the Science and Innovation Campus concept

Against the background of current R&D and unmet needs, we tested the relevance of the Science and Innovation Campus as described in the draft RES. Where people could see a role for a Science and Innovation Campus they generally hoped it would meet a set of needs which were very specific to their company. These are listed in Table 3.

Table 3. Interviewees' views on the nature of a Science and Innovation Campus

Company	A Science and Innovation Campus should include…
'Financial services company'	• Ability to act as a catalyst for more creative and entrepreneurial thinking • Idea generation and brainstorming – workshops rather than seminars (although good seminars are valuable) • Safe environment for brainstorming and facilities. Being away from the work-place, so being off-site is a benefit and can include team-building and development
'Aerospace Company'	• Independent territory to foster innovation • Team approach – multi-disciplinary • Trust • Brokering of solutions – taking ideas from TRL 3 up to industry • Flexible operation – the future is uncertain so the structure needs to be flexible to cope with needs and able to adapt appropriately • Have an appropriate environment for innovation. Most corporate structures constrain innovation; an Science and Innovation Campus can loosen the chains and allow more innovative thinking • Should be a magnet to attract people with high profile projects and demonstrators. Once operating, its reputation will bring more people • Address the issues of dual-use technology. Only about a dozen companies provide major university funding and these are in the pharma and defence sectors. Chance to take technology out into new markets.
'Medical device company'	• High intellectual calibre people • A forum for sharing ideas and leading edge thinking • Offering something on our technology roadmap • Ability to develop new ideas that can lead to radical business growth • Being close to market and users as this brings in market feedback most effectively
'Mobile telecoms operator #1'	• It should not waste money by starting from scratch. Build on existing campuses and their strengths

Company	A Science and Innovation Campus should include…
	• Be pragmatic not academic • Be multi-disciplinary, collaborative • Facilitate a common language or dialogue • Industry is fed with ideas from customers, suppliers, or employees. Universities have a direct impact on employees (by training new ones), less so on customers and suppliers. Therefore, the relationship between companies and universities should take account of this. • **National** Centre of Excellence – look at BT and Surrey University as models. Do not focus on being a ***Regional*** Centre of Excellence – not relevant to major companies. Scotland talks about ***Scottish*** centres as being National. • Avoid any effect that will lead to a dilution of benefit and competing with other resources • A campus that leads to better knowledge transfer and then to international R&D projects
'Magnet company'	• Co-location on a campus would not make sense • Consider costs in the region – can high quality staff afford to move into the region to build up the expertise of a Campus?
'Aeroengine company'	• Maybe more relevant to smaller companies • Intelligent technology brokering between small and large companies
'Electronic equipment company'	• Maybe more relevant to smaller companies • Shared space concept would depend on financial incentives

'Agrochemical company'	• Elements of the successful model used by Georgia Institute of Technology.
	  • State of the art facilities available for renting. Centres of Excellence but not used for teaching
	  • New business areas dedicated to new exploratory work.

'Mobile telecoms operator #2'	• National Centre to support roll-out of IP into standards • National Centre on radio technology – can support industry and inform government • National Centre can host events and, as a National Centre, can gain benefits and attract academic excellence. Acts as a stimulus for new work – thinking globally with international recognition • Research should be led by academia but guided by industry • Programmes should be flexible to cope with variations • A Science and Innovation Campus should take ideas and provide a route to industry. It should have academics to provide a leading edge position, ahead of the game, as this will determine the direction of the research with some industry influence.

These expectations as to the roles of a Science and Innovation Campus did not coincide between interviewees so we cannot report a consensus from the demand side as to what it should be like, and what it should achieve.

4 DISCUSSION

4.1 The RES proposition

The Science and Innovation Campus proposition as presented in the RES incorporates all three motivations – content, context and collaboration - as can be seen in Table 4 below.

Table 4. Analysis of RES text

RES text	Motivation
"… drawing together all of the elements needed to maximise the economic and societal benefits of the regions world class science, engineering and technology base and business strengths."	Context
"These campuses will build on internationally recognised regional research groups and provide business with new opportunities to develop new and innovative knowledge based products and services needed to compete in the global marketplace."	Content
"The Campuses will seek to address the gap left by the demise of many large corporate research and development laboratories and capitalise on the trend towards greater business to business collaboration particularly at the pre-competitive research and development stage of new product development."	Collaboration
"Building on international best practise, these Campuses will provide a space, and access to specialist scientific instrumentation and facilities, where businesses and academics can research and rapidly develop new products and services to address current and emerging market needs."	Content and Context
They will a provide focal points for business clusters and knowledge transfer networks together with training, innovation and enterprise services. Consultancy and technology brokerage services will also be provided for smaller firms.	Content

4.2 Three pure options for a Science and Innovation Campus

If a Science and Innovation Campus were to be based on all three motivations simultaneously then there is a risk that the demand for a Science and Innovation Campus would be rare. We did not uncover such a coincidence of needs in our interviews. However, if a Science and Innovation Campus could satisfy these motivations separately then there could be more *existing* demand. We have therefore considered the extent to which the Science and Innovation Campus concept meets demand and solves problems for each of the motivations individually. In effect, we have looked at three 'flavours' of Science and Innovation Campus.

4.2.1 Content-based Science and Innovation Campus

The greatest current use of external R&D is for reasons of content – expertise or facilities.

Companies' main problems in externalising for content reasons were locating the right expertise from within the UK university system and dealing with universities from a contractual and operational point of view.

Internationally recognised groups already exist within the SEEDA region's universities and are identified within the directory of research excellence[1]. The relation between the Science and Innovation Campus concept and these existing centres of excellence would need to be clarified. The options include:

- Creating new centres of excellence on the campus
- Seeking national or world status for an existing centre, and re-badging it as part of a Science and Innovation Campus
- Bringing together existing centres under one roof on a Science and Innovation Campus.

Attempting to create a new centre of excellence would be a long term project. Competition with existing centres would lead to tensions, long-term funding concerns and would not necessarily satisfy customers.

Seeking national or world status for an existing centre is a plausible approach which would help companies access excellence, but is not assisted by the UK's regionalisation agenda, nor by the autonomous nature of existing institutions.

Bringing together existing centres under one roof is again plausible but is likely to take a long time to achieve.

Overall, it seems that a content-based Science and Innovation Campus is not a very malleable proposition from an RDA's perspective. The facilities and expertise are where they are, and are unlikely to be amenable to relocating within a short time span.

4.2.2 Context-based Science and Innovation Campus

Some companies expressed a desire for space and facilities to allow groups of people to interact creatively to address emerging market needs. Universities were seen as potential partners, as were other companies.

It is likely that such a proposition would be best implemented at a local level on a relatively small scale. There would be benefit in spreading a consistent model across the region's HEIs.

[1] http://www.researchexcellence.org/index.php?id=47

4.2.3 Collaboration-based Science and Innovation Campus

As is recognised in the RES, collaboration is an increasingly important aspect of industrial research. It is not universally applicable however. While many people talk about the benefits of pre-competitive research, major companies are more concerned with controlling IP at an early stage and therefore would be unlikely to want to engage in this level of R&D in their core technology areas.

Most UK and EU public sector support for research is for collaboration. Most, however, rely on virtual, multinational, teams and the problems of achieving outcomes efficiently in a virtual environment are well known. There could be an advantage in giving these teams a physical home in a collaboration-based Science and Innovation Campus. The collaborations would need to be 'bottom-up', not prescribed from above. Where similar entities have been formed in the UK and elsewhere they have generally been in the IT/telecoms area[2], reflecting the inherently multi-sectoral nature of these technologies.

[2] eg the Advanced Digital Institute in Yorkshire; and the Centre for Telecommunications Value-Chain Research, Ireland

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study has explored demand from large companies for the science and industry campus concept, based on the short description in the RES.

1 We researched large companies because they provide most employment. We found that these companies, by virtue of their size, resources and sophistication, are coping well with their R&D and in many cases are reasonably self sufficient. The companies did not report major unsolved problems. The situation might well be different for medium-sized companies and additional research would be needed to test demand for the science and industry campus concept from such companies.

2 India and China are very much on the R&D agenda for large companies and most of the companies interviewed had some R&D in these countries. In general terms we saw an interest expanding R&D in India and China rather than in expanding in the UK.

3 All the companies we spoke to had relationships with external parties such as universities and other companies. The choice of partners depends on the motivation for the external relationship, which we have split into: content, context or collaboration.

4 **Content**. When looking for content – ie expertise or facilities – large companies have the ability and inclination to look internationally for the best. A number of companies reported that they would benefit from having access to single national centre of excellence in their field rather than having to deal with a fragmented network of university departments as at present. UK national centres with global reputations and critical mass would be more likely to 'get on the radar screens' of large companies. One way to work towards this would be to combine a number of university departments and industrial development groups into one location.

5 **Context**. When looking for context – eg a shared space - companies are likely to choose local universities.

6 **Collaboration**. Despite the apparently increasing importance of collaboration, few of the companies we spoke to devoted much attention to such arrangements in the interviews. However, collaboration is unlikely to disappear from the landscape of industrial R&D, and is particularly necessary where
   (i) individual companies need to work with others in the same industry to develop standards or common platforms, or
   (ii) there is a need to work with companies in different industries where a common agenda cuts across industry boundaries – such as health telematics.

5.2 Recommendations

1 If it is intended to concentrate on large companies then SEEDA should not seek merely to 'satisfy existing demand' for the reason that there is no strongly voiced coherent demand to satisfy.

2 This constituency may instead benefit from a supply-led approach where an imaginative and specific concept is put forward by SEEDA in order to stimulate and focus demand. In designing such a scheme two elements are suggested by our interviews

- One element is **content**. Large companies will be responsive to national centres of excellence in key future fields. These cannot be quickly created from scratch, but could conceivably be formed by combining existing departments and centres of excellence.
- Another element is **collaboration**, reflecting the increasing structural need to collaborate across industries and technologies. There are many existing 'virtual' collaborations such as the DTI's Technology Programme that could possibly be made more effective if they had a physical 'home'.

3 To further refine the concept we recommend turning from structures towards the specialism(s) of the science and innovation campuses. Possibilities include:

- identifying existing regional departments and centres of excellence that could be transformed into a national centre of excellence
- technology convergence (eg health informatics)
- emerging cross-disciplinary themes (eg 'homeland security')
- collaboration within or across supply chains, where there is a structural need for collaboration (eg telecoms)
- providing a context for collaboration between a large company and its smaller suppliers
- reflecting the themes of existing programmes such as the DTI's technology programme which has already spawned the creation of industry-based collaborations.

4 This research has been confined to large companies so we recommend that the needs of medium-sized companies be researched too.

APPENDIX A INTERVIEW SUMMARIES

A.1 'Financial services company'

The respondent said that working with Sussex was very happy and had been successful.

The starting point for them was to look at their IT needs for the future. They used to go through the traditional training path for analysts but outsourcing changed this. They currently send a lot of programming work out to India because it is more economical.

This is a short-term solution.

However, longer term, they need to answer the question, "where are all the technology leaders going to come from?" This led the company to ask about leadership roles within the organisation to ensure they understand the technology relevant to their business.

They look for graduates with exceptional calibre to join the course. These are not average graduates – they are exceptional ones who are then trained to get blue chip experience.

Most of the work these people do is UK focused although they may report to a US Director. When the idea was originally set up, it was originally an on-shore campus where the graduates would be used as sub-contractors to do project work that would then be shipped back.

The company looked for a partner who could best provide this ability and had the credentials. Also, they looked for a willingness to partner, bringing creativeness. Since the world of academia is different from theirs, they needed a point of contact to manage relations with the University. Sharon Phillips (at SEEDA) has done that admirably. She provides a single point of contact which is important since a lack of hierarchy in a university makes it difficult to communicate effectively.

Sharon has made the job much easier and Sussex has been very co-operative in its willingness to accept criticism of the course and make changes on both logistics and content.

The course has become a resource provider into the company and brings a breadth of experience that can be used to stimulate brainstorms. They like to tap into entrepreneurial thinking around Sussex (including the Enterprisers programme, http://www.enterprisers.org.uk/) as such programmes can trigger people to think creatively.

Guarding IP is an issue that has been addressed by a variation on Sussex's normal ToB. IP tends to come in the form of the dissertations.

When asked about innovation within the company, they are doing OK but could do with more catalysts to be more entrepreneurial. They might benefit from more idea generation and brainstorming and they hope to bring out the creativity within the graduates through workshops, rather than seminars.

The benefits of the University for facilitating such innovation:

- Safe environment for brainstorming and facilities
- Away from the work-place, need to build up off-site
- It's not being offered at the moment but would be useful
- What is not needed: consultancy.
- Need to build credentials
- Training courses and team work

A.2 'Aerospace Company'

The interviewee has many roles outside the company: He chairs the CBI-academic interaction group, has chaired the External Challenge Group for EPSRC (producing a report "Knowledge Transfer in the Eight Research Councils" for EPSRC in April) and the Economic Impact Group (an OSI/DTI group whose report has just been submitted to Sir Keith O'Nions and will feed into the House of Commons Science & Technology Committee.

He recommended a read of the EPSRC report and the Economic Impact report when it becomes available.

The concept of an Science and Innovation Campus is very close to thinking that is current within the company.

Like many companies, the idea of a regional focus is not helpful. An RDA can help by linking local universities to local businesses but if the local university is not excellent, then it puts the local business at a disadvantage. A better model would be for the RDA to be able to help make links with the best in the UK rather than be limited to regional boundaries.

There is no real understanding of the process of technology transfer. Research Councils, universities, RDAs all lack a coherent view of this complex process that needs structure to manage. Models such as Technology Readiness Levels are helpful in managing the process and controlling risk.

One major issue for businesses is the time taken to establish in-depth capability. This time is getting shorter to remain globally competitive so companies need to get the research from various places rather than spend time building it up in-house.

However, the UK has a "small problem" culture. There is a tendency to be responsive to the way that Research Councils fund work: they think over 3-5 year time scales and budgets around £300k to £500k leading to good RAE scores. This does not support break-through thinking.

What is required is a mechanism that can produce demonstrators of sufficient size to bring significant economic impact.

Large companies have large product and R&D portfolios and need to have a balanced research portfolio. The company works with EPSRC to put large footprints down for research areas. If industry looks to the future (5-20 years), they can make forecasts on technology and set seeds for research. These can lead to a requirements document giving business drivers and technical challenges.

You need to give the academics a **relevance** for their research. You also need to allow some flexibility in the research programme to allow for disruptive ideas to emerge within the ”relevance footprint” of the research programme.

Note that about 12 companies fund most research in UK universities and these are in the pharma and defence sectors and are supported by Government. Dual use technologies are good. There is a lot of under-pinning science that can feed into these areas, and others.

However, the **BEST** teams do not exist in a single university. Big projects need resources from many different universities so you need to form a network. This needs to be managed and the company takes the responsibility for managing this network. But it relies on having strategic partners who have a breadth of knowledge and can pull the major research work together. Cranfield, for instance, does this on a UAV project where the in-depth partners (Swansea and Loughbrough + Cranfield) have individual areas of research that need to be brought together. The company adopts a systems approach to project planning.

One opportunity is to consider more secondment of academics into the primary site of exploitation – however, this is a compromise as there is always an issue of people movement and the academic world is not well set to manage this. It was one of the recommendations in the Economic Impact report (yet to be published). One suggestion was a secondment after completing a PhD with a strong link back to the Head of Department which ensures that the Post-doc can slide back into academia, if desired, when the secondment is complete.

Elements of an Science and Innovation Campus that are important:

- It should be seen as independent territory
- Since the future is uncertain, it needs to have a new structure that is flexible enough to adapt to needs and can adapt appropriately
- An environment for innovation can bring out new approaches (many corporate structures can hamper innovation). A Science and Innovation Campus can loosen corporate chains and allow more innovative thinking.
- It should be a magnet to attract people with high profile projects leading to demonstrators. Its track record, when it gets going, will be the magnet but it will need effort in the early days to achieve the attraction.
- Trust is a key element to success in such a venture
- Neutral territory can lead to faster innovation – provided you can trust the people around you.
- The mode of operation should be as teams and multi-disciplinary
- It could act to broker technology development to take it from TRL3 up to a level to be accepted by industry

A.3 'Medical device company'

The interviewee raised the point that maybe SEEDA's thinking about talking to large corporates about the SICs might actually be the wrong approach. To some extent, the focus for the questions is very much about how can SEEDA attract large corporations to grow more in the region. He did not quite say that our focus for the questions wasn't right, but he did suggest that there might be three elements to consider and we ought to be aware of these options:

1) What is it that would bring a large corporate to SE England when the corporates tend to have global R&D capability and vision?

2) Is it simply that SEEDA wants to gain the kudos/PR value of having a significant R&D facility set up in the region?

3) If the Science and Innovation Campus model is what they want to achieve, then maybe they need to be trying to engage SMEs who do not have the resources and/or vision to operate globally.

The interviewee was able to talk about point 1; he passed on his observations of how the company benefits from some activities under point 2; and he suggested that our questions might need to change if we want to look at the SME world - there are aspects of the corporate R&D process that might be of value to the SMEs and we might want to re-assess our approach.

However, sticking with the script …

Firstly, location. If a company like this is going to go anywhere, there has to be high intellectual calibre of the people. While the University of Surrey may have a good track record for industrial collaboration, it is not necessarily an intellectual power-house so it's not so attractive to big corporates. The company, for example, has its own labs in New York, Munich (tied into the University), Bangalore, and Shanghai. The locations are all chosen for good reasons and provide a global capability. Setting up the Shanghai labs took time but gets access to some very good chemists at rates with which the West cannot compete. Bangalore brings in high class staff who have a lateral thinking approach to innovation and creativity that is different from most Western approaches and is therefore valuable for them.

The second criterion is: Is this facility providing technology that is on our corporate road map? If so, then it may be of interest; if not, then the case is much harder to make for them to get engaged. It is important to understand the 'Medical device company' sees there is a boundary between the medical imaging world (their territory) and the world of therapy. However, there are times when therapeutic techniques are enhanced by imaging to give non-invasive procedures but this is done as a collaborative approach. For example, they did a deal with a company in Israel where former military phased array techniques (for radar) were

transferred into the acoustic/ultrasonic domain so that, when combined with a real-time scanner, one could direct energy to a specific point within a tumour (for example) to heat the tumour up to around 45-55C to kill it without needing invasive surgery. But the company keeps this type of collaboration under close control.

And then the usual one: Money. Funding is controlled by product groups. Therefore if there is any development (or research) in areas of imaging, then it will have to come from a budget controlled by a product group so selling the technology is only possible through that route. The Chairman has a budget for some blue sky research but being blue sky, this is harder to sell to him and make the case. The main funding (from within product groups) leads to incremental development but radical development comes from outside this process and the company has to keep its options open. While there is the Chairman's fund, the company, as an organisation, does have a financial services arm and they are willing to invest or lend money as appropriate. The Israeli venture is one example where they have a stake in the business

The venturing part of 'Medical device company' at Amersham receives about 1,000 ideas each year which go through an internal, formal, staged review process. In general, only about two or three survive this process.

The interviewee's role takes him across the globe but spends a lot of his time presenting to a wide cross-section of the medical and technical community. This gives him a very wide view on things and he is regularly used by VCs to review business cases as well as being on various panels to review proposals.

He sees that collaboration and convergence of technologies are approaches that have the potential to open up new businesses. As a mode of operating, an Science and Innovation Campus might consider how it could manage something that addresses these two topics. A Science and Innovation Campus might be a forum for sharing ideas and leading edge thinking so running world class conferences ought to be part of the function of such an facility.

However, he knows from experience that what will make or break something like this will be the management of IP. If a sensible deal is not possible - and a flexible model for managing IP is in place - then anything will be doomed. This is a major issue and one that SEEDA has to consider itself - how much control will it insist on having over any IP that may be created within an Science and Innovation Campus? Since it will be funding the venture, as a public body, it should be seen to be involved and getting a fair return for its investment.

'Medical device company' has two approaches to IP. For imaging techniques - it cross-licences with its competitors which helps establish the IP in the market. However it hangs on very closely to IP that provides specific targets for image enhancement. This means that any molecular binding that can enhance the visibility (through any imaging system in their product range) will be valuable as their ability to give doctors better diagnostic capability is core to business growth. So the onset of Alzheimers can be detected through deposition in the brain which

gives a very early diagnosis that allows treatment and prevention long before symptoms appear. Similarly there is a debate about the way to detect conditions that will lead to heart failure - cholesterol is seen as the main factor but there are other indicators that are earlier in the chain and can be better to use. However, this brings into sharp focus the market issues: cardiologists are the ones who charge the money for their work and are in control. If one takes an earlier diagnosis technique, then their business is threatened and the radiologists (who only provide a service) suddenly become more important and they have control of the imaging and diagnosis. So there are complexities in market behaviour that have to be managed in addition to the technology development.

And this brings in something of the way that they approach the introduction of their technology to the market place. By being co-located with a University and/or Hospital, they can train people on using their kit and, similarly, they can rapidly respond to market feedback. While they might develop the imaging hardware, it is the user community that has provided the software stimulus - for instance rapid image capture allows one to track movements of the heart and this came from working with the medical community. So the company gets the user feedback to help product development and also promotes the product range by training people using their kit.

And this brings out the issue of PR and the benefits that come from being seen to be close to centres of excellence. This works both ways and he quotes Stanford where they have a good working relationship: The company gets value from being seen to be associated with Stanford and Stanford gets value from having the company there. So it's mutually supportive - but this only works where you have 'brands' that are mutually compatible and recognisably so. This is not a model that would work well for start-ups as the University would not be able to claim anything special. In a sense, it is like research funding - you cannot always control what you get, and what you get may not be what you need. Universities tend to seek money to achieve their objectives - the age-old paradox of industry and academic collaboration.

However, if something could be done that would involve a SEEDA facility and ‘Medical device company’ at Amersham then you may begin to get somewhere. But the question is what is being created and why?

The company set up their facility in Munich and immediately hired 150 PhDs so there are clear employment benefits. But this was a -specific facility rather than a Science and Innovation Campus supposed to help a broader range of companies.

One observation was the old one: the UK is pretty good at idea creation and invention but it needs Japan and the US to innovate and get technology into the market place. India produces people whose creative thinking processes tend to come at a problem sideways. If the Science and Innovation Campus could address this issue, that might be beneficial.

Overall, a useful meeting that covered a lot of topics and gave some specific insights into what SEEDA might be trying to do.

A.4 'Mobile telecoms operator #1'

The respondent voiced an initial concern about the fragmented approach to national strategy that is the result of RDAs competing against each other and diluting the benefits for the nation. As an example, he quoted Scottish Enterprise competing against UKTI for stand space at international trade shows. This level of competition between RDAs means that major companies consider it a waste of time talking to too many of them and there are too many differing views being presented abroad. Major companies don't think about their activities on a regional basis - they don't care where expertise exists, just as long as they can get the benefits they seek.

His view is that it is a mistake to create new Science and Innovation Campuses. One should build on existing campuses where there is acknowledged expertise. You should focus on knowledge transfer with a pragmatic, market focus and avoid being too academic. Two successes to consider would be BT's Brightstar initiative and the application of satellite expertise at Surrey University. These build on expertise that existed. You should aim to build on centres of expertise, not to try to create new ones to compete with other RDAs. Institutional interventions are difficult.

For example, 'Mobile telecoms operator #1' looks for applications development and there is a lot of that around Cambridge. This is a direct consequence of the wireless and radar development work done during and after WW2 and supported by the University. Surrey has radio engineering expertise, Imperial has computing, City University has location, Coventry has automotive (in a pragmatic way whereas Warwick is too academic). 'Mobile telecoms operator #1' has relationships with these and Kings College, UCL and Leeds (largest UK university).

There is not a desire to get into major collaborative R&D work. 'Mobile telecoms operator #1''s parent has done more comms R&D work than anybody in Europe through Framework projects. The data is published to show how much they have gained. However, the DTI does not encourage this form of collaborative research and this attitude ripples down and shapes how the UK approaches EU projects and their funding. However, He sees that there is an important opportunity for applications, particularly where a multi-skilled solution can be created to deliver something into a specific sector, e.g. health telematics where you bring together healthcare and telecomms experts to create some new application.

So a campus might provide a focus for knowledge transfer, international collaborative R&D, and sector specific multi-skilled R&D. The telecoms market is global and collaboration is the way to progress. However, EU projects are cumbersome and the deliverables are often difficult to achieve so it's not entirely the DTI's fault.

However, Korea (for example) defines a strategy that is coherent from the top down and is fully supported by Government. There are equivalents in Japan and China. In the UK, the approach is too fragmented and leads to dilution. Devolving to the RDAs is seriously diluting UK capacity.

Industry gets ideas from three main sources: customers, suppliers, and employees. Companies can only control the employees and the pool comes from Universities so there is a clear role for universities in Knowledge Transfer through a good supply of employees.

There are things a campus might be able to achieve - facilitating suitable, pragmatic, knowledge transfer (and being clear at what level in the market place they wish to operate, i.e. know their customers), developing a common dictionary for multi-skilled teams (medical, telecoms, transport, energy, etc.) and it should focus on being a National centre of excellence, not just a regional one. You might want to consider the "Scottish Innovation Centre" and its focus on being **Scottish**. A campus should also consider developing applications. He was sceptical about the ITI model in Scotland as he does not see that platform technologies will work in a global market. Platform technologies are global, not regional, in nature.

A campus might want to consider many of the issues facing the energy market where dynamic digital utility management is an opportunity for the industry and consumers. This has only come about because of the development of technology, green issues, global ownership and the desire to manage peak demands. The digital world is advancing rapidly but we are not planning for it. He avoids the term "convergence of technology" as it means too many things to too many people but favours sector specific multi-skilled development and comes back to transport, health and energy as sectors where digital comms will bring major changes. Health-care telematics, transport telematics - why are our approaches in these sectors so old-fashioned? We need easier access to applications development and universities need to provide skills training for the employees of the future but guided by market insight. One can see that we have achieved digital phone technology (about 8 years ago) and will have digital TV set by ~2010-2012 and we ought to think about digital benefits to healthcare as patient care is not very high on priority lists.

He gave a time-line for the development of the mobile phone. In the early days, the US determined the technology and markets. The focus then shifted to the Nordic countries where uptake was faster and higher than anywhere else. This then shifted to Korea and Japan where many of the innovations were piloted. These markets have now been overtaken by China and India and China is a particularly important opportunity because the Olympics will give an unprecedented growth in mobile TV for example.

It's also worth considering how easy it is to set up a business and manage IP in the US compared with the UK - so many start-ups are hampered by attitudes and behaviours in the UK.

Conclusions
He was clear that technology development in his industry does not take place at a regional level. However, application development could do, and this is where regional agencies could be helpful. eg, making the south east a centre for remote health monitoring of the population.

Overall, it has to be said that he saw a campus as a distraction and not really a useful strategic initiative from his point of view.

A.5 'Magnet company'

'Magnet company' was founded by two people with complementary business skills: one was a very bright scientist and his wife provided the economic focus and HR skills to complement this. It's 45 year old spin-out from Oxford University and holds close to the University partly because they provide a pool of talent and partly because they are customers.

It was the result of several factors:

- Two bright people to create the business
- Local environment provided staff, collaborators, and customers
- It was idea whose time had come

However, it was never big enough to take control of MRI technology globally but still provides superconducting technology to Siemens through its partnering agreement.

Their primary interest is on innovation and inventions. They are not set up for volume manufacture (and could not afford to do it in their region anyway). Nor was an IPO part of the plan. They succeeded in getting past the 150 employee barrier but are now at 1,500 and wondering how to manage future growth.

They work with various universities, Oxford, Cambridge, and Imperial and have a very high level of PhD staff. Their interactions with the universities lead to 1/3 of their turnover as they industrialise ideas coming from this interaction. These academic customers are the engine for IPR.

They recognise the importance of IPR and are engaged, typically, in two IPR deals each week. However, they have about 200 active patents, many of which are not being developed and some of it is sitting on the shelf, decaying. When I asked them if SEEDA might have a role in helping exploit these, he indicated that while this might seem attractive, domain knowledge is critical, not simply process knowledge.

They outsource about 15% of its R&D. Often, they have academics approach them directly with ideas.

They keep ahead of the game with an innovation process that takes every part of the business, every six months, and examines the future. This generates between 100 and 500 one-line ideas. They have formalised their process with stage gate reviews that include technical reviews and voice of the customer.

If SEEDA was able to help deal with planning issues, they would be very pleased. They find the planning process to be very obstructive. They need, for commercial success, to move to one site. One council does not want to lose the company and will not allow the current site to be sold for housing development; the other

council is obstructing development of the other site to allow both parts of the company to be located there. Furthermore, there is a toll bridge between the two sites and it can take up to 40 minutes to get between the sites so there is a significant cost to the company which is a direct consequence of local planning issues. If SEEDA was able to support companies that seek to grow and prosper yet are hampered by local planning issues, there would be significant benefit to the region.

Note, however, that it does not see itself as a regional company. Fewer than 1/3 of its staff are in Oxford, over 1/3 are abroad. Oxford, however, is a very stimulating entrepreneurial environment where there are many investors with strong technology interests and very strong networks. SEEDA's support of this entrepreneurial network would be a good thing to do

One local issue that affects them is the very high costs in the region. Housing and salaries are very high making it very difficult to attract people into the region.

One part of the work that SEEDA could do is to urge a coherent science policy for the UK. This would lead onto the identification of resources that are needed to support this. Furthermore, a national procurement policy that supports national high technology industries would be helpful. If SEEDA could influence the Treasury, that would be good.

Having a strong regional centre of excellence would be good and it would need strong regional support to make this happen. Establishing a National NMR facility would be a good thing to do. You could consider it to be a parallel to the national centre for MRI that involves Culham/RAL/and others. DIAMOND[3] is a great draw for staff and is a good model for a National Facility. (France and Japan are set up with National Champions with their own synchrotrons). The French model of procurement of national facilities works well as it could be co-ordinated and part-funded by the public sector. In Taiwan, however, the overall national technology policy is such that there is no need for such an approach since there is a coherent national policy.

However, given an Science and Innovation Campus or a National Centre, it would not necessarily make commercial sense for the company to be co-located. It is worth remembering, by the way, that the location of Diamond was entirely determined by the private sector (GSK applied pressure).

The company's development of products often is customer-led, particularly with software so that their High Wycombe facility is working at full capacity.

[3] http://www.diamond.ac.uk/default.htm Diamond Light Source is a new synchrotron currently being built in South Oxfordshire on the Harwell Chilton science campus.

A.6 'Aeroengine company' (1)

The respondent is responsible for the engineering capabilities in fluid and thermal systems research. There are a range of such capabilities across the company to meet their needs. The central R&T allocates budgets for the capability groups to use. The capability groups have to bid into R&T for their budgets.

The respondent deals mainly with two universities: Surrey and Sussex (both within the SEEDA region) and he co-ordinates research with these universities. The model that they use is the University Technology Centre (UTC) that is formally set up as a long-term relationship. He inherited the links with Sussex and Surrey, the one with Sussex goes back about 20 years and provides specific expertise and has built up a large suite of facilities to study rotating flow.

The relationship with Surrey is about five years old and arose from personal contact. The professor at Surrey is an ex-company person who went to academia to do research. This has developed from being a single person consultancy to a full UTC.

The company approaches a university to set up a UTC and gives a 5-year contract to help them build up strategic research. This gets reviewed after three years but is generally regarded as a rolling contract and gets renewed. UTCs are seen as long-term projects which help build a secure relationship.

They do a lot of research in-house. This tends to occur at TRLs 4-6. They see that TRLs 1-4 are the province of universities and have a high failure rate. By taking TRLs 4-6 in-house to produce in-house demonstration vehicles, they can control the development and then pass it on, at TRL 6, for development of production processes. At TRLs 4-6, things stall and development gets expensive; need to demonstrate pull from the market.

It's quite a well-controlled process but they do struggle with analytical methods as these relate less clearly into TRLs. You can produce good research code but this can be very difficult to translate so analysts can use and validate it. With hardware, the TRL process works well but it can be hard to get resources in-house because of competing with resources for project work so R&T work can slip.

Although they have the UTCs, the company also uses secondments. They will have an academic come and work on-site to get short-term work done. This leads to variable results since the change from the academic world to industry is difficult.

The company sometimes uses the UTCs to get PhD work done so they have their staff work at universities for lengths of time.

When asked about collaboration with other industries, he said that the cultural issues are similar in aerospace so it is easier to talk with people in that industry. However, he does agree that it might be better to have collaboration with other industries but none come to mind. But, since his industry area is all about cooling hot components, his immediate thoughts were that the problem is common to automotive and other industries, ventilation, and electronics (where he commented on the clever cooling techniques used on devices in computers).

They do have an issue with communications where they need to get data back from service. The bandwidth needed I huge which creates a problem in downloading to a ground station with a need to compress data.

Broader issues and decisions about options for development are covered in the interview with the Head of Technology Strategy.

A.7 'Aeroengine company' (2)

He confirmed that the company likes to bring technology in house when appropriate basic research is complete. They tend to create UTCs close to established Corporate Engineering facilities using universities with relevant research (US, UK, and Germany).

Over the coming years, they will be changing their UTCs so that instead of having 20 in the UK and only 7 abroad, they expect to have fewer than half in the UK.

The company sees TRLs 1-3 as research in the university sector. By TRL 4 and above, it becomes an issue of validation of the science and this clearly requires major facilities (e.g. a full jet engine is large, expensive and comes with a range of health & safety issues). TRL 4 and above needs to integrate science and technology in ways that are not appropriate for university.

Where they have engineering centres (US, UK, Germany), these will have UTCs set up close at hand. Sometimes there will be collaborative projects between two of the UTCs and it is expected that the universities will communicate regularly.

In this sort of development work (and, by implication, for an SIC), communication is very important.

Also, it is taken as given that high quality people are involved.

One other factor is affordability and this has two aspects to it:

- Cost base for the people involved
- Government support which can have a significant impact on the countries where one goes for work.

For example, in Singapore, they have long had a maintenance centre. Using this, and government support, they have been able to develop a collaborative venture and a research base (a UTC in all but name).

Similarly in Japan, they anticipate big business with All Nippon Airways who want engines for the new 787 planes. About 10 years ago, with Cambridge University, they established a relationship with a Japanese university with a materials group. This operates as a partnership.

They have, with the help of Oxford University, set up a UTC in China on heat transfer.

The company judges things on affordability – the technical expertise is taken for granted.

We then moved on to discuss the SIC and the relevance to big corporates. he thought it might be relevant to SMEs. He then talked about EPSRC's desire to get SMEs more engaged with the UK research base (he's on an EPSRC panel that looks at this).

The problem, as EPSRC sees it, is that you need to find out what SMEs need and then guide them to the right researcher to help their business.

It was also suggested that SMEs might welcome the chance to be part of what EPSRC described as a technology "car boot sale" to showcase their capability. Warming to this theme, he then went on to suggest that a forum is needed to allow interaction between major corporates and SMEs that allows show-casing in an intelligent way. This means that you need to understand the future requirements of the major corporates, outside their core business. So, for the company, you would not look for high-temperature alloys (they know more than anybody about these) but could explore possible opportunities where new technology may meet needs that cannot be met with in-house resources. However, such introductions should only be made once the need has been qualified and both parties are informed before the meeting.

Maintenance is a key business issue so anything that helps it along faster and cheaper is good. Most of the business has long timescales (represented by Vision 5/10/15/20 models). In maintenance, their shorter timescales are represented by Vision 1/3/5.

The showcasing model needs to be able to interpret business needs at a high level and in an intelligent way and then relate SME business to these needs. It might also provide a forum for them to sell their technology.

It's a form of intelligent technology brokering. This could be complemented by EPSRC which has a very large database on all the research they have funded and they are willing to allow people to search it – although it may be an iterative process. The trouble is that not enough people know about this database.

A SIC that operates on this model provides a big training opportunity. The SIC could provide small-scale development and would be seen as a "half-way house between University and Industry". It would provide flexible and responsive science and trains people to have that kind of valuable mind-set. They would understand technical and commercial issues because of experience in handling different problems in different sectors – leading to a different mind-set from those who work only in one sector. Such people would develop as entrepreneurial technology brokers.

A.8 'Electronic equipment company'

'Electronic equipment company' is part of Magnetic Resonance which in turn is part of Medical Solutions Business Unit.

The majority of Magnetic Resonance is in Germany.

In March 2005 in China, Medical Solutions established the Magnetic Resonance Imaging (MRI) Centre of Excellence for Asia, which is the only MRI R&D and manufacturing facility outside Germany.

There are:

- 300 hardware and software engineers in Germany
- 70 in the UK
- 100 in China

80% of the activity and resources is on new products (ie, next generation). 20% is on technologies which are further in the future but have no immediate product embodiment. They have a roadmap for what these technologies are.

On the '80%' they are self sufficient within the company as a whole. There are internal partners such as Munich for production engineering and Princeton for software. Roke Manor on RF. These internal collaborations are easier to organise than external ones because there are no IP issues to get in the way.

More on the 20% they have external collaborations too.

We started off talking about the contacts with universities. They have students from sandwich courses and short projects. The two universities they are closest to in the UK are Bath and Cambridge. Bath, they have good relationships through former students becoming employees. Cambridge there is a formal arrangement. Bath is OK but not the best. Cambridge is world class. But they do not only want world class employees "You can't employ too many people who are sitting in the laboratory dreaming on how they will become CEO".

They also have contacts with Rutherford for materials and TWI. Also independent testing houses such as CTG. These are all narrow, specialised requirements that they have.

So what problems, if any, exist?

Sometimes a project doesn't deliver the results they want. But this is not a problem with the setup. It's more that some problems are not easy to solve. He was convinced that in general the internal network was so good that they'd locate the best person in the world I they needed to.

How could EEDA help?

“The SIC concept sounds more appropriate for smaller companies without the good network that the company has”.

They do use external agencies for clinical trials – but this is not what a development agency does.

Materials testing. At the moment they use a university - “very unreliable”.

They transport magnets to Germany for vibration testing. “A local source that could service all the magnet companies in the UK would be good”. I mentioned NPL.

We discussed the shared space concept. He thought it would depend a lot on the nature of financial incentives. The USA makes it easy to employ academics as cheap labour. In Germany it is the opposite. It is well worthwhile having good contacts with universities because of:

- Potential recruitment
- Training – it gets the guys aware of the latest techniques
- Good PR.

As a final topic he mentioned the problems of shop floor recruitment. They’ve raised this with SEEDA. There’s also a lack of manufacturing process skills in the UK.

A.9 'Agrochemical company'

Meeting today with 'Agrochemical company' was interesting. A campus might be useful for them if they could turn to it for some stuff that would be high quality and rapidly delivered. This might be non-core stuff to complement their service offerings rather than main-stream business. The have four main business areas (Bracknell deals with herbicides and pesticides) and one issue is controlling IP and costs. One solution is that they are opening a lab on Goa to get good and low-cost chemists who work within the fold - they have discovered how leaky it can be using sub-contractors and consultants out in India and China but they do use facilities out there for a lot of work. The definitely have a global perspective on outsourcing and are in the process of reviewing strategic approaches to this.

They are working towards developing a strategic model with a UK university to allow them to do something like the Georgia Tech model of having facilities on site that are world class and not dedicated to teaching. GTI will organise the rental of these facilities and access, as required, to academic staff to make things happen. Putting a team into a similar facility in the UK may be of interest to them but it needs to have the right mix of experts in the field and facilities to be useful. Key to setting up a strategic partnership is getting expertise, quality and speed of service.

A SEEDA facility - or a university - also opens up the possibility of well-geared funding so that their contribution can be matched by "Government" funding (i.e. any public funding). The costing model should NOT be driven by the artificial Full Economic Cost model being pushed by the DTI and/or The Treasury. This is a disincentive for companies and will kill off collaborative working.

The do not feel that the traditional model of funded research works. It is either: we decide what research work we want the university to do, pay them and ride them hard to deliver (which does not truly motivate the academics) or the University rings up and badgers them to fund a PhD student so the result are tied to a three year programme and may not be relevant. Neither of these options is a win-win.

They also see that bigger collaborative projects are better than lots of small ones - this is as true for SEEDA as for 'Agrochemical company'.

Where they started to depart from their current model came when we talked about needs outside their core business. They might, for example, welcome the ability to develop their sensor expertise but they don't have the facilities to get these up to the appropriate level of sophistication. Where things got really interesting was when they talked about things that are not core to their business and two bits came out:

- Developing non-core techniques into products that are separate from their business (this is exactly the Scottish Enterprise Idea Farming concept)

- During their development work, they produce samples of which their assay testing only requires a fractional amount. Therefore they have a large number of varied samples that may well be of benefit to drug development businesses. Managing that offering would be of interest and could be a specific activity in the Science and Innovation Campus.

This is only one interview and possibly atypical since 'Agrochemical company' has four different businesses each of which operates differently and it has a global approach to its business plus is market leader However, clear ideas did emerge that will be useful.

A.10 'Mobile telecoms operator #2'

The respondent also sits on the Technical Advisory Board for the LDA, so he sees RDA engagement from two perspectives. For 'Mobile telecoms operator #2' , however, this does raise the question "What is SEEDA? What role does it fulfil for big companies?"

SEEDA does not include some of the big Universities (e.g. Cambridge, UCL, IC) so operating in isolation is not helpful to big companies. In London, they are encouraging the Universities to pull together. In fact, there has been discussion between some Universities (including Brunel, Reading, Surrey and Royal Holloway) about forming a single campus.

Regional boundaries are artificial and silly.

He has been on the board of Mobile VCE (http://www.mobilevce.com/) which has been operating for about 10 years and cuts across the country (Edinburgh, Bristol, Surrey) and is led by industry[4].

His view is that good research, of relevance to industry, should be led by academics but with guidance from industry. One approach is to identify a common interest (around technology) between companies and then pursue this across boundaries. Constraining it to regions is too limiting and of no relevance to big companies.

'Mobile telecoms operator #2' does a lot of its research in-house as it is important to know what you want and to control the important IP. They have half a dozen centres across the globe. Development can be done with partners.

Note that the concentration of IP in a few suppliers has a direct consequence on standards. Each tries to influence standards to suit their IP. However, standards operate globally and there are battles to get specific IP into standards.

A campus should cross regional boundaries. As an example, a National Centre on radio technology would be useful and there is a huge amount that it could do. It should be a centre for the UK expertise and knowledge but would have to be based on an existing centre of excellence, most probably academic.

However, another model would be to **host** such a centre where participants can come in as appropriate. A National Centre[5] would imply excellence and act as a

[4] From the web site: Mobile VCE provides industrially-relevant, long-term, world-class, research in mobile and personal communications defined & steered by our industrial members.

Its innovative structure accesses the highest quality academic skills and staff, whilst ensuring that research is industrially relevant, yields valuable intellectual property, and provides a very high financial gearing.

stimulus for new work. It could follow the model of the Centre for Maths in Cambridge that hosts two-week workshops that are attended by an international spectrum of participants. Cambridge acts as a centre to pull in participants and their interaction during the workshop creates an enduring buzz and enhances its reputation. Hosting such a centre means thinking globally, not regionally, as it should be aiming to achieve international recognition.

In the current funding model, 'Mobile telecoms operator #2' supports a range of EPSRC applications. Their involvement is often in providing an industry person to lead the research work. 'Mobile telecoms operator #2' also take students during the summer to give industry experience.

Closer involvement is also possible with embedded laboratories – Thales has created one of these at Surrey.

Any campus model needs to be flexible enough to cope with variations and changes. A Science and Innovation Campus should be able to take idea into something close to market. It should provide a credible route into industry. Industry can influence the direction so that the research knows where it is going. However, good academics need to be "ahead of the game".

He could not think of any models elsewhere to consider for copying. Fraunhofers, maybe, but in the US, the 100 big teaching universities dominate the landscape.

[5] We did not discuss the political issues and funding issues that would arise in trying to create such a venture. This is a market-focused survey and presents a set of opportunities.

APPENDIX B TECHNOLOGY READINESS LEVELS

This is a brief explanation of Technology Readiness Levels (TRLs), a model used by ‘Aeroengine company’ and ‘Aerospace Company’ to assess the maturity of technology.

TRLs help to quantify the level of maturity of a technology, i.e. how far has the science moved towards being an exploitable technology. The levels that are used range from 1 (a paper study on a concept) to 9 (successful operation in the field and proven performance in flight). They are defined in the following table:

TECHNOLOGY READINESS LEVEL	DESCRIPTION
0	No prior work in field.
1	Lowest level — typically paper studies of a technology's basic properties. Scientific research begins to be translated into applied research and development. Basic principles have been observed or reported.
2	Practical applications begin to be invented but still limited to paper studies and not proven or supported by detailed analysis. Technology concept and / or application has been formulated.
3	Active research and development begins including analytical studies and laboratory studies to validate predictions of separate elements of technology. Analytical & experimental validation of critical function standalone.
4	Basic technological components are integrated in a laboratory to establish that the pieces will work together. Technology component and / or basic technology sub-system validated in a laboratory environment.
5	More sophisticated laboratory integration of components with reasonably realistic supporting elements so that technology can be tested in a simulated environment.
6	Major step up in a technology's demonstrated readiness — representative model or prototype tested in simulated operational environment.
7	Major step up from level 6 — demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space.
8	Technology 'flight qualified' through successful test and evaluation of the system in its final form in intended weapon system under expected conditions.
9	System 'flight proven' through successful application of the technology in its final form under operational mission conditions.
10	Technology is obsolete

Some purists choose to include level 0 (not yet imagined). Level 10 becomes relevant when considering end of life and disposal issues, particularly where legislation (e.g. WEEE directive) applies.

In general, university research operates around levels 1-3 but major companies (e.g. ‘Aeroengine company’ and ‘Aerospace Company’) look for technology at TRL 6 and above. This is because much of the risk during development has been removed and the route to successful operation (and commercial benefit) is more clearly planned.

TRLs 3-6 cover technology development that is seen as risky and prone to falire. Start-up companies often emerge from universities and enter this space hoping to

complete their product development before the money runs out. When they reach TRL 6 or 7, the hope is that they attract the attention of a major company and are acquired. ‘Aeroengine company’ may strategic decisions on whether to support a technology using the TRL model.

However, from SEEDA’s perspective, an Science and Innovation Campus might aim for the space between levels 3 and 6 where innovation is essential for successful exploitation of technology and the risk needs to be managed better than at present.