THE PEOPLE CENTRIC APPROACH TO ECONOMIC DEVELOPMENT

A policy maker's guide to growing a technology cluster from a research university

by Stephen Allott,
Founder
Cambridge University Computer Laboratory Graduate Association (the "Ring")

Universities can help catalyse local economic growth particularly in technology industries. The flotation of Google is a spectacular example which will bring great wealth to California. Google could have been based anywhere but, in fact, it's based there. We need to understand why. Every major country wants its own Silicon Valley. Every major country wants their own universities to catalyse the growth of local technology clusters.

Why have, so many policy attempts to develop university led clustering, failed to produce significant results? Why have attempts to encourage academics to do more industrially relevant research failed to boost the economy? Why have more recent attempts to commercialise academic IPR failed to produce wealth?

Will the attempt to stimulate industrial demand for research inspired by the Lambert Review fare any better? Once new businesses have been founded, will they grow to global scale like their American counterparts? It's unlikely. Past efforts have focused on only a part of the mechanism. Recent policy has been based on the theory that clusters are mainly idea centric and grow out of the idea flow. This article suggests that people flow is an essential additional element of the cluster creation mechanism rather than just idea flow on its own. Economies are made of businesses. Businesses are made of people. People are the raw material for the knowledge economy. Put some additional focus on the people and the technology businesses will, more or less, take care of themselves.

This article is in 3 parts. We start with a discussion of the link between research and economic growth. Second we look at the failures of the idea flow approach. Finally the people flow approach is described as part of a detailed action plan on how to use people flow to grow a technology cluster. The results of an experiment to pilot one, small, element of the action plan conducted over the past 2 years at Cambridge University Computer Laboratory are described.

The costs of implementing the people flow approach in a strategic department in a research university are very modest. Most of the infrastructure required will be self financing and could, at scale, generate a small surplus. Start-up capital of about £250,000 would be required to reach the scale where self-financing would be possible. One person in the infrastructure required might require financing although suitable individuals might be prepared to do the work on the basis of an honorarium. Substantial benefits should accrue to the economy as a result.

If the thesis in this article is correct, namely one can achieve a large positive economic impact for a modest cost, one might ask why universities have not already

pursued this approach. The answer is that it is not and has not been the mission of a research university to promote economic growth per se. Responsibility for economic growth lies more with local development agencies yet a major source of impact on economic growth, people, comes from the university system.

UNIVERSITIES CAN CREATE WEALTH IN THEIR COMMUNITIES

Education is an acknowledged route to increased living standards, progress and indeed civilisation. In more recent times, there has been a well observed and increasingly envied connection between great research universities and the growth of technology business clusters around Stanford University and around the universities in Boston, Massachusetts. A small technology business cluster has even grown up around Cambridge here in England but on a much smaller scale. There is a similarly sized technology cluster around Oxford. European policy makers would like to repeat the success of the US clusters. Furthermore, economists have noticed a correlation between spending on scientific research and economic growth, making 2 good policy reasons to attempt to stimulate university led economic clusters. As part of the Lisbon programme for Europe, spending on scientific research is set to rise whilst attempts are being made to catalyse the creation of wealth by universities. UK science is already productive, producing many more papers per pound of research spending than US science. This scientific productivity is a good platform for using universities as a engine of economic growth provided we can understand and accelerate the mechanism by which one leads to the other.

BUT WE DIDN'T FULLY UNDERSTAND THE MECHANISM

Despite years of trying in at least 3 different ways, UK policy makers and universities still don't appear to understand fully the mechanism by which universities augment outputs from capital and labour and thereby catalyse the growth of technology clusters. Research relevance, research commercialisation and most recently stimulation of industrial demand for research have all been wrongly identified as the broken link in the chain. Policy actions to mend these links have failed to produce results because these were not, in fact, the broken links.

- The first theory was that wealth was created by businesses using or based on academic research. Policy measures to increase the industrial relevance of research and to encourage research in strategic areas were tried. Research councils applied money to the target areas. Industrial research collaboration was encouraged and in some cases mandated. Academics had to find industrial co-sponsors in order to receive funding. Secondments from industry to academia and vice versa have been encouraged. Many schemes have been implemented from CASE studentships to the Teaching Company Scheme. Most recently, it has been suggested that academics should sit on company boards.

- More recent policy efforts have focused on direct efforts to commercialise research by universities licensing direct to industry or by setting up spin out companies. Generally known as "technology transfer", this differs

from publication in that usage would require some commercial return to the owner of the intellectual property ("IP"). An added attraction was that the money raised could fill the university funding gap. Large industrial liaison departments have been set up in many universities to identify promising technologies and maximise the commercial returns to the institution. However, not all is going well and there are several ominous signs. Many university spin outs from the last five years have failed. UK Government research about US experience found that almost all such activity, loses money. Note that pharmaceutical patents are an exception to this general rule. Of the 20 or so spinout companies proudly displayed on one university's web site, not one claimed a single commercial customer. A director of industrial liaison with 10 years experience at one leading London college told me that overall technology transfer commercial results had been poor. Published research confirms that marketing efforts by a university's technology transfer office are the least effective mode (out of 6 possibilities) for generating leads for potential technology licences; see Thursby and Thursby, Industry Perspectives on Licensing University Technologies, 2000. This paper is based on research carried out in 6 institutions in the US. Not only has commercial success been patchy but there have also been major costs to the universities themselves. Licensing the IP means owning it first. For Cambridge University, this meant taking the IP away from the individual academics, who had owned it since time immemorial. The scholarly Cambridge Phenomenon Report, 1st edition 1985, found that individual rather than institutional IP ownership had been found to be a significant positive factor in the growth of the Cambridge technology cluster. Taking the IP away from the faculty would therefore harm cluster growth. University IP ownership also appears to damage academic freedoms, hinder academic mobility between universities and make recruiting low paid faculty harder. A rebellion ensued at Cambridge. Currently there is stalemate in Cambridge on the IP issue. There is also a technical tax problem. Recent changes in tax law mean that shares distributed by an employer to staff in spinout companies are taxed at the time of grant as a benefit in kind. Since this came into force, all formations of university spinout companies have ceased. We suggest that current university technology transfer activities are damaging economic growth and damaging UK universities' research.

¶ Most recently, the Lambert Review, set up to inquire into how universities can contribute directly to economic growth, has noticed that industrial demand for academic research is weak. They explain this partly by the fact that there are few research intensive industries based in the UK. In other words, there is weak "pull". Remember that everyone agrees that universities catalyse the creation of technology based research intensive industries in the first place and that we already have great research universities. So Lambert's observation doesn't address the key question of why our universities have failed to catalyse the growth of research intensive industries nor propose any means of fixing the problem. Lambert did correctly identify that there has been an over emphasis on spinouts but is taking us back down the, mistaken, technology transfer route again.

- Real industrial demand for academic research is weak because it's rarely a significant factor in business success. Business people are pretty good at working out what it takes to succeed. If buying more curiosity driven research was a major means to business success, they would do more of it. Consider that the definition of academic research is that the academic can decide what to do and whether to publish and you can see that that is hardly likely to be relevant to a business. Imagine going out to tender to a supplier and saying that that what you want can be anything the supplier chooses to deliver and that the results can be published for free usage by anyone. Thursby and Thursby, cited above, asked firms who routinely buy licences to externally developed technology from other sources, why they rarely licensed in university developed technology. The single largest reason given was that "University research is generally at too early a stage of development".

- There is real business demand for contract research, i.e. applied problem solving and there are plenty of specialist consultancies and commercial research houses who meet that demand. Confidentiality is of course essential. University faculty and PhD students can and do satisfy some of this demand and it is proper for them to do so but consultancy can conflict with their core role of publishing novel research in their specialisation simply by consuming their time. A professor in a leading science department in Cambridge who has a global industrial company as a generous sponsor told me that proprietary applied problem solving for industrial clients under contract and doing academic work don't really mix, at least not all of the time.

- So why do industrial companies actually sponsor academic research at all? If one segments industrial companies by size and market position, their motivations become clearer. There are several reasons but none are related to gaining competitive advantage through proprietary knowledge transfer. Note that funding academic research which may be published may not result in any proprietary knowledge transfer to the provider of the funding.

    . Monopolists want influence over Government, regulatory bodies and the society in which they operate. Elite research universities can help provide this cost effectively. Very large companies have sometimes established research institutes alongside universities. Rank Xerox EuroPARC, AT&T Research and Microsoft Research, all in Cambridge, are examples of this approach. The institutes then sponsor joint research in the university.

    . Monopolists need to increase market size to grow rather than increase market share. Intel wants more applications for their chips rather than better chips than their competitors.

- Monopolists also need to recruit top quality talent into their organisations to maintain their institutional leadership. Research sponsorship builds links with faculty which helps recruitment of good students.

- For companies of all sizes, global, national, medium and small, managers may be motivated by a sense of philanthropy or by a desire to socialise or work with academics in a particular field and may need to recruit staff. Rolls Royce is a good example of a UK company with a vested interest in building relevant skills and a local science base.

- Clearly in some instances companies may need some technology and a university may be a cost effective supplier but a university will be in competition with established technology suppliers and pre-existing alternative technologies.

To sum up, economic growth is not primarily about the idea flow from research. The linear model of innovation from science to R & D to production to markets is too simple a model of economic development. This is hard for academics to accept because their work is about the value of their ideas; which are very important. But not, really, for growing technology clusters. Nor is industrial demand for research terribly important. In fact, the 2 fields, business and research are pretty distant cousins. So what is the answer?

PEOPLE (ESPECIALLY POSTGRADUATES) ARE THE MISSING PIECE OF THE PUZZLE

As you may have already guessed from the title, it's the people. People are the additional part of the mechanism which enables great universities to grow technology clusters. Universities are magnets for quality people. They attract, train and retain quality people within their locality. They enable people to network amongst each other. Universities help make a place an attractive location in which to settle and bring up a family. They are engines of loyalty and retention.

People are repositories for technology knowledge until it’s needed in a commercial application and people perform a matching mechanism for that technology when it's needed. Innovation has been said to be the application of old technology to new, valuable, problems rather than the application of new technology to old problems. Blockbuster applications for technology may not to be the application intended by the inventor. Transistors were invented for hearing aids and the telephone was envisioned to be a means for broadcasting concerts. Who would have expected CD players to be a major application for lasers? So, technology cannot be force fed into a commercial application but is likely to have to wait until it’s needed. Sometimes this wait can take decades.

The People Flow Mechanism

Not only do people grow businesses but they have the added attraction than they are easier to monitor, control and encourage than ideas which diffuse unpredictably and by multiple means. Not only are people a key mechanism but they are an actionable mechanism as well. Teaching science and engineering students is not enough on its own. France and the UK have far higher numbers of science and engineering graduates per head of labour force than the US yet we lack US style technology dynamism. France has 1,430 such graduates per 10,000 members of the labour force aged 25 to 35. Comparable figures for the UK are 1,360 and 950 in the US all according to the OECD. There has to be a mechanism which enables these people to be involved in business growth. We suggest there are several elements to the people flow mechanism; inbound entrepreneurs, knowledge transfer in the heads of PhDs taking full time jobs in industry and, third, graduates generally who form a pool of skilled but good value labour who work in local cluster companies.

- Inbound entrepreneurs are key. Sergey Brin, who co-founded Google, is Russian but is in California because he went to do a PhD at Stanford. Postgraduate students are the key element of people flow. Around half of foreign PhD students in the UK settle permanently, enriching the economy. One such, Dr. Hermann Hauser, came to Cambridge from his native Austria to do a Physics PhD and stayed on in Cambridge. His first company, Acorn, is believed to have led to around 30 subsequent companies. One of those, ARM p.l.c., is believed to have led to a further 20 or so companies. Dr. Hauser's venture capital firm, Amadeus, has invested in many local companies as well. Dr. Hauser's contribution therefore to the Cambridge technology cluster has been very large, leading in total to the creation directly or indirectly of around 100 companies. Recent research from the Cambridge Centre for Entrepreneurial Learning confirms the important contribution of a relatively small number of such entrepreneurs in Cambridge. In the other direction, around 70% of British students doing PhD's in the US never come back according to an article by Sami Mahroum of the Institute for Prospective Technical Studies in Seville in Spain. This is the highest stay on rate of any country. Only 8% of Japanese PhD graduates stay on in US as a comparison. The high British staying on rates have led to there being over 7,000 UK science and engineering PhD graduates in the US in 1999 according to the OECD, the highest number of any country. Canada is second at 5,500 whilst Germany is a distant third at 2,500. Students like to do their first degree near home. But after that, if you are entrepreneurial and want to get into the US, a good route has been to do a post graduate degree. If you are bright, you can usually get a scholarship, can then study in your desired field for a few years and are guaranteed a work permit if you want to stay.

- Specialised knowledge transfer from academia to industry occurs best in the heads of PhD graduates according to British Government research conducted in 2003. Undergraduates don't have knowledge from a research group. Faculty, in general, don't go into industry. PhDs take their own knowledge and knowledge of their supervisors' and peers' work, their social relationships with the department and their peer group and their

sector expertise into their new employer. Thursby and Thursby, cited above, found that personal contacts between R & D staff and university personnel was the single most important source for identifying the technology. This is evidence that movement of PhD students into industry and the maintenance of subsequent contact with faculty is the best means for promoting technology transfer from universities into industry. Superior US economic performance might be partly explained by their relatively high number of masters courses and the relatively high number of science and engineering graduates produced. Fewer UK graduates go on to postgraduate study than in the US. We need therefore to increase postgraduate student numbers and nurture their career moves into technology industry. Careers are central to the university contribution to the economy but this barely gets a mention in Lambert.

¶ Both PhDs and graduates with first degrees provide a talented labour pool in the cluster from which local employers can recruit. Wages for computer programmers in Cambridge with Cambridge University computer science degrees are relatively low because a Cambridge computer science degree in Cambridge is a commonplace. Elsewhere in the country such a qualification would be rare and prestigious. Retaining the pool of graduates locally therefore is a prime policy objective for cluster development because it provides a high quality and relatively low cost labour pool.

The Action Plan for University Led Economic Growth

Now that the people flow mechanism has been explained, an integrated 3 part action plan for a university can be developed which covers the people in the university (both students and faculty), companies (whether founded by graduates or others) and, thirdly, strategic industries that one hopes will grow.

1 The first element of the Action Plan, "People Flow", is to nurture the basic raw material, the students, who in due course graduate with a degree and then become alumni. There is a significant potential payoff to nurturing them at each stage.

- Investing in People Flow starts with student recruitment and admissions. Growing an industry in a particular field, e.g. bio tech, requires recruitment of promising students into that department from all over the country and the world. Successes of past graduates need to be celebrated. A book detailing their achievements should be given to undergraduates and applicants. Schools need to be visited and teachers briefed on how to help good students, whatever their background, to make the most of their talents. Each technology department's web site needs to excite potential students about both the degree course and the subsequent career opportunities.

  . Post graduate scholarships are particularly valuable. Most should be based on academic attainment but some should be

awarded on entrepreneurial and separately, social leadership, potential.

. Undergraduates should be told about the department's aspirations to help grow an industry and should be briefed on successful prior role models.

. Social bonding between students through joint projects, team work and department based social activities should be conducted to establish strong links which will be useful later in their career. This is particularly important in collegiate universities where the primary social axis is college and then activity (sport, drama etc) rather than subject.

- The second part of People Flow is helping students get off to a good start in their careers. This has a substantial potential return. The role of University Careers Services was reviewed extensively in the recent report of Sir Martin Harris. Careers Services are clearly important. They become strategic when one sees a key goal as being that of helping build an industry through People Flow.

  . There should be a careers talk in every department at the start of the course and then again at the start of each academic year. The basic talk should be given by the Careers Service. Some departments in leading universities don't do this at the moment. Through the course of the academic year, inspiring graduates who have had interesting careers should be invited back to tell their stories and provide role models to current students. This is standard practice in leading universities in the US and Europe and should be adopted more widely in the UK.

  . Summer placements organised by a summer placement officer have been shown by our research to be very valuable to students in informing their career choices and valuable to employers in forming an extended interview. Summer placements make the matching process between graduates and employers more effective. Major effort should be invested in finding companies to accept summer students, providing them with summer accommodation and encouraging students to take up such work. Summer placements also form a convenient focus for companies belonging to a departmental industrial supporters' club, discussed at greater length below.

  . To enable them to find work, PhD's should be given bursaries to stay on in the university after their studies have finished. Foreigners wanting to stay on in the UK after graduation should be given automatic work permits.

- The third element in People Flow is taking care of the graduate community once it has left the university. As well as the economic

benefits resulting from helping individual graduates do better, developing an active graduate association also brings benefits back to the department. The Harris Report mentions approvingly a North East university which works closely with a team of their alumni to support their students. Their alumni take part in employer presentations, in summer schools and offer work experience opportunities; see Cameo 3 on page 26. The Cambridge University Computer Laboratory Graduate Association (the "Ring") was founded in 2002 to achieve both goals, namely helping graduates and helping the department. Overall the Association seeks to enable graduates to derive a lifetime benefit from their Cambridge degree through social, business and technical contacts and information.

. 3,500 people have graduated from the Cambridge University Computer Laboratory since it started teaching in 1953, the oldest taught computer science course in the world. The Ring set out to understand where they had ended up, what they needed in order to do better in their current job, whether they had fulfilled their personal potential and if not, why not.

. The Ring provides careers help for its members through a panel of volunteer careers advisers, a jobs board and is developing a mentoring programme. Note that is directed to graduates after they leave Cambridge and therefore complements the University's Careers Service which helps students find their first job. The Ring organises regular social events and speaker meetings on topics of interest. It provides an online contact directory and regular Newsletter as well as a helpline. So far, 300 members have joined and events have been well attended.

. The Ring has catalogued companies founded by Laboratory graduates. The current number of 110 companies (the "Hall of Fame") which is far from comprehensive, is the most of any department in Cambridge, and is far more than the number of university spinouts based on university owned IPR. It seems obvious that the graduate community is far more fertile ground for stimulating entrepreneurship than the faculty and students. The currently most successful Ring company, Sophos p.l.c., recently came back to the Lab to give a talk about their success story. They employ 758 people and are the largest anti-virus vendor in Europe and the 4th largest in the world.

The People Flow element of the Action Plan covers students during their studies, getting them into jobs in strategic industries (but only if it suits them as individuals) and helping them to realise their personal career potential subsequently.

2 The second element of the Action Plan is to help companies do better by enabling Company Growth. Government policy initiatives to help small business and technology business performance are legion. The focus here

is on companies in a strategic industry which have links to the university department in question. The link can be either that they are a Hall of Fame company (founded by a department graduate) or a local company which has become a member of the departmental Industrial Supporters' Club. Both the Halls of Fame and the Supporters' Clubs can be used to motivate company management by holding annual awards dinners where company successes are celebrated. Press clippings about member companies should be circulated on a regular basis for example as a supplement to a regular Newsletter.

- Companies can be helped by de-bottlenecking growth. Growth barriers should be studied and identified (commonly product sales, recruitment of staff, access to capital and US market entry) and steps taken to remove the barriers. The Cambridge University Computer Laboratory has already conducted a study of its Hall of Fame companies to find out why they have not grown further than they have. This revealed that many stopped growing once they reached 50 employees.

    . Local companies' product sales can be helped in several ways. Seminars on Sales Management Basics are popular and well attended in Cambridge. The local business school should consider spending more time on management education about sales force management. There appears to be demand from technology companies for more sales training which would in the ordinary course be met by commercial sales training companies. Getting introductions to potential customers is particular valuable. The Ring Who's Who (its directory of members) can be searched by company, industry and location and therefore can help members contact potential customers. The Ring Newsletter publishes articles about Hall of Fame companies to build awareness amongst potential customers.

    . Seminars can be held on US market entry; potential local US contacts found through the Ring Who's Who and US students in Cambridge returning to the US can also be used. The author is frequently asked to give talks and seminars on technology sales management and US market entry.

    . Access to venture and development capital is already helped through a variety of local mechanisms in Cambridge and is a well studied policy area.

- In addition to encouraging the University Careers Services to continue their good work, People Flow into companies can be assisted in several ways:

    . By major investment in encouraging student summer placements in strategic companies.

. Proactively inviting strategic companies to give more careers talks to key departments and encouraging them to recruit students. This is the same point as helping students into good careers but this time it is viewed from the company rather than the graduating student end. This illustrates the important win / win element of nurturing the People Flow into strategic businesses.

. Encouraging use of the Ring jobs bulletin board which enables members to post jobs ads free on the Ring web site enabling access to a pool of experienced talent (as opposed to fresh graduates).

- Companies can also draw on resources from university departments by active participation in Industrial Supporters' clubs. These may be research focused or student recruitment focused. Demand for both can vary within a short space of time with the result that companies not needing either at a particular time may drop out. An elegant solution is to focus Industrial Supporters' Clubs on student summer placements. This is a simple and low cost proposition to the company, can be expected to happen every year and requires reasonably close contact between the department and the company every year. With summer placements as a secure foundation, the Clubs will maintain their membership each year. Industrial Supporters' Clubs also then encourage active permanent recruitment of students, purchase by companies of consultancy from the faculty, the provision of ideas and clients for student projects as well as hosting valuable executive networking dinners and social events. Commercial consultancy and student projects provide contextual information for academic research. Without the regular contact driven by summer placements, such clubs can easily atrophy.

3 The third element of the Action Plan is to develop future industries proactively, i.e. Industry Growth. First identify an area where a university has an outstanding faculty member working in a field with good industrial growth potential. A good example would be to develop more of an industry based on the recent House of Lords Report on "Chips with Everything". Then our suggested approach is as follows:

- Recruit, on secondment, a senior and respected industrialist (a "Visiting Business Fellow") to work full time in the target department to write the industrial development plan. The plan needs to be done closely with the faculty and agreed with the Head of Department. All available resources should then be mobilised as part of a coherent plan e.g.

. Department graduates already working in the target field should be identified and encouraged to join the department's graduate association.

. Related companies should be identified, asked to join an Industrial Supporters Club and then recruit current students, suggest projects and purchase consultancy.

. Technical, business and social events should be organised by the department on topics in the field. These can take a wide variety of forms from executive networking, industry case studies, academic briefings, problem solving workshops and recruitment.

. PR can be used to communicate the department's business development goal and successes so far.

- Next, attract more excellent faculty in the department or from around the world to take up posts in the field and join the group. Great faculty not only do good work and but also attract outstanding students. Set up an MPhil programme as well as taking on PhD students in the area. Include leadership and entrepreneurial aptitude as admission criteria for some of the faculty and students to ensure that the pool of people contains a balance of leadership and academic excellence. IPR should be ceded by the university to the faculty to both attract people and make it easier to found companies. Entrepreneurs should be invited to network with the graduate students so they may co-found companies together. This is a key motor of cluster development.

- Finally, a departmental support organisation should be set up to help achieve the goal of industry growth. The relevant activities fall under 3 headings:

  . Business development related

    i) Strategic planning
    ii) PR (including web site editing)
    iii) Handling inbound queries for consultancy and research

  . Student careers related

    i) Summer student placement admin
    ii) Industrial Supporters Club sales and admin
    iii) Student Careers Advice (performed by the Careers Service)

  . Graduate association management related.

  We propose therefore that an industry development team room be set up containing 3 people full time and having 2 further desks for team members. This should be called the Action Plan Office. The team members should be:

1 A Visiting Business Fellow doing the business development activities above

2 An Industrial Supporters Club manager who recruits companies (who have to pay a Club membership fee) and then persuades them to take summer students and recruit graduates.

3 A Director General for the graduate association.

4 A desk which is used by the Careers Service person dedicated to the department and who should visit frequently.

5 A desk for someone from (what is known in Cambridge as) Research Services Division to help smooth the way to getting research contracts agreed from research funders.

- The Graduate Association director general will, at scale, be funded by individual membership subscriptions. The Industrial Supporters' Club manager, at scale, will be more than funded by corporate membership subscriptions. One may reasonably expect these activities to generate a surplus. Before scale is reached which may take 3 years or more, start-up costs will have to be incurred. The incremental ongoing costs of the departmental support organisation described above are limited to those of the Visiting Business Fellow. Some suitable candidates might be found who would work on a voluntary basis or on an honorarium but one should budget conservatively on a cost of the Business Fellow at £100,000. Based on the experience in the Cambridge University Computer Lab costs will be in the order of:

  . One off start-up costs: £250,000
  . Ongoing costs: up to £100,000 p.a. from inception.

- The measures of success of the Action Plan are easy to identify.

  . People Flow is measured by strategic industry participation and graduate earnings. This requires a regular survey of graduate salary and employment; a common place in professional associations.

  . Company Growth is measured by turnover, profit and employment. The Hall of Fame should include these metrics.

  . Industry Growth is the aggregrate of Company Growth.

<u>Complementary initiatives in the town</u>

Some modest complementary activities should take place in the town to help industry cluster development

- Business management talent interested in relocating to the area should be encouraged by providing an agency or first point of contact to help them move in and find contacts. They have to be helped to meet promising technical talent so that they can jointly found and run companies.

- Prize giving events should be held for functional expertise e.g. in technology sales. This allows functional knowledge sharing to occur. Such events have been commonplace in the past for example amongst technicians and apprentices.

- Investment in local schools should be make it more attractive for couples to stay and bring up their children in the area.

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CONCLUSIONS: PEOPLE FLOW IS LOW COST AND HIGH IMPACT

The mechanism by which universities catalyse technology industry growth is complex and delicate but includes an important people centric element. An integrated programme to develop People Flow through a university department and into a nascent local industry will help a technology cluster grow with resulting substantial benefits. The programme requires a diverse range of activities many of which need strong social leadership to make them work.

People are more manageable than ideas. Encouraging industrial sponsorship and research collaboration, downstreaming research into businesses and investing in improving the university / academic interface have all been tried as means of encouraging economic growth but do not appear to be leading to the desired results as fast as policy makers would like. Our submission is that people centric investment will have a higher pay-off than current idea-centric policy initiatives.

Recent work on the development of social capital in technology clusters suggests that a further area of study could involve understanding whether particular social protocols amongst these groups engender desirable emergent phenomena. In other words, cluster success may be partly explained by the fact that people behave in certain ways towards each other. The attraction of this for policy makers is that behaviours may be be identifiable and replicable.

How can universities be encouraged to adopt the Action Plan set out above? They already have substantial incentives to attract good students and play a role in their subsequent career success and the success of their companies. Good students want to have good careers. Strong links into successful companies can provide this. Faculty want ideas for research areas and outlets for their work. Strong links into successful companies can provide this as well. Universities as a whole are hoping to raise more money from philanthropy in future. Future successful companies and graduates who have derived a life time benefit from their alma mater should make future fund raising more productive

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