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9. APPENDICES

9.1 UNITED STATES INTERVIEWS

9.1.1 BROWN UNIVERSITY

9.1.1.1 Eugene Charniak - Computer Department Chair

Interviewes: Eugene Charniak
Job: Chairman, Computer Science Dept
Organisation: Brown University
Interviewer: Tom Haigh
Date: Monday, 19th September 1994
Location: Brown University
Revision: 1

The bulk of the CS department's funds still come from the government, which is able to take a 'more long term' view than companies, and unlike them is not looking for an immediate return on its investment or for exclusivity agreements to create competitive advantage 'which of course is completely anthietical to everything which universities believe'.

However, there are attractions to industry in investing in universities. For example,

> *'although it's not ethical to say to your students "Go to company X", if company X has a bigger presence in your department, with their people coming round more often, then that presumably has something to do with attracting students... they get this idea that company X is doing really interesting work.'*

Some of the work done at Brown, particularly software, is directly applicable enough to attract industrial funding.

> *'The company feels that even if they don't get exclusive use of this stuff they will be in a better position to commercialise it than any of their competitiors would be.'*

> *'Industrial money does come, but it's not a huge source. One of the key reasons, from my vantage point, for encouraging industrial relations is that it means to the governement that you're not some ivory tower intellectuals. That's probably the core benefit that a university gets out of industrial funding - it helps them to look legitimate. I would say that the second most important thing is that it helps them to be legitimate - and we actually do get some feel for what's worrying people in the "real world". Even if you choose not to work on those, I think you should at least be aware of what you're choosing not to work on. The last and least important benefit is the money.'*

The most important direct benefit is donation or subsidised purchase equipment. *'It is certainly very helpful if a company like Sun will make special deals with universities... in general terms equipment and maintainence are probably most of what we get out of industry.'*

Is this compatible with Bill Jackson's comments that equipment grants are usually undesireable? The contradiction is

'more apparent than real... We've actually gone through several interations on this question - at one time we were really looking to build up our equipment, so we would take pretty much anything that anyone would give us. This turned out to be a bad idea because it meant that we were operating on five or six different operating systems and the maintainence people were just going nuts.... We then went to the other extreme which is basically saying that "There's only one platform that we will allow in this department" - we obviously couldn't expect any one vendor to give us enough machines for the entire department but we could and did try to organise a sort of competition among the vendors so that we would get the best possible deal... and that tended to work very well.'

Currently a modified version of this strategy is in place - the departmental support and administration team only work on Suns but '*if you have anything else then firstly you've got to get approval, and secondly it's up to you to maintain it.'* In practice other platforms are found in specialist areas - for example the graphics team use Silicon Graphics machines; the system also allows the flexibility, for example, to ensure that IBM sponsored work can be ported to an IBM machine. '*The net result is that by and large we're pretty much a single vendor site and when people offer us equipment we politely say "No thank you.*"'

One advantage of industrial funding is that there may be '*fewer restrictions'* on its use. '*There's more restrictions on making sure that it's spent on that project that the sponsor cares about, but within those projects there's often less restrictions on precisely where it goes*.'

How much does Brown's reputation help it in its dealings with industry?

'That's a good question and I'm not sure what the answer is. First reaction is that it's probably secondary - mostly these sort of things work because of particular individuals rather than group reputation. If you have an individual who is super-dooper at X, and further more is a good sales person, that works a lot - and that person can then bring in things even if the rest of the department is medicore. Obviously it helps if the rest of the department... is also very good.'

Would he agree with the observation, made by several interviewees, that whilst the proposed deal itself may be judged on its merits the reputation and contacts of a prestigious institution are very helpful in being able to contact the right people in the first place.

'I would agree with that, but at the same time I would make a distinction between how a development office views this sort of thing from how the department views this. Development offices are used to thinking in terms of alumni, and what they are selling is benefiting the university on the basis of shared experiences. Computer science departments don't think in those terms, but in a way they do the same thing. It certainly doesn't hurt, in fact it helps a lot, if your alums are at this particular company - they are your natural entry point. Sometimes you'll get money from a company just because you do have alums there - a company says "Gee, we've had a lot of really good people from X, maybe we should throw a little money at them."'

Whilst academics view the making and maintaining of contacts as an intergral part of their professional life, rather than primarily as a source of funds, they may build up similar relationships to those cultivated by development officers - though of course alumni working at a company with no interest in the department's work will be unable to help.

Has Brown found itself in situations where companies have sought to negotiate research agreements involving unacceptable terms? '*Yes... they want us to do some research and basically give them control over the results, and we had to say no. A lot of of companies seem to be aware that you're going to say "no" and adopt slightly different policies*.'

Is it likely that growing financial problems may cause weaker institutions to modify their policies in such areas?

'I would say even stronger ones might, it's easy talking to you to take a holy position, but if someone waved a very large cheque in front of me I might reconsider. In my experience, though, companies don't wave cheques that large anyway - so probably it's not a situation that's ever actually going to occur.'

Is it possible that change could be forced on universities as radical as that undergone by corporations in recent years?

'If funding really dried up, what would that mean? It would mean less PhD students, it might mean that universities would have to teach more, it might mean that departments would shrink. Probably it's not going to mean anything like what happened to IBM - Brown University is not going to shrink by a half. If funding really dried up enormously, perhaps a science department go from sixteen to fourteen... money is a shade harder to get these days but it's still out there, my guess is that there is still as much out there, it's just that there are more people going after it.'

Some specific sorts of funding, such as support for academics during the summer, are becoming much harder to find.

9.1.1.2 Maurice Herlihy - Computer Science Department

Interviewee: Maurice P. Herlihy
Job: Associate Professor (research in concurrency, etc.)
Organisation: Brown University
Interviewer: Tom Haigh
Date: Monday, 19th September 1994
Location: Brown University Department of Computer Science
Revision: 1

Maurice Herlihy is familiar with University/Industry interaction from both sides - having spent five years as a professor at Carnegie Mellon University before spending time at Digital. At Digital, support for academic research was primarily through grants of equipment - to support a research team in a university his organisation '*needed to come up with 5% of the book value*' of the equipment. The remainder was made up by a central subsidy - though as actual costs are secret the extent of the subsidy was unknown to the group, and tax-writeoffs are based on the book-value. '*By and large this wasn't considered very expensive*' - though it has now been cut severely. Groups supported in this way would be carrying out research relevant to that being carried out by his own group. Some engineering groups at DEC also made similar grants - '*perhaps more so because we were a research laboratory, so there was a presumption that we should be doing our own research.*'

Was there a bias towards in house research?

> *'It had to do with what people thought was interesting to do. If it was of strategic long-term importance then the in-house research laboratories would have the resources and time to work on it' - for example Multimedia. 'If you really think it's of strategic importance then you don't give a handful of workstations to an academic somewhere with high hopes. In some senses we felt we had our hands full doing internal technology transfer. The support for academic research was viewed as a long-shot that you don't put much money into, but it was somewhere where a little bit of money could have a big pay-off.'*

How distinct are different types of research activity? '*The perspective within industry is that a lot of what people in industry call research is actually more advanced development.*' This kind of production quality work is hard to do in a university, not least because of shortage of labour for such work. '*The National Science Foundation and so on have over the past few years had an increased emphasis on deliverables, which has had the effect of pushing research into a more applied area - it's hard to get funding for pure theory these days'* without at least a suggestion of an application. This increased emphasis on applied aspects of work has not primarily been a direct result of industrial research funding.

How fundamental are the changes produced?

> *'It is producing a real culture change in computer science, because for a long time computer science was going through this almost inflationary growth... now it's hard for students to get jobs when they graduate. [Academic] departments are full... and with the exceptions of companies like Microsoft and Intel everyone else is in deep trouble or heading that way very quickly.... Computer science is going to become much more like mathematics or electrical engineering.... so there's going to necessarily be a lot of readjustment and belt-tightening.'*

Has there previously been a stigma attached to industrial projects in academic circles?

> *'I think here, if you look at the parts of academic computer science that are most prosperous and happy, they tend to be things like hardware systems work, operating systems - the very applied engineering work with very little mathematical basis. Theoreticians, people who design languages and so on are very much viewed as poor relations. At Carnegie Mellon people used to go on about the "theory tax" as theoreticians didn't bring in enough money to support themselves... and I don't think there's any stigma attached to bringing in large amounts of money.'*

How will the changes in corporate culture and organisation alter the way in which they perceive the value of university links?

'Well it's always been a value for money thing - but the question is how can you evaluate this. In places like Digital and IBM there are two conflicting forces at work - one is a very strong pressure to contain costs in the short term, the other is the sincere realisation of top management that the only hope of these large companies of surviving is to discover these high-overhead applications and to be in that market before everyone else is. On the one hand research is expensive and hard to evaluate - but if you don't do research then basically you're going to end-up building washing machines. The profit margins on building PCs are so razor thin that you can't support a company of the size of Digital or IBM. Research is at least touted as being the best way to do this - whether it is or not is somewhat mysterious.'

Is there a simple distinction between basic (pure) research which universities can conduct, and applied research (development) which companies should undertake? Actually the situation is not this simple - '*Universities clearly cannot do serious development work, because they don't have the resources, but they can certainly do research in engineering areas - things that are not pure at all, you might produce a prototype of a system which isn't of production quality*.' For example, '*the people who made RISC famous were working primarily at Berkeley and a few other places in California*.'

Massive collaborative projects such as OSF have been attempted in the industry recently - can universities provide additional leverage of research funds? '*OSF1 is kind of a mixed bag.... I think it's still in some sense up in the air.... It looks promising but the jury is still out.... On the whole MCC doesn't seem to have been so impressive. US Memories seems to have worked out well.*'

'Companies like Digital and IBM are going to be increasingly concerned with survival. Companies like Microsoft do have research laboratories, but it's uncertain how much is genuine research and how much is advanced development.... Unless big companies find some way to make big money in a way that isn't going to be over-taken by the next generation of personal computer then research may end up being thrown out along with everything else in a desperate attempt to stay solvent so it's very hard to tell. People I know at IBM are getting a lot of pressure towards the applied and to justify themselves.... Research is such a high risk undertaking that nobody really understands how to make it work right - it's pretty much that people work and hope that they do something right. It's very hard to evaluate - you can retroactively point to things that went well and were successful, but the successful things don't always make money for the company who did it.'

'At Digital I wish I had a dollar for every meeting I had to sit through about technology transfer and evaluating the effectiveness of research. People come up with these theories - they claim that every researcher on average has to increase the revenues by some millions of dollars to be cost effective. One of the things which research can do is go around telling people that the company's going to make a big mistake. There are a couple of instances, for example, where Digital wanted to do something and researchers went around saying "you shouldn't do this, it's not a good idea"... but it's hard to say how much money you make by not doing something which would be disastrous'.

However, the situation may change. '*Prosperous companies will do research, and the more prosperous the company the more basic the research will become - and the less prosperous the tighter the constraints on the research will be. As far as effectiveness goes it's very hard to tell if a place where they don't ask tough questions produces better research than one where you have to account for every moment of your time*.'

Is it reasonable for researchers to expect industry to 'make up the gap' in government funding?

'I think that's naive - industry is not going to come to the rescue of academia. The places that have large research organisations have their hands full managing internal technology transfer among people whose salaries they pay and who they can fire if they're not happy with them - and so the likelihood of these people going to decide that it's better to talk to a bunch of independent minded, remote academics seems extremely remote.'

'Jim Morris, who was head of the department at Carnegie Mellon and used to be at Xerox PARC, claims that successful companies have always stolen their technology, and that Apple was a big success because they stole Xerox's technology - if they had developed it in house they would have had to take the good along with the bad and it never would have worked, but because they could ruthlessly select the good parts the Macintosh was a success. You might make an argument that successful, lean, companies aren't going to do research and it would make sense for them to hire out research the same way a lot of companies now hire out a lot of stuff that used to be done internally. It sounds sort of plausible - but I'm sceptical. I'm willing to believe that they will take successful ideas, I'm not so convinced that they're willing to actually pay to develop them in the first place.'

9.1.1.3 Bill Jackson - Brown Research Foundation

Interviewes: Bill Jackson, PhD
Job: President, Brown University Research Foundation
Organisation: Brown University
Interviewer: Tom Haigh
Date: Monday, 19th September 1994
Location: Brown University
Revision: 1

Brown University Research Foundation has a contract to manage the Intellectual Property of Brown University, including patents, copyrights and trade secrets. Brown has a separate office of 'Research Administration' which handles all external research contracts. '*I get involved in the negotiation of the terms of those contracts if it involves industry.*' Outright gifts are handled by a separate Development office, with which he is only involved when Intellectual Property rights are expected in return.

The technology licensing and sponsored research functions, although assigned to different offices, not wholly distinct - *'The licensing part often leads to a grant or contract.'*

> *'The philanthropic side can very often lead to the largest amounts of money available to a university, but they are the most difficult to obtain and somewhat difficult to keep going, and they tend to be in areas other than technology.'*

During the fiscal year ending June 30th 1994, they received $3,797,000 in 'corporations and industry support' - from total external research support $57,800,000. Of that $2,527,000 was to the medical sciences groups - much of it from major companies. $800,000 came from the New American Schools as part of the Coalition for Essential Schools programme, this money is not 'quid pro quo' in any direct sense.. Other grants went to chemistry, computer science, engineering and policy development. These figures include only cash payments, not gifts in kind.

> *'We try to avoid those, the in-kind stuff is a favoured trick of computer companies and electronic gizmos and so on, "We'll give you ten of our gizmos, which are worth $30,000 a piece and you'll do this or that", well we're not accepting those, because in fact what you wind up with is in fact a liability. One has to house them and feed them, so we generally don't like that and we're able to get what we want otherwise'.*

The *'most aggressive approach'*, which Brown followed with a technique which looked promising against Parkinson's disease, is to seek venture capital for a new company. '*We became an owner of a corporation, we have a licence agreement with the corporation in which the corporation has rights to the technology that we developed, and we have a research contract from that corporation back to Brown to do continuing research work in that general area*.' This is not considered as posing potential product liability problems, because *'the entire product development is being done by the company*' in which Brown is only a minority shareholder. The university's stock was worth over one million dollars when it was recently cashed in, and royalty payments will follow when products reach the market.

A blanket grant of rights to the results of sponsored research is usually avoided in favour of a *'first right of refusal to take an exclusive licence to any invention made during the course of the investigation'*. Sometimes pairs of linked arrangements are entered into, where a piece of existing technology is licensed along with a 'Research Support Agreement' to fund continuing research in the same area.

> *'What one has to be very careful about in that process is not ever to feel that the granting of a research contract to an investigator is a suitable substitute to payment for the intellectual property rights granted. That's why we like to keep them as separate agreements and negotiate them separately, otherwise you under collect.'*

What makes a technology licensable? *'It's normally fairly intuitive... you know it when you see it. Clearly it has to be an invention that could lead to a product that could be sold to customers for money, it also has to be something that might have a fairly broad market.... unless there's a clear and distinct advantage of new technology over old technology it's very hard to license*.' An invention might be a process or a product. 'The nature of the market might

play a large role', for example a technology involving a vaccine for a tropical disease is hard to license, and so may not be worth patenting. There is no specific checklist. A positive intuition can be tested via 'non-confidential conversations with potential licensees, which might involve calling up someone in one's network of potential contacts' and asking if any commercial interest for that product area is likely to exist. *'If we find that we're getting a reasonably positive response from a number of companies to this sort of initial test question then that would give us the courage to go forward with the expense of patenting something*.' Sometimes it is difficult to gain an informed opinion without giving away the nature of the invention, so sometimes an invention in a very promising area must be patented before this is risked.

What characteristics would a technology need to make it suitable for a spin-off company? '*The first thing that one has to be certain of is that it is a business, not a single product. So, for example, if one had a new compound that was useful in treating a particular disease it's unlikely that that would form the basis of starting a company - it's too narrow, it's not a technology, it's a thing*.' In contrast, a technique with multiple applications is a potential

> *'core technology' - a technology which can be used to support a number of different products... using the same basic technology.... The initiation can come either from the faculty member or from the university, in some cases you'll find that the university would find it attractive to put together a team to carry this forward, even if the faculty member is not interested, but you'd have a tougher test at the front end... you've got to be very certain that you've got something that's saleable to a venture capital firm.....'*
>
> *'On the other extreme you might have a group of faculty members who are very anxious to start a company, and they have a technology that under some circumstances might not represent a core technology, and under other circumstances might not be capable of supporting a corporate endeavour. If that's the case, you still may go forward because the knowledge of the faculty members who are coming forward and their participation in the development and start-up of the business may be sufficient to overcome the obstacle of narrowness of the invention, and they may make other developments as they go along which will ultimately constitute a set of core technologies, so sometimes you bend the rules.... In every case, one of the key elements to making anything happen is that there must be a champion, who will promote the cause and drive it forwards, and do all of the incredible number of things that are necessary to bring a company into being.'*

Would licence fees be required as cash? *'We've been happy to receive equity in some cases... if we feel that it's a company which would have considerable up-side potential, and that the company would be convertible to cash within some reasonable time-frame then we would consider such a trade-off*.' However, equity in a smaller scale company which never grows beyond a few million dollars or offers stock is *'not worth having, in my view, our objective is to generate cash....*' An alternative would be the spreading of cash licence payments over a period time, or a '*royalty structure with minimum payments*.' Most income is covered by the 'patent policy' and '*is divided between the university and the inventors. The first $100,000 is divided equally between the inventor and the inventor's department, and over $100,000 to $1 million the inventor receives 25% and the university 75%. Over £1 million 20% goes to the inventor and 80% to the university.*'

'One of the great frustrations of this whole process is that on the one hand the easiest technology to license is new, novel and useful medical technology... the medical industry in this country is quite happy to acquire technology from the universities... but you have an incredibly long wait to see any fruits of that....' To offset this, where possible, a drug would be licensed with a series of milestone payments corresponding to each step of the trials and approvals process. '*We do not want to burden the licensee with an obligation to make big payments unless and until it's proven that the stuff works.*'

Researchers have sometimes joined consortia involving other universities to seek funding for joint research projects. Research groups have also sought 'multiple industry support', for example the Laboratory for Man Machine Systems which has

'succeeded in bringing in industrial affiliates of one sort or another who sit on an advisory board and help define directions in which the laboratory may go in studying these problems. These are very hard to keep going at anywhere other than the largest, most technically oriented, leading edge institutions'.

'MIT in my view is unique in all the world... even Stanford doesn't hold a candle to MIT's leading position in many developing technologies. People there are willing to join their industrial liaison programme at a considerable price... and many, many, many companies are members of that affiliate programme, and they get nothing other than some glossy newsletters and the right to sit for a little time with faculty members when they come to campus and invitations to seminars which are put on specially for them, but there's no technology transfer other than discussions.'

What is the policy on consultancy and conflict of interest? Well, people do consult -

'it creates a dual interest situation, in which one must be very careful to avoid interests on the one hand which are in conflict with one's interests on the other hand. I would say that being vigilant monitors of and paying attention to that kind of thing is the simple price that you must pay for being a good citizen, it is my view that the simplistic approach of simply banning consultancy and doing research in your laboratory, or being a stock holder and doing work in you laboratory and doing work related to that company... I think that that's a mistake... Brown is willing to tolerate these dual interest situations and to put in place appropriate monitoring mechanisms to assure that there are no conflicts that actually do occur, but it is our view that this is conducive to good economic development in the region and good transfer of technology from university into the public sector, and we want it to happen, we want to encourage it.'

Full disclosure to colleagues and the head of department is expected, and so far *'no messy situations have developed*', although as a small institution they 'feel happy' with a less formal system.

'I think that American academics have come a long way from where they were in the 60s... the idea of collaborating with industry was not considered to be particularly attractive. I think that there's a much higher interest in that - for some it's a matter of tolerating it, for others it's a coveted position to be in.... I think there's been a shift, but there are still many people who do not want industrial support, they'd much rather be supported by a federal grant or contract.'

9.1.1.4 Steve Reiss - Computer Science Department

Interviewee: Steve Reiss
Job: Professor (programing environments research)
Organisation: Brown University, Dept. of Computer Science
Interviewer: Tom Haigh
Date: Monday 19th September 1994
Location: Brown University Department of Computer Science
Revision: 1

Steve Reiss does research into programming environments. One of his research projects, the FIELD environment, has seen considerable exploitation, with the ideas being used by HP in Softbench and Sun in Tooltalk. DEC said *'we're falling behind, we have to do something here'* and licensed their research code directly as the basis for their project. However, DEC were not willing to fund his own further development of the system - *'you'd think that they'd want to fund ongoing work as it's closely related to their stuff'*. The software is still being sold.

The agreement was negotiated with the help of the Brown University Research Foundation. *'It was the first time the University had really licensed software, so the university set up all the procedures based on this'*. Negotiations took around six months. He is adamant that the charge was for the code and not for the ideas behind it - *'we're not in the business of selling ideas'*. Although some of the concepts might have been patentable '*I'm not in that job, I'm not in that market. HP tried to get a patent on the message sever ideas - obviously because we had developed it first they tried to include us in it. We said "Well, you want it basically to charge Sun for ToolTalk - we're good friends with Sun these days, what's it worth to us to alienate Sun." It is possible that this idea was patentable, but I do the research, I don't worry about such things.*' Partly this is pragmatic because patenting would impact on his available time, but also '*I'm in the business of producing ideas... I'm very happy when people pick up on my ideas and use them. If I patent them then that's less likely to happen. It depends how you want to measure success...*'

Computing companies have had to cut back on their research budgets - '*probably even more than the Government has - I used to have funding from IBM, Digital, Sun - now I have funding from none of the above.... There are two ways of getting industrial funds - one is to promise to do something, the other is to get them interested enough to fund basically whatever you feel like doing...*' His own agreements has involved deliverables, but of the kind '*copies of our research papers, access to our software (because we give everyone else access to our software), we'll meet with you three or four times a year'* - there were no exclusive deliverables.

'*I keep trying for industrial money.'* One problem with trying to target work at the interests of companies would be when *'you commit to actually build something. I have no idea, as I'm in research, whether what I'm working on is ever going to work or not.*' If money was forthcoming it would probably be spent primarily on graduate students - details would depend on the level of funding. '*I tend to pool all my money - I say "I have all these grants, let the secretaries and or administrative staff worry about how I'm going to spend so much on this, I want to fund this student and this student and this student, find the money out of my pots as appropriate.*"

Grant proposals are time consuming. One factor is that an industrial grant proposal might be only one page, whilst a federal one would tend to be 20 or 30 pages. Response time is also important - currently federal grants are taking something like a year to be determined,

> *'they say six months, but normally it's nine moths until they get the reviews in, and another month until they make a funding decision, and another couple of months before you actually see the money.' ARPA can be 'a lot worse than that.... They say "Yes, we're going to fund this - let us figure out how". They don't fund directly - they go through channels - and they have to set up all the channels and everything else. Last time it took a year from them saying "Yeah, we're going to give you the money" until the money actually came to Brown, and it took them a year to say "We're going to actually give you the money"..... Companies aren't any worse than that, and sometimes they can be better and turn it around very quickly'.*

How does the future look?

'I see the government continuing to cut back, not that much because there is some knowledge of the need to continue funding education. I think funding will be available from the government, but not at the level which that we are comfortable with - at the level of supporting the faculty member and one grad student say. If you want more than that it gets a little trickier. Applied funding is there - if you want to work with the government on a specific problem or with industry - but if you don't want to do that then it's going to get harder and harder to get funding. If the computer industry gets out of the slump, it still doesn't look likely that they'll get back to the point where they were in the 80s when that had a lot of money to fund researchers.'

Does he support the argument that decentralised companies are more likely to look to outside bodies for their research?

'The companies that could afford to fund research were the bigger companies. They could pool research money, and say "If we fund 20 projects and two of them pay off then we get our money back". Smaller companies can't afford to fund 20 projects, if they only fund one or two then they need more of them to pay off, they're going to fund fewer and more concrete research projects which have more direct benefits to them, and only if they have a direct bearing on what they're currently working on.'

Previously he had five graduate students, now there is enough funding only for one. More generally - the number of PhD students is down - '*as much due to lack of funding as it is to lack of jobs. The current market trend is that companies aren't hiring PhDs*'. Previously industry would hire something like four or five hundred from a total of seven or eight hundred of the graduates, now only around one hundred jobs exist. Except for exceptional candidates and those working in systems, the likely impossibility of finding work has acted as a deterrent to applications.

He says that there are different reasons why people work in a university rather than in a company. *'One is that we are doing things which aren't of interest to industry ..... In my case whilst I'm a systems person and what I'm doing is of interest to companies, the reason I'm here is because I like doing what I want to do. I like the freedom, and I'm going to stay here for that reason.*' He doesn't like giving pre-published papers to companies, but accepts that they may wish to protect their own trade secrets if they have supplied some of the material being worked on. '*They can't stop you because they don't want to research that you are doing to be public.*'

He does accept consultancy work. How specific is the expertise he is being hired for? '*I've had some very specific. DEC wanted me to consult on FIELD - I know the code intimately because I work with it. I've had people who just want me as a general systems consultant. I don't solicit work - I take what comes along*'. Interestingly, although the license to DEC on the FIELD system was with Brown, the follow up consultancy was a private agreement - this is a common pattern..

9.1.1.5 Andries van Dam - Computer Science Department

Interviewees: Andries van Dam
Job: L. Herbert Ballou University Professor. (head of Graphics research group)
Organisation: Brown University Dept. of Computer Science
Interviewer: Tom Haigh
Date: Monday, 19th September 1994
Location: Brown University
Revision: 1

The work of the graphics group is supported both by the governmental NSF and ARPA agencies and by industrial sources which currently include Autodesk, Sun Microsystems, Microsoft, a called called Tako and IBM. Digital, IBM and HP have all provided equipment - Digital used to sponsor with cash, but this has *'dried up recently*.' Although some research sponsorship takes the form of 'hands off' grants, much involves

> *'active collaborations where we work with people on joint problems, and they may put in a minor amount of time and we put in a major amount of time, but it's still a two-way communication - I thank that's the best; it's even better than research sponsorship because that way you really learn from the other party.'*

The group avoids proprietary '*work for hire'* - students must be able to work on the projects and their findings and ideas are placed in the public domain. The group itself negotiates its own contracts - their Office of Research Administration is '*not proactive - they're really competent bureaucrats who make sure that the paperwork is good and they deal with the terms and conditions...*' '*Basically I'm responsible for hustling the money - and that is generally true in American universities*.' These contracts are different from the kinds of contracts companies enter into between each other because they do not stipulate deliverables with particular characteristics or constraining time scales.

> *'The difference is between grant and contract - a grant is simply "here is a bunch of money, have fun, do something useful (and presumably publishable) with it" whereas a contract tends to have more boilerplate about what the problems are that are to be studied and to have language that makes it clear that the sponsor will learn something from the exercise.'*

Some companies sponsor the overall work of the group, whilst others are 'targeted towards a specific research project'.

> *'Over time I think companies are getting more specific about what they would like to see, even though they are not supposed to use terms like "deliverables"'. Our policy has been that any software which we produce any of our sponsors can get. In point of fact they typically don't because it's idiosyncratic university software, and what they're really interested in is the ideas, the algorithms. What we emphasise is idea transfer rather than specific software transfer.'*

The advantages to companies lies in the chance to gain more rapid access to new technologies and techniques.

> *'We have certainly over the past 25 years given things to companies that they were able to exploit commercially, but it's been relatively rare. It's been more likely that they've been able to leverage ideas (and, more importantly, well-educated students with project experience).'*

When approaching a sponsor, he would try to show

> *'that we have technology that could benefit them, either in the relatively near term or more likely in the long term - that we are investigating a research area that they are not themselves investigating which I believe can have pay off for them. Certainly there is never a philanthropy argument - philanthropy is dead, basically. In my particular case, just to make it very concrete, what I pitch is that 3D graphics is going to become very very big and it's going to augment, and at some point possibly replace, familiar 2D graphics and what we offer is experience and insight into how that's going to happen...'*

Have the recent levels of hype surrounding Virtual Reality influenced people's perceptions of this field?

'I would say that most people who know something are pretty sceptical of VR at this point, and it's easy to see that we are going to have a "VR winter" not unlike the "AI winter", a backlash, so I resisted getting into VR for quite a while. But I think we are now at a place where the technology is coming to be somewhat useable and one can do some fairly interesting experiments and I think that in the next five years we will in fact have an explosion of VR applications and we may even have some money-making ones - the technology is coming along extremely rapidly. And by the way, the UK is one of the leaders in this technology.'

Does he see a clear distinction between basic research and applied technology in this kind of area?

'I think in general the field is getting more applied, and I was part of a committee sponsored by the National Academy of Sciences National Research Council which produced a very controversial report called "Computing the Future: A Broader Agenda For Computer Science and Engineering." We advocated that computer scientists should be less inwardly directed and should reach out more and broaden the research agenda. Not get rid of basic research - not in the least - but think of basic research as being involved with other disciplines or even, God forbid, applications - which is something that computer scientists have disdained for a long time. I'm not in the least worried about whether computer science is a science or isn't a science or is an engineering discipline - any attempt to pigeonhole it is stupid.

van Dam sees consultancy as an important part of an academic's work. '*I consult for Microsoft - I'm on their technical advisory board.'* Multiple companies have spun-off from Brown in the Providence area, he consults for '*one in particular known as Cadre Technologies which is the leader in CASE tools.*' He also consults for Electronic Book Technologies which '*capitalises on research which we did here, interestingly enough, primarily in the seventies and eighties.*'

'I think it's very important and I've done it all my professional life. I started consulting when I was still a graduate student and I found it a very, very useful way of keeping anchored in reality - a source of problems and also a way of learning what the really important issues are. Plus there are a number of very smart people who you come into contact with through consulting who you wouldn't otherwise meet, it keeps you from getting in-bred.... It's also a way in which academics can afford to teach.'

In his work for Microsoft, sponsored rearch and consultancy

'kind of overlap, because some of the things that I'm consulting for them on are also topics that they are sponsoring as research, but that's not so common.... I think typically companies are looking to bring in a heavy-hitter from outside who has expertise in a particular area that they don't have in-house, or they use it to check the expertise that is in-house, but it's a way for them to get somebody on a temporary basis that they otherwise would have to hire and pay a lot of money to - temporary employment basically.'

His personal speciality has been *'the setting up and running of technical advisory boards... technology input and oversight into companies both large and small.'* Inevitably this implies a very high workload - typically seven days a week of which one is spent consulting.

'If you want weekends to yourself you don't have time to consult and still be a contributing academic - you're allowed a day a week for consulting but if you took it on a regular basis, it would destroy your research and publishing productivity... if you're going to do consultancy then basically it has to come out of your spare time'.

How does he see the future progressing?

'I'm certainly very, very keen to have colleagues everywhere get some industrial experience.... I think it's very good for faculty members to have industrial ties, both of the research sponsorship and preferably collaboration type and also of the consulting type. It broadens and enriches, gives you perspective and helps you see the world through non-academic lenses.... Both parties put something into the team - so instead of running "open loop" it's a little more "closed loop". The sponsor has the opportunity to offer advice and, in effect, consulting - so we find it very constructive, it makes us more focused and it does two way technology transfer - we get ideas from the sponsor and they ideas stuff back.'

Is it realistic to expect industry to shoulder an increasing proportion of the overall research bill in universities?

'I have had to work enormously hard to build up my base of industrial sponsors and keep that portfolio constantly changing as old sponsors drop-out in the process of cost-cutting, and must be replaced by new sponsors. It has been enormously disruptive of my time, and I think trying to make ends meet for a reasonably sized group today is almost a full time job for whoever takes on that responsibility. I think it's a way of surviving and it's something you've got to do - you've got to have a broad portfolio, you can't rely on either government or industry because they're both downsizing and you've got to change who your industrial partners are.... It's constantly looking for opportunities - to support a group with a research lab in it you really have to be very entrepreneurial. And all that time spent being an academic entrepreneur does interfere with research, publishing and other professional obligations. Senior faculty have trouble doing justice to all that they are responsible for, including working with their students. It is not a job for those who want a calm, "scholarly" life as the layman frequently pictures it.'

9.1.2 DAIMLER-BENZ

9.1.2.1 Gary DesGroseilliers- Daimler Benz Research & Technology

Interviewee: Gary DesGroseilliers
Job: Technology Liaison Manager
Organisation: Daimler-Benz Research and Technology, North America, Inc.
Interviewer: Tom Haigh
Date: Wednesday 21st Septemeber 1994
Location: MIT Industrial Liaison Program offices
Revision: 1

Gary DesGrosilliers was a graduate student at MIT and also received a degree in business administration from Stanford University, going on to work as part of the MIT Industrial Liaison Program for some years. The Daimler-Benz technology liaison office consists of two people, one German, and had then been in existence for about two years. Its purpose is '*to establish and maintain technical contacts in the US for the research and technology organisation of Daimler-Benz. We have contacts at universities, government laboratories and we have established contacts with other companies as well'* - a very general programme.

Daimler-Benz is a holding company, with four operating divisions. Mercedes-Benz, AEG Daimler Benz Industries, DASA and DEBIS - an information systems and services organisation. The holding company employs about 3,000 people - roughly half of them associated with the central research organisation. Their office is an arm of the Technology Strategy group and reports on a level *'a couple down from the top*' inside the research organisation. This group ' *co-ordinates the research activities of the holding company to be sure that our company is working in areas which are important to our operating divisions and to take advantage of synergies between the different operating divisions and to try and co-ordinate the research programme*'. Technology Liaison offices have also been established in Moscow and Tokyo to '*provide a window on technology throughout the more important parts of the developed world'*. As a European company, Daimler-Benz already has a good knowledge of European opportunities.

On a practical level, the office might '*respond to a request for specific information*'. For example, they might conduct a search to identify '*people, products and contacts at universities and companies that are of interest'*. They also manage ongoing relationships, such as those with MIT. 'We have a list of about ten universities which we consider key universities because of the importance of the academic research in fields that are of interest to us'. This interest is obviously scoped by commercial considerations to areas such as microelectronics, materials, electro-chemistry and so on. Contacts are maintained in different ways - '*MIT is the only university where we have a formal, established, contractual relationship.... The main reason that we have not entered into that kind of a relationship with other universities is that there are very few other universities which have the breadth and scope and importance of research that MIT has.'* Because their office is located in Massachusetts, they can maintain a higher level of contact and have regular meetings with MIT faculty, making the agreement good value.

> *'Another reason that we do not pay other universities for this kind of access is that it's not always necessary - most universities are relatively open places, and we can call a faculty member at any university in the US, and if they are working on a project that is of interest to Daimler-Benz, and if we have people who are working on that same subject then it is very easy to schedule a meeting and to have discussions with anyone at any university in the US....'*

Even at MIT faculty members would usually be willing to talk to a representative of any major company. '*The access that we gain through the ILP is really quite general - what we get is an hour or two of a person's time to discuss to discuss a general interest in a topic.'* Even though faculty members 'receive a small payment' from the ILP for taking part in meetings, their primary motivation is the chance it might lead to something more significant.

In this case, his office would have a role in follow-up. One programme they run involves the donation of $30,000 p/a to universities doing work of interest to them to sponsor graduate students. This programme is new and expanding - to perhaps 10 or 15 universities throughout the US by mid 1995. Contacts made through the liaison

programme can also result in 'visiting scientist' status for Daimler-Benz researchers - 'three or four' have come to MIT over the past two years. The TLO helps with or conducts negotiations, but '*often once the contact has been established it works more efficiently if the communication occurs directly from the faculty to the researcher at our company'* as far as technical information goes. They have an initial role to play in '*making sure that the parties understand each other*' - especially important in international collaborations.

What kinds of qualities would need to be apparent in a university to make them attractive as partners in a sponsored research arrangement? '*It's always the same things - people are always concerned about the proprietary rights and the licensing agreements, and exclusive access to the information....'*

The Technology Licensing Office at MIT is now working well -

> *'a few years ago that office was run by lawyers, and their main interest and activity was to protect the rights of MIT in any negotiation over a technology. The result of that was that they were so good about protecting it that MIT was never able to license anything or gain any advantage or know that the technology was being used.... They got rid of all the lawyers, the patenting process is something which is handled by outside attorneys now and that's not the major part of their activity - the major part is that when there's a technology that is worth commercialising is to find an outlet for that technology and to structure a deal that is favourable to both parties.... If a company is taking a technology from a university then they're making a major investment... it usually require a large investment of capital to commercialise it and if they're charged too much money or they're not given some kind of guarantee that they have at least a lead time... then they won't make the investment so it could be a very good technology but no-one will use it.'*

One faculty member who invented several important materials processes in the 1970s joked to him '*"the problem with my patents is that no-one ever uses them until the patent expires" and that's probably a result of the strategy of the TLO back in the 1970s'.*

How about the technology under consideration itself?

> *'It needs to offer a unique advantage to a commercial technical problem at a reasonable price.... Technology licensing is a good thing, and I think it needs to be considered, but I don't think it's the primary mechanism of technology transfer. I think the primary mechanism for technology transfer is direct contact between researchers in similar fields where they exchange information and know-how.... It's normally exchanged freely on the basis that it's of benefit to both parties. It doesn't cost anyone anything.... it's an informant network.'*

This is more important than the protective legal approach.

Since the early 1980s, there has been a substantial shift in the perception of university/industry relations. At that time

> *'most companies had large central research organisations and they were able to spend a portion of their budget as a goodwill gesture toward universities. A lot of the memberships of programs like this one at MIT were goodwill gestures on the part of the corporations. In many cases the payment came from the philanthropic side of the company. Around 1980 there was a legal ruling in the states.... that a company's philanthropic organisation could not make a donation to a university and receive a donation in return. This was considered a violation of the gift tax laws... All the memberships in this industrial liaison programme had to be converted from gifts to actual research co-operations paid for out of the research budgets of the companies.'*

During the same period, the trend towards corporate mergers reduced the number of member companies.

> *'There is another change that I would say has taken place over the last seven or eight years, and that is the stream-lining of companies' research organisations - they are relying more on external sources for basic and long term research, in some cases medium term research.'*

Hence, any programme '*has to have some real benefit for the company*'. In the case of Daimler-Benz, membership of the MIT ILP is paid for from a central research budget, '*we expect to receive a return on that investment -*

information about research which is beyond the scope of what we might be doing in our own research organisation. We use it as a mechanism for supplementing our own research.'

No company can today hope to do all its research and development internally.

> *'There's quite an active debate going on in most companies as to what is the proper balance of internal development to external development. I believe that some companies like Chrysler, no longer do any internal research - they rely on their suppliers to provide them with the technology that they need for implementation of their vehicles. That's a strategy that seems to be working, at least in the short term. It's a low price option - instead of having a research laboratory doing research you have a smaller number of people whose job is to reach out and access available technology in the public domain. In the long run that might be dangerous.... It's difficult for a person to be an expert in a subject merely by reading the papers and the research of other people in that subject. Sometimes the only way to be in a position to evaluate what is available externally is if you are trying to do some of the same things internally - and then you know what is difficult, you know where the road-blocks are and when you see someone who has achieved some results you are able to recognise that'.*

Does the impossibility of doing confidential research within universities limit the amount of research work which can be 'outsourced' to them?

> *'It's not as big a problem as you might think - universities will not only not do secret research, but they also tend not to do very much applied research. If they aren't doing very much applied research, it doesn't matter that the work which they are doing is not secret. There's a whole field of research, pre-competitive basic research, the idea I think is that universities should be doing pre-competitive, long-term, breakthrough kinds of research and companies then will access that for their own applications... what's important is how [companies] implement that research.'*

A big problem facing companies is thus *'how do you access technology and where does the value occur in the technology stream - and there are many examples where the technology was developed in the company, was wholly owned by the company, but they failed to generate any economic benefit*'. One local example is Raytheon's development of the microwave oven - by the time the commercial potential became clear they had left that market. In the computer industry the famous example is of course that of Xerox PARC and their string of breakthrough developments.

Are basic and applied research still clearly distinct in the kinds of areas Daimler-Benz works in? '*Even though there might be some examples where the distinction blurs, or the time difference between application and the basic technology shrinks so that it becomes harder to see the difference I think in many areas it is still possible to distinguish between a basic research activity and some kind of applied research activity*'.

The activities of Daimler-Benz are typical of those pursued by similar companies, but are perhaps more formalised. Daimler-Benz has a strategic research alliance with the United Technologies Corporation - '*the two companies have agreed that there are common interests in basic research, but not very much competition, even in areas where we have similar businesses we are operating in different markets, so there's not so much competition.*' Several strategic pre-competitive basic research projects are underway. '*It's a very formalised program which was negotiated at a very high level between the companies*'. Another example is the US Cooperation on Automotive Research - CAR between the three automotive companies on about a dozen research projects, made possible by revisions of anti-trust agreements in the mid 1980s. Until then, even meetings between competitors were forbidden. Very large scale research programmes have been undertaken in areas such as electric vehicle technology.

9.1.3 DARTMOUTH COLLEGE

9.1.3.1 Mark Woodward - Thayer School Development

Interviewee: Mark Woodward
Job: Assistant Director of Development for Corporate Relns.
Organisation: Thayer School of Engineering, Dartmouth Col.
Interviewer: Tom Haigh
Date: Thursday, 15th September 1994
Location: Thayer School of Engineering
Revision: 1

Dartmouth is a small, liberal arts college with a strong focus on undergraduate education. There are about 4,000 undergraduate students, joined by 1,200 graduate students mostly centred in specialised areas such as the business, engineering and medical schools. Engineering has existed at Dartmouth since 1871, and the Thayer school today offers an Engineering Science major which usually takes an additional year and is unusual in giving full engineering skills to students with a liberal arts background. Graduate programmes include M.Sc. and M.Eng. degrees and a doctoral programme in research or design. The Thayer School is financially independent from the college - overheads are shared and a tuition stipend exists but revenues are raised directly.

The Thayer School development office has responsibility for all development, sponsorship and industrial relations activity in the Thayer school, but also works together with the Foundation Relation office and the Grants and Contracts office which represent the entire college. '*It's a peculiar system'* reflecting the internal structure of the college - *'at Dartmouth we are schizophrenic about not knowing whether we are a college or a university*.' Both the Alumni and the administration are keen to avoid 'trying to turn into a mini-Harvard' but at the same time excellence must be sought in the activities which are undertaken.

> *'Development is a term which achieved currency, in this country anyway, over the last quarter century. It embraces fund raising and institutional planning in various proportions - the raising of money from all the sources from which a college raises money: alumni, foundations, corporations, the government... The planning of how that money gets raised and how it gets allocated when it is raised.... and, in industry especially, where are we going and what do we need to do in terms of physical plants development or expansion.... though in college it is used to mean primarily fund raising. It is a growth profession in the non-profit sector'.*

The Thayer School office employs three people in its development office. The director handles major gifts and oversees generally, Mark Woodward who handles foundation and corporate relations, and a third person who deals exclusively with the 'Annual Fund'. They work together very closely - '*we have the same databases, we talk, we know who's talking to whom about what, we give each other leads....*' so that someone initially approached as, for example, a member of the corporate advisory board might also be persuaded to contribute to the annual fund. '*This system - which to my way of thinking is how it should work everywhere - is hardly how it works anywhere. There are a lot of corporate and foundation relations people who are not considered to be integral with the development function in the same way that [we are], there are out there a lot of miscommunication and bad communication and just bad reporting relationships among the various sectors of development functions.... Everyone is envious of me when I talk about how we do things and I don't understand why other people don't*.'

'*Where you are going is the cream of the crop. When you get out into the second tier of colleges and universities, and then the third and fourth tiers, you will find that things go down-hill quite rapidly*'.

Corporate relations is '*considered a development function, though it isn't entirely, and the college has one of the most sophisticated development systems anywhere - our alumni relations and alumni fundraising offices are considered to be models by many places*.' The college has a '*gift recording system*' to allow follow-through and acknowledgement, and a computerised system exists to support '*stewardship - the term we give to the care and feeding of our donors*' in terms of regular progress reports on the results of donations.

'Corporate relations, as we practise it here, encompasses a little more than development - my function is not measured solely by bottom line, though that is a component of it. What I view my task as being is to encourage any and every kind of mutually beneficial relationship or interaction or transaction between the corporate sector and the institution..... It encompasses to a certain degree student placement and internships with companies (there is a separate officer who helps students get jobs, but I work with her quite considerably because I'm out there talking to companies), it involves establishing a relationship with an engineering or technology oriented company such that members of the company who would make good speakers to classes about their professions and the real world out there are encouraged to come here and be guest lecturers, establish relationships such that classes that might have an interest to go out to a facility can do so, the establishment of various advisory panels and boards to provide a window onto the real world for both students and faculty and we know we're teaching the right things that are going to be useful.'

These activities are integrated with activities such as fundraising, solicitation of gifts in kind and of equipment and the establishment of consultancy for faculty members and sponsorship for graduate students. '*It is the totality of what an industrial association with a school should be*' - though faculty obviously have their own contacts - '*I consider myself as much as anything a switchboard operator.... trying to match people together to see if anything comes out of it.*' The job also involves the writing of grant proposals, but little direct technology transfer or sponsored research - this is handled directly by faculty and the college Grants and Contracts office.

Mark Woodward runs the fairly recently organised Thayer School Corporate Advisor board - about 20 *'high level management people from various companies that have a relationship, or should have a relationship, with the Thayer School'*. Most, but not all are alumni, there are two meetings a year - one involving career advice for students, another including research presentations. They 'mix and mingle' with students, and subcommittees are working on curriculum matters, particularly the Masters of Engineering degree and a new 'structured internship programme'. Some are very keen, for example a division manager with Ford who is '*extraordinarily enthused about the kind of people we produce.... who has personally seen to the hiring in the last few years of five or six of our best students*' helped in a major grant of lab equipment and *'leaned on a supplier of CAD software to donate a considerable amount of their software*' and encouraged divisions to donate problems for students to solve. Looking after the board and 'selling' the idea to faculty is one of his major tasks. The importance of computer modelling and visual presentation of data has meant that considerable software and hardware resources must be obtained to work in the area, particularly if it is to be integrated into the curriculum. As a small school, they have to select areas for specialisation and attempt to keep up to date in them, and so grants - particularly of equipment - are crucial.

How extensive is industrial input into courses content? There is a body called ABET which grants 'Accredited Engineer' status to courses. '*Our curriculum is totally the responsibility of the faculty... however that doesn't stop us establishing boards that can give us advice.*' A board of overseers, who exercise 'a fierce independence' govern the school according the charter, although since its establishment was agreed the CAB has '*within certain broad confines'* been allowed to define its own role. *'The faculty hasn't needed a lot of convincing that the board should exist.... some of them feel a little bit of disdain or just benign neglect, but there hasn't been a great deal of resistance'*. For example, when the Masters of Engineering degree, involving business content and industrial relevance, was readdressed five years into its life advice was sought from the board, 'which had the effect of opening what might be a Pandora's box... and it is very busily doing so'. However, the advice has no 'force of law', but as many on the board have personal experience of earlier programmes at Dartmouth their views carry some conviction. The role of the board was agreed as to '*offer some curricular advice, provide periodic oversight updates.... help bring in corporations who might establish an internship program which might be integrated into the degree itself and might even raise money for it.'* He suggested that at larger engineering centres, programmes with industrial involvement would run more formally and on a much larger scale.

As a result of the changing climate following the end of the cold war, '*it is felt that a significant amount of government funding for research is going to be drying up over the next few years*'. Because of the role of Federal Government agencies such as the DOD and NSF in driving basic research in universities, this '*turning inward and contracting'* means that engineering is coming to be driven *'not by the defence and aerospace sectors, which it has been since World War II, but by corporate competitiveness issues, by perhaps health care, by perhaps national infra-structure (though this hasn't really happened yet) and that basic research in general and engineering in particular are going to be funded differently. The government has attempted to do some 'funny book-keeping' and keep the money flowing by means of Technology Transfer grants - which is a fancy way of saying we take money*

that we've allocated to the Defense Department for defense related things and use it to fund things that have less of a defence need and we'll call it technology training and retraining and transfer... the equivalent of winding down the war effort at the end of World War II and turning it into consumer products and things'.

'There is some sense that the money is going to dry up, and there is some hope that industry will pop in and help - it may be a forlorn hope. What we find here in this small school is that because our faculty are eminent at what they do they prefer to rely quite heavily on government funding, and because they are eminent, although the competition is fiercer for government funding they haven't seen much of a drop-off in it yet, so they haven't become convinced that they need to deal with industry more than they have done. The fact is that it's easier to get a couple of hundred thousand dollars from the government with a vague idea of where you're going with it and be set loose to follow your own agenda then it is to have a very specific contract with a company which has to be renewed every year, with time lines and checkpoints and the necessity of moving forward to a goal which that company wants over a specific period of time..... There are faculty members who enjoy that kind of challenge - that's what engineers do - but it's easy to be spoiled and over the year's we've been spoiled'. Hence is necessary to motivate faculty as well as companies '*and they are moving - slowly but surely. It's like pushing a glacier, but it's happening. At the last meeting the members of the board sat down with young faculty members and each side tried to explain to the other side what its concerns were and how it worked - which was an eye-opener for many people. Faculty asked some stupid questions and got some straight answers about what they could expect and not expect.... though there is one faculty member who is almost a wholly owned member of a medical products company.'*

'Engineering by definition is supposed to be applied, but a lot of the people we have are doing basic theoretical research that has dividends on the applied end, but where any given faculty member falls in relationship to that very fuzzy dividing line is peculiar.... There is probably, in terms of academic politics a little bit of uncertainty and friction between the computer engineering people and the computer scientist people up campus because that dividing line in computers is so hazy - what is engineering and what isn't?'

*'*Adaptability is a particular strength of Thayer, there are no departmental boundaries and specialisation is left as late as possible - reflecting the fact that '*in the real world engineers tend, ten or fifteen years out to be doing something totally different from what they started with*'. To this end a broad mix of faculty are required, '*encouraged to follow their muse wherever it takes them*' and to exchange ideas and work with faculty in other parts of the college. Funding such interdisciplinary projects has proved possible 'by hook or by crook'. Because of the small faculty '*everyone winds up teaching something which they didn't know anything about at some point during his career*'. Those faculty from an applied background have tended to have much closer links with industry.

What kinds of return were companies looking for? Increasingly they seek bottom line returns. '*Corporate philanthropy is a tradition in this country... it goes back to the Robber Barons... but back in the 80s there was a sea change in the way corporates viewed their missions. Some of it had to do with the business climate encouraged by the Reagan & Bush administrations... there was a reaction to what was viewed as softness, a too great a concern on the corporate level... toward things other than shareholders - which in one very large area of business theory is viewed as the only constituency a corporation should have a responsibility to.... There was a pulling back from a lot of the things which happened in the 1960s and 70s...the major mergers and acquisitions, the restructuring of companies, the assumption of debt equity and leveraged buy-outs - which had the effect of increasing share value not necessarily to the benefit of anyone but the shareholder.... There was a lot of downsizing, and the catch phrase has been 're-engineering' which is a polite way of saying cost cutting and increased productivity any way you can get it... so one end of that was a rethinking of what can we get out of corporate philanthropy, and it has become much more narrowly focused..... Some of them are geographical - let's focus our money on the region from which we draw our employees... some companies deliver homeless shelters and things like that... focusing on what they perceive as societal needs that they can help address and get good PR from - a major thing now is focusing away from universities and into kindergartens through grade 12 education.'*

'What gets dispersed to colleges is increasingly limited to specific grant and fellowship money to aid minorities or women... or specific research interests that have a specific relation to the corporate product and might provide some output to it. With gifts in kind, such as computing equipment, it is slightly different... but the big focus in the computer industry has been equipment gifts which will not only help certain research interests but will provide computer infrastructure within the institution.' Dartmouth has a 'most favoured buyer' relationship with Apple, putting them on 90% of desks, and the computer centre received gifts of mainframes and workstations from IBM

and scientific computing equipment from DEC over the years - and of course the idea of timesharing was pioneered at Dartmouth. DEC, HP and Sun have provided scientific computing equipment to the Thayer school.

'The general feeling... is that by providing outright gifts or steep academic discounts one establishes one's hardware product in an environment where people who are going to be future users and buyers of your equipment are going to be exposed to it, and will be predisposed to want to import it to their companies. We trade on that... I don't know if we're being disingenuous by so doing because the environment being what it is and workstations being outmoded every three to five years anyway, and the major players changing as people with new ideas come in, it's hard to know if five years down the time the people you're accepting equipment from will even be in business...' However, a company naturally bases its decisions on the assumption that it will survive.

As a small school with a good reputation, Dartmouth has a relative advantage in this field. However, with the re-engineering of 'human resources departments' they are '*more and more narrowing their focus, saying "Why don't we limit our recruiting to just a few campuses where we know we can get a large number of the people we need to fill the positions we have open*"' and fill their vacancies at a few schools. '*We have to convince them that the one or two people they will get here are really top flight people, who will be in management positions within a few years and among the best they will have - and because they are narrowly focused that's hard to us*.' They face a similar struggle in competing with larger institutions for equipment donations - '*you have to convince people on a company by company basis'.*

Some programmes are run with joint input from the CS department and the Tuck business school. '*The situation has waxed and waned over the years*'. The business school is one of the best in the US, and has achieved this by concentrating on its MBA. In contrast the Thayer school offers a much more diverse range of programmes, so it can be hard to integrate the elements of a joint programme - not least because the 'applicant pools have diverged', with business schools seeking people with several years business experience and engineers tending to go straight to further study after their first degree. The faculties, especially the Deans, of both schools need to be convinced the co-operation is mutually beneficial. Currently an M.E. degree is offered - including some specially designed courses from Tuck school faculty which are less detailed than the MBA courses. A Total Quality Management course designed for engineering students also proved popular with business students, *'so there's a level of collaboration, but not as great as I think we need'*. A building physically connecting the two schools was opened about 20 years ago, holding an engineering and business library with the intention of bringing the student bodies together - but there remains significant distance between the engineering and business students. '*There are right now a lot of hybrid courses - there is a trend towards what is called a techno MBA which is an MBA with some technology courses grafted on to it*.'

Is there a policy on consultancy? It happens, but is not closely supervised or monitored. For example one professor consults with nuclear power companies, and a number of small engineering companies have grown up in the region, partly around the college who sometimes hire faculty as consultants. The time allowed for consultancy is specified in their contracts. '*We like to promote it because it helps to develop contact between the school and outside corporations which may lead to other things*'. The potential for conflict of interest is recognised, especially with regard to technology transfer and the ownership of start-up companies, which 'they scrutinise very carefully' in the Grants and Contracts office. '*The college here tends to err on the side of being conservative and very careful about things'. 'Trying to determine what is whose property and who should be paid for it can be a very touchy thing*'.

What kinds of long term effects are the changing patterns of funding likely to have?

'It's hard to know - you'll find as many theories as there are people you speak with, because no one knows. It's been 'conventional wisdom' that government funding will dry up and that industry will assume a larger role, but it is not an apparent fact yet. Industry, and some other people who claim to speak with voices of authority, say it's not a slack that industry can pick up, and I'm not sure that they're wrong, but it's so hazy now. My guess is that the government will find ways to 'cook the books' so that sufficient money will go into basic research... from different directions than it has before although there will probably be less of it because they're dealing with major deficits and a rethinking of what government in this country should do. There are competitive issues... how to maintain whatever momentum we have in the technology development field.... I don't see industry research money drying up too much, philanthropy is achieving a steady state, but as the economy expands that may do so also. My best guess is that there will be more rather than less university/industry partnership - if only for economic reasons... the corporate downsizing trend and the trend to virtual corporations... would encourage going outside...'

'My sense here is that, of the small faculty we have, there are maybe a third who are quite willing to do industrial work, another third who couldn't care less and probably would be unwilling unless they absolutely had to and a third in the middle who are sitting on the fence but recognise that they may have to change. Some of that breakdown occurs along generational lines, with younger faculty members tending to be more openly working with industry than older ones. There is an element of non-tenured versus tenure, with people who are struggling to achieve tenure tending to be open to more ways to achieve it.... I don't know if those proportions are a nation-wide phenomenon, but it wouldn't surprise me if there was a similar breakdown at other institutions.'

'There is a very real concern that... there may be a shaking out of financially less strong institutions. Demographically the number of students is going down... the cost of higher education has far outstripped the inflation rate... the middle class... is increasingly strapped to afford higher education.... so it is likely that some universities will fall by the wayside.'

Uncertainty as to the future of industrial ties must be seen as part of the wider uncertainty as to the future shape of the educational system.

Would an increased reliance on sponsored research, technology transfer and consultancy change academic culture significantly?

'Probably not a lot, though... it would bring academics more in line with the real world and out of the Ivory tower... there would be more of a scramble for fewer dollars and it might increase productivity. I think you would wind up with less basic research being done, except as directly applied to a programme that one is working on.... More practical solutions... because what industry tends to sponsor are solutions rather than knowledge creation - but knowledge creation comes from going out for solutions.... My guess, from my limited perspective, is that on a school like this it will not have a significant impact....'

'With corporate philanthropy it's harder to tell - it depends on the individual corporate culture and corporate climate. I was at a conference six months ago at which a number of corporate foundation people gave talks.... it was amusing because each of them had their own priorities.... They all said "Our priorities are much more specific than they used to be" and they listed some. One of them - a large well known food processing company - from the examples given seemed to limit its philanthropy almost entirely to named public spaces and facilities that had absolutely no use to the university at all except as a gathering place for students. Maybe it means something to the company to have its name on courtyards and student lounges and gazebos and fountains, but I can't imagine what.... Many of us there laughed afterwards, because we thought "How does that help us at all?". It was an example of a corporate priority that had no match to an institutional priority what so ever.'

'One hopes that private foundations will pick up some of the slack... the question is as much now "who you know" and "what you know" and establishing a good, productive long term relationship with a company is in the minds of many development people.... To cast a narrower, deeper net, pick out a small number of companies (small can mean anywhere from a handful to fifty depending on the institution) and concentrate on establishing a very broad relationship with those companies that encompasses all the aspects of corporate philanthropy.'

'The general sense would be that industrial funding is less remunerative than government and is more results oriented, is unfortunately less long term focused. A corporation establishes its research budget on an annual basis and whether one's grant gets renewed or not each year depends on both the budget which comes from up top... and secondarily the results that you're getting - if you've met the checkpoints and have proved that you're moving things ahead in the direction that they want on their timetable then you're more likely to get funding... it means that people have to break up their projects into smaller attainable goals... it probably increases one's adrenalin levels.'

9.1.3.2 Peter Knox - Dartmoth College Development

Interviewes: Peter G. Knox, Jr.
Job: Associate Director, Foundation & Corporate Relations
Organisation: Dartmouth College
Interviewer: Tom Haigh
Date: Thursday, 15th September 1994
Location: Dartmouth College
Revision: 1

Many major projects are underway at Dartmouth, including a new psychology building, a new cancer radiotherapy building, a renovated library for special collections and a new computer building. '*There's a big focus throughout the entire campaign on the liberal arts aspect, which is probably the toughest kind of money to raise. Very difficult*'.

> *'It's really been a major shift over the last ten years or so. Whereas previously they would give unrestricted funds to colleges and universities in this country, because they just looked at education as a good thing and it was very wide open, now we find it's really a quid pro quo situation - they want some kind of payback and in most cases a direct payback, whether it's in the form of recruiting, or sponsored research as you just mentioned, or advertising - whatever they can get out of it. It makes it more difficult from a fundraising standpoint, but at the same time even at a small college like Dartmouth there is so much going on here that we are usually able to find some kind of match.'*

Has the move from traditional philanthropy towards an increasing targeting of corporate funding of universities and research come about as a change of strategy within particular branches of the company, or has the change resulted from one budget being slashed and another entirely separate function expanding?

> *'It's really a mixture of both I'd say.... Many companies, as you know, have their own private foundations set up, their own private by-laws and board of trustees, set up for the express reason of giving away philanthropic dollars. But then within the corporate structure itself there's often pockets of money that we can go towards, whether it comes out of an advertising or public relations budget, or out of a technical marketing budget, or from a technical area - that's where you get more involved in technical arrangements as opposed to the straight philanthropy. We're always looking for any pool of money, wherever we can get it, but the competition for those dollars is really fierce.'*

Given the mass layoffs and harsh economic conditions, being seen as major donors might even damage companies from a PR viewpoint. Money has been directed towards local communities, '*and we've seen a switch away from Higher Education and towards some of the more basic things like the social services - and it's a tough argument to make that Higher Education is more important than these starving people*'. One current programme, Prometheus (formerly CLIPP) teaches high school teachers computing and Internet skills - corporate giants and communications firms have been targeted *'It's probably going to be a very tough sell, frankly. Because we don't have a corporate base here... Ameritech would probably be more inclined to give their philanthropic dollars to organisations in Chicago as opposed to hand it over to Hampshire where they don't have a presence and don't need one*.' One problem is ensuring that new programmes will be viable when their initial funding expires - the Prometheus programme ran for ten years on a foundation grant which has now expired '*and we're scrambling for money to try and keep that programme running, and if we can't find it then it's going to disappear.... Somebody should have foreseen this a couple of years ago...*' One problem is that proposals might take nine or twelve months to be assessed.

Except for the professional schools, '*recruiting is probably a tough one for us*' since because of the geographic isolation and small size of the potential intake. A specialist office exists for student placement. Professional schools take *'the lion's share*' of sponsored research, because there is relatively little liberal arts research and it is less obviously relevant to corporate priorities.

How does Dartmouth compensate for these disadvantages?

'The quality of the education clearly is an advantage. Being part of the Ivy League there's a name recognition there.... it's already got a stamp of approval, if you will. That's probably the primary strength that we have to offer. We're also a leader at this point in curriculum revision and in revising the grade structure... But still, when you get in to trying to get a corporation to fund a history department or an English department it's virtually impossible.' Some language work has been successfully funded.

Does this mean that the more technical departments are effectively subsidising the liberal arts? To some extent possibly, but departments would expect to hold onto money which they raised and so such a process could only happen very indirectly. Programmes are reviewed periodically to see if they will continue - for example the 'Executive Education' programme was recently shut down because the shift away from corporate philanthropy had deprived it of its funding.

'Corporations, because of the financial pinch that they've found themselves in over the last three to five years, and the restructuring that they're gone through to become more competitive and more profitable, have cut back on those things and the executive education courses that colleges like Dartmouth would offer them, and realised that actually they can do it cheaper in-house, or they'll even in some cases hire a Dartmouth professor to go down and train their people, and that's cheaper than having fifteen of their people come up here for two weeks.'

Is there a potential danger that a department which becomes totally dependent on industrial funding might be locked too closely to the short term goals of that company?

'Absolutely, we have a situation here where companies are really facing a direct payback. We have a situation with one of the drug companies, where we were approaching them for a straight grant to fellowships for the medical school and the company basically said "Well that's great, but what do we get out of it? Now we want a direct payback". The proposal which we eventually put on the table... is a combination of them funding fellowships for our students but then we would also plan and produce a program where their employees could come through and get medical education.'

'Increasingly in this country, stockholders are taking a much more critical view of corporate philanthropy. They're basically saying "Look, I'm a stockholder, why are you giving away my profits, without even talking to me and getting my opinion on it.... You mentioned that there's more focus on the short term, I would definitely agree with that, and in a sense it's almost the nature of the beast, you know - make as much money as you possibly can. Organisations such as IBM, which was this country's largest corporate donor, when they ran into problems - a lot of which were probably because of that sort of short term almost myopic vision of things, and when the money was coming in great - but when it stopped they had to reinvent the entire corporation, and part of that re-inventing was slashing their contributions budget.'

'Even after the changes of the last ten years, it's absolutely astounding to me the amount of philanthropic money which is still there. New companies starting up all the time... there's just a phenomenal amount of money if you can tap into it. But having said that, there's whole industries too which have never been terribly philanthropic, the pharmaceutical industry is very tough and they tend to get more involved in sponsored research than in anything philanthropic.'

So, what potential does the changing pattern of funding have to alter the nature of universities? *'I think it will favour the more technical oriented universities, the engineering schools, there ought to be a good level of support for the business schools and the medical schools, but your general Liberal Arts college is going to run into trouble. Dartmouth is in an enviable position in that regard, in that we have something like $750 million in endowment, which for a school our size is quite good.*' His previous university had an endowment of only $40 million - and tuition cannot be increased further. '*They just won't be able to survive - I wouldn't be surprised if you started seeing over the next ten or twenty years a lot of these smaller schools either folding or merging.*'

Will Dartmouth's tradition reliance on reputation, alumni and contacts serve it as well in this climate?

'Absolutely, we rely a lot on alumni contacts in the corporations we deal with, it's the name of the game. Dartmouth being a very small school has an intensely loyal alumni base, it's really quite extraordinary.... Many of them are the heads of corporations or very high up. Even that doesn't guarantee that you'll get a gift... One of the things we have to constantly guard ourselves against is going in academic directions which are dictated by the dollars that come in. We have a vision here, and we can't allow ourselves to change that because there's more money over here in this pocket.'

'It's going to make it tougher, no question about that. There's a whole other issues, for years colleges and universities have been ratcheting up the cost of their tuition to the point where now they're really pricing themselves out of their traditional market.... A lot of families are dealing with that by saying "Well you're not going to be able to go to a private school, because we can't afford it....". It's a combination of that and the potential for a lot of cases in recent years of investigations into federally sponsored research, and they've found cases of real fraud on the part of universities... really gross misappropriation of the funds. The attitude from the general public is more one of suspicion than it used to be. "What guarantee do I have that if I give your organisation money that you aren't going to really misuse it?"'

'One of the primary aspects of the job is the use of keyly placed alumni, and it is very much a who-knows-who game. Ultimately, though it's a corporation giving to a college - and though those are two separate entities, it still comes down to people giving to people. It's the relationships that I establish, the relationships that the provost establishes, the deans establish, that they are then able to translate into actual funding support. A large part of successful programmes like Dartmouth's is a stability in the fundraising operation. Development, by its very nature... is a long, long term process - and a lot of smaller colleges and universities I don't think understand that, and they have extraordinary staff turnover over a five or ten year period... and that's just not conducive to developing relationships... it really does have a negative impact on fundraising.'

9.1.4 HARVARD

9.1.4.1 Donald Walker - Office for Technology and Trademark Licensing

Interviewee: Don Walker
Job: Technology Transfer Officer
Organisation: Office for Technology and Trademark Licensing
Interviewer: Tom Haigh
Date: Wednesday 21st September 1994
Location: Harvard University
Revision: 1

The Office for Technology and Trademark Licensing (OTTL) is staffed by three technology transfer professionals, a working director, and a half-dozen support staff. Walker has been assigned the technical fields of software and certain applied sciences. One of his colleagues handles chemistry and molecular biology and yet another colleague handles the biological sciences. *"We all do our [marketing] tasks quite differently-due simply to the difference in technology and the diverse nature of the markets being served."* In the broad field of physics, for example, when reviewing a new report of an invention and thinking about how he would market the technology, no single "road map" comes to mind. By contrast, he thinks that a colleague evaluating a discovery in, say, the molecular pharmacology field, may well have in mind a "short list" of industry companies that can be approached with licensing in mind. Inventors report their technologies "pretty much on a voluntary basis" and sometimes the office needs to engage in "outreach" to make sure that faculty are aware of their services.

Another role for OTTL is the licensing of Harvard insignia for use on various products, including coffee mugs, folders and clothing. (Boston was flooded with Harvard t-shirts during my visit.) Revenues from trademark licensing can fluctuate sharply with some universities, often tracking the success or failure of the college's athletic teams. If a national manufacturers can be convinced to produce authorized university-emblazoned sportswear, sizable royalties-around $25 million for the University of Michigan-can be reaped by the institution. Harvard takes in about $2.5 million yearly, and whilst this is not significant in light of Harvard's investment income from a nearly $6 billion endowment, "*the trademark [royalties] are important to us, among other things, because they are used to fund student scholarships*."

The university's technology licensing and insignia licensing functions have been grouped into a single office because they both involve the negotiation of intellectual property (IP) agreements. The overall role of the office is to serve as a centre of expertise in IP for the university. (A noticeable exception to this rule is the Harvard Medical School, which has its own Office of Technology Licensing and Industry-Sponsored Research (OTL). Even so, OTL's licensing activities are reviewed and approved by OTTL.). The functions of this latter office parallels that of OTTL, bringing in substantial license fees and royalties. As the name implies, this office handles sponsored research and technology licensing in an integrated fashion-not surprisingly, the world-class Medical School is responsible for a great many of Harvard's total invention disclosures each year.

Harvard does not have a central Industrial Liaison Office (ILO) programme such as that found at the Massachusetts Institute of Technology (MIT). Walker's opinion is that this is so because Harvard has not stressed the engineering sciences (the base of MIT's ILO constituency) for a number of years.

This university also has an Office for Sponsored Research (OSR) which handles all incoming grants-whether from foundations, government agencies or industry. They work closely with OTTL, which must review and approve the intellectual property terms in proposed grants or research agreements with industry. OTTL will, on request from OSR, negotiate with industry on the IP terms in these agreements.

Harvard's Development Office-tasked with the responsibility of seeking donations from alumni and other benefactors-is located in the same building, and the same storey, as OTTL. Yet contact between the two offices on marketing matters is rare. This may not be surprising since a supposed key marketing tool of the two entities (respective computerized data bases of companies, individual contacts, etc.) may be incompatible for each other's purposes.

Walker believes that most aspects of technology transfer, as currently practised at Harvard, are similar those employed by other institutions, "*although each university believes there are better ways to deal with the growing administrative burden attending technology transfer.*" One favorite, and apparently common, "solution" is the design of the computerized database mentioned earlier, one aspect of which would be the linking of potential licensees to newly reported licensable technology. This system, in addition, would also facilitate the necessary government reporting, patent expense tracking and royalty disbursement chores. Stanford University has developed a similar program. However, its effectiveness-if employed by other universities-might not be optimal.

One area where policy differs between institutions is the formation of start-up (often called spin-off) companies where university educators and researchers may have a close financial interest in the new firm. What is Harvard's current policy and experience there? There has been moderate activity with respect to helping launch start-ups, but Harvard's experience is certainly not as great as that of other universities, and nowhere close to MIT's. "*Financial risk issues aside, there's always the spectre of a real or perceived conflict of interest (COI) issue which arises in start-ups, where the involved faculty member's ongoing university research is the sole basis of the company's existence.*" Walker believes the best way to minimise the potential for COI is to market the new technology to a firm or venture capital group in which the inventor is a disinterested financial party. Failing that, one might license the invention to a firm in which the university researcher's financial interest is "not substantial." Just what this latter term means is subject to a great range of interpretations. There are, of course, problems whatever course is taken. If a technology is successfully licensed to an existing company but the inventor is not prepared to champion the technology and work closely with the company, either for personal or professional reasons, then the discovery may not flourish. "*My co-workers in this office, and the tech transfer people at the Medical School, are better qualified to comment on this COI-management question. Thankfully, in my stay here, I haven't had to deal much with it.*"

While OTTL does its part to monitor university conflict of interest situations involving technology licensing, the best watchdogs, believes Walker, are the various senior faculty and peer committees which review and act upon questionable professional faculty conduct. Walker feels that such bodies "*often don't have enough information to consider a case until the fire is well under way.*"

Faculty consulting is another area where COI situations could arise, but OTTL is "*not really in the picture on such matters. The faculty are expected to be self-monitoring. If asked, we can provide a sample consulting agreement.*" When a formal technology transfer agreement has been concluded, "*it's almost inevitable that the inventor will become a consultant to a licensee-and that's fine as long as the independence of their academic research is not compromised.*" Faculty are not allowed to use university facilities or time for their consultancy, or to steer the academic pursuits of their students towards the objectives of the industrial licensee.

At Harvard, software is licensed strictly "as is" with no support, maintenance or bug-fixes. It is quite likely that a company will seek consultancy from its author at some point.

One Harvard software program, out of many created at the university, has been granted a U.S. patent.

> *"Seeking patent protection for [scientific] software is rare at Harvard. I may have influenced that policy: I'm convinced that, with few exceptions, copyright protection is both timely and adequate, given the dynamics of the market. The sole patent I mentioned before has yet to be licensed. I'm sure that's a coincidence, but the fact isn't lost on me when I consider how to quickly make the technology available to the public."*

The exclusion of support and maintenance from software licenses is one area in which Walker "*will not yield.*" Improvements will be considered if they fall naturally within the direction of on-going research in the area and the research interests of those involved, but "*we cannot be a development house.*" (At the time of the interview, Walker described a situation wherein a licensee was arguing to reduce royalty payments on the grounds that support from Harvard had not been forthcoming. Aside from the fact that the language of the agreement clearly stipulated the "as is" condition of the program, Walker's counterpoint was that the fee and royalties the licensee had paid were perhaps only a tenth of what it would have cost them to develop the software on their own.)

The legal status of software which is derived from licensed material is problematic-the U.S. copyright laws suggest that the right to create derivatives remain with the original copyright holder and would have to be specifically granted to the licensee if they are to own the results of its commercialisation.

"That's a very hard issue to resolve... I am still looking for ways to measure the relative intellectual input to derivative works... simple examination of the code is clearly inadequate.... It's hard to know who "owns" what portion of a program after it's gone through multiple revisions."

Walker describes the threatened erosion of the U.S. Bayh-Dole Act as an ongoing concern of his office and of its director, Joyce Brinton. She is president-elect (1995) of the professional association which serves university technology transfer professionals, serves on several other national-level collegiate committees, and has helped draft material for presentation to congressional staffs. Brinton is "quite vocal" in discussing with government the new programmes for technology transfer which

"curiously, leave the intellectual property ownership with the industrial partner rather than the university. That is difficult for us to grasp because the rules with which the university operates are different from those of industry, particularly the issue of confidentiality. Universities need, and must reserve, the right to publish freely."

Another current issue for Harvard is *"the University's acceptance of equity in licensee companies in lieu of (or in addition to) license fees and royalties .... In the past, the conservative nature of Harvard led to policies which avoided that kind of involvement for fear of compromising its academic principles for financial gain.*" Derek Bok, Harvard's former president, felt this very strongly-but under new university leadership "*we're moving towards a point where greater university ownership is possible*" with regard to start-up licensees.

Inter-university agreements can be another problematic area. "*Frequently, institutional partners which jointly own a piece of intellectual property cannot agree among themselves how best to license the technology, pay the patent prosecution costs, and share royalties. And, with the movement of faculty inventors from one institution to another, the ownership and royalty sharing rules become quite complex.*" Policies laid down by different federal agencies or foundations which have funded the research can also add to the mess. Differentiation of the ownership of software derivative works, according to Walker, can be particularly vexing.

As previously mentioned, sponsored research agreements are handled by a separate office, OSR, although they work closely with OTTL on intellectual property clauses. Often, such agreements include some kind of priority access or option to license the results of the research; few companies are willing to make outright grants without some condition of having a look at the researcher's results, *"but there are no guarantees ... that by funding the research they automatically become licensees.*" There are some companies that hope to, right from the beginning,

"establish licensing terms as conditions which are buried in the grant document; [Harvard] won't participate in that ... it is inappropriate to lock in and make captive the research activity of a university laboratory. The faculty could then become indentured researchers for the companies supplying the money ... the influence can become quite pervasive."

On a project lasting several years a company which saw work moving in a direction unlikely to benefit them commercially might seek to redirect it-occasionally by withholding money-but usually in more subtle ways.

What the company would get, in addition to a right of first option, would probably be a chance to read papers produced from the research before their competitors-though not before they are sent for publication.

"Many companies, in their proposals for industrial research, will require the researcher to submit the paper to the sponsor before they submit it for publication. That, of course, is not acceptable-not in my cases. Maybe others in the University would find that acceptable, but I don't."

One of the other benefits which companies see from such an agreement is the increased prestige gained from "*affiliation with the university and with a particular researcher.*" Given the high profile of many Harvard faculty, this can be a significant incentive. Interestingly, the Japanese "*take a long term view of it: they will often impress you with their long-range plans, as well as the size of their pocket books."*

Academic networking is a valuable source of contacts for potential agreements, and Harvard makes its alumni "*part of the family.*" "*But, I haven't found having an alumni champion inside the company for a technology license of very significant importance. It could be that the CEO is, in fact, an alumni and is more approachable, but business decisions are made on very rational grounds*." However, industry can tend to be more tuned to the

"*cult of personality*" and therefore, a world-renowned principal investigator is a major asset when seeking research funding. Even so, a degree of "vision" is still required on the industrial side.

Firms are prohibited from capitalising on the Harvard name when promoting products based on licensed technology. For example, Harvard reserves the right to inspect material mentioning Harvard which is to be used in a national magazine. On the other hand, due recognition of their contribution is also expected-in the case of software this might be an acknowledgment message on the title screen.

Harvard benefits from the cluster of high technology companies in the Boston areas attracted by, or spun-off from the many universities, particularly MIT. "*Within a radius of twenty or thirty miles of this campus there are literally hundreds of firms that owe their existence to the universities in this area .... We have a huge talent pool of consultants available.*" Although MIT's departments, as a whole, can tend to overshadow Harvard's in many applied science areas, not least in terms of size, many Harvard faculty in these areas are very strong. This can mean more of a concentration in particular areas. Harvard's policy is to bring in the best available faculty, although this may mean that many bright, junior Harvard faculty may have to look elsewhere for tenure.

Walker agrees that many areas of computing are inherently applied, and can benefit from industrial contacts.

> *"You need a lot of feedback. In licensing you try and find the industry leader, because you feel that their direction is the most `real world' as well as most likely to result in revenues which lead to high royalties .... One of the benefits of licensing is that the faculty and the graduate students working on it get to go beyond the theoretical-they never loose sight of what it is that they are doing, they are doing basic research for educational purposes and they're going to write their theses about it-but all the more valuable that the thesis will be widely read and not just by academics, but by those who are in the field. It certainly doesn't hurt in applying for work to have on your resume that you have written something which is fairly widely accepted in the industry in which you are trying to find a job."*

How important are the revenues raised from licensing? Walker believes the main purpose of technology transfer at Harvard is to disseminate knowledge and ensure that university discoveries are promptly placed into public use.

> *"That's a very real, as well as idealistic, goal for this office. Although nobody [in the university's central administration] looks at our small group with a totally 'green eyeshade' viewpoint, they have been known to ask us to project what our royalty revenues will be next year.... It's my observation that universities themselves quietly note their relative technology transfer 'rank' among peer institutions. It's natural to compare which school had the most [invention disclosures], or had the highest royalty income-to-staffing ratios, and so forth. However, technology transfer professionals readily admit such comparisons are specious: The broad licensing of a single `hot technology' can make even the most inept office look productive. But, as a group, we need the 'comfort' of quantitative reckoning."*

Will the reorganisations of large corporations such as IBM and DEC alter the technology transfer landscape?

> *"I think that most of the best work done in applied computer science today has not been done in universities at all-it's being done by the large commercial organisations with well staffed research groups [such as] IBM, Digital, and Silicon Graphics .... The reason they've been able to do this is that their profits were, or are, large enough to support this. Furthermore, they are driven by competitiveness and anticipation of market changes. Universities seeking knowledge don't have the 'commercial hunger' seen in for-profit companies."*

Walker has seen "the pendulum swing three or four cycles over the last twenty-five years" with regard to industrial attitudes towards research. Policies change and new approaches are tried. At one time aerospace companies such as Raytheon Company and TRW used to sharpen the wits of its research people by posing the same design problem to two groups, one significantly larger (and better funded) than the other, to gain the benefit of different approaches. (It is reported that Apple Computer has used this same internal competitive style.)

One trend on the university side has been towards the re-labeling and restructuring of group activities into "centres" and "institutes." For example, Walker mentioned Harvard's Center for Textile and Apparel Research. These initiatives represent a re-focusing of university talent to allow its application to national economic needs-while steadfastly maintaining the university's academic research goals.

How does Walker see the situation developing in the future? First, reduced federal funding of research at institutions of higher education forces universities to consider alternate sources of revenues. Walker believes that economic necessity may cause some universities (but, certainly not Harvard) to re-examine their "freedom to publish" policies with the possibility of imposing limited confidentiality on results of industrially-sponsoredresearch.

Second, there is a real possibility that, under certain circumstances, universities may loose permission to take title to certain future federally-funded research discoveries. Walker concludes,

> *"In recent years the creation of a new `advanced technology program' by federal agencies effectively counter key provisions of the [Bayh-Dole Act]. There is also another 'technology reinvestment program' which, while not precluding university ownership of intellectual property, nonetheless places control of the research in the hands of the for-profit partner, and places the university in a disadvantageous negotiating position. And, there is draft legislation being considered by the U.S. congress that would create a government-operated corporation to centralise and control all federally-related technology transfer-including, perhaps, university inventions."*

9.1.4.2 Peter Williams - Harvard Medical School

Interviewee: Peter Williams
Job: Senior Manager, Licensing & Business Development
Organisation: Harvard Medical School - Office of Technology
Licensing and Industry Sponsored Research
Interviewer: Tom Haigh
Date: Wednesday 21st Septemeber 1994
Location: Harvard Medical School
Revision: 1

Before coming to work at Harvard Medical School, Peter Williams had been involved in technology licensing at Newcastle University and so is well placed to comment on differences between approaches

'This office is the office of Technology Licensing AND Industry Sponsored Research. I would argue that [the cultivation of industrial research funds] is an important activity which should be handled by the licensing office because the targeting has got to be done in science and technology terms, so you're trying to match up an interesting piece of work with a company which has an interest in that field. They don't give broad brush funding anymore, so that's an essential activity - otherwise research which might be industrially funded will never see the light of day. What industry will want in return of course is intellectual property rights, so you should have a licensing office dealing with that'.

'There is a school of thought that says that if you have any contact with industry then that should be handled in one office and that office has one label that anyone in industry can recognise, and you tell industry "Within this office we do the following things: technology licensing, sponsored research...". I can see arguments on both sides. I think a lot of that issue is about 'outreach' as we call it here - what label do you put on it, how do you get in understood'.

A sucessful overall programme of industrial interaction requires certain capabilities, however these are packaged.

'What Bayh-Dole does is give universities title in inventions that come out of government funded research. It's not quite as simple as that because we have to elect title - title is not automatically invested, unlike the UK where you can be passive and comfortable that if SERC or MRC has funded the work in your institute then you automatically have the rights. Under the public laws we have to notify the government that we wish to retain title in a specific invention.'

The government has 'march in rights' to inventions which are not being properly handled.

'There's quite a lot of reporting required to the government - if you talk to any tech transfer office they will tell you that they have one or two people doing this as almost a full time job.'

'There's a body that lobbies Capitol Hill on behalf of the non-profits, the Committee on Government Relations - COGR. These are still very much live issues. An awful lot of time and effort is put into this.... An important piece of this is that there are congressmen who are very concerned at the relationship between non-profits and industry with respect to intellectual property rights and whether US industry is actually getting a fair crack of the whip.'

Congressman Whyden has been very vocal in examining specific industry deals and questioning whether the current framework is appropriate. The Department of Commerce is also involved in this area.

With regard to the patenting of software, it is not under current law possible to patent software in isolation. However, as an essential component of a larger system - such as a point of sale retail system or a genetic mapping technique it can be patented. An advantage of this is that '*the coverage you get is very good - it means that if somebody comes along with a system including software that does pretty much the same thing you can enforce your monopoly*.' Patentability requires industrial utility for the larger system and so is a complex and specialised activity.

Does the lack of a local base in most high-tech industries handicap the efforts of British universities?

'To the extent to which research in Britain continues to be four or five star rated, I think that the infrastructure argument is of secondary importance because it is a world market, and people in tech transfer offices in the UK are going to be speaking to as many American, German and Japanese companies as they are UK companies. Overseas companies are willing to invest.... if the science is good then the UK can sell it.'

'I think the government in the UK is paying attention to what the universities are doing, which universities have been successful in getting licenses and sponsored research for the job.... There are rumblings that if a university isn't too successful in it's tech transfer programme, maybe the government won't allow it to go ahead for ever more taking all the rights'.

The question of 'What is technology transfer good for'? is another big issue. On the economic side, 'it allows small companies to get off the ground' *and specific funding to allow them to work with non-profits has been made available by the US and EU.'*

'There is another model for technology transfer emerging now in the UK. In the old model somebody in the administration would handle technology transfer, and that person probably had a hundred other things to do, so that was a very busy person. In the model emerging the university will set up a separate wholly owned subsidiary company that will undertake technology transfer - the people in that company will be working full time on technology transfer and in many cases it will mean that they are paid a living wage, they won't be tied to academic salaries. Sometimes those companies try and raise their own seed-corn venture capital funds. It's interesting that perhaps the universities doing this, following the US pattern by employing full time professionals, are in some ways more adventurous than some US universities. We have more of a free hand in deciding what is worth licensing to industry - if you like we're more commercially driven....

On both sides of the Atlantic you get institutions that patent anything and everything, and in my view this is flawed. Optimally you have to be selective, and admit that you are taking some risks. "Patent everything" is a risk minimization strategy that doesn't work - you spend so much money that it is difficult to show a return, and the managers dilute their efforts across a large number of cases with poor commercial value. The result shows up in poor performance ratios of income per employee, per patent filed, income to expense or non-re-imbursable patent expenses... but NOT in simple measures like number of patents filed or gross incomme. Performance is now a concern in both the UK and USA. We continue to file patents on 50% or less of inventions reported.

The British Technology Group (BTG) was the successor to the National Research and Development Council. At one time they would acquire rights to SRC and MRC funded research, and they were the clearing house for all inventions. Today universities can use BTG if they wish and the BTG is now privatised. *'There was a time when BTG could actually put up venture capital money, and I don't think they have that activity anymore - so really what BTG used to do is being done to a great extent now by the universities themselves.*' BTG has now closed its regional offices in the UK, though its presence in the US has expanded.

At Harvard formal declarations of interest are required. Most UK universities have less formal mechanisms. *'It's not an issue that the tech transfer office on its own can deal with.*

'Conflict of interest policy is, I think, very well managed in the US and is looked at in a very formal way. The policies are written and the investigators are made aware of them. Very often there might be a committee or an office that would consider specific cases of conflict of interest'.

Both government and private funding have similar objectives.

'They both want money to go to centres of excellence, and I think industry long ago gave up open-ended funding where they just said "Here's ten million dollars, that just goes in the lab, we don't care what comes out of it but if anything does we'd want to take a look at it". They want to give money to focused programmes where they have at least some idea what might come out of it. I think that because the government now has less money they have given up spreading the funding around thinly. They're more likely to say "this is a centre of excellence for particle physics so we're going to give them a larger slug of money for the lab".'

9.1.5 IBM - HOECKER & GREIS - HIGHER EDUCATION BUSINESS

Interviewees: B.M. Hoecker & Michael J. Greis
Jobs: Manager – Business Development/
Computing Research Specialist.
Organisation: IBM North America / IBM US
Interviewer: Tom Haigh
Date: Friday 23rd September 1994
Location: MIT Industrial Liaison Offices
Revision: 0 (No feedback obtained from interviewees)

As Business Development Manager, Bernie Hoecker formed part of a team with Michael Greis within IBM's newly organised *Higher Education* business. IBM had recently reorganised, but despite recent downsizing was still planned to employ around 200,000 people at the end of 1994. Internal organisation into divisions is now vertical by market - a fundamental restructuring prompted by the need for '*a new way to bring products to market'* and education is structured as a business sector in the same way as health, insurance or manufacturing.

The Higher Education (HE) business is grouped under the '*education businesses umbrella*', but '*we deemed it very important when we made this change that HE should be a separate industry within IBM*'. IBM has strengths to share with higher education, for example in the joint testing and development of software technologies under *'shared university research programme*'. Such partnerships complement the marketing, consultancy and support functions also delivered by the HE business to provide 'transparency' to customers whilst identifying and meeting their needs. '*To be successful we need to understand what goes on in a university*'. The general reorganisation of IBM was pushed for by those working in HE, and they were '*ahead of the pack*' when it came.

IBM looks at a university from several perspectives. One is that of a customer who will buy products and services. However, the university is also a talent pool who will come out of that university and work possibly for IBM or for one of our customers - they need to be impressed by the service IBM offers.

> *'We see a research partner. IBM Research's view [is that] our mission is to do world class science and be relevant to IBM's business..... We can no longer do all the research we need to do ourselves.... we just don't have the resources to. Doing a 64MB chip is a hell of a lot more expensive than doing a 4 MB chip or 1MB chip. [They] look Universities and say 'I have a talent pool, a pool of people doing quality research. I'd like to have them do research for me, and with me.'*

The nature of a collaborative research arrangement could range from a simple grant of money or equipment, to a mutually supportive joint project where *'we're not buying a piece of work*' - rather IBM is seeking to '*get the jump*' on others by working along with research teams.

Because universities are always at the 'cutting edge' of technology, they also have an important role to play as a test bed - technologies such as TCP/IP, scientific computing in general and UNIX would never have been industrialised without the support, testing and feedback they received in Universities.

Given the multi-faceted role of the university, how can IBM best organise to '*take advantage of this?*'. The job *'cuts across IBM research, IBM Manufacturing Development, Headquarters...*'. It is important that both sides work as partners and '*know what they are going to get out of it*'. Contacts '*on the ground*' maintain the business relationship, and oversee other aspects as well as they can.

Education in general is of interest to IBM, and in more general terms IBM's huge corporate philanthropy budget has been directed towards primary education. HE was traditionally looked for to solve national problems in the cold war - they can now work along with IBM to help improve the '8 through 12' educational system and benefit indirectly from this.

Confidentiality is a major issue in a collaborative research situation. *'Most companies don't go to universities and say "I want you to produce this confidential piece of work that only I will ever see" because that's just not practical*.' However university may be given confidential corporate information to work with - which is itself problematic. '*The last thing I want is having some guy who spends all his time surfing the Internet having my*

*information with no restrictions on i*t'. An arrangement acceptable to both sides can usually be found. '*What you get... is a role in how the research goes - you're helping to direct it and you're going to be the first to see the result*'. This produces an environment where researchers are happy *'doing what they want to do, but with interlock between what they do and what we need*'.

Companies 'just don't have the money' to give away large, open-ended lump sums anymore, and '*you look at the way the US government is heading, a lot of the programmes that support research are being much more tied to technology getting to the marketplace*'. Many government grants now demand a corporate partner, for example the Advanced Technology Programmes.

Links between IBM and university researchers are generally made professionally, through student relationships, publications, conferences and so on - rather than through a more formal grant application process. Research groups undertake the support of groups, in the shape of post-doctoral grants and so on, directly. IBM's new structure means that this kind of support is not undertaken with centralised corporate funds - *'the people who pay for it should be the ones who get the benefit*'.

However, initiatives such as the Shared University Research (SUR) programme involve the selection of a group of 'premier' institutions - each of which is allocated a designated campus representative and '*a large chunk of money to be used toward IBM equipment*'. Projects are jointly identified and submitted - the programme is now in its second year.

As hardware costs have dropped constantly, the most expensive part of a support agreement is the provision of a '*resource person to work with the university*' - essential if any hardware donated is to be used effectively. '*A lot of universities have discovered - they get a lot of free equipment from people, they end up with this huge mess that costs them more to maintain than they would have paid for it*' in terms of networking, software updates and training. '*Because you get something for free, it doesn't mean it doesn't cost anything.*'

When Brown decided to standardise their computer science department, '*they made themselves such a visible target that they got all the companies involved, including IBM to offer this incredible good deal.... You won, you got the rights to basically give your stuff, but it would be all over computer science at Brown.*' This route is proving increasing attractive to universities - especially given the need for a long term relationship with a (surviving) supplier to allow a smooth 'roll over' onto the next generation of technology. Universities are having to pay '*more and more*' of the true cost of their machines, as an increasingly competitive marketplace forces companies to recoup costs. '*We see a lot more in software and consultancy and the services, if we can do it right*'.

Will the new patterns of funding necessarily favour institutions which are already highly successful?

> *'You hit on a very interesting question... to some extent the quality which they represent will help them a lot, I think what they've had to do is be a lot more flexible and responsive than they have been. I think that most of the prestigious universities their attitude really, historically was, "We are here, you have to come to us and do business the way we want to do business" - which really isn't doing business, its kind of "you need to give us stuff and we'll give you the benefit of our wisdom". That doesn't work any more...'.*

As they learn mutuality then they will continue to be successful, but opportunities may exist for 'hungrier', institutions which say '*we understand that we're not the big name, but we've got some good people, and we help you so you can help us*'. However, only if more prestigious universities fail to exploit their opportunities will corporations turn in large numbers to research groups of lower perceived quality. They are becoming more willing *'to say "how can we work with you", rather than "what can we get from you"*'. Many of the problems faced by universities are analogous to those affecting industry itself.

What attributes would an institution need to attract a significant amount of industrial funding in the current climate? '*High quality research, and a reputation are probably the most important ... but after that would be willingness to work co-operatively'*. More specifically, in the field of object oriented technology, IBM works with universities in several ways to bring product to market - for example by approaching an elite university which produces graduates of proven quality and offering equipment to help teach new techniques in the classroom. Even if the graduates do not work for IBM, they will carry their experience of IBM technology into the marketplace. The advantages to universities of having access to state of the art technology is obvious. Universities increasingly want to produce people who will 'go out and have an impact'.

For this kind of project, IBM would seek out a university with strength in one of their own areas of research and development - such as ATM communications, virtual reality or VLSI.

IBM has a very diverse range of research interests, including engineering and computer science, materials science, chemistry, high energy physics and some areas of biology. As well as technological products, IBM also works to jointly develop '*teaching and learning techniques*' such as distance learning.

How does the value of IBM's overall contribution break down? Ten years ago, hardware was probably the most significant part of IBM's overall donation. '*When you're putting together a proposal, spending the time, I'm not sure that anyone adds up the total dollar value of the people involved in collaboration'.* Another general trend has been away from cash and more towards equipment, some grants involve a matching of donations - 1:1 if taken as cash, 3:1 if taken as equipment. Cash is still available for specific purposes - for example postdoctoral grants to support research teams. '*Everyone recognises that you can't do research just with equipment*'.

Because of the variety of different forms co-operation can take, and the different sources of funds, evaluation of results differs greatly. *'I think sometimes there isn't as much as anyone would like there to be...*', but as responsibility is now placed as locally as possible within IBM individual research teams will look for value in projects funded from their own budget. '*If they can't justify in their own mind why they spent that money, they won't do it again*'. More formalised programmes have their own reporting mechanisms.

So, will the trend towards 'virtual organisations' and 'outsourcing' change the research relationship? *'I think in general, overall, I wouldn't say it will change the way we do collaborative work*' - the research groups having already recognised the advantages on offer. Within IBM, the role of research continues to be respected - however in smaller companies with less of a tradition, it might be better 'to just have a small group who go out and find the technology'.

However, *'no one can afford any more to design their own chip*' and a complex web of 'strategic relationships' has grown up within the computer industry. 'They're kind of like mushrooms in the rain - some of them disappear after about a week' and over the long gestation period of a new technology companies can grow apart.

Software licensing is another '*extremely complicated*' area - '*some universities used to like to develop algorithms and code and put it out, but then they realised they had to support it*'. Increasingly they seek development partners. One approach is to develop an algorithm which will not be proprietary, but its developers will be in the best position to help a company develop it. '*Copyright law is very difficult*'.

'If you look at the history of computer science departments in this country, you'll see (and I'm sure somebody's written a paper on it) but they came out of different areas... in fact you'll see great difference in the personality of the department, depending on its ancestor. If it came out of Math it will have a more theoretical cast, if it came out of engineering it'll be more practical.'

How does technology transfer occur? As a *'marketing and relationships*' organisation, the HE business is a single point of contact. Just as they channel maintenance requests from customers, so they can direct others within IBM towards universities with potentially valuable technologies - although usually established research groups have their own relationships. Technology transfer officers cultivate their own corporate contacts, and where appropriate can direct faculty members towards interested companies.

How special is MIT? Michael Greis had worked with MIT for six years - '*very special, MIT has had a long history with IBM - some of it very contentious. They were two organisations that both believed at different times that they were at the top of their game, at the top of the world, pretty strongly believing that they knew what they were doing. I would say that, over time, it's kind of gone back and forward*', but a lot of strong relationships exist. On IBM's CEP - Campus Executive Programme - sixty six campuses have been allocated an IBM '*pretty top*' executive contact. The executive who works with MIT is the Senior Vice President of Technology and Research (top man in IBM research) who visits regularly. MIT's president is now a member of IBM's board, a pointer to further strengthening of the relationship, and the relationship also benefits from the number of MIT graduates working at IBM. Both IBM and MIT are *'struggling with this new world.*'

How about the specific 'Industrial Liaison Programs', exemplified by MIT's? For a company like IBM it is useful to provide another way of maintaining relationships, but *'for a smaller company it can be very beneficial for smaller companies that don' necessarily have the resources or the relationships, because these folks at the ILP can really help a company negotiate the MIT maze and find out where things are of interest*.' Would the approach work for anywhere apart from MIT? '*If you identify a very motivated, bright group of people to do it then I think other universities could do it, but I think the less visible and the less known they are the more they have to get out there, and they might need to be more flexible about what they ask from the companies.*' The best approach might be to identify corporations, work with them for a year on a trial basis and then ask them to help support the costs involved. '*Good seminars*' are invaluable, to '*show companies what they're getting*'.

Is IBM's world-wide HE strategy strongly co-ordinated? The HE organisation has a global structure, with sister organisations overseas, and obviously many of IBM's research centres are also overseas. A pan-European organisation to co-ordinate research co-operation is now in place. So would a British university find the lack of locally based research companies made it harder to attract industrial support? Conceptually not, but *'there are still companies that don't understand that research is international, may not be looking beyond the borders*' - although IBM's long established international base helps them here. The international migrations of top researchers helps to spread corporate relationships, as does the increased number of international collaborations between universities.

In conclusion, *'businesses will continue to evolve'* but no dramatic change is expected in IBM's relationship with universities - which overall is *'very good*'. Because corporations have to focus strongly their more limited resources, they are looking to '*better understand what they are getting*' - though a spectrum of different attitudes exist here. IBM is seeking to

> *'be as flexible as possible, because we haven't always been - we had a reputation for being very inflexible, which we are having some success at overcoming - trying to look at both sides. We want university benefit, but we also want them to realise that we need to benefit, and be able to say what that benefit is - for out stock holders and the people we work for. Universities are coming to realise this.'*

9.1.6 MIT

9.1.6.1 Alex Laats - Technology Licensing Office

Interviewee: Alex Laats
Job: Technology Licensing Officer
Organisation: MIT Technology Licensing Office
Interviewer: Tom Haigh
Date: Friday 23rd Septemeber 1994
Location: MIT Technology Licensing Office
Revision: 1

MIT has both an Office of Sponsored Programs and an Office of Technology Licensing, in addition to the Industrial Liaison Program which is also run separately. The OSP provides the mechanism whereby companies sponsor research at MIT, and the TLO serves to transfer MIT's intellectual properties to companies via license agreements. MIT owns the rights to industrially sponsored research, but the company typically has a 6 month period following the identification of patentable technologies to elect to license them - either exclusively or non-exclusively. If rights are not taken, the company can claim 25% of royalties which are eventually derived from licensing the technology elsewhere.

MIT typically retains the right to decide whether or not to file a patent application, with the TLO responsible for such decisions. If MIT does go forward with a patent application, then the sponsor will typically have six months to elect to take a license. As a practical matter, the TLO's decision to file a patent will often be based on a preliminary expression of interest from a sponsor. In cases where there is no sponsor, then the individual technology licensing officer will be faced with the decision of whether ' there is anyone else out there who is interested in it for other commercial purposes'.

> *'The real difficulty in terms of taking technologies and getting them from an embryonic stage to a product stage, and then from a product stage through a scale up to a large market is funding along each step of the process. Whether it be an industrial sponsor or the US government that is funding research here at MIT, MIT is not in the business of delivering products - its role tends to be more open-ended - taking the technology to a very embryonic stage'.*

The first stage is research - '*MIT all the way*', followed by development - generally also funded by the sponsor and carried out at MIT. However, the government rarely goes beyond these to the next stage - '*the creation of prototypes on a bench in the lab'*. Still more rarely will it fund trial manufacturing of a product. Industry by contrast, is usually much more interested in an idea if it can be presented in the form of a manufacturable prototype which they can then investigate the scaling up and marketing of. '*The problem is in the gap between R&D and the things that industry is interested in capitalising on*'. Sometimes the gap is bridged sufficiently by government to allow the production of a prototype, and the manufacturing can be outsourced - for example in the design of aeroplanes for the government, something which led to a new industry. A current example today at MIT is '*a supercomputing technology which can fit in a box the size of a PC and give you more power than a Cray super computer for mathematical operations, but cost a hundred times less*'. Because no such technology was available in industry, the government was willing to fund the development of the product - which will '*probably start a new industry*'. The government also funds some medical research to the product stage to satisfy its social responsibilities.

Laats stresses the central importance of this process of '*bridging the gap*' from R&D to products to successful technology transfer.

MIT is interesting here because of its historical mission - it has always been oriented towards 'problem solving' research, particularly manufacturing related and *'students and faculty have always been encouraged to have an entrepreneurial side*'. This is reflected in the acceptance of faculty holding equity in start-ups and consulting - '*many many companies*' with high net values have been founded around MIT, and graduates have gone abroad.

'Sponsored research is industry saying "we have a general problem - we think that we can sponsor additional research in the area that may ultimately help solve our problem"'. Universities cannot be expected to produce products as part of their normal work.

The TLO works '*when the results of sponsored research*' begin to become known. They are governed by contractual obligations which will have been laid down in the agreement reached with the OSP. Knowledge is sometimes shared between the TLO and OSR, for example, he currently has a number of pattern-recognition technologies and the contacts of the OSR would be very useful in marketing them. The ILP can be similarly helpful, although as the TLO has grown and become internally profitable it generates sufficient contacts and opportunities. Usually inventors will have their own contacts, and as time pressure is severe these are usually followed up in preference to searching for multiple potential licensees.

When negotiations are underway with a company which appears '*credible and has the where-with-all to take a technology to a certain level*' a particular field of use is defined for that licensee. Technologies are thus licensed as widely as possible, but the aim is to get the technology 'out' as soon as possible. All agreements contain 'due diligence' trip-wires and the performance of licensees is monitored to make sure that the commercialisation is proceeding - if these conditions are not met then the OTL can terminate the agreement.

Most inventors are realistic as to the worth of their inventions, and recognise that the market may be small or in the distant future. Perhaps a third to a half of his job is marketing - '*which means understanding the markets, trying to determine whether or not the technology will fit, whether someone out there is going to be interested in it*'.

A technology which has '*bridged the funding gap'* is often suitable for a start-up company, as no major '*leap of faith*' is needed here. This is balanced by the fact that a technology creating a number of distinct product opportunites is the most suitable basis for a company. For example, a technology offering a substantial performance improvement at a comparable or better cost to existing products and can be relatively easily brought to market is ideal for a start-up. If the inventor is entrepreneurially minded, then fundraising is likely to be successful as the financial risks involved seem reasonable. The super computer project mentioned previously has as its deliverable the basis of a commercially marketable product. In this case manufacturing can be outsourced, a clear market is identifiable and the product has price/performance superiority. Because of MIT's previous success, a group of venture capitalists has been cultivated who will meet inventors and *'are willing to come on board because it is MIT*' - at least to the extent of considering the proposal seriously without elaborate business plans having already been drawn up.

By the same token, technologies which are more embryonic are usually more suited to licensing to existing companies. The companies must have long term development cycles, and be prepared to invest in a technology which they are prepared to ensure will be saleable '*four or five years down the line*'. *'It's a low cost way for them to get valuable R&D ... $100,000 as a down payment license fee is cheap, considering that MIT has spent in any given case two, three, five years with a budget of millions of dollars developing the technology to that point*'. Not all technologies have a clear suitability for start-ups or existing companies - in many cases the entrepreneurial nature of the inventor is what will decide the matter.

Is the inventor ever wrong about the worth of their technology? Perhaps, but a lot of 'pooling' of industry contacts goes on to determine the marketability of a technology - as inventors are highly intelligent academics whose primary purpose is not *'to make a ton of money*' they will usually accept this.

How far does technical excellence go in assuring the success of a start-up?

> *'You need to have marketing and sales ... you need to be able to identify the markets which are attainable for the resources you have and obtain profitability at a quick enough rate that you can capitalise on other markets. Once you have shown that ability then you can raise sufficient equity capital to enter into other markets, but all of the key is marketing and sales - the technology has to make a good sales story but if you can't sell it ...'*

Another of MITs strengths is the 'MIT Enterprise Forum' - an organisation '*dedicated to starting new enterprises and helping new enterprises develop*'. They provide seminars and training to help provide marketing awareness to technical people. The TLO itself will help an entrepreneurial inventor by drafting their own summary of '*potential*

markets, what we think the performance improvements are, what we think we can establish as an intellectual property position and use this to identify potential investors.' These investors help the inventor set up a management team - usually including '*someone who is more sales and marketing oriented who can work with the technical inventor to take the product to market*'.

How clear is the distinction between basic research and technology? Is research in some areas, such as computer architecture, inevitably applied? Often it is blurred - for example an algorithm can be implemented as hardware or software. Software can be basic research, or - if in a finished or usable state - has '*already bridged the gap*'. '*It's something you can sell, and not only that - you can protect it with copyright so you don't necessarily even need to file a patent*'. Similarly in the bio-medical area the products of research - strains of viruses or animals - may have direct commercial value. Sometimes computer research in areas like architecture can '*be far ahead of current technology*' but most companies have shorter term horizons. Thus a company is unlikely to come looking to '*establish the standard for high speed computing in the year 2000 or 2005 - they're working on next year's chip*'. The focus is on year long, evolutionary projects. Because of the nature of the industry, a long term project to produce a technically superior product is of no use if the industry moves towards different standards on a year-to-year drift. For example, nobody would have designed the modern PC architecture in its current form if it had been derived from first principles with a long-term view, but it dominates the industry.

Universities license software 'as-is' - any further consultation on the software must be paid for. It is impossible to *'patent software as software - you have to patent software as a process or method'*. An algorithm is not patentable in itself, but the idea of the process which it conducts is. Like any other idea for a process, if the process performed by the algorithm is 'new, useful of non-obvious' then it can be patented. '*I think copyright protection is a viable system ... with all software someone else could develop it, but in business, as you know, if I have something and it would take them a month to develop it then that month is time, and that month is valued - there is some value to be obtained.'* Usually six months or a year would be a viable time-saved period to justify licensing, especially on software for a new platform. Hence, '*licensing software, even when it's not patentable, is a way of making money*.'

'*A lot of people who have developed software in the past have just thought that everyone should get it....*' so it is not universally protected. X-windows is MIT copyrighted and can be licensed, although it was not fully commercialised at MIT. '*Sometimes the value to a company is in preventing other people from making, using or selling*.' In that case only a patented invention is valuable. Sometimes '*an inventor who thinks they are broadly disseminating their invention by not patenting it and letting it go free to whoever wants it are actually producing the opposite result because they don't have any commercial engine to distribute it. Putting something on the Internet, for example - the Internet is so big and there's so much on it, only those few people who are really keyed up to exactly what they are looking for are going to find it. It's not going to be widely distributed*'. There are, of course, exceptions - such as the Mosaic programme, which in the absence of any alternative was very widely used and allowed its inventors to develop the idea commercially.

How important is the continuation of legal and government provisions, such as those of the Bayh-Dole act.

> *'The main thing about the Bayh-Dole act is that it provides incentives for researchers or educators to take what they develop and look for commercial applications and take equity in other companies. If you were to take away these incentives ... then the funding gap, I think, would get larger. The directors of this office have spoken to congress on many occasions about the issue of whether the current statutory provisions are appropriate - the act could be repealed and the whole thing go out of the window, but in the near future? I doubt it. The whole US government is working towards this technology transfer as a means to keep the US competitive.... [what technology transfer is doing is] taking all the technology that has been developed with government funds and turning it into jobs, the last thing the federal government would do at this stage is take away mechanisms which have been established to do that.'* This is particularly important in a climate of shrinking defence spending.

In patent law '*you can get a patent for anything if you make it narrow enough*'. The patenting of software is now better understood, and is possible if claims are well drafted. *'In my opinion the market will dictate real economic value - if you get a patent, fantastic, but if people in the market don't recognise its value then it has no value, and to try and enforce it unjustly is a real burden.*' A patent which is unreasonably broad can be challenged and invalidated on these grounds when an attempt is made to enforce it.

Could any university hope to set up a successful technology transfer programme? *'You need good people, because the resource in the technology transfer office is people who believe that technology transfer is the way to create jobs and to improve life, and it's a pretty direct correlation, who have contacts in industry, experience with business and who are dynamic enough to be able to market technologies. If you have those, and you have a resource of good research....'* His office benefits greatly from MITs reputation as a premier scientific and technological research institution, and with seven full time technology licensing officers '*you can get a great deal of technology out to the world*'.

Has the trend towards 'virtual corporations' and decentralisation within large organisations helped the acceptance of technology transfer within industry?

> *'Absolutely, the companies no longer think .... if they don't develop it internally then it's bad. Companies are recognising that with everything from legal work to menial work to R&D that they can piggy-back off R&D that is being funded by the government or they can cheaply, by funding MIT research, take advantage of all the MIT overhead and equipment and experience to take a technology and move it forwards.... companies will start to recognise that it's the same thing, by giving up a little bit of a big pie you have more than if you try to keep all of a small pie. That's the way to make money. Industry is looking to be flexible in its R&D and to capitalise on opportunities to collaborate, not only with universities but with other companies.'*

Was he less cynical than those who suggested smaller business units were likely to forgo long term planning and research altogether?

> *'I don't think those are contradictory, I think in fact that contracting out is the way that companies think that they can be flexible about getting what they need now... When I say they can come to universities and do the same thing, the OSP is more long-term, like a three year research programme to do X,Y or Z. What my office does is to look for companies that are interested in finding technologies today, taking those technologies and turning them into products. Even companies that are interested in licensing, it's short term - now in 1994 companies are planning their products for 1996 or 1997 and are looking for technologies that fit in with those plans'.*
>
> *'More than anything else, whether you really believe in it or whether you're cynical about it - it's more popular, it's the buzz. Licensing out is acceptable, it doesn't mean that you're weak - it means that you're nimble and competitive.... It's seen now as smart business. '*
>
> *'In Japan what's seen as conservative is the sharing of ideas ... and the very close alignments between various industries and technologies.... Sub-license to others, spread things around that way. I'm all in favour of it - it costs money but the idea is you make everyone better of, so although everyone is paying everyone else what you end up with is more than what you would have otherwise'.*

Will individuals become very rich? '*You don't become very rich off royalty payments....* [but in the future] *you get the ramp up. On our income graph, look at the difference where there's a cash-out. On a ten million cash-out, you've made a millionaire with an inventor where we take 15% off the top, and of the remainder one third goes to the inventor...*' When companies go public and equity is realised, very large sums result. A very successful license can also generate large sums in royalties. '*This is going to go up, not only because of all these new agreements being put in place here, but because of* [previous agreements] - *when these come to fruition with more being created there'll be a steady increase overall, but with blips*.' As yet in computers there have been no 'jackpots' when equity has become liquid. Often equity holdings are significantly diluted by the time they are realised.

So far many offices have derived a large portion of their income from a few isolated successes - for example the 'Gatorade' (check spelling) sports drink developed by the University of Florida. MIT has a more even distribution of revenue, but the potential for a hugely successful license is always there.

'I have a business plan on my desk for a technology where I'm seeking a 5% royalty, and the business plan calls for revenues $26 million in a couple of years. I'm making $1.3 million, and that's if the company doesn't take off. That's a lot of money - it's not Michael Gates of Microsoft, but 5% of sales for any good company could be huge. It [technology licensing at MIT] *has only been around in its current form since 1984 or so, a lot of the pay-offs are in the future'.*

How does he see the situation progressing in the future? For MIT specifically, the Lincoln Lab is run by MIT but is a government laboratory, primarily for federal defence projects.

'In the future that will either become more nimble, in terms of seeking industrial sponsorship, or it's going to die'. 'MIT will continue to be an education institution, and fund itself by endowment and from alumni contributions to the endowment and from student's tuitions. MIT will not have a hard time holding very solidly to its educational purpose; for nothing else if it varies from that purpose and brings in money then it has to pay taxes on that money.... I don't think you'll see MIT driven towards making money from sponsored research. I think sponsored research is developing more as a phenomenon driven on the side of industry - seeing this a chance to target research opportunities of the future.'

Does an increased emphasis on applied research necessarily work to the detriment of pure research?

'I'm an optimist... some of it will decrease, it could have a tendency to "corrupt" the academic environment - in a worst case scenario some people who are worried about the corruption could impose limitations, you cannot hold equity, you cannot consult'. However *'none of the sponsorship agreements today provide for the provision of any particular product or prototype or anything, it's just research in the area of, and I think there's pressures to continue that. I think that you've captured what the issues are and you know what the possibilities and the worst case scenarios are - and there are people like me who hope that those scenarios won't be realised.'*

9.1.6.2 John Leech - Industrial Liaison Programme

Interviewee: Dr John Leech
Job: Industrial Liaison Officer
Organisation: MIT Industrial Liaison Program
Interviewer: Tom Haigh
Date: Monday 29th August 1994
Location: MIT Industrial Liaison Program Offices
Revision: 1

The major function of MIT's Industrial Liaison Program (ILP) is *'to link the university to industry and to act as a partner with industry in research.*' The ILP was established in 1948 and was the first of its kind in the US - today it remains the largest and best established. Flows of ideas and expertise are not one-way, as the support for researchers provided from industry goes beyond the merely financial. Separate offices handle both sponsored research (the Office of Sponsored Research) and formalised technology transfer (the Technology Licensing Office). Since 1988 the ILP has been merged with the traditional Corporate Development function and is a part of the Office of Corporate Relations. The ILP runs a small office in Japan with a *'client base which is quite strong... we have had ties there for many years.'*

The programme enjoys widespread support among the faculty. Corporations come to the ILP which approaches faculty on their behalf, although occasionally the initiative comes from the faculty member seeking industrial contacts. *'There is an interpretative function, but the linking function is the one you really want to emphasise.*' In practical terms, this usually involves the direction of interested groups within the company towards faculty members working in relevant areas. When faculty make travel plans the ILP may suggest meetings with interested companies which could be incorporated into them.

The ILP also provides specialised information services, including a seminar series which is free of charge to member companies. In 1994 topics included 'Designing the 21st Century Organisation' and 'Global Communications Networks: Corporate Visions'. A monthly newsletter is distributed including details of ongoing research at MIT and outlining findings and new inventions.

Companies pay an annual fee, determined by their size and revenues, and over two hundred are currently members. The programme produces an internal surplus which is returned to MITs general revenues rather than being earmarked for particular industrially linked projects - although some 10% is returned to faculty members on a pro-rata basis in return for their participation in activities such as company visits.Further revenues are indirectly generated through sponsored research and other agreements coming about as a result of the contact. Consultancy agreements are another common outcome of industrial contact. Individuals keep fees for such work - the arrangement is purely private.

As far as industrially sponsored research goes the role of the ILP is secondary. '*The ILP is involved in research but it's not a full time occupation*' and specialists in the OSR can assist during detailed negotiations between faculty and potential sponsors. A project would normally be sponsored by a single source, although sometimes a consortium of several companies might support it. A company would receive a 'sponsored research contract' and would be looking for a 'direct return' on their investment. They would also have to reach an agreement with faculty over the publication of results - though a brief delay might be reasonable in the case of commercially sensitive details. The focus at MIT is not on applied research. Intellectual property rights would not be automatically granted to a sponsoring company, though they would 'receive some preferential treatment.'

Will an increased reliance on industrial funding lead to more emphasis on applied research? '*Yes, I think it will.*' This is not necessarily a bad thing, and in a climate of decreasing government funding there is little alternative. Rules forbidding on-campus applied research may be revised. Traditionally, one way that MIT has applied its research is through the creation of spin-off companies by faculty members and this will continue 'one year we actually started five companies.' A spun-off company could take advantage of MIT's facilities in the same way as any other, and the personal relationships of its members would probably be maintained. MIT also enjoys close relationships with many of the computer companies in the area, and forms part of the nucleus of resources which attract high technology firms to the area.

At the time of the interview 'this office is undergoing a series of changes' designed to improve the service provided to industry and to faculty members. Change had been underway for about a year - involving a re- evaluation of '*what we want to do and how we do it*'. The basic job remains the formation of links between faculty and industry but '*methods of communication*' and '*new structures to the relationship*' are under consideration. One example of recent change is the rethinking of the directory of MIT research activity, which is now structured by lab and research group: 'a list of the expertise of all our faculty at the Institute - we used to put out a book which listed all the research projects at the Institute'. The new volume is entitled ‘MIT Expertise’.

9.1.7 THE UNIVERSITY OF PENNSYLVANIA

9.1.7.1 Norman S. Badler - Center for Human Modelling and Simulation

Interviewee: Professor Norman Badler
Job: Director, Center for Human Modeling and Simulation
Organisation: University of Pennsylvania
Interviewer: Tom Haigh
Date: Thursday 8th September 1994
Location: University of Pennsylvania
Revision: 1

The centre has as its goal '*to do the best job that we can do in understanding humans and simulating them by computer'*. There are three more specific subdirections - '*human factors - how can we build a synthetic human which can be used as a subject in experimenting'*, for example in vehicle research, '*distributed interactive simulation*' - putting people into dynamic environments in real time and medical work which looks inside the body and builds functional model of its internal functioning.

Research of this kind has been going on at Penn since his arrival 1974. Around 1980 the growing volume graphics equipment was split between two labs and it *'became convenient to call ourselves the computer graphics research lab*'. The motivation to become a 'centre' came from the fact that '*increasingly the status of something called a laboratory inside a university is very informal*' and so to gain formal recognition status as a centre - between department, or an institute - between schools. 'Technically the Center for Human Modelling is a joint venture between the Computer Science, Computer Information Science and Bio-Engineering departments', though at the time of the interview the bio-engineers had not been fully brought in as the centre was founded only eight months previously.

> *'The advantage to being a centre is that you have this legal status and there's a director that is appointed.... there's a faculty committee - basically the faculty who are associated with the centre and there's an external advisory committee.... who provide external insights about what we're doing and its perception to a much wider degree than just academic'.*

When dealing with potential sponsors, the overall goal of the centre is remembered.

> *'It never hurts to say to them "These are our overall goals, and you can help us move toward them and along the way we will provide back to you the fruits of the labour and your investment.' The centre is fortunate in that its work has many applications, and to repay sponsors and satisfy their own 'engineering' instincts they are happy to 'turn these things into useful tools and deliver software to sponsors'.*

Is there a clear distinction between basic and applied research in this kind of area?

> *'It's very fuzzy here - because I think that very few of the students working on Ph.D.s believe that they're doing applied research - they all expect, and I believe for the most part that it's true, that each one of them is doing basic research in the sense that we don't know how to solve these problems. It just so happens that, as a by-product,when they do solve them frequently there is an application or code which actually works. Applied research has a slightly different flavour... we do see this from corporates - they outline a problem to us, "Can you help us solve that problem?" and usually the problem is fairly specific and instead of saying "Yes, I'll solve your problem" my preference is to say "I'd like you to fund us to help solve a slightly more general problem of which we hope some of that you really need to solve will be a special case".... I believe that strategy (though it might just be the area that we are working in) has paid off.... We've got a lot of interesting specific problems from sponsors but have built general solutions'.*

So, how far does this dictate the work carried out at the centre? Because the overall goal is so big, a lot of flexibility as to specific work naturally follows. A distinction can be made between the overall strategic goal of human simulation and the particular tactical research areas which are undertaken to move towards it. As so many of the latter are available to decide them with sponsors is reasonable.

'I think it's a mutual exchange of desires - we want to meet our goal and the sponsors want to meet their goal, and then we decide what we can both be happy with.... personally I like very much to know what people want - I don't necessarily need to promise them that but I like to know... people with money are like any other people, they want to be listened to, they don't want to be sold to.... it's not a push situation, it's a pull situation'.

Do they actively seek out corporations who might fund them, or is the process less directed and more passive? Usually they are approached by the companies since it is hard for them to have a sense of 'the internal directions of the company' whilst the work of the centre is more 'exposed' to those with an interest in the areas. With the government, a 'proposal' oriented approach is normal -'one of my main tasks in life is writing proposals', and these are more likely to be successful if slanted towards the approach of the particular governmental body.

All sponsors, even the NSF, attach money to particular projects and other sources tend to specify deliverables. How do companies evaluate the worth of what they receive?

'The answer to that question has changed over the last fifteen years. It used to be that government agencies wanted to know how many Ph.D.s you produced, how many publications, how fat is the final report that you submitted, and "Oh yes, is there any software that we might be able to try". Increasingly it's turned the other way around - most of our sponsors, not all, expect that they will be able to use, literally use, the software which we produce as part of a research project. It's not so important to some of them whether we generate Ph.D.s or write papers - though if we do they like the attribution..... We have found that these are good drivers .... to codify our ideas and research in a way we might not have done previously.'

Writing useful software can be a valuable education experience.

The university does not allow classified research, so even military funded research is public. There has not so far been problems with obtaining private funding for publicly published research - though so far only about 10% of funds come from private companies. So far this funding has been to provide features and enhancements from which '*everyone benefits, so there's no reason to suppress or delay publication. That too may change in the next few years when we start to get specific funding and they want to get product advantage. We'll worry about it when we get it.*'

How does a large organisation decide whether to perform particular research in-house or fund an external group? Companies with large research groups, such as Bell Labs or IBM may see an advantage from internal work because they own the results. Small and medium sized firms which lack large dedicated research teams are likely to see university research as being more attractive - '*we haven't got that much money off those firms for research, but we do get them for license fees for example.... so essentially they are buying into a research project without the investment... everyone benefits and there's no unknown there*'. Software is sold in its current state - enhancements can be purchased but the enhancement is then provided to all customers. *'Everyone leverages up everyone else... putting into a pot and getting back more than you put in.*'

In the long term 'we have serious concerns about how much we can actually do within the university - a good place where the system breaks is in software maintenance' which isn't really a job for students or even paid staff. With more than 50 installed sites, 'Jack' - their more important system - threatens to overwhelm their direct ability to support and some kind of transfer to a private company may be required.

The situation is changing constantly. For example, this year '*the problem has not been in the total amount of funding, which has been very generous, but in actually getting the money from the government*'. Money due in March had still not arrived by September - but students cannot be laid off during the interval. All funding is insecure and this is very hard to deal with. '*This country basically has trouble figuring out how it should make long-term investments in research. It's on an extremely short, volatile cycle right now which is very detrimental to progress.... I shouldn't have to worry about when my money is coming... it's very difficult to plan*'. The administrative load and stress which this imposes is itself detrimental to research. Fortunately the centre is large and diversely funded enough - with about a dozen sources - to be able to hold back expenditure and transfer money internally - '*that strategy is the only thing that kept us going this summer, you feel wealthy if you have a zero bank account*'.

The centre is also fortunate in that even its military money, in a time of serious defence shrinkage, is coming from diverse sources - even within agencies.

> *'At the present time it looks like one of our major funders will not have research funding, but because of some very conservative planning we'll be able to survive if that's the case. Secondly a lot of our 'military' money is not actually 'research' money'*. Military funds can be earmarked as research, development or training and *' it turns out a lot of our money is from 'development' and some is even from the 'training' category which is not really the way it should be.... however if the government decided to cut back on basic research spending it would partia*lly impact but not devastate us.... *The groups that might have the worst time are those that are dedicated to one particular project with one agency, and if that agency's budget is cut then they're doomed. We do science as well as we can under the present circumstances.'*

Has the fashionability of graphics and VR helped?

> *'Well, it doesn't hurt to be in an area people hear about in the popular press, but I'm very careful not to mislead people and say either "virtual reality will solve your problems" or to come across as a virtual reality guru.... it goes back to an old adage "know thy user" and I simply want to learn about what the sponsor's ideas and expectations are.'* Realism and an honest dialogue are crucial*, 'the trouble with a buzz-word is you get characterised as doing that and then it's very hard to do what you want.... it drives sponsors crazy that they don't have a buzz-word for what we do.'*

9.1.7.2 Jeff Solash - Technology Transfer Center

Interviewee: Jeffry Solash, PhD
Job: Director, Center for Technology Transfer
Organisation: University of Pennsylvania
Interviewer: Tom Haigh
Date: Thursday 8th September 1994
Location: University of Pennsylvania
Revision: 0 (No feedback obtained from interviewees)

General Background:

Traditionally, universities have had very well developed corporate gift departments experienced in '*making the ask*' with a high rate of success. However, limits do exist on the amount which can be given by corporates. A number of factors have caused universities to examine other approaches over the last 15 years.

In the late 1970s a debate began on the ownership of intellectual property. Since the Second World War the US government had been by far the greatest funder of university research, but universities felt they had a right to profit from innovations resulting from their research. In late 1980 the Bayh-Dohl or 'Technology Transfer' Act gave rights from government sponsored research to universities. At the same time there had been a few spectacular successes such as the Cohen-Boyer patent held by Stanford and UC San Francisco which has been licensed hundreds of times and is now worth about $20 million per annum, a patent for a successful breed of strawberry and the patent for fluoride in toothpaste. There is no inherent limit to the amount of money which universities could theoretically derive from this source - for example Columbia University earns over $32 million per year solely from royalties, a sum which is rising rapidly and is being used to build new buildings.

Many businesses resent this, as they are now having to pay realistic sums for technologies which were formerly '*had for a song*'. *'There are still many who feel that way, that the role of universities is to educate people, and please don't try to invent as we, the corporate people, know all about inventing things - just send us the right people*'. Some have been lobbying for repeal of the Bayh-Dole act, but in his view they should view the availability of technology from universities as a cost-effective way of maintaining their competitive edge and bringing products to market.

Another incentive to the licensing of technology was in the way patent infringement cases were handled by the courts. At one time the most severe punishment likely was 'reasonable royalties.' Companies could therefore routinely infringe patents, and treat any damages eventually awarded as a part of normal costs. A ruling by CAFCE - the Court of Appeals for Federal Court - changed this, allowing the specialisation of appeals judges in the arcane and case based field of patent law. They have enforced the law far more rigorously, and some high profile cases have resulted such as one involving triple damages running to hundreds of millions of dollars awarded against Kodak. Judges are also willing to enforce injunctions on the sale of disputed products, making the production of goods which are known to infringe on patents a huge liability - *'all that money would essentially be flushed down the toilet bowl.*'

Despite all these advantages, there are potential pitfalls for universities engaged in technology transfer. A university would not involve itself directly in manufacturing itself, but any involvement in commercial agreements carries risks - '*you have potential infringement suit problems, and let's face it: if you are a licensee who is selling goods and making money, chances are there is someone else out there who will try and take their business away*'. Patent infringement suits are expensive both in terms of dollars expended and the time required from technology licensing professionals and the inventors themselves in dealing with them. In North Carolina a university has incurred more than $5 million from their royalty stream in direct legal costs, in addition to tying up the head of their office for two years doing almost nothing apart from managing the case and requiring the inventors to seek release from their faculty duties for the duration to handle the workload imposed. The latter represent a loss of skilled time an opportunities which is very hard to quantify. These kinds of potential costs can easily be overlooked when considering potential income from patents.

Cultural changes are also very important - '*the face of university research in the US is going to change forever*'. The post-war research apparatus has been very successful in terms of training, Nobel prize collection and so on, and represents a massive set of vested interests.

> *'An example, a lot of lip service is paid these days out of Washington to so called "interdisciplinary research". It's a total fabrication. Interdisciplinary research does not exist, it is not funded from federal sources. Why? If, for instance, you were a chemist interested in exploring the behaviour of peptide mimics, and you want to explore various clever chemical things like computer aided synthesis and assisting the compounds, and you wanted to collaborate with your medical school friends just to see how useful this stuff is in an interactive way, where would you send that proposal? If you sent it to the NSF, to which you had sent all your previous chemistry proposals, the National Science Foundation would come back and say "Gee, this looks like a medically related proposal. Dear Researcher, you should send this to the National Institutes of Health." You send it to the NIH, they say, "There's an awful lot of chemistry involved here, we think you should send it to the NSF because they handle chemistry." Because the reviewers at the principal basic research funding agencies are all pigeonholed in disciplines, there is no formal mechanism to evaluate an interdisciplinary research proposal.'*

'Increased corporate involvement, by necessity, will change the way people think about doing research and how it is conducted.' In corporations, interdisciplinary research is done all the time because it is necessary to bring a product to market.

> *'There is a prejudice against doing research that has practical implications in the US, at the major research universities. It's an interesting prejudice because on every grant application that goes in, you would not get funded if you told the truth and said "There is no way in hell that things are coming out of this research over the next five years that you're going to give me five million dollars to do, Mr Government (thank you very much) will have any practical aspects what so ever. I'm just doing it for the greater edification of learning, to enhance my reputation and to publish eighteen zillion papers per year. So instead they write all these happy words and wave their arms and make all these arguments as to the possible utility of the research when in fact they, if they were honest about it, there'd be a slim prayer of having anything useful come out. In fact when they review them, they themselves, because it's a closed community - the same people who write these grants review them - if it smacks of industry or is too utilitarian then it's downgraded, it's not as good as something which has less utility.'*

Industrially sponsored research requires a shift away from this attitude. At one extreme, it has always been legal for a researcher to submit a grant proposal of which every page is marked '*confidential and proprietary'* to avoid its public scrutiny under the Freedom of Information act. Legally, this may be crucial since such disclosure has been claimed as 'prior art' in patent law and might make patenting of resultant technology problematic. However, such a grant proposal would stand no chance of acceptance by traditional funding bodies such as the NIH and even by the DOD and Energy funding groups.

Today competition is 'cut-throat', with few new sources of government or foundation money, and for some industry is the only hope of funding. *'Here the rules are a little different and so, slowly but inexorably, things are changing. That's not so say that you can't still do high quality research, but now it's got to have a point to it*'. The graduate school system in America is the great strength of its educational system, and the culture of publication and discussion is deeply ingrained in academics. 'Publish or perish' may be replaced by the 'ears open and mouth shut' approach of industry. '*I predict that within the next ten years there will be major changes in the way that US graduate school culture is perpetuated*.'

> *'Until recently most academics had the concept that you watered the tree of basic research with dollars and the fruits of that tree would be inventions, and in much the same way that an apple falls from a tree, an invention would sort of fall (somehow), in rich fallow ground (somewhere) and spring forth into a new product'.*

This kind of process works much better if a more active approach is adopted, going out into the world to seek licensees and developers. However, there are also factors in corporate culture which have mitigated against technology transfer. If a company are offered a piece of technology, they will often send it through internal channels to an expert in R&D, together with a vague covering memo asking him to evaluate it. The natural reaction this causes is often one of suspicion and resentment, worry for his own job security and an instinctive rejection of the technology - '*Why don't you increase my funding instead*?'. A switch is required away from

thinking in terms of a 'Research and Development' department to a 'technology acquisition' department - *'the president of Technology Acquisition should be in the business of acquiring technology whether it comes from internal or external sources*'. This department also needs to be better integrated with sales and marketing efforts.

Work at Penn:

Penn has traditionally handled sponsored programmes through a different office. However, '*corporate sponsored research and patents and licences have become so intertwined that right now my office is handling most of the negotiation of corporate sponsored researched agreements*.' This is because sponsors want to know at an early stage the details of how technologies developed might be licensed - before they are actually discovered.

> *'Sponsored research has a real sharp point to it, and what I mean by that is that a company will come in, speak to a particular professor - because that professor has particular expertise in an area of interest - and enter into discussions with the professor to undertake certain set of experiments or body of work, they'll pay for that and if any inventions come from that they'll want rights.'*

The precise rights gained are not automatic - a company might seek the right to negotiate first, or a 'right of first refusal'. Penn is reluctant to grant the latter, and the exact field over which rights will be gained must be carefully defined.

Many universities have charters which specifically forbid 'purely applied' research. However, engineering research would generally be regarded as 'applied', and so what is looked for more is evidence of 'originality' or 'creativity' in research. The clinical studies of drugs undertaken by all medical school are unquestionably applied.

> *'It depends who is doing the defining, usually - and I know this may sound a little cynical - if a professor is employed by a company to do some research, he is apt to find that research basic or useful, and not apt to find it applied in that definition.'*

The responsibility of ensuring propriety rests with the department chair. In computer science rules tend to be very fuzzy in this area - one pragmatic measure might be 'can a graduate student get a thesis from it?'. The most important question today is 'is someone willing to pay for it?'

Most companies prefer to undertake actual product development themselves, rather than entrusting it to a university, so this provides an example of self regulation. For example, a biology professor received a large sum to develop an invention - the early stages of this were undertaken at the university but as the work progressed its nature changed and '*both he and his colleagues began to feel uncomfortable to allow the work to stay at Penn and he moved off campus*' on a leave of absence.

What is the procedure for technology licensing? Every piece of technology presented to them is evaluated to decide how best to protect and commercialise it. Some might best be licensed to existing companies, others used as the basis for start-ups. A problem here is that the faculty members presenting an invention usually do not have the temperament or mind-set to become chief executives of new companies, so the office can attempt to help them find business experts, accountants and venture capitalists to provide the services and expertise needed. They do not get involved in fund-raising for start-ups.

As new companies are '*almost universally cash poor, the only thing they've got to trade is stock*' when they license a technology. However, '*the university does not want to sit on the board of directors of these companies, and does not want to own anywhere close to a majority in them*'. The latter is chiefly inspired by the avoidance of product liability, insurance against which is almost impossible to get. For example, one company were paying $551,000 p/a for insurance against $3 million of liability - which given that the first case to settle against the manufacture of a similar product gave damages $7 million is insufficient. Tension is produced by the balancing of likely returns from stock, which will only be realised if the company goes public, against the risks involved.

In practice successful agreements usually come about as a result of informal networking by faculty and their students and the exploitation of corporate contacts. '*Your inventors are often the best sources of information as to who is really interested - though their field of view is limited'*. Generally an inventor will suggest a potential licensee, though they would usually welcome interest from other companies and an auction of the rights. To find other companies which might be interested several tools are available, targeted approaches such as library work

and consultations with business school students and 'seeds to the wind' approaches such as the listing of technologies in electronic databases such as 'Best North America' and 'Knowledge Express'. Technology licensing people themselves must network, via professional meetings and the development of personal contacts.

This kind of general promotion of sponsored research opportunities is less common. As with a piece of technology for licensing, it is likely that researches inside a company who were given a proposal to evaluate by their management would react in a hostile manner. Generally contacts are made directly between 'bench experts' within the company, and members of faculty and mutual interests are developed. For this reason there is little direct overlap between traditional donations and sponsored research - although charity donations are made with an idea of strategic interest they come from a fixed overall budget rather than that of a particular interested group. Whilst gratitude is expressed for sponsored research support, results of the research are *'discreet bits of technology*' and the company must pay the market rate for them - '*they'll try to connect it, when you get into licensing negotiation, but it fails*'.

When companies have been interested, strategy and negotiating positions must be established. *'Even there it pays to do your homework, and that is where I often depart from the company of a lot of my peers'*. A case must be made to the company in terms of business opportunity, in a business like way. Companies will have carefully analysed the business worth of the technology, done Net Present Value calculations, formulated marketing ideas and so on. Despite the great pressures of work on technology transfer officers, they need more than a 'vague idea' as to the possible worth of the technology or they will face *'a rather severe disadvantage.*' They have a responsibility, as guardians of the intellectual property, to have a good idea as to its worth - which is difficult and time consuming.

There are strict US government requirements, relating to conflict of interest. It is his view that if technology transfer is to be successful, with the attendant involvement of faculty with particular firms, potential conflicts of interest are inevitable - *'the question is how to manage a conflict of interest, not whether it exists*'. Some conflicts are so severe as to be unmanageable.

Industrially derived revenue currently is around 5 to 10% of the university's total revenue. Does this alter the direction of research undertaken? *'Yes, it may not be apparent at the moment, but it is unavoidable and as funding increases the effect will be compounded*.' This is not a cause for worry though - academic freedom has always been a chimera, with fashions in research dependent on the current direction of government funding. Faculty will remain free to do whatever they can find financial support for, '*nevertheless the tension will increase between traditional academic views of things and the corporate need to focus on end products*.'

Is industrial sponsorship of students and involvement in degree programmes common in the US? Gifts may be given to students, and types of work suggested by companies. The sponsorship of degree programmes varies from institution to institution, with places like MIT being far more sensitive than Penn to industrial needs. At the Penn business school, providing the only undergraduate programmes in the Ivy League, teaching is aligned closely with industrial need - as in the 'Management in Technology' programme which gives students degrees in both business and engineering. Most universities stick largely with traditional methods.

Different approaches do exist toward technology transfer. Some institutions might favour the use of ILP rights as a means of attracting sponsored research, others might view the establishment of a spin-off company as the generally preferred way of exploiting technology. Other institutions say '*To heck with small companies, 90% of them fail, they make all kinds of ridiculous demands, they give me stock, I don't care for stock, it's worthless - the best I can do is stick it on my wall and hope it goes with my colour scheme. I want cash up front, I'm going to license to big companies*'. Almost an infinite variety of approaches exist, and of course flexibility is required - no single approach is best for all types of technology.

> *'We try and evaluate the best place and spot for the technology.... Who's got the best philosophy? There are some early indications of the best mode if you're interested in maximising in licensing revenue, but in my view it's too early to draw any firm conclusions.'*

9.1.8 YALE

9.1.8.1 Nick Carriero - Computer Science Departmert

Interviewee: Nicholas Carriero, PhD
Job: Research Scientist
Organisation: Computer Science, Yale University
Interviewer: Tom Haigh
Date: Wednesday 14th September 1994
Location: Yale University
Revision: 1

Nicholas Carriero's work is in the design, implementation and use of parallel systems. He has been most closely associated with the 'Linda' project, a *'software system that creates the illusion of a shared memory resource*' for process communication. The group works on a range of 'follow-on' projects, one of which is 'adaptive parallelism'. This involves the harnessing of the largely idle processors in networked workstations by providing 'software resources' so that a large computation can be spread over the network to idle processors, which will be 'relinquished' when their primary users need them. This project is of great interest to '*virtually all large research centres*' with an investment in workstations.

> *'Typically any organisation, whether its a university or a government research lab or a commercial research lab, enjoys certain economies of scale from buying large numbers of pretty much the same kind of workstation and they have to pick workstations that more or less meet the peak demands of the few high-end users and so otherwise just aren't being used to their capacity.'*

Another area of research has been the 'packaging' of distributed computation so as to be invisible to the end-user. For example, information extraction from a continual data flow is crucial for a Wall Street dealer or an intensive care monitoring system - to provide an *'informed snapshot'* of the status of the world. This is most easily intellectually structured as a sequence of independent tasks, such as the 'cleaning' of raw data followed by various stages of filtering, analysis and high level trend analysis and diagnosis. It is thus natural to represent these tasks in terms of a hierarchical arrangement of 'boxes' with input and output streams. What is needed is a system which takes definitions of these boxes, prepared by a domain expert and *'figures out how to actually execute them on a bunch of machines so that as data pumps into the system answers pump out'* in real time. This specialised parallel model is called 'Trellis' due to its lattice structure.

FGP - 'Fetch, Generalise, Project' is a system which *'takes a lot of data records and treats them almost as diagnostic cases'*. A medical system might represent patient information as an n-tuple which forms a single point in a space. By examining the clustering of these points a possible diagnosis for a new case can be produced without the need to derive explicit rules. The technique has been applied to areas as diverse as the analysis of mammograms and folk dances; one obvious commercial use is the analysis of credit card transactions to organise marketing efforts around common buying patterns. This application is even further from explicit parallelism than Trellis, the user *'would be absolutely oblivious to any issue of parallelism'*. However parallelism 'underneath' allows the very heavy computational demands of the technique to be met.

> *'The trajectory of these projects is to start out with exclusive concern for parallel systems, build explicit parallel applications, and then begin to build software frameworks which rise higher and higher in the level of presentation to the end-user and hide away more and more of these details, but as they rise higher focus more and more narrowly on a particular style of application.'*

Are basic research, applied research and technology inseparable in this kind of work?

'From our point of view they are... there are people who pursue strongly conceptual research with no real concern for bridging that gap between the conceptually interesting problems and how they might be applied in any kind of practical domain. I have to say, though, that the field we chose to work in doesn't allow us that luxury - if you're working in parallel computing.... by and large most people working in the field are very concerned with the practical issues - how do I get things done faster? Once you come into that kind of field you don't just want to do things in the abstract, you want to see practical gains achieved from this practical concern. Much of what has driven parallel computing has been the demands of a bunch of different people in industry and in the government....'

The government's involvement was originally prompted, in the days of national labs with huge budgets, by the rate at which Crays were being consumed. '*They were just building the machines and shipping them down to the lab*' and would be saturated within a week. The demand for better ways of achieving very high performance led to a revival of interest in parallelism. As time has gone by, attention has shifted from these '*very exotic performance at any cost large scale machines*' aimed at ever larger problems towards industrial demand for machines to solve large problems in more cost-effective ways - making new applications of computing economically viable. Thus, instead of machines being designed with the aim of '*selling at least three to the national labs*' they are being aimed at corporates such as Boeing and sold on grounds of cost performance and economies of scale in their components.

Yale's research is an extreme example of this, which '*uncovered, as it were, parallel machines that people already owned, in the shape of their local area networks*'. '*For the cost of a software system they could realise performance improvements that were significant, and made a difference to their production cycle of computing*.' This is reflected in a shift in the group's interactions from basic work with massive government and industrial laboratories, such as AT&T Bell Labs, towards more applied work with corporate entities.

They now have a co-operative arrangement with a local software house for the distribution of their software with a local company who has '*opened the doors to a number of different environments*' - providing a point of contact with the financial, petroleum and microelectronics simulation communities and developing finished code for industrial use. '*This company for the most part is the one that takes on the responsibility of doing the serious, commercial grade research and development of the software*'. This arrangement is very beneficial, as the group aims to produce software '*which people will use*' but cannot practically aim to produce and support finished products itself. They have the flexibility to '*pursue interesting ideas, get the software to a point where we have a prototype that demonstrates feasibility'* and then transfer them for debugging, further implementation, porting, support and maintenance to the company. SBIR (Small Business Innovation Research Program) grants from the government are designed to support companies engaged in this kind of work. They are important because an idea which is too close to commercialisation to attract academic grants will require further work before saleable products are ready.

As far as he understood the terms of the agreement, Yale gained royalties on sales of the software and usage of the code produced. Ideas on the division of royalties are '*so much sifting sand over time'* but are currently paid to the university, which shares a portion with the department - some of which goes to the individual researcher. Royalties have not been a major motivating factor in the agreement - sales from the product meet the costs of commercialisation and continuing development, but Yale's own costs have already been funded by granting and do not need to be recouped.

Another advantage of the arrangement is that companies are '*less generally interested*' in funding general research and '*much more interested, both in their in-house research activities and in their dealings with others, in research projects for which there is not some mysterious leap of faith between that research project and something of practical interest to the company*'. If the company deals with another company, rather than directly with the university, they have the feeling that '*they are dealing with a serious organisation that knows and understands*' the way companies function, corporate culture and so forth. An external example is the transfer of the Mosaic software to a company for support and maintenance.

'*As a research institution you quickly begin to feel the pressures on your normal activities from dealing with software distribution and support in dealing with something that has become popular in the outside world*'. Most major departments have produced spin-offs of one kind or another. Another group at Yale set up a small company around the 'wavelets' compression technique, and historically a company called 'Cognitive Systems' was set up around AI researchers. Yale has an 'incubator site' in shape of their Science Park

'The ideas are there, the interest's there, the enthusiasm's there - the difficult part is the set of legal entanglements.... it's just a problem that the universities have got to come to terms with. In the recent past their model of the product of intellectual activity was the book... That model doesn't really apply any longer when you talk about pursuing interesting high-tech ideas.'

Different interests might be claimed by funding agencies, graduate students, universities and faculty members in the rights to inventions, and academic freedom must be preserved, but companies look for exclusive licences. So far the system has allowed a '*roll with the blows*' approach which has been workable in practice, but '*one would much prefer.... to know what the bottom looks like before you jump*'.

The group has a good working relationship with IBM, which supports the approach of cost effective, scalable systems with their SB/1 and SB/2 lines and switching technology. They provide Yale with hardware, equipment and joint study arrangements. This contrasts with their far less product oriented work a decade ago in conjunction with AT&T's basic researchers. From IBM's point of view, a major gain is '*creating the ability to demonstrate the technology to their customers*'.

'The focus has shifted dramatically from exploratory research to practical development, which from IBM's point of view allows them to say "Oh, you want to speed up your application? Well, let's try to work with Yale and we can talk with them...", and there's a much tighter relationship with business activities than we would have had with Bell Labs in the past.'

This development of example case studies allows a '*portfolio of technology demonstrations*' and data to be built up for IBM's use. This relationship is symbiotic, as Yale welcome the provision of equipment and real situations for their work. '*We don't just want to build parallel systems and let them sit and say "Well, we've done it so let's more on to something else". We want to use them, make sure they work, achieve a certain level of efficiency, understand where the weakness are and improve them - and in the course of doing that work we will naturally develop the kinds of case studies that IBM are interested in.*' This willingness to be involved with real '*industrial codes*' is a great strength of the group in its relations with industry. Yale provides '*reasonable access*' to IBM, its sales people and its potential customers - most demonstrations are internal within IBM. IBM's contribution is a '*loan of equipment*' valued at over $1 million - machines, switches and resources to support them. As far as he knew, no cash was involved. IBM gets the results of the group's efforts for a substantially lower price than they would cost to duplicate internally, and the group are doing '*work that they wanted to do*' anyway. An agreement which provided resources for work which was not of direct interest to the group would be counter-productive.

In the past it has sometimes been possible to obtain grants which match donations of equipment from industry with donations of cash, but in '*corporations themselves, at least recently to my mind, there is some willingness to give cash, but they prefer to give as equipment, or possibly even researcher time on their end.*' They have '*talked endless with company representatives.... we see a lot of them in the hope that one of them pays off*'. Alumni relations provide another means of making contact - again low probability and requiring careful nurturing.

How are industrial links likely to develop in the future? '*The particular combination of sponsored research mixed with focused industrial collaboration will become more prominent.... Everyone seems to have brought into the "let's get a little more practical" style of funding.*' The development of royalties are much harder to predict and are not the motivating factor. '*We'd love to spawn two or three companies with significant revenue streams, but I think realistically that can't be relied upon.*' About 10 years ago a company, Multiflow, was set up to build computers in a Silicon Valley style operation, but this was not successful in the long term.

Will this trend favour certain sorts of institutions? Well, Yale suffers to some extent from its '*non-technical image*' as opposed to MIT, Stanford or Berkeley. Smaller institutions will tend to have smaller expectations - although sometimes deliberate efforts have been made to change the balance through the backing of 'centres of excellence' by government and the wealthier states. One example of this is the funding of Syracuse university by New York state - and with its proximity to important manufacturing companies it enjoys an environment productive to this kind of research. With projects such as 'North Eastern Parallel Architecture' and their 'Infomall' initiative they are very focused on technology transfer and compare interestingly with nearby Cornell.

'There was a time when high tech companies, to some extent, helped fund research, but I don't believe that it was ever as generous as the perception was, and we got to rather a difficult time a few years back (it hasn't really changed now but people are more honest about it) when the government was saying "Well, we're not financing that" and industry was saying "That's what government grants are all for" and they were just pointing at each other'.

The poor fortunes and reorganisations of organisations such as IBM, DEC, AT&T and Xerox and the *'lean, mean economic machine'* approaches they have adopted limit their willingness and ability to invest in basic research to create ideas for products in five or ten years time without any provision for competitive advantage.

Would restrictions on publication and increased exclusivity for research sponsors make such corporations more willing to fund universities? Possibly, but the large issue is '*do universities need to undergo the same kind of restructuring that industrial concerns are going through? Can the universities continue to be pure bastions of abstract reflection, or do they need to get their hands dirty and begin to worry more seriously about what's really important to current economic environments'*. When a Yale education costs a student around $100,000, questions of 'value for money' cannot be ignored. '*What did I get from that? What am I able to do that I couldn't have done some other way*'. Such questions require a reappraisal of mission given the standing commitment of Yale and other distinguished universities to diversity in their intakes and '*bring to the university the best young minds, regardless of their background and training*.'

Such considerations make the search for practicality and relevance in research part of a '*wider Zeitgeist'*. The quest for intellectual freedom may have led to '*excesses in the academic environment*' in some areas, but there is merit '*in maintaining at least some notion of an ideal cannon - stuff that should be pursued because it is intellectually important, not because it will help your bottom line in the next three months.... Finding the balance there is going to be the trick*.'

9.1.8.2 Henry Lowendorf - Technology Licensing Office

Interviewee: Henry Lowendorf, PhD
Job: Technology Transfer Associate
Organisation:Office of Cooperative Research, Yale University
Interviewer: Tom Haigh
Date: Tuesday 13th September 1994
Location: Yale University
Revision: 1

The main responsibility of the Office of Cooperative Research is the commercialisation of inventions made by members of the university. This includes the evaluation and examination of their patentability, the contacting of companies which might be interested in the technologies and the administration of their licensing and patenting. The office also advises on the setting up of 'spin-off' companies, and helps to obtain research funding for relevant research. It provides expertise on negotiating contracts and ensures that agreements meet university policy with regard to Intellectual Property and conflict of interest issues, and the director of the office - Robert Bickerton - works with the '*highest levels of administration*' to develop policy on these matters. Industrial Liaison Programmes, of which one currently exists in computer science, are another responsibility. It also has responsibility for the university's reporting requirements to governmental and other (funding) bodies. These functions have been integrated within the office since its formation in 1982.

Yale also has a separate Development Office which performs traditional 'fund-raising'. '*More and more the people in that office go to industry and say "we would like money for certain kinds of research - so in the past it used to be more gifts, but now it's aimed at something that companies will benefit from.*"' There are also two grants offices, which, in addition to administering government and foundation grants and contracts, include some industrial work and are involved in drafting research agreements.

The office works with a whole spectrum of different type of companies. '*I went over the licence agreements database recently, and determined that a large fraction of the licence agreements we have are with very small companies - start up companies. I was surprised*'. Industrial, chemical, pharmacology, computing and engineering companies are all represented - '*basically the companies we work with are determined by the kinds of inventions we have and the kind of research that's being done*'.

What kinds of research are acceptable to Yale? '*The kind of research that's done is determined by the faculty, based on their interests and sources of funds*.' 'Secret' research is forbidden at Yale, but the most powerful driving factor for non-tenured faculty is recognition of the kind which will gain them tenure. *'Largely the university sees itself as advancing knowledge through fundamental research*'. There is no explicit ban on applied research, and much clinical research is based around drug trials which are unquestionably applied - medicine offers a very wide range of research from basic to applied.

The computer science department has '*some interesting relationships with small companies, where small companies take, say, a new language and generate applications with that language. That allows the people in the department to focus on basic research, but at the same time know that the stuff that they create, if it's useful, will find outlets.*' Some universities, such as Johns Hopkins, have set up development centres intended to take technologies and commercialise them - but at Yale this is done indirectly, through private companies.

What does a company which sponsors research get for its money? “First of all it gets the results from the sponsored research.” Often it wants ownership in any resultant inventions, but Yale refuses this - '*if the invention is made in the course of research by a member of staff at the university then it is owned by the university*'. In our experience most companies accept that.' What is offered is a 'right of first refusal' for licensing of inventions. '*We are careful to limit what a company gets to the results of research that a company paid for*' and avoid clauses which attempt to grant rights to the whole of a laboratory's output.

'An agreement is "sold" by a researcher and her work. A company comes to Yale not because of a general interest in research (although we do get that) but because there is someone at Yale doing research that is of interest to the company. The company may not be doing specifically that research at the moment, but wants a window on what happens to that research, or a company may have its own research projects going on but wants to keep close tabs on that particular investigator's work.'

Thus a research agreement provides access to information, and '*the research agreement and research funding is connected often to consulting by the person doing the research*.' Discussions on consulting agreements are ongoing at Yale - '*we're in the discussion phase and we've been in that for a long time*'. Conflict of interest questions are still unresolved - for example the

'range of material that an investigator is consulting around. It used to be that someone in chemistry would be hired as a consultant because he knew something about catalytic chemistry, and not specifically to consult on his own research. That's changed - more and more consultancy requires faculty to talk about, and give advice about and respond to questions about research very close to or even in the investigator's own area of specific research.'

If an invention results from this discussion, based on the faculty member's ideas, who owns it? Different universities have taken different positions on the issue.

Voluntary guidelines are in place, these are principally designed to protect the interests of faculty members from dangerous clauses in consultancy agreements - '*sometimes agreements companies come up with are extreme, giving the company basically any rights to intellectual property that the investigator comes up with at any time in the future*'. Yale explicitly forbids some clauses, including restrictions on publishing - although a short delay is allowed and of course the university cannot directly force faculty members to publish. Restrictions on the dissemination of confidential information provided by the company itself are allowed. Faculty are also advised on appropriate rates: *'sometimes a company would like to say we're going to pay you five hundred dollars a year and you're going to consult with us once a week*'. Faculty are not allowed to spend more than one day a week on external business or consulting.

Another problematic area is the funding of research by companies where faculty hold equity. Faculty may be connected to companies in ways including research agreements, consulting, directing and ownership - the more of these exist the more potential problems. Chairs of departments must be informed of all such relationships - possible conflicts are examined by a committee.

Have joint projects proved attractive in providing 'leverage' for each participant? In practice, this has been limited - '*we have tried to create situations like that*' - for example the Center for Applied Neuroscience which seeks funding from a consortium of companies - but '*that's difficult to do*'. At the moment the only common form of joint funding comes from a government source and a single company.

How is technology licensing addressed?

'We first have to identify companies that are interested in the technology. We have to look at the technology and determine if it is patentable, or is it something that would be licensed without being patented, such as a cell line or antibodies or something like that. We look at whether it would be the kind of technology that would be licensed non-exclusively or exclusively, whether it is a technology that might make sense to encourage a company to start up around, whether the technology can be divided up into fields of use so that we could license exclusively in one field of use to one company, and exclusively in another field of use to another company - or if we might want to divide it up geographically.'

Another issue is the kind of royalty demanded - a specialised research instrument might have a limited market. Probable profit margins must be considered, as must the costs and risks involved in commercialisation - for example the chance of a drug passing trials may be low and the costs involved enormous. A proposal is made to a company as the basis of negotiations, standard 'boilerplate' involves product liability, payments for patenting, definitions of the company and sublicensing. The times at which payments must be made are specified, and 'due diligence' clauses obligate the company to devote a certain amount of effort to the technology.

Valuation is very difficult as there is no empirical measure of 'worth' other than the eventual sum negotiated. '*The inventor usually has a very high valuation of his own invention*' - which can produce problems. Other experts in the field might be asked for their opinions to counterbalance this. '*Sometimes you can't come to an agreement*' with a company on terms agreeable to all.

Product liability is a particularly important issue 'which Yale tries to stay as far away from as possible'. '*The concomitant care is taken that we don't try to be involved in the company's plans - marketing and so forth*' although they do ask for a business plan as evidence of the company's seriousness. '*We try to keep out of the company's business, partly because we're not experts in that and that's not our job, but partly to keep the liability question in the company's pocket*'. This would be particularly dangerous in the case of a small company, where its limited resources might make Yale a tempting target.

How does this affect their involvement in start-up companies? Equity has been accepted sometimes rather than cash upfront payments for technology - but this is usually limited to a small minority. Equity is not accepted 'in-lieu' of royalties payable as the invention is commercialised.

Usually the decision on whether to license a technology or form a start-up around it is easy. When inventors want to start a company, '*in my experience we take that seriously as an important opportunity*'. Likewise, if no existing company can be persuaded to license but the technology seems viable then this is a strong option. The hard decision is faced when neither the inventors themselves, nor any existing company, are interested. Venture capitalists might then be approached '*but they're not going to do it unless they can get some kind of help, in terms of consulting or something like that, from the inventors*' and so complex technologies cannot easily be treated this way. Yale has not so far started-up companies without the involvement of inventors, though the possibility has been examined on occasion.

> *Yale does not so far have formal industrial advisory boards to provide input of the content of the curriculum, skills demanded from graduates and the like. 'The faculty feel they know best what the curriculum should be'. Faculty maintain their own personal contacts. One recent development was the appointment of a Dean to the School of Engineering, one of whose roles is 'to create better links with private companies. I expect him to be successful, and I expect there to be much more interaction.'*
>
> *'Yale already feels that the undergraduate engineering curriculum is a very high level curriculum, very intense, and the students who come out are well prepared to do whatever they want to do. But generally I think Yale sees itself as providing the academic leaders of the next generation, and not so much the industrial engineers.'*

How is industrial funding likely to develop in the long term?

> *'My own feeling is.... it is not going to become significantly greater than it already is, and Yale gets about fourteen million plus dollars from industrial research annually now. I think that industry is not prepared to take over the role of government funding and lately as US companies downsize they seem to be less and less willing to pay for general research and more interested in paying for specific research - that is research that's going to lead to applications and products right away.*
>
> *Everybody is concerned about the decrease in real funding by the US government, and I think that faculty here have often looked to companies to supplant money that didn't come in from government and was less than they expected. I don't think that's going to happen. I don't think we've reached the limit, but we're not going to get enormous quantities of money from industry - though it might become more important as it becomes a bigger proportion of the university's total research budget.'*

Currently Yale's total grants and contracts are around $250 million, so the $14 million derived from industry is significant but by no means the most important source. At the same time, as implied previously, this money is being more directly targeted by companies. *'People in big companies that in the past could give large gifts are tending to give less money and say more "what are we getting for it"'*. Development people are tending increasingly to involve faculty and their research in their work with companies.

How great a part does Yale's name play in their efforts? '*I think it helps a lot. Initial selection of students, excellent faculty and facilities and the Yale name'* ensure that alumni do well, creating contacts at the highest levels. '*More CEOs of American corporations have graduated from Yale than any other university*.' This ensures respect for

Yale is maintained, something which the Alumni association bank on '*both literally and figuratively.... For all those people who graduated from Yale, to enhance the name enhances their own image*'.

> *'On the negative side I think it is important to realise that Yale still has in the state of Connecticut a reputation for being "ivory towerish", and this office has done a lot I think to break down this image, because we do work with industry and we do work with companies, gladly.... But this image does still exist, and it exists among people who ought to know better because they've worked with us.... It's not that that image grew out of nothing... but at least in terms of industrial relations it persists despite the fact that we have a million and a half dollars coming in from licence agreements we signed with companies all over the world for inventions and fourteen million dollars in research agreements with companies.'*

One of the benefits gained for Yale is therefore the improvement in its 'image'. Not all faculty view this in the same way. '*Some are anxious to connect up with industry, and others couldn't care less. I remember a case of an invention which was disclosed to the office and the inventor refused to patent it. He said "Look - I'm not interested in patenting this. I want to publish this, I want the people to use it, freely*"'. Sometimes this approach is correct, but at other times it can actually prevent it being used effectively, as for any technology with a high commercialisation cost (for example a drug) it is likely that only an exclusive licence will attract a company to invest in it. This has other unfortunate consequences - for example if a technology has already been patented but university work has discovered new uses for it Yale is unlikely to be able to license those uses independently from the original technology with sufficient protection to encourage investment. '*To summarise the point, if it's in the public domain it may not actually get used*'.

Is a significant change in university culture likely to occur as a result of the relative increase in importance of industrial funding? The office has had more than 600 inventions disclosed in the 12 years of its existence by perhaps 500 inventors - each one of whom has '*learn't about the value of technology transfer*' as a result. This represents a more general surge in interest '*and the culture of the university is changing - I don't think there's any doubt about that*'.

> *'Important questions need to be asked whether that's good - or where it will lead, maybe that's better, less of a value judgement - and what that increased commitment on the part of the faculty toward applied research will mean for the future of the university; and on a more general scale the future of the research establishment. I think probably, however, that funding is going to have a much more profound effect on whether faculty lean toward more basic leading edge research or more applied, practical research.... People go into research because they really are interested in discovering new things and while there's funding to discover new things I think people will do that - but there will be people who say "I want to discover new things, but I also want to have inventions and make money"....'*
>
> *I don't see that changing, but if the direction we've seen in the last period of time continues.... if there's a government emphasis on applied research, on products or "maintaining US competitiveness", whatever the hell that means, then I think that's the direction will go, and I think the culture will change in a very distinct way, a very radical way.... Conceivably the universities will become an adjunct to the companies, a research institute which carries out work for them. I can't see that happening tomorrow, but a lot of people here are very worried about that.'*

Some faculty are more excited by the idea of making money than others. '*We're going to have some millionaires come out of the pharmacology department in the next few years.... and I don't think the people who discovered those inventions had ever conceived of making lots of money when they went to university*.' This will play its part in altering the kind of research undertaken, though '*I'd put weight on the direction of funding rather than the technology transfer side*' as the more important factor here though '*they obviously inter-relate'*.

9.2 UNITED KINGDOM INTERVIEWS

9.2.1 CAMBRIDGE UNIVERSITY

9.2.1.1 Richard Jennings - Industrial Liaison and Technology Transfer Office

Interviewee: Dr Richard C. Jennings
Job: Director, Industrial Liaison and Technology Transfer Office
Organisation: University of Cambridge
Interviewer: Tom Haigh
Date: Friday, 5th May 1995
Location: Cambridge University
Revision: 1

The Industrial Liaison and Technology Transfer Office is responsible for the general promotion of contacts between the University and Industry - specific responsibilities include technology licensing and IPR issues in sponsored research contracts. More generally, it provides advice and guidance on all forms of collaboration and deals with external enquiries. Its precursor, the Wolfson Cambridge Industrial Unit, was established in 1970 and was originally part of the Engineering department.

Dr Jennings' background is as an organic chemist, with experience in industry and in a government lab. '*You need a scientific background, I think, to be credible - but you don't need to be an expert... no one person could possibly understand all the technologies of the university.*' The office is currently expanding, and as well as Dr Jennings comprises a PA, a secretary and a consultant - with additional recruitment planned for later this year. Its small size allows it to function efficiently in a catalytic rather than bureaucratic role.

With regard to sponsored research, the Office is involved '*at the front end of things*' in initial contact with companies and negotiations. They have responsibility for the intellectual property aspects of all collaborative programmes (including Research Council funded projects), and work closely with the separate administrative offices which administer research grants, from both industrial and non-industrial sources. Recent university reorganisations, including for the first time a full time Vice Chancellor with executive responsibility, are leading to a large number of internal changes which are likely to include a consolidation of responsibility for research administration similar to that seen at other universities.

The university's technology exploitation company is called, for historical reasons, Lynxvale Ltd. It has no employees, is wholly owned by the University and provides a legal and financial mechanism for commercial interaction - its main formal link with the Office comes from the position of Dr Jennings as one of its directors. Initially it was used by the university to sell works of art - during the late 1970s its role expanded to include the sale of software and the provision of consultancy. Following the removal of the BTG's monopoly on technology exploitation, the remit of the company was in 1986 expanded further to include the patenting and licensing of technology produced with Research Council grants.

In this case a patent would usually be applied for on behalf of Lynxvale and rights transferred from the university and inventors to the company for exploitation and licensing. Sometimes a company might be set up to commercialise the technology in which equity was held jointly by the inventor and by Lynxvale. Lynxvale's revenues from technology transfer are just over £1 million - of which £200,000 or £300,000 comes from consultancy arrangements made through the company and about half the remainder comes from sales and licences of software. The rest comes from sales and licensing of other forms of intellectual property, including tangible items such as cell lines and antibodies.

Revenues are divided between the inventors, their departments and the university. A standard formula exists for inventions funded by the Research Councils, in other cases a variety of arrangements have been made. Cambridge's revenue levels are fairly typical for a large British university - they have a broad, well balanced portfolio without any hugely successful single items. There is a major element of chance in the achievement of

spectacular revenues - several therapeutic antibodies licensed to pharmaceutical companies were recently abandoned during clinical testing.

'That's the nature of technology transfer - it's a high risk activity but the rewards are there. You have to be very patient, it takes a long time to build up and you can't predict where they're going to come from.'

Often the technologies which bring in the biggest revenues when licensed are not those which result from dazzling scientific breakthroughs - the commercial value of a technology may depend far more on business related factors. In many cases the technology may not even be the expected end-product of the research.

'I feel very strongly that what we deal with is often a by-product. A very clear responsibility for offices like this is the educational function - both to educate the researchers to keep an eye out for potential commercially useful results of their research... I think we collectively have a responsibility to do that because we receive so much of our money from the public sector and charities, and to make sure that we have mechanisms which allow that process to happen and, very importantly, which motivate the academics to use them. Without the academics collaboration and enthusiasm, in my experience, very little happens.'

This educative role includes the giving of seminars and other activities within departments. An important tool for the stimulation of interest is the promulgation of previous success stories - if someone within a department has had a good experience then their colleagues will be greatly encouraged.

Cambridge has an unusual IPR policy, in that it does not take out patents in its own name and allows employees the right to patent and exploit their own work, as long as it has not been produced with external funds involving a commitment to other exploitation frameworks. Cambridge imposes relatively light contractual obligations on its employees -

'Employees are supposed to carry out research, teaching, scholarship and the pursuit of religion.... during term time - which in Cambridge is three eight week terms per year. Essentially what they do the rest of the time is up to them.'

This 'flat and democratic' structure gives considerable individual freedom in the discharge of obligations to the university - providing that these are met then faculty are free to spend an entire vacation on consultancy work. There is no extensive or formal conflict of interest policy, expectations are largely implicit. To some extent academics are protected from conflicts of interest by the webs of potentially conflicting obligations to university, department and college which must be carefully balanced and negotiated. The emphasis on consensual decision making has the advantage that the eventual decisions will have been made for clear reasons and that enthusiasm and motivation will often follow. An excessively rigid and formal system is likely to demotivate and irritate faculty.

'In my view that's one of the things which has contributed to Cambridge's success.... whether it would work anywhere else, or whether - if you were starting again from first principles - you would do it like this, is a moot point....'

One important aspect of the Office's industrial liaison role is the handling of speculative enquiries from companies. Cambridge has attracted a proportionally similar amount of industrial funding to the other major research universities,and are are in absolute terms one of the most sucessful - though because they do very well in obtaining Research Councils and Charity funding this is a smaller proportion of the whole than for some other institutions, especially the former polytechnics. Cambridge has a great number of departments officially ranked as excellent in research by the government - this makes the idea of collaboration with the university per se unusually attractive to companies.

'One of the side effects of the quality assessment exercise has been that companies approach me and say "We're interested in collaborating with a university, but our resources are finite so we are just going to talk to the top six universities in the country."'

Large companies, who are by far the most active in research collaborations, have their own substantial research teams. These have close contact with their university colleagues -

'they're similar people, they read the same journals, they go to the same conferences, they go to the same seminars - therefore they'll meet each other. As a result I feel that the academics themselves are very much at the leading edge of the marketing activity.'

In such cases the Office is more likely to become involved when approached by an academic who wants advice on the appropriate mechanisms for collaboration available at Cambridge and how to ensure its success. The Office is most likely to be the first point of contact for smaller companies.

'Always, the perennial difficult question is - how do universities link with small companies? My answer to that question is rather facile, and is "With great difficulty". There isn't at first sight a natural basis for collaboration, because the small companies don't have the resources, they don't do research - they are product and market oriented and the timescales on which they act are in general very much shorter and more immediate than those on which most university research activity occurs. Having said that, it's the exceptions that prove the rule and there are increasingly high-tech companies which are more research focused and the start-ups do increasingly undertake research activities with the University.

In general the links are to do with specific problem solving, in many cases consultancy type activity on a single person basis. Participation in more applied student projects and things of that nature can be very effective... you can get a bright undergraduate to work on a project for a month, and somebody good... can make a very valuable contribution to a company provided the management issues are addressed. Sources of material, exchange of materials, use of equipment, use of libraries - transfer of knowledge in a very broad sense is clearly a very real thing. Small local technology companies are increasingly employing graduates, and that's a very real, and in some ways the most important, source of technology transfer: the movement of intelligent people.'

These kinds of contacts with small companies have been encouraged and subsidised by a number of schemes, including the DTI's LINK programme, Teaching Company schemes and CASE awards for postgraduates. Cambridge was very well known in the 1980s as the centre of an exceptional growth of smaller, high technology companies. This has continued, although the emphasis has moved away from electronics, communications and computing based firms and towards biotechnology as a major source of current growth. Around 1,200 technology based companies are located near Cambridge, employing a total of 27,000 people - however very few of them are large and there are no local giant companies.

'These sponsored awards are very helpful in principle, the problem with all of them is that small companies see them as bureaucratic and difficult and see an enormous opportunity cost associated with them.... LINK is a very good programme in principle but it's a bureaucratic nightmare - everybody's been saying that from the very beginning but there's no will by the DTI or anyone to sort it out - the people involved are just saying "Oh you sort it out, we're government, we don't get involved in that sort of thing" and that's not helpful.'

Something as simple as a model contractual agreement, to provide a framework for negotiation, would greatly aid the practical usefulness of the scheme.

Currently attitudes towards biotechnology in the UK are '*optimistic but realistic*' and there has been a lot of interest in the area recently. An advantage of the shortage of venture funding in the UK has been that those companies which have managed to raise funding are in general well conceived and attractive to investors - in contrast to the American situation where during a period of optimism and hype large number of companies were started without good prospects in the longer term. In his view *'we are getting increasingly more intelligent investors, it's fairly slow but it is onwards and upwards*' - and people now realise the need for companies to have a strong technological base.

You need a platform of technology within a company which you can spin products off from - you can't base your companies around a single product approach. It's always been the problem in Cambridge - you set up a company with a nice bit of technology, well what do you do for an encore? That's one of the major weaknesses of many high-tech companies.

The Office deals with a '*steady trickle*' of start-up companies, and is usually involved in two or three at any given time. There are two local seedcorn venture funds -the Cambridge Quantum fund and Cambridge Research and Innovation Ltd, which '*I'm afraid in Britain this is almost a unique resource - the shortage of funds needed to get*

over the so-called development gap is as bad as ever.' A number of companies have been set up with the help of these funds, with stakes also held by Lynxvale on behalf university and by the individuals themselves. Equity stakes are now held in around ten companies, and the rate of activity is increasing.

He sees technology licensing mechanisms as being '*almost ideal'* for universities, bringing a revenue stream and further consultancy, and possible additional research contracts, as well as ensuing that the technology is utilised. Small companies account for a high proportion of licensees - they are less likely than larger companies to have developed their own, and '*see technology from universities as very much a potential source of new technologies and new business*.' The problem, as always, is that the number of technologies well enough developed to be used 'off the shelf' is limited, and so additional resources must be found.

Terms relating to eventual exploitation of the results of research are often build into sponsored research agreements. Cambridge is quite flexible in agreeing terms and has no model agreement of its own, though previous agreements and collective experience are obviously crucial. '*Model agreements can be very useful as a tool, so that you at least know where you start*.' They are 'comfortable' in assigning IPR to the company, providing that revenue sharing, obligations to exploit and so on can be agreed accordingly. '*Where we have missed tricks is where universities have assigned rights and the companies haven't done anything with that technology, or they use it as a blocking device*.' Problems arise because terms must often be agreed before the value of the results is known - ideally specifics would be negotiated only when more information was available, this is more common in Europe and is gradually coming to be accepted here.

> *'It's a cultural thing too - different countries are happy with different arrangements. In America companies in general are quite comfortable for the university to retain ownership, comfortable to have an option to license. British companies traditionally go for assignment and ownership.'*

A large number of companies make gifts to the university and to individual colleges. These are kept clearly separate from research agreements - not least because tax can be recovered from them by the University and so they have a different legal status. Legally, nothing can be demanded in return for a gift, and it is important to make sure that companies understand this. Currently an appeal to raise £250 million is underway by the development office. However, big companies are now less likely to make large donations with no strings attached - for example whilst a company might once have established a chair in perpetuity they might now fund it for a fixed period and in a more highly specified field. In the current business environment '*just giving money away isn't always favoured, people may not like showing it on their accounts*'; most donations come from trusts and from private individuals.

Have the recent changes in emphasis by the government produced any practical changes yet?

> *'There is a great anxiety on the part of many academics that "Oh, we'll be receiving all this industrial money, it will change what we do". I think the more interesting question is "Why are you doing what you are doing in the first place...?" Every academic, if you ask me, wants their work used in some form or another... they do see a value in it.*
>
> *Despite the role of this office I think that it's crucial that we don't eat our future seedcorn - there is some extraordinary naiveté around in government, it suits current party dogma. That's what I find so distressing - they are intelligent people, they know the situation and yet they pretend that it's different from what everybody tells them it is. I don't know how they live with themselves, frankly - all logic tells you that you can't predict where future breakthroughs are going to come from.... The trust has been lost, I think - the government does not trust its researchers. It is clear that the current government does not like universities and does not like academics - Margaret Thatcher particularly believed that the universities had failed the country.*
>
> *Because of both external and internal factors, the level of interest in this area is growing considerably. People recognise that collaborations are a good thing.... not a rather offensive peripheral activity.'*

Has he seen any signs of increased commitment to collaboration on the side of companies? The move towards the outsourcing of research has '*certainly been seen*' - one short term benefit from this has come with the donation of millions of pounds worth of equipment from corporate labs which have been closed. In the longer term, of course, this reduces the number of potential partners.

'People looking very much at what their core business is, considering whether to spend money internally or outsource, ultimately this must benefit the universities. The good news is that it's reached the top of the industrial agenda - when I started in this office seven years ago, one felt that, both in companies and universities, industrial liaison officers were somewhat marginal. Now, both are much more a part of the core business, and the quality and the exchange has increased dramatically, as has the support in both sectors.'

In the long term, companies need to retain some core research activity - '*you can't transfer technology if there is no one in a company to receive it*.' Some companies may have moved too far towards outsourcing, but fashions change in business and often trends are cyclical.

Awareness of, and support for, technology transfer is now greater than ever before. Resources do need to be increased if it is to happen as efficiently as possible, though in general it is not a hugely expensive process to support and pump-priming money is likely to be a good investment. Many benefits appear in the longer term, and it is essential to take a careful view.

'It's very important that people don't just look at flows of patents, because there is a crucial quality issue there. It's very easy to file hundreds of patents and to say that you've got a great technology transfer office, revenue is another measure but it's long term - the Americans say ten to fifteen years to build up a substantial activity.'

9.2.1.2 Roger Needham - Cambridge Computer Laboratory

Interviewee: Prof. Roger Needham
Job: Director, Computer Laboratory
Organisation: University of Cambridge
Interviewer: Tom Haigh
Date: Friday, 5th May 1995
Location: Cambridge University
Revision: 1

Patterns of industrial involvement within the Computer Lab vary over time. Some industrially sponsored development is undertaken, but it is the exception rather than the rule - *'we are not in the business of doing boring work for money.*' However, a large amount of funding comes through ESPRIT and EPSRC via schemes involving collaboration with industrial partners.

Informal relationships are very important, many of which involve no contractual element whatsoever. Companies have provided equipment donations '*because they thought it would be a good thing and they enjoy talking to us.*' The best example of this is Olivetti - the head of Olivetti research is a member of faculty, and resources have been supplied to the Lab over a long period, most of them on an informal basis. Such donations bypass the central University mechanisms, which are based around contracts, and so do not appear on official statistics. Many faculty members have good relations with, and sometimes receive support from, various companies.

An Interdisciplinary Research Centre is currently being set up to research communications systems - a total of £100,000 has been raised from companies and trusts to employ a senior person to oversee its establishment. Pledges were raised on the strength of long term relationships, rather than particular contracts. A '*supporters club*' is run for companies, many but by no means all of which are local. In return for an annual contribution, which varies according to size and wealth, members receive invitations to seminars, copies of technical reports and easy access to faculty. A mutual benefit is the opportunity given to companies to recruit students from the department - smaller companies do not have the resources to participate in the Milkround and so value the annual event where they make presentations to the students. A dinner afterwards allows the companies to form links and to do business with each other - and some formal collaborations have emerged from these relationships.

> *'If you look at formal relations, they underplay the reality. If you insist on formal relations to make the statistics look good then you're not doing anybody a kindness; and the best things are corporate friendships, where you may formally collaborate from time to time, but probably not all the time. When a collaboration is obvious then it happens. At the moment I would say that we are on those kinds of friendly terms with Hewlett Packard, Digital and Sun. This takes all kinds of forms: I consult for Digital in a purely private capacity, but it's because I consult that so many of our students are taken on as summer interns in their research lab, and it's because Digital know me so well that they're lending us some equipment to use in a research project, but none of this is written down anywhere....*
>
> *I think this is all good.... If there wasn't an industry concerned with making and using computers the subject wouldn't exist. It's not like physics - physics was made by God, but computer science was made by man. It's there because the industry's there.'*

The Lab offers short courses to industry. Currently a very successful course is being offered on ATM networking, which is taught publicly and on an in-house basis. Some of the proceeds go to the Lab and some to the University, most goes to the individuals - '*which is important because they are paid so little.*' This helps to keep staff motivated and happy within academia. He feels that rigid restrictions on the activities of academics are counterproductive -

> *'Cambridge has a very relaxed attitude to this sort of thing. Provided you are visibly doing your job right we don't fuss ourselves over what else you are doing.'*

Some departments, such as materials science, have opportunities for very short term industrial work based around services such as the provision of time on their machinery and instrumentation. This is far less common in computing, re-enforcing the dependence on longer term relationships. Contract research is not usually undertaken -

'Companies tend, perfectly reasonably, to have short term goals - and a good computer science department does not want to do short term work. Maybe it sometimes will, to keep the wolf from the door, but it's not what grade 5 departments should be doing.'

'It would be bad it we were diverted by the need to get money in this way from doing what we are good at and what we are for. It's good if you pick up good ideas from talking about industrially relevant projects, and it happens sometimes. We did some consulting the other year to do with burglar alarms which gave us some very interesting ideas and we got several papers out of it.'

When long term projects do take place, it is because a company is interested in the same kind of project as the Lab, allowing research to take place in valid areas which might not otherwise be funded. Currently work is being undertaken for BT and for the Korean telephone company. Prof. Needham sees one of the most important functions of the Industrial Liaison and Technology Transfer Office as the provision of advice '*to make sure that we don't get taken to the cleaners.*'

Companies are now seeking to outsource more of their research, and they can gain tangible benefits and know-how by funding university research, they also gain the advantage of awareness of and access to university research in general. In his view this is more common in the US.

'At the MIT Media Lab, at lot of companies - including many British companies - subscribe to fund their research without controlling what it is. You can whistle for money from the same companies if you are British, and the companies will spend money at MIT when they won't spend it here, even if they got the same thing for it. It's for the same reason that grocers sell imported delicacies - you tend to think that the thing from overseas is better.

Also there are difference of national habit - big American companies like Digital, Hewlett Packard and Xerox quite often telephone me, send email or visit saying "Do you have any really high flying doctoral students finishing this year?" These companies have people on their payrolls, part of whose job description is to stay in touch with the work of my lab and to know when there is someone really hot coming out so they can try to hire them. No British owned company has ever asked me if we have anyone really good coming out this year - I think this is extremely sad, but it is true. Go to Palo Alto train station in California - there are about two dozen of our PhDs within 10 miles.'

Many British companies seem to have failed to realise the importance of high quality research staff, but '*if you don't have your research done by the best people it's so inferior.*' In his view '*the best method of technology transfer is by people.*' Another problem is physical remoteness from the main research centres of the big computer companies - local companies are mostly smaller and less able to sponsor major research projects, though the Lab's other links with them are valuable to both parties.

The Lab has been involved in a number of EU projects. Their experience of collaboration with other academic institutions, via '*Basic Research Actions*' has been

'entirely favourable, we are involved in a number of them and I am sure that this has increased greatly our contact with Continental European universities. It's an interesting observation that people of my generation tend to look west for collaboration, because when we were young there wasn't much going on in Europe to collaborate with, whereas my colleagues twenty years younger tend to look to Europe.'

The Lab has also been involved as minor participants in a number of the large scale ESPRIT projects with international industrial partners. '*My observation, which I hope is untypical, but I fear isn't, is that if you're going to waste that much money there must be easier ways.*' Companies often try to base projects on work which they have already undertaken, are subcontracting or planned to do anyway, whilst often most of the work in a project comes largely from one of the partners. However, some projects have achieved '*respectable'* results, and of course, the process does encourage greater contact between European companies - '*but it's hard to think that you couldn't achieve this amount of conversation slightly more cheaply.*'

ESPRIT funding has the advantage of being assured for a number of years once allocated. However, a general feature of industrial funding from this kind of consortium based system is that it cannot be relied upon until contracts have been signed. Whilst a university will almost certainly respect a commitment to a project once a

broad agreement has been reached, a company might pull out at any stage before signing for reasons such as bad results, change of personnel and so on.

> *'Everyone says that technology transfer is truly wonderful, but everybody also says that universities ought to "exploit" the technology which they have generated for money, as effectively as they possibly can. These two things are actually slightly opposed to each other. I think that there is a very widespread view among university people, unfortunately, that what they had developed is worth more than it actually is. In the computer field patents that are worth anything are quite uncommon - I have my name on two or three patents, but they are not worth the paper that they're written on in my opinion. Much of it is know-how, and know-how resides with people. You get the people by hiring them and paying them what they're worth.'*

Of course, some fields - such as medically relevant areas of biology and chemistry, generate intellectual property which can be patented and licensed to generate significant income. Similarly, chemical engineers may develop processes with direct industrial applicability. Although academics produced some potentially very valuable and patentable developments in the early days of computing, today such developments are rare. Furthermore, attempts to patent algorithms have not proved productive - '*all they have done is to cause people to go off and do the necessary research to find algorithms for doing the same thing which don't infringe the patent.*' Successful software companies tend to have done well as a result of understanding customer requirements and producing marketable packages rather than great technical innovations, and copyright is more important than patents.

The most important licensable technology developed in the Lab was the Cambridge Ring networking system - this was given away to a number of companies for nothing more than tuition fees. '*Our policy was that we wanted to see it used, not exploited.*' Some money has been raised by the sale of natural language software tools, and a few academics have gained personal income from the sale of compilers. A start-up company is producing under licence a piece of equipment developed by the Lab - the company is owned by current and former members of the Lab.

> *'Very little has been done in taking ideas and licensing them to people in the serious outside world, and I don't think this is because we are slack in this regard, I think we have as good an eye for a fast buck as anyone. It is because very little of our work lends itself well to that sort of treatment - particularly without our taking our eye off the ball.'*

In his view, there is less of a need for formal policies relating to matters such as conflict of interest in Cambridge than in the US. Americans are often more legalistically minded, and are more likely to push the limits of what is permitted.

> *'I know some British universities own companies which actually do things, and I've always considered it to be a great mistake. There have been instances where Cambridge University has held shares in local companies, but this has always been regarded as an investment - just like we own 33% of shares in the local water company.... For the University to be the majority or only shareholder in a company that conducts a business in the ordinary sense is not terribly sensible - because as a class we are not terribly good businessmen...'*

He does not feel that, in the computing field, commercial applications are likely to arise as an unexpected result, or by-product of basic research.

> *'Our research is pretty well goal directed - but the goals are set by us. In a lot of computing there is no such thing as basic research, excepting some theoretical areas of the subject. We do a lot in networks and communications and so forth - I would assert that there isn't any basic research in networks and communications... the statement "They discovered an important truth about packet switched networks and it's no use for anything" is just inconsistent - it wouldn't be an important truth unless it was useful for something.... One of the heresies of recent times is the view put about by government and such people that people in universities are not able to set their goals properly - and in computer science this view is no doubt found as offensive in Manchester as it is in Cambridge, for obvious reasons - I mean we invented the bloody things. For it to be suggested that there is some sort of magic touch that industry has, and we don't, which allows industry to select goals for worthwhile research is quite rubbish, but ministers are not deterred by that fact that something is rubbish from asserting it.'*

So far, no practical changes have been experienced as a result of recent developments in government science policy. He finds it probable that the Technology Foresight programme will eventually have effects - these are as yet

unknown but *'bound to be good*' for computer science and related fields because their crucial importance is recognised by the panels responsible for very many of the different areas represented in the programme. For example, research into security, privacy and authentication in computer communications - one of his own interests - is seen as crucial for several fields including retailing and financial services as well as IT.

He feels that industrial interest in funding of university work does have potential to increase, largely as a result of the trend towards outsourcing. However, like much else in business this has an element of fashion and so can swing from one direction to another. No clear increase in overall support from industry has been apparent to him during the last five years.

9.2.2 INTERNATIONAL COMPUTERS LTD.

Interviewee: Peter Wharton
Job: Chief Engineer
Organisation: International Computers Ltd.
Interviewer: Tom Haigh
Date: Thursday, 23rd March 1995
Location: University of Manchester Dept. of Computer Science
Revision: 1

Though Peter Wharton's post of Chief Engineer is essentially a corporate function, because ICL no longer has an extensive corporate infrastructure - having moved to a structure based on autonomous business divisions vertically integrated by market - he is a part of the Corporate Systems Division, which deals with larger systems. His own background is in ICL's mainframe business and its VME operating system, which involved him in work with a number of universities.

The job entails a general responsibility for '*improvements in engineering*' within ICL, a major part of this consists of the encouragement of networking within the engineering population of the company - both informally and through schemes such as the ICL Fellow and Distinguished Engineer programmes. It also includes responsibility for coordination of work in areas such as development and redevelopment techniques in the Software Engineering field and the adoption of standards within the company.

ICL's overall strategy for higher education is coordinated by a high level steering group, including the Head of Research, the Technical Director, the chief sales person for universities and education and a Human Resources representative. The group meet approximately quarterly - until recently it was known as the Universities Committee, but the sales force prefer to consider the whole of the education sector in an integrated manner and so it is now known as the Education Committee.

Traditionally ICL has had strong links with several universities, most especially Manchester, whose computer science department produced a lot of research which has found its way into ICL machines since the early 50s. Today, attention is focused on a small group of universities with particularly relevant strengths. A significant recent project involved research teams at Manchester and Imperial collaborating on the EDS massively parallel computer system, which formed a basis for an important commercial product.

At one time, central funding and grants of equipment were available to internal groups that wished to provide support to universities via joint projects. Many of these collaborations went on to become part of Alvey and ESPRIT projects and received further support from the government. Another main area of activity was in the employment of academics as consultants - professors are valuable to the company both for their knowledge and for their standing in the community, and so their participation in meetings and other activities can provide a useful perspective. They usually enjoy the chance to try out their ideas with a company.

Technology transfer is an important outcome of collaboration, and includes formal elements such as IPR agreements. He sees the *'missing link'* in this activity as the capability to pilot a technology which has been developed and is now '*loosely around*'. Whilst universities produce a large number of interesting technologies they are usually not mature enough for immediate use; before work can begin on incorporating any such technology into a product an internal technological demonstration must be produced. In Germany the Fraunhofer helps to provide this missing link, whilst in Japan companies tend to conduct much more research internally and so can work on technologies which are less well advanced. In his view the DTI do not provide sufficient support for this activity, and its schemes are too complex and bureaucratic.

The move towards autonomous divisions and an internal market caused something of a 'hiccup' in collaborations with university. '*A whole lot of things stopped happening.*' Of course, more efficient use of resources is one of the main motivations in moving to this kind of corporate structure, and there is therefore an argument that this is a good thing and that activities which no one is willing to pay for are not needed. A problem remains when the benefits of a collaboration might be spread over a number of different business divisions, providing good value

overall but failing to justify the total cost for any single division. To facilitate this kind of activity a small R&D unit is being established to put in place mechanisms for joint support. This kind of support is particularly important for technologies *'in the gap*' between research and product development.

Whilst consultancy agreements have remained popular, joint research ventures outside of programmes such as ESPRIT have become significantly less common. Research funding, like most other spending, has been devolved to the various business divisions - so central support is no longer available. Businesses have found that in general better value for money is available from other methods, though individuals may collaborate when suitable opportunities arise.

Another mechanism for collaboration is via 'visiting professors'. Under this scheme, ICL staff spend spells from a few weeks every year upward working at ICL, during which they are unpaid by their university. Placements have been made with universities including Manchester, Edinburgh and Imperial - three of the country's top centres for computer science research. At the other end of the academic spectrum, students are involved in development projects with the company, often supported by EPSRC initiatives including the CASE awards and the 'Teaching Company Scheme'.

How is spending on universities evaluated? Some spending, like the work on EDS, is product based and is designed primarily to bring in expertise. Other spending, such as that to support sponsored chairs with universities, whilst valuable as a general promotion of the company is not expected to bring a short term payback. The institution involved is often in geographical proximity to the business division involved.

Most spending is reviewed regularly - for example when a group of four standing consultancy agreements were reviewed recently two were dropped and another transferred to a different budget because the focus of the work had shifted. Expenditure on university research support brings both technical knowledge and marketing advantage for the company - too often one of these advantages is ignored. He sees it as important to evaluate both when judging the returns on such investment, and synergy may be produced between them.

At one time ICL was a major supplier of computing equipment to universities. The rise of DEC and a general shift to minicomputers, and later still to desktop computers eroded this position. With the establishment of ICL as a leading corporate vendor of PCs in recent years, attention has again been focused on education as a significant market. Relationships are being built, and more effort expended on client management - though ICL does not operate any formal 'favoured buyer' scheme for selected institutions.

He sees a general problem for collaborations as being the differences in personal driving forces usually found between academics and industrial developers. Because academics are oriented towards writing papers, having these published and seeing them cited by others they tend to seek widespread individual credit as the primary outcome. On the other hand, industrial teams are oriented towards the integration of work from a number of different sources into a saleable product, are concerned with competitive advantage and do not wish to give their work away.

Because of the potential for mutual misunderstandings and culture clashes which this produces, it is very important for personal relationships to be developed. These lead to much better understanding of the priorities on each side, and provide a sound basis for subsequent collaboration.

Does the shift towards the internal market lead to an increased willingness to look outside the company for technology acquisition? Overall it does, but collaborative ventures remain the primary source of technology transfer from universities. Complex chains of relationships develop, because universities collaborate with each other and so collaborative work with one leads to contacts with others. However, support for university research remains *'an act of faith'* and ultimately the company must give money to good researchers and hope that good work is produced.

9.2.3 UNIVERSITY OF MANCHESTER

9.2.3.1 Peter Schaefer - Vuman

Interviewee: Peter Schaefer
Job: CEO, Vuman
Organisation: University of Manchester
Interviewer: Tom Haigh
Date: Wednesday 26th April 1995
Location: Vuman Offices
Revision: 1

Vuman's aim is the exploitation of research carried out by the University. There are two main channels through which this can be accomplished - the protection and licensing of intellectual property and the setting up of companies by the university. So far around ten companies have been set up, and joint ventures are favoured wherever possible.

In practice Vuman learns of research with potential for exploitation when members of faculty come forward with ideas. Ideally a regular technology audit would be conducted, and an obligation exists to exploit work funded by the research councils wherever this is possible. Unfortunately the resources required to conduct a full audit are not available, although strong links now exist between Vuman and the university's Research Support Unit.

> *'In practice few of the companies have been founded on an invention, most of it is the university's "know-how", which is another form of intellectual property.'*

Of the companies themselves, the oldest is Medeval, which provides services and conducts clinical trials on behalf of pharmaceutical companies. Their strength is in pharmacokinetics - the rate at which drugs are metabolised within the body. The company has been established for twelve years and is soundly profitable with a turnover of around £2.25 million.

Predictive Control, the second largest of the companies, is now an associate company rather than a wholly owned subsidiary. They have developed programs which manage process control within complex industrial plants. Their customers include Unilever, ICI, BNFL, Nestle and other major corporates. Turnover is between £750,000 and £1 million.

APEM specialises in aquatic pollution, and has been involved in projects such as the Salford Docks reclamation - it has expertise in environmental monitoring and has also worked with the National Rivers Authority and English Nature. Vuman Interactive provides multimedia training, and Flow Science capitalises on the expertise and laboratory equipment of the Aeronautical Engineering department to pull in around £300,000 of turnover. Another company offers educational assessment services.

The company established in conjunction with the department of Computer Science is Manchester Informatics - this was founded '*initially as a way of legitimising the outside work which they were already conducting*'. It is now '*starting to look at what skills might be saleable'* within the department.

Sensor Solutions is the only one of the companies to be founded on a particular novel technology, it has '*an extremely strong patent base*' based on work by a Professor of biochemistry in the School of Medicine. Their sensors were originally developed for diabetic screening, but they are now pursuing developments such as alcohol sensors and potential applications in agriculture and the food industry. Medical applications will take longer to reach maturity due to the more involved development and approval process.

Several potential opportunities for companies based around pieces of university technology are currently under consideration. No general rules exist to establish whether a piece of technology is most suitable for licensing to an external company or setting up a new company to exploit. Decisions are made case by case according to the position of the technology in the marketplace.

'The only rule that we've come across talking to our counterparts in the other forty university companies is that there are no rules that apply... each case is different.'

Whilst they listen with interest to the advice of American universities over the setting up of start-up companies,

'it's very hard to draw analogies... there's such a different culture, especially in the investment community, that's it's very difficult to apply that over here. People there are very much less concerned about risk, they realise that risk is necessary and that if you're going to risk then failure is inevitable in a number of cases - you play the percentages. Universities don't like risk, venture capitalists don't tend to like risk, there is not much of a market in start-up funds. Making the investment and managing the investment is out of all proportion to the return which you are likely to make in the early stages.

With the exception of Predictive Control, the university is the majority owner of all the companies, though in some cases there are other major stakeholders. These may include faculty members - although '*we use very few members of faculty in our companies - I can only think of one member of faculty who's got a stake*.' The only significant restriction which is imposed on the companies as a result of their university ownership is that '*they are precluded from investing major amounts of money in new development - if we need development then we have to find outside sources for that.'* One source of investment has been three SMART awards totalling around £150,000, revenue was also raised via an option fee on a piece of technology and in several cases industrial sponsorship has been forthcoming. In all other respects they act as a commercial company and are subject to normal restraints and responsibilities.

Government support for the companies has been limited to the SMART awards. The only other prospective source of government money is the Regional Development Fund of the EU.

'There are very few [incentive schemes] for which university companies are eligible, which I think is an inconsistency in approach. On the one hand the government is saying that it wishes to encourage universities to exploit IP, but on the other hand it removes all the incentive schemes such as SMART - that's been withdrawn now, they are saying that universities are not small companies.'

The university does not run any kind of risk of liability from its ownership of the companies. '*Legal entities are legal entities... and unless there is fraud, dishonesty or anything else like that then the liability remains with the company*.'

Returns to the university department from the longer established companies are made by covenant. The current model for new companies, following the establishment of Manchester Informatics, is to deduct university costs from the profits of the company and return the remainder not required for re-investment directly to the department, avoiding the 'central university tax'. So far no significant returns have been generated by these newer companies. Other benefits include 'a strengthening of industrial awareness, both for research and teaching'.

Peter Schafer also has a senior role within the University's Research Support Unit as head of the Research Development division. The Unit was only established in August of 1994 and is still distributed over a number of locations. His role is '*to make sure that research contracts are wholly compatible with later exploitation and to bring a greater degree of commercial reality to the negotiations and again to strengthen the links between university and industry*.' Currently priority is being given not to general industrial liaison but to the development of information systems - this includes the development of a database of research, but

'goes wider than that - there was no single point to which a researcher could go to find out which programmes might support his work. He might be aware of the Research Councils, he is unlikely to be aware of the charities, he probably wouldn't have an awareness of all the European programmes, he probably wouldn't know what kinds of industrial sponsors might be around. We want to bring together that information and make it accessible over computer or hardcopy... if we want to see more targeted information that requires us to know what research is going on.'

The challenge is to make sure that researchers are aware of likely sources of funding without swamping them with masses of information about funding sources which are unlikely to be applicable to their work. In the first round of ROPA awards, general awareness was poor among researchers - for the current round publicity has been targeted at those groups which meet the requirement threshold of £25,000 of industrial funding and the response rate has been very high.

How are exploitation issues dealt with in the research agreements which the university negotiates with industrial sponsors?

> *'There's a complete spectrum here - from the sponsor claiming rights to not just what comes out of the research but everything the investigators find in the next fifty years to no rights being conceded to the sponsor. We are trying to put some policy in place - there is quite a long education job there because often the researcher has more or less agreed all the terms before he comes into the Research Support Unit... the researcher can't commit the University, but in practice the University is seen in a bad light if after something has been purportedly agreed by a researcher somebody in the centre says "No, you can't do that." We want to get all of that clear, the fact is that we are keen to see intellectual property exploited, but we are not keen to see the University exploited by industry. We want fair reward for the inventive efforts of out staff.'*

Terms in sponsored research must be agreed with a strong framework, so that, for example, a sponsor which makes no attempt to exploit their options on a technology will lose them and so will not be able to prevent competitors utilising a technology unless they are prepared to invest in it themselves. It is possible to agree this framework as part of the sponsored research agreement itself, and to delay negotiations over the exact rates of royalties and precise conditions until the value of the research has become apparent. University policy is to split net receipts from licensing approximately equally between the inventor themselves, the department or resource centre responsible and the central University.

Finally, how does he react to suggestions that it is inappropriate for a university owned company, subsidised indirectly by public money, to compete in the marketplace against private concerns?

> *'We are not competing with industry using public money. The university made an investment in us, but we have to stand on our own feet. The university has earned a lot of money, for example it put £50,000 into Medeval twelve years ago and this year it will make in excess of £200,000 pre-tax profit.... The university is allowed to buy shares in the stock market, it is allowed to buy buildings. We are not taking subsidies, none of out staff on the commercial side are paid by the university.'*

But surely the 'know-how' of the departments, which is the main asset of the companies, is a public asset?

> *'Well let's have a look at where that comes from. You received a state education, at least to a degree. Therefore, do you feel that that belongs to the state, or has it been subsidised by industry? If you go into business on your own, are you competing unfairly with industry. I don't think there's much of an argument there. If we generate business it's rarely in direct competition with private companies. Iit's new technology which would not otherwise be funded. I think it's bringing benefit to the country - perhaps the worst thing to do would be to sell it abroad, although we do license abroad.'*

9.2.3.2 Mike Taylor - Research Support Unit

Interviewee: Mike Taylor
Job: Industrial Liaison Manager
Organisation: University of Manchester Research Support Unit
Interviewer: Tom Haigh
Date: Thursday March 9th 1995
Location: University of Manchester
Revision: 1

The Research Support Unit (RSU) is a relatively new body, having been set up in August of 1994 as part of the restructuring of the central administration of the University. It is responsible for the administration, development and exploitation of research carried out by the university. All research funding falls under its remit except for postgraduate research which at the time of the interview was still managed by a separate office. Development and Alumni matters are also the responsibility of other offices.

Previously the various tasks had been carried out by a number of separate offices, for example the Industrial Office, Grants and Contracts Office, the European Office and so on. The integration is aimed to give a coherence and a common set of strategies and aims to the university's activities in this area. The new unit comprises around 30 staff, headed by Mike Littlewood.

The RSU is split into two divisions. Academic Research Services supports tasks relating to the university's core research funding from HEFCE and similar bodies, which totalled around £28 million an 1993/94. It is also responsible for co-ordinating the university's preparations for the Research Assessment Exercise. The other division, Research Development, is headed by Peter Schafer who is also CEO of Vuman, the university's exploitation company. It includes responsibility for grants and contracts work, European funding and industrial projects.

In 1993/94 industry provided around £4 million of the £39 million annual total of grants and contracts from different sources. Manchester's particular success has so far been with other sources, especially charities. The bulk of industrial funding has been directed towards the medicine and the life sciences, for example an award from Glaxo of £750,000 over three years and a £1.5M contract from Zeneca. A number of industrial contracts of somewhat smaller size are in place for departments such as Physics, Computer Science and Engineering. Some of the contracts involve collaboration with other universities.

In general the impetus towards industrial funding comes from academics themselves. The process is market driven - academics network professionally with corporate researchers and can use the opportunities presented to seek funding for their research. In general, funding does not spring from interaction between the university and central corporate offices. Smaller companies which do not have their own substantial research teams tend to treat the matter differently - they will usually be seeking immediately relevant work to provide short term benefits in a specialised area. They are less likely to have existing contact with researchers, and so may make initial contact with the central administration or a particular department.

All research contracts require the approval of the RSU - academics are not allowed to sign off agreements on their own behalf. Often the Unit is presented with a contract which has already been negotiated, so only minor changes can be made to maximise the university's interests and integrate it into an overall framework. If a contract would work to the detriment of the university - for example unacceptable exploitation clauses or an unreasonably low price, then it must be re-negotiated or vetoed. For a major, long-term contract exploitation rights must be negotiated carefully, and the company will be presented with a standard contract as a basis for negotiation. If the academic involved has experience of contract negotiation then the role of the Unit is likely to be much less important than in cases where researchers without previous experience in the field need to '*have their hands held.*'

When a contract with a smaller company is being negotiated it is necessary to identify whether the work can be undertaken, and to refer the company to relevant contacts within the appropriate department. An understanding of

the capabilities possessed by the university in different areas is needed to accomplish this - a database holding the expertise and interests of researchers exists within the RSU.

The rights which will be granted to companies over research which they have funded depends entirely on the type of work undertaken and the terms negotiated. A consultancy agreement will routinely give all results and exclusive rights to the work undertaken to the sponsor - it represents commissioned work and will more than cover costs. At the other end of the spectrum, a major piece of sponsored research may be negotiated with academic rights as a priority. The university prefers to retain ownership of resultant intellectual property, but often builds exploitation rights - exclusive or non-exclusive, into the initial contract. Agreeing exploitation rights at the outset has the advantage of transferring risk onto the company involved.

Some aspect of philanthropy may be seen at work in the actions of larger companies - their eventual returns may come ten or fifteen years after the conclusion of the research which they are funding. Smaller companies are more concerned with immediate returns on their investments. Geographical proximity is much more likely to be a factor in attracting interest from smaller companies - larger companies are more likely to be based in Europe, the USA or the Far East but to act globally in their research funding.

Consultancy is not regulated exclusively by the Unit. Dividing lines are '*rather blurred*' - whilst consultancy is clearly distinct from large scale collaborative work, strategic research it is not always clearly possible to distinguish it from applied, contract research. Some consultancy work is agreed directly between the individual's department and the academic concerned - it is possible that the RSU will '*never get to hear about*' such work.

Even centrally processed consultancy agreements do not generate direct revenue for the university. They are permitted and encouraged because they motivate academics and stimulate more general relationships with companies. Whilst it is not practical to centrally support very small pieces of work, some 'fairly significant' projects are undertaken on a consultative basis. Consultancy agreements can also be made directly between the individual and the company - these cannot include significant use of university time or resources. Private arrangements are carried out at the individual's own risk and do not benefit from the university's liability insurance. At the time of interview, the university did not have a formal conflict of interest policy - the situation was being looked into at a senior level.

The importance of industrial funding of research is expected to increase. This is driven in part by government policy and the common theme of 'wealth creation' adopted by the Research Councils. According to HEFCE guidelines, the next Research Assessment Exercise will include a higher weighting for industrial research. This presents a problem for Manchester, because it is hard to identify direct industrial returns from many traditional areas of prestigious pure research such as astronomy and particle physics. HEFCE also encourages universities to recover their full costs when negotiating terms for contract research - though this will not be judged in the exercise itself.

In general there has been a steady increase in direct funding from companies, although this is dependent on their economic health. A similar increase in indirect funding as a result of industrial cooperation has resulted from government (national and EU) sponsored programmes such as Framework 4 and the DTI LINK programme. The recent recession prompted a general trimming of companies' own research capabilities, which has led to a more widespread reliance on contracted work - universities sometimes being seen as a cheaper alternative to commercial research teams.

9.2.4 NEWCASTLE UNIVERSITY

9.2.4.1 Tom Anderson - Centre for Software Reliability

Interviewee: Tom Anderson
Job: Director, Centre for Software Reliability
Organisation: Newcastle University Dept. of Comp. Sci.
Interviewer: Tom Haigh
Date: Friday 17th March 1995
Location: Newcastle University
Revision: 1

The Centre for Software Reliability is an official research centre of the University, located logically if not physically within the department of Computer Science. The work of the centre is fairly broadly defined in terms of increasing 'dependability' of systems - including safety, availability, reliability and so on. Not only must these characteristics be built into systems, but their existence must be demonstrated. Almost any area of systems development research could contribute towards these goals, but work tends to focus on core areas such as formal methods and new software engineering techniques. The centre's mission includes an explicit commitment to transfer of results beyond the academic community - '*the aims are to progress our objectives in research and to succeed in communicating our own and relevant research... to the industrial community*.'

What are the benefits of formal organisation as a 'centre' rather than informal existence as a group within the department? The centre was established around ten years ago to provide a '*label to hang things on... at that time it consisted of a secretary and a telephone - rather more support than the standard university infrastructure gives an ordinary member of a department.*' Increased independence as a centre allows the raising of additional resources - '*secretarial support and then research staff and projects and other activities get attached to your organisation, and before you know it you have something much more substantive*.' After five years the centre expanded with the recruitment of additional researchers and moved physically out of the computer science department. Currently the unit employs twelve staff.

The centre has two main 'strands' of industrial sponsorship - from British Aerospace (BAe) and Scottish Nuclear. Funding from BAe is long term and is renewed on a rolling basis. Scottish Nuclear are supporting work on behalf of a larger group within the industry, and their funding is for a two year project. Both projects are directly funded exclusively by the industrial sponsors, though indirect leverage of their investment occurs through the expertise which researchers develop on other projects and the infrastructure provided by the centre.

Each member of the centre has their own contacts so relationships exist with a range of other firms - which are strengthened through the approximately monthly events organised by the centre. These are based round 'community clubs', most of the members of which come from industry. These are mostly one day affairs, though some are longer and a three day symposium on safety systems with around 200 delegates is held annually. Club members which contribute a small 'participation fee' receive a newsletter and a discount on the cost of participating in the events - income from which is the other source of funding for the clubs. At present the clubs' income does not cover costs, in the longer term it will have to do so. Approximately 2,500 contacts exist on the centre's database. Some individual consultancy occurs, but on a fairly small scale due to time pressures.

Around 25% of the centre's income comes directly from industry. The governmental ROPA (Realising Our Potential Awards) are only available to groups with a minimum of £25,000 of industrial support and so represent potential additional revenue. The changes of emphasis by the research councils are '*in a sense a game, a system within which you have to work... and there's some value and validity to all this but there are also also weaknesses and deficiencies....*' An increased stress on wealth creation by the Research Councils may lead to more support for work of the kind undertaken by the centre.

The Alvey programme was influential in the early development of the centre and was overall very helpful despite problems with the contracting mechanisms. The experience of working with consortia involving industry, gained as part of the Alvey mechanism, has been continued by the department as a whole through involvement in Esprit programmes. Tom Anderson feels that collaboration is most successful when it involves '*basic research with*

collaboration between researchers... in collaborations with industry the partners often have very different drivers which can lead to different directions with the collaborative project.'

What does the centre tell its sponsors they gain from funding research?

> *'The reality is that you do two things, you seek to latch into the things that they are seeking - you select among and align yourself with what they see as the objectives of buying external research... they've usually got a fairly clear idea... the alignment may not be perfect but by and large you've got to talk to them and therby maximise the alignment that already exists in terms of the research that you can undertake. The other thing that we would stress is our track record and the established body of "successful research" that we would lay claim to and the benefits that they get from being associated with a cohesive set of ancillary activities.'*

Sponsored work should be publishable, but '*if you work with an industrial sponsor then I think it's legitimate to accept that they have a commercial position to protect; so our deal with British Aerospace is that it is normal to anticipate publication but that they have a right of veto*'. The clearance process works efficiently, as immediate approval can be given for non sensitive information. Product related commercial information can usually be removed without compromising the core of the paper. Secret work is not currently undertaken, although *'in these hard times... there may be ways of persuading us that that is acceptable to work in a different mode... or take the contract on a consultative basis.*'

Would contract development work ever be considered? This work is not suited to a university department, essentially for pragmatic reasons. Any spin-off software business would be handled by the University's exploitation company NuVentures. Thus whilst it not impossible that the group might become involved in development this would be done on a consultative basis and through a separate company. So far a situation has not arisen where the needs of a potential sponsor were close enough to development to make this necessary, perhaps because industrial partners have been attracted by the Centre's research rather then being approached speculatively.

> *'We have not got the time to set up a research marketing team... it's more a case of responding to opportunities that either come in at the door explicitly, or are around and we are aware of them.'*

What kinds of deliverables do the industrial sponsors expect? Scottish Nuclear work in 'hands off' mode. '*They impose demands that follow patterns that they insist on us working to; so they require project plans, time-scales, deadlines - very fixed deliverables, on schedule. They would criticise if these were not adhered to.*

> *I think this is an aspect of what you do see from industry - that's the way industry operates in its own field and they are reluctant to accept that real research, which is what we're genuinely supposed to be doing for them, does not fit that model. What they may do is to say "Yes, we fully accept that it doesn't fit that model" and then ask you to follow the model anyway, because they have nothing else to operate with, and attempt to convince you that it's a good thing in terms that you can't argue with...'*

Adherence to this pattern is '*a little bit artificial for us... but it's easier to adhere to it because they don't pester us, they let us get on with the work. They don't give us as much feedback as we'd like...*'. In order to gain feedback from their engineers it was necessary to build into the contract additional money to be returned to Scottish Nuclear to pay them to take part - although this arrangement initially struck the academics as odd, '*when you think about it, it makes sense... looked at from their perspective.*' This kind of cost accounting is an example of the kind of cultural differences which exist between the two sides.

Problems had previously existed in the relationship with one sponsor due to differing expectations of what constitue appropriate management structures. '*You can fall into the trap of over specifying, over-stipulating, over-egging the pudding with things that are beneficial. Separate activities, ideas and ways of working when treated on an individual basis can be hard to criticise, but that does not mean that the entirety of those things, taken together, is a good thing - indeed it can be enormously detrimental... Early on we fell into the trap of trying to do too many good things and over-managing the process... We realised that this was the case and now have a much better mechanism in place. Now when good ideas come along for us to do we say "That's a really good idea, which of the last set of good ideas are we going to drop?"... put too much management overhead in and you won't have any research..*'

Aside from the revenue, what other benefits does the centre gain from its industrial collaboration?

'I think you get potentially enormous benefits. [With British Aerospace] there was an opportunity to get the best of both worlds: well funded academic computer science systems research that was grounded in extremely practical applications - real engineers very committed to the work, seeing the need for it, wanting to support it, both very much pulling in the same direction... They get the benefit of independent, academic, longer term perspectives embracing a much broader community of work; we gain from their experience of building real applications. Potentially, that is very good at steering what we do and enlightening what we do - and what you want is to get the best of both worlds rather than falling between two stools, and early on we maybe didn't get that balance right... The lesson for us was that you couldn't make it up as you go along... those benefits don't come for free - you have to work for them.

BAe, one of their principle sponsors, is not a monolithic corporate entity, and so the collaboration involves several distinct firms within their overall structure - a process with its own potential problems.'

Is industrial funding of university research likely to increase? The department as a whole has been strengthening its long term links with companies such as ICL and BT. However,

'they've all got budgets for how much they're going to support, and although the government wants to encourage research, it costs money - the Treasury knows that it has to control this burgeoning expenditure and wants quite sensibly to have its cake and eat it - it wants to persuade industry to pay for this by exhortation and not by tax incentives. Industry would like the tax incentives.... and I think it's for this reason that we won't see any sea-change in the situation.'

However, in the current climate this is something which '*the universities have to do in order to survive, so we may be able to persuade and cajole more out of industry. If we were not so strapped for resources we would do far more*' but the department must seek to balance its budget and attempt to preserve core activities such as teaching and mainstream research. The financial situation in the Computer Science department as a whole is much less satisfactory than that within the research centre, and so older research equipment can be transferred into the department - which is now on an eight year equipment replacement cycle.

9.2.4.2 Nick Cook - Computer Science Department

Interviewee: Nick Cook
Job: Research Administrator
Organisation: Newcastle University Dept. of Comp. Sci.
Interviewer: Tom Haigh
Date: Friday 17th March 1995
Location: Newcastle University
Revision: 1

Nick Cook is involved in the negotiation of research contracts for the Computer Science department and in liaison with the university Research Services office. The Distributed Systems group is one of the Department's two main recipiants of industrial funding (the other being the Centre for Software Reliability which is dealt with in a separate interview) . Roughly 25% of overall departmental external research funding is currently coming from industry, and, interestingly, another 40% or comes from Europe - the proportion from the Research Councils has declined to around 25%. He attributes this partly to a general increase in availablity of funding from other sources and to the increasing difficulties of attracting Research Councils funding as well as to their particular success with Europe and industry.

The three current sponsored research agreements have arisen from long term relationships involving the researchers themselves - particularly via the ESPRIT linked ANSA consortium for companies interested in Distributed Systems research. Long term relationships have been crucial to these contracts, and therefore a importance is attached to activities such as the annual ESPRIT workshops which may allow further links to be established with corporate R&D departments. These involve invited speakers, often from industry, as well as presentations of results.

As the Distributed Systems group's research has progressed it has shown its strength and moved closer to application and so has recently been in a strong position to attract industrial funding. Because of this there has been a good degree of agreement on the technical work involved, though obviously the negotiation of financial and intellectual property aspects tends to be more involved.

When negotiating contracts, ILP and money are '*obviously linked - if the university retains ownership of all the intellectual property then one would expect the amount of funding to vary because they are not buying the results - they're buying the right to exploit the results rather than the actual ownership.*' One contract leaves ownership with the university but exclusive exploitation rights with the company, another involves essentially the reverse. In some senses this is a mutual learning process. A clause will exist to ensure that companies will loose rights which they fail to attempt to exploit. A certain overhead exists in terms of the increased reporting and management.

Consultancy to individuals is often agreed as a part of a contract, though the overall levels involved are not high. Individuals can enter into agreements directly - these are not regulated at the departmental level.

The end results of each project were far from clear when the contracts were agreed and no guarantee exists that exploitable results will be obtained - this is a product not just of the technical progress of the project but also of the changing organisational priorities of the companies involved. The university's direct involvement is with research groups within the company, but obviously eventual exploitation would involved product development groups. '*The nature of research is that you don't know what your results are and you don't know if they're exploitable - but you do know what you're delivering to a company.*' What the university agrees to provide is essentially a certain set of reports and '*a certain level of effor*t.'

This is not necessarily always the case - a contract currently under negotiation would involve the further development and integration of an existing piece of software to form part of a larger commercial system. Further maintenance would be provided as consultancy.

'The key thing in all these contracts is that you define the results by what you deliver in the report to the company. That's where we have to be careful that we don't deliver results that haven't been genuinely funded by the company, because that becomes the basis for any exclusive licensing or ownership by the company.'

Have any results been seen yet from the Research Councils' new emphasis on 'wealth creation'? The Distributed Systems group has been successful in winning a ROPA award worth around £50,000 p/a which it was only eligible for as a result of its industrial funding. More generally, given that successful collaborations are so dependent on personal relationships, he sees difficulties in trying to centrally enforce this kind of cooperation. Another problem would be the inappropriateness of any attempt to use public money to conduct applied research specialised to the requirements of a handful of companies. Potential problems obviously exist if industrial funding becomes a more general prerequisite for government money and the focus moves away from basis research all together.

Some areas of research, such as Distributed Systems, tend to be inherently 'labour intensive' and can only be undertaken with the additional manpower provided by research contracts. However even the governmental awards, such as those from the ESPRIT programmes, are now oriented towards industrially fundable projects and therefore the direction of future research is likely to move further from basic areas. Another trend is for such contracts to be awarded only to consortia with previous experience in such projects.

'Increasingly, as the research selectivity exercises bites and, due to funding pressures, the University's room for manouver is limited, research groups are forced to rely on research contracts - they cannot expect additional money from within the institution.'

Because of the increased management overheads involved and the distraction away from basis research, industrial funding '*cannot be increased forever - a balance has to be struck*'. The Distributed Systems group is approaching the limit of industrial collaboration it can cope with, and there is a limit to how much the group can grow.

So far a situation has not arisen in which a company has tried to contract the department to undertake development work which has not included sufficient academic content. '*We'd have to look at the resources required... at the moment given financial constraints you'd probably do it anyway but certainly it's a concern.... you'd have to make sure that it wasn't detracting from your other activities'*. The university itself would also be concerned about such work if it were seen to be by public money - so the potential for profit might be a crucial consideration. However, they would still rather engage in a worthwhile research collaboration giving lower financial return than undertake contract development work on more generous terms.

9.2.4.3 Richard Tomlin - Research Services Unit

Interviewee: Richard Tomlin
Job: Head of Research Services Unit
Organisation: Newcastle University
Interviewer: Tom Haigh
Date: Friday 17th March 1995
Location: Newcastle University
Revision: 1

Research Services is an integrated unit which is responsible for *'just about everything that the administration does that touches on research in the university*.' On the highest level this involves a '*very intimate relationship*' with the Research Committee - which sets policy and allocates resources, performs the internal performance review and is responsible for a budget of £750,000 to support 'pump-priming' projects and a £2.5M budget to prepare for the research assessment exercise.

Another area of involvement is the production of the research directory 'REFUND' which lists up to date funding information and to which other institutions can subscribe. The same team provide an in-house consultancy service to those looking for research funding. A further group are responsible for grants and contracts - around 1,100 applications for external research funding are made every year resulting in 700 awards totalling in the region of £40M.

These responsibilities have been gathered together in a single unit since December 1990. Newcastle was one of the first of the large civic universities to adopt this model, which has since become commonplace. Previous administrative organisation was around faculty groupings - this system gradually collapsed as the world of grants and contracts became increasingly more specialised and complicated and policy became more important.

Around £4M of the research total, representing roughly 10%, is from industrial sources. A further 10% is from the EU and so targeted towards projects involving industrial cooperation. Another £3M comes from the UK Government, much of it is from the DTI and is also targeted towards industrially relevant areas. Industrial funding is '*remarkably diverse*' - there are few single huge projects. Much industrial interaction does not involve direct research funding and is handled at the departmental level - for example the Engineering Design Centre offers training to local companies and the Design Unit in Mechanical Engineering handles about £2M of consultancy projects each year.

The Unit's involvement in a particular agreement typically begins when a contract is in the process of being negotiated.

> *'There's almost a triage in these things - there are those academics who know how to do it, because they've done it before. They do it well and basically they come across to us with three quarters formed projects and deals, which are essentially fine. At the other end of the spectrum there are people who turn up with something so comprehensively awful and done at the last minute that there's not really anything we can do with it... and then there's the group in the middle... of people who come fairly early on in the conception of a relationship with a company and come to talk about customer pricing and what kind of an agreement would the university look for.... That's grown substantially in the last few years, largely on the back of work which we've done with people's EC projects.'*

Because the EU funding process is so complicated and unknown to most academics, they realised the need to seek help from experts and did not feel that they were 'losing face'. As a result they have become more aware of the services offered by the administration and are now far more likely to talk about other kinds of applications. The Unit's approach is to focus on the project and look for all possible sources of support.

A certain amount of centralised promotion is attempted by the university, in terms of presentations at exhibitions and so on and a comprehensive research directory is produced. Some industrial enquiries are fielded by the Unit, but the vast majority of contacts are made directly by the academics concerned. They have also been able to provide support to academics seeking consortia partners for the various EU grant programmes, particularly in other European countries - for example by providing contributions towards the cost of travel.

Many of the agreements processed by the Unit include grants of equipment instead of or as well as cash. There are also DTI Club and Link projects where contributions can take the form of man-years of skilled effort. Financial payments have risen as a proportion of the total, aided by the trend towards 'outsourcing' of activities by larger companies in recent years. '*It's generating more cash for us, that's for sure. Not for everybody*.'

A technology transfer company, NuVentures, exists, with which the Unit works closely. Rights over possible resultant technologies must be considered when research agreements are being negotiated, and so this company has a '*legitimate and necessary involvement, on occasion, in negotiating the intellectual property conditions in particular*.' Likewise, a new research project is likely to be building on background intellectual property of previous projects, the licensing of which is undertaken jointly with NuVentures. Whilst any published patent may legally be used as the basis of research, it will be impossible to gain sponsorship for a project if there is no prospect of exploiting the results - which will require some kinds of rights to the original work. These must be safeguarded when licences are being agreed - this might be achieved by the university retaining ownership but could also be achieved in a number of other ways.

What rights over the results would a sponsored research contract typically grant a company? The minimum provision would usually be a right to negotiate and an assurance of 'fair and reasonable' terms. They would be reluctant to assign a value to the results before the conclusion of the research, although companies sometimes attempt to insist on capping the maximum level of royalties payable. Compromise is necessary on a case by case basis during the negotiation process. As mentioned above, the rights to publish and to use as the basis of future research will not be surrendered - '*providing we can arrive at that we are happy to enter into almost any arrangement that makes both parties feel comfortable.'* It is important to make sure that the contracts reflect the fact that the results are unknown and may not be in the form expected - no guarantees can be made as to the nature or usefulness of the results themselves.

The proportion of the overall cost of the project which must be met by the sponsor depends on the closeness of the work to the kind of basis research which the faculty would be carrying out without sponsorship. Work which represents a diversion from academic priorities would carry a premium. The advantage of a university over specialised research contractors comes principally from its ability to share costs, and so to leverage industrial money.

The new ROPA awards from the Research Councils represent an attempt to apply '*quite small sums of money, at the right time and the right place'* to act as a catalyst in altering internal priorities. Most of the departments at Newcastle already have some tradition of industrial partnerships and are therefore quite well placed to benefit, with only a minor change of emphasis required.

Does he feel that the amount of money which companies are prepared to spend is likely to rise in the future? His impression is that

> *'companies are becoming much more discriminating, and a little more demanding, and that's no bad thing. Many companies have scaled down their in-house R&D, and that's a bit of a worry because I don't really want the university to be doing research which is of such central commercial importance to a company that if it goes wrong or it gets leaked at a critical moment then some major calamity is going to befall the company. Companies need to think carefully about why they are commissioning research within a university.*
>
> *The emphasis here always comes back to the collaborative project and to try and get a clear dialogue between our academics and the sponsors in which both sides recognise that the other side is contributing and has it's own goals in the project, and that the art of a good project is so to align those goals that there is a viable project - not to substitute one for the other.'*

During the recession the overall amount of money available from companies was fairly '*flat'*, but did not fall significantly. However its spread is becoming much more concentrated. The philanthropic element is minimal outside occasional gestures such as sponsored chairs. Research contracts are entirely separate.

Is an increasing reliance on industrial funding changing the nature of research undertaken or the culture of researchers?

'I personally don't think that there's been any huge change Perhaps there's been a slight shift of emphasis, but good researchers still want to do what they see as good research - though perhaps they are showing a little more flexibility in how they adapt and how they present things.'

For example, many senior academics are willing to take advice on the new styles of grant proposals now required by funding bodies. He does not feel that there is an optimal proportion of industrial funding, beyond which academic priorities and basic research must inevitably be disrupted. '*It depends entirely on the requirements that industry is attaching to that funding*.' Arrangements such as the CASE awards have no adverse consequences, proving that the source of the money need not in itself disrupt academic culture.

9.2.5 RANK XEROX

9.2.5.1 Bob Anderon - Director, Rank Xerox Research Centre

Interviewee: Bob Anderson
Job: Director, RXRC Cambridge Laboratory
Organisation: Ranx Xerox Research Centre
Interviewer: Tom Haigh
Date: Friday, 24th March 1995
Location: Manchester Business School
Revision: 0 (No feedback obtained from interviewees)

The RXRC Cambridge lab, established in 1987, is now a part of Xerox's European Research Centre, one of four world-wide of which the most famous is PARC in California. The European Centre also includes a lab in Grenobles. The different centres world-wide concentrate in different areas - the European Centre is concerned with document services and '*next generation but two*' techniques. As well as research groups, the lab also houses part of the Business Development Group '*whose job it is to take technologies from the start to the market.... or to help commercialise them within the company*'.

The mission of the lab is unusual in that it is structured around a set of problems, centring on exploration the work of individuals and organisations with documents and looking at ways in which technology can support this work. Thus the lab employs teams with diverse backgrounds - such as psychologists, cognitive scientists and sociologists. They came to realise that the issue in human-computer interaction was '*systems integration, not in terms of hardware and software but business systems, work practice systems and technical systems*'.

An incentive for Xerox to place a major research facility in Europe came from the expectations held in previous decades that moves towards a monolithic European trading block, particularly the establishment of the single market and the foundation of the EU, would lead to increased trade barriers to foreign firms. To be regarded as European a company must manufacture in Europe, export goods from Europe and perform sufficient R&D within the EU - an the establishment of the European Research Centre allows Xerox to fulfil the latter requirement.

What does Xerox expect the lab to produce?

> *'Envisionments, prototype technologies, design specifications and intelligence. What corporate research does for Xerox is to manage risk, it reduces uncertainty. All these things are outputs by which we reduce uncertainty for Xerox.... We do lots of other things for Xerox that it doesn't really often recognise it gets - we give it high visibility, we penetrate communities... we provide a certain credibility for some of its longer term envisionments and provide a "feel good factor"....'*

These less obvious contributions can be very important. For example, to retain and motivate able and ambitious staff it is essential for a corporation to present a credible future strategy for continued growth and the potential for "exciting" careers. '*Corporate research provides a part of that internal credibility, and I think that's something which is often forgotten*.' Equally important is the appeal to customers of knowing that their investment in the relationship is protected by corporate commitment to technological improvement.

Roughly 40% of current research is intended for publication. Does this open distribution of results compromise the advantage Xerox accrues from having conducted the research?

'Look at publication as a management tool... you need external validation, and all research organisations need that, to make sure that the work which is going on is world class. The fact of publication is a good way assessing your credibility, also it's a good way of "moving the barrier", and as a manager you can insist on certain kinds of publication.... It's also important motivationally that the people feel that they are in a community, and that community is of course providing feedback and the flow of information and knowledge in is often much greater than the flow of information out.'

Designs can be patented before publication to ensure their protection. If a researcher's project as a whole is not publishable then components can be identified which are suitable to be placed in the public domain - this is done between the scientist concerned and their managers.

Does the lab sponsor research within universities? Yes, but not '*contracted research - I don't do that because I don't believe in management at a distance... it's hard enough to get software delivered on time and to specification when you've got control*.' Sponsored research primarily takes the form of CASE agreements, student sponsorships and internships.

It is important to make sure that a genuine coincidence exists between the academic interests of the researcher and the commercial interests of the company. '*...the important thing is not to force it. The great mistake that I've made, other people have made, is to say "This is a great person, we must get him to do research for us.*"' Without identification of a genuine area of mutual interest the result is either an unhappy and unmotivated researcher or work which the sponsor views as a waste of money.

'I have found that some academics are much better than others at doing it, and you learn which ones will be able to serve you the best, and those are the ones which you build a relationship with.'

Does the interdisciplinary nature of the lab affect the people it attracts and the work which is carried out there? '*The kind of people that we tend to attract are people who have a wide ranging curiosity.*' As far a results go, this is reflected in the pushing of boundaries in the research itself.

How would Xerox go about evaluating the cost effectiveness of the lab's work? One of the main answers is simply '*the gut feel of me and my managers*' - this is based on a number of signs such as '*engagement with business divisions, engagement with Xerox's vision of itself, closeness to something approximating compartment transition.*' (?) This intuitive sense of confidence is increasingly 'buttressed' by factors such as '*return on intellectual property, return on investment in research*' and so on - these calculations are '*very interesting*' but will not replace the judgement of managers.

Whilst it is important for the results of research to be shown to be useful, it is just as important for decisions to be made openly and to be seen as well grounded.

'If nothing I did in the lab ever ended up in the marketplace then people would start to ask questions, but if 90% of what I do never ended up in the market place that wouldn't necessarily be a disaster - as long as it was clear that we made the decisions and what the basis of those decisions was.'

Xerox has a complex research and development structure, and other parts of the company are responsible for the commercialisation of research. For example, a specialised 'scale up' facility in Toronto looks at the transfer of processes to commercial scales. The Business Development Group within RXRC, which performs some technology transfer functions, primarily looks for external partners to share in technologies, for example to allow their application to new areas or to provide the expertise needed to bring a new technology to the marketplace.

'If any organisation tells you that they've got a smooth flow from research into development then they're lying to you. It's a political process... it's about negotiation, it's about getting win-win situations, making investments.... Taking a technology, no matter how revolutionary it is, and getting a development group that's made a amount huge investment in personnel and skill to accept it, if that technology actually undermines what they've invested in, is extremely difficult.... '.

Has the nature of research at Xerox been altered by the transformation of corporations into increasingly autonomous divisions? There are now nine divisions, with complex management and contracting mechanisms connecting them. However, research and development is still a corporate entity in itself. This arrangement is not as radical as that adopted by some companies, for example divisions do not currently have to undercut external bids in

order to win contracts from each other. As far as research goes, these changes have '*forced a closer alignment... in both dimensions. Researchers have become more concerned with knowing how business is going, but the business themselves now realise that they are dependent on research, and since they are paying for it... they ask questions like "How can I make sure that the investments I am making are the right investments for me to make."*' Overall R&D spending has not diminished as a result of the changes, and although research itself now probably represents a lower proportion of overall spending than it once did he does not see this as a direct result of the contracting process.

He sees changes in the nature of metaphors used to discuss the nature of the research process as significant.

> *'We used to talk about pipelines... we don't talk about pipelines anymore, transactions are one thing that we think about - the ways in which we are exchanging between groups.... It's no longer viewed in this linear way where we "see what's coming down the line" or try to "speed up the flow"'.*

Could any aspect of Xerox's relationship with universities be characterised as philanthropic? '*Even a philanthropist does things for a reason*' but there are some activities which have little relation to immediate business needs - these tend to be oriented directly towards the Cambridge community, such as their donations to the university labs which are expected to produce little more than minimal goodwill.

> *'I have two concerns, one has to do with research funding for universities. Research funding goes to the research centre - it's too unfocused, and as a consequence very little useful knowledge is generated - knowledge which I can use.... In the longer term I get less and less interested in getting involved with the SERC and doing validations and that kind of stuff, because I really don't think that system is working very well.... A very good example of it for me is the Cognitive Science Initiative.... it looked to me that they tried to cut the cake so many ways that nothing came out of it.*
>
> *The second worry I have is that universities are looking at themselves increasingly as businesses. Trouble is that they don't know how to play the business game, and I have some very difficult relationships with universities simply because they haven't learned the difference between collaboration and competition.... If a university will insist on owning patents totally for collaborative projects then it will not get collaborative projects, and I'm worried about the way that commercialness has been forced into the university setting.... I can see their fear, they've been told that they have to generate funding and revenue and they may think that we're going to shaft them, but that aggressive defensive response does not help anyone.'*

9.2.6 THE TURING INSTITUTE

Interviewee: Peter Moforth
Job:?
Organisation: The Turing Institute
Interviewer: Tom Haigh
Date: Wednesday 19th April
Location: The Turing Institute
Revision: 0 (No feedback obtained from interviewees)

The Turing Institute is named after the great English mathematician and pioneer of computing theory Alan Turing. Turing is well known for his war time work in Bletchley Park, and for his time at the universities of Cambridge, Princeton and Manchester. The link with Scotland comes via Donald Mickey, a colleague of Turing's who became interested in Finite State Automata and was instrumental in the establishment of the pioneering department of Artificial Intelligence at the University of Edinburgh in 1963. Following the Lighthill report in 1973 and the effective removal of government support for AI in Britain, work in the area subsided until the early 1980s and the revival of interest in the subject brought about by the Japanese 5th Generation project. The resultant infusion of money to the field, governmental and industrial, led Mickey to move from his small Machine Intelligence Unit at the University of Edinburgh to a new body called the Turing Institute which was intended to '*sit part way between industry and academe*', formed in 1983 as a limited company. Glasgow's status as a development zone made it an attractive location for the new Institute, and close links were formed with the nearby University of Strathclyde. The Institute grew to employ around fifty people by the late 80s.

Scottish Enterprise, who were responsible for the influx of electronics manufacturing to Scotland and were keen to encourage the software industry, stepped in to rescue the company after it ran into acute financial difficulties. The influx of cash was accompanied by '*professional managers, who knew a lot about business and marketing, but they didn't know anything at all about computer software and our business.*' Two years, and a great deal of money later, the company floundered in this commercial incarnation.

It was saved by the intervention of Glasgow University, and returned to its core business and original non-profit status - funded by the Glasgow Development Agency and the University. It is intended to cover its costs without further subsidy, and derives roughly half of its income from contract industrial R&D, the remainder coming from 'soft' sources such as ESPRIT and LINK. Since its reformation in July 1993 targets have so far been met and an upturn in business has taken place. The University has made it clear that more money will not be forthcoming and that their loan will eventually have to be repaid.

> *'At the moment about 60% of our turnover is commercial, where we deal with companies, and the reason why we are in a position to win business quite successfully is that one of the things that the University does is to very significantly lower our costs as a commercial company.'*

These advantages include cheap accommodation, low cost network access and IT infrastructure and access to graduate students. '*We're a small company - at the moment we only have seven members of staff, although there's quite a number of PhD students.*' Their links with the university give them advantages comparable to those enjoyed by members of a huge corporate research lab, such as access to experts in a vast number of fields, but with none of the huge cost overheads which such organisations entail for their parent companies.

'Depending on where you're coming from you can see the organisation in different ways. One way of reading the articles and memoranda is that we are a part of the University, and that is very important because it means that success that we have in winning R&D moneys, in publishing papers and running PhD students are counted within the University's success, and as such they get a better score in comparative studies with other universities... and they get a larger block grant. That's the main benefit that they see out of it.

As far as we're concerned we have this access to cheap labour and cheap infrastructure, it's symbiotic - quite mutual. However, when we talk to commercial companies it is very important to stress that we are an independent, commercial company and we tend not to stress the university involvement. I'm not talking confidentially here, because a lot of other organisations do this, but when we talk to suppliers about getting equipment and they say "Are you part of the University?" we say "Oh yes, we're part of the University", because you get your academic discount. There are other sums of public money which you can only get access to if you're a commercial company - universities don't have access to that, we do. Basically you're dealing with an organisation which has a big hat rack: some commercial and some academic. Every new situation that comes along you adjust your presentation to optimise the amount of resources that you get. It's very simple.'

The work of the Institute has machine learning and knowledge based systems as one of its main foci. Their approach is firmly symbolic, involving the automatic generation of humanly transparent production rules from data. For business use this technology has the distinct advantage over sub-symbolic approaches like neural nets that the operation of the system can easily be understood, debugged and validated - important for mission critical applications and for compliance with various international standards. Their other main area of activity is 3D image processing - in the last year they have serviced four separate contracts involving the synthesis of a 3D surface image from photographs. This technology has a wide range of applications - from the production of 3D models of the earth to the representation of human heads for medical work, and such has been the interest in this area that they are currently working to 'productise' the system.

This is a shift away from their mission as a contractor of R&D.

'It's an interesting question - how often do you do repeat business before contract R&D become a product. If you do the same bit of contract R&D twenty times then it begins to look very much like a product. One way to migrate a technology from contract R&D to being a commercial product, which is a completely different business with almost nothing in common, is to do the same thing over and over again. I say that because the contract R&D business has a culture and a community of people in it whose interests are in "pushing the envelope", they have academic and scientific interests to "boldly go" - whereas in a products company everything's about the bottom line, and it's basically 99% marketing and sales and 1% yesterday's technology. It's likely that our organisation may split in the coming years, because of the cultural problems of keeping the products side in parallel with contract R&D.'

In his view it is inevitable that universities will eventually '*have to bite the bullet*' and consider the setting up of spin off organisations to provide support and maintenance on any products which they wish to commercialise.

He sees the move by larger companies towards 'rightsizing' and increased reliance on external contractors as working to the advantage of service organisations, including research service organisations such as the Turing Institute. '*It's definitely flowing with the direction of what's happening in the marketplace - people outsource and you go in there and get business which otherwise would have been handled within the company.... People have come to recognise that the most successful companies are small, but make up for having a small size by having a big network.... The social side is as important as actually writing code*'.

Does he see technology exploitation in the software field as similar to established methods in other fields, such as biotechnology or pharmaceuticals? He holds the film industry up as an perhaps the closest relative - like software it is project based and has technical and non-technical components. Studios are loosely organised, large numbers of small and highly specialised companies handle work on a contract basis and many participants are self employed. Distribution is a separate process and can be handled via a variety of channels. '*We're probably where Hollywood was in the 1920s - still at the silent movie stage. Perhaps in the 30s*.'

Have traditional ideas of basic research, applied research and product development no place in the software field? The film industry model suggests that the strict framework of conventional science, funding bodies, laboratories, hypothesis and so on with research papers as the primary output is restrictive. '*You don't do software for its own sake, software is always targeted to somebody else's problem. That always takes you into other disciplines*'. Within the Turing Institute itself some have artistic backgrounds, others were trained in mathematics, physics or computer programming.

> *'The traditional departments which make up universities, the Department of Physics, the Department of Chemistry, these things are starting to break down anyway - and what you're replacing it with is just a big soup of people.... You work in one subject and you end up contributing to another subject - and all the time, when dealing with people in the university doing mechanical engineering and genetics and geology, all the projects that people are getting involved with are all interdisciplinary, multi-disciplinary.... I think that because computers and computer software are so esoteric that they tend to permeate almost everything so that to an extent people in the area of computer software tend to be leading this cultural change.... replacing the conventional barriers within universities with a heterogeneous series of barriers, all of which are project based.'*

For example, a robotics initiative within the university also involves the departments of zoology, aerospace engineering and mechanical engineering. These kinds of temporary groups of interested participants, raising money and working together for a particular purpose, again remind him of the film industry. This kind of organisation is far more suitable for the addressing of complex, real-world problems - '*I can't think of any problem we've come across in the last five years where you can go to a single department and have all the expertise you need.*'

How important does he feel local contacts are? Despite the potential of modern communication technologies, '*none of these are a substitute for people getting together, scribbling on the back of beer mats and that kind of thing.*' Similarly, although bands can now record together without entering the studio at the same time, the creative quality of the music suffers. '*I think geography is very important - location and image*'. The Turing Institute is just a five minute walk from the campus - distinct enough preserve a separate identity, but close enough for regular social interaction and university members to drop by for coffee. In future the role of a computer lab may become primarily social, with development work best undertaken in more private conditions on a laptop or at home. However, so far no particular benefits have accrued from the relative concentration of computer companies in 'Silicon Glen' - '*my personal view is that we are yet to achieve the critical mass*' achieved in California where high staff mobility and strong personal contacts ensure rapid transfer of ideas and expertise.

> *'All the time... I keep going back to social things, cultural things and presentational things. I think that those are some of the most important issues to get right if you're going to treat software as a business successfully and make money from it.'*

The Institute has been involved in projects as part of ESPRIT I. II and III. How did he regard the experience?

> *'I regard it as a total a waste of time. We were in there right at the start, and we've been involved in a dozen different ESPRIT projects in one way or another, and I can't think of a single useful bit of technology we generated, or a case where we did something that led to any kind of genuine commercial business or a technology produced as an ESPRIT result actually went out and was commercially successful for Europe. The only beneficiaries I have actually witnessed are the international airlines and the hotels. I'm extremely cynical....'*

The projects involved work with organisations of all kinds, including large and small companies and universities. '*I suppose we have made some interesting links, but I honestly there's any business has come from them.*' However, a further ESPRIT proposal is currently under preparation. Preferred projects are those 'in the corners' of a diagram which are not reliant on the inputs of other groups.

'It really has to be a piece of code that you've already written, or failing that - which would be annoying - something that you had to do anyway.... You've also got to make sure that there's a member in Greece or Portugal to hold your summer management meetings and someone near Grenoble for your winter meetings - quality of life. Given the amount of money that's gone into ESPRIT it would have been far better used if people had made these projects much smaller, with a much much lower bureaucratic overhead.'

What is the Turing Institute really in existence to accomplish?

First and foremost, operating as a hard-nosed commercial company, to make money. If you've got money you can do anything - make a nice pleasant environment for yourself to work with, buy lots of machines, pick and choose on some things, it's definitely a way of solving a lot of problems.... The second element of the mission statement is "to boldly go" - everybody inside the Turing Institute has got a reasonable CV. I've got about 80 research papers to my name, and although I've talked about the commercial side you always like to carry little grains onto the beach of scientific knowledge... doing a bit of that is pleasant. The University can build that into their metrics of success, so there's no conflict there. The third element, which is implicit in almost every organisation, is doing things so that you can hopefully have a bit of fun... the Turing Institute organised the first Robot Olympics in 1990 - that was a real boost, put us on the map and it was a lot of fun.

How does he react to the suggestion that universities are public institutions which should not be heavily involved in ownership or support of commercial companies competing in the marketplace?

I think that is nonsense. If the suggestion here is that private companies are not receiving soft money from the government then that's baloney - just look at Nissan, how many millions did they get? You look at all the grants and so on which are available to commercial companies - we've set ourselves up sitting on this fence to try and kind of milk from both sides, and if you've set it up right and have a clear view of your goals and objectives and are prepared to do accounts and all that then you get your VAT back - that's 17.5% on the bottom line we're talking about, and there's all kinds of things you can do as a company which connect you to soft money which universities don't have access to.... Universities should be free to compete, the only thing is they need to be a little bit more professional about it, and a lot of that just comes down to people being honest with themselves, I think, about what they have to do.

I think universities do need to undergo some restructuring in thought, in as much as part of what a university is there for is to be a centre of broad based expertise in research and development... a conglomeration of people with in depth, specialist knowledge in certain areas. A university should also be a place where large numbers of people come to get taught, and I think that those are the two vision statements of universities, and that duality should be reflected far more in the physical structure of universities.... This obvious and natural dichotomy of what the goals of a university are will separate out into the R&D thing, in which people need to be sufficiently professional that they can compete on equal terms with commercial companies, and the teaching side - with whatever metrics and so on are appropriate there....

Whilst the two tasks should remain in the same institution, there is a case for differentiating between teaching and research staff, especially since prestige and promotion tends to accrue only as a result of research and publications under the current system - which is unfair to staff whose interests tend towards teaching. '*I think that's something which universities need to come to terms with, and they have barely started that process*.'

'If you look at many computing science department they run like businesses - take away the teaching side, what you've got left is at the level of a commercial business. They've got millions of pounds worth of turnover, they've got contracts, they've got deliverables, I think one of the major reasons why universities do find it hard to compete is that they are managed by people who have so little experience of those things. Typically you find the senior manager is an academic with a great CV who is suddenly promoted to be the departmental Prof. and are expected to play the role of a company CEO, and I don't think that they're cut out for that. There are some departments which are headed by people who do have the skills of a company Chief Executive, they are few and far between, but boy do they make their departments go super nova... they can get incredible leverage over the departments which aren't as good as they are.... Sometimes departments bring in people called Business Managers, but when you look at how this is done, particularly in British Universities, they do what the Prof tells them.... On the business side of things, and let's be blunt it typically is a business - look at all the contracts you get - they should be run by someone with formal business training. Most Profs don't even know how to read accounts... and I think universities lose out by not having a management structure that reflects what they're trying to do.'

He doesn't see any conflict between a more 'commercial' approach oriented to fund raising and the continuence of a strong tradition of basic research. Rather increased activity will create a surplus which can be chanelled to knowledge creation.

'Look at MIT, it's very comercially managed, yet you've got lots of people in there doing totally hare-brained things. The important thing is to get away from all these horrible old monastic traditions which I think have held academia back.'

'All of these ideas are only relevent at this time now - I'm sure that if we'd been having this conversation in the late 1980s I would have said different things, and all the people you've talked to would have said different things, and in five years time they'll be saying different things again. I've used the example of the football team - because these are the rules which apply now we're all developing these finely tuned strategies to optimise our play. At the moment it's football, maybe by the turn of the century it'll be hockey and we'll all be playing a different game.'