

1991

Institute for Manufacturing
Cambridge University

2007

IFM

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This report looks back over a 15 year period since the Gatsby Charitable Foundation began its support to expand the Institute for Manufacturing's Advanced Course in Design, Manufacture and Management. Over the intervening years the IfM has worked with Gatsby in helping to raise the profile of modern manufacturing and in particular to develop new approaches to dialogue between universities and industry.

The past 15 years have seen much change in UK Universities with an increased emphasis on the importance of knowledge transfer from the research base through constructive links between academics and firms. As the report demonstrates the IfM has built exemplary links with a variety of firms who speak warmly of their value. It has also developed and, crucially, deployed in partnership with industry, new tools to help improve productivity and competitiveness. At the same time it has maintained a strong academic reputation.

This success has not been achieved without some difficulties. There can be real tensions between achieving excellence in research, ensuring a high quality student experience and working with firms – not least because of the competing pressures on academic staff time. However, when the balance is well struck, students can benefit greatly from exposure to firms – directly through student projects as well as indirectly through enhanced teaching materials – and firms can provide both expertise and resources to focus and expand the research agenda.

Supported by Gatsby funding, IfM's Industrial Links Unit has worked actively with SMEs and public agencies to develop new tools which can, cost effectively, provide them with high quality advice and assistance. However, even in Cambridge's dynamic regional economy, work by university groups, with and for SMEs, remains a challenge and the indications are that some continuing public sector support will be required.

When the report was commissioned both Gatsby and the IfM were keen that it should provide useful learning from both successes and disappointments. The report describes some areas where, with the advantage of hindsight, outcomes may have been improved. This is hardly surprising when the number of projects is taken into account and should be expected given the fact that Gatsby funding was always intended to test new approaches and ideas. Within this context the overall conclusions are strongly positive.

Alan Bookbinder
Director

Background

The Gatsby Charitable Foundation has provided substantial grant funding, totalling some £6.93 million, to Cambridge University's Institute for Manufacturing (IfM) over a 15-year period since 1991. Grants have been given for a variety of specific purposes, reflecting the Foundation's view that manufacturing is important to the UK and its broader concern, to foster the processes of interaction between universities, colleges and industry.

At the time of writing (2007) there is a broad national commitment to such interaction. Significant public funding and other incentives encourage universities to engage positively, both in their regional economies and, more generally, with firms in production and service industries. This was markedly less true at the beginning of the 1990s and it was only towards the end of the decade (1999 on) that finance was provided through *Science Enterprise Challenge* (teaching entrepreneurship), *University Challenge Fund*¹ (for seed investments) and *Higher Education Reach Out to Businesses and the Community* (to build universities' capabilities and capacities in knowledge transfer). By that time, Gatsby had already funded pilot technology transfer initiatives in six universities, including the IfM in Cambridge. The first grant to support an Industry Links Unit (ILU) in the IfM was made in 1996.

Encouraged by the increased national emphasis on interactions with industry and greatly helped by sustained financial support from Gatsby, the IfM has grown both in overall size and the scale of its industry-related activities. Most revenue from such activities (but excluding research work for companies – which is contracted directly with the University) goes through Cambridge Manufacturing Industry Links Limited (CMIL) – a University-owned company dedicated to the IfM. In 2001/2002 the revenue was £285,000 yielding gift-aided profit of £11,000 and by 2004/2005 these amounts had increased to £1.45 million and £200,000 respectively.

There is no single data source for the number of people who have engaged with IfM but a broad picture has been pieced together² for the period from October 1997 to October 2006 which shows that:

- numbers of undergraduates on the Manufacturing Engineering Tripos (MET) course varied over the period but are now at similar levels to those in 1997 (annual intake of about 40);
- postgraduate numbers on the Advanced Course in Design, Manufacture and Management (ACDMM) dipped significantly owing to funding difficulties for students but climbed sharply three years ago to about 40, when the course awarded an MPhil for the first time;
- numbers of PhD and other MPhil students increased sharply from around 10 in 1997 to around 80 in 2006;
- full-time staff increased from around 25 to almost 90; and
- staff employed through the ILU (including posts supported by Gatsby) increased from four in 1999 to 18 in 2006.

A substantial part of the growth has been achieved by expansionist-minded Principal Investigators who have succeeded in winning research funding from public sector sources and from industry. However, there have also been some important additions to the range of IfM expertise which initially centred on operations and technology management, but now includes auto-identification technologies, industrial photonics (laser applications) and service and support engineering.

¹ Gatsby and the Wellcome Trust provided funds for this programme alongside Government.

² By Huw Richards

How is the IfM regarded?

Consultations undertaken for this report (listed in Annex A) evidence a highly positive and widely shared view of IfM's engagement with industry and suggest that this has been achieved while maintaining high quality in both teaching and research. With such ringing endorsements in chapter three, it may seem surprising that chapter four, which considers perspectives from within IfM as well as external views, suggests that not all aspects of work grant-aided by Gatsby have been wholly successful. Perhaps this is, in part, due to the tendency for academics to be self-critical and to set high standards.

Experience from the projects supported by Gatsby

The overall picture is positive. In all cases the resources have been applied to the intended purposes and, with two partial exceptions, to good effect. Most of the support provided by Gatsby in the most recent years aimed, in one form or another, to assist IfM's engagement with industry. For **large firms**, a successful approach has been developed to increase the IfM's capacity to undertake project work through the use of Third Party Associates. This is not without difficulties but they are recognised and should be manageable.

Some good work has been done developing new approaches to work with Small–Medium Enterprises (**SMEs**) and action-research with firms to refine them seems to have generated excellent value in itself. Additionally, the ILU has now built up a track record of successful work and should be able to attract funds from the regional and local development bodies to continue with it – despite having concluded that work with SMEs cannot be financially self-sufficient. There was a period when, despite strictures from Gatsby, the ILU might have been behaving similarly to a commercial consultancy, but this was stopped.

The two earliest Gatsby grants were for courses. The numbers of UK students on the ACDMM course must be considered a disappointment and, to a lesser extent, is the fewer-than-anticipated numbers on the Manufacturing Leaders' Programme (MLP). Both are, however, highly regarded.

The Manufacturing Professors' Forum has been warmly welcomed, although only a limited number of discussions were held with individuals in a position to offer informed comments. Similarly, there were only a few comments on issues of administration and governance relating to the IfM. The overall impression is that, following a period of some disorganisation during the most rapid growth, appropriate systems are now in place and working well. There are separate issues relating to governance, which a number of external consultees raised. They can be summed up by one consultee's comment that: 'Consideration should be given to management systems and sustainability after the retirement of the current director'.

There is only one grant which, with the advantage of hindsight, it may have been better not to make. That is in respect of the building at Wolfson College and this comment is based on the use so far made of that building. However, a good quality asset has been created and there is still scope to achieve the purposes for which the grant was made. There is no question of the funds having been used improperly.

Conclusions

The conclusions in the final chapter are very much a personal view and it may be of interest to read them in conjunction with this overview. The overall conclusion is that, even for a discipline such as manufacturing, which is inextricably linked to practice, engagement with industry needs to be carefully considered and reflectively managed. The IfM is highly successful in working with firms but potential downsides are clearly evident which need to be worked around.

Bill Wicksteed
Senior Research Associate, University of Cambridge
January 2007

This report looks back over the period since 1991 during which the Gatsby Charitable Foundation (hereafter referred to as Gatsby) provided financial assistance to the Manufacturing and Management Division of Cambridge University's Engineering Department. Since 1998 a substantial part of the Division's activity has been identified as the IfM. The report has been prepared at the suggestion of Gatsby's Trustees, but with the positive engagement of IfM, with a view to taking stock of how the IfM has developed over this period. The intention is to help both IfM and Gatsby reflect on the successes and disappointments of what has been a joint mission while at the same time drawing out issues that may be of wider interest to others concerned with the interactions between business and universities.

In several senses this is an 'insider's' perspective. Bill Wicksteed has undertaken previous work for Gatsby in connection with their support for Technology Transfer³ activities and he has also had a long-standing involvement with the Institute for Manufacturing⁴. If this were a formal, arms-length, evaluation such previous involvements might be considered disadvantageous. However, in view of the emphasis on learning for the future, there are considerable advantages in having a deeper empathy with Gatsby's and IfM's objectives, as well as having an understanding of its social organisation/everyday operations and of the constraints within which IfM, as a University department, has to operate.

This report is based on a wide range of consultations, all of which took place in the second half of 2006.⁵ They covered:

- firms with which IfM has worked – whether in a long-term relationship or on a specific contract assignment (opinions were sought both from SMEs and from major multinationals);
- IfM staff – including both those with close connection to the Gatsby-supported activities and others in IfM who have an overview on its development and current standing;
- academics and administrators elsewhere in Cambridge University with a perspective on the IfM whether from their roles in the Engineering Department or the Judge Business School, or the University's links with industry;
- senior academics working in the field of manufacturing and management at other UK universities; and
- civil servants in the Engineering and Physical Science Research Council (EPSRC), the Department for Trade and Industry (DTI) and the regional and local development agencies.

As is the case with many university groups, the IfM has extensive networks and, if time had not been a consideration, it would have been easy to have spoken with far more people than those selected. In particular, the IfM has strong international links and views have not been canvassed outside the UK. In deciding who to approach externally the aim has been twofold: to obtain perspectives on the Institute's academic standing; and to gauge views on its links with industry. Discussions within IfM focused, in particular, on the tensions and occasional difficulties that arise from high levels of commercial and research interactions with firms. What these difficulties have been and how the IfM is seeking to deal with them may be of particular interest for the general reader.

This report seeks to emphasise, where possible, the general lessons that may be taken from the IfM's purposeful pursuit of links with industry and the importance of Gatsby support in making this possible. Two blanket cautions must, however, be applied to all such commentary. In terms of general context, there have been far reaching changes in the policy framework relating to, and financial resources available for,

3 Rapporteur for a CVCP mission to the USA *Technology Transfer – the US experience* February 1999. Reviewer (with Walter Herriott) of Gatsby-supported *Six UK studies in Technology Transfer*, December 2000. Joint author (with Tim Minshall) of *University spin-out companies: starting to fill the evidence gap*, January 2005.

4 Currently he has an appointment as a part-time Senior Research Associate in the IfM's Centre for Economics and Policy.

5 A list of people consulted is given in Annex A.

university-industry links during the period covered by this report. Of equal significance, it must be remembered that the IfM is operating from its position in a division of Cambridge University's largest department (engineering). The University 'brand' has strong positive recognition amongst companies, government and other academics and this has been an important asset for the IfM.

The largest single Gatsby grant to the IfM, £1.5 million, has been for the construction of meeting facilities and residential accommodation in partnership with Wolfson College. There are elements of commercial confidentiality relating to the project and in this report coverage is limited and general. [A separate note with more detailed commentary has been given to Gatsby and the IfM management team.] With this single exception, all relevant grants to IfM are considered in this report.⁶ Further commentary is provided, in Annex B, on the complementary grant funding to St John's Innovation Centre in support of activities to promote knowledge transfer and entrepreneurship.

The report is structured as follows:

- chapter two introduces the IfM and how it has developed over the last 15–20 years. It also provides a broad overview of the support received through Gatsby grants;
- chapter three gives feedback on how the Institute is regarded by others;
- chapter four considers the objectives which motivated Gatsby support for the IfM and discusses the experience gained to date from the activities funded by the grants; and
- chapter five highlights some issues that may be of wider interest.

The process of assembling the facts and views that underpin this report has involved imposing upon the time of many busy people. With the exception of a very few who escaped through unavailability, they have been generously tolerant of the imposition and keen to help. This willingness reflects the generally positive light in which the IfM is viewed. Critical comments and some concerns have been raised, but in a positive spirit, with the aim of improving the relevance and effectiveness of a group whose commitment and contributions are valued. Thanks are due to all consultees who contributed to this report.

⁶ Gatsby has also given grant support to the Cambridge Massachusetts Institute.

2 An overview of the IfM's development and Gatsby involvement

IfM's development⁷

Division E – Manufacturing and Management – of the Engineering Department, within which the IfM sits, provides courses to the engineering department as a whole and its 'own' undergraduate and postgraduate courses, both of which have a strong project content where students gain a practical understanding of industry. The ethos of involvement with firms was established by the Advanced Course in Design, Manufacture and Management (ACDMM), which has been offered as a postgraduate course for some 40 years – for the past three awarding an MPhil. When, in 1979, Cambridge moved from a three to a four-year undergraduate degree in engineering, the Production Engineering Tripos became an option which undergraduates could choose as years three and four of their degree. This is now known as the Manufacturing Engineering Tripos (MET).

In the mid-1980s, Professor Colin Andrews was appointed as Professor of Mechanics – which at his request was changed to Manufacturing Engineering. In addition to a strong academic reputation, he has experience of running a business and was interested in the potential of the 'Cambridge Phenomenon' – which had recently been given heightened prominence through the 1985 SQW book.

Mike Gregory was at that time a lecturer who had been running the MET course for five years and had previously worked on the ACDMM course. He had an embryonic ambition to establish a manufacturing institute. Professor Andrews was sympathetic towards the idea, but counselled that a convincing academic track record was a prerequisite for such a move. At around the same time (1984), two Harvard academics, Steven Wheelright and Robert Hayes had published an influential book – *Restoring our Competitive Edge – Competing Through Manufacturing*. The combination of an internal stricture and a stimulating academic context encouraged Mike Gregory to develop an academic perspective on manufacturing.

Following a series of industrial and academic consultations in 1985 and 1986 an EPSRC Research Grant *Manufacturing Audit* was won. It aimed to explore how manufacturing strategies might be understood and designed in a business context. The appointment of Ken Platts in 1987, and his pursuit of the project as a PhD topic, achieved a sharper academic focus and a DTI project to produce a 'workbook' for industry ensured industrial engagement. This strand of research led to the **Centre for Strategy and Performance** (which now has 16 associated staff)⁸.

A further key appointment was that of David Probert, who joined in 1990 on a Royal Academy of Engineering/Lucas Senior Fellowship, whose work has subsequently evolved into the **Centre for Technology Management** which has a staff of 33. The Centre has many and varied links with companies and achieved a distinctive success in the development and application of road mapping techniques. A number of major companies from a wide range of sectors have joined the Centre's Industrial Membership for which they pay an annual subscription of £10,000 and through which they are encouraged to engage in active dialogue with the Centre's staff.

Also in 1990, Mike Gregory took sabbatical leave which he used to visit Japan and the United States so as to benchmark the relevance of the MET course against international comparators and, more generally, to learn how others approached manufacturing education. Gatsby provided financial assistance for these

⁷ In this section a small number of illustrative snippets mention some important links with industry. Further information is available on the IfM's website: www.ifm.eng.cam.ac.uk

⁸ These numbers, which are indicative rather than precise, date from mid-2006 and include both doctoral students and part-time associates but exclude MPhil students.

trips. The post-visit report prepared for them highlighted the Leaders for Manufacturing programme at Massachusetts Institute of Technology as a prompt for a possible mid-career MBA in manufacturing in Cambridge. It also reinforced the importance of responding to shortening product lives, through new approaches to rapid product introduction, and the importance of technology management as a domain. In response to the report, Gatsby made a general offer to consider requests for assistance that would help advance manufacturing engineering at Cambridge.

A further key appointment was made in 1994 when Yong-jiang Shi came from Tsinghua University to undertake a PhD on International Manufacturing Network Configurations. This work provided the basis for the **Centre for International Manufacturing**, which now has 19 associated staff and which has developed distinctive expertise on mobility issues, alliances, networks and location issues. It currently has two major projects with memberships from large companies (each pay a substantial subscription of over £30,000 or £50,000 per year) – the global manufacturing networks forum and the supply chain consortium.

In the same year, Mike Gregory was appointed Professor and Head of the Manufacturing and Management Division, having indicated in his application the ambition to build an institute for manufacturing. Duncan MacFarlane (since 2006 Professor of Service and Support Engineering), joined in 1995 from Broken Hill Properties in Australia and his work has led to the **Centre for Distributed Automation and Control** (now the Distributed Information and Automation Laboratory) which currently has 18 staff.

Ian Hutchings was appointed GKN Professor of Manufacturing Engineering in December 2000, having previously worked in the Department of Materials Science & Metallurgy and built an international reputation in tribology (friction, lubrication and wear). As a Fellow of St John's College he has, since 1996, been Chairman of St John's Innovation Centre, a key actor in Cambridge's high-tech cluster. He is the Principal Investigator for the major research project on next-generation ink-jet technology.

In 2001, the IfM was given a major grant as one of the first of the EPSRC's 'Innovative Manufacturing Research Centres' (IMRCs). In 2003, Bill O'Neill joined, bringing with him from Liverpool University his IMRC-funded research into laser-based micro-engineering. One of the motivations for this move was the profile offered by the IfM, the multiplicity of its links to firms and enhanced access, at a senior level, to major companies. The **Centre for Industrial Photonics** now has 12 staff and over the past three years has worked with upward of 30 companies – charging large ones healthy commercial rates, but providing some free time for worthwhile SMEs. It is expected that the Centre's work will generate commercially attractive Intellectual Property and process expertise which will generate funds for the university team.

These five centres which, taken together with the smaller **Centre for Economics and Policy** account for just over 100 staff, are distinctive in that they are constituted as voluntary co-operative entities but have the clear purpose of providing continuity, infrastructure and longevity in key research areas. To varying extents, they pool the income derived from consultancy, publications, royalties and executive education. Pooled funds are held through an account with Cambridge Manufacturing Industry Links Limited (CMIL) which can be used for purposes such as paying the salaries of research staff between contracts, or to undertake specific research projects prioritised by the Centre. Not all staff choose to join a centre and the IfM website features three further research groups:

- the Production Processes Group;
- the Sustainable Manufacturing Group; and
- the Decision Support Group.

There is a good deal of overlap between the first two groups and the Centre for Industrial Photonics also features as part of the Production Processes Group. The other major element of this Group is the research consortium studying **next-generation ink-jet technology** in which the team at Cambridge leads a team, including researchers from four other universities, on a five-year project looking into the use of ink-jet printing techniques for different materials (including some with a high solids content). The project has a £3 million budget with a £2 million grant from the EPSRC and £1 million in contributions from the

eight member companies (five of which are based in the Cambridge area). There are encouraging signs that the Research Group may well expand beyond its grant in both scale of activity and longevity.

About one third of the members of the Sustainable Manufacturing Group are also members of the Centre for Technology Management. After these overlaps are netted out the three research groups account for a further 32 staff. This brings the grand total to around 136⁹ of whom 66 are Doctoral Students. A further 27 staff,¹⁰ some of whom are research-active at the Judge Business School, work on the MET, ACDMM and MLP or are employed in administrative or other support roles. The **Industry Links Unit** employs a further 18 staff (FTE) although three of these provide more general support to the IfM's overall activities. On this basis there is an ILU team of 15 staff, with line management responsibilities for a further 10 self-employed 'industrial fellows' which provide outreach to industry alongside some 70 research staff.

Gatsby grants to IfM from October 1995 to date¹¹

Over this 10-year period, Gatsby made grants totalling almost £3.6 million principally in connection with technology transfer and knowledge diffusion. In broadly chronological order these grants:

- supported the development of an informal **network of instrumentation manufacturing companies** – the first such sector-specific initiative coordinated by the IfM – which aims to help member firms to solve technical and manufacturing problems, understand new developments in product and process technology, provide firms with a forum to discuss issues of mutual interest and meet their education and training needs through seminars and workshops. Grants totalling approximately £405,000 supported this work over a five-year period from the end of 1995;
- enabled the establishment and development of the **Industry Links Unit**¹² through the provision of core funding totalling £830,000 over an eight-year period from mid-1996 to mid-2004;
- supported specific **action–research work with SMEs**, undertaken through the ILU, with grants totalling £1,450,000 over a period from end-2000 to mid-2007. This has sought to develop, test and disseminate analytical 'tools' which advisers can use to assist manufacturing SMEs at crucial points in their development path;
- funded the appointment of a **Senior Research Fellow** to the IfM staff with the remit to research into and engage in knowledge transfer and dialogue with firms. Two grants totalling £615,000 covered employment from mid-1998 to end-2009 (the original expectation was that the money would cover just over five years);
- provided grants of £160,000 to contribute towards the **administration** requirements of the IfM, and in particular the need for enhanced marketing and promotion, over the period from end-2000 to mid-2004; and
- supported the establishment and operation of the **UK Manufacturing Professors' Conference**, which brings together heads of UK manufacturing groups from across the UK and also invites selected leading academics from overseas. Through an annual conference, its aim is both to share views on priority issues and encourage further networking. At the conference dinner, policy-makers and leading commentators from various organisations have the opportunity for dialogue with the academic community. Grants have totalled £135,000 for the period from the beginning of 2002 to mid-2007.

In chapter four, the operational experience from these activities is discussed and considered against the objectives Gatsby hoped to achieve. Before that, chapter three sets a broader context by giving feedback as to how IfM is regarded by selected 'stakeholders'.

⁹ A few are part-time

¹⁰ A few are part-time

¹¹ The overview provided here focuses on all the major grants with the exception of the £1.5 million provided to Wolfson College. It ignores some small and one-off grants that appear in Gatsby's records. These are considered in later chapters.

¹² The initial work on the ILU was undertaken by Tom Ridgman. The first full-time recruit was John Lucas who was followed by Paul Christodoulou. The current director, Peter Templeton, has been in post for about three years.

3 Feedback – ‘to see ourselves as others see us’¹³

The previous chapter sketched an outline of the IfM’s growth in scale, breadth and engagement with industry. Growth in a business usually entails some risk although, in financial terms, the support from Gatsby has helped to avoid some of the problems and tensions that arise from pure bootstrapping (financing growth through internally generated surpluses). Growth in a university setting can bring particular problems in maintaining the balance of effort between teaching, research and knowledge dissemination. A further issue arises from the nature of university appointments and the high level of competition for teaching posts (lectureships etc), which confer academic freedoms as well as a rather greater element of job security when compared with contract-based employment.

The feedback offered here is based on a range of discussions¹⁴ outside the IfM and further informed through insights provided by a number of self-critical discussions within the Institute. Even so, the justification for its conclusion is more on the basis of *faute de mieux* than any claim for scientific rigour. It should be seen as offering the basis for further discussion and reflection rather than a definitive judgement.

At the risk of obscuring the niceties of differing individual views, they are grouped under the following headings:

- feedback on the taught courses;
- feedback on research; and
- feedback on engagement with industry.

It is hoped that these groupings adequately observe the confidential nature of the discussions from which they draw. Where there is a strong consensus on a particular point, this is generalised. However, there are other points that come from one or two individuals which can best be conveyed by a verbatim quote.

Feedback on the taught courses

When deciding who to interview, most emphasis was given to obtaining feedback on links with industry. Nonetheless, all the academics interviewed outside the IfM offered considered views on taught courses as did a number of companies. Several other companies, including SMEs, spoke of student projects being helpful.

A set of overarching comments referred to the importance of manufacturing being taught by a group with strong and varied links to industry – ie students being taught within a creative milieu which gives great emphasis to the application of research. Cambridge attracts the top echelon of undergraduate engineers and it is important that those who choose the manufacturing option are motivated to consider careers in industry. It is the most able students who are likely to aspire to top management positions later on, so it is vital that they are exposed to the human dimensions of manufacturing – ‘where people work in complex, dangerous, technological and expensive environments’.

So far as the Manufacturing **Engineering Tripos** is concerned, comments were consistently very positive although, encouragingly, the sentiment within IfM was to make continuing efforts to sustain its attractiveness to the top undergraduates:

- ‘The MET is a stellar success – it is very highly regarded in colleges and the university.’
- ‘MET is absolutely first rate.’

¹³ Robert Burns wrote: ‘O wad some Pow’r the giftie gie us, to see oursels as others see us, it wad frae mony a blunder free us, and foolish notion’.

¹⁴ See Annex A for a list of individuals consulted.

The **Advanced Course in Design, Manufacture and Management** was also well regarded:

- ‘The key to ACDMM’s success is that it is steeped in practice and industry involvement.’
- ‘ACDMM is a very expensive education but it attracts very bright young people and educates them very well – it should be replicated elsewhere.’
- ACDMM has been a very successful course but ‘perhaps consideration could be given to an ACDMM run for 30-year-olds rather than recent graduates’.

With respect to both ACDMM and the **Manufacturing Leaders’ Programme**, the question was raised as to ‘whether teachers are sufficiently rigorous on the management and economics aspects?’. It was suggested by one consultee that there could be a case for strengthening the team with a specialist management academic. Other comments on MLP were, however, clearly positive:

- A company which is recognised as a global leader said: ‘we are keen on MLP and pick out key internal talent for grooming – students are typically promoted afterwards’.
- ‘The work undertaken in the MLP is of very good quality.’

Feedback on research

Views on IfM’s research were generally highly complimentary. There was, however, something of a divide between those from industry and some of the academics. A few academics queried the nature of the central mission of IfM and which ‘big questions’ are being addressed through research. For other academics the latter question is irrelevant in a practical academic discipline – ‘don’t listen to those who snipe about the research process and claim lack of rigour, but look at the effect. Research should be judged in terms of its value to industry.’

Although there is a concern that being overly close to industry could distort the research agenda, this is a general caution rather than a criticism of the IfM’s work. Rather, ‘IfM people have been important in establishing the view that manufacturing research is academically respectable’. Moreover, when many policy makers were dismissive of manufacturing, ‘The IfM and Kumar Bhattacharyya kept manufacturing on the agenda and sustained a research base on which it was possible to build when a more balanced view on manufacturing was re-established’.

Several people had a rather outdated view of the IfM’s current range of research as they tended to concentrate on the strategic and technology management elements. ‘IfM has come from operations’ management – almost a social science applied in an engineering context – a translational discipline.’ Another consultee said ‘manufacturing spans both engineering and social science – so it is looked down on by both’. While positive mentions were made of the work on distributed automation and control and of the centre for industrial photonics, they were not as widely identified with IfM as the less technical research areas.

Even within Cambridge’s engineering department, some of the department do not know what happens in IfM (and are generally not interested in the management aspects) though ‘it is generally recognised that the IfM addresses serious problems and does so well’. One external view was that ‘Cambridge University has a great strength relative to other universities because of its across the board excellence’, the research that IfM undertakes is done very well, but could it make more of this positive context? Another consultee also wondered whether IfM could collaborate more actively with other parts of the University.

Views from major firms were uniform in being strongly positive:

- ‘Consultancy companies increase our capacity, the IfM deepens our capability and it brings its own powerful network. IfM has a distinctive ability to link/listen, an easy engagement for firms, and thereby to make its work useful to industry.’
- ‘The radio-frequency identification (RFID) work is very relevant.’
- ‘The technology value road map should be valuable (as the road mapping tool has been more generally).’
- ‘A colleague with a wide international overview on product creation processes rates the IfM and Cambridge University very highly.’

Feedback on engagement with industry

Feedback on IfM's engagement with industry was uniformly and strongly positive. The importance of this was encapsulated in the comment of an external academic who said that for manufacturing academics 'industry is the laboratory, so interactions with senior industrialists are essential'. More detailed consideration of the work with small firms is given in chapter four, although general comments from two small firms are included in the verbatim comments reported below:

- academics
 - 'The IfM and Kumar are the two big success stories. The IfM has a good reputation in the UK and this is more than one person deep.'
 - 'Networking to industry is exceptional.'
 - 'IfM's willingness to talk with small companies is much appreciated.'
 - 'IfM is held in very high regard in industry.'
 - '... much better than other universities – best in the UK.'
- public officials
 - 'Very engaged with manufacturing and have a serious understanding of industry – positive about engagement, which is very unusual.'
 - 'IfM is distinctive because of a collective willingness to work with industry – in other universities it's often just loners.'
 - 'Able to engage sympathetically and effectively with traditional firms.'
 - 'IfM is not too driven by short-term metrics and is therefore pretty relaxed about giving access to SMEs.'
 - 'Global economics briefing (eg China) is useful for firms – especially when it's translated into "this is what it means for your business".'
 - 'Has Cambridge University handed over its regional responsiveness to iio?'
- firms
 - 'IfM is very strong in technology management – through dialogue with them we can help shape their research agenda so it's useful for industry generally.'
 - 'We had to persuade other parts of the university to take an interest in a strategic partnership – Mike Gregory responded positively.'
 - 'Find IfM very open and keen for a relationship – can use IfM people to get into the rest of the university.'
 - 'David Probert's team are unique in their approachability and understanding of industrial problems.'
 - 'IfM are very good at listening when compared with other university groups – who tend to argue rather than engage in reflective dialogue.'
 - 'IfM flies the flag for Cambridge University's engagement with local industry – it breaks through the barrier of academic snobbery.' *small firm*
 - 'It is impossible by contrast to get into other parts of the University – eg chemistry and the rest of engineering – IfM makes small business feel important.' *small firm*
 - 'IfM does better than MAS East – which is too target driven.' *small firm*

In summary

With such ringing endorsements it may seem surprising that chapter four, which considers perspectives from within IfM as well as external views, suggests that not all aspects of work grant-aided by Gatsby have been wholly successful. Perhaps this is, in part, due to the tendency for academics to be self-critical and to set high standards.

4 Gatsby's objectives and the experience gained

As in chapter two, this chapter groups the Gatsby grants under a set of generic headings which are considered in turn below. These are:

- expanding the ACDMM course;
- launching the MLP course;
- network of instrumentation manufacturing companies;
- Industry Links Unit;
- Senior Research Fellow;
- 'Growmore' action research work with SMEs;
- grant for facilities at Wolfson College;
- administration; and
- UK Manufacturing Professors' Conference.

However, before delving into this finer grain commentary, it is helpful to consider the higher level objectives that motivated the Gatsby grants and to consider them against the feedback reported in chapter three. An important aspect of Gatsby grant-giving, which distinguishes it from many other sources, is the willingness to take risks, to expect some failures, to be open about them and to share learning from them – recognising that the lessons from projects and programmes that have not succeeded according to their initial hopes are likely to be at least as valuable as those lessons learnt from successes.

Gatsby's overall objectives and decision to provide sustained support for IfM

At the broadest level Gatsby has, over the range of its involvements in the UK and overseas, sought to identify and address important but unfashionable problems which need to be tackled through long-term and consistent approaches. An important aspect of the implementation approach has been to find an individual with relevant enthusiasm, energy and ability and to back them.

Gatsby wants to inspire young people to be excited about engineering and for them to be excited about making a business out of ideas. It also has an interest in manufacturing and a sense that it is important for the UK, alongside which there is a general interest in knowledge transfer from universities and further education colleges to industry.

How the involvement developed

The engagement between Gatsby and the IfM was essentially developed by a small number of individuals. Gatsby's priorities reflected the concerns and convictions of David (now Lord) Sainsbury before he became a Minister and had to withdraw from involvement. For the technical education element he was closely supported by Roger Baker¹⁵ who joined Gatsby from Cranfield University, where he was Dean of Engineering. The initial approach to Gatsby came from a visit to David Sainsbury by Lord Pilkington and the then Vice-Chancellor of Cambridge University, Professor (now Lord) Broers. They sought to obtain Gatsby funding support for the University.

¹⁵ When Roger Baker wished to leave his Gatsby post, the Trustees provided funding to support him as a Visiting Professor based in the IfM. He has worked full time at the IfM since 1998 and for a year so before that had a part-time involvement in helping to establish the Gatsby-funded instrumentation group.

As a follow-up to the meeting, Gatsby undertook its own enquiries into where funds might best be applied; which brought them into direct contact with Professor Colin Andrews. This led to support for the ACDMM course and subsequently, in conjunction with Mike Gregory, the MLP programme (see chapter two). During the dialogue with Gatsby, it was then decided to undertake a pilot knowledge transfer project involving the IfM with instrument firms (a personal enthusiasm of Roger Baker) and that Gatsby would support an Industrial Liaison Unit within the IfM (a priority for Mike Gregory). The grant for a building at Wolfson College was in support of the ILU's enthusiasm to develop a short course, although there were also other considerations at play.

The next major area of grant support was for IfM to explore the possibility of a Steinbeis-type knowledge transfer model, which followed a visit to Germany in September 1999 by Roger Baker, Mike Gregory and John Lucas (then the ILU head). This led on to support for work with small and medium-sized companies (latterly focused on companies 'on the cusp') through a series of grants known as Growmore. The initial impetus for the Steinbeis model came from Gatsby, although the subsequent proposal to develop work with SMEs was enthusiastically embraced by Mike Gregory and the ILU who recognised that engagement through research was not enough and that networks of SMEs were playing increasingly important roles in UK manufacturing. As outlined below, it is less clear that there was full buy-in from other key University staff in IfM.

The final new activity supported was the UK Manufacturing Professors' Conference in which Mike Gregory took the lead, which was a deliberate move by Gatsby to broaden out its support from a narrow Cambridge focus.

The grant support given to IfM is a reflection of Gatsby pursuing its objectives through the IfM as well as the IfM securing Gatsby funds for its development priorities.

In view of the positive feedback reported in chapter three, the overall objectives for both organisations appear to have been achieved. The IfM has established an ILU with a business plan which envisages the generation of significant surpluses, has further enhanced its relationships with companies and other stakeholders and has 'been able to achieve things that it could not have achieved without Gatsby's support'. For its part, Gatsby can point to an enhanced standing for manufacturing engineering and, in IfM, an organisation which is an exemplar for effective knowledge transfer to, and two-way dialogue with, both large businesses and SMEs.

A question to keep in mind when considering the individual activities in the paragraphs that follow is the extent to which they will continue after Gatsby's support has come to an end (with the proviso that it may not, in all cases, be necessary or even desirable that they should continue).

Expanding the ACDMM course

Gatsby support for the ACDMM course aimed to expand the numbers of students by means of two annual intakes each with 36 students. The grant was used primarily as seed funding to meet staffing costs during the build up and to help with vehicle purchase. By 1995, student numbers had grown to 33 on the September course and 23 on the December course and approximately half the Gatsby grant had been used. In view of the failure to achieve targets, IfM offered to seek more support from the University so that there would be no need to draw down the rest of the Gatsby funds. Up until 1996, there were two other universities working with Cambridge to deliver the course – Durham and Lancaster.

However, in 1996 Higher Education Funding Council for England (HEFCE) support for staffing costs was halved as part of its reallocation of resources to research. Durham and Lancaster sought funding from Cambridge to cover their shortfalls and when it was not forthcoming dropped out of the course delivery. As an immediate response, Cambridge merged the intakes to a single stream of 50 in 1996. The level of this combined intake then dropped to 35 in 1997 and drifted further down, to around 30 between October 2002 and October 2004. This was mainly as a result of the cuts in studentships from 47 in 1996

down to eight in 2006 (these do not cover travel in connection with research but meet all other costs). In parallel, most students had moved from having their first degrees fully paid (fees and some subsistence costs) to the current situation where they have substantial debts on graduation.

IfM's response was to reshape ACDMM to offer an MPhil qualification (known formally as the MPhil in Industrial Systems, Manufacture and Management) and, at the same time, reduce the timetable to nine intensive months, ending with a major dissertation. This brought an immediate increase in student numbers – which have remained at just over 40. There are now around 250 applicants per year, of high calibre. However, the majority come from overseas; of the current 42 students there are only six with UK passports and, perhaps, another 15 from other EU countries. Such high proportions of students who are unfamiliar with the UK make for difficulty in running the course, although there are advantages from student exposure to a wide range of other nationalities. Considerable effort was made to increase the numbers of UK students through sponsorships (and Gatsby provided additional funds to develop an ACDMM alumni association), but these have proved unsuccessful. However, work on the database was amalgamated into the overall IfM contact database.

If the positive feedback on the course mentioned above is representative, the survival of the ACDMM in the face of adverse developments has been a positive achievement. Moreover, it is likely that without Gatsby support the course would have foundered.¹⁶ It is not, however, clear that Gatsby's original objectives have been met in terms of the impact on the UK economy, nor is it clear that there is a solution in sight for the fundamental problem of attracting more UK students. The impasse remains despite clear identification of the problem and strenuous efforts to address it.

Launching the MLP course¹⁷

As mentioned above, the initial stimulus for this course came from MIT. Considerable effort was, however, devoted to developing a course outline that would meet the needs of UK companies for a 'post experience scheme to prepare high potential technologists for very senior management roles in manufacturing industry'. The concept of a course during which 'students' would remain actively employed within their own companies was tested in workshops with major companies – who also helped to draft the prospectus. The outcome was a two-year course during which students spend four periods, each three weeks long, based in Cambridge. At the end of the course, students prepare a 12,000-word thesis along the lines of 'if I applied what I have learned in my own organisation ...'.

The highest level of intake for MLP was 16 and somewhat unwieldy. The current level of 12 works well, but is below the initial calculation of what was required for commercial sustainability. In some years numbers have been lower than this and, whilst the course has always gone well, there has never been a need to turn good people away. In recent years, a more serious problem has arisen from a shift in student ages which have increased from the initial average of around 30 to rather older and more senior managers, some of whom have struggled to complete their theses in the face of increased work pressures within their firm.

In order to resolve this issue, suspending the new intake for a year will allow a fundamental re-think of the course. In particular, there may be a need to re-address the economics of the course to ensure a comfortable break-even, bearing in mind the level of market interest and the reported trend for fewer companies to offer a two-year personal development programme. From Gatsby's point of view, MLP can be seen as a success – the companies attracted include ABB, Ford, GKN, GSK and Rolls Royce. For IfM, sustaining another line of connection to such companies provides significant potential spill-over benefits and MLP is recognised as an important programme that merits careful attention.

¹⁶ When the Gatsby funding came to an end in 2000, a major EPSRC grant was given to support the next five years, but the hope then expressed of using this breathing space to 'generate industrial funding to cover the majority of places' has not been fulfilled.

¹⁷ The MLP benefits considerably from the new facilities at Wolfson College, although there are some niggles about levels of service.

Network of instrumentation manufacturing companies

This sector/cluster initiative was to be aimed at medium-size companies 'who (. . . with the globalisation of manufacturing . . .) need to be able to assimilate, develop and apply new techniques and technologies swiftly and reliably if they are to remain competitive.' The instrumentation sector was chosen 'as it meets the criteria of high technology and experience of growing international competition. It remains, nevertheless, a serious international force and sufficiently typical that lessons learned might be transferred to other sectors.' In practice, supply-side considerations were also relevant as Professor Baker, then the Gatsby executive leading on technology transfer, had a particular interest in the sector and intended to secure collaboration with Cranfield University (though they later dropped out of the reckoning as 'their financial expectations of return are greater than we can realise at present').

After some initial recruitment problems, it took more than a year to recruit the full-time project manager although preliminary work had been initiated by others, a considerable degree of company interest was generated and 'a significant proportion of companies tell us of problems which need solutions'. In some instances, such assistance could be provided through student projects or short consultancy inputs from the project managers. Others, however, required more substantial assistance and Gatsby was approached for a grant to fund 'two bright young graduates who would be available to work on the industrial problems under guidance . . .'. It was expected that this guidance would come from the project manager and from academics with expertise pertaining to the particular problem.

Initial results were encouraging and when an interim review was undertaken in 2000¹⁸ there were 27 member companies (half from the Cambridge area) and work was under way to develop a Motor Sport Manufacturing Group. The instrumentation group itself was forecasting a membership of 90 by mid-2002, which prompted a comment in the generally positive report from the interim review, that 'to achieve its future membership (and hence budgetary) targets, however, it would seem that considerably more effort will need to be put into marketing'. Partly as a result of staffing problems, these ambitions were not achieved – efforts to promote the group ran out of steam and the formal group membership scheme was merged into the IfM's overall membership within which there are affinity groups for both instrumentation companies and for companies interested in manufacturing planning and control.

There is, however, continuing work with the companies thanks to the interest and efforts of Professor Baker (now full-time with IfM – see below under Senior Research Fellow) who is involved with two major projects, has continuing links with several others and also arranges two or three one-day workshops each year (which typically attract 10–15 participants from industry). Several other instrumentation companies maintain active links with the IfM (eg through a 'Skills' project). Perhaps most encouragingly, it was from experience gained during the work with instrumentation companies that the idea for the next-generation ink-jet technology project emerged.

A number of lessons can be suggested from the experience of the instrumentation group:

- the initial expectations were over-optimistic; without a detailed evaluation it is not possible to judge the impact of the young graduates' work with individual companies funded under the second Gatsby grant, but they would appear not to have been sufficiently viable to cover costs in the way that was originally hoped. A more in-depth appraisal of the market may have been appropriate (and more attention to the cautionary remark in the interim review report?);
- it may have been easier to sustain the momentum of the instrumentation network membership if there had been a substantial research group working on instrumentation-related issues. This would have produced new research and insights to reinvigorate the seminars and other activities and such content could have been generated, at least in part from academic research projects using public research funds (if the intended link with Cranfield had been achieved, that would have helped in this respect);

¹⁸ In December 2000 *Six UK studies in Technology Transfer* were undertaken by Bill Wicksteed and Walter Herriott for the Gatsby Charitable Foundation ISBN 0951020234.

- in terms of both market conditions in the selected industry and the research base within IfM, the context for the instrumentation work was less favourable than that facing the Gatsby-supported research group in Nottingham University whose positive experience was mentioned in support of the second project application; and
- the sustained commitment of an individual academic has paid off – both in terms of the continued engagement with IfM of several instrumentation companies (and some very positive feedback from them) and in terms of the major ink-jet project. There are two general lessons from this:
 - first, the need for an established enthusiastic academic with appropriate expertise, interpersonal skills, capacity and commitment to remain involved after commencement of the project; and
 - second, that new initiatives should plan for a positive exit strategy so as to avoid wasting potential further opportunities by effecting an over-sudden closure – there should be plans, with allocated budget reserves, to allow an ‘after-care’ activity (government programmes have an unfortunate tendency to go for a ‘clean break’ with the past).

Industry Links Unit

When Gatsby approved the grant for the ILU, the Trustees ‘encouraged’ the Unit to achieve the following objectives:

- a) industrial outreach – a pro-active approach from the centre;
- b) collaboration with all regional bodies – Training and Enterprise Councils (TECs), Industrial Liaison Offices (ILOs), science parks, as well as other departments in the University including the Judge Institute;
- c) a sound financial basis to balance long-term viability with realistic overhead and recovery;
- d) close linking between education, research, technology transfer and practice; and
- e) appropriate arrangements to attract and keep high quality academic and professional staff to work across academic/industry boundaries.

While IfM colleagues have raised some issues about the ILU’s structure and operations, which are outlined below, and are being addressed following a recent review, there is only one of these five objectives which is not being addressed effectively. The exception is objective b above. There has been good engagement with East of England Development Agency (EEDA) and the Greater Cambridge Partnership as well as St John’s Innovation Centre, but the scope for greater collaboration with other departments in the University and other divisions of engineering, was specifically raised as an issue by consultees. This is, however, a more general issue for the IfM as a whole and it is perhaps unreasonable to expect the ILU to behave counter-culturally – there are positive advantages from the IfM having a culture that is rather different from that of a typical academic group.

The report from the interim review in 2000 was strongly positive but highlighted the difficulty in recruiting a director who ‘requires a set of skills and experience that are scarce’. That difficulty has persisted, both with the director post and others. Two directors have left since 2000 although there has been encouraging continuity with the present incumbent over the past three years (and one of the two ‘leavers’ remains in close touch on a freelance basis). There has also been mixed success in the recruitment and retention of staff to work with firms. It has, by contrast, been relatively easier to recruit and retain good people for events organisation, marketing and promotion.

At Gatsby’s request (to ensure transparency) the University agreed, after a good deal of soul searching, to set up a separate company, Cambridge Manufacturing Industry Links Limited (CMIL), which is wholly University-owned. This too had some teething problems, as it was difficult to recruit a good financial administrator – University accounting systems are somewhat arcane and CMIL has 20-plus cost centres. However, CMIL now operates effectively and the company structure is a significant asset for the IfM which enables centres and individuals to be rewarded tax-efficiently for their work with industry. The administrative resource that the ILU provides through CMIL is widely appreciated by IfM colleagues.

In order to increase the capacity to undertake work for industry beyond that which the academic staff can provide, the ILU has developed a structured approach to the use of Third Party Associates (TPAs).

The need for this has been recognised for some time. The 2000 interim review reported (paragraph 7.10):

‘In due course, the ILU may also face the problem of balancing the interests of industrial outreach against the requirements of teaching, research and scholarship. The need is to increase the level of industry-related activity without diverting too much energy from IfM’s central educational mission. Already there has been some call made on freelance resources to help deliver events using material and approaches pioneered by IfM’s research centres. The ILU is alert to the need for this approach to be extended so that the scarce academic resource can be devoted to the creation and pioneering of new products and services.’

For projects that will bear commercial charge rates, typically with large firms or groups with rates of £1,000 per day and upwards, the ILU draws on a group of TPAs who have held senior posts in industry or, less frequently, consultancy. Several have been on IfM courses. They work for the ILU at their own risk on projects for industry in which IfM’s analytical tools or other research-derived knowledge can be applied. The TPAs are charged with keeping abreast of developments in IfM expertise, focusing on a particular centre or research group, and with feeding back the experience that they gain from the industry projects. A set formula shares fees between the individual TPA, the ILU (to cover overheads) and the research centre whose expertise is applied. In cases where a specific research tool or technique is applied, a surcharge is added to the day rate (25% for a mature product or 10% for one under development). While most projects are for large firms, there have been two cases in which SMEs have been willing to pay full commercial rates and they both involved the solution of a pressing technical problem.

The contributions from outreach activities can be substantial. In the case of ‘road mapping’, the technique has been used with a diversity of organisations such as large firms, groups of SMEs (typically from the same sector), central government, Faraday Institutes and a Regional Technology Centre. Delivery is through one or two-day public training courses and in-company courses in the UK and internationally – where coverage has extended to Hong Kong, Japan, Singapore, South Africa, Spain, Thailand and the USA. Since 2003, the revenue from this work has supported a senior research associate and a research associate. Road mapping is also featured in IfM’s undergraduate and graduate courses and has been the topic for a PhD and two Master-level theses.

Apart from its intrinsic strengths, one reason why road mapping has been able to evolve is that the researcher who was active in its initial development, and continues to develop the technique further, is also happy to have a very active engagement with its delivery – thus ensuring that the two-way feedback works. There are other tools/techniques where the academic with the core expertise does not have time (or perhaps the aptitude) for a substantive involvement in delivery. In such cases, there is much greater reliance on a TPA resource and a danger that further development work proceeds too slowly to maintain its freshness.

While in many respects the TPA model has proved excellent in expanding the outreach effort (and generating funds to support the ILU and the IfM), it is the source of some internal concern and there are also concerns about the overall scale of ILU. These and other, often positive, comments can best be summarised in consultees’ own words:

- ‘The ILU is very good on handling contractual mechanics. It is also good on art/design/presentation and on events organisation. But it should do more in marketing to win contracts for in-company training courses (which are less stressful for the deliverer than an open workshop).’
- ‘The size of the ILU means that its overhead is too high and not enough revenue comes back to the centre. It was a bad move for the ILU to try and develop its own “products”. The ILU did very well in upgrading the standards of events and the distribution of published material. It should now do more to encourage short courses for major firms. The ILU is not good at selling.’
- ‘Although local links are desirable, could courses be run in other parts of the country?’
- ‘There is a fall off in demand for courses using established material and a possible need to take them to new areas – possibly in partnership with other organisations.’
- ‘Events management is very good.’

- ‘It’s disappointing that more progress has not been made in developing executive education through short courses.’
- ‘There is not enough feedback from TPAs to research centres, centre staff should have some direct involvement with projects. It’s questionable whether TPAs are using IfM tools or using their own – in which case there are worries about quality control and the integrity of the “brand”. Not all TPAs are “part of the IfM family”.’

These comments should, of course, be considered in the context of the positive feedback reported in chapter three and they also need to be set alongside the experience of what has been the most difficult of the ILU engagements with industry, the work with manufacturing SMEs.

The Steinbeis model for knowledge transfer

The Steinbeis Foundation and its associated operating company were established in Baden Wurttemberg (BW) to provide the seed funding and infrastructure to encourage professors to establish Steinbeis Transfer Centres (STCs). In the early years, these centres were only in the Universities of Applied Science (Fachhochschule) and not universities proper. Now the distribution of STCs is much more varied. An extension to universities was prompted by the BW State Government, which had a poor opinion of university Industrial Liaison Officers and concerns about the level of overheads charged by the universities for applied research. The STCs have spread from the BW to the rest of Germany and overseas.

From prior knowledge, Gatsby had a favourable impression of the Steinbeis Foundation and this was reinforced after a visit to see both them and two Institutes of the Fraunhofer Gessellschaft (jointly with IfM staff). There was early discussion about setting up a separate technology transfer trust which would take over all Gatsby’s technology transfer and manufacturing activities. The aim would have been to establish between three and six new Gatsby technology transfer centres each year and enlarge the Cambridge Centre to accommodate the network director, a PA and an administrator.

The grant to the IfM was to undertake research on how such a model could work in the UK context to ‘provide a targeted service to high-potential technology-based businesses’. Fourteen companies participated in detailed research to explore the key problems experienced during growth, the support services used currently and the distinct core support required by manufacturing firms. Initial suggestions were made on delivery methods, including some interesting, but so far abortive, work on a ‘manufacturing incubator’.

However, plans for Gatsby’s national initiative did not proceed, although the IfM’s engagement with the exploratory work led to the subsequent development of the **Growmore** initiative. Steinbeis clearly demonstrates the value of academic engagement with medium-size enterprises (MSEs) and some small companies rather than SMEs in helping them to solve problems through consultancy and short/sharp applied research projects. As will be considered below the parallel between Steinbeis activities and IfM is less than perfect as the Steinbeis network can cover the full range of technological expertise, whereas IfM has only recently been developing research expertise in selected ‘hard’ technologies.

Interestingly, the Government-supported i10 project which networks 10 regional universities to provide their expertise to firms across the East of England is seeking to meet many of the Steinbeis objectives and also to foster collaborative sector/cluster groups. A number of IfM staff members have contributed actively to Cambridge University’s participation in i10.

Senior Research Fellowship

This post, occupied by Professor Baker, was supported by two grants which were sufficient to provide four-and-a-half-years’ employment. Mention has already been made of the contributions Professor Baker has made to work with instrumentation companies and the initiation of the ink-jet project – in which he

was strongly supported by Dr Rick Mitchell the former technical director of Domino Printing Sciences. The appointment was made on the basis of a detailed proposal and the Trustees have received a detailed final project report on the work undertaken through the grants during the period from July 2000 to December 2006. This confirms that the objectives agreed by the Trustees have been fulfilled.

It is, perhaps, invidious to comment further on an individual appointment and the fact that it has been a successful one largely removes the need to do so. There are, however, two findings of general interest in the final project report. First, sufficient income has been secured from the work undertaken with firms to almost double the term of the appointment. Second, a number of student projects were undertaken, including ACDMM students, and the University secured three Knowledge Transfer Partnerships (KTPs).

Substantial efforts were devoted to generating the KTPs involving several false starts and the project report concludes:

- ‘Unless the KTP is central to the University staff member’s interest, it is unlikely to have the priority it needs, and may become a drag on their work and in the end wholly negative.’
- ‘To find a company which is in an appropriate area of interest, has a project in that area, is interested in developing the KTP, and sees it through, is probably long odds.’
- following a discussion of some daunting practicalities, the overall answer to the question ‘is it worth it’ was ‘yes – if due care and thought is taken in advance and a good RA is forthcoming’.

Growmore – action research work with SMEs

The ‘Steinbeis’ research (2000–2002), undertaken by Derek Ford and Vanessa McNiven, identified two poorly-served areas of need:

- ‘high potential start-ups – which require assistance in developing product design and initial production capability, and
- established small companies with high growth potential – which require assistance in developing more sophisticated production processes and controls.’

A substantial Gatsby grant (£761,050 over three years from 2002–2005) was approved on the explicit understanding that, as noted in the IfM proposal, ‘... this is essentially an ambitious and high-risk proposal’. The hope was that ‘... the deployment of high quality intervention managers, closely linked to the IfM and well linked nationally and internationally, will have a much higher success rate. The proposal envisages break-even in five years but funds are only requested for the first three years. A “hard review” after two years is proposed to assess progress’. The Trustees, in giving approval to the grant, suggested that it may be useful to obtain benchmarking skills from expertise within the Judge Institute and commented further that they would like projects to be brought forward for consideration, ‘which encourage collaboration between engineering and management’.

An interim report covering the first two years of work supported by this grant was submitted in July 2004 under the heading Growmore Research Project. This concluded that the most effective approach for the IfM to engage with Small and Medium Manufacturers (SMMs) was:

- 1) ‘Use a diagnostic audit tool to determine objectively the areas of the business in greatest need of improvement.
- 2) Apply Strategy, Functional, Innovation, Technical engagements in line with the conclusions from the diagnostic audit.
- 3) The MSS is encouraged to implement the outcomes of (2) with minimal support from the IfM as this has been found to improve adoption. However, it has also been found that a side-effect of (this) light-engagement implementation approach is that it can lead to a delay in implementation follow-through.
- 4) Transition to a Mentoring form of engagement on completion of the high priority projects.
- 5) Re-engage with Strategy, Functional, Innovation, Technical engagements when the SMM’s circumstances require new input.’

In order to deliver this approach, individuals need to have 'broad manufacturing industry experience and knowledge/skills in the application of the following:

- diagnostic audits;
- definition and facilitation of business and functional strategies;
- business process improvement;
- manufacturing/supply chain education and training;
- mentoring;
- team building; and
- account/relationship management'.

In setting out this list of personal attributes, the report hits on the central dilemma of SME advisory work. Arguably, not many such individuals exist, even fewer are especially interested to work with SMEs (apart from some true venture capitalists – who are ferociously selective) and only some of those will be content to do so within the financial bounds of the university system. Unsurprisingly, recruitment of the industrial fellows who are employed by the ILU to work with SMMs has been an issue. In particular, only one of six staff employed by the IfM (largely full-time) on Growmore has demonstrated an ability to sell.

The interim report considered national roll-out and its preliminary conclusion was that commercial organisations would not be interested and that Higher Education Institution (HEI) involvement depended upon their having 'significant interest and abilities in "softer" manufacturing-focused management and business process disciplines'. It did not venture to suggest where those HEIs might be found, but commented more generally that:

'to maintain quality and shorten time to productivity, the tools and methodologies must be turned into "products" which can be learned and adopted more quickly. As the service providers become more numerous and widespread, a more formal quality assurance mechanism is required to maintain delivery standards'.

The implicit delivery agents in relation to these suggestions for 'productisation' and quality control systems are public sector-funded organisations and programmes, but the report does not consider whether such organisations are likely to have people with the requisite qualities or which of those attributes the 'productisation' might render unnecessary.

These points do not appear to have been raised in the Sponsor's meeting in July 2004 at which the interim report was discussed, although it was noted (somewhat opaquely) in the minutes that 'the provider needs to be closely allied to the businesses it is supporting, either by geography, function or specialism'. The final report on **Growmore Phase 1**, which included a proposal for continuation funding to enable further work with firms and refine the 'products' does, however, state that:

'The plans for Phase 2 of the programme envisage a series of deliverables which will 'package and disseminate' the learning from the programme, making the tools, techniques and approaches widely available. An integral part of this activity will be to understand the needs of various providers of business support so that the packages can be tailored to their needs and those of their customers.'

For **Growmore Phase 2**, Gatsby accepted the conclusion that outreach to firms could not be commercially viable (commercial providers would need both to charge the SMEs they were assisting and to receive a subsidy from the public sector) and made a specific grant to the ILU (accounted separately) 'towards engaging – on a non-profit basis – high potential manufacturing enterprises'. The aim was to intervene positively in providing value-added services to two types of high potential SMEs 'on the cusp':

- type A companies with two or three people, with a solid commercialisable product or service and no idea of how to turn it into a business; and
- type B companies, typically with 50–100 people, which need to get over the hump between being a small business and a medium-sized one – moving from management by the entrepreneur/owner to professional management structures and staffing.

In the event, increasing pressures for the ILU performance to become more commercial led to the work with Type A companies being downplayed and more focus being given to Type B.¹⁹ In any case, it proved very difficult in practice to identify firms of either type that were 'on the cusp' – an outcome that might have been foreseen by those with prior experience of work with SMEs. The conclusions from a complementary piece of work are germane to this point:

'It has been challenging to engage with target companies for this project. This is evidenced by the fact that only 25 companies responded to invitations sent out to more than 750 companies to attend the workshops. This low response is often because firms lack the money or time to dedicate resources to external events, even though they are aware that these events might be worthwhile in the long run.'²⁰

At the time of writing, Phase 2 is still under way, but there are some encouraging signs that roll-out through 'productisation' may have a future (although not all the 'products' are yet developed). Both the **Manufacturing Advisory Service for London** and the **Red Meat Industry Forum** are paying for training in, and the right to use, 'products' that have already been proven through the Phase 2 work (£15,000 and £23,000 respectively). Moreover, some well-regarded work has been done with firms. Evidence collected by Derek Ford, who heads the work for SMEs within the ILU, for his ACDMM thesis reported that 19 firms (90%) out of 22 were with either satisfied (42%) or very satisfied (48%) with IfM collaborations.

Discussions with SMEs to obtain feedback

For this report conversations were held with eight firms selected at random from a list provided by the ILU (10 firms were approached and two did not respond). Before the conversations they were asked, through an introductory e-mail, to consider five points:

- your overall experience of working with IfM;
- how you rate them relative to other external providers of information and expertise;
- whether the work provided 'value for money';
- which areas of their performance should be improved (and how?); and
- any other points you would like to make?

Overall, the responses were very positive as the following verbatim comments show (grouped by question rather than firm to ensure confidentiality):

Your overall experience of working with IfM

- 'Went to short courses and liked them. Had an MLP project (extended?) which was very good. Rest of services too high-flown so dropped membership.'
- 'Performance is very person-dependent – one man very good, another not as service-minded or knowledgeable.'
- 'Overall happy.'
- 'Diagnostic went well, recommended them to another company, have maintained membership, involved in student projects and had mentoring for a divisional manager.'
- 'Have done student projects and had mentoring help from IfM. Believe that it is an excellent two-way relationship.'
- 'Very positive and professional. A good range of expertise and experience.'
- 'Overall experience very good. Diagnostic model is excellent.'
- 'They undertook a review and helped implement systems, then there was a student project. Very professional. Very helpful – made themselves available any time of day.'
- 'Student project went well and overall experience during follow-on work was good but lacked in final delivery – however, will stay in touch.'

19 However, work with Type A companies is being undertaken in Cornwall, financed through a Gatsby grant, by Paul Christodoulou; a previous head of the ILU. He is working with clusters of companies in: (1) agriculture/food (companies which that have some kind of production process), (2) environmental technologies and (3) media.

20 *Growth through High-Value Manufacturing* – report to the Greater Cambridge Partnership and the East of England Development Agency, April 2006, by Derek Ford and C Jelbert, IfM.

How you rate them relative to other external providers of information and expertise

- ‘Rated very well against others.’
- ‘Not just after money, had firm’s interest in mind.’
- ‘The people lack sophistication in terms of range of experience that large consultancies provide – though probably not a problem for SMEs.’
- ‘Match other externals well, though can be a bit over-theoretical because of their research interests.’
- ‘IfM better than have seen so far in commercial sector.’
- ‘Go to Manchester for production management.’

Whether the work provided ‘value for money’

- ‘Good value, will likely use again.’
- ‘Good value for money – really pleased that such help available for a medium-sized company.’
- ‘£500 per day is good value and at that price it’s quite acceptable that IfM are finding their way. IfM could charge more if their offer was clearer in terms of “what we’ll provide, what we’ll deliver against agreed objectives, timetable” etc.’
- ‘Work was value for money though could be high for a small firm.’
- ‘Very good value for money.’
- ‘Mentoring work with one manager is good value for money – but how dependent is IfM on one or two good people? Would have done a research project but couldn’t afford it.’

Which areas of their performance should be improved (and how?)

- ‘Although the diagnostics work was good they didn’t go on to point out operational weaknesses. Good on processes, but fought shy of judging people and helping managers to understand how they and others are performing. Big firms don’t need this, but small ones on the cusp of growing to medium do.’
- ‘There was variability in the quality of people and no one followed up after the consultant had left the IfM.’
- ‘Fed up with long questionnaires after an event and there’s too much paperwork after a visit.’
- ‘Should set expectations beforehand and measure outcomes at the end.’
- ‘Would like to see more mentoring for the lone MD who lacks an internal support infrastructure or the money to buy it.’

Any other points you would like to make

- ‘Firm’s link to IfM goes down well with customers.’
- ‘Fery good that they’ve pulled together a group of manufacturers in the UK – networking is really important.’
- ‘Have used IfM/Cambridge University “brand” to show customers/suppliers/staff that the firm is working with top people – it’s a very strong brand.’
- ‘Some good companies are going to stay small even though they are profitable. They provide good jobs and shouldn’t be ignored in public policy.’
- ‘Need to avoid putting firms off by over-emphasis on theory.’
- ‘Although courses are good we don’t need to use regularly as only relevant to one or two people in the firm and we have a low staff turnover.’
- ‘Maybe they should be a bit less diffident about selling at the workshops/seminars.’
- ‘Relationship with the Manufacturing Advisory Service (MAS) East is unclear, clarity would help.’
- ‘IfM should make much more value/leverage out of university link. Also, would like to see more numerous networking events.’

Feedback from others on SME issues (including IfM and ILU staff)

There was interesting feedback from others about working with small firms. The internal comments tended to be informed by a view on the work being done by the ILU team. The outsiders’ views were sometimes reflections from a more general perspective, as they were not necessarily abreast of all aspects of the ILU work.

Views from IfM staff:

- ““Productisation” won’t make SME work viable without a subsidy (although the ILU team have done some good work with SMEs).’
- ‘Government publicity convinces SMEs that they will get top-notch business advice that is either free or very cheap – not a big help.’
- ‘The Growmore programme didn’t get much marketing support from the ILU generally.’
- ‘To speed up the pace, the ILU tried to hire its own people to develop “products”. That was wrong, this output should come from the academic base (ie the research centres and groups)’.
- ‘For a time the ILU SME work become efficiency-focused rather than learning- focused. This was inappropriate and has now been put right.’
- ‘What small firms need is education on dealing with a changing environment.’
- ‘Providing there are research outputs to work with (research centres need to get smarter in making their work useable) and overheads are kept low, then a team from within IfM would be able to work with SMEs provided there was a public sector subsidy of around 50%.’
- ‘Intervention approaches need to be based on case histories through which diagnostic tools can be properly developed.’
- ‘Providing SMEs with a good enough service (which is affordable) to justify their IfM membership is a challenge.’
- ‘Hard to systematise work for small companies because their problems are so general and they often need help across the board. The likelihood of a systematised tool being what the firm needs is rather low. The IfM should get involved with SMEs when:
 - IfM is offering a product that firms actually want to buy
 - there is an exciting new challenge to tackle in partnership with the firm.’
- ‘There was only one person in the ILU SME team who would sell – so self-sufficiency was never likely. The others wanted to be paid more than their academic colleagues but still wanted academic freedoms (didn’t like being told what to do).’
- ‘There was insufficient feedback from the ILU SME team, for instance on the diagnostic tool or to guide the development of future courses aimed at SME development.’
- ‘Whilst working proactively for SMEs is unviable, being re-active may be different as they are willing to pay commercial rates when they have a compelling problem.’

Views from external discussions

- ‘The criteria for SME engagement should be:
 - is it an interesting problem?
 - are there any project opportunities for students?’
- ‘How about approaching SMEs through their supply chain relationships with major companies?’
- ‘The Engineering Design Centre is being asked by the EPSRC to relate more to SMEs, it would be good if the ILU team could help with this.’
- ‘It has been very tricky to financially free-stand work for SMEs – they don’t exert much knowledge pull.’
- ‘SMEs usually need technical help not management research. It is hard to sell the benefits of things that prevent cock-ups (good management is invisible).’
- ‘Work with SMEs has to be affordable for them in both money and time (their scarcest resource is top management time).’
- ‘Universities are perceived to be altruistic, not manipulative, the promise to a SME should be reliable expertise offered in a friendly manner.’
- ‘Dubious about the relevance of outreach to SMEs (though the IfM has done it really well) it’s not really appropriate for Cambridge.’
- ‘The importance of SMEs for student projects should be given full weight.’
- ‘For the technology-focused groups within IfM (eg photonics and distributed automations and control) a technology transfer scientist – along the lines supported by Gatsby at Nottingham University – might work.’
- ‘Despite the fact that SME work is not viable for the IfM it has been of real value for the firms assisted; as can be demonstrated through case studies.’

- ‘Could an IfM client company act as a demonstration project and partner the IfM in training other firms in the application of IfM techniques (and earn some money by so doing)?’

What next for SME engagement?

Much, if not all, of the foregoing is known to the ILU management. Whilst there are some consistent messages (for instance about better links to the research centres) a number of other views are divergent. The overall IfM decision is that efforts to work with SMEs should be sustained but that the future approach will be not to maintain in-house SME delivery capacity within the ILU except what is necessary to maintain the quality of the products **and** to deliver subsidised public sector programmes, which offer learning benefits that are of interest to the IfM. Put more positively, the ILU report for July 2006 says as follows.

‘We have found that work with small and early stage firms is not financially self-sufficient.

To address this we have:

- secured an allocation of the University of Cambridge HEIF-3 funding
- secured a competitive HEIF-3 award led by the University of Essex to develop and disseminate (the above) tools for early stage firms
- developed a business model which should generate income from the licensing and support of the (above) products
- submitted a proposal to the GCP and EEDA for the development of an enterprise hub . . .

Additionally, we shall continue to generate income from our services to SMMs and from our membership programme.’

In summary

From Gatsby’s perspective, the outcome is rather positive. Some good work has been done developing new approaches and work with firms to refine them seems to have generated excellent value in itself. Additionally, the ILU has now built up a track record of successful work and should be able to attract funds from the regional and local development bodies to continue with it. There was a period when, despite strictures from Gatsby, the ILU might have been behaving too similarly to a commercial consultancy, but this was stopped.

There is, however, a sense that what has been achieved could have been done more efficiently and that during the period when there was a focus on viability (and when feedback to the research centres suffered as a result) the grant’s objectives were not being addressed as fully as they ought. Put more crudely, the same could have been achieved with less money. Some of the blame must be shouldered by the (then) ILU management and the IfM’s internal steering group. However, Gatsby’s emphasis on sustainability/viability will not have helped. Developing an approach through which viability is understood and the learning reflected in new approaches, which aim to increase viability is one thing. Aiming to move towards viability during the experimental phase is another, and this objective may well conflict with the development endeavour – leading to confusion and waste.

Grant for facilities at Wolfson College

A grant of £1.5 million was made to Wolfson College ‘in response to a proposal from the Institute for Manufacturing, so that the IfM could contribute to Wolfson’s building programme and thereby secure substantial first refusal rights on use of the new facilities for short courses’.²¹

The IfM’s request for funding summarised current problems with other facilities for teaching and accommodation in Cambridge which were constraining the development/operation of some of its current courses and inhibiting the development of new programmes.

‘The trends in industrial education indicate a move away from conventional degree courses, as applications for engineering courses are in sharp decline. To compensate for this there will be

²¹ Extract from a letter sent by Gatsby to the Cambridge Foundation and copied to the IfM and Wolfson College before payment of the first tranche of grant.

an increasing need for in-service education, both to broaden individuals as they progress through their careers and to enable them to understand and implement new technologies and management philosophies and techniques.’

In the event, IfM has made less progress in developing executive education than had been hoped at the time of the grant application and there have been practical problems in the relationship with Wolfson College, some of which could not have been foreseen at the time. For instance, when the ACDMM became an MPhil course, students were no longer all enrolled as members of Wolfson College as had previously been the case. Additional problems emerged in relation to the building layout.

The overall result is that the Gatsby grant has been used less productively than it should. However, a general lesson for Gatsby is that, when substantial sums are being granted for building projects, the Trustees may wish to consider appointing their own independent expert to monitor preparation of the brief for the building, implementation of the project and management plans for its subsequent operation.

Administration and governance

Specific grants were made to help pay for administrative support. Without this support, the level of growth achieved by the IfM may well have run into severe problems. There are multiple complexities in building an organisation that presents an efficient and friendly face to industry within the constraints of a democratic university structure – in which competition for resources is always strenuous. Even with the benefit of Gatsby help, one external view was that ‘the level of administrative support is insufficient compared to what would be the norm for a business school’.

This review has not looked specifically at, or sought feedback on, questions of administration. The overall impression is that, following a period of some disorganisation during the most rapid growth, appropriate systems are now in place and working well.

There are separate issues relating to governance, which a number of external consultees raised:

- ‘Consideration should be given to management systems and sustainability after the retirement of the current director.’
- ‘Mike needs someone strong as a deputy to challenge him and take over the day-to-day running’.

Perhaps IfM may be thought of as a Type B company on the cusp, in which there is a need to move from leadership and management by the founding entrepreneur to a professional management structure. If issues of governance and management had been raised by a fully independent reviewer they would, doubtless, have elicited a voluble (and probably rather disparate) set of responses from IfM staff. It was not within the scope of this report to consider such issues and the reviewer’s good personal relationships with a number of the key individuals – saints, sinners and hybrids – would, in any case, have vitiated an attempt to do so. Suffice it to say that questions of succession planning merit attention before too long.

For similar reasons, this report does not presume to consider issues in connection with the IfM’s new building, towards which Gatsby has promised a substantial contribution.

Manufacturing Professors’ Forum

In April 2002, Gatsby and the EPSRC sponsored a conference of UK professors associated with manufacturing. This provoked much enthusiasm about developing a more active community. The background justification for this was set out in the proposal to Gatsby:

‘The academic community associated with the manufacturing industries has traditionally been rather fragmented reflecting a narrowly focused industrial view of manufacturing in some circles and the discipline based organisation of the universities.’

As the understanding of manufacturing broadens to include the full range of business activities from understanding markets through design, production, distribution and service, there is an increasing need for a more integrated academic approach to the field.'

Only a few of the consultees had knowledge of the Forum, but their feedback was positive:

- 'The Forum has been a success, people are still keen on it but is there potential to give it greater long-term sustainability through developing a broader-based manufacturing academy.'
- 'Mike provides subtle leadership to the rest of the manufacturing community. He has used the Cambridge brand of excellence in a very positive way.'
- 'The Manufacturing Professors' Forum has brought together the technical and management people concerned with manufacturing and has strongly influenced the ESRC's AIM initiative.'
- 'IfM has handled relationships with others well and generously.'

Without Gatsby support, it would seem likely that the Forum would have faced a tougher challenge to become established, as the EPSRC decided against providing funds – so that the Forum could be an independent lobbying group.

In summary

The overall picture presented above is positive. In all cases the resources have been applied to the intended purposes and, with two partial exceptions, to good effect. Gatsby indicated that it would be useful to have an overview under four headings and these are the ones used below.

Mistakes

There is only one grant which, with the advantage of hindsight, it may have been better not to make. That is in respect of the building at Wolfson College and this comment is based on the use so far made of that building. However, a good quality asset has been created and there is still scope to achieve the purposes for which the grant was made. It would not be unreasonable for Gatsby to ask that the IfM and the College jointly consider how best to do so. There is no question of funds having been used improperly.

Failures

None of the initiatives funded has proved an outright failure. The numbers of UK students on the ACDMM course must be considered a disappointment and, to a lesser extent, this is true of the rather lower than anticipated numbers on the MLP course. Both are, however, highly regarded. With relation to the Growmore initiative, there may have been a period during which sight was lost of the primary objective of the grant, but that has been rectified. Finally, not much progress seems to have been made as yet in working with other parts of the University in ways that Gatsby hoped would develop.

How clearly articulated were the objectives when the grants were made?

From the limited documentation to hand the conditions attached to the Wolfson grant appear to be insufficiently precise.

As already mentioned, the objective of achieving a self-sustaining activity in working with SMEs could have been elaborated more reflectively. There may also have been a case for further consideration of the context within which Steinbeis operates and, by comparison, the position in the UK and the IfM before such a substantial grant was provided. Furthermore, there could have been benefit from a clearer break between the initial action research and the subsequent operation of **Growmore 2** (although significant breaks in funding do make for severe difficulties in retaining good staff and this may have been a justifiable consideration).

How well were outcomes monitored?

In May 1998, the first 'Sponsors' meeting of the 'Cambridge engineering related programmes' was held. This involved senior Gatsby staff and key individuals from the IfM and SJIC. Thereafter, a pattern was established of meetings in January and July each year. Reports were submitted to each meeting in relation to the grant-assisted activities and these appear to have been informative, although the minutes for 2006 suggest some Gatsby irritation with a failure to respond to requests for information. Up until the end of 2005, the minutes are discursive in tone. They provide a useful way of following through the evolution of the various projects. For the meetings in 2006, the minutes are more formal and descriptive and are less helpful for that purpose.

Neither the minutes nor the progress reports make any mention of the Wolfson College building but, apart from that one omission, the monitoring seems to have been effective – if not overly rigorous. This last observation is not a criticism. One of the great strengths of the Gatsby funding is that it is given in a flexible spirit which is very different from many public sector grants – which require elaborate record-keeping against targets that are often unreasonably detailed in their scope and unrealistically optimistic in their ambitions. Such apparent rigour can easily lead to inadvertent distortions in execution and greater waste than a more pragmatic approach would have achieved.

5 Dangerous conclusions – issues of possible wider interest²²

The reason that the discussion in this section is ‘dangerous’ is that the extent and depth of research undertaken might well be thought insufficient to provide a base from which to reach ‘safe’ conclusions.

As a preface to hazarding some overall conclusions, it may be helpful to start by quoting from a perceptive report produced by Science Policy Research Unit (SPRU) on ‘The Impact of Publicly Funded Research on Innovation in the UK’.²³ Under the heading ‘Talent not Technology’ it makes the following, somewhat uncomfortable assertion:

‘The UK Government has developed policies to encourage the exploitation of knowledge produced by the UK university sector, highlighted in a Competitiveness white paper (*DTI*, 1998). The strategy includes new funding streams to support technology transfer, including University Challenge (which provides seed-corn funding), Science Enterprise Challenge (which encourages the incorporation of entrepreneurial training into science and engineering curricula) and the HEROBAC scheme (which aims to build capability in knowledge transfer in universities and colleges in England and Northern Ireland; comparable initiatives to promote commercialisation are under way in Scotland and Wales). The Government also set a target of a 50 per cent increase in the number of start-up companies to come out of UK universities (*DTI*, 1999).

The current approach of the UK Government contains much that is positive, but there is also a danger. There are limits to the commercial role of universities and research. Although UK universities could be more entrepreneurial, it is in general true that universities tend to be poor commercial agents. This report suggests that an exaggerated emphasis on promoting university commercialisation would be misplaced because it would see universities as a source of technology rather than talent (*Florida*, 1999). The UK Government needs to be conscious of the limits to commercial exploitation of university research, and should attempt to emulate the best of US practice. Where US universities have been most successful in supporting economic development, they have been allowed the academic freedom to develop and publish new ideas freely and to recruit and retain talented people.

The evidence shows that the transfer of academic ideas into industrial practice is best achieved where universities are given the freedom and resources to conduct high quality research. Short-term, aggressive and narrow drives to force universities to commercialise technology are rarely successful (*Geuna*, 1999). Universities should be magnets for talented people. The current environment in the UK of low pay, heavy administration and limited flexibility undermines the recruitment and retention of talent in the university sector.

There is a risk that UK universities could face an unattractive prospect: an overly aggressive commercialisation strategy conducted by low paid, disinterested university staff. The prospects for commercialisation of university research will be more successful if UK academics have access to the resources and freedom they need to conduct high quality research and are given the right mix of incentives to promote new ways of working with industry.’

At one level, this summary could be read as a rather plaintive bleat for higher salaries and more money for research (and there was a strong case for both in 2000 when the report was produced). There are, however, some proper cautions about the ways in which universities should engage in the processes of wealth creation and this report concludes by considering, briefly, the value of the IfM experience in this context.

22 ‘For if he rises and touches the stars with his head, his feet are no longer anchored on the ground. Clouds and winds buffet him about. If he stands solidly on safe, firm ground he can never reach up far enough and only be compared with the oak tree or the vine.’ *Grenzen der Menschheit*. JW von Goethe.

23 Ammon Salter, Pablo D’Este, Ben Martin, Aldo Guena, Alister Scott, Keith Pavitt, Pari Patel and Paul Nightingale – Science and Technology Policy Research (SPRU), University of Sussex May 2000.

Context

In so doing, the following caveats should be borne in mind before seeking to generalise more widely from the IfM experience:

- the nature of manufacturing as a discipline is that engagement with industry is of great importance for both teaching and research – ‘industry is the laboratory’;
- Cambridge University is justifiably proud of the high tech cluster that has grown up in the surrounding area but, until fairly recently, was supportive mainly by implementing systems which did not interfere with engagement. In terms of policy, this has now moved to a positive stance, but the IfM’s proactive engagement with industry – and in particular with local SMEs – is very much the exception rather than the rule;
- whilst the IfM has benefited greatly from Gatsby funding, it has had less opportunity to gain funds from public sector bodies than would have been the case in other regions. In its early years EEDA was instinctively opposed to supporting ‘prosperous Cambridge’ (this stance has now become a much more balanced one); and
- the IfM undoubtedly benefits from being part of Cambridge University:
 - in terms of the image it conveys to firms;
 - in the quality of student intake – and thereby of student projects for firms; and
 - in the recruitment of high calibre staff.

In the absence of proper comparative research, it is difficult to know whether there are other groups of similar size to the IfM which undertake the same level of interaction and engagement with industry. However, it is reasonable to suppose that the efforts made by the IfM – and the achievements secured – would be near the top of any league table. They have reached this level because of the entrepreneurial energy of the IfM’s leadership and the commitment that key research leaders in the IfM have given to all forms of outreach and to growth (it is far easier to manage an organisation which is growing than one which is static or in decline).

CMIL and the research centres

The University has, in general, been supportive to the IfM – although it must be wondered whether the experiment in establishing CMIL, the company that serves the ILU and IfM, would have been authorised without Gatsby’s enthusiasm for transparency in the accounting for its funds. CMIL has been invaluable in facilitating the flexible use of the income derived from work with industry. For instance, University regulations dictate that when a research grant comes to an end, staff who do not have a University post must be dismissed – which often means staff seeking alternatives, and often finding them, well before the research is completed (and being unavailable for further, related work).

The combination of CMIL and the IfM’s research centres means that, providing funds have been accrued from previous work, or the ILU has tasks for which the individual is suited, it is relatively easy to provide bridging income through which a good researcher can be sustained between contracts. This has helped to secure continuity in the process from initial research to further development and it is often in the development stages that outreach to firms, and SMEs in particular, is most fruitful.

In terms of outreach to industry, the research centres have the additional advantage of offering firms a structure to which they can comfortably relate. If their relationship is with an individual working within a centre, then there is some sense of comfort that back-up may be forthcoming if adverse circumstances hamper the individual’s availability.

The ILU

The ILU seems now to have reached the point at which it should be able to ensure the generation of a reasonable level of surplus for reinvestment in the IfM's research activities, and also to share the risk of holding events such as training workshops or short executive education programmes. By using Third Party Associates, it has widened the competencies that the IfM can offer industry and increased the capacity to deliver substantially beyond that which could be achieved by academic staff alone.

Academic staff members have some real concerns about this approach – and these have been mentioned in chapter four. The importance of the outreach being firmly based on IfM expertise is one concern. Another is that experience from working with firms should be fed back to the research centres and groups. The balance between the time provided by research centre staff and the time provided by TPAs in undertaking project work with firms should be kept under careful scrutiny.

Equally, the question of financial rewards will always be a sensitive one and research leaders need to win both hearts and minds to:

- build a consensus about the fair division of rewards;
- obtain buy-in to a transparent system of information; and
- ensure that an individual who develops the initial core expertise which is deployed receives a fair 'rent' (even if the IP cannot be protected).

These are not easy objectives to achieve, but this does not vitiate the value of the model, rather it points to the need for watchful management and good communication to provide early warning of any emerging problems.

A connected issue, and this relates most strongly to the work with SMEs, is recruitment both of the risk-sharing TPAs and of staff employed by the ILU. Remarks quoted in both chapters three and four draw attention to the difficulty of recruiting and retaining staff of the right calibre. It would be unacceptable if the ILU were to develop a range of activities and an associated overhead that motivated it to recruit less than wholly satisfactory staff in order to sustain activity levels. (It would be dangerously easy to 'get away' with less than excellent performance, at least in the short-term, because of the strength of the Cambridge brand.) This is a matter for the internal governance of the IfM and one which should be given continuing vigilance. The issue is of redoubled importance because the IfM is often taking the initiative in approaching firms, rather than responding passively to requests.

This leads on to the question of 'marketing' and 'selling'. There is a view in some of the research centres that the ILU could do more to sell their consultancy time or their expertise to run executive education programmes. Given the competing pressures on academic time, which can be extreme at certain periods, and the need for duties such as teaching and examining to take absolute precedence over other activities – this enthusiasm for others to do the selling is understandable. It is, however, probably somewhat unrealistic and this is an issue on which an open discussion within the IfM could help to improve performance. In particular, the comment in chapter three which suggests that IfM staff members are too diffident about selling at the end of their courses and workshops should be explored.

Work with and for SMEs

It has proved especially difficult to engage with SMEs. Identifying firms that will benefit from IfM help is less than easy and, even after identifying them, clinching a 'sale' depends on making contact at a time when they are open to taking stock of the business (and not subsumed into short-term fire fighting). One approach could be to follow up the suggestion, offered in chapter three, of identifying SMEs in the supply chains of large companies with which the IfM already has established relationships.

Another approach is to work with companies in ‘affinity groups’ and the experience of work with instrumentation companies has been positive. It is, however, difficult to sustain the momentum of such groups over an extended period of time required to justify the initial investment in establishing the group. One answer is to obtain a public sector subsidy. However, even this may well be insufficient unless there is also an established research group either within the IfM, or with which there are close collaborative links, whose research work can provide a continuing stimulus. Sharing knowledge between firms is a valuable outcome from affinity groups, but it tends to produce diminishing returns over time.

For the IfM, a precondition for involvement should be a research group that is committed to dialogue with a particular sector/cluster and has the relevant expertise and the time resources required. It is the two-way flows of learning benefits, accruing to both teaching and research, which justify engagement of a top university in such activities.

To sum up

The overall conclusion is that, even for a discipline such as manufacturing that is inextricably linked to practice, engagement with industry needs to be carefully considered and reflectively managed. The IfM is highly successful in working with firms but potential downsides are clearly evident which need to be addressed.

Simple metrics, which focus on the volume of engagement with firms, should not be taken seriously. The worst case scenario in the extract from the SPRU report, which is quoted at the beginning of this chapter, is a possible outcome from engagement with industry – but it is one that can be avoided and the experience gained by the IfM may help others to think about how best to do so in their own distinctive circumstances.

Annex A: Individuals consulted²⁴

Outside IfM

Professor Chris Backhouse	Loughborough University
Bob Bates	Royal Philips Electronics
Professor Lord Bhattacharyya	University of Warwick
Professor Lord Broers	House of Lords Select Committee on Science & Technology
Nigel Brown	Glaxo Smith Kline Limited *
Phil Burnell	Engineering and Physical Sciences Research Council *
Ludo Chapman	Grant Instruments
Richard Clayton	Seaglaze Marine Windows Limited *
Stephen Coulman	Baltic Manufacturing Limited **
Dame Sandra Dawson	Sidney Sussex College
Lambert Dopping-Hepenstal	BAE Limited
Martin Garrett	Greater Cambridge Partnership
Professor Keith Glover	University of Cambridge
Alan Goodbrand	Hale Hamilton (Valves) Limited *
Lawrence Grasty	LDS Test & Measurement Limited *
Philip Guildford	University of Cambridge
Steve Hales	Cambridge Fluid Systems *
Walter Herriott	St John's Innovation Centre
Richard Jennings	University of Cambridge
Christopher Moir	Department of Trade and Industry
Ken North	RJ Herbert Engineering Limited *
Kate Philips	formerly East of England Development Agency
Walter Scots	Wilkin & Sons Limited *
John Seagrave	Wolfson College Cambridge
Professor Nigel Slack	University of Warwick
Nik Thomas	BAE Systems Limited
Professor David Tranfield	Cranfield University

IfM Staff

Nicola Anson	Roger Baker
Paul Christodoulou	Derek Ford
Elizabeth Garnsey	Professor Mike Gregory
Jo Griffiths	Bill Hillyer (formerly EPSRC)
Professor Ian Hutchings	Finbarr Livesey
Graham Martin	Tim Minshall
Rick Mitchell (formerly Domino)	Roger Morgan
James Moultrie	Simon Pattinson
Bill O'Neill	Rob Phaal
Ken Platts	David Probert
Tom Ridgman	Peter Templeton

* Telephone discussion

** email interchange

²⁴ Discussions were also held with Gatsby staff and access was granted to the Foundation's internal records.

Annex B: Gatsby support to St John's Innovation Centre²⁵

Assistance provided to St John's Innovation Centre (SJIC) is formally separate from the grants made to the IfM, although the overall concept was of a 'three-cornered project between the Judge, the IfM and SJIC'. In practice, the objectives have been complementary to those pursued through the IfM as they have focused much more on nascent and very small firms and on helping to animate aspects of the Cambridge high tech cluster. There have been three specific connections with the IfM:

- Professor Ian Hutchings (as chairman of SJIC) chaired the steering group for the Developing Entrepreneurs project and Professor Mike Gregory was a member of the steering group;
- Dr Tim Minshall, now a lecturer in the IfM and a director of the SJIC, was the full-time project manager and was responsible for ensuring fruitful links between SJIC, the Judge Institute of Management Studies, Cambridge Entrepreneurship Centre (now Cambridge Enterprise) and the IfM; and
- a grant – GAT 1738 – financed the secondment to SJIC of Dr Elizabeth Garnsey from October 2000 to September 2002 (she holds a Readership post in the IfM).²⁶

The following grants from Gatsby have been made available to St John's Innovation Centre:

- | | | |
|------------|---|--------------|
| • GAT 1385 | £ for £ funding (August 1997) | £300,000; |
| • GAT 1521 | Developing Entrepreneurs Phase I (1998–2001) | £300,000; |
| • GAT 2215 | Developing Entrepreneurs Phase II (2002–2004) | £210,000; |
| • GAT 2462 | Revitalising Entrepreneurs (2003) | £64,500; and |
| • GAT 2792 | Developing Entrepreneurs Phase III (mid-2005) | £56,000. |

£ for £ funding

Initial consideration was given to this fund being managed through the IfM, but it was thought that SJIC would be better placed. Initially the fund had a slow start, there being a difficult balance to strike between raising awareness of its availability to serious candidates and guarding against an avalanche of inappropriate applications that would make heavy and heedless demands on management time. As at August 2006, a total of 33 projects had been supported – accounting for disbursements of £252,797.70 (against £298,894 requested funding). Requests for funding were appraised initially by Walter Herriot, an IfM technical expert, and Tim Minshall, who brought the views together and then prepared a submission for Gatsby approval. In most cases, the requirement for matched industry funding was fully applied, but some exceptions were made to allow contributions of resources in kind.

The dialogue between the management team and final decision-maker in Gatsby seems to have been constructive and effective – contributing to well-considered decisions in a non-bureaucratic manner. For the applicant the lack of cumbersome application requirements and the speed of decision has, reportedly, been welcomed.²⁷ A fuller judgement of the scheme will be possible when Dr Minshall undertakes his planned follow-up research to note the progress of the grant recipients – though this will fall short of a rounded evaluation.

25 To do full justice to these activities it would have been necessary to undertake a parallel programme of interviews – which time and resources did not permit. The observations recorded here are, therefore, based very largely on progress reports submitted to Gatsby and the minutes of the steering group – both of which are excellent.

26 This was principally to support academic research and Dr Garnsey's report to the Trustees evidences a strong academic output including coverage of entrepreneurs. She found the opportunity offered for practical engagement with firms and entrepreneurs to be deeply interesting and to add considerable value to her teaching. The Gatsby funding gave her the opportunity to spend time practically with small firms (though during a period when many businesses were facing severe pressures) and the intellectual space to develop work in a new sphere – complexity theory. There is no further consideration of the grant in this Annex.

27 This is from the SJIC team rather than direct discussions with assisted firms.

Developing entrepreneurs

The overall aim of the **Phase I grant of £300,000** was to support the early stage growth of knowledge-based firms through the provision of mechanisms for developing business skills and knowledge essential for ensuring their survival and long-term growth. Initial thoughts included the development of a web-based resource centre supported by a dedicated phone line for enquiries. This was partly a reflection of the enthusiasm at that time for specialised web-based approaches. In the light of experience gained, the web-based resource was merged into the Cambridge Network and employment of a full-time help-line operator was dropped as usage had been low.

This pragmatic response to operational experience and to the fast changing external context is illustrative of the more general approach adopted in the initial years of the project. Such flexibility was made possible by the attitude and broad competences of the staff appointed (who were willing and able to respond to new requirements) and the heavyweight composition of the steering group. In the earlier years of the programme, when the level of annual grant was highest and the external scene changing rapidly, there was a good record of attendance from people who were both knowledgeable about and highly influential in the Cambridge high-tech cluster.²⁸

The steering group minutes of 5 July 2002 summarise the results from the Phase 1 grant:

- ‘Formation and management of ‘Enterprise Link’. This is now a very active business network with a membership of nearly 200 early-stage knowledge-intensive ventures in the Cambridge area.
- Development of an on-line ‘Resource Centre for Technology Entrepreneurs’. This was developed in Cambridge and then rolled out to Oxford (via the Oxford Trust).
- Business planning, fundraising and interim management for the **University of Cambridge Entrepreneurship Centre (CEC)**. The project team have helped drive the development and growth of this key resource for the University of Cambridge.
- **Research and publication of review documents** on support activities for knowledge-intensive entrepreneurship. These have included “Funding Technology” reports on Israel and the United States, and the “Cambridge Technopole Report”.
- Coordination of **key representatives of the regional innovation support communities** – this has proved to be a particularly valuable communication and dissemination channel for this and related projects.’

Behind this accurate report is a major shift in resource allocation. The project manager, Tim Minshall, was seconded to the University to provide vital assistance in the preparation of applications to bid competitively for government funds that were becoming available. These could provide finance for some of the activities that the Gatsby grant had been supporting. He then helped further in a series of interim management roles and, in addition, Walter Herriot was, for eight months, Director of the Cambridge Entrepreneurship Centre. Whether the University should have been better resourced in the first instance is a moot point, but the Gatsby-funded resources bridged a crucial gap.

The **Phase II grant of £210,000** allowed for a continuation of the Enterprise Link for companies (looking at ways of replicating the approach elsewhere) and for further work in the Funding Technology report series. It also envisaged the team spending time with others to help them think through the development of new initiatives. At the behest of the steering group, the team were also asked to ‘coordinate regular meetings of key representatives of the innovation support communities in the Cambridge area to help ensure effective integration of current and future activities’.

²⁸ Ian Hutchings (chair), Sandra Dawson, Mike Gregory, Hermann Hauser, Walter Herriot, Richard Jennings, Tim Minshall.

Under this grant the support for the project manager and network manager posts was reduced to cover, respectively, 40% and 60% of their time from 2002 to 2004 inclusive. During this period, an additional **grant of £64,500** was given to support two pilot projects which sought to respond to 'revitalise entrepreneurial activity' during the economic slow down. They were:

- "Skills Link" – a range of innovative activities to develop and deliver new employment opportunities for the many highly skilled people in the area who are currently without employment.' and
- "Cambridge Minds" – an infrastructure to support the temporary placement of newly graduated MBA students in start-ups.'

The **Phase III Grant of £56,000** is for a period of two years ending in mid-2007 and provides continuing support for the Cambridge Technopole Group and the Enterprise Link's work to help 'shyer companies' to develop their business skills in a supportive environment. It also provides funding for a fifth *Funding Technology* report and for the continued publication of the *Cambridge Technopole Report*.

Conclusions

Although detailed fieldwork has not been undertaken, it is almost certainly the case that the outreach work carried out by SJIC and the 'glue' that Walter Herriot, personally provides to the social fabric of the Cambridge high tech cluster are widely appreciated. It is definitely the case that Gatsby funding has freed the expertise in SJIC's management team to engage creatively in local activities – rather than meeting its financial obligations to the College by undertaking less focused commercial consultancy on an opportunistic basis – wherever the demand arose.

In terms of sustainability, it is encouraging to note that the developmental work undertaken on a programme to provide management training and development for start-ups, led to joint continuation funding from EEDA and the *Greater Cambridge Partnership*. More generally, there are signs of public sector recognition of approaches developed from SJIC, and of the competence residing within SJIC, that may bode well for continued support when Gatsby grant support ends.

A particular success seems to have been achieved with the meetings of the Technopole Group and the associated report. Initially, strenuous efforts had to be made to encourage key people to attend 'yet another meeting'. Now people are asking to come onto the committee! This was a timely initiative which may well have been stillborn without Gatsby support.

As is often the case, success can be attributed to the individuals recruited for the tasks. Both managers responsible for the Enterprise Link have been first-rate. Tim Minshall was recruited at just the right point in his career and thereby worked most effectively and benefited in his personal development. Walter Herriot was empowered to undertake the tasks which he was keen to pursue, but would not have been able to prioritise without the payment by Gatsby for his time. The main caution in this respect is that his retirement looms.