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The Dome at MIT.

View of main campus from Charles River.

Solar-powered car.

Collaborating with Cambridge

An MIT perspective

David Newland, head of the Cambridge University Department of Engineering, provided a thought-provoking comparison of MIT and the University of Cambridge for the November 2000 edition of Ingenia*, based on his nearly forty years of experience with both 'Cambridges.'*

John Vander Sande's association with Cambridge University and David Newland's re-engagement with MIT both stem from the formation of the Cambridge–MIT Institute (CMI), a joint venture of the two universities launched in July 2000. Initiated by the Chancellor of the Exchequer in 1999 and funded by the British government and by industry, CMI was formed to help stimulate industrial development in the UK and to create a new generation of leaders and innovators on both sides of the Atlantic. CMI's programmes include exchange of students, academic and research staff; joint curriculum development, particularly in the area of professional practice programmes; integrated research, including research on productivity, competitiveness and entrepreneurship; and coordination of a National Competitiveness Network within the UK.

Now with the first year of formal activities of the Cambridge–MIT Institute nearly complete, Professor Vander Sande shares some observations about Cambridge and MIT in four major areas: their academic and research structures; people and centralized functions; how they treat their students; and risk taking.

Academic and research structures: exploiting opportunities at the interfaces

At first glance, the formal academic structures of MIT and Cambridge appear similar. Both universities have strong 'vertical' units, that is, academic departments. At MIT the 24 academic departments plus two divisions are grouped into five schools (Engineering, Science, Architecture and Urban Planning, MIT Sloan School of Management, and School of Humanities, Arts and Social Sciences) and the Whitaker College of Health Sciences and Technology. Each member of the teaching staff at MIT belongs to an academic department or division. MIT departments are uniformly strong, and the governance structure allows for a great deal of responsibility and authority to rest within the departments.

At Cambridge, there are some 60 departments which report to 21 faculties. The faculties are administrative sub-divisions of the university responsible for the primary organisation of teaching and research in a particular subject (e.g. English) or group of related subjects (e.g. Clinical Medicine). The division of a faculty into departments is widespread in the scientific subjects, but much less so in

the arts. Cambridge groups its faculties administratively into five schools (Physical Sciences, Biological Sciences, Technology, Humanities and Social Sciences, and Arts and Humanities).

The differences between our two universities become more apparent at the boundaries between these schools (or faculties at Cambridge) and departments. MIT has long been aware that many advances in both research and education take place at the interfaces between classical disciplines, such as biology and chemistry, or management and engineering, or biology and engineering. This requires that there be a horizontal system of links creating a matrix structure that allows researchers and educators to move across these vertical academic departments. MIT has many examples of this. Most research at MIT, in fact, is conducted through the more than 60 interdisciplinary laboratories, centers and programmes that bring together faculty and researchers from many disciplines and departments.

MIT also applies this use of horizontal or connecting structures in education. MIT has long had cooperation between the School of Engineering and the MIT Sloan School of Management through the Management of Technology Program (MOT) and the Leaders for Manufacturing Program (LFM), to name but two. In the Engineering School at MIT, we have created two divisions, with the status of academic departments, to provide for education and research at the interfaces of traditional fields. The Division of Bioengineering and Environmental Health (BEH) is intended to generate and communicate new knowledge at the interface of engineering and biology. The Engineering Systems Division (ESD) combines the strengths of the School of Engineering with those of management and social sciences to develop a new spectrum of solutions for contemporary engineering problems. Academic and research programmes in ESD span all eight engineering departments as well as the MIT Sloan School of Management, the School of Humanities, Arts and Social Sciences, and the School of Architecture.

MIT has developed extensive linkages that extend beyond the walls of the university to the interface between MIT and industry. In the 1970s and 1980s, MIT pioneered the design of the multi-company research consortium, a collaborative model now widely employed at universities across the United States and Europe. In 1988, the founding of MIT's Leaders For Manufacturing Program (LFM) set the standard for ambitious educational partnerships with industry. There are more than 100 other progressive industry programmes at MIT that provide for collaboration across the interface between the university and the outside world.

Visitors to MIT are struck by the richness created by horizontal linkages across disciplines that seems substantially different from what we see at Cambridge. Departments, or faculty acting alone, recruit interdisciplinary colleagues into research and education programmes, find funding, and then over time re-form into different teams as they pursue new intellectual interests and as new research opportunities appear – often as not at the boundaries.

My observations of Cambridge are that collaborations across boundaries in education, research and outreach to industry are much more limited or perhaps less visible than at MIT. One example is the newly formed Centre for Applied Research in Educational Technologies (CARET), which provides an interdisciplinary approach for applying research on the use of telecommunications and computing technologies to teaching and learning in the departments, schools, and colleges. Cambridge has many well-funded partnerships with industry including the BP Institute, as well as those with GlaxoSmithKline and others, through The Institute for Manufacturing and the Chemical Engineering Department. The Cambridge–MIT Institute (CMI), which has signed on BP and BT as its first industrial participants, is itself a source of expanding university–industry cooperation.

Cambridge has an invaluable source of collaboration and interdisciplinary stimulation which we lack at MIT – the college system. College membership for students (undergraduates are admitted to Cambridge through a college) and Fellows alike provides the opportunity to build on social contact across academic and research disciplines within the college. I wonder, however, whether the competing demands that colleges place on the time of academic and research staff make it more difficult for them to establish projects that must bridge both departmental and college boundaries.

People (and our centralized functions)

I have the honor of holding the title at MIT of the Cecil and Ida Green

Facts about MIT and the University of Cambridge
(Figures are for the 1999–2000 academic year)

Total number of students
MIT: 9972 (4300 undergraduates; 5672 graduate students)
Cambridge: 15,700 (11,100 undergraduates; 4600 graduate students)

Percentage of international students
MIT: 24%
Cambridge: 15%

Number of academic staff
MIT: 1500+ (includes 931 professors of all ranks)
Cambridge: 1276 (includes professors, readers, lecturers, assistant lecturers and other academic staff)

Schools and academic departments
MIT: 5 schools and 1 college (24 departments + 2 divisions)
Cambridge: 5 schools (21 faculties, 60+ departments)

Distinguished Professor. Cecil Green is one of the top benefactors of higher education in the world. I once heard him asked to describe what it was that led to his great success. His answer was simple but powerful. 'People,' he said. This answer is, of course, well known by all of us who are involved in a 'business.' And so it is that the universities of MIT and Cambridge have grown to their prominence by investing in people.

We at Cambridge and MIT are both justifiably proud of our outstanding faculty, whose creativity, independence and empowerment form the core strengths of our universities. But a university does not succeed on faculty and research staff alone. At each institution, there are large numbers of people required to manage and administer the support functions upon which education and research are based. These include financial administration, technology licensing, corporate relations, contracting, housing, physical plant, and development, to name a few. When these offices function well, the faculty and upper administration, along with our students and external collaborators, are the beneficiaries.

At MIT, we work hard to hire well in the administrative areas and we attempt to pay competitive salaries. We strive to make people in these positions feel like first-class citizens who are not subservient to academic and research staff. We encourage them to grow professionally by taking courses and attending seminars and conferences in their fields of interest. MIT as a whole, and most of its schools separately, bestow each year a series of awards – recipients are given a place of honor and acknowledged for their contributions at important events. Some key administrative positions over time achieve significant influence over MIT programmes, a state generally welcomed rather than objected to by MIT academic and research staff.

The situation at Cambridge is somewhat less clear in this regard. I am struck by the low wages offered for some administrative positions and – at least on the surface – their relatively lower status. One of the most serious consequences of this is the unnecessary use of academic staff to solve problems which could be handled by administrative staff. Unless the problem relates to intellectual leadership in research or teaching, involving a respected professor to sort things out should be a last resort, not an early choice.

One consequence of relying on strong, non-academic professionals at MIT is that our academic and research staff have a lower administrative burden and therefore more time for research and teaching. Another is that MIT can start and maintain professionally run research and education programmes quickly and effectively, supporting the diverse partnerships and interdisciplinary activities mentioned above. Third, MIT has evolved a strong and respected central administration that supports functional activities that are usefully placed outside the academic departments.

Let me cite the example of the MIT Office of Corporate Relations, which is responsible for corporate fundraising and industry relations. Fifty staff manage the MIT Industrial Liaison Program (ILP) for nearly 200 corporations worldwide. Departments and individual faculty members continue to have their own direct relationships with companies, but the MIT Office of Corporate Relations provides a strong coherent approach to coordinating overall relationships with many companies, providing industry with a stable point of contact.

As I understand it, until recently this function has been led more by separate departments and academic and research staff at Cambridge. The situation is changing, however. With the creation in 2000 of the Corporate Liaison Office at Cambridge, there is now a central point of contact for companies interested in developing a university-level relationship with Cambridge.

Another strong functional area at MIT is its Technology Licensing Office (TLO), which manages the patenting, licensing, trademarking and copyrighting of intellectual property developed at MIT and serves as an educational resource on intellectual property and licensing matters for the MIT community. Reorganised some 15 years ago from an office with a few patent attorneys to a staff of professionals who combine strong backgrounds in science and technology with industrial and consulting experience, the MIT Technology Licensing Office is recognized universally as a world class model of excellence in university technology licensing.

The goals of MIT's Technology Licensing Office are in concert with a large part of the mission of the Cambridge–MIT Institute. In the area of technology licensing, Cambridge is rethinking its approach, and CMI hopes to be of some assistance.

We are not yet certain how best to adapt MIT's structures and concepts to the Cambridge environment, and sometimes the answer will be that one should not do so. But we see CMI as a vehicle for the two universities to work closely together and to learn from our experiments. And I should stress that there are a variety of areas where MIT expects to be doing the learning, most particularly in the areas of undergraduate education and quality assurance.

The responsibility we give our students

At CMI we expect that undergraduate education and student exchange will provide a major vehicle for cultural exchange through 'body' contact. No amount of distance learning or videoconferencing can substitute for face-to-face interactions among students of the two universities.

Our two educational systems are very different and we can learn from each other. MIT, like most universities in the United States, has adopted a 'continuous assessment' approach to monitoring progress. Students complete homework assignments, which are usually graded; quizzes, which are short

A group of MIT students taking part in the first phase of the CMI Undergraduate Exchange. (Photograph: Gair Fraser.)

exams given throughout the semester; midterm and final exams at the end of each course; papers; and laboratory reports, where applicable. Our system presumes that a student needs to be prodded to do his or her work, to be continually judged and evaluated. MIT students are taught in large lecture classes, which then have smaller sections called 'recitations.' The academic staff or graduate teaching assistant leading the recitation reviews homework assignments and graded exams and deals with questions about the lectures for the 20 to 30 students in the recitation section. If an MIT student is having a problem with the coursework, it becomes obvious fairly quickly and can be dealt with through extra help sessions, for example. There is in general at MIT nothing like a tutorial as in the Cambridge system. Academic advisors at MIT are responsible for counseling students about curriculum, not course content.

At Cambridge, students attend lectures and tutorials during the term. We at MIT are only barely able to accept the notion of a term that ends without an examination. This approach to education is remarkably different from ours, requiring students to be much better disciplined and to take much greater responsibility for their own education. We suspect that Cambridge students are able to be more thoughtful, and of course we have strongly held views of the compensating value of a high-pressure work environment.

Both of our systems work. Almost certainly the very best education would borrow elements from both. From an MIT perspective, undergraduate education is where our assumptions will be most fundamentally challenged, and this cooperative effort in CMI is where we have the most to learn.

Risk-taking and learning from failing

Of necessity we at CMI have thought a great deal about attitudes towards risk. CMI's remit is to move ideas created in British universities into the world of commerce. To meet this goal we will need to nurture an entrepreneurial spirit and culture. Of course, to be entrepreneurial requires the acceptance of a certain amount of risk. Yet our British colleagues tell us repeatedly that one of the greatest barriers we face with this task is a relatively higher level of reluctance to take risks in the UK. One necessarily turns then to the place of risk in our cultures at Cambridge and MIT. Certainly the most immediate risk is my making observations about this extremely difficult and complex topic, to which untold articles and books in education and management have been devoted. But with apologies in advance, our institutions seem to deal with risk very differently.

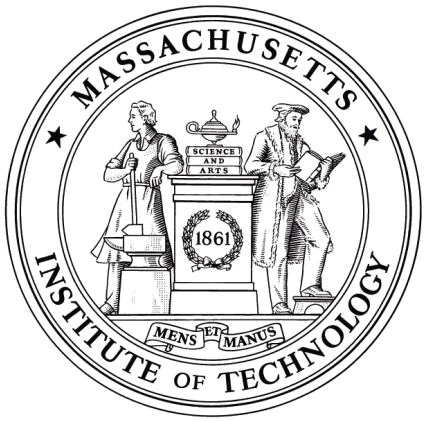
Different systems and cultures accept failure to varying degrees. In the Far East, for example, failure leads to loss of face which can be devastating emotionally, psychologically and professionally. We tend to view the Far East as risk-averse and therefore less entrepreneurial than Europe or the US, with the US and its cowboy tradition being somewhat less risk-averse than the UK. Rightly or wrongly, our view of the Cambridge community is that its members are far more concerned with using process and getting it right, and are willing to take what we might consider an unacceptable amount of time to reach closure. By contrast, MIT is at the far, far extreme end of this continuum even by US standards, believing that experimentation is invaluable and that simply trying and trying again often leads more rapidly to an optimum solution.

Failed attempt versus experimental success?

Now, failure is in itself a very interesting concept, especially to an educator and scientist. At a minimum none of us promotes a ready acceptance of failure and we certainly do not begin an endeavor expecting to fail. So one needs to distinguish between a failed attempt and an experiment that taught us something. One might say we acknowledge that there is much to be learned from failing, but the word itself is rarely used in that context. In our culture, an experiment that does not lead to expected results – which is therefore a 'failure' – will nevertheless provide valuable information and is often the shortest path to the best scientific results, engineering application or industry design. If there is a single distinguishing characteristic of MIT education, it is that we are rather relentless in our encouragement of our students to innovate and experiment. Through Cambridge eyes, it must often seem that we are stumbling about, but as a philosophy it has served us well.

Perhaps a trivial example will serve to demonstrate how far this culture is taken. Despite what others might tell

The top of the 'brass rat' (left), the traditional MIT seal (centre) and the redesigned seal that appears on the side of the 2002 class ring (right).



you, MIT does have a few traditions we honor, and one is the class ring. Made of brass with the image of a beaver in relief (hence 'brass rat' is the ring's affectionate name), the ring carries the MIT motto and seal. It is a tangible symbol that many MIT graduates wear proudly and it is easily recognized by other alumni. Each year the graduating class seizes the opportunity to change even the ring, however, making it their own last innovation. The Class of 2002, unhappy with the low-tech image of a great book being carried by a scholar, changed their rings to replace the book with a laptop computer. And to make the scholar a woman!

My experience with Cambridge is that process is sometimes used to avoid – or at least to spread – risk. Whether in research, teaching or management, valuable time and resources that should be invested in driving towards success are instead expended on defending against possible failure. And emphasis on process can also lead participants to become vested in a particular strategy, which they may then be reluctant to abandon, regardless of the evidence.

The big idea

I must stress that these comments about Cambridge and process most certainly do not apply to our colleagues involved in CMI. We have joined together in a rather grand ambition with the shared confidence that, first, we know that we will make a number of mistakes. Some may even be embarrassments, but we will be learning together. And in the spirit of experimentation we are committed to getting it right.

At its inception, a rather bold individual wrote about the CMI idea:

Creating a bridge of minds across the Atlantic between Cambridge, England and Cambridge, Massachusetts: CMI brings together the best in education and industry for the benefit of the UK's future as a world leader in technology and innovation.

Drawing on the knowledge, expertise and resources of the University of Cambridge and the Massachusetts Institute of Technology, CMI offers unrivalled research, learning and business opportunities for students, academics, corporate partners and government. Its mission is to provide a catalyst to improve economic competitiveness and productivity whilst working with UK universities to encourage the entrepreneurial spirit in higher education.

CMI is indeed a Big Idea. Let us hope that we are up to the task.

Acknowledgements

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Websites

MIT facts: see http://web.mit.edu/facts/

Cambridge University facts: see http://www.cam.ac.uk/

The Cambridge–MIT Institute: see http://www.cmi.cam.ac.uk/

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