Case Study: The University of Strathclyde in Glasgow by Helyn Thornbury, Derek Law and Brian Henderson[1]

Introduction: "I love my laptop!"- No, not the impassioned ranting of a techno freak regarding their lifetime companion, but four words that made fourteen months of unremitting effort seem worthwhile. This heart-felt statement was found in the very first student evaluation questionnaire examined as part of the University of Strathclyde's ubiquitous computing pilot. The student responsible could not have realised the genuine feelings of delight and relief that would be felt on reading such a positive response by the team of staff involved in this strategic initiative.

Much time, effort and finance had been invested in what had become colloquially known around the University as the "millennium laptop pilot". The general feeling regarding the pilot from associated University academic and support staff was that progress was good and that real benefit was being seen in a number of different areas. However, starting from the premise that the customer is always right, the reaction of the student population involved was eagerly awaited to confirm, or not, whether the University had been correct in proceeding with a paradigm, which had not been proven to work in a European, let alone a British context.

Further, on a personal level, for many in the laptop team the preceding months had been an intense period of uncertainty: detailed planning; complex implementation procedures and interaction with departments; setting up administrative processes that were new to all participants. Beyond this planning stage, further effort had been necessarily directed into the support and enhancement of the sizeable 354-machine pilot. As is typical of many public institutions, there was a very limited ability to dedicate staff to such work in isolation from their "normal" day-to-day work and it was becoming increasingly obvious that positive reinforcement was also required to help motivate staff to maintain their exceptional level of effort.

Unwittingly then, with those four words, our nineteen year old student and many others who responded in a similar manner, helped galvanise the University to continue with this major initiative. More importantly, they made an ageing project team very happy!

In the Beginning:
In 1996 the British government set up the Dearing Committee on the Future of Higher Education in the UK and its report appeared the following year. Buried in almost 2000 pages of evidence was a prediction that by 2005 all students would have a personal

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portable computing device and that this would transform teaching and learning. Sir John Arbuthnott, the then Vice-Chancellor of Strathclyde was a member of the Dearing review group and many of its recommendations became part of the university strategic plan for 1997-2001. At the same time and for the same reason Strathclyde became an early adopter of institutional information strategies. Such a strategy was drafted in 1998 and led to the appointment of a Director of Information Strategy late that year, one of whose tasks was to develop thinking in this area. This led to the development of the "Strathclyde Eye" (fig.1), which attempted to take a holistic overview of what was to be targeted. It was also assumed from the start that if the university was to be a leading player in this process it should undertake activity in each of the areas identified. This was not seen principally as a cost saving exercise but as a way to give public evidence of commitment to what is seen as a gigantic transformational exercise.

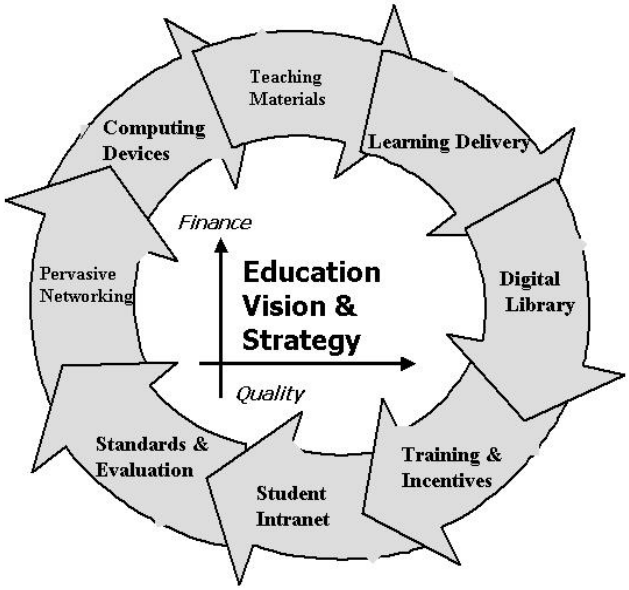

Figure 1: The educational vision and strategy is broken down into discrete elements which aim to transform quality without driving up cost.

Each of the components was reviewed and a work programme attached to it. Some of these were funded internally, some from external sources and some from research grants, but there was a clear view that while some work on each element was necessary, no single one was sufficient to transform the teaching process. Thus the decision to use ubiquitous computing was made in the context of a much wider whole – although it is only one area which is considered in this case study.

As part of this last decision, visits were made to a number of North American universities to learn from their experience. Many lessons were learned but perhaps the two most important were to start with a pilot programme of a few hundred machines – a lesson obeyed - and the second to ensure the project team were given a remit with extended and

manageable timelines – a lesson ignored. Both political pressure and an ambition to have a leadership role in Europe meant that a "get go" decision taken in March was coupled with an ambitious implementation date of September. The plan was to pilot the programme in the first year intake of one faculty covering some 354 students, then to extend the pilot in year two.

One crucial decision was to invite to the UK two IBM staff based at Chapel Hill in North Carolina. They ran a two-day seminar attended by a disappointingly small number of academic staff. However the seminar provided extraordinarily useful insights, gave staff confidence and gave a kick-start to the process which ensured that the scale of the project being attempted was understood by all the attending stakeholders and gave rise to a project management structure and initial timelines.

Basic Characteristics of university and the program today:

Strathclyde University was founded in 1796 as Anderson's University and was set up at the wish of its founder to be "a place of useful learning". That mission statement remains appropriate after over 200 years and is still a meaningful and common point of reference which trips off the tongue of all Strathclyders, in what is now a major research led university with some 15,000 full time equivalent students and a further 45,000 students undertaking some course of vocational study on or off campus. Traditional strengths have lain in areas such as Business, Engineering and Education, with Science and Arts completing the list of five Faculties. The University also has a highly rated business school.

In addition to the Faculty body, there is also a Central Administration Service (CAS) area providing a raft of support services to both staff and students across the University.

In terms of the Millennium Laptop Pilot, the primary academic department involved was that of Management Science from within the Business Faculty. Much of the resource for operational matters came from within the IT Services department. The IT Department ultimately reports to the Head of the Information Resources Directorate and forms part of an integrated service provision including the University Libraries, Audio Visual Media Services and Continuing Education Services.

From an academic perspective, clearly the technical and more particularly software needs vary dramatically between say engineers and historians. Most of the emphasis has therefore lain in pioneering teaching methods rather than in courseware design – although over 200 degrees use some e-content. Broadly speaking, the university is following the move 'from sage on stage to guide on side', from teaching to learning, with a special focus on group work of various sorts.

Strathclyde has a deserved reputation as an innovative, business like organisation which has continually shown itself willing to break the conventional mould in order to achieve success in many diverse areas, including: professional development programs, technology in teaching and overseas partnerships (Clark, 1998).

Additionally, the University was founded as an institution, which met the needs of people who had been excluded from a University education. (The first intake included a majority of women – over 400 – and was the first example of mass tertiary education for women in the UK.) Today as never before, it is a wider access University. We strongly associate with the British Government's commitment to social inclusion and are investing additional effort in promoting opportunities for students from disadvantaged backgrounds and in providing a supportive university environment to help them to be successful.

Because of the strategic importance and potential long-term impact of the laptop pilot, it was realized that useful information would only be produced if the number of students and laptops involved was sufficiently large. Only then could an attempt be made to quantify the likely impact and scale on the University if the pilot was extended to cover the majority of students. Fortunately, the course nominated by the Business Faculty involved over 350 first year undergraduate students – thereby satisfying this requirement.

Great care was taken in the selection of the laptop to be used in the pilot, both in terms of the manufacturer and the technology specification. A full European tender exercise was undertaken, which resulted in IBM Ltd being the chosen supplier. This was a time consuming and exacting task, but was cost effective as it produced very aggressive laptop pricing. The laptop chosen for the first year pilot was from the Thinkpad A Series and had the following specification:

Hardware Specification

- Processor: Celeron 500 MHz
- Memory: 128 MB
- Hard Disk size: 6GB
- Screen: 12.1" TFT
- Video: 4MB Memory
- CD: 24x CD-ROM drive
- Modem: Integrated V90 56K
- Ethernet card: Integrated 10/100 Mbps
- Radio card: PCMCIA based 11Mbs Radio Card

Default Software Load

- MS Windows 2000
- Microsoft Office 2000 - Professional Edition
- Eudora Mail Client
- Web Browser: Internet Explorer 5.5
- McAfee Anti Virus software
- Adobe Acrobat Reader - Version 4

At the time of pilot inception, this specification was in absolute terms relatively high in terms of what was available in the UK market. Further, it was markedly above that

required to run the services required by the pilot group. The reasoning behind this was two fold. Firstly, the laptop lifetime is likely to be 3-4 years and over specification would help to ensure continued functionality. Secondly, it hopefully left the pilot to concentrate on issues of pedagogy and not be undermined by performance issues with the technology.

The inclusion of radio technology was a further pivotal element of the laptop pilot. The traditional method of network provision via multiple network sockets was proving to be expensive and inflexible, especially in some of the aging buildings that the University undertakes teaching and learning. A number of important areas around the campus were also kitted out with radio receivers – including the main room to used in teaching the pilot class, 4 floors of the main University Library, floors in the student union and the main refectory area. The pilot was then seen as a major test of the functionality and viability of large scale radio usage.

The distribution of the laptops to the Business students was undertaken at a number of mandatory 2-hour training classes. It was expected, rightly so as it transpired, that student IT knowledge would vary considerably - this is especially so with respect to laptop technology. This training ensured that everyone had the basic skills required to feed and care for the laptop, but it also presented a valuable opportunity for some important administration tasks to be undertaken with a captive audience, e.g. serial number to student tagging.

A fully comprehensive support service for the students was provided by IT Services. This included laptop configuration and training to help minimize the number of calls logged. Loan pool laptops, rapid software imaging and an extended manufacturers maintenance contract were all used to underpin the continued operation of the pilot.

Security of the student and laptop was a major concern for the University. Having our main campus in the middle of a large city presents a number of potentially serious issues. Basic advice was given, e.g. if threatened, hand over your laptop and also a comprehensive insurance policy was taken out by the University to cover the replacement of damaged or stolen laptops.

In year one all machines were put out to students on loan to test the impact, but crucially in year two (2001/2) it was known that student purchasing behaviour would have to be tested. Since UK government regulation means that purchasing must be optional rather than mandatory, this will be the decisive factor in whether the project has a long-term future.

Educational Rationale:
The rationale for introducing the use of laptops within the institution can be categorised into two main areas: educational benefits and organisational efficiency. For Strathclyde, the decision was primarily focused on the educational benefits but this had to be accompanied by efficiency in terms of computing provision and support, for any initiative to be viable.

The educational benefits possible through the use of technology in education are well acknowledged (Laurillard, 1993. Schacter & Fagnano, 1999). A more beneficial question, and one that many University staff ask, is why *mobile* computing? Through the widespread use of laptop computing facilities, several improvements in the educational experience for students can be achieved.

In the first instance, it removes an organisational constraint on the educational process. The traditional model of teaching in many subjects involves lectures, tutorials and labs. The lectures and tutorials were, by necessity, held in a different location from the lab sessions. The use of computing within subjects is often integral to the learning objectives for the class, where not only a theoretical understanding of a subject is required but also a practical competency. This separation of lecture and lab was a constraint imposed on the design of the educational activity. Mobile computing removes this constraint by releasing the tie of IT activity to a single location, the lab. The lecturer can design the educational activities without the need to group activities to fill 1-hour lab time or 1-hour lecture time. These activities can be integrated, allowing the educational objective to dictate learning activities, rather than the physical location. The increased access to IT also provides an opportunity for lecturers to make more use of technology within their teaching, using educational resources and telecommunication software.

Laptops can make the process of group work more efficient. The current system of lab based computers is not conducive to group based computer work - a major component of many classes. Use of mobile computing readily supports the students in this activity, providing much more flexibility in locations for meeting and general increasing access. Importantly, the reduced space required by a laptop does not impede the group dynamic to the same extent as a desktop resource, allowing discussion to take place more readily. This process is much closer to the way graduates will work with colleagues in the future, better preparing them for employment. Mobile computing allows flexibility in location for work and in accessing networked resources (Igbaria, 1999). The student no longer needs to visit a lab to use a computer and access the network; their computer can be used when and where it is convenient for them and the network and its resources can be access from various convenient locations around the campus. In addition to ready access to email, increasing communication, a student can easily access other learning resources and information available, both on the University network and through the World Wide Web.

IT skills have become a requirement for graduates in most disciplines. In fact Strathclyde is one of the few universities in the UK which is in the process of introducing a mandatory IT skills component to all degree courses. Mobile computing allows the students to gain computing skills and experience in a manner more closely reflecting the environment they will enter on graduation. The experience of managing their own computer in conjunction with the increased usage, which the greater flexibility of mobile makes possible, combine to develop IT skills and confidence.

The key elements to addressing stakeholders' concerns within Strathclyde's scheme has been evaluation and information. By exploring in a transparent, rigorous and defensible manner, the benefits and costs of introducing laptops to Strathclyde, valuable information and experience have been gained to inform discussion and future developments. The evaluation process involved close consultation with stakeholders to achieve transparency

in the process, ensuring that the results were not disputed on methodological grounds and that all aspects that were of interest to the stakeholders were investigated. The evaluation results were reported to various groups and committees (including the Student Union), providing opportunities for debate and allowing concerns to be aired and addressed.

Information has been available on the University web site with a dedicated email address for any detailed questions. The website describes in detail the University initiative, including the rationale behind the scheme, with links ranging from the current range of equipment available, to the academic course site for the classes involved.

The Teaching and Learning Pilot:

The Integrative Core in Strathclyde Business School provides a 3-year grounding in key business skills, which any Business graduate requires, regardless of their principle subject discipline (Belton *et al*, 2001). The first year of the core focuses on 5 main area: communications skills, numeracy, team work, problem solving and IT skills. It was this class, which was the first class in the University to use laptop computing. Each student in the class has a ThinkPad and the organisation of the classes exploit this to create a realistic business environment.

For a 3-hour session each week, the students attend group session in the specially designed Millennium Room. In contrast to traditional rows of desks, the room contains student puddles, U-shaped desks seating 6 students. This design was heavily influenced by Sheridan College's work on student work environments (Smye & Greyborn, 2000). The combination of radio transmitters and power supply (underneath each desk) creates a flexible work environment.

The students work in the same groups, at the same table, for each week of the course. They are presented with a series of business problems, and use the group sessions to work on them. The emphasis of the course is to use relevant resources as required rather than learning a set approach, as Granger and Lippert put it:

> *'they need to view the software as a tool that enables them to produce useful products '*
>
> Preparing Future Technology Users, 1997

This first pilot area was the subject of considerable scrutiny. A crucial focus of this scrutiny was the measurement of educational outcomes. Comparison was made with the same course taught the previous year, without the benefit of mobile computing. By the mid point of the pilot year, teaching staff were struck by the marked difference in the IT skills level attained by the 2 cohorts. By the year's mid point, the pilot class had attained the same average skills level as the class had by the *end* of the previous year. Staff and evaluators were unsure whether this indicated a steeper learning curve, and the skills level would plateau over the remainder of the year, or heralded a higher attainment in IT skills for the year. The students went on to finish the year showing no signs of a plateau in skills, exceeding the skills level demonstrated by the previous group!

Governance Issues:

Strathclyde has a very devolved faculty based structure of governance, so that decision making is a very consensual process, however the Vice Chancellor, the chief executive of the university, has discretionary funds which can be used both for experiment and to lead/guide policy formulation. In executive terms, the Director of Information Strategy (in effect the CIO) was charged with progressing the initiative and attempting to create buy-in. The majority of financial responsibility in Year 1 also rested with the Director of Information Strategy and this fact coupled with the fact that in year one only the Business Faculty was ready to move meant that the political environment was initially a clear and supportive one. Decisions at this stage were largely those of implementation.

As the reality of the resource commitments required to support the pilot became clearer, it is true to say that the clear waters did begin to muddy. Choices with regard to other service areas had to be made and external interest began to rise as the profile of the project began to grow. Fortunately, the primary story was one of successful implementation and the political environment was becalmed once more through the laptop team attending various strategic University committees and reporting in detail on the project life cycle to date.

Further, this initial success led to a great deal of interest with respect to the second year of the pilot and so competitive bidding was used as a method for deciding who should enter the programme next. The Deans of each faculty were themselves then asked to rate the bids from each of the other faculties ensuring both the transparency of process and the integrity of the year 2 selection. Thus every faculty was able to support the programme feeling that it had a chance of gaining access to the Vice-Chancellor's pump-priming funds. In year two, the fourth and fifth years of the Faculty of Engineering are being targeted, as well as a small masters course in Psychology. As pilots these will again be based on loan machines in the first instance.

Given the pedagogic imperative an early decision was taken to evaluate academic outcomes and this has proved a significant element in winning over hearts and minds to the view that this is a response to educational rather than technological imperatives. The University has a small number of quasi-independent units which specialize in pedagogical issues. It was agreed to representation from these groups as a trusted but neutral panel of evaluators within the context of the main evaluation group being chaired by a senior academic involved in the pilot. In addition it was agreed that reports would also be produced on Estates issues, Support issues and Funding models.
With regard to the setting of policies regarding the use of computers in instruction and further community-building in this area, the University has a number of high level committees where the academic and administration establishment are jointly represented. Importantly, it is always the case that decisions in the above areas will be made by these existing and trusted committees – thereby helping to ensure a properly informed and transparent process. Even if the discussions do get a wee bit heated on occasion.

Financing Issues:

Undoubtedly the most vexed question has been that of the pilot funding. This was true in terms of the inception of the pilot and continues to be the single largest issue facing the University in terms of the ultimate sustainability of this strategic initiative.

With regard to the two-year pilot, an approximate estimate of the overall cost of the technology, associated services and staff time would be slightly over £1,000,000 - technology costs making up more than 75% of this figure. Ultimately, over two years, this finance will have facilitated the use of ubiquitous computing in an innovative teaching and learning environment for nearly 1000 students – a quick division indicating that in relative terms, exceptional value has been attained.

In absolute terms, this finance has been made available primarily from the Information Resources budgets, with a welcome injection of funding from the Vice Chancellor's strategic initiative fund. There is no doubt that the redirection of Information Resources budgets for the pilot necessitated choices to be made regarding other service sectors as the amounts involved amounted to a sizeable portion of the overall budget spend in this area. Budgets were allocated such that the lifetime of the two-year pilot was underwritten, but this was done with the proviso that a plan for sustainability or graceful exit would be produced through the experiences of the pilot. Although painful financially it was seen as of long-term strategic value. The University is about to embark on a £50 million pound building programme and whether or not to build and wire conventional classrooms is clearly a major cost factor. At the same time the ratio of centrally provided computers to students was eroding to the point where computers are not generally available at a time when they become ever more necessary. More and more students arrive at university with a computer which seems always to have non-standard software and non-standard interfaces. These are almost impossible to support and yet students increasingly expect such computing support.

In Year 1 of the pilot, laptops were lent free of charge to the entire pilot area. In Year 2, these laptops were then offered for sale to incoming students, who also had the ability to purchase new laptops from a University sponsored scheme. Purchase rates are running at approximately one third of students which is encouraging and does ultimately provide more cash for reinvestment into the pilot.

However, the political and financial environment in which the University operates seriously constrains the number of options available to secure the ultimate sustainability of the pilot throughout the student population. It is inevitable that the cost of the personal devices will have to be passed on to the student. However, a number of issues exist which make this difficult. University Fee levels are set by National Government in the UK, while the list of items for which extra charges may be made (photocopying, field trips) is also firmly defined and prescribed by the same body. It is not therefore, in the power of the University to make any computing device a mandatory component in a student's education. Thus, persuasion and an excellent financial package are the only available tools. Even then, the University sits in a historically poor inner city area with many local

students. We are rightly proud of our inclusive and accessible educational establishment, but this does create a real issue as to how the less well off are to be supported within the context of ubiquitous computing.

However, if academic colleagues are to be presented with a student cohort that is technologically enabled to meaningful levels, then ways must be found to significantly increase the level of students purchasing technology and also deal with the less well off students.

Operational Issues:
The lead project manager for the ubiquitous computing pilot was also the Head of User Services and Support for the University IT department. This duality of role helped ensured that one of the most vital operational areas – i.e. the technical support of the pilot – could be successfully accomplished.

Right from the inception of this sizeable pilot, it was felt that as much work as possible should be subsumed into the normal day-to-day routines and processes of the University. This was seen as necessary to ensure that sufficient resource was available to carry out the work, as staffing levels would not allow for the dedication of staff to this task alone. Clearly, also, much more would be learnt regarding the potential impact of such a strategic course if this path was followed to its logical conclusion.

With respect to the non-academic pilot support, it was decided to channel ALL enquires, faults and administration through one widely publicised service point, i.e. the student IT helpdesk. This helpdesk is a well-established service point where students would normally go with any IT related enquiry or fault. Strategically, this physical area had been upgraded with network radio access and printers that would be of specific use to the pilot students.

In order to facilitate this total service, the following points were important:

- Training of all levels of technical staff
- Provision of a loan pool for the temporary replacement of faulty machines
- Clear managerial policy that all support staff were involved in the laptop pilot

Ultimately, this central focusing of service proved to be very popular with students due to its location, approachability and effectiveness in providing solutions. Although some negative feedback was received from students regarding the service, this was less than 1% of reported calls and although improvement can be made this structure was one of the major success stories of the pilot.

The most significant mistake in Year 1 of the pilot was an inappropriate budgetary structure and additionally not delegating budgetary responsibility to a level where operational decisions could be quickly implemented.

Budget for the pilot in Year 1 was not sectioned off into a separate account structure. Ultimately, this led to argument regarding the final cost of the pilot in Year 1 and also difficulty in some other projects gleaning their final costs from the University financial system. This situation has been rectified in Year 2 of the pilot.

Further, in a project of such a scale and complexity, it is almost inevitable that decisions have to be taken at short notice and monies spent to allow the purchase of service or product to facilitate project progress. Budgetary responsibility for the pilot was lodged at a very high level, despite many of the project team being experienced budget holders. The reality of this is that senior managers can be absent at times when operational issues come up – the technical term here being "sod's law". This structure led to unnecessary delay and had a negative impact on a number of occasions.

Academic Issues:

A distinctive aspect of the Strathclyde Initiative has been its affect on the students' educational achievements. The evaluation process highlighted several general educational benefits linked to the use of the laptops.

The IT skills level of the class showed a marked increase, a development specifically linked to the increased amount of access to technology and the flexibility of that access. Further evaluation revealed that there were general learning benefits from the use of the laptops in terms of increased communication and collaboration: through email; transfer of files and work management, allowing flexibility in location for work and benefits from standardisation.

Basic statistics and numeracy skills were also a focus and staff noted that the students' numeracy had been helped, by focusing the students at a higher level, on structuring and interpreting data rather than the arithmetic of calculations.

Groupwork was highly supported by the use of laptops. The greater access and flexibility offered by the laptops proved beneficial to group activities. This benefit also occurred in other classes, which the laptop students shared with other students. The group working practises developed by the laptop students became their standard way of working and were carried into all their groupwork activities.

Overall, the first year of the pilot has shown a positive impact on learning outcomes. The students themselves rated the laptop as very important to their education, both within the pilot class and in their studies generally.

The structure of the project team has been highlighted as a key aspect of the success of the Strathclyde project so far. The creation of one specific role, that of Academic Project

Manager (APM), has been particularly beneficial. The APM works as part of the project team, providing an academic perspective on operational and organizational aspects of the project. This has been useful in maintaining the educational focus of the project, grounding technical aspects in academic practicalities.

Further to this role, the APM also works as a technical translator and focal point for any teaching staff involved in the project. The initial Pilot area involved a class which had 10 members of the teaching team. The APM is a specific, academic person who can deal with any queries the staff may have and explain technical arrangements and decisions to the teaching team. In reality, this person also acts as a filter, answering questions or redirecting inappropriate questions away from the technical team. This has freed the technical team from an additional pressure and helped to maintain good relations between the different groups. The Academic Project Manager can put the technical case to the academics and the academic case to the technicians without the misunderstandings that are too often the result of different groups working closely.

The role also involved the evaluation of the project, allowing the integrated evaluation of: learning outcomes, organizational infrastructure and technical aspects. The results of this evaluation were then reported back to the academic community, a key group, by an academic who had knowledge of both the teaching issues and the technical arrangements. This combination of knowledge was helpful in dealing with the variety of questions which such an exercise created.

Concluding Insights:

The University ubiquitous computing pilot is a sizeable and complex project sited in a large, hierarchical, resource constrained and political organisation. Many people reading this book will recognise this type of environment and also be skilled in steering projects through such choppy waters. So, rather than repeat a list of well known and generic project management techniques, it would perhaps be of more use to pass on two specific facts based on our experience of a ubiquitous computing pilot.

Firstly, by definition such a pilot is concerned with technology but in reality this is only a small portion of the task. A similar project of any size will spread through the University requiring effort and resource from both academic and administrative stakeholders. Without exception, our pilot received a willing and helpful hand from such parties – Registry, Finance, Security and Management Science to name but a few. By way of a thank you and a confession, it is recognised that often little warning was given to such groups of the need for their input. The lesson learnt here was to concentrate sufficiently on the information requirements and information flows required to sustain the use of the technology – rather than the technology itself. If this has implications the project team structure, then so be it – the important result is a professional and sustainable service, not a laptop computer.

Secondly, it is fair to say that the divide that typifies many educational institutions is that between academia and administration. It is ultimately vital that a pilot of this nature is strongly backed by both sides of this traditional divide. An underlying plank of the

University pilot was the assembly of a multi-disciplinary team that had shared responsibility for the ultimate product. The team included staff from senior management, academia, IT Services, Purchasing and others. This helped ensure focus and that the views and needs of all were brought to the table. Whilst helping to ensure the healthy progress of the pilot, this team also accomplished something else vitally important– it made it a far more enjoyable and satisfying task. Many of us gained an understanding of the work of other parts of the University and now have access to knowledge, communication lines and friendships that will be beneficial in areas of further work.

One of the areas where Strathclyde has excelled is that of enlisting student support. It was recognized from the start that supportive students were the best and most persuasive advocates for change, so that the perception would change from a technology driven view to a student/customer driven view. (In reality we believe that change is driven for sound pedagogic reasons, but perception is always more powerful than reality). In order to do this, and again following examples seen in the USA, we sent a small group of officers from the student association and the student newspaper to North America to see the transformational effect of the ThinkPad University. The gamble paid off and they returned as enthusiastic converts and advocates. It is simple to find examples of the devastatingly bad publicity that can occur if you neglect to get the students onside in such initiatives.

The University of Strathclyde embarked on a pilot in ubiquitous computing essentially believing in the overall benefits to staff and students across a broad range of activities. The last fourteen months has seen many lessons learnt but nothing has yet come to light that makes us question that belief. The University strategic plan for the next four years specifically mentions the success of the pilot and it's continuation. Crucially, it does however indicate the need for a financially sustainable model by which the laptop pilot may be extended to all students – this will be the real test.

Lessons for Beginners

- Value of evaluating
- Support for academic staff to develop materials
- Importance of scheduling time for training support staff in the technology.
- Importance of helpdesk
- Communication between registry and other admin, and the academics.
- Involve academic staff so that it is seen as a sensible pedagogic development and not a technology driven process
- Use the academic project director as a trusted point of contact and "interpreter" for other academic staff
- Location is important – ensure that any locations where the laptops are used, especially teaching space, are appropriately designed to support their use.
- Importance of political process internally – especially student officers
- Estates benefited from the lower cost of radio for networking but new way of working requires rooms.
- Start small and have success – go for the low hanging fruit

- Give yourself leeway on 1st classes/ 1st runs e.g. make your first training class only half capacity.
- Do have a clear, identifiable senior management sponsor**.** If your sponsor has the finance – good!
- Do tightly form a multi-disciplinary team for the lifetime of the pilot.
- Do embed as much of the work as possible in the core activity of the departments.
- Do get the student body involved formally.
- Do 'go on the road' and sell the pilot.
- Do have a Web site detailing not just the technical options but the *whys*.
- Do telephone us – its good to talk.
- Don't imagine technology is the issue – total service is the issue
- Don't imagine that everyone will like or support the pilot
- Don't lose heart – it'll be fine!

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