Mobile Computing at Rensselaer Polytechnic Institute

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ABSTRACT
The mobile computing program has transformed computing on our campus. Students and faculty now move about on and off-campus with their laptops and have come to expect constant access to their personal computing environment and to the Internet.

Starting with the class of 2003, our students are required to have a laptop computer. The mobile computing program is a four-year phased-in plan with each new freshman class participating in the program. The size of the 2003 freshmen class was 1340 and the size of the class of 2004 is expected to be 1300. Both class sizes are larger than any class for the past 5 years. During our presentation we will discuss the program from the early days of the voluntary laptop pilot program through the early part of the second year of the required program.

KEYWORDS
ThinkPad, Mobile Computing, Rensselaer Polytechnic Institute, laptop computers, RPI

INTRODUCTION
The mobile computing program is part of a larger goal at Rensselaer. Quite simply, we want to attract more and better-qualified students by improving the learning experience. Those of us involved in computing technology expect change. In fact, our livelihoods depend on it. Many people within SIGUCCS have been involved in programs that involve a dramatic change in the way computing services are provided to campus constituents and it does appear that human beings have a natural resistance to change. Our mobile computing effort was met with resistance. Today, after one full implementation cycle, the resistance is fading. This doesn't mean everything is perfect, just that the program has been well accepted by those required to participate.

This paper is designed to provide an overview of the mobile computing program at Rensselaer. The paper will cover a broad range of topics and will include information from the early pilot programs to the current 2000-01 academic year.

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THE PILOT PROGRAM
The pilot laptop program started in the fall of 1995 and continued through the fall of 1998. Approximately 100 freshmen participated each year. This was a voluntary program with the students bearing most of the cost of the hardware and software.

The laptop sections of these courses were taught in studio mode, a method of teaching developed at Rensselaer that combines lab and recitation sections, emphasizes interaction and teamwork, and minimizes the use of lectures

Courses with laptop sections:

Math I and II

Physics I and II

Introduction to Engineering Analysis

During those early years, the laptop sections met in 3 classrooms equipped with power and network connections for each laptop.

Listed below are the laptops that were made available to the students.

Fall 1995: AT&T Globalyst 200s, 75 MHz 486, 12MB RAM, 540MB Hard Disk, 10.5" dual scan Display – cost $3600

Fall 1996: IBM ThinkPad 365X, 100 MHz Pentium, 16MB RAM, 1.0GB Hard Disk, 10.5" active matrix screen – cost $2950

Fall 1997: IBM ThinkPad 365XD, 133 MHz Pentium, 40MB RAM, 1.3GB Hard Disk, 11.3" active matrix screen – cost $2760

Fall 1998: IBM ThinkPad 600, 233 MHz Pentium II, 64 MB RAM, 3.2 GB Hard Disk, 13.3" active matrix screen – cost $2975

The pilot laptop program was initiated by the Laptop Committee faculty and supported by the staff of Computing and Information Services (CIS).

In December 1998 the Laptop Committee, chaired by the Dean of CIS, recommended a mobile computing program for freshmen entering in the fall of 1999.

MOBILE COMPUTING AT RENSSELAER – FALL 1999
The Laptop Program Mission Statement**:** Consistent with the mission statement at Rensselaer, the goals of the laptop program are to improve educational value for students, to increase the number of public-access client systems, to provide a mobile and more ubiquitous "anywhere/anytime" computing environment for students, to improve the "turnover" rate of client systems, and thereby attract more and better students to Rensselaer

In order for this goal to become reality it was imperative that the program have the support of all the campus groups from the beginning. A Campus Laptop Committee was formed with

membership coming from all campus groups – faculty, students, administration and staff.

In December of 1998 the Campus Laptop Committee proposed: "*We should proceed with the phased implementation of a required laptop for all students beginning with the entering class in the fall of 1999. We should provide a lease to our students which will be about $100 per month. The institute will work with vendors to provide the students with exciting technology which will be refreshed in the junior year. Implementation of this program will be phased in over four years, i.e., in the fall of each year after 1999, freshman will be required to have a laptop.*"

This proposal was approved by:

SCAIT (Rensselaer Steering Committee for Academic Information Technology)

Faculty of IT (Information Technology)

Faculty Senate

Information Technology Committee of the Board of Trustees

Dean's Council

President's Council

The Student Senate met in February, 1999. They did not OK the proposal. Instead, they sent out a questionnaire to students and asked additional questions. The Student Senate's main contention was that this program had not been researched enough. They felt that the Institute was rushing in the program and that the Fall of 2000 was a better target date.

THE LAPTOP IMPLEMENATION TEAM

To implement the program, the Dean of Computing and Information Services, formed a team that represented all the major constituencies on campus that would be affected by the laptop program: faculty, students, the Admissions Office, Residence Life, the Registrar's and Bursar's Office, and, of course, computing support staff.

The Implementation team was divided into five groups: Acquisition and Affordability, Curriculum, Marketing, Students, and Technology & Facilities. The Distribution and Training Group was added later and replaced the Technology & Facilities group after it had completed most of its original tasks.

These groups saw the program through the early planning stages, the selection and configuration of the laptop, the publicity to the campus and incoming students and their parents, the renovation of classrooms, the design of payment programs, and the distribution of laptops. Documentation and training were handled by Academic Computing Services staff, who were actively involved in the implementation groups.

THE FALL 1999 SYSTEM GOALS

Early on in the process, it seemed apparent that there would be substantial benefits from selecting a standard for the laptop model.

Advantages of a standard laptop model to faculty and staff include:

Standardizing the toolkit with very high quality, affordable equipment ensures that all our students have equal access to the benefits of a Rensselaer education.

It would allow Rensselaer to provide its users with a high level of consistent support.

There would be less class preparation time needed to make sure assignments work on every platform. This is important as we have three UNIX platforms, the Mac OS, Linux, and several versions of MS Windows to deal with.

There would be less classroom confusion and increased ability for students to collaborate and help each other.

The Institute would be able to obtain volume discounts.

There would be lower support costs.

Advantages of a standard laptop model to students:

Value – Students will not find an equally powerful system (hardware and software) anywhere at this price.

Commonality – The professors, their roommates, everybody will be using the same system with the same software. Being able to turn to instructors and classmates for help is an invaluable asset.

Appropriateness – The right software will be loaded and tested. The laptop is configured correctly for the network.

Service and Support – Repairs are performed on campus (loaner systems available). The Help Desk is familiar with the system.

THE FALL 1999 SYSTEM

Hardware
IBM ThinkPad 600E (2645-4AU)
Pentium II 366 MHz processor
128 MB RAM
6.4 GB hard disk
3.5 in 1.44 MB floppy drive
13.3 in 1024x768 TFT display
24X CD-ROM
Internal 56Kb modem
10/100 IBM Etherjet network card
3 year warranty

Software and Extras
MS Windows 98
MS Office Professional 2000
MS Visual C++
Waterloo Maple V
National Instruments LabView
Norton Anti-Virus
Backpack carrying case
Mobile Computing @ Rensselaer Manual

The ThinkPad 600E came preloaded and pre-configured. The hard drive image was developed at Rensselaer, shipped to IBM and pre-installed on the system hard drive before the student received their systems.

When the laptops were distributed, the students were assisted with the personalized configuration during the initial boot sequence. During this configuration, students were able to establish a network connection and were given instructions on how-to items such as configuring electronic mail and installation of a network printer.

Acquisition Options	Cost to student	Number of students
Purchase	$2,500	309
Two yr Lease	$2,400	404
Dean's gift	$0	92
Free with ownership after 4 years	$0	385
Early decision first year lease free	$1,200	81

Thirty students declined the Rensselaer laptop offer and brought their own laptop. The minimum specifications were: 300Mhz Pentium II, 96 MB RAM, 6 GB hard drive, 3.5" 1.44 MB floppy drive, CD ROM, audio card, PC card slot, 10/100 3 Com ethernet card, Win 98, and the purchase of standardized software.

The laptop cost is not included in the cost of attendance but is subsidized by Rensselaer. Our goal was to provide exciting technology for a price of $2,500 and that remained the case for the class of 2004.

FACULTY DEVELOPMENT

Faculty were offered a formal two-day workshop as an introduction to the laptop program with two incentives: a $600 stipend and an opportunity to receive a laptop. Eighty faculty attended the workshop.

Strategic funding from the Provost's office was made available to develop pedagogy associated with laptops in all major first-year courses.

The Faculty Laptop Program delivered 144 laptops to selected faculty. These laptops were available to the departments at attractive rates. If requested, faculty were assisted by staff with setup and software installation. In the previous year 97 laptop were distributed to faculty in a similar program.

Additional laptop workshops were developed and presented to faculty. In addition, workshops were presented on computer-based online tools such as WebCT, web page development, and Library services.

CLASSROOM CHANGES

With the arrival of over 1300 students all carrying laptops it was necessary to provide classrooms that would accommodate them. During the summer of 1999, 24 classrooms renovated at a cost of over $1,000,000

9 new laptop classrooms with new furniture, networking, power, teacher station computer, printer, and projection (1024x768) were completed.

Even classrooms that had desktop units had laptop connections installed. We developed 4 of these hybrid rooms to accommodate freshmen classes taken by upper classmen.

Other classrooms received networking, power, and projection upgrades for the teacher's podium.

NETWORK CHANGES

The network upgrades were significant and very noticeable in the residence halls. The goal was a "port to every pillow" and this goal was accomplished with only a few bumps. Many of the network upgrades would have been implemented regardless of the laptop program. The largest change directly related to the laptop program was the use of DHCP for serving IP addresses.

In addition to upgrading classrooms and the residence halls, there was a push to have public laptop connections added to public areas such as the library and the computer center.

DISTRIBUTION OF LAPTOPS

The planning process for distribution of the laptops required the coordinated effort of many people. The staff of CIS was the primary group involved in the planning and implementation. We worked closely with the Residence Life staff and involved 70 or more volunteers during the distribution and configuration of the laptops.

There were three distribution events. The first distribution involved small groups including the ROTC students and several sports teams. These small distributions allowed us to test and improve our process.

The second distribution involved all the students who attended the final student orientation session. This distribution included 260 students, who picked up their laptops and the full cast of support people to hand out and configure the systems. The number of support staff (many volunteers outside of the computing support staff) involved in the distribution at anyone time was 45 people.

The largest distribution took place between 9:30 A.M. and 1:30 PM on the Sunday before classes began. The goal was to distribute and configure 200 laptops per hour. We were able to distribute 800 laptops during that time.

The distribution process began with staff from Residence Life leading a group of 50 students from residence areas to the distribution site every 15 minutes

Students were required to complete and sign paperwork for software agreements. This was done in a separate room next door to the pickup site. As students in the group completed the agreement forms, they went to the pickup sites.

Students queued into one of 10 lines. The lines were broken down into equal portions of the alphabet. They picked up their laptops and signed receipts. There was no money transaction involved in this stage. If there were problems with the paperwork, students were directed to the available admissions staff person who was on hand. When this occurred, it usually involved students who responded to information late, were transfers, or international students. Admissions would verify that the student was indeed part of the incoming class and would complete acquisition forms on the spot.

Students were queued until the group reached about 20 in number. They were then led to one of ten configuration rooms.

At the configuration room, students unboxed the laptop and were provided with a two-page worksheet that led them through a step-by-step process to configure and test the laptop. The configuration rooms were staffed with professional computing staff and student assistants. No student left the configuration room without a working networked laptop.

In the event that a system failed, we had our IBM certified technician available to correct any out-of-the-box problems.

While we planned and worked hard to make the distribution a positive first experience, one thing stood out. The weather was very

agreeable. Of course, we have ordered similar weather for all future events of this type.

RESULTS

Without question some people were worried that the requirement to buy a laptop would discourage potential students. The final decision to accept the mobile computing program came after some students had accepted early decision entrance. In addition, students who were not included were not fully behind the program.

Many of us believe that mobile computing is, at least in the short term, the way of the future. As an Institute, we worked hard to provide all the incoming students and their parents with as much information as we could. The result was a larger than expected class despite our fears. As mentioned earlier, the 2004 entering class was the largest in recent history.

The IBM ThinkPad 600E was an excellent choice. The number of systems that were dead on arrival was 2 out of over 1400 systems. One area where we did not do a good job was in providing students with enough information on caring for the laptop. This was in part due to our own lack of experience. We plan to stress how to care for the laptop during the fall of 2000 distribution.

The laptop distribution brought the campus together. Many of the people who volunteered to help out were upper class students and when they were able to see and touch the laptops they started to believe the program was, at the very least, not bad. Still, it took some months before the mobile computing program was accepted by the upper class students. Many decided to purchase a laptop. We were surprised to learn that 150 return upper classmen purchased a laptop.

The laptop classrooms opened on time. This was due to many long days by Rensselaer's physical facilities staff as well as good planning by the Implementation Team's Facilities group.

One problem that kept us busy in the first dew weeks of the program was the failure of our network equipment under the "back-to-school" load.

Laptops were used in many classes including all required freshmen classes in:

Math

Physics

Introduction to Engineering Analysis

Computer Science

Chemistry of Materials

Humanities and Social Sciences

Architecture

We have no hard data on the impact of the laptop on learning except from the student surveys.

Students reported that they used their laptops extensively and that they found it convenient to be able to take their work with them.

STUDENT SURVEY RESULTS

The results of the student survey questions were uniformly favorable:

70% of students used their laptop more than 10 hours per week

55% of students spent more than 20% of class time using the laptop

55% of students took 4 or more courses that required a laptop during the year

67% of students were very satisfied or satisfied with IBM laptop

9% of students were unsatisfied or very unsatisfied

43% of students had a laptop problem that required repair

77% of students agreed laptops enhanced their interaction with the instructor

88% of students agreed laptops made learning more enjoyable

77% of students agreed laptops in class enhanced learning

75% of students agreed laptops enhanced ability to take control of learning

Complaints in student comments:

Network speed and availability

Network card dongle failure

Software CDs not provided. This was a licensing cost decision.

FAT 16 C: drive too small, bigger hard drive

Not reliable enough, too many crashes, hard drive problems

More training needed. Interestingly enough we were taken to task for not telling students to make better use the user manual that was distributed to them at distribution.

Too expensive

Battery life and warranty. While the ThinkPad is warranted for three years, the battery has a one year warranty.

Not used in class or not suitable for class (Arts)

In some cases the laptop became a distraction in class (instant messaging, read e-mail, etc). There were some requests to block Internet access during class time. It seems much easier to instruct students to close the laptop during periods when it is not in use.

REPAIRS

An on-campus repair facility with two technicians performed 834 laptop repairs from distribution time until April 2000.

Hardware problems listed in order of descending frequency:

Battery (one year warranty)
Ethernet Card or Dongle
Keyboard
System Board
Hard Drive
Bezel (acidic perspiration dissolved paint)

Discussions with IBM indicate that they understand the problems with 600E and have made improvements in all areas listed above. We will be able to provide some comparison numbers at the SIGUCCS conference.

Months	Repairs
Sept 99	82
Oct, Nov, Dec 99	287
Jan, Feb, Mar 00	382
Apr 00	83

The Help Desk staff reloaded the original image 181 times. We discovered that most students were not skilled at system

administration. Most of the system reloads were caused by self-inflicted errors.

With the students able to bring the laptop into the Help Desk, staff were better able to diagnose problems but these problems take longer to resolve.

We had planned to use the campus tape robot as part of the backup program. Due to licensing costs, this did not turn out to be feasible so we did not have a reliable and supported back up system. We have worked out the licensing issues and will be able to offer the backup system to the students.

A number of students failed to effectively use the Norton Anti-Virus software. In some cases, the virus protection was turned off and in others the virus definition files were never updated.

THEFTS AND INSURANCE

During the pilot programs, thefts and losses were extremely small. Unfortunately, this changed when we moved to the mobile computing program.

Most thefts appeared to be a case of carelessness or crimes of opportunity. As the chart shows laptop left unattended in public areas and unlocked residence rooms were the primary targets.

Months	Public Area	Residence Halls
Nov 99	2	0
Dec 99	0	2
Jan 00	3	0
Feb 00	1	2
Mar 00	1	1
Apr 00	2	11
May 00	0	6

Security cables, not issued with the ThinkPad 600E, are part of the fall 2000 laptop package. We also need to provide anchor points in public places and residence halls.

Rensselaer allows freshman students to lease as well as purchase laptops. For the lease, Rensselaer owns the laptop and provides insurance as part of the lease payment. The loss deductible is currently set at $500. Students who purchased systems were responsible for their own insurance. It is interesting to note that of the 31 systems missing only 4 of them were systems that had been purchased by the students.

MOBILE COMPUTING AT RENSSELAER – FALL 2000

The web page http://www.rpi.edu/dept/cis/web/laptops/ has been updated as more information about the fall 2000 program has been completed.

This year we worked with IBM to provide the ThinkPad T20 to our students.

Hardware
IBM ThinkPad T20 (2647-41U)
Pentium III 700 MHz processor
128 MB RAM
12 GB hard disk
3.5 in 1.44 MB floppy drive
14.1 in 1024x768 TFT display
6X DVD
Internal 56Kb modem
Internal 10/100 network card
3 year warranty

1. Software and Extras
MS Windows 98
MS Office Professional 2000
MS Visual C++
Waterloo Maple V
SolidWorks
MapInfo
National Instruments LabView
Norton Anti-Virus
SecureCRT
Tivoli Storage Manager
Backpack carrying case
Security cable
Mobile Computing @ Rensselaer Manual

Acquisition Options	Cost	Students – as of July 14, 00
Purchase	$2,500 plus NYS sales tax	611
Lease	$2414.68 4 @ 603.67	320
Dean's Gift	$0	93
Free Use with ownership after 4 years	$0	322

This program is open to all matriculated students at Rensselaer. It will be interesting to see how many order the T20. We will have this information in early September and will be reported on this at the conference.

CLASSROOMS

Additional laptop classrooms will come online for the fall 2000 semester. We have converted 3 of the desktop computer labs to laptop classrooms. In addition, we converted 3 previously unwired classrooms to laptop classrooms.

SUMMARY

The mobile computing program has been and continues to be an exciting aspect of Rensselaer educational experience. What started in the Fall of 1995 as a pilot program has become a active part of our students' everyday life on campus. We still have issues to resolve – some mentioned in this paper and some that haven't arrived yet.

As for the future years, we expect that computing changes will continue to come – that's good for our job security but perhaps not so good for our blood pressure. We have enjoyed the mobile computing program. In many regards, it has pushed us to our limits, but it has made our school a better place to learn and that has made our jobs more enjoyable.