The Economics of Notebook Universities

Given the increasing ownership of notebook computers, will notebook universities be the next big wave of technological progress on campus?

By **John M. S. Bryan**

In the fall of 2006, students could purchase an entry-level notebook with a 15-inch LCD for $500. This price crossed an important threshold, moving notebooks into the range of consumer electronics—the category of phenomena that fuels mass consumer trends such as cell phones, digital cameras, and iPods. Within the next three to five years even mid-range and high-end notebooks will fall into this category. By then, the majority of college students will probably own at least three computers—a desktop/game console, a notebook, and a combination phone/PDA/GPS/camera/media player—and they will bring them all to college.

Most colleges and universities today operate computer labs. What are the implications of a shift to ubiquitous notebook ownership by students? What can colleges and universities do to plan for this trend?

The likeliest move is a shift to notebook university models, which require students to have notebook computers and to bring them to class. Notebooks will eliminate the need for open general-purpose labs, potentially turning all classrooms into active and collaborative learning environments.

The prices for notebook computers are easily tracked from the Web pages of any notebook vendor, but what about the economics of higher-education computer labs? My purpose in this article is to share actual notebook university costs and compare them with general-purpose computer laboratory models and other notebook approaches likely to be used in one of the next inevitable waves of technological transformation that will soon flood our campuses.

Description of the Cost-Comparison Models

To compare the costs of a traditional computer laboratory approach to those of a notebook university, I collected comprehensive factors for the two different methodologies and modeled them. I explored more than 100 notebook models and fully developed six of them; the two most relevant notebook models are presented here.

Clayton State has been a notebook university for nearly 10 years, so I used Clayton as the primary source of data

to build the notebook-university cost models. Costs for the computer laboratory approach were calculated from my experience as a CIO building and operating general-purpose computer laboratories at public universities.

Computer Lab Model

A lab-seat-to-headcount ratio was calculated from historic data for an urban, public, comprehensive/doctoral university. In 2004, the comparison university operated approximately 450 general-purpose lab seats for a headcount enrollment of 18,000 students. This is a lab-seat-to-headcount enrollment ratio of 2.5 percent (450/18,000 = 0.025). The computer lab model constructed for this analysis applied the actual 2.5 percent ratio to Clayton State's headcount enrollment, producing an expected number of lab seats and computer labs if Clayton State were to use a computer lab model. The 2.5 percent ratio applied to Clayton State's 6,000 students produced an expected count of 150 computer lab seats in 4 general computer labs.

The factors for the computer lab model included capital start-up costs for space, electrical wiring, air conditioning, hardwired Ethernet, security, a classroom audiovisual (A/V) presentation system, tables, and chairs. Operational costs for the lab model assumed the purchase of PCs and staffing for a lab manager and a technical manager. The lab manager would supervise student assistants, and the technical manager would handle the software configurations and the hard-disk images. Student assistants would staff the labs an average of 72 hours a week, 45 weeks a year.

In-Sourced Notebook Model

With the in-sourced model, the university purchases notebooks from a single vendor, configures and supports the notebooks on campus, and adds the cost to students' tuition and/or fees. Given the many incompatibilities that occurred in the early days of notebooks, the in-sourced model was considered a necessary best practice for implementing a successful notebook program.

Advances in hardware and software compatibility have created reliable notebooks that require much less support, and today, newer, cheaper outsourced support options exist that are just as successful as early in-sourced models. For this reason, I excluded the completely in-sourced notebook approach from my analysis. Outsourced notebook models have the potential to become new best practices for next-generation notebook implementers.

Outsourced Notebook Model

The outsourced notebook model takes the approach to its extreme by outsourcing the purchase of the notebook, all software, maintenance, and support. With the outsourced model, students purchase a notebook computer directly from a vendor that meets a minimum set of hardware specifications. The notebook comes preloaded with specific software (operating system, office suite, and antivirus) and has extended hardware maintenance and support, typically two to four years. Thus, the outsourced model imposes no additional cost to the university for the support of notebook hardware or software. However, additional costs to the university are necessary under the outsourced notebook model—for additional space and staffing. The outsourced model will need an expanded help desk to field increased questions from more students using existing university e-mail, library, administrative, and Web-based instructional systems. For the purposes of this analysis, the outsourced notebook model assumes an additional 160 square feet of space for the help desk and call center; one additional full-time support position; and three additional half-time student assistants.

Clayton State's Hybrid Notebook Model

Clayton State became a notebook university in 1997. Initially, the university used the in-sourced model, purchasing about 5,000 student notebooks and providing configuration and support in-house. In 2001, Clayton State switched to a hybrid outsourced model where students purchased notebooks directly from vendors and the university provided on-site support and repair. President Harden shifted the course of the university because it was difficult to obtain and manage the large capital and support resources necessary to replace notebooks regularly on a large scale. The hybrid outsourced model has been successful for Clayton State, and it is still in use and working well.

The Clayton State hybrid model is referred to as a "choice" program because the university has no required hardware vendor. In Clayton State's outsourced choice model, students can purchase any notebook that meets the university's minimum requirements.

Clayton State has three levels of notebook specifications set by colleges and departments to ensure that student notebooks can run all of the application software necessary for their degree programs. The three levels of notebook specifications translate into price points of approximately $800 for an entry-level notebook, $1,200 for a mid-range machine, and $1,600 for a high-end notebook.

Clayton State has multiple preferred vendors for which the help desk is certified and authorized to perform on-site hardware warranty repairs. Students who choose a non-preferred vendor must obtain hardware warranty support directly from their vendor. Despite this limitation, the help desk assists with the diagnosis of hardware problems for all machines and can configure any student notebook, regardless of vendor or warranty status.

Students pay a technology fee of $50 per semester, which is used to purchase heavily discounted, campus-wide site licenses for operating systems, the Microsoft Office Suite, and antivirus software. The student technology fee also supports the university-operated help desk for walk-up assistance. The help desk installs software (operating systems, antivirus, office suite, and applications), configures notebooks, troubleshoots, and performs hardware warranty repairs.

The hybrid outsourced model offers many advantages for notebook programs. The most important is that it reduces the financial obligation for a university and simplifies procurement.

For public universities in particular, the procurement and financial impediments can be significant. The hybrid model can also be quickly and easily implemented, especially by universities already using the in-sourced notebook model.

To provide the higher education IT community with more information on this potentially important model, I collected 2006 cost data from Clayton State's hybrid outsourced notebook program (Model 2) and compared the actual costs of the hybrid model to cost estimates for a general-purpose lab model (Model 1) and the outsourced notebook model (Model 3). Because universities using a hybrid outsourced model provide repair and support in-house, costs for the hybrid model include significant expenditures for support. The Clayton State hybrid model includes costs for 2,319 square feet of space, 4 full-time support staff, and 27 half-time student employees. A call center operates whenever the university is open; the help desk is open 72 hours per week; a software support center is open 40 hours per week; and both the help desk and software support center operate 45 weeks per year.

Assumptions for Notebook Models

Both notebook models, in-sourced and outsourced, assume that faculty laptops are provided by the university in lieu of desktops and that no additional costs are required for already existing administrative systems, e-mail, file, print, Web servers, instructional courseware, or faculty development. All notebook models assume the use of laptops by students and faculty alike when in the classroom. This assumption requires classrooms to be equipped with A/V presentation systems and furniture that support effective use of notebooks. Half-tablet-arm student desks are not conducive to notebook use in classrooms. Also, both notebook models assume the need for additional network and electrical power in classrooms.

Results of the Analysis

Table 1 presents the costs for implementing three technology models broken out by 13 different factors for a university with a headcount enrollment of 6,000 students. Each of the factors can be categorized as either a capital startup cost or as a life-cycle operational cost, depending on the campus funding model. All of the data contained in Table 1 are based on headcount and can be applied to other universities by dividing each cost factor by 6,000 and multiplying the resulting cost per student headcount ratio by their own headcount enrollments. The traditional laboratory model requires extensive amounts of space, while the outsourced model does not; therefore, space was included as a comparison factor for all of the cost models. For some universities, space costs are expenditures that must be considered, while for others space is not a factor. To accommodate either approach, the costs for each model were calculated to both include and exclude space.

All notebook programs assume intensive use of laptops in class by students and faculty

Model 1: The Traditional Laboratory Model

Because of the extensive amount of space required by the traditional laboratory approach, space is the largest cost factor when included in the calculations. Space adds $279,000 to the total cost of the traditional lab model and constitutes about 25 percent of the total expenditures. When space costs are excluded from the analysis, the total cost of the traditional laboratory model drops from $1,125,234 to $846,234. Excluding space costs, desktop PCs constitute the largest cost factor for the lab model at $270,000, which is about 32 percent of the total. The desktop PC costs are ongoing, and the PCs must be replaced when they become obsolete. Student lab assistants and permanent support staff add another 18 percent to the support costs of the lab model, which brings the total operational cost of the traditional lab model to more than 50 percent of the total.

Model 2: The Hybrid Model

Of the three models presented, the hybrid outsourced notebook model is the most expensive, regardless of space. The hybrid's total of $1,392,249 includes $239,733 for space. Excluding space, the hybrid total of $1,152,515 is $306,282 more expensive than the traditional lab model. Of this difference, $98,080 is due to pass-through expenditures for additional student software licenses ($148,980–$50,900). The additional $306,282 for a university to implement a hybrid notebook program instead of a general-purpose lab approach translates into an additional cost of $51 more per year per student.

The major benefits of the hybrid model that justify higher costs are the availability and quality of notebook support services. In the hybrid model, notebook support is provided on campus, the help desk is open extended hours, and students and faculty can get immediate assistance with their notebooks. At Clayton State, customer satisfaction ratings for the help desk typically average about 97 percent satisfied or very satisfied.

Model 3: The Outsourced Model

The outsourced model, regardless of space costs, is the least expensive of the three models. Both notebooks and support are outsourced, and the model requires only a modest amount of additional staffing and space. The total cost for the outsourced model, including space, is $762,003, which is $363,231 less expensive than the traditional lab model ($1,125,234–$762,003) and $100,764 less expensive than the lab model, when space is excluded from the costs. The outsourced model is the most efficient notebook model available, and

Table 1

Comparison of the Cost Models*

Cost Factors	Unit Costs	Model 1: Traditional Lab			Model 2: Hybrid			Model 3: Outsourced		
		Cost	Percent		Cost	Percent		Cost	Percent	
			With Space	Without Space		With Space	Without Space		With Space	Without Space
Desktop PCs	$1,800, 3 yr life	270,000	24.0%	31.9%	0	0.0%	0.0%	0	0.0%	0.0%
Space	$100/ sq ft	279,000	24.8%	0.0%	239,733	17.2%	0.0%	16,533	2.2%	0.0%
Electrical Wiring	$150/PC	23,250	2.1%	2.7%	39,060	2.8%	3.4%	39,060	5.1%	5.2%
Air Conditioning	$569/PC	93,830	8.3%	11.1%	0	0.0%	0.0%	0	0.0%	0.0%
Hardwired Networking	$250/PC	50,625	4.5%	6.0%	91,125	6.5%	7.9%	91,125	12.0%	12.2%
Wireless Networking	$1,000/ AP	0	0.0%	0.0%	37,868	2.7%	3.3%	37,868	5.0%	5.1%
AV Systems for 15% of Classrooms	$15,000/ Rm	66,000	5.9%	7.8%	194,400	14.0%	16.9%	194,400	25.5%	26.1%
Lab Security	$75/PC	15,500	1.4%	1.8%	0	0.0%	0.0%	0	0.0%	0.0%
Student Lab Assistants	$7.50/hr	97,200	8.6%	11.5%	224,640	16.1%	19.5%	24,960	3.3%	3.3%
Staff Support	$37,000/ yr	55,500	4.9%	6.6%	201,214	14.5%	17.5%	91,929	12.1%	12.3%
Software Licenses	$57/yr	50,900	4.5%	6.0%	148,980	10.7%	12.9%	50,900	6.7%	6.8%
Tables and Chairs	$300/PC	51,429	4.6%	6.1%	123,429	8.9%	10.7%	123,429	16.2%	16.6%
Internet Bandwidth	$400/ Mb per month	72,000	6.4%	8.5%	91,800	6.6%	8.0%	91,800	12.0%	12.3%
Total With Space		1,125,234	100.0%		1,392,249	100.0%		762,003	100.0%	
Total Without Space		846,234		100.0%	1,152,515		100.0%	745,470		100.0%

*Costs for 6,000 headcount enrollment

for universities needing to implement notebook programs economically, the outsourced model will likely become the model of choice.

The critical factor in determining the overall success of the outsourced notebook model will be the quality of hardware and software support from the vendor over the life of the extended warranty. Name-brand vendors with good long-term financial viability who receive high customer satisfaction ratings for their support should make good preferred vendors for outsourced notebook models.

Classroom Upgrades for Notebook Universities

All notebook programs assume intensive use of laptops in class by students and faculty. As seen in Table 1, both of the notebook models include the same expenditures to make classrooms more notebook- and learning-friendly. Table 3-4 from the EDUCAUSE Core Data Survey report for fiscal year 2005 indicates that about 57 percent of university classrooms have A/V systems and about 47 percent have wireless Internet connectivity.[1] Therefore, for the notebook approaches, the models assume that universities have existing funds sufficient to upgrade 10 percent of classrooms annually and that notebook programs only need to add another 15 percent so that universities can upgrade 25 percent of classrooms each year. Excluding space costs, the 15 percent supplement for classroom upgrades ranges from about 42 percent of the total for a hybrid model to as much as 65 percent for the leaner outsourced model.

Ideally, for notebook programs, all classrooms should have an A/V presentation system and every seat should have a notebook-friendly table, chair, network connection, and power plug.

Most universities already have an extensive A/V infrastructure, and it is feasible to expand A/V to all classrooms. Upgrades for tables and chairs will also be necessary. The table upgrades can range from simple and inexpensive full tablet desks to traditional computer lab tables or even to custom tables with rolling chairs. Classroom network upgrades will also be important, and they can be mostly wireless, with a mix of wired connections where high-bandwidth applications are needed.

Batteries can only operate for a few hours at a time, and students will need to frequently plug in and recharge. Electrical power will become the scarcest resource for new notebook programs, and retrofitting every classroom seat with power at the start of a notebook initiative will be unfeasible and cost prohibitive. Requiring spare batteries is a good option to mitigate the need for power, but many students will fail to keep their spares charged or will forget to bring them to class. Therefore, universities will need to provide students with ample recharging locations in common areas such as the cafeteria, library, and study areas, and the power upgrades for the common areas should be finished before the notebook program is implemented. Universities will also need to begin a multiyear power upgrade for campus classrooms. For this to be cost-effective, it will need to be coordinated with upgrades for classroom tables and chairs. The notebook models assume that 25 percent of classrooms can be upgraded with power to get the program started in the first year and that an additional 25 percent of classrooms will be upgraded in subsequent years. Thus, over four years, universities should be able to upgrade the majority of their classrooms with power, networking, A/V, tables, and chairs.

The readiness of campus classrooms for notebook programs is an area that needs additional investigation. Universities starting notebook programs should survey their classrooms at least a year in advance of start-up to ensure that they have sufficient time to adequately plan, budget, and implement the needed upgrades.

When the notebook wave hits, colleges and universities will have a number of successful implementation strategies from which to select

Summary and Implications

The comparison models indicate that in 2006 dollars, the outsourced notebook approach (Model 3) is less expensive to implement than a traditional general-purpose computer lab (Model 1). The hybrid notebook approach (Model 2) is more expensive than either the traditional computer-lab approach (Model 1) or the outsourced approach (Model 3). Because the hybrid model provides in-house support, higher costs were expected; however, they were not excessive, given the high levels of service and satisfaction that in-house support provides.

Reports from colleges and universities indicate that in 2006 approximately 25 percent of college students owned notebook computers. Given that entry-level notebooks are now in the sub-$500 range of consumer electronics, I predict it will only be three to five years before notebooks become a mass consumer phenomenon, owned by a majority of households and college-bound students. Therefore, the time for colleges and universities to begin planning is now.

When the notebook wave hits, colleges and universities will have a number of successful implementation strategies from which to select. Hardware and software incompatibilities are no longer problematic, and universities will not need to purchase, configure, and distribute notebooks directly to students. This approach is not easily scalable and will overwhelm any higher education IT organization. The best-practice acquisition model in terms of notebook affordability will be outsourcing, with students purchasing notebooks meeting university specifications directly from a list of competing, preferred vendors.

For notebook hardware and software support, the unique needs and resources of universities, programs, faculty, and students will interact to determine the selection of support models. Because of the complexity of the multiple support factors, there will likely be no initial best-practice support model for hardware and software, and universities will use a wide range of models, from in-house to hybrid and outsourced.

Given the unrelenting trend of Moore's Law and the 30-to-50-year life of facilities, all new buildings should be designed for notebook computers. All new classrooms should have A/V presentation systems with sound, lighting control, wide desks, electricity, and wired or wireless networking to accommodate notebooks. Colleges and universities should also begin the process of upgrading existing classrooms so that the campus is ready when notebook programs are adopted. The cost and time required to retrofit classrooms for notebooks will be significant and will take years to complete. Given the capital investments already made, general-purpose computer laboratories will continue to operate for another decade; however, they will probably be converted into notebook-friendly classrooms to mitigate the need for additional space.

The biggest change for the campus will be the ubiquitous nature of computing. Faculty will need a notebook computer to teach notebook-equipped students, and with full-featured notebooks, most faculty will not need a desktop. Now is the time for universities to begin devising notebook programs to ensure that faculty are prepared when the next big wave hits. *e*

Endnote

1. B. L. Hawkins and J. A. Rudy, *EDUCAUSE Core Data Service Fiscal Year 2005 Summary Report* (Boulder, Colo.: EDUCAUSE, 2006), <http://www.educause.edu/apps/coredata/reports/2005/>.

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