

Tooling and Printing in 2010: The Undergraduate's Perspective

Recommendations on Athena Spaces and Student Printing to the Athena
Working Group

UA Committee on Student Life

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Introduction/Background

The financial crisis in 2008 prompted MIT to form the Institute-wide Planning Task Force, a group charged with identifying efficiency and cost reduction opportunities that would not interfere with MIT's mission. The Task Force released a report outlining several proposed cost-saving measures, including the elimination of Athena clusters and the institution of a per-page printing fee. A working group of students, faculty and staff was formed in order to assess the future of MIT's printing and computing landscape. The UA Committee on Student Life conducted a survey to gather information and feedback from undergraduates. The purpose of this report is to make recommendations to the working group based on student preferences.

Athena

Much has changed since the completion of Project Athena in 1991. For example, almost all students now have their own laptop. However, many students still rely on Athena computers to some extent.

During the day, students use Athena clusters to sit down between classes, catch up on email, and print out documents. On nights and weekends, especially after the libraries are closed, clusters are great locations for quiet study. Some students also use special software which is only available on Athena.

The fifth floor of the Student Center (W20) is popular because it offers a mix of individual table space, group work space, computers, printers, and lounge space. If Athena clusters are consolidated into fewer, larger areas, we recommend using the fifth floor of the Student Center as a model.

The libraries are also a popular place to study. Students appreciate both the tables in the open reading areas and the quiet nooks among the stacks. The Athena workstations in the libraries are among the most utilized workstations on campus.

The Institute-wide Planning Task Force suggested reducing the number of Athena clusters on campus in order to free up valuable space and reduce the cost of maintaining and renewing workstations.

In addition, we believe that the Institute could further save money by better utilizing existing spaces to create studying environments. For example, libraries could provide large amounts of study spaces after hours.

The survey results indicated that students strongly desired more group study space. The group study rooms in both the W20 reading room and Hayden 24 hour study locations are very popular.

Other clusters

We recommend against closing the clusters in buildings 12-129, 56-129, and E51-075; they are located in heavily traveled areas and are thus extremely convenient for students during the day. On an average school day, each of these clusters peaks at over 85% utilization.

The clusters in 37-312 and 1-115 are both used as classrooms during the day. 37-312 is also available to students on nights and weekends. MIT should explore how and if these clusters can be open to students from 5pm to 9am, while maintaining readiness for classes to be taught in the morning.

Some students expressed a preference for a very quiet work space without windows. If changes are made, we hope that such a quiet space will still be available. Currently, the cluster in building 66-080 fits this description.

MIT should also look at spaces that are not used from 5pm to 9am. Many departments have conference rooms or clusters which are only used by their department between 9am and 5pm. We recommend exploring options to make these spaces available to students during non-business hours.

Quickstations

Students listed location as the most important quality of Athena clusters. In further discussions, students identified quick access and printing during the day as the reason why location is important. Location is not as important in longer work sessions, when the several minutes required to walk to one's favorite workplace is outweighed by increased productivity or comfort. Installing additional quickstations around campus is critical, regardless of any changes to the number of full Athena clusters. Most quickstations should be accompanied by a printer in its vicinity, as access to printing is the primary reason students use quickstations.

The quickstations would also have to be placed in easily accessible locations, ideally on the ground level in well-traversed spots, or near Athena clusters that will soon be removed. One advantage of quickstations is that because of their size, they can be placed in small, otherwise unusable spaces.

Other Recommendations

In aggregate, MIT students operate on 24-hour workdays. Any changes must preserve 24/7 access to study locations. The current Athena clusters show that this does not present a security risk.

MIT should install RFID card readers instead of combination locks. RFID readers alleviate the need for students to remember a combination, and would slightly increase cluster usage.

When building group study rooms, MIT should build actual rooms. In both the 24 hour Hayden space and W20, only partitions were provided. This is insufficient because sound easily leaks between the rooms. Group study spaces should be outfitted with a Whiteboard and either a projector or an LCD television with VGA input. We do not recommend digital whiteboards. The one in the building 56 cluster receives almost no usage.

MIT should also innovate on new technology and service offerings. For example, software virtualization should be explored. This would allow students to run powerful software on less-capable laptops and may be cheaper in a licensing context. This would allow students to run powerful software from locations of their choice.

In addition, some students expressed interest in using laptop docks. These offer a monitor, mouse, keyboard for students to hook up their own laptops. These would be particularly popular among netbook users. MIT should install some of these and observe their usage.

Many students do not study in classrooms because they do not know when the classroom will be used next. Making the information public would allow students to use classroom space more during the night time. The information could be made public on a website, preferably a website optimized for mobile phones.

Printing

Printing is an essential component of the MIT education; students depend on printed homework and readings for class. The recent push to digitize MIT has mostly served to move printing from departments to students. Most students print material, rather than reading it off the screen. Some professors even require that problem sets be printed out and submitted with solutions filled in. Longer form reading is easier on paper as well, and students are unable to make markings on the screen, such as taking notes for further study.

The printing system has grown old and unreliable. IS&T is working to modernize the backend systems, but the changes that they make are not being adequately communicated, further decreasing the apparent reliability of the system.

Charging and Quotas

We believe that a large amount of printing waste occurs due to poor communication (lack of knowledge about turning off header pages, printing

double-sided, and removing jobs from the queue) and quality problems (re-printing due to paper jams, faded or smudged pages, and stalled printers).

We also understand that a small portion of Athena users print an unreasonably large number of pages. To counteract this, we recommend a reasonable per-semester printing quota and a reasonable per-page fee for printing beyond the quota. The quota should be in the form of pages, and not sides of paper, to encourage students to print double-sided when possible.

The recommendation from the Institute-wide Planning Task Force was to reduce printing waste by charging a per-page fee. We believe that a per-page fee would not be appropriate. Students should not subconsciously put saving a few cents over their education. In an all-you-care-to-eat trial at Simmons, students drank five times as much milk when it was unlimited. Although dining and printing are not analogous, the move to equalize the playing field by removing cost from students' minds is. The improvements in the system will cut waste, and the quota will ensure that students do not print an inordinate number of pages.

We do caution, however, that the implementation of any sort of charging mechanism must be done smoothly. In order to charge the right person for jobs that they print, jobs would need to be authenticated. This would require new technology, and it may further complicate the already precarious driver situation. Care must be given that authentication would be supported in all environments in which students print. In addition, a procedure must be created for granting students refunds in case of printer malfunction.

Currently, faculty and staff can print for free on Athena printers. The Institute should decide whether faculty and staff should pay for printing out of department funds. If MIT decides to collect revenue from printing, we do not object to charging faculty and staff.

It currently costs 10 cents per page to use copy machines in the Library or the Student Center. Paradoxically, copy machines also have a lower cost per page in terms of supplies than Athena printers. However, for students they have a higher price per page. If a quota is implemented, users should be able to choose whether pages printed on a copy machine should be paid for using cash or quota pages.

Dorm printers are currently paid for by the dorms themselves. If a quota is implemented, the dorm printers should be part of the system. The printers would be supported by IS&T and pages printed on them would count against the quota. This is only fair because if quotas are implemented elsewhere, more students would just print in the dorms. FSLIG printers should not be affected by these changes. Care should be given that free labor by the students in maintaining the printers is not replaced by costly labor. In addition, students can fix problems on nights and weekends, where as employees are not.

There could be a separate quota for color pages, or they could count more significantly against the quota (for example, one color page could count as five quota units). If Athena clusters are consolidated, each main cluster should have its own color printer.

Fees collected from printing should not become a source of revenue beyond funding capital improvements and maintenance to printing equipment.

Instructions

The instructions on the IS&T website are lacking. They do not explain the wide variety of ways to print from each system. The basic instructions are falling out of date and the in-depth documentation is virtually non-existent. There is no explanation about which printing technology is used and the architecture of the printing system, including the print server. The recent change over to CUPS was made first, with the documentation put off for a later time. Documenting the system will help MIT weather turnover, both of staff and student developers.

In addition, some students have noted that the posters in the clusters are out of date. The lack of consistent, correct information produces confusion, which in turn causes printing waste.

Hold-and-release or Queuing System

Currently a document is sent to a queuing system which prints without any further human interaction. The queuing system is a relic of the command line days. Many students do not know how to view the queue and cancel their jobs. Either the queuing system should be improved or a hold-and-release system should be implemented.

A hold-and-release system holds the job until a user manually releases the job using a touch screen located next to the printer. A hold-and-release station at the printer would eliminate the need for a queue, because the jobs would only be printed by people physically standing in front of the printer. Dedicated touch screens are best for this purpose.

MIT is currently testing the Pharos hold-and-release system in Baker House and the first floor of the Student Center. In Baker, students were generally happy with the trial. The Pharos system was installed at the same time that the printer was replaced with a new HP 9050. The Pharos system combined with the new printer worked well. No users complained about the extra step of using the touch screen or the extra wait as their jobs printed, and several students praised the system as an improvement. The new system does not choke on large jobs as often as before, and paper jams are no longer an issue.

We believe the Pharos system is very usable, and does not represent an increased burden for students. However, further investigation is needed to determine if this strategy is cost-effective (i.e., if the costs of such a system outweigh the savings produced by the reduction in waste). There are also concerns about becoming locked in to a particular vendor. The system only supports a limited set of business models with no way to add a new model. One example of a new model would be a public scorecard for shaming users who print too much. Such ideas would not be possible with a system purchased from a vendor. MIT should carefully study the pros and cons of

becoming reliant on a vendor. MIT could also create its own hold-and-release system. The Athena working group should study this possibility.

If a hold-and-release system is not implemented, the queue system must be improved. The School of Architecture and Planning's IT division runs a self-developed queueing system with the following features:

- It automatically discards jobs that are too big
- It limits the number of pages per job
- It limits the number of jobs that can be active at once to 5
- It has a graphical user interface on the web where users can see:
 - A list of printers and how many jobs they have
 - A list of jobs at a printer
- Users can remove their jobs from the web interface
- Users can remove the first job from the queue in case of problems
 - This sends a notification to the owner of the job
 - has not seen any problems with users maliciously removing other's jobs
- Jobs are automatically removed after a length of time

This easily accessible queue system brings greater transparency to the print queues. Merely seeing this information affords users greater control over the process. In addition, allowing users to remove other people's jobs with strict logs of accountability builds a respectful community and reduces the need for administrator's involvement. By automatically removing jobs that have no hope of printing, the system increases its reliability. The notification system provides information and transparency, both of which are currently lacking.

In addition, DUSP has provided repurposed old MacBooks next to the printers to allow access to the queueing system for those without a computer nearby.

All printing-related websites should be consolidated if possible. CUPS, the printing server used by MIT, already has a web site which displays the queue. MIT should look into making modifications to CUPS instead of creating a new site. Such modifications should be contributed to the upstream project if possible. Quickprint and other printing-related services should be rolled into this site in order to create one site for printing control.

Locations and Equipment

The number of printing locations should be kept the same or expanded. Students often have to print something out on the way to class, and most students print from Athena computers. Faster printers with a hold-and-release system reduce the need for multiple printers located next to each other. However, two printers should still be provided in busy clusters for redundancy.

All quickstations should have a printer nearby. A quickstation must have a printer next to it in order to be considered an acceptable replacement for a cluster.

In busy clusters with multiple printers or select quickstations, some printers should be designated as "express lane" printer. These printers should only allow jobs under 20 pages. They may also need to limit the number of jobs each user can print within a given time period.

New printers must be purchased. The 8150s were released 10 years ago and are no longer suitable for MIT. Their limited memory and worn parts make them slow and unreliable. A single large job can clog a printer for many minutes as it slowly prints one page every few minutes. This builds up a long queue of jobs to the printer. Coupled with an antiquated queue display software, many students print to multiple printers to increase their probability of success. This leads to further waste and frustration. MIT should continue to standardize around printer models to reduce driver complexity and increase efficiency in ordering supplies. In addition, MIT should budget for periodic replacement of printers.

IS&T should look at remanufactured toners and offer Institute-wide guidance on which brands of re-manufactured toners, if any, are cost-effective.

Double Sided

Students reported that better guidance is needed on printing double sided. Similar to installing the printer in the first place, enabling double sided access differs on every platform due to driver interactions. Defaults are set differently for different people. In addition, the recent unreliability of the printing system has further decreased students' abilities to reliably know when documents will be printed double sided and how to change the settings. Furthermore, the documentation on printing double sided is scant.

The hold-and-release system should warn students if they are printing single sided and offer them to continue single sided or switch to double sided. If the hold-and-release system supports this, the UA feels that this would be the best solution. If this is not possible, the documentation for enabling double sided printing should be part of the documentation for installing the printer. In any case, students should be able to easily predict if their job will print double sided.

Header Pages

By default, a header page with the user's name is added to the beginning of each print job so it can be easily located in the stack of completed jobs. Survey responses indicate that 57% of undergraduates do not find header pages useful, and that 29% do not know how to turn them off. To reduce waste in the short term, we recommend that header pages default to off, with the option of turning them on. This change, like any other change to the printing system, should be well-communicated through all available channels.

A hold-and-release printing system eliminates the need for header pages entirely. We recommend this as a long term solution.

Drivers

The state of the printing system has been in flux recently. This was not communicated well with students. As a result, the system appeared less than reliable. In the comments on the UA survey, many students complained that commands that previously worked were now broken. Some were fixed a few weeks later. If the system is changed, the changes must be communicated to the community.

MIT supports a wide range of ways to print. This wide range of options is difficult to maintain without breaking things. It is also harder to document, and harder for users to understand. MIT should look to reducing and clarifying the ways a printer can be "installed" on each computer. We recommend support for the two methods discussed below.

Installing a printer on a machine: IPP with Auto Configuration

With this method users can install a print driver on their computer for a particular printer. This implementation of this method varies widely between operating systems and it requires a driver written for that combination of printer and operating system.

Currently printers are set up using the Line Printer Daemon (LPD/LPR) queuing system. This system is old and requires the manual installation of a driver for a particular printer. In addition, LPD/LPR is not well supported by newer versions of Windows and the protocol is seeing decreasing use in the world. The many different configuration options are difficult to support.

MIT should accelerate the deployment of configuring printers using the IPP protocol. This protocol is the default used by Windows for networked printers. IPP supports auto configuration which automatically selects and provides the proper driver. MIT should study moving to this method in order to take advantage of the auto configuration. Whatever decision MIT makes, MIT should make sure that any changes are communicated to the community and that all help pages are up to date.

Cloud Printing (Quickprint)

SIPB created Quickprint, which is a "cloud printer". One generic printer driver is installed on a user's computer. After a user prints to this driver, the user must log on to a website and select the printer they wish to use. The Quickprint server contains all of the actual drivers, so users do not have to install them. This system significantly reduces driver management, especially if a user prints to multiple printers.

The developers of Quickprint should look into the possibility of selecting the printer and options in the printer driver itself, without having to go to a website.

Alternatives to Printing

MIT should consider alternatives to requiring large numbers of printed documents. However, caution must be given to make sure that these systems simplify life - not complicate it for the purposes of saving paper. For example, moving course packs to the web only increased student printing. These course packs are now printed individually at a higher cost, instead of all at once on a lower cost machine. This move to save paper, did not do much to conserve paper, and only increased cost.

Although E-ink technology was invented at MIT, Princeton conducted a trial of using Amazon Kindles in humanities classes. Although the trial reduced pages printed by about 50%, students disliked not being able to annotate readings easily and professors did not like how students were unable to locate passages during discussions.

Caution must be given to any sort of electronic submission system. Paper is still the best way to read and mark up papers. It is far more natural to make corrections on a paper copy than to use the commenting feature in applications such as Microsoft Word. This is true even for students who are more able to adapt to the new system. An electronic submission system would likely result in much of the work being printed out by the professor or a TA.

The cost of printing for students is currently \$270,000. This amounts to \$27 per student. Any proposed changes aimed at reducing costs should keep this figure in mind.

The incentive now is for students to print course materials on Athena printers rather than buy them from CopyTech. Even without revenue, it is cheaper for MIT to print on the large printers of CopyTech rather than on Athena printers. (Although it is not known how much cheaper - the Institute should study this). However the disincentive leads students to print on more expensive printers. MIT should re-look at collecting revenue for these course packs. In addition, MIT should look at providing a print-on-demand service on large printers which would comply with Copyright regulations and incentivize students to use it. One idea is that pages printed on demand on a large printer have a lower impact against a quota, if a quota is implemented.

It is also easier for professors to post material to Stellar or their course website as the year goes on, rather than prepare a course reader in advance of the CopyTech deadlines. The Institute should study how much money would be saved to have materials printed in advance and whether the added burden on professors is worth the savings.

Professors and course administrators should assure that PDFs posted online are correctly oriented for proper reading. Scans from a book download sideways which prevents on screen reading. Many students do not know how to rotate the PDF for on screen reading.

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Things that are not going in the report:

Student Center

The fifth floor of the Student Center (W20) is a popular space for students to study. It provides a mix of individual study space, group study space, computers, and lounge space. The group study rooms are frequently full, and the Athena cluster rarely sees more than 50% occupancy; about half of the computers should be removed, and more group study rooms should be installed.

Barker

The fifth floor of Barker Library should be open 24/7. The front desk should be moved to the sixth floor, and more computers should be added in its place. The sixth, seventh, and eighth floors, where books are available, should remain open only during staffed hours. The spaces on the fifth floor should maintain a mix of computers and tables, and the shelves of journals should be moved to other floors. The Athena cluster on the sixth floor should move down to the fifth floor, and all spaces should remain quiet except for the existing group working room.

The staircases and elevators should be configured to allow the 6th, 7th, and 8th floors to close while maintaining emergency exits and handicap access to the bathrooms on the 4th floor. We hope that these changes would require only minor construction and could be made over the summer of 2010.

Hayden

The first floor of Hayden Library should be open 24/7, and the front desk should be modified so that it can be closed off after hours. The books should be removed from the mezzanine and the area under the mezzanine, and those areas should be partitioned into group study rooms. We estimate that five study rooms could be created on each level, requiring moderate construction. Further group study space could be created by reusing some or all of offices 14N-132, 134, 136, 144, 148, M52, M48, M44, M40, M36. The occupants of these offices could be relocated elsewhere in building 14.

There are a moderate number of books on the first floor and mezzanine now. These should be moved to other places in Hayden if possible, but there may not be enough room in Hayden to accommodate all of the books. The library should make further accommodations to hold books in the Library Storage Annex. These changes require more planning and could be accomplished over the summer of 2011.

Other

66-080 should remain open as a quiet cluster for doing long periods of work. Some students like working in an environment with fewer

distractions. In addition, it is the cluster most closely located to East Campus, which does not have Athena machines in their buildings, unlike other dorms. Between one quarter and one half of the machines should be removed and the table space should be expanded.

37-312 should remain as a classroom 9 to 5 and it should continue to be open 5 to 9 for students. These machines run Windows, which is needed by some students. One of the remaining rooms, either 318 or 332, could remain open running Linux to provide the only public working areas in the north side of the main group for use while classes are in session. Care should be given to place a printer so that it does not disturb the class in 312. In addition, only one printer is needed here.

38-370 should be closed. It is nearby to building 37 and sees the lowest percent occupancy of any cluster. A quickstation with printer should be placed in either Lobby 34 and or in the 3rd floor of lobby 34 (34-300CA).

1-115 is similar to 37-312 in that it is a classroom which is reservable by classes. However, it differs from 37-312 because it is not open to students while it is not being used. If the schedule was posted, students could know when it was ok to be used. 37-312 has shown that this model can work.

E51-075 sees a lot of usage, in particular from the Sloan school. This cluster should not shut down. Instead, discussions should be had with the Sloan School on the future of this cluster. Either IS&T should continue to maintain it, or it should be turned over to the Sloan School, with the understanding that it remain open for all students.

4-167, 2-225, and 2-032 are all located within a short distance of each other and are relatively small. They are also relatively close to Hayden Library. 2-032 is currently set up in a classroom configuration and is located in the basement without any windows. This cluster is sparsely populated, but it sees the occasional person looking for a quiet place to work. 4-167 has old Sun machines as part of a transition which is ending June 2010 when the machines are scheduled to be removed. Despite the older hardware, 4-167 sees 80% of machines filled at some point of the day on average. 2-225 also sees about 70% of machines filled at one point of the day on average. Certainly, having 3 clusters so close to each other makes little sense. The data suggests that if all were closed but one, it would remain popular. However, due to the proximity to Hayden, the inconvenience would be slight compared to other clusters.