Tablets for a Small Department with a Tight Budget and Their Effectiveness

Hosung Song

Department of Information and Computing Sciences

University of Wisconsin-Green Bay

Green Bay, WI 54311

`songh@uwgb.edu`

Abstract

Using tablets and pen-based computing in education has been known to offer many benefits like increased student engagement and highly active learning. However, the cost of providing every student in class with a tablet PC can be a major prohibiting factor, especially for a small department or institution with a tight budget. On the other hand, computer labs with desktop PCs are still ubiquitous in most organizations, and there are many economic entry-level USB graphics tablets available in the market. This paper describes my experience of implementing the idea of equipping every desktop PC in the author's department computer lab with an economic USB tablet. Firstly, the hardware aspect of this project is discussed with the considered USB tablet models in terms of their features, physical characteristics, and costs. Next, the software aspect is discussed in terms of the operating system choice, which also affects the available pen features on any tablet-enabled applications. Finally, the effectiveness of the deployed entry-level USB tablets is discussed using preliminary student survey results. Because entry-level USB tablets may be unnatural for some to write on due to their detachedness from the actual display and their small form factors, one may need some time for adjustment and familiarization with writing on a detached USB tablet. Surveys are conducted at multiple time points of usage (every few weeks from day 1 to several weeks later) on different types of inking activities (writing texts or drawing figures). The technical contents and the survey results presented in this paper would be much useful for any departments or institutions with tight budgets if they are thinking of adopting pen-based computing with tablets for their students and instructors.

1 Introduction

Tablet PCs are attracting much attention due to their potential to enhance learning and teaching [4, 3, 6, 8]. Many educational applications utilizing tablet features are available these days [7, 1, 2]. With such applications instructors can increase the level of student engagement using various tablet-based activities and this results in more active learning and thus better learning outcome. Research and development related to utilization of tablets are very active now. Many conferences focusing computer science education feature tablet-related research presentations. There are even dedicated workshops for tablet technology in education. It is also evident from my own experience that tablet PCs will play an important role in education in the near future.

However, all these innovations require investment of resources, especially expensive hardware for full-tablet laptop PCs. Since I was introduced to the world of tablet technology in computer science education at the 38th ACM Technical Symposium on Computer Science Education (SIGCSE 2007), I tried to find a way to equip our computer lab with tablet PCs, but the high cost of hardware has always been a serious inhibitor. In the meantime, I noticed that detached USB graphics tablets were becoming pretty inexpensive and that they could be used as an alternative to expensive full-tablet laptop PCs. I started to try out a few detached USB graphics tablets on my own and identified possibility. With a proper tablet-enabled OS (e.g. Windows XP Tablet Edition, Vista, or Windows 7), detached USB graphics tablets could be used as well for providing students with tablet features on many useful applications.

This paper is a full description of my experience of deploying USB graphics tablets on desktop PCs in our departmental computer lab at University of Wisconsin-Green Bay's Computer Science department. This deployment took place over a considerable amount of time due to various considerations and investigations that needed to be conducted for successful completion. This paper describes the overall process and also presents insightful findings from the process. Because this type of project requires consideration of various options, the findings include comparison of various hardware and software choices for successful deployment. Also important in this project is the user experience with detached USB tablets, as writing/drawing on a detached USB tablet would be certainly different from writing/drawing directly on the screen (like with a full-tablet laptop PC) and certainly require quite dextrous hand-eye coordination skills. This paper also presents some survey results related to this issue. They show that for most users using detached USB tablets for writing/drawing is not very difficult and not very unsatisfactory.

This paper proceeds as follows: Section 2 discusses issues related to hardware USB tablet devices. Section 3 discusses issues related to software spanning OS, device drivers and applications. Section 4 describes the overall process of my deployment from the beginning to the end. It also presents survey results regarding usability of detached USB tablets. Section 5 summarizes previous sections and concludes the paper.

2 Hardware Consideration

We focus on entry-level USB graphics tablets only (under $100) and discuss in this section their characteristics that any interested department should consider for their tablet deployment.

2.1 Features

The USB graphics tablets of consideration mostly offer just basic pen-based pointing/drawing capabilities. However, some models bundle wireless mice, or some modern models started to offer touch capability (e.g. Wacom Bamboo Touch), aiming at Apple's iPhone-like multi-touch experience. For those who'd like to avoid using a separate mouse, a tablet with a bundled wireless mouse would be a good choice, but since most lab PCs are already equipped with wired mice, mice bundled with tablets would become redundant. The newer models with touch capability have yet to prove themselves useful with proper operating system choice. At this point, I do not have any experience of multi-touch capability with Windows 7.

2.2 Physical form factor

Most entry-level USB graphics tablets under $100 price range provide moderate to small active area size. Their widths range from 4 to 6 inches and their heights range from 3 to 5 inches. Pen-only tablets (without touch capability or wireless mice) of about 6-by-4 inch dimension cost about $60. Some bigger units near $100 price range provide as large as 10-by-6 inch active area dimension.

When I considered my first USB graphics tablet unit, I favored a bigger dimension unit over smaller ones, thinking that smaller units would provide too small area for handwriting throughout the entire desktop (of at least 1024x768 resolution). However, after I got my first tablet (Genius G-Pen F610 which is 10-by-6.25 inch active area dimension), I felt that it's plenty and even bigger than adequate, resulting in wide hand movement in many occasions. I tried another unit (Wacom Bamboo MTE-450 which is 5.8-by-3.6 inch active area dimension) as another possibility and it wasn't too small. A downside of a smaller unit would be lower resolution, because the maximum LPI (Lines Per Inch) resolution is usually limited (typically 2500 LPI) and the physical area is smaller. Therefore, writing on a smaller unit usually results in somewhat crude, not very smooth, outcome. Note that this is purely my personal experience and that it could be widely different from person to person. To decide the right form factor, one would better try a few models of different sizes. Also affected by the physical form factor is the level of pressure sensitivity of the graphics tablet. Small form factor tablet devices usually support 512 or 1024 pressure levels, whereas bigger form factor tablet models usually support 1024 or 2048 pressure levels. The number of pressure levels that are desired, however, is not that big for usual classroom usage of digital inking, so lower number of pressure levels wouldn't be that big an issue. On the other hand, if the tablets are to be used for graphics design tasks like extensive PhotoShop-ing and desktop publishing, the number of pressure levels could become a major factor. Therefore, when making decision about the tablet device type and

model, it is important to consider all aspects of usage scenario like in any other hardware decision.

2.3 Physical security

Since these USB graphics tablets are to be deployed in a student computer lab, the physical security of the devices should be carefully considered. Most lab PCs are secured with braided metal cables and cable locks, and USB devices such as graphics tablets can be physically secured just in the same way as mice and keyboards are secured with the cable locks. However, some USB graphics tablet models have a feature of fully detachable USB cables and this won't be very good from the physical security's perspective. There are few models of such USB graphics tablets, so anyone who will decide a model should definitely see the actual device and find out whether the USB cable is fully detachable or not.

Another physical security aspect is the stylus. Every USB graphics tablet based on pen input is accompanied by a stylus, and usually styluses are not secured to the main body, but freely movable. This may cause frequently lost styluses and could increase administrative burden. Styluses might be considered consumable, but it's definitely better to keep them as long as possible. There are some models that do have an attached stylus holder (cloth-based). An example is Wacom's Bamboo Pen Tablet model. Still, styluses are not tied to the main body, but I find the stylus holder is pretty usable. Students have to remove their stylus from the holder, and they usually remember to insert it back to the holder. Since the deployment of Wacom's Bamboo Pen Tablet devices in our lab in this January, there haven't been any lost styluses yet and I believe the holder plays an important role. Better than the holder would be a string-tied stylus and one might want to check out other available models before decision.

2.4 Cost comparison

Even though laptop PC price is falling rapidly, it's still quite more expensive than a desktop PC. According to Computing and Information Technology of University of Wisconsin-Green Bay (the author's institution), a typical HP desktop PC system including monitor costs about $700[1]. On the other hand, an HP tablet PC they support cost almost $1200[2]. Therefore, a detached USB tablet of $100 or less could be highly economic alternative to a full-tablet laptop PC, provided that the USB tablet's usability is comparable to that of the full-tablet laptop PC.

3 Software Consideration

A lot more important than hardware are the device driver (if needed separately), the operating system support, and the applications of interest. We consider such software factors in this section.

---

[1]http://www.uwgb.edu/compserv/purchases/WindowsDesktop.htm
[2]http://www.uwgb.edu/compserv/purchases/WindowsTablet.htm

Figure 1: Tablet PC input panel (TIP) on Windows XP Tablet Edition. Only becomes active when the user explicitly clicks the TIP icon on the taskbar (right side of Start button). Mouse clicking can activate it and mouse actions can be still used as pen input.

3.1 Operating systems choices and device drivers

Operating systems greatly affect the usability of USB tablets as well as the applications that can be used with the devices. Because Classroom Presenter, our main target application, can only run on a Windows platform, non-Windows OS's like Linux or MacOS are not considered. Still, there are a number of possible Windows OS choices for any possible USB tablet deployment. Of course the choice of operating system might be made not by an individual department but by a university-wide IT management support staff group. Still, it is important to know the different behaviors of USB tablets under different Windows OS choices. We limit ourselves to Windows XP, Vista and Windows 7. Also, we consider the device driver aspect here too, because the choice of operating system is also related to whether we need to install separate vendor-provided device drivers or not.

3.1.1 Windows XP Professional Edition

Like the author's institution, some universities/colleges may still use Windows XP for their computing platform due to negative reputation of Vista and relative infancy of Windows 7
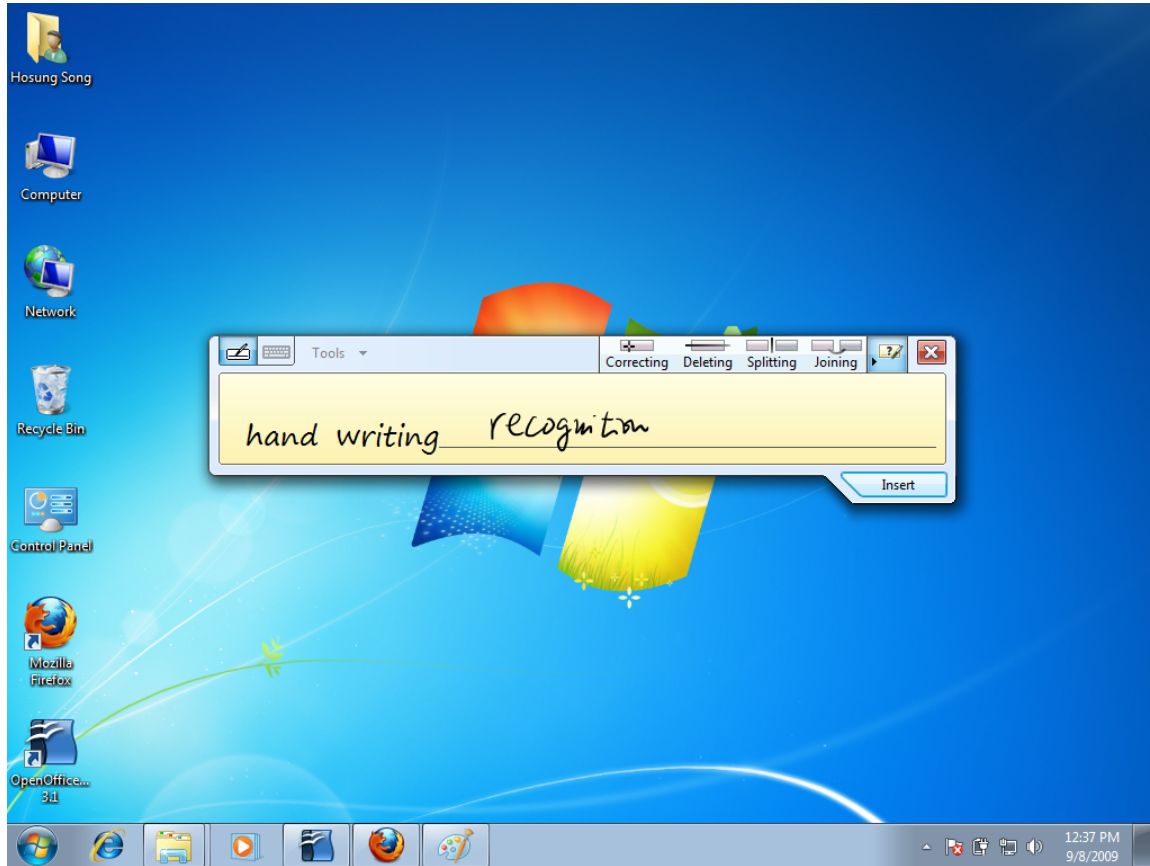
4

Figure 2: Tablet PC input panel (TIP) on Windows 7. Automatically shows up when the user moves the stylus close to the USB tablet surface. Inactive otherwise as minimized in the middle-left border. Mouse movement doesn't activate it.

at this time. Therefore, we first consider Windows XP Professional Edition as the OS of choice for a possible USB tablet platform. First of all, most USB tablets are not plug-and-play devices under Windows XP Professional Edition. Therefore, a proper device driver provided by the hardware vendor must be installed separately in order for the USB tablet model to be usable. Even if a proper device driver is installed, Windows XP Professional Edition does not include any tablet software components, like tht Tablet PC Input Panel[3] and handwriting recognition feature [5]. Therefore, USB tablets under Windows XP are mostly just mice-replacement, which is not very desirable. I tried many ways to enable tablet PC input panel and handwriting recognition feature on a Windows XP Professional Edition PC by downloading and installing tablet software components: There are tablet PC SDK and tablet PC recognizer pack that can be installed on Windows XP Professional Edition, but I couldn't get the desired tablet features like tablet input panel, handwriting recognition, and pressure sensitivity. In fact, there's an extensive list of steps described in a web page[4] to convert an XP non-Tablet Edition installation into a tablet-enabled state. However, it's questionable whether it's worthwhile to go though all the described steps for tablet features, when Windows XP Tablet Edition can be freshly installed.

One may wonder why it is so important to have the tablet-enabling features (tablet PC input panel, handwriting recognition, and pressure sensitivity) when the tablet could be used as a mouse replacement. Figure 3 shows the difference of the inking examples under different situations. As one can see from the figure, the smoothness of handwriting on applications (like Classroom Presenter or PowerPoint) is much better when those applications are executed on a tablet-enabled OS edition (like Windows XP Tablet PC Edition or Vista or Windows 7). Another important disadvantage is that Microsoft Office 2007 the Inking menu (as shown in Figure 4) of Microsoft Office 2007 products is only available on a tablet-enabled OS, not on Windows XP Professional with just the hardware device driver installed. Lack of inking capability in Microsoft Word 2007 could greatly decrease the usability of USB tablets when an instructor wants to use a USB tablet for mainly adding handwritten comments directly onto Microsoft Word files that students submit as their assignments. Therefore, I believe tablet-enabled features are very important for successful USB tablet deployment and Windows XP Professional is not adequate in that sense.
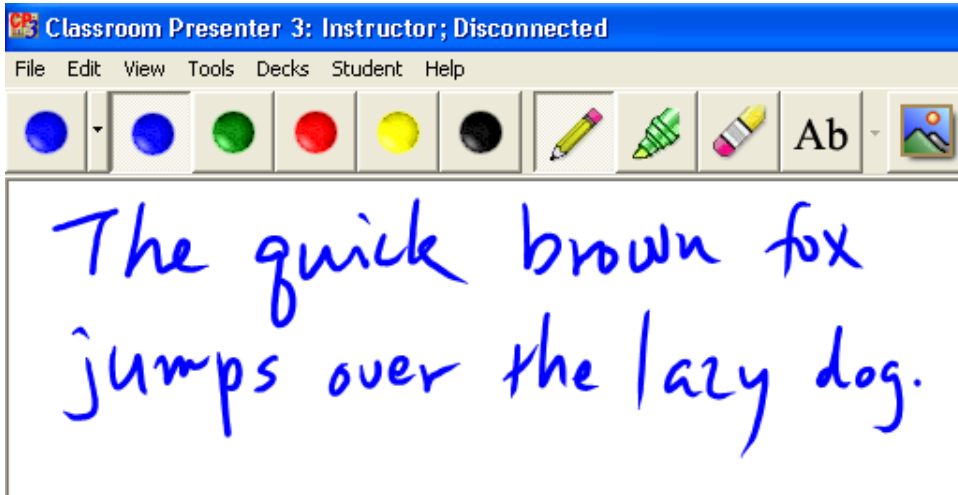
3.1.2 Windows XP Tablet Edition

If the department doesn't have freedom to install a newer OS like Vista or Windows 7 on their own and the university still requires Windows XP, one may consider this option of using Windows XP Tablet Edition on the desktop lab PCs. Windows XP Tablet Edition is available for many computer science departments through Microsoft Developer Network-Academic Alliance (MSDN-AA). Windows XP Tablet Edition is usually available only as OEM on a tablet PC hardware, but I confirmed that it can be installed well on a non-
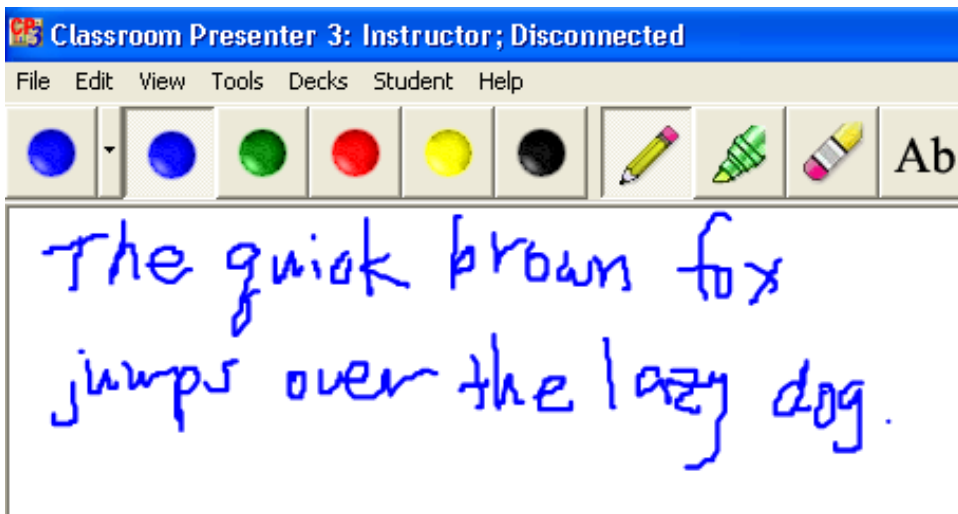
---

[3]Also known as TIP. Consists of a virtual keyboard with clickable keys on screen and character input panel with handwriting recognition. Activated when the task bar icon is clicked (on Windows XP Tablet Edition), or just by hovering the stylus on the tablet (on Vista and Windows 7). Figure 1 shows the Tablet PC Input Panel under Windows XP Tablet Edition, and Figure 2 shows it under Windows 7.

[4]http://www.winmatrix.com/forums/index.php?/topic/
21199-tablet-pc-input-panel-for-xp-pro-home-mce-and-original-windows-7-mat/

(a) Inking example when the tablet is recognized as a pen.

(b) Inking example when the tablet is recognized just as a mouse.

Figure 3: Comparison of inking results with a tablet as a pen and as a mouse.
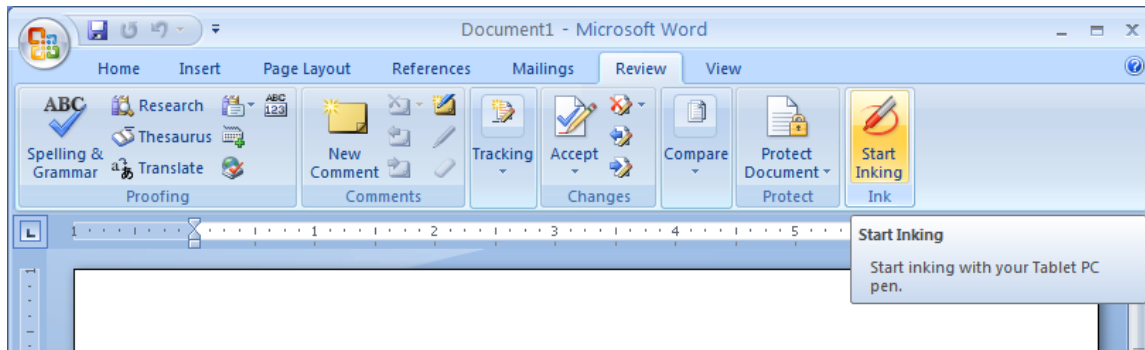
Figure 4: Inking menu on Microsoft Office 2007. Only available on a tablet-enabled OS: XP Tablet Edition, Vista, or Windows 7.

tablet desktop PC and that full tablet functionalities are supported when the desktop PC is used with a compatible USB graphics tablet. Windows XP Tablet Edition includes all the tablet-enabling features like tablet PC input panel (TIP), handwriting recognition pack, and application software such as Windows Journal. As long as the attached USB tablet is recognized as a tablet device, those features are available just like they are on a full tablet PC.

However, I realized that it is not a simple matter whether a USB tablet is recognized as a tablet or not. Why it becomes nontrivial is that some USB tablet models (e.g. Genius G-Pen F610) are directly recognized as tablets under Windows XP Tablet Edition without any vendor-provided device drivers installed (therefore truly plug-and-play tablets), whereas some USB tablet models (e.g. Wacom Bamboo Pen) are still plug-and-play devices, but work only as mice, not as tablets, if the vendor-provided device driver is not installed. Under this circumstance, the USB tablet works just as a mouse, and that may be OK for most situations. However, a mouse doesn't support pressure sensitivity, so if pressure-sensitive input is required for applications (like Photoshop), those applications won't benefit from the tablets of those kind. Also, Microsoft Office products don't recognize those tablets as real tablets, so inking needs to be manually triggered. Finally, as shown in Figure 3, inking with a tablet that is recognized only as a mouse gives very poor writing quality with very rugged, not smooth, patterns, even under a tablet-enabled OS like Windows XP Tablet Edition. Therefore, it is best to avoid this situation by installing proper device driver. Unfortunately, there are some instances where even vendor-provided device driver doesn't fix this problem. An example is Wacom Bamboo Pen. I purchased Wacom Bamboo Pen USB tablets in November 2009 and when the device driver bundled in the accompanying CD is installed on a Windows Tablet PC Edition PC, Wacom Bamboo Pen was not recognized as a pen tablet but only provided mouse actions. This was a huge disappointment and caused quite a frustration. However, soon after that, Wacom upgraded their device driver software and the upgraded device driver does make Bamboo Pen recognized as a full pen tablet. This was only discovered after the Windows XP Tablet PC Edition image with the old device driver was fully cloned to all individual desktop PCs, and updating the device driver was not very smooth either because the update couldn't be done on PCs with virus scan software running. I had to boot all the PCs to the safe mode, uninstall the old device driver, and

8

reinstall the new device driver manually for all 27 PCs in our computer lab. This episode tells us that one shouldn't assume anything about any specific USB tablet model's compatibility with a Windows OS. One needs to try out each and every device under consideration on the chosen Windows OS version/edition in order to avoid any unexpected behavior.

3.1.3 Vista and Windows 7

There is no separate "Tablet PC" Edition for Vista and Windows 7 because tablet PC support is built-in by default in all editions of the two operating systems (except Starter Editions). Not only all the tablet-enabled features mentioned in Windows XP Tablet Edition are available, but there are new features like touch screen (with proper devices) and math equation recognition. Regarding USB tablets with these operating systems, it's the same as with Windows XP Tablet Edition—As long as the USB tablet is recognized as a tablet, users can experience all the tablet features mentioned. The same issue with the tablet's device driver as in Windows XP Tablet Edition arises here too. Some USB tablets are directly recognized as tablets by Vista and Windows 7 (e.g. Genius G-Pen F610) and some are not recognized as tablets but as mice (e.g. Wacom Bamboo Pen). For those models, installing device drivers solves the issue, but device drivers usually take about a few tens of megabytes of main memory. One thing different from Windows XP Tablet Edition is that in Vista and Windows 7 users can't even use tablet PC input panel (TIP) with tablets that are recognized just as mice. In Windows XP Tablet Edition, an icon for TIP is always available on the task bar, so even if a tablet is recognized just as a mouse, the user can still use TIP. However, in Vista and Windows 7, TIP is not available if the system doesn't detect any tablet. Only when a tablet is detected, Vista and Windows 7 shows a minimized TIP on the middle left edge of the desktop.
I find that it is best to use a plug-and-play USB tablet model with a newer OS (Vista or Windows 7). This will minimize the administrative overhead of installing additional device drivers and maximize the usability of the deployed USB tablet devices.

3.2 Applications

Most important among all are tablet-enabled applications that will be used. As long as the deployed USB tablets are recognized as tablets not just as mice, most standard applications show uniform behavior. Typical applications under consideration of the deployment in our department include Classroom Presenter [1] and Microsoft Office suite, especially OneNote. Classroom Presenter is the software I use for presenting lecture slides and engaging students in various in-class activities. OneNote is very good for note-taking in general as well as for the purpose of various research such as web search. Again, the device's recognized type is very important. In Classroom Presenter, inking with a tablet recognized as a mouse is still possible, but the writing quality is not very satisfactory. As shown in Figure 3, writing is very rugged and there is no pressure sensitivity. On Microsoft Office products, the same quality degradation exists under the same condition and also the user must manually change the mode between mouse and pen (if a tablet is recognized, that mode change is automatic).

4 Deployment Experience at Author's Institution and Usability Study

In this section, my experience of deploying USB tablets in our computer lab is presented. Also included is a usability study of USB tablets, as using a USB tablet requires hand-eye coordination and it might not be very natural for some users.

4.1 Deployment at University of Wisconsin-Green Bay

The project started as an individual investigation of the idea around 2008 after I attended SIGCSE conference in 2007 and learned about the tools and benefits of tablets for higher education. I got a Genius G-Pen F610 as my pilot device and a Wacom Bamboo MTE-450 (no longer in market) at that time. Both are entry level USB tablets less than $100, but the Genius G-Pen F610 gives a bigger active area (10-by-6 inch, compared to 6-by-3.75 inch of Wacom Bamboo MTE-450), and thus costs a little more (almost $100, compared to about $60 for a Wacom Bamboo MTE-450). Physical features and characteristics of these two models were mentioned in Section 2. They worked well for most classroom usages. Initially it felt 10-by-6 inch active area was a little big, requiring wider arm movement, so I favored the smaller model. However, I now find that the bigger active area gives more precision even for small handwriting. Anyway, these usability-related preferences should be experienced by individuals and can't be generalized for all. There is also a budget concern, so when there was a call for laboratory modernization projects in my institution in late 2008, I proposed to purchase 27 units of Wacom Bamboo MTE-450 to support tablets in our department's computer lab. Luckily, my proposal was accepted, so I got to think about the actual deployment of the USB tablets in 2009. I investigated the operating system issue, and at that time, Windows 7 was not even released and Vista was rejected by my institution because of its negative reputation. Therefore, Windows XP Tablet Edition was the only option for a tablet-enabled OS, or I needed to give up most tablet-enabled features if only the device driver for the tablets on Windows XP Professional Edition were allowed. Fortunately, my colleagues and computer center staff agreed that Windows XP Tablet Edition might be considered and tested. Since Windows XP Tablet Edition is a superset of Windows XP Professional Edition, I didn't expect any issue with existing educational applications, but there were few small differences in their detailed behavior on some specific example code and compiled binary for my colleague's classroom example. Everything else was fine and identical to Windows XP Professional Edition's behavior. Generously, my colleague accepted to adapt his example to the Tablet Edition installation, so the project got the final approval during summer 2009 and the actual deployment was scheduled for Spring 2010 or Fall 2011. In the meantime, the tablet model proposed was replaced by a new line of Wacom's Bamboo series (probably due to the release of Windows 7 and its touch capability) and the expenditure deadline was near, so I ended up placing an order for 27 units of Wacom Bamboo Pen (about the same active area size and the same price as Bamboo MTE-450) in October 2009. They were delivered in a few weeks and we decided to deploy the tablets with Windows XP Tablet Edition over the winter break before Spring 2010. The final OS image was created right before the Thanksgiving break, and as

mentioned earlier, the old device driver bundled in the accompanying CD was used, and the lack of pressure sensitivity and problem of not being recognized as a tablet were only discovered in January 2010 when the OS image and the tablets were actually installed on our lab machines. This led me to investigate the issue and manually uninstall/install the old/new device driver to solve the problem. After that, everything worked as expected. The first presentation in the lab using the deployed tablets was given by me in the Annual Faculty Development Conference at our institution (January 2010) and it was about the tablet technology itself in education. And in my Spring 2010 classes, the deployed tablets are used on everyday basis mostly with Classroom Presenter and Microsoft Office products.

4.2   User experiences

My biggest concern about deploying USB tablets was whether it would give users usable experience of writing and drawing, because users must coordinate their hand-eye movement when writing/drawing on a detached USB tablet, which is not the case with a full tablet PC where users do writing/drawing directly on the screen. In order for this project to be successful, users of USB tablets shouldn't feel significant difficulty when they write/draw on a detached USB tablet device. To investigate this matter, I conducted a series of small survey studies with simple questions on the students in my classes this semester (Spring 2010). This section presents the study and the results.
To let students experience the installed USB tablets, I asked them to write a quote and draw a diagram (shown in Figure 5) and they were asked to answer the following questions after the experiments:

- Question 1: How was it to write with a stylus on a detached USB tablet? Choose one among "Very easy (5)," "Easy (4)," "OK (3)," "Difficult (2)," and "Very difficult (1)."

- Question 2: On the scale of 1-5, how much are you satisfied with your writing (compared to when you write on paper)? 5 means very much and 1 means very little.

- Question 3: Same as Question 1, except this question is about drawing.

- Question 4: Same as Question 2, except this question is about drawing.

The same survey was done three times in each of two classes of mine (one lower division course and one upper division course) with a few weeks of intervals between successive studies (January 25/27, February 17, and March 10). The results of the studies are shown in Table 1.
The results clearly show that most users don't feel that writing/drawing using a stylus and a detached tablet is very difficult. The results also show that most users are not very dissatisfied with their own writing/drawing results compared to when doing the same thing on paper with a pen. The results also indicate that overall in general, the level of difficulty users feel decreases over time and the level of satisfaction of users on their own writing/drawing increases over time. Overall, these results suggest that USB tablets are pretty usable for most users. It is also interesting to note that students in the upper division course show higher adaptability and satisfaction scores than those in the lower division course.
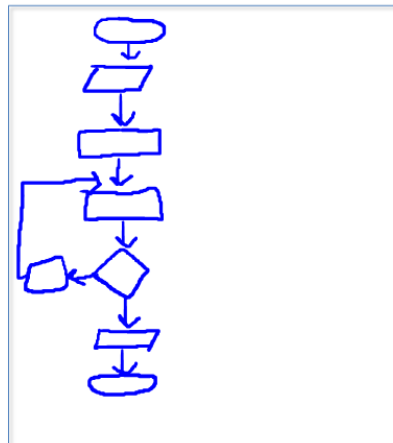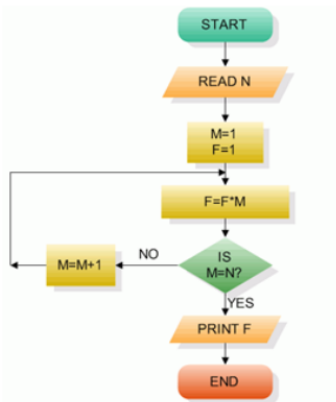
Tablet Exercise: Duplicate left paragraph in right blank

- Be nice to nerds. Chances are you'll end up working for one.

  - Bill Gates

(a) Writing exercise

Tablet Exercise: Duplicate left drawing in right blank (No letters, no fills)

(b) Drawing exercise

Figure 5: Tablet exercises for usability study.

Choices	5	4	3	2	1	Average
Q1-1/25	2	8	10	5	1	3.19
Q1-2/17	4	10	4	2	0	3.8
Q1-3/10	3	11	3	3	0	3.7
Q2-1/25	-	-	-	-	-	-
Q2-2/17	0	13	4	3	0	3.5
Q2-3/10	2	9	4	6	0	3.33
Q3-1/25	3	6	9	6	2	3.08
Q3-2/17	0	9	8	3	0	3.3
Q3-3/10	0	9	8	4	0	3.24
Q4-1/25	-	-	-	-	-	-
Q4-2/17	0	7	8	4	1	3.05
Q4-3/10	0	9	7	5	0	3.19

(a) Results from a lower division course

Choices	5	4	3	2	1	Average
Q1-1/27	0	3	4	3	0	3.0
Q1-2/17	0	4	6	0	0	3.4
Q1-3/10	1	6	1	0	0	4.0
Q2-1/27	0	2	2	5	2	2.36
Q2-2/17	0	2	5	3	0	2.9
Q2-3/10	0	5	4	1	0	3.4
Q3-1/27	1	0	8	2	1	2.83
Q3-2/17	0	5	5	0	0	3.5
Q3-3/10	1	4	3	1	0	3.56
Q4-1/27	1	0	6	5	1	2.62
Q4-2/17	0	3	5	2	0	3.1
Q4-3/10	0	5	3	2	0	3.3

(b) Results from an upper division course

Table 1: USB tablet usability survey results. Each entry indicates the number of students that responded to that question with the choice in the column heading.

5 Conclusion

In this paper, I described my experience of deploying detached USB tablets on desktop PCs in our computer lab to support tablet features for our students. Points of consideration from various perspectives were discussed. I believe the most important decision factor would be the operating system. Newer OS's like Windows 7 and Vista would be preferable as their tablet support is built-in. If Windows XP is required, it's still better to use Windows XP Tablet Edition to exploit all the features of tablets. It is also important to confirm whether the chosen hardware USB tablet model is fully supported and recognized as a real pen tablet under the chosen operating system. Some tablets are just recognized as mice on any OS even if vendor-provided device drivers are installed. One would need to confirm about this themselves before full deployment. Because user experience with detached tablets could be different from that with full-tablet laptop PCs, I conducted some survey study about the usability of detached tablets with students in my courses. The survey results are pretty favorable. Most users felt that using a detached tablet for writing/drawing was not very difficult and most were not very dissatisfied with the quality of their writing/drawing compared to when they would write/draw on paper. This leads us to conclude that detached USB tablets could be an economic alternative to expensive full-tablet laptop PCs.

References

[1] ANDERSON, R., DAVIS, P., LINNELL, N., PRINCE, C., RAZMO, V., AND VIDEON, F. Classroom Presenter: Enhancing interactive education with digital ink. *IEEE Computer 40*, 9 (2007), 56–61.

[2] BERQUE, D. Pushing forty (courses per semester): Pen-computing and DyKnow tools at DePauw university. In *The Impact of Tablet PC and Pen-based Computing on Education: Vignettes, Evaluations, and Future Directions.* (2006), Purdue University Press.

[3] BERQUE, D. A., KONKLE, L. M., AND REED, R. H., Eds. *The Impact of Tablet PCs and Pen-based Technology on Education: New Horizons* (2009), Purdue University Press.

[4] BERQUE, D. A., PREY, J. C., AND REED, R. H., Eds. *The Impact of Tablet PCs and Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions* (2006), Purdue University Press.

[5] PITTMAN, J. Handwriting recognition: Tablet PC text input. *IEEE Computer 40*, 9 (2007), 49–54.

[6] PREY, J., AND WEAVER, A. Tablet PC technology–the next generation. *IEEE Computer 40*, 9 (2007), 32–33.

[7] ROSCHELLE, J., TATAR, D., CHAUDBURY, S., DIMITRIADIS, Y., PATTON, C., AND DiGIANO, C. Ink, improvisation, and interactive engagement: Learning with tablets. *IEEE Computer 40*, 9 (2007), 42–48.

[8] TRONT, J. Facilitating pedagogical practices through a large-scale tablet PC deployment. *IEEE Computer 40*, 9 (2007), 62–68.