Digital Ink for Online Teaching

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Reading with a pencil in hand to mark-up a book or article, scribbling questions and notes (along with rude drawings in some cases) in the margins of a committee meeting agenda, marking a student's essay with a red pen—all of these are everyday activities for most faculty. It is hard to say exactly how much of what we do can be defined as reading or writing because we are always engaging in both, simultaneously and seamlessly. But our behavior suddenly changes when we sit down in front of a PC. Suddenly, reading and writing become discrete activities, separated from one another both mentally and technologically. The screen is for reading. The keyboard is for writing. But what if there were a way to integrate reading and writing on the computer. What kinds of hardware and software would we need?

The idea of integrating the reading of print with scribal input has had a large place in the short history of modern computing. We can easily find it in Vannevar Bush's celebrated article, "As We May Think," which appeared in the <u>Atlantic Monthly</u> in 1945, just at the end of World War II. Bush described his vision of a desk-sized,

"…future device for individual use, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility… it is primarily the piece of furniture at which he works. On the top are … screens, on which material can be projected for convenient reading. There is a keyboard, and sets of buttons and levers.[There] is a transparent platen. On this are placed longhand notes, photographs, memoranda, all sorts of things. Any given book of his library can thus be called up and consulted with far greater facility than if it were taken from a shelf. As he has several projection positions, he can leave one item in position while he calls up another. He can add marginal notes and comments, … and *it could even be arranged so that he can do this by a stylus*" [our emphasis].

When Alan Kay presented his vision of a portable "Dynabook," some twenty-five years later, he had the widest range of users in mind, not simply the desk-bound scientists, scholars and bureaucrats that Bush had envisioned for his device. Although it is unclear whether Kay intended to include a stylus as one of the tools for his portable Dynabook mode of ubiquitous computing, he has been quoted as saying that his guiding metaphor was a computer as natural to use as "pencil and paper." (Kay 2001)

Many attempts to introduce stylus or "pen" input and digital ink followed during the succeeding thirty years between the Dynabook and the present. One such experiment took place at The College of Staten Island during the early 1990s and involved the use of a "Telepad," a very early version of the tablet PC. In this project, an outstanding student in an advanced mathematics course used the Telepad to transcribe her class lecture notes, which were simultaneously displayed on a large monitor where they could be seen by a deaf student who would otherwise have been unable to follow the instructor's lecture. Due to the relatively low power, small memory capacity, and short battery life of technology available at the time, the experiment lapsed, but not before it demonstrated the value of applying pen input and graphic ink to assistive technology.

During the past decade, researchers at Intel, Microsoft and Xerox, including Gene Golovcinsky, Catherine C. Marshall and Bill Schilit, among others, have been working to actualize their vision of "XLibris," which they describe as a "reading appliance" combining both hardware and software components. In an article, "As We May Read," whose title echoes the title of Bush's famous paper, they present their aim of creating an environment that will "allow people to work on electronic documents much as they would on paper." (Schilit 1999) As described in a number of published articles and conference presentations, XLibris takes into account such demands of "real world" reading and writing as the ability to retrieve and view multiple documents simultaneously, the opportunity to make free form, graphic annotations anywhere on a document, as well as the freedom to move seamlessly between reading and writing.

Up to now, we have been speaking about "visions." Neither the Memex, nor Kay's Dynabook (not to be confused with the Toshiba product of the same name), nor the XLibris are available in stores. You can't buy them from vendors over the internet or even find them on e-Bay!

Now, let's move from vision to reality. After many premature announcements, the technology for pen input and digital ink annotation of electronic documents does finally exist in a wide variety of "off the shelf" products across a broad range of hardware and software platforms. During the past year, a group of colleagues at The College of Staten Island, City University of New York, has been actively exploring what is available to support teaching on the college level.

It is possible to conceive of many situations in which the capacity to combine keyboard and pen input would be desirable for teaching faculty, especially in disciplines where the standard typewriter keyboard does not contain the signs or symbols that are needed to express and communicate content. Mathematical notation and non-alphabetic (character) languages are obvious examples of this. Academic subjects, such as chemistry and physics, which often demand both free form drawings and text within the same document are further examples. But there is one situation in which faculty across the full range of disciplines can all benefit from: the use of pen input and digital ink—marking and responding to student written work.

When we began teaching online, we quickly discovered the absence of a satisfactory technology for marking student written work that would even approach the traditional red pencil in terms of ease of use. Marking essays by keyboard was a much more labor-intensive process. Further, it didn't permit us to write comments "in between the lines" of a student essay, or use proofreader's symbols. And although there were ingenious features in our word-processing software for embedding comments and highlighting or colorizing text, the process of annotation and

commentary by keyboard and mouse was far less intuitive than with pencil and paper. Indeed, as Bill Schilit has remarked, "It is hard to improve on paper and pen."(2001)

In fact, we found that many online instructors at our university had responded to the problem by choosing to collect essays on paper instead of downloading them from a "drop box" and continuing to mark them in the traditional manner. Those who had attempted to mark papers and give students feedback electronically complained about the additional burden of work required. And some even confessed that they had stopped "line marking" altogether!

Personal Digital Assistants (PDAs) were the first widely used computer hardware device to support the use of a stylus and digital ink as a regular feature. With one notable exception—E-Notate--an inexpensive ($50) program developed by a British company which allows a Palm OS PDA to be used as a graphic tablet for use with a PC to annotate Microsoft Word documents, little attention has been given to the use of PDAs as annotation tools.

The improved graphic tablets that have come on the market during the past few years provide an inexpensive way to equip standard desktop or portable PCs with pen input and digital ink capability. We have worked with them extensively over the course of a year at The College of Staten Island (CSI) with support from the Center for Excellence in Learning Technologies (CELT), which spearheads faculty development.

In terms of hardware, a very wide range of alternatives is available from small, "no-name" tablets costing less than $50 to the $1800 Wacom Cintiq, which is basically an LCD monitor that allows pen input on its surface. We experimented with two tablets, an AceCAD Flair (5"x3.75") and a Wacom Intuous2 (6"x8"). The Wacom was clearly the superior of the two, with a far better software driver, pen and writing surface. The price difference was dramatic. The AceCAD retails for about $35, while the Wacom costs around $270. (Since these are niche products--mainly used in the graphic arts industry--their prices do not generally reflect price declines of other PC peripherals).

The surface of the Wacom Intuous2 line is sufficiently well-mapped to the computer screen (PC or MAC) that the user quickly learns to use the stylus as a more precise mouse for launching and controlling a wide variety of applications as well as a pen for writing which then appears on the screen. The tablets connect easily to any desktop or laptop machine via a USB port. They also fit easily into a briefcase along side a laptop PC if portability is desired.

We found two excellent software programs for graphic annotation of documents using graphic tablets: Adobe Acrobat and Meander's Annotator. Acrobat has the advantage of working across platforms (PC and MAC), whereas Annotator allows annotations to be saved within Word documents and opened by users of virtually any version of the software without the need for a viewer.

Acrobat is sufficiently well-known that it probably needs no introduction here. Suffice it to say that it is a full-featured, highly complex, relatively expensive program that can be adapted to many different purposes. However, it has the disadvantage that when students submit their essays in a standard wordprocessor format, their files must be converted ("printed") to Acrobat's

Portable Document Format (PDF) before being marked. Further, students must download a viewer in order to view the marked essays.

Meander's Annotator is simple, single-focus program that retails for less than $25 for a single user license and requires very little computer memory. We found it highly functional for our purpose and very easy to master and use. The manufacturer, located in Shanghai, China, has also been very responsive to our suggestions for improvements to the product. For example, a major limitation of graphic annotation software up to now has been that annotations are not anchored to text. After we called this issue to the attention of the manufacturer, the software has been upgraded so that annotations are now anchored to some extent.

Once downloaded from the internet, Annotator appears within Word along with other tool bars at the top of the screen. Using the stylus as a mouse, it is possibly to select from a range of options in terms of line width and color. Annotator's cursor, a simple dot about the size of a period, seems more intuitive and natural than the corresponding feature of competing programs. Erasing, another area where the software has recently been upgraded, is relatively intuitive and easy.

During the Spring, 2004 semester, several tablet PCs (Hewlett-Packard TC1100) were made available to selected faculty members at CSI for the purpose of evaluating their use for online teaching. We have continued to use both Acrobat and Annotator for marking up student papers, the choice of software being dictated by the students' choice of word-processing software.

The primary requirement for any type of computer-based scribal input device is that it mimic paper and pen as closely as possible. Generally speaking, we have found the experience of marking essays using the TC1100 more closely approximates paper and pen than the Intuous2. Although the tablet PC's pen is less pressure-sensitive, hand-eye coordination is much easier in the tablet environment where one can literally write on top of the student's text while maintaining the illusion of holding the manuscript in one's hands.

One cannot claim, however, that marking an essay with a stylus on the TC1100 totally mimics writing with a pen on paper. For one thing, the small size of the tablet PC screen makes it difficult to work in portrait mode if the essay under consideration requires extensive marking and annotation. When the text is enlarged to the point where it is easy for a teacher with standard-sized handwriting to write between lines of a double-spaced essay and circle or underline individual letters, however, an entire horizontal line of print cannot be viewed all at once. Switching to landscape mode makes entire lines visible, but reduces the total display to about half of a typewritten page at any one time. This necessitates a good deal of scrolling and makes it difficult to perceive the impact of each individual page of the manuscript, taken as a whole. As noted by Schilit and his colleagues (1999), "fixed page layout" is an important support for reading printed documents and this feature is sacrificed when the students' essays are viewed in landscape mode.

The ease with which a tablet PC can held and written on, plus the fact that it connects wirelessly to the internet, truly makes it possible for an instructor who is teaching online courses to download and mark student written work anytime/anywhere.

We anticipate making further use of the tablet PC's annotation features in online teaching within the near future. For example, online instructors often present reading assignments in the form of PDF files posted on their websites. Using the full Adobe Acrobat program, they can now mark-up such documents to facilitate students' reading and draw their attention to key points. Similarly, Meander's Annotator can be used to annotate Power Point slides, Excel spreadsheets or other MS Office programs.

Although today's scribal input and digital ink do not yet quite fulfill the vision that Vannevar Bush shared with his readers in 1954, we feel that the day is rapidly approaching when users will be able to move as seamlessly between stylus and keyboard as they now do between keyboard and pencil.

References:

Bush, Vannevar, "As We May Think," Atlantic Monthly. Aug. 1945, pp. 101-108
http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm

 Kay, Alan, Interview. 2001 http://www.artmuseum.net/w2vr/archives/Kay/01_Dynabook.html

_____, (Interview), "The Dynabook Revisited," The Book and the Computer, 2003
http://www.honco.net/os/kay.html

Marshall, Catherine C., Morgan Price, Gene Golovchinsky, Bill N. Shilit, "Designing e-Books for Legal Research," Proceedings of the first ACM IEEE Joint Conference on Digital Libraries (JCDL 2001), (Roanoke, VA, June 24-28), ACM Press.
http://seattleweb.intel-research.net/people/schilit/mar01a.pdf

Schilit, B. N., G. Golovchinsky, and M. Price, Beyond Paper: Supporting Active Reading with Free Form Digital Ink Annotations. *CHI 98 Conference Proceedings,* ACM Press, 1998, pp. 249-256. http://seattleweb.intel-research.net/people/schilit/sch98a.pdf

Schilit, B. N., M. N. Price, G. Golovchinsky, K. Tanaka, and C. C. Marshall, "As We May Read: The Reading Appliance Revolution" *Computer,* Vol. 32, No. 1, January 1999, pp. 65-73.