Tablet PC: Blackboard to the Web

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ABSTRACT

The use of the Tablet PC® as a lecture aid allows for the best of both worlds: the ability to present prepared lectures with well thought out graphics and the ability to annotate and develop a lecture in real time as would be done on a conventional blackboard.

As classroom presentations become more computer based, they generally become less flexible and interactive. As the lecture becomes "canned" using tools such as Microsoft PowerPoint, the ability to change direction, annotate or illustrate on the fly becomes difficult if not impossible. For mathematics, the sciences and engineering, the ability to illustrate points is absolutely critical. If the classroom is darkened to allow for projection capabilities it is problematic to use the blackboard without completely disrupting the flow of the presentation.

Using a Tablet PC with wireless connectivity and projection capabilities, an instructor can simply change applications and use the computer as a digital writing pad, projecting directly to the class instead of using the blackboard. The presenter is no longer tethered to a podium but can wander about freely. As an added bonus, all notes, illustrations, and annotations to presentations can then be published directly to the web.

Categories and Subject Descriptors

K.3.1 [**Computers and Education**]: Computer Uses in Education – *Computer-Assisted Instruction (CAI).*

General Terms: Management, Human Factors, Verification

Keywords: Tablet PC, Microsoft Journal, OneNote, classroom method, lecture, notebook computing

1. HISTORICAL PERSPECTIVE

When one thinks of a classroom setting the blackboard immediately comes to mind. A blackboard gives the instructor the ability to develop materials on the fly but has two major shortcomings: all material must be put up on the board during the lecture and once the blackboard is full, parts of it must be erased to allow space for more material. Students must copy material from the blackboard if they want an accurate set of notes.

An overhead projector can be used to replace or supplement the blackboard either with sheets prepared before or during the lecture and these can be kept for later reference or reuse, but in general are difficult to distribute to students unless they are somehow copied. This is cumbersome at best. Beyond that a digital whiteboard can be used in a manner similar to a blackboard, with a computer capturing all information for display to a projector or stored for later use. Unfortunately this is in reality merely a computer-enabled overhead projector with all information stored in bitmapped form. Again, there is no easy way to prepare materials in advance, other than for the lecturer to copy from his or her notes.

If lectures are developed using software such as Microsoft® PowerPoint or developed directly on web pages, spectacular presentations can be prepared in advance, projected during the lecture, then distributed in hard copy form or by uploading to a web site. Information can be revealed a line at a time, made to fade in and out, and video and/or sound can be incorporated. The complexity of the presentation is limited only by the time and talent of the instructor. Since it is not feasible to develop a detailed presentation during the lecture, the material must be fully laid out in advance. Unfortunately this makes for a "canned" lecture and discourages classroom interaction. While the lecturer can annotate verbally, if additional material needs to be presented or questions explained then that has to be done on the blackboard, on a whiteboard, in another computer application, an overhead, etc. Two or more unrelated technologies come into play, and the results can be less than optimal.

Consider the example of a presenter using a laptop with PowerPoint to give class in engineering. Even with the best preparation, questions from students will arise. Answers may involve a derivation or diagrams which mean that the instructor needs to use something other than the computer; usually the blackboard is the only alternative at hand. In many classrooms or lecture halls, the front of the room is dimmed to allow projections to be clearly seen, so that the blackboard cannot be used without changing the lighting. This can be disruptive in answering a short question. Secondly, the projection screen may well block a significant potion of the blackboard. In many smaller (40-50 student) classrooms, only 20% of the blackboard is available on either side of the screen so only a small amount of information can be presented, and only in the corners of the room. If the information being discussed becomes too involved to be addressed in only these small portions of the blackboard, it

SIGUCCS'04, October 10-13, 2004, Baltimore, Maryland, USA.

may be necessary to raise the projection screen and turn off the projector, then turn it back on and allow for it to warm up before the presentation is resumed.

Beyond this disruption in flow from changing back and forth from various lecture modes, the main drawbacks of the blackboard remain: the inability to record information for later use. Certainly video or still cameras can be used but this is generally impractical. A digital whiteboard could be used but the chances of every classroom being equipped with one are fairly slim and whiteboards are not by any means easily portable. Obviously some better integrated solution is called for which pulls together all the positive attributes of the blackboard, digital whiteboard, and presentation software. This solution can be found in the Tablet PC

2. THE HARD AND SOFT OF TABLET PC

A Tablet PC is a fusion of the technology behind the hardware and the software made available by the operating system. Obviously, they are highly codependent.

2.1 Hardware

The hardware end of a Tablet PC is very straightforward, and comes in several flavors but in general falls into two categories: pure slate or convertible. Essentially the Tablet PC is the melding of two technologies over a decade old: the notebook form factor plus touch screen input with a touch of magnetism thrown in.

When using a tablet PC, one uses a pen-like stylus to move the cursor and write directly on the screen. At first glance it looks like the same technology used by popular PDAs (Personal Digital Assistants), but in fact it is very different. Most PDAs track input only when the stylus touches the screen (resistive digitizer [1]). Tablets track the stylus whenever it is within an inch or so of the screen-performance specifications are spelled out by Microsoft [2] - through a magnetic field called an active digitizer (digitizing tablets have worked this way since the seventies). Actually touching the screen can be used to mimic a click of a mouse button for selection, but the cursor can be moved over various objects to display link information, tool-tips, etc without actually making a selection. Right-click operations are performed either with a button on the stylus or by touching and holding a selection.

A pure slate tablet PC works very much like a writing pad. It has no keyboard, and the only methods of input are via the stylus, by pushing a limited number of configurable buttons, or through voice recognition. In general keyboards and mice can be attached through standard USB ports. The advantage of the pure slate format is that these Tablets tend to be thinner (1/2 inch or so) and lighter since there is no integrated keyboard (figure 1).

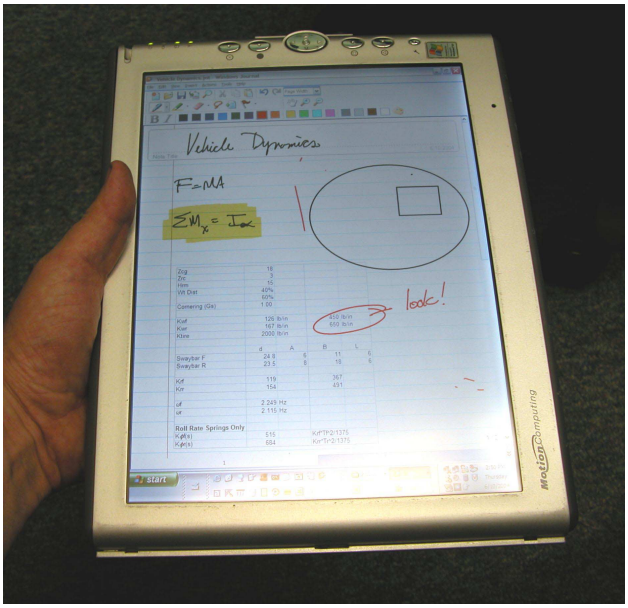

Figure 1. Motion Computing Pure-Slate Tablet PC[3].

The convertible type of Tablet PC looks very much like a standard notebook PC. In notebook mode, it operates just as any other laptop, taking input from the keyboard, a touch pad and/or a mouse. With the LCD screen rotated 180 degrees and folded flat over the keyboard it gives a slate-like appearance. These models offer the most flexibility but only at the expense of added bulk. Most screens are 12" to 14" diagonal and are limited to XGA (1024x768) resolution. Weight is approximately 4-6 lbs.

Other than the display/input screen, the underlying architecture of Tablet PCs is identical to those of notebooks. Pricing is slightly higher than that of a comparable notebook. As of this writing, convertible Tablet PCs start at around $1800 and fully equipped pure slates at $2500 or so.

2.2 Operating System and Handwriting Recognition

From a software standpoint, the Tablet PC's operating system is an extension of Microsoft Windows XP and is officially called "Windows XP Tablet PC Edition." It offers the ability to do handwriting recognition integral to the operating system (OS) and allow for this to occur with all applications, whether or not they are Tablet aware (i.e., specifically designed for the Tablet PC OS). This handwriting recognition is fairly advanced and uses whole-word rather than character-by-character recognition. As such it can only translate words it recognizes from the operating-system-based dictionary as opposed to any that are included with whatever application is currently being used. This can be problematic since there was initially no way to add words to that dictionary. If a word is not recognized, the OS selects the closest match. It also displays an icon to the right of recognized words with a list of other near matches and an image of the original inked text. As an example, the author's last name "Timmins" was always translated into "tinning." Microsoft has

recently introduced a utility to allow the user to customize the dictionary, virtually eliminating this problem.

What is interesting is that the operating system seems to do a better job of recognizing script writing than block characters. It seems that this is because it can better detect the flow of the script writing and associate a grouping of characters as a word if they are written continuously. This is despite the fact that writing styles vary more widely with script than with printed or block characters. It turns out that even sloppy writing can be decoded by the OS as long as characters are close to the proper shape, whether or not they overlap. This can be attributed to the storage of the digital ink as a set of curves rather than as a bitmap.

A small but crucial addition to the operating system is the inclusion of a pop-up input panel which can be toggled between a keyboard and a handwriting input panel for interface to all applications. Because it is part of the OS, it has the ability to intercept input and transfer it to applications without their being Tablet aware.

In summary, input can be done in one of three modes:

1) in the form of ***digital ink***, where pen strokes are converted to spline curves and their color, thickness, etc., are maintained;

2) in the form of digital ink converted immediately to text (as in the handwriting input panel) and then passed to the application as if it came from a keyboard;

3) in pure text mode, whether from an actual keyboard or from the virtual on-screen keyboard supported by the operating system.

2.3 Microsoft Journal and One Note

Journal can most easily be visualized as a paper notepad (Figure 2). Across the top are a set of tools (pens, erasers, select tools and highlighters, similar to any drawing package). The user can write text (block or cursive), draw freehand, highlight, etc. What is interesting is that all input is captured as a set of curves rather than pixels, and that, if the user is writing, handwriting recognition is occurring in the background. This has several implications:

1) handwriting can be resized, boldfaced, italicized, etc. just as easily as standard typed text;

2) because handwriting recognition underlies all text (though the input is displayed), the resulting document is searchable;

3) because all images (digital ink) are kept as spline curves, they can be resized without loss of resolution;

4) annotations can be added to imported documents and are stored in a separate layer.

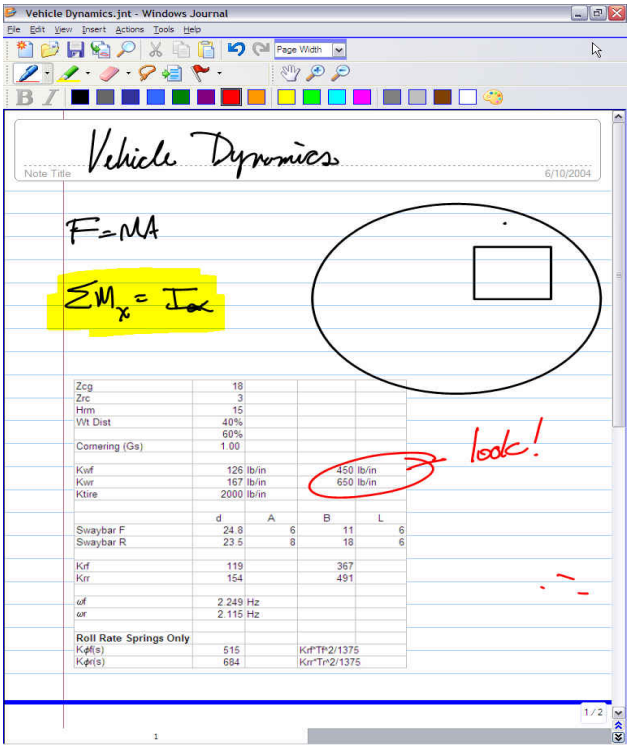

Figure 2. Microsoft Journal

In addition a variety of tools are available to convert drawn graphics to objects such as circles, lines and rectangles. Journal also has the ability to insert a limited number of graphic formats and text in line so that full presentations can be made right in the application. Unfortunately these objects cannot be edited once inserted and are stored as bitmapped images so that resizing results in loss of resolution. As a result they cannot be edited at a later time. Additional animations and video clips cannot be included either. Another advantage of Journal is that it allows the user to insert space anywhere in the document. Imagine skipping a step or detail and then later being able to insert spaces, either lines or an entire page. This is quite handy both during a lecture or as will be discussed later, before publishing notes.

Even as more and more applications become Tablet aware (extensions are available for all MS Office products) any application can be imported into Journal. Applications which are not recognized (such as Adobe Acrobat .pdf files) are imported by first invoking the application and then "printing" into Journal. The result is that the data from these applications comes into Journal bitmapped at a fixed resolution.

Microsoft One Note, a product which must be purchased separately, expands on Journal by allowing for OLE (Object Linking and Embedding) insertion. This allows for the insertion of data from other applications, including audio and video clips, which can later be edited using their native application. One Note is included in some academic versions of Microsoft Office 2003 or can be purchased at academic prices separately so it may be available to many presenters at little or no additional cost.

3. DIGITAL BLACKBOARD

With the use of the Tablet and Microsoft Journal, the Tablet PC can be used as the blackboard, with projection directly to the screen. Background colors and patterns can be chosen from an assortment of pre-defined styles including lined paper, grid, and user defined formats. As the lecturer develops the materials live, the information is stored in digital ink in a Journal document. Tools can be used to change color and line weight, and, if necessary, erase either as a pencil eraser would or by individual pen stroke. Any written text is translated into character text in the background. Although this is not displayed it does make the document searchable. In addition it can later be converted to text a block or document at a time.

Everything that is entered in Journal is then available for later use, either in native digital ink format or as converted to whatever format is appropriate. Further, during a lecture, the presenter can easily switch between the Journal application and a standard presentation, web pages or other applications to illustrate points or answer questions.

4. ANNOTATION AND INTERACTION

Because Journal allows importation of almost any application, it can be used to annotate documents directly. This feature can be used to illustrate or highlight topics during the lecture or to revise, correct or comment on digitally submitted assignments.

If a PowerPoint presentation is imported into Journal it can be annotated on the spot. That means that the lecturer can highlight important points using the highlighter pen feature (Figure 3) or can add comments, illustrations, etc. by using other digital ink capabilities. A page can then be inserted into the presentation directly by using that page as a section of digital blackboard. Alternatively, open spaces can be left in the original presentation slides for just this purpose.

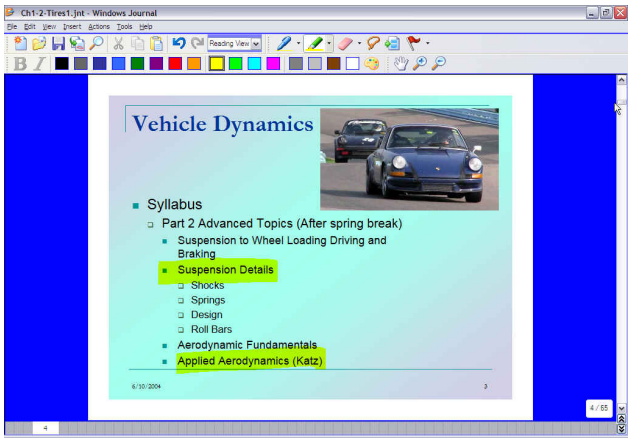

Figure 3. Microsoft PowerPoint annotated in Journal

Another feature which has been in use in the authors' and colleagues classes at the University of Delaware Mechanical Engineering department is to accept certain assignments only in digital format. The student can submit a paper in Microsoft Word and the instructor can mark it up with digital ink. It can be returned to the student electronically with written corrections and suggestions. Since Microsoft makes a Journal viewer available free of charge students can download this to read the revised document.

Use of OneNote allows the editor to make changes to the original document and save them either in OneNote, Journal or HTML format. No freely distributable OneNote viewer is currently available.

5. UNTETHER THYSELF

One of the problems of using a laptop during a presentation is that the lecturer tends to get stuck behind the podium. This may happen because the lecturer wants to keep an eye on the presentation without constantly looking at the projection screen or that the lecturer needs some form of input device such as a mouse to proceed through the presentation. The latter can be solved with specialized wireless motion detecting mice.

The Tablet PC is designed to be used while the operator is mobile. There is no need for a desk, podium or even lap on which to place the computer. In fact the Tablet is uncomfortable to use unless it is held with one hand while the other writes. Battery life is between three and six hours so it is generally not necessary to plug in to AC power during the average lecture. That leaves two attachments: the Ethernet and the projector display cables. The Ethernet connection is only needed if wireless networking is unavailable and the network is needed during a lecture (this can be remedied either by using a wireless networking transmitter or by downloading all information needed prior to lecture). The lecturer is then attached to the podium or projector with an unwieldy cable. Recently (January 2004) wireless projection adapters have come on the market [4] which can transmit the video output via the popular 802.11b standard and an upgrade to the faster 802.11g standard is expected shortly. The Tablet can then transmit the video signal to a special receiver attached to the projector, giving the presenter the freedom to wander about the room.

In general the Tablet is used in portrait mode, while the projectors tend to display landscape mode. One final hurdle that has yet to be overcome is the ability of the projector (or the Tablet itself) to rotate the projected image to reflect that shown on the Tablet.

6. PUBLISHING LECTURE NOTES

Publishing lectures either to the web or distribution via e-mail is easily done with either OneNote or Journal. Both allow documents to be saved in native or HTML format where they can be read with either the appropriate application or with any browser. As mentioned above, a MS Journal viewer is available for download from Microsoft at no charge.

In addition to publishing lectures as presented, the material can be reformatted, added to or changed to make the notes more appealing. Beyond that inked handwriting can be converted to text either for display or in the background. In either case it becomes searchable.

7. CONCLUSIONS

The Tablet PC, when used as a lecture tool, allows the presenter to develop well thought out presentations in advance without

being tied to a completely canned lecture. Materials can be developed on the fly, especially useful in derivations and proofs for the sciences, while a complete record of the lecture can be kept for later publication and distribution to students. The Tablet PC offers what is currently the best mix of computing technology and old-fashioned blackboard flexibility.

8. REFERENCES

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