Digital inking and lecture screencasts

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Summary

Digital inking on electronic slides combines the benefits of presentation software with traditional handwriting-based classroom presentation, while avoiding the main weaknesses of both methods. Presentation software, or slideware (such as PowerPoint and Keynote), allow the instructor to include rich graphics, and to have a well-structured pre-prepared lecture; but they lack interactivity and thus students can quickly become disengaged with the lecture. In contrast, the chalkboard is very interactive, and it allows a comfortable pace of presentation, but only simple written word or sketches can be produced. On-screen annotation of slides using either a tablet PC or a graphic tablet therefore can provide the best of both worlds.

Moreover, the use of digital inking allows a very simple and inexpensive means of lecture capture: screen video. Traditional lecture capture is based on live video, which involves additional human resource (camera operators) and post-processing time for video editing. On the other hand, screen video capture only requires an inexpensive piece of software installed on the laptop used for class delivery, and post-processing is minimal or zero. Thus, we have a very inexpensive means of providing self-study materials and post-lecture replay and support: the *screencast* of the annotated slides.

For the Spring'09 offering of the undergraduate introductory course on Fluid Mechanics (ME303), I am delivering live lectures using electronic slides, designed specifically to support on-screen annotations using digital ink. During the lecture, I use a graphic tablet to handwrite on the screen, which allows for spontaneous addition of material and gives me flexibility for mathematical notation. The handwritten material helps control the pace of the lecture for student understanding and note-taking. In addition, I use screen capture software during the entire lecture, at the end of which I have a full video of the projected slides with digital ink on them, including the in-class audio. The video material requires minimal post-processing (perhaps trimming at start and end, plus any interruptions), and is distributed to the students via the Blackboard online learning environment in a timely manner (usually a few hours after the lecture). Students can view the video online and replay the complete lecture or portions they feel need recollection. They can potentially download the video and export to other formats to use with their mobile devices (such as iPod), thus allowing replay on idle times like commuting, etc.

Details of the technology

The technology requirements for digital inking and screencast production are listed in the table below. The only non-standard items are the graphic tablet and screen capture software. In addition, a USB-powered microphone can be used to improve the quality of the recorded audio. The overall cost of these items adds to a few hundred dollars.

Table 1. *Hardware and software requirements*

Class preparation and presentation	In the classroom	Post-lecture screencast delivery
A laptop computer, with slideware. Either a tablet PC or graphic tablet.	Data projector and laptop. Screen capture software running on the laptop.	Video editing software such as Quick Time Pro. Delivery via online learning environment, such as Blackboard.

In terms of the difficulty of use, for the instructor, the main skill to learn is writing or drawing with a stylus on the tablet, while looking up at the monitor of the computer. See Figure 1. This becomes unnecessary if using a Tablet PC, but it is the only option for Mac users such as myself. Because of this difficulty, handwriting can be a little awkward at first, but adeqiuate legibility can be achieved quickly with a little practice. Figure 2 shows a sample of a portion of a slide, with digital ink annotations added live during lecture.

Figure 1. *Using a graphic tablet requires some eye-to-hand coordination which takes a little time to get used to. [Illustration from http://www.jaredandlindsay.com/]*

There are several software choices for screen capture. I use a small app called iShowU which is extremely easy to use. Basically, just set the recording area (e.g., full screen), select the audio source, click on Start Capture, and start the presentation. At the end, click Stop Capture and you have a full Quick Time video of the whole lecture on the desktop. Distribution of the video to the students is seamless and fast by means of some courseware, such as Blackboard.

To ensure quality of the recorded audio, I use a wireless lapel microphone with USB device connection to the laptop. In general, the built-in microphone of the laptop records too much room noise, and the quality is poor.

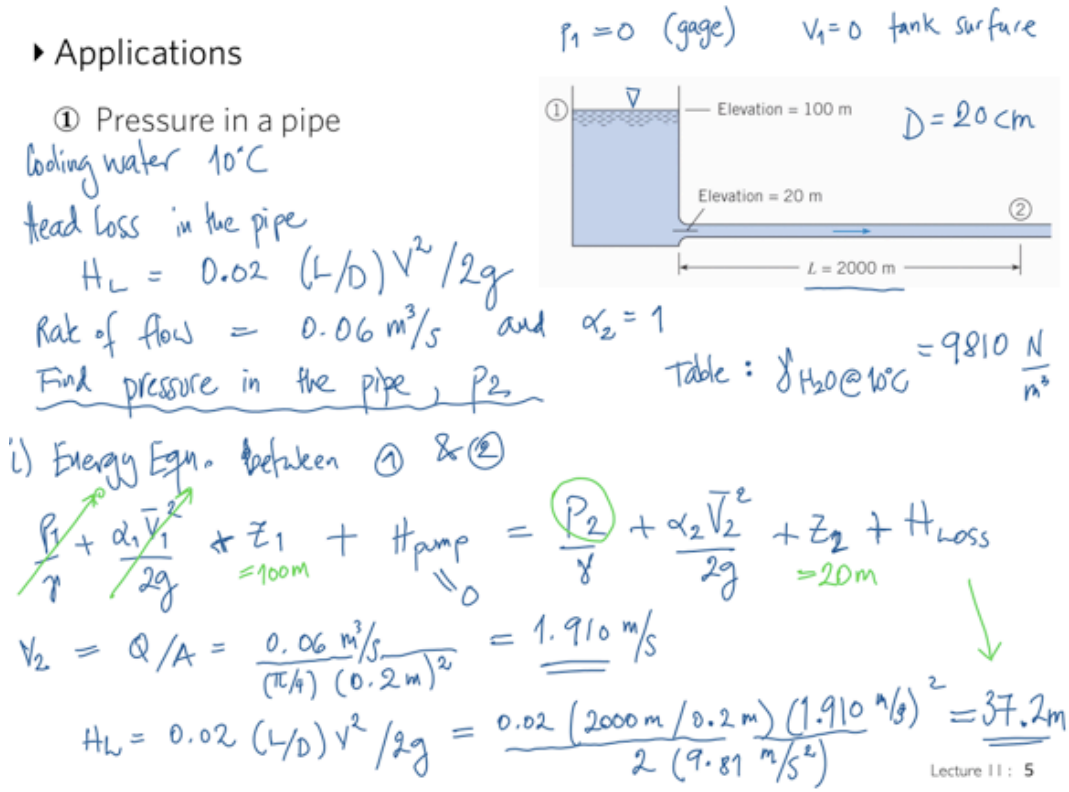

Figure 2. *A sample slide, annotated with digital ink during lecture. Real lecture of 02/23/09.*

Educational objectives and benefits

The target students of this teaching innovation are undergraduates, who are mostly taught in lecture format. Increasingly, lectures have large numbers of students, and in these conditions it is easy for students to become disengaged. A large class can thus be counteractive to one of the main benefits of the chalkboard: interactivity. On the other hand, for any size, the lecture format normally presents far too much material for a typical student to process and learn[1]. One solution to this problem is minimizing cognitive load, but under the constraints of time and space in today's university this may not be entirely feasible. Instead, one can support the students by digital capture of the lecture and distribution for later replay. Lecture capture by means of screen video is a low cost alternative to live "cameraman" video, and has most of the same advantages. The only thing that is lost is capture of the instructor's gestures and body movement; most of the time, however, the function of these instructor gestures can be accommodated using handwritten attentional marks during the presentation.

[1] Wienan, C., Perkins, K. "Transforming physics education", *Physics Today*, Nov. 2005, pp. 36-41.

Objectives

The objectives of this innovative teaching approach are:

1. Reduce cognitive load via a clear organizational structure, provided by the previously prepared slide presentation.
2. Allow introduction of rich graphics and high quality images, by means of slideware.
3. Provide interactive classroom experience via spontaneous handwriting on slides with digital ink.
4. Control the pace of the lecture to a rate that permits student understanding and note-taking.
5. Capture lectures digitally by screen video capture software, and distribute for replay and self-study.

Benefits

Classified by the technology components, benefits of the innovation are:

- Benefits of electronic slides
  - high quality projected images
  - other software applications can be used in the lecture presentation (e.g. browser, mathematical software)
- Benefits of digital inking
  - interactive, spontaneous addition of material
  - flexible introduction of sketches and mathematical notation
  - controlling the pace of the lecture via handwriting
- Benefits of screencast
  - complete lecture is captured as video of the screen, with instructor's voice
  - low cost alternative to live classroom video
  - virtually no post-processing
  - easy and timely distribution to students via courseware
  - students can replay and recall, and view lectures they have missed.

Final remarks

It is important that the use of technology for in-class presentation be non-intrusive and non-distracting. The use of the techniques described here require the instructor to set up three pieces of hardware: laptop (and connection to projector), graphics tablet, and microphone. It is highly desirable that the data projector be already in place in the classroom, to avoid additional transport of equipment and set up time. In many cases, this will require coordination with scheduling services well in advance of the start of classes, to ensure a classroom is assigned that has the necessary equipment.

Preparation of the base slides requires some reflection, as they need to be specifically designed to support digital inking. At the very least, this means leaving appropriate blank space for annotations. But other factors to consider ahead of time include allowing time for students to take in the information, as the system limits the amount of material that can be left up for students to just one slide-full at a time (in contrast to chalkboards, which usually allow one or more boards to be left un-erased).