# Using a Computer Screen as a Whiteboard while Recording the Lecture as a Sound Movie

Jonathan Lewin*†
Kennesaw State University (e-mail: lewins@mindspring.com)

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## 1 Introduction: Technology for Communication

The use of technological tools in the teaching of mathematics has come to be identified, largely, with the use of computing tools such as computer algebra systems and hand-held calculators. Accordingly, the programme of a typical technology conference bristles with presentations on the use of a variety of computer algebra systems and on the use of hand-held calculators to enhance the teaching and learning of mathematics.

The author of this paper recognizes the value of such technological tools but feels that the mathematical community has taken too narrow a view of technology and has plunged headlong into an orgy of computer algebra and calculator activity that is out of proportion to its true value. I am concerned that some mathematics courses may be losing their frame of reference and abdicating their responsibility to teach understanding of mathematical ideas and principles as they attempt to embellish the material with the use of computer algebra systems. I am also concerned that some mathematics curricula and technology conferences may be tainted by the financial support that they receive from those whose hardware and software products are featured in them and who therefore have a financial interest in the content being presented. There is a danger that the academic integrity of such curricula or conferences may, in some cases, be compromised.

This paper presents suggestions for a different role of technology, a role of *communication.* I discovered some years ago that it is possible to train oneself to write with an efficient scientific word processor much more rapidly and effectively than anyone can write on a chalkboard. I started producing my lectures by typing into a laptop computer and projecting my image onto a screen, and I

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found that I could generate a set of lecture notes that was vastly more readable, complete, and precise than anything that could be written on a board, while still having the benefit of being the actual notes that were created during the teaching process in the classroom. In this way, I could free my students from the responsibility of compiling the notes while they are also trying to absorb what I am saying to them, and I could guarantee that the notes on which they based their studies were complete and reliable. Furthermore, since the notes thus created could be read both as hard copy and on the computer screen, where use of a computer algebra system happens to be appropriate, I can make my notes interactive with the help of the computer algebra systems that are bundled into the mathematical word processor that I use.

Then, about three years ago, I took the next logical step and started recording the entire process as I teach in the classroom. I use a recording utility that can record everything that appears on my computer screen and, in this way, I produce a sound movie reproduction of my lectures, exactly as they take place in the classroom. Thus, students who are having trouble working through their lecture notes have the option of a virtual re-entry to the classroom to receive any chosen item of the material again in a lecture environment. Within a few minutes of the end of each of my lectures, I have mastered a CD that contains the complete set of lecture notes given, to date, in the course, and contains the movie recording of the latest lecture. The master CD is carried to my office where I have a CD copy machine and, a few minutes later, I am placing CDs on a table for the students to pick up. Each student receives a CD for each time that the class meets.

# 2 Using The Computer Screen as a Whiteboard

## 2.1 Producing Lecture Notes with *Scientific WorkPlace* or *Scientific Notebook*[1]

The entire process of using a computer screen as a whiteboard hinges on an ability to type quality documents that support mathematical notation and an ability to produce such documents rapidly and effortlessly. This ability is provided by *Scientific Notebook* and *Scientific WorkPlace* which are truly outstanding software products. There is nothing else like them in the marketplace. Not only is it possible to learn to type quickly and effortlessly, but all mathematical content is understood by the built-in computer algebra system that comes with these products. Typing aids such as "drag and drop" make it possible to produce notes at a vastly greater rate than anyone can realize while writing on a blackboard, and, using these products, I am able to show many more working steps than would otherwise be possible. During the lecture, I can return at any time to any position in the document and insert additional working steps in response

[1] *Scientific Notebook* and *Scientific WorkPlace* are trademarks of MacKichan Software Inc. (www.mackichan.com)

to student questions. The dragging process also provides a visual effect, allowing the students to see where something comes from.

No matter what method is used, some considerable training is required before one can type mathematical material rapidly in front of an audience. It would, of course, be easier to write directly, albeit more slowly, onto an electronic whiteboard, or onto a conventional board while someone is holding a camcorder. But, for those who take the trouble to acquire the skills for efficient typing with *Scientific WorkPlace* or *Scientific Notebook*, the advantages are manifest. The document screen allows rapid and continuous scrolling so that nothing has to be erased as the lecture progresses. The notes being produced have a truly professional textbook look. I build in several different colored highlighting options to make it easy for the student to distinguish between different items in the notes. The notes are easy to publish on a website and, in order to read and print the notes, a student is not required to purchase any software.

I often begin a lecture by opening the notes of the preceding lecture, saving it under a new name, and then working through homework problems that were placed in that document. This saves me the time and effort of rewriting those homework problems.

While teaching, I can sometimes make my typing even more rapid by using the built-in computer algebra system to perform operations on my algebraic or calculus expressions, or to draw a wide variety of graphs. Moreover, I can insert interactive ingredients into my notes that allow the student to use the computer algebra system to explore the mathematics as the notes are being read.

In addition to supplying the lecture notes for interactive reading on-screen and for posting in a website, one also has the option to print the documents. Morever, if one has *Scientific WorkPlace*, one also has the option of typesetting the documents through LaTeX with professional quality.

## 2.2 Producing Graphics

When I am using my computer screen as a whiteboard as I write into a *Scientific Notebook* document, I can produce all of the mathematical graphs directly. However, there is also a need to make drawings of the type that one would draw freehand on a blackboard. Again the process requires some training but the effort is well worth while. I use the following graphics products.

### 2.2.1 SmartDraw[2]

My principal graphics work horse is *SmartDraw* which is a really terrific piece of software. *SmartDraw* works comes up and works very rapidly and reliably and is one of the most friendly software products I have ever seen, and the *SmartDraw* technical support service is excellent. While teaching, I can Alt+Tab to *SmartDraw*, draw a figure, copy it to the clipboard, Alt+Tab back to *Scientific Notebook* and paste in less time than I could draw the figure on a blackboard.

[2] SmartDraw is a trademark of SmartDraw.com.

The Copy As Picture feature of *Scientific Notebook* also allows me to paste mathematical symbolism into my *SmartDraw* figure.

When I need more complicated figures, I can "cheat" by making them in advance of the lecture. The analogue in conventional teaching would be to walk in with the figure and project it with an overhead projector, but my method actually imports the figure into the notes that the students will have in their own computers or in their hard copy prints.

#### 2.2.2 PaintShop Pro[3]

Once in a while, I need the freedom that comes with raster style graphics and, for this purpose, I work in a raster layer in *Paint Shop Pro*.

# 3 Recording Computer Activity

An instructor who is sufficiently fluent with the process of using a computer screen as a whiteboard can move to the next level and record the entire process as a sound movie. There are two principal software products that may be used for creating such recordings of computer activity. These are *Camtasia Studio 2.1*[4] and *ScreenCorder 4*[5]. Each has its own role to play.

## 3.1 Recording in the Classroom

For recordings of lectures given in the classroom in front of the students, speed and reliability are the main considerations. My choice for this purpose is *Camtasia Studio 2.1*. This product includes a recording utility called *Camtasia Recorder* that is able to record any rectangular region of the screen, together with all sound, and to export the recording as a high quality AVI file. I use this recording utility in the classroom. It has the advantage of being very fast and totally reliable. I have never experienced a crash with Camtasia Recorder. Once the AVI file has been made, I use the *MenuMaker* feature in *Camtasia Studio* to master a CD. Within a few minutes, I have a CD mastered with a nice friendly welcome menu that shows links to all of my lecture notes and to the latest movie. The *Camtasia Player* is also bundled into the CD and is used automatically to play the movie. In that way, I am assured that all students will see exactly the same thing and that there won't be any technical difficulties. *Camtasia Studio* also provides a *Pack and Show* method of supplying movies, supplying them as EXE files that can be the targets of hypertext links in any good on-screen word processor, or in an HTML file. I recommend the *Pack and Show* method only for for shorter movies (not much more than 30 minutes of full screen playing).

[3] Paint Shop Pro is a trademark of Jasc Software Inc. (www.jasc.com)
[4] *Camtasia Studio* is a trademark of the TechSmith Corporation. (www.techsmith.com)
[5] *ScreenCorder 4* is a trademark of Matchware. (www.matchware.net)

## 3.2 Recording Outside of the Classroom

Recordings made in the classroom are "warts and all" recordings of the actual proceedings of a lecture. But there is also a need for recordings of a much more polished nature that would be made in the privacy of an office. Such recordings could be companions to textbooks or supplied in their own right. For the recording of such movies, I recommend *ScreenCorder 4*. Although *ScreenCorder 4* exports its video more slowly than *Camtasia Recorder*, and although *ScreenCorder 4* does not match the stability of *Camtasia Recorder*, there are features in *ScreenCorder 4* that make it a *sine qua non* for quality recordings done in the office.

A principal and unique feature of *ScreenCorder 4* is its ability to supply some editing functions while the actual recording is taking place. At any moment, the movie may be paused and the cursor dragged back to any chosen point to allow playing of the movie made from that point. That facility allows for much greater continuity of the recording even if the instructor needs to pause the movie many times. Moreover, if, after a pause, the recording is resumed from any point before the end of the previously recorded material, then the material that comes after that point is overwritten. ScreenCorder therefore makes it easy to correct errors and polish the material while the movie is being made. *ScreenCorder 4* also allows the project to be saved at any time. This saving is instantaneous because it does not involve export of the movie. One may therefore come back at any time, even after the computer has been turned off, and resume the job of recording the movie.

Thus, by using *ScreenCorder 4*, one may make movies that are vastly more polished than movies that have to be made in a single recording session that contains no pauses. After the movie has been made, one may, of course, import it into *Camtasia Studio* and use the editing features in *Camtasia Studio* to perform further editing of the movie, to adjust the audio properties and to splice movies together. The movie file can then be presented either with the *Camtasia Pack and Show* feature, or its *MenuMaker* feature.

## 3.3 Protecting your Work from Piracy

I don't bother to protect my lecture notes. They are available to anyone who interested enough to want look at them. I only wish that I could generate more such interest. However, for more polished movies that I make in my own home and that are intended for commercial distribution, I do take the trouble to protect my work. I have looked very extensively at the options for protecting the kind of movie material that I have described in this paper and have come to some definite conclusions about what I think is the best approach.

I believe that the various options that exist for copy protecting CDs and DVDs are much less suitable for the kind of movies that I have described than they are for the protection of software products, full length DVD movies, and music supplied on a CD. For the kind of movie that I am describing, the Microsoft DRM protection process is excellent and affordable.

In order to protect a movie using the Microsoft DRM technique, one must first convert the movie into a WMV file that will play in the Windows Media Player. Apart from the fact that such conversion opens the door to DRM protection, it has other advantages:

- WMV files are much smaller than their AVI counterparts.
- WMV files are ideal for streamed viewing from websites.

The disadvantages of conversion to WMV are as follows:

- The quality of sound and video is not quite as good in a WMV file as it is in the source AVI file, but it is still good enough if the conversion settings are chosen carefully.
- The Windows Media Player is not as good as the Camtasia Player that I bundle in with my AVI presentations. A principal defect of the Windows Media Player is its crude fast forwarding and rewind capabilities.

Whatever recording software you use, do not let the recording utility export to WMV at the end of the recording process. The export should be made first to a high quality AVI file using a lossless codec such as the TSCC codec that is supplied with Camtasia Studio. One may then use Camtasia Studio or, better still, the Microsoft Encoder, to make the conversion to WMV. There are a number of issues involved in getting the best results and I invite anyone who is interested in this process to contact me.

To make use of DRM protection, you need to open an account with a good DRM provider. My strong recommendation is to use a full service provider that will not expect you to purchase your own expensive equipment and will walk you carefully through the setup process. My own choice is a company called BuyDRM. Their website is http://www.buydrm.com and my main contact person there is Christopher Levy to whom I write at clevy@buydrm.com. While I have no doubt that there are many good suppliers out there, I am thankful that I chose BuyDRM. Their service is outstanding and they did much to take the fear out of the DRM process. They also use state of the art software that is distinctly more convenient than DRM software I have seen from other providers and, most important of all, they respond promptly and positively to all my many enquiring letters and requests for features.

The DRM method allows you to supply a license to any would-be viewer of your movies. The license supplied to a particular computer. The licensing method applies to movies yo supply on a CD or DVD and in exactly the same way to movies placed on a website for download. You can elect to make the license permanent or for a limited period or for a limited number of plays. You can make a single license apply to a whole bunch of movies or you can require separate licenses for different movies. The DRM process is therefore very flexible. A company like BuyDRM will talk to you about the way you would like to supply your movies and set things up they way you want them to be.

# 4 Hardware Issues

## 4.1 Recording Sound

In order to record sound, one needs to have a microphone. I do not advocate use of a microphone that may be built into a laptop computer. Instead, a microphone can be mounted on the instructor's head. For good quality sound, the microphone should be plugged into a small tube preamplifier that, in turn, is plugged into the line-in jack of the computer. You can expect to pay about $200 for this sound equipment. For sound equipment needed to make movies, I recommend that one visit a good music store, rather than a computer store.

Note that some of the more recent laptop computers from Dell are no longer supplied with line-in jacks, but I have been instructed by Dell to use the microphone jack and have had no problems.

## 4.2 The Need for a Good Graphics Card

A computer to be used for the making of movies should have a reasonably fast CPU. I don't know how fast is enough but I have evidence that 1.2 GHz seems to be insufficient and that 3.0 GHz is sufficient. Above all, the computer should have a good graphics card. I ordered my present Dell 5150 laptop with an upgraded graphics card and this computer works well during the recording process.

If a computer lacks sufficient computing power to make the movies efficiently, it is necessary to go into the screen display settings and, in the Advanced menu, to disable the graphics acceleration before recording a movie. Failure to disable graphics acceleration in a slow computer could cause the computer to choke while the movie is being made. Both *ScreenCorder 4* and *Camtasia Recorder* offer an option for automatic disabling of graphics acceleration, but I prefer to do it manually. Note that the disabling of graphics acceleration can cause a variety of undesirable effects and so it is vastly more preferable to have a sufficiently powerful computer and not to disable graphics acceleration. One may also reduce the load on the computer by reducing the color depth but, in my opinion, reduction of the color depth is very undesirable.

## 4.3 Mouse and Keyboard

In my opinion, under no circumstances should one try to use the built in screen mouse and keyboard of a laptop computer. For fast, efficient, and reliable typing, carry a conventional mouse and a high quality ergonomic keyboard. Never use a standard flat keyboard. Use the same keyboard at every computer at which you work. Never type on someone else's keyboard.

## 4.4 Burning CDs

CD and DVD copy machines have become much more common over the past couple of years, and the price has dropped sharply. You can expect to find an

nice free standing copy machine for about $2000 and, if you are willing to load the disks by hand, you can find a machine for much less. By looking for specials and by bargaining on the basis of the large number of CDs that I buy, I have been able to reduce the cost of CDs to a minimum. I don't bother with labels. I write the course number and date on the front of each CD with a Sharpie pen. I don't bother with sleeves or jewel cases but some of my students have their own. Others treat my CDs more harshly, but they play well in spite of such treatment.

My department finds it necessary to require students to pay for the CD blanks that are used for my courses and this comes to between $5 and $7 per semester. I have made it clear to my students that, if anyone comes to me and tells me that he or she is unable to pay the fee, then I shall willingly do so on his or her behalf out of my own pocket. To date, I have not had anyone take me up on that offer.

# 5 Conclusion

The process of using a computer as a whiteboard requires some hard work and intensive training, and it also requires the spending of some money on software and hardware. But, for those to take the plunge, it is possible to elevate the quality of mathematics teaching to a new level. The response I have had from students is enthusiastic and they show great appreciation for the service that I provide to them. Time and time again, I have heard students complain that they felt that they understood the material when they were sitting in the lecture but then they couldn't make sense of it later when they were reading the notes. My movies allow them to go back to the actual lecture whenever they like and to sit through any part of it that they need.

And yes, I have noticed a lower drop rate and higher course grades.