

## **Distance Learning: A Multimedia Approach**

**Graham Walker, Paul Marnell, and Richard Heist**  
**Mechanical Engineering / Chemical Engineering / Chemical Engineering**  
**Manhattan College, Riverdale, NY 10471**

### **Introduction**

Many of the industrial advisors to the Engineering School at Manhattan College have indicated over the years that they would like to improve the education level of their workforce by allowing them to study for a Master's degree. However, in many of these cases it has been difficult to achieve this because of work constraints on the employees. This was particularly true of the companies that were located at significant distances from the college campus.

In the past the Engineering School at Manhattan College has arranged for an instructor to travel to a facility located at or near the plant where most of the company students were employed. However, in the present industrial climate it has become difficult to arrange for all of the potential students to be able to attend the classes together on a regular basis, mostly because of conflicting shift requirements.

To address this problem, the School has created a number of courses (Applied Instrumentation, Engineering Economy, Quality Engineering, and Legal Aspects of Engineering) that can be offered asynchronously using CD-ROM's and/or the web. All students take the class during the same semester, but they are able to access the class materials as needed. This was done by providing the students with prepackaged lectures on CD-ROM and class material via the web.

### **Course Materials**

The lecture material for the course is distributed to the students on a CD-ROM and a video where necessary. Supplementary materials are also made available to the students on the web via the Blackboard software package. Blackboard is also used to communicate with the students.

#### **Compact Disk**

The CD-ROM associated with the course contains all of the lectures for the courses and they are broken down into topics. This is advantageous over traditional class formats in that the course is not unnaturally broken into segments that are all of equal length, but instead have natural breaks at the end of each class topic.

The format of each lecture is such that the student is shown a slide and hears the associated voice-over. At present they are also shown a still image of the instructor associate with each slide. The students can also see an overview of all the slides associated with each topic while the lecture voiceover continues its presentation. If desired the student can then skip to any of the slides associated with the lecture and the voice-over will follow suit and remain synchronized with the slide. The students also have the ability to use a fast forward or reverse feature on a slider bar that allows the lecture to be moved to any slide rapidly within the lecture. Clicking on the image of the slide produces an enlarged version for easier viewing. All of these tools exist on the GUI associated with the CD-ROM software (Fig. 1). Consequently, this ability to move around within a specific lecture therefore allows the student to listen to the lecture material repeatedly and at whatever place is most appropriate.

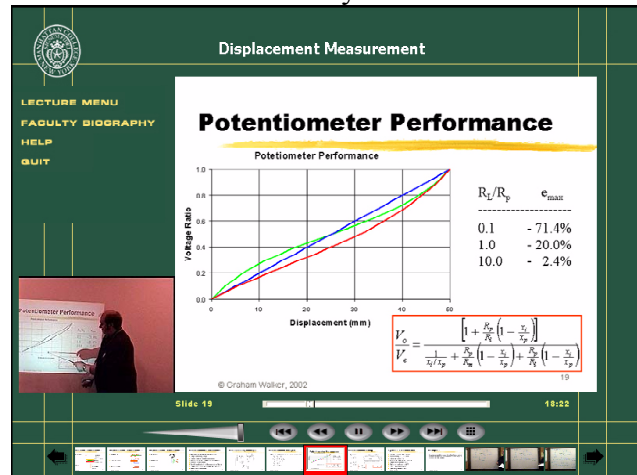


Fig. 1: The GUI for the CD-ROM

## Video

In one of the courses (ENGG620: Applied Instrumentation) it was necessary to teach the students how to use a specific piece of software (LabVIEW from National Instruments), and it was felt that this could not be done by merely having static images of the instructor, since the students would have to see how the various elements of the program were used. To achieve this, a video capture of the computer screen and an associated voiceover was recorded as different simple LabVIEW programs were constructed. This was then used in conjunction with a voiceover and slide presentation associated with the lecture on how to use of the software (i.e. LabVIEW).

## On-Line Content

To complement the lectures and assigned textbook a variety of other materials are made available to the students via the internet. This on-line material is accessible using the Blackboard software, but the amount and type of content varies significantly among the different distance learning courses. However, in the case of the course that at present makes most use of this facility, the students are provided items such as the lecture presentations, lecture notes, images, prewritten program files, and worked examples.

## Blackboard

Blackboard is a software package from Blackboard Inc. that allows material to be easily uploaded onto a web site. This software comes with predefined formats that allow the instructor to create web pages that contain text, images, and downloadable files that are accessible by only the course participants or the world at large. The software also allows various forms of communications to be used between the instructor and a specific student, or among all of the users who have access

to the web pages.

Blackboard is also used in many traditional courses at Manhattan College, however, it has proved to be particularly valuable when employed in a distance learning course, because it allows vast amounts of information to be communicated to a student asynchronously. The utility of this product can best be appreciated by examining the materials that are available to distance learning students.

## Written Materials

Written materials are placed on Blackboard to compensate for the fact that the distance learning student cannot directly ask questions of the instructor. For example, the lecture notes are primarily intended to anticipate possible questions that might be associated with the lecture material. In addition, they also provide the detail and derivations that are often omitted from lectures. Other written materials have included general course information, the slides associated with the lecture material, class assignments, and sample tests. A more detailed description of these various elements is given below.

Course Details: this provides the student with general information about the course such as course objectives, topics covered, timetables, grading policies, the bibliography, and course operating procedures.

Presentation Slides: these are the slides associated with the lectures, and they are made available as Adobe Acrobat files (i.e. *pdf* files) to allow the students to make a hardcopy of the material, which can then be annotated as necessary.

Lecture Notes: these consist of documents that provide a more in depth description of the subtopics within a single lecture than is given within the lecture and worked examples. These notes are typically five to ten pages long, and are also provide in Adobe Acrobat format (Fig. 2).

Assignments: these are the assignments that the students have to complete during the course, and they can be timed to appear as needed using Blackboard, or they can be made available to the students at the beginning of the course along with the assignment due dates.

Sample Tests: since distance learning students do not have immediate access to the instructor, sample tests and quizzes can also be placed on Blackboard to allow the students to gauge their rate of progress and prepare for the actual tests and/or quizzes.

**FIGURE 2** The balances of the down payment investment in Example 2. Excel calculates the smaller *IRR* without a guess, with a guess of 150%. It calculates the larger *IRR*.

**What is the Meaning of a Negative Balance?**  
Before I answer this question, let me review the assumptions, conditions, and definitions that took us from the balance equation to the GRP.

1. **Balance Equation:** The balance equation

$$B_j = B_{j-1}(1+i)^j - F_j \quad (j=0,1,\dots,n) \quad (7)$$

has two boundary conditions

$$B_0 = 0 \quad (8)$$
$$B_n = 0 \quad (9)$$

2. **General Repayment Equation:** The derivation of the GRE

$$\sum_{j=0}^n \frac{F_j}{(1+i)^j} = 0 \quad (10)$$

from the balance equation contains two assumptions

A. The interest rate is constant  
B.  $1+i > 0$ .

3. **General Repayment Polynomial:** We obtained the GRP

$$p(x) = F_0 x^n + F_1 x^{n-1} + \dots + F_{n-1} x + F_n \quad (11)$$

by rearranging the GRE and introducing the definition

$$x = 1+i \quad (12)$$

As you can see, the balance equation, GRE, and GRP are mathematically valid for negative intermediate balances. Hence, in many non-simple investments one or more negative intermediate balances appear. For example, in Figure 2 the first balance of the 35% *IRR* is negative, and the first two balances of the 100% *IRR* are negative.

When a balance is negative, the investment does not owe the investor any money. In fact, it provides the investor with the magnitude of the balance. The balance equation implies that

A negative balance earns interest in an external investment at the same interest rate that generates the interest carried on a positive balance by the investment.

For example, in Figure 2 when the *IRR* is 100%, the \$10 x 10<sup>3</sup> down payment, which is a negative balance, is mathematically invested in an external investment that also pays 100% per year. At the end of

Fig. 2: Example of a Lecture Note

## Images

In some classes equipment is often shown to students to provide them with a better understanding of the device's operation and application, however, in the distance learning case, it proved difficult to present a high quality image using only the small still image shots on the CD-ROM. In addition, the large space available on Blackboard allows a very large variety of images to be made available to the students. Consequently, many images associated with a specific course can be made available via Blackboard (Fig. 3).

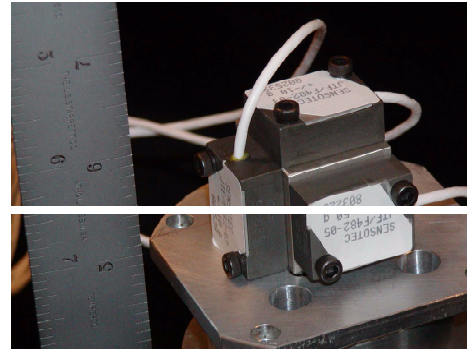


Fig. 3: A Typical Instrumentation Image

## Programs

In most of the graduate course in engineering an analysis or modeling package is used to interpret or generate information (e.g. Excel, SPSS, MathCAD, Matlab, Simulink, VisSim, ProModel, I-Deas, SmartCAM, and LabVIEW). In the distance learning case Blackboard is used to make files associated with these programs available to the students to allow them to perform appropriate analyses. This is particularly effective in the case of LabVIEW, where the students are required to purchase the student version, and are then able to both learn how to create programs using LabVIEW, and use the program to run virtual experiments.

Sample Programs: these are used to help the student learn how to create LabVIEW programs by providing them with files that contained small simple programs that illustrated different aspects of the software: these are the programs that are associated with the video component of the course.

Virtual Laboratories: these are used to provide a laboratory experience at a distance, by providing the students with a number of virtual experiments (Fig. 4). The experiments are simulated using LabVIEW, which allowed the non-linearities and stochastic noise of an actual experiments to be included. In the experiments the students are presented with a GUI that looks like the front panel of a signal conditioner for a transducer (e.g. a strain gauge amplifier) and an output device (e.g. an oscilloscope). The students are then asked to perform the experiment by adjusting the various input options and observing the subsequent result, via the output GUI. They then have to present the data in an appropriate format via a laboratory report. Since in typical classroom laboratory experiments the students do not, in general, set up the experimental equipment, but

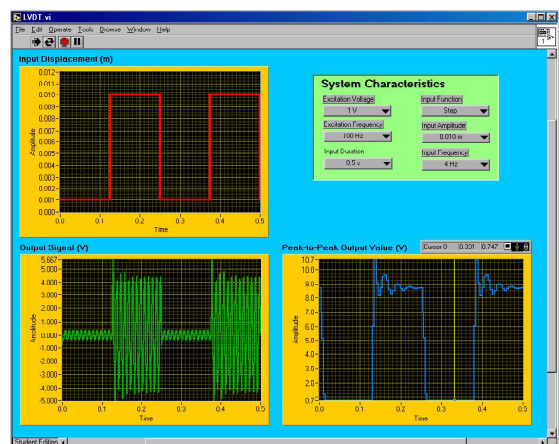


Fig. 4: The GUI for one of the LabVIEW Experiments

merely operate the equipment, it is felt that the loss in authenticity is minimal.

## Web Links

Blackboard is also used to provide the students with web links to sites associated with the material being covered in the course. An example of this, in the Applied Instrumentation course, are the links to many instrumentation manufacturers. This provides the students with a wealth of addition and practical information about the operation and selection of instruments and sensors. In the instrumentation case a homework assignment is also given where the students have to use the manufacture's data to select an appropriate piece of equipment, thereby providing them with a realistic equipment selection experience.

## Communication

In distance learning communication is an essential element, since the student has minimal contact with the instructor. Using the telephone was considered, however, this often leads to "telephone tag" which can be very frustrating. Consequently, it was decided to use only electronic forms of communication such as e-mail, discussion boards, and the virtual classroom, since they allowed questions to be stated clearly and in a written form, which provided a record of all communications.

### E-Mail

E-mail proved to be the main mode of communication between the instructor and individual students, since this allows messages to be obtained easily. This form of communication, however, is intentionally limited to assignment submission and one-to-one communication about grades and other organizational matters. The reason for this is because any course material questions should be made available to all members of the class.

### Discussion Board

The discussion board substitutes for the typical question and answer experience that is found in a traditional classroom setting. This proves to be the best form of communication to address course material questions, since it allows all participants to see all questions and answers as needed.

### Virtual Classroom

The virtual classroom component of Blackboard (Fig. 5) is used at a minimum because of the asynchronous nature of the present format of the distance learning courses. However, in the cases where a student needs one-on-one help about a question involving a complex diagram, the virtual classroom gives an option that allows diagrams and equations to be communicated interactively.

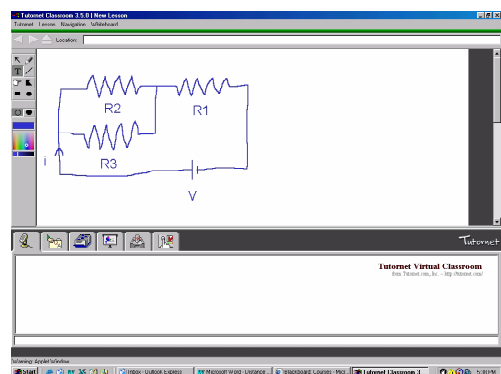


Fig. 5: The Virtual Classroom Screen

## Production Issues

A significant effort had to be made to create all of the materials that are necessary for the distance learning courses. Filming the lectures requires a filming and editing facility and an associated staff. The creation of lecture materials is also very time consuming because all materials are produced using Powerpoint, Microsoft Word, Photo Editor, and Excel. Also, all web based materials had to be generated in-house because of copyright issues.

## Lecture Format

Initially the lecture component of the course was filmed during the presentation of an actual traditional lecture, however, this approach proved to be problematic. Primarily it was found that the discontinuities produced by student questions and instructor/student interactions, which in a class setting is very productive, created a chopped presentation that is distracting when viewed as a stand alone entity. The user of the CD is not interested in the many often incorrect paths followed by students in the classroom. They want a clear exposition devoid of annoying side tracks. In addition, simultaneously filming a lecture has a negative impact on the students in the studio/lecture room. The filming process often intimidates them, and the spontaneity and levity present in a traditional lecture room, is stifled in the darkness of the filming process.

Consequently, the distance learning courses are now filmed in a studio. This mode also allows retakes and updates to be achieved. It also gives better control of the lighting, audio, and image characteristics (e.g. composition, formatting and resolution). Unfortunately, the studio approach results in a lecture that is less spontaneous and faster paced, with few asides, which often increases the students understanding, since many asides are a result of audience questions.

It was also found from the filming of a traditional classroom that the class materials written on a whiteboard, blackboard, or overhead projector resulted in poor quality and unprofessional looking images. Consequently, it was decided to use computer generated slides for all presentations, and the images of the slides are captured directly from the computer. This subsequently results in a communication issue in that when the instructor refers to an element on the slide the instructor tends to point to the item. However, since only one still shot is recorded for each slide, the students sometimes have problems following the presentation on an initial viewing. This problem has not been resolved fully at present, but one solution being explored is to capture a new still image of the instructor each time the instructor points to the slide.

## Video Limitations

The video element also proved to have a significant flaw in that the resolution proved to be too poor to clearly capture clear computer screen shots. Initially, the images from the computer screen were projected onto a large screen and taped using a video camera. Then in an effort to improve the image quality the video output from the computer was capture directly and recorded

onto video tape, however, even using this approach the picture quality was poor. CD-ROM was also considered but it was not possible to store enough data to encompass a whole lecture. To address this problem DVD is now being considered as the storage medium, since this will allow a large amount of high-resolution visual data to be recorded.

If the DVD solution proves to be successful the use of video will be expanded to include videos of in laboratory experiments to demonstrate specific physical phenomenon or equipment operation. The higher data densities available using DVD would then allow all course elements lectures, video etc. to be stored on a single disk, or set of disks.

### Class Materials

The lecture materials (i.e. the lecture notes and presentation slides) are placed onto the internet as Adobe Acrobat files (i.e. *pdf* files). This is done for two reasons. The first is that the *pdf* format can be read by anyone once they have the free Adobe Acrobat reader installed onto their computer, while a word processing file could only be read if the student owned the word processing software in question. The second reason concerns protecting the instructor's intellectual property in that the *pdf* format makes it difficult for anyone to capture the images and equations in a format that would allow them to be manipulated or changed; however, the text remains unprotected, since it is possible to use OCR software to put the text into a word processing format from the *pdf* file. In any event, a copyright notice can be placed on all material to help protect it. Finally, it should be noted that the presentation slides use a white background, since it is not possible to change a slide's background color in the Adobe Acrobat format, and slides with non-whites backgrounds cause printing problems. Obviously, care has to be taken not to place copyrighted materials onto the internet without permission from the copyright holder. Consequently, this implies that all diagrams and images have to be generated by the instructor, which is very time consuming if the course makes heavy use of such materials.

### Operational Issues

Since there is minimal contact between the instructor and the distance learning student, it is essential that class operating protocols be established otherwise confusion can be created among the students and unnecessary work can be created for the instructor. The students are therefore made aware of all operating rules immediately prior to the start of every class, and the rules are placed on a prominent place on the Blackboard web pages.

### Communication Procedures

Most of the course operating protocols involve communication issues. For examples, all content questions have to be placed on the discussion board; this is to ensure that all students see all questions and all answers associated with the course content. Another rule is that when assignments are submitted each assignment has to be sent via its own e-mail; this is to facilitate assignment management by allowing the instructor to save the different assignment e-mails in their own folders. Also, assignments can only be submitted as either a Word document, an Adobe Acrobat file of typed or written text, or a *jpeg* of a typed or written text; this allows students to

write their assignments by hand and thereby avoid the need type complex material into a word processor. When Excel spreadsheets are submitted by the students, it is important that the Instructor provide specific instructions for and examples of properly formatted spreadsheets. Otherwise, the jumble of poorly formatted and printed spreadsheets will be a time consuming grading nightmare.

Corrected student work is returned via regular mail, however, the grade is immediately e-mailed to the students. In the case where a student is very distant from the College (e.g. in a different country) the corrected material is scanned, put into *pdf* format, and e-mailed back to the student. Also, in the case of quizzes the grade and the correct answers are e-mailed back to the students.

## Assessment

Assessment is done using homework, quizzes, tests, virtual experiment reports, and papers. Homework assignments reports and papers are given out as needed, and are identical to equivalent assignments given to students in traditional classes. Quizzes are also similar to those given out in traditional classes in that a common time is agreed on and the quizzes are made available on Blackboard by using its timing facility. The students then e-mail their results to the instructor by a specified time (all e-mails have a reception time marker). Tests, however, proved to be a little more troublesome, since they take longer to complete, and it is more difficult to select a common submission window. The completion time was therefore made longer than that used in traditional classes. Most students were able to adhere to the scheduled submission dates listed in the course syllabus and schedule. However, on a case to case basis, some flexibility was allowed to accommodate illness, excessive travel or overtime.

## Honesty declaration

To address the issue of cheating, all students are required to sign a statement at the start of each course to the effect that all work submitted by them will be their own efforts and that they will not copy the work of other students or submit plagiarized materials. This solution is being viewed as a temporary measure and other solutions associated with giving test are being explored, such as using on site exam proctors.

## Conclusion

The distance learning course using multimedia has proven to be very successful in that it allows the students to learn the course materials while still staying within the overall timeframe of a traditional graduate course. Even though this type of course requires the students to be more involved in their education than does traditional courses, it is found that the distance learning program attracts the more motivated student. Also, the use of Blackboard, to provide additional course content, has proved to be so successful that it is now also used in the traditional versions of the distance learning courses.



## Biographies



Dr. GRAHAM WALKER is a member of the Mechanical Engineering Department at Manhattan College. His field of interest is systems engineering. His research has included work in instrumentation and biomechanics. He also teaches courses in design and manufacturing.



Dr. PAUL MARNELL is a member of the Chemical Engineering Department at Manhattan College. His field of interest is plant design and engineering economics. Currently he is writing a book titled "Modern Engineering Computations with Mathematica."



Dr. RICHARD HEIST is the Dean of the School of Engineering and a member of the Chemical Engineering Department at Manhattan College. His field of interest is nucleation, aerosols, phase transitions, and applications of microcomputers to engineering laboratory instruction.