

# An Experiment in Pseudo-Asynchronous Course Delivery

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**Abstract:** This paper describes an experiment in delivering a graduate level course in a pseudo – asynchronous manner using modern digital communication technology. The purpose of this effort was two-fold. One was to reduce the logistics and increase flexibility in an existing distance educational delivery system for engineering graduate courses. The second goal was to improve the efficiency and academic effectiveness of graduate course offerings for both on-campus and off-campus students. The mechanism employed was to place all knowledge content normally presented by live lectures on a CD ROM. This CD included graphics, text, and mathematical content with accompanying audio presentations in a book format. With the classical lectures delivered by the CD the class meeting schedule was reduced from three to one weekly meeting. Assessment of the acceptance and value of this form of delivery and the resulting educational experience was performed by administering pre and post-survey instruments to all the participants. The results of the evaluation were positive but not dramatically conclusive in the opinion of the students. However, the performance of the class was significantly better than experienced with previous classes that took the course in the standard offering delivery format.

Keywords: CD-ROM, graduate, distance education, experimental exercise, asynchronous

In the late 1970' s the College of Engineering at North Carolina State University implemented a program to deliver graduate level credit courses to non-resident students who wished to pursue Masters degrees in Engineering. Initially, these courses were delivered in a live format by faculty who traveled to a select number of approved sites where the off-campus students met for classes. These courses carried regular university credit that applied toward graduate degree requirements. This method of delivery quickly became both cumbersome and unworkable as the demand for university accredited off-campus educational course offerings rapidly grew across the state.

To meet this need a more convenient and less burdensome delivery method was required that satisfied appropriate academic requirements for university credit. This gave rise to the current VBEE (Video Based Engineering Education) program in the College of Engineering that now serves some 400 students each semester across North Carolina. The method of delivery consists of video taping the class meetings of regular graduate courses taught to students enrolled on-campus and providing these tapes to non-resident students enrolled in a general engineering masters program. These off-campus students must complete all the work assigned to the on-campus students and take the same examinations under proctored conditions. Personal interaction between faculty and off-campus students is accomplished as needed by email, fax and phone. Satisfying these requirements successfully results in full credit for the course applicable to the master' s degree sought.

Although this system has worked well academically and has been received enthusiastically by the participating students its logistics are overwhelming. Video taping three classes a week, mailing tapes to some 400 students in twenty different courses and having the tapes returned at the end of each semester is costly in time, manpower and monetary resources. A number of experiments are now being conducted to hopefully simplify the delivery logistics and improve the academic effectiveness using modern digital communication technology. Reported in this paper are the results of one experiment of a pseudo-asynchronous delivery method that employs presenting all course lecture materials including graphics and audio in a formalized format for delivery on CD ROM. Coupled with this experimental delivery technique the course structure was reorganized to take advantage of this change in knowledge content presentation method to improve the efficiency and effectiveness of the educational process.

## 2. Typical Course Offerings

Most engineering graduate course offerings follow a fairly similar pattern. The instructor meets with the students three times a week for class periods of 50 minutes over the length of a semester. Most class meetings consist of the instructor lecturing to the students from notes previously prepared but hopefully updated from the last time the course was offered. While this takes place students attempt to reproduce for themselves notes on the material presented on a blackboard or with overhead transparencies. If the material is on transparencies the instructor will probably provide copies to the students. This reduces but

does not eliminate note taking. If some portion of the lecture presentation is missed or not understood clearly there is no way in this live format for a student to rehear that portion. The following year the process is repeated except with a new group of students.

This may appear to be a somewhat harsh description of formal graduate engineering course offerings but it is not far from the truth in too many instances. This part of the process is not very efficient nor does it make for a very effective learning environment. Students sit in classes transcribing notes like monks in a monastery while the instructor lectures from notes that he may have only reviewed shortly before going to class. However, when these courses are supplemented with laboratory, project and one-on-one personal research interaction with a faculty advisor the total graduate educational experience appears to work quite well even with the shortcomings of the formal course lecture process. Why should we not then look to improve the course offering portion of this process and provide an even better and more effective educational experience?

One shortcoming of the course delivery process described is dealt with in the VBEE program by capturing the lectures on tape. This at least permits students to go back and listen again to some portion of the presentation they either didn't quite hear right or understand the first time through. This feature is frequently cited by off-campus students as being very valuable. However, the tapes still represent the classic lecture mode with the instructor appearing as a "talking head" on the video screen with all the flaws of a normal live lecture presentation. It was to change this part of the course offering that the experiment described and reported on here was directed.

### 3. CD ROM Preparation

The graduate offering selected for this experiment was Mechanical Design for Assembly. The course deals with the principles and methodology used in mechanical product design to insure ease of assembly in the manufacturing process. This offering is a core requirement in the Master of Integrated Manufacturing Systems Engineering program and is a popular general interest selection among VBEE students. This insured a reasonable enrollment of both on and off-campus students of value in the assessment of these two audiences in the acceptance and academic effectiveness of this delivery approach. Existing texts for the course are very limited which further required students to be more dependent on the CD for the course knowledge content.

The CD presentation of the lectures was organized as a book whose chapters (or modules) cover one week of normal course content. The book consists of eight chapters whose titles are listed below:

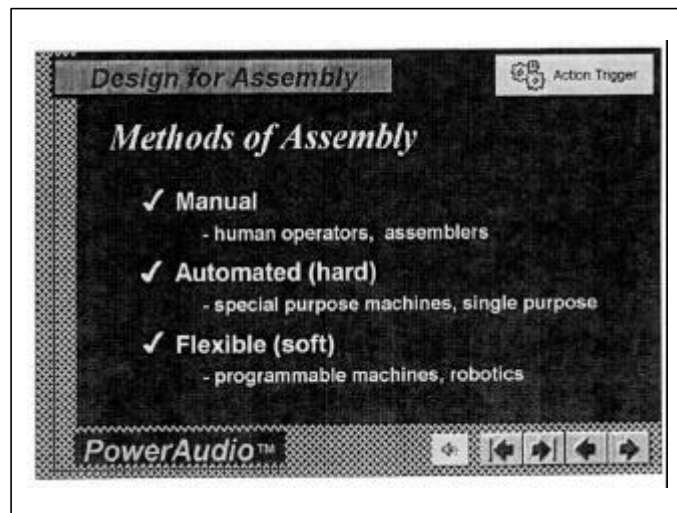
- Introduction to Design for Assembly
- Assembly Definition and Process
- Assembly Systems
- Design for Assembly Principles – Product Design
- Design for Assembly Principles – Design of Parts
- Design for Assembly Examples
- Quantifying Ease of Assembly
- Module Summaries

Each chapter of the book contains 20 to 30 individual pages of graphics, text and mathematical content. There is also a "start" module and "exit" module that provide for initiation and termination of the CD program. The entire book contains some 250 pages. Figure I shows a typical text page from Chapter 3.

Carefully scripted and recorded audio presentations accompany each page of a chapter. These play automatically as the viewer selects a page. The audio files for each page have been filtered and modified to provide a media type smoothness that contains no hesitations, mispronunciations, unnecessary repetitions or other typical live lecture flaws. The graphic and text materials are programmed to appear with appropriate audio segments on each page. Capability to replay the audio with the text material on any page before proceeding is provided and any page will replay completely if revisited once passed over. The result is kind of a "talking" text book.

Each chapter begins with an introduction and index permitting access to any page by hyperlink. It is recommended that viewers proceed sequentially through the pages but the choice is theirs. Following the presentation of the knowledge content of the chapter an interactive exercise is provided to test the viewer's understanding of the material covered. Several chapters also include interactive exercises in the midst of the content presentation. The end-of-chapter exercise provides immediate visual and audio feedback on the correctness of the viewer's responses. Hyperlinks are also provided to return to that portion of the chapter relating to the exercise if needed. The last item in each chapter is an off-line exercise to be completed as a home work assignment submitted for the instructor's review in accordance with an activity calendar schedule. These exercises are submitted at the class meeting following the chapter to be studied. Convenient navigational aids are provided throughout the entire book for easy access of any material on the CD. Each page is equipped with four navigation buttons (see Figure I) that permit going to the next page, the previous page, the last page in the chapter and the first page in the chapter. The main menu

Figure 1 – Typical Text Page and Script



There are really only two basic methods of assembly. These are manual assembly and assembly by machines. Manual assembly is carried out by human operators and is normally done by hand. Assembly by machines is generally accepted as being made up of two separate categories: so called automated assembly and flexible assembly. Automated assembly is machine assembly by special purpose machines designed for a specific assembly function. It is often referred to as "hard" automation since it usually is a one of a kind device performing one function. The second category of machine assembly is designed flexible automation or "soft" automation. These machines are programmable and can perform a variety of functions depending on their programming and capability. Assembly robots make up this category.

in the "start" module provides hyperlinks to each chapter as well as a link to the "exit" module for terminating the program. The last page in each chapter provides a link to return to the main menu and the "exit" module permits returning to the main menu as well as exiting the program completely.

The entire book is a self contained unit on the CD requiring no other software or application to run. A setup program on the CD loads the book chapters on the user's hard disk and creates shortcuts in the Windows program listing to each of the book's chapters. Only the run application and graphic pages of the book are loaded on the user's hard drive. All audio wave files which are quite extensive remain on the CD to save space on the user's hard drive. Hence, the CD is required to play the audio with the book's pages.

The entire book was created using Asymetrix Toolbook II Assistant™. This is an application created specifically for the development of industrial training modules. Through a very user friendly and icon oriented process this application provides the capability to create all the graphics, text, navigation, hyperlinking, audio recording and interactive exercise features already discussed. Syntrillium's "Cool Edit" program was used to filter and modify all the wave files recorded with Toolbook II Assistant™. The final product was found to be very robust and compatible as exemplified by the fact that only one of twenty students enrolled in the course encountered a minor problem installing and/or running the program from written instruction provided with the CD.

After learning the Toolbook II application the production of a page required from one to two hours. This included the programming of all text and graphics, writing the script and recording, editing and integrating the audio. It is estimated that the entire book required some 400-500 hours to create. This included the final assembly of all chapters, extensive checking for navigation consistency and packaging of the final product. The project was carried out over a period of about eight months.

### Course Schedule Reorganization

Each student enrolled in the class was provided with a personal copy of the CD at the beginning of the course. With the course knowledge content now provided on CD ROM replacing the normal lecture sessions, there was no longer any need to schedule three weekly meetings for the course. However, it was felt it would be necessary to maintain some periodic interaction with the students. One class meeting each week was considered to be sufficient. This arrangement resulted in the pseudo-asynchronous delivery method. That is, students could access the lecture material at their convenience but still were required to meet with the instructor on a regular scheduled basis.

Reducing the class meetings to once a week immediately reduced the amount of taping and mailing of videos to the off-campus students to one third of the normal number, a significant reduction. Having the lecture material on a CD also provided the off-

campus students with an added feature not available with the video recordings. The tapes required access to a VCR that was not always as convenient as a PC. Most VCRs are in homes whereas PCs are available in the office or with a laptop access could be anywhere. One student this past semester took the CD with him on a special three-week work assignment to Australia and kept up with the class via email and the internet. With the lectures on CD the on-campus students could now also review the lecture presentations any time they wished or needed just as the off-campus students would do with the video tapes. This is a feature well liked by the off-campus students.

The one class meeting each week served a variety of functions. Each class began with a five-minute quiz on the CD lecture material the students covered the previous week to insure they kept up with a prescribed schedule. Off-campus students were asked to take these short quizzes prior to viewing the video of that day's class meeting. These quizzes were graded and included in the final course grade. The class was also used as a common time for students to turn in homework assignments included at the end of the lecture material they had just completed. The remainder of the class was used to review highlights and answer questions about the previous week's lecture material, discuss and go over a typical solution to the assignment just turned in and cover any appropriate supplementary materials that would complement the just completed lecture material.

This class meeting format was employed for the first two thirds of the semester. One class in this period was also used for a mid term examination. After about 9 weeks all lecture material on the CD had been covered and the remainder of the semester was used for group projects for on-campus students and individual projects for off-campus students. The purpose of the project was to provide the students with an opportunity to apply all that they had learned to the redesign of some existing commercial product to improve its ease of assembly. Off-campus students were encouraged to select project topics that were related to products their employers produced. During the project period the weekly meetings were used to discuss project activity progress and cover additional related course material not included on the CD. The last weekly meeting was used for formal presentations by on-campus student groups of the results of their project work for the benefit of the other students.

It should also be noted that all materials developed and used in the class meetings not included on the CD were placed on the NCSU VBEE web site for access by the students. This included items like the instructions for installing and playing the CD, the activity schedule calendar, home work solutions, the weekly quizzes, supplementary course material and the project requirements.

### **Course Assessment Process**

To evaluate the effectiveness of this experimental course delivery system an assessment survey instrument was created for both pre and post course evaluation. The survey consisted of a series of statements dealing with a variety of issues associated with the course and its conduct. Students were asked to respond with a ranking from 5 to 1 depending on whether they strongly agreed, somewhat agreed, neither agreed nor disagreed, somewhat disagreed or strongly disagreed with the statement. The instrument used at the beginning of the course contained statement seeking opinions about anticipated outcomes. The instrument administered at the end of the course covered the same issues but addressed them in terms of actual outcomes. An example of these two approaches follows.

Pre course survey example:

Knowledge content on CD ROM with audio will be as effective a learning environment as class room lectures by the instructor.

Post course survey example

Knowledge content on CD ROM with audio was as effective a learning environment as class room lectures by the instructor.

The fifteen opinion statements included in the post-course survey instrument are presented in Table 1. The first thirteen of these statements were included in the pre-course survey document. Other information requested of the students included:

What you liked best.

What you liked least.

What changes should be made.

Twenty students completed the pre-course survey, 10 on-campus and 10 off-campus. Respondents to the post-course survey numbered 17, 10 on-campus and 7 off-campus. The responses of the off-campus and on-campus students were kept separate to permit comparison of these two groups.

### **Assessment Evaluation**

The tabulated responses to the pre and post-course opinion survey statements were compiled in terms of on-campus, off-campus and class averages. Although the responses did not result in any unexpected dramatic changes in opinions some interesting movements in the ranking values deserve noting and comment.

Table 1 – Post Course Survey

Opinions on Delivery Method : Circle one answer for each statement as follows – (5) strongly agree, (4) somewhat agree, (3) neither agree nor disagree, (2) somewhat disagree, (1) strongly disagree

1. Knowledge content on CD ROM with audio was as effective a learning environment as class room lectures by the instructor.	5	4	3	2	1
2. One class meeting each week was sufficient with lectures provided asynchronously on CD ROM.	5	4	3	2	1
3. Asynchronous delivery of course content did not significantly impact my normal study schedule.	5	4	3	2	1
4. One class meeting each week was sufficient during project portion of the course.	5	4	3	2	1
5. Asynchronous delivery and reduced class meetings did not create a problem in keeping up with the course schedule.	5	4	3	2	1
6. This course did require less time than similar courses delivered by conventional methods.	5	4	3	2	1
7. CD ROM with audio was more useful than a text book as a reference for the course knowledge content.	5	4	3	2	1
8. This course did require greater discipline and time management compared to standard offerings.	5	4	3	2	1
9. CD ROM method of delivery did provide a better learning environment than usual course offerings.	5	4	3	2	1
10. Computer hardware requirements for playing CD ROM were restrictive to enrollment.	5	4	3	2	1
11. This course was more educationally effective than a course delivered by standard methods.	5	4	3	2	1
12. A practical course project did significantly promote the understanding and application of the knowledge content.	5	4	3	2	1
13. Weekly quizzes and exercises did assist my remaining on planned semester schedule of activity.	5	4	3	2	1
14. Review of the course material on the CD ROM at the weekly class meetings was useful.	5	4	3	2	1
15. The interactive exercises at the end of each chapter were helpful.	5	4	3	2	1

The initial class average for Statement 1 (CD as effective as class lectures) was 3.76 with both the on and off campuses responses within 0.25 of a point. At the end of the course the on-campus ranking increased by 0.36 while the off-campus value increased by 0.54 for a final class average of 4.18. This would indicate that there was better than somewhat agreement that the CD lectures were as effective as the class lectures particularly on the part of the off-campus students.

There was general agreement both before and after the course that one weekly meeting (Statement 2) was about right with the knowledge content delivery system used.

Surprisingly, the off-campus students were somewhat more skeptical about the delivery method not impacting their study schedule (Statement 3) but both groups were more in agreement that this was not the case at the end of the course (class average: 4.18).

There was an obvious initial concern (Statement 4 – class ranking value: 2.82) as to whether one weekly class meeting during the project period would be sufficient. After completion of the course this value increased to 4.65 indicating that one meeting actually was just about right for this part of the course. The opinion of the off-campus students increased twice the amount of the on-campus students on this issue.

The class average for Statement 5 (delivery will not effect keeping up) received the highest final ranking of 4.70. This issue received the highest ranking of both groups.

Initially the class average for Statement 6 (course will require less time) received a ranking of 3.13 with the off-campus responses at just 2.56. At the end of the course the class average increased to 4.00 due to a 0.6 point increase for on-campus students and a 1.2 increase for off-campus students. Could this be a perceived increase in efficiency?

Somewhat disappointingly the class average on Statement 7 (CD more useful than text) dropped from 3.51 initially to 2.88 at the end of the course. It should be noted that this drop was the result of a 2.6 point decrease (with rankings ranging from 1 to 5) for the on-campus response compared to a 0.33 point increase for the off-campus students. The on-campus result was confirmed by several comments suggesting changes to permit finding specific material on the CD more easily. This may also be a consequence of not having a textbook for the course that has been such an important part of past course experiences.

Somewhat supportive of the results of Statement 6 the responses to Statement 8 (requires greater discipline) decreased from the initial survey to the end of course opinion (3.84 to 3.12).

The jury appears to be still out on whether this delivery system is more educationally effective. The initial class response was only 3.39 and only increased to 3.59 by the end of the course. Both groups responded in similar fashions to this issue.

There was general agreement that the project would promote understanding (Statement 12) and that the quizzes assisted in keeping on schedule (Statement 13) but the opinions on both of these issues dropped a little by the end of the course. Perhaps the regiment of the quizzes, which were quite easy, was considered somewhat an affront to the maturity of a graduate student. The slight drop in the project value may have been a consequence of the project basically being a compilation of the individual chapter homework assignments applied all together to a single product. This may have led to the feeling that not as much was learned from the project as anticipated. However, there was still general agreement as to its value.

Two positive anecdotal comments repeated by a number of students was that they liked the flexibility the CD ROM provided in covering the lecture material and the fact that the class only met once a week. The flexibility issue was a particular favorite of the off campus students. Suggestions for improvement included expanding the CD to cover more material and to provide greater depth on some of the subject areas covered.

## **Conclusions**

Although the assessment results were not dramatically conclusive there were other factors associated with the conduct of this course that together with the formal evaluation indicate the experiment was successful. The student's performance appeared to be measurably better than that of other similar groups of students the author has taught in previous offerings using classical classroom delivery techniques. This improved performance was observed in three areas.

The home work assignments at the end of each chapter were completed before any of the knowledge required was discussed in class or any instructions given as to how the assignment was to be carried out other than what was provided on the CD. Nevertheless, the submitted work was as good and in most instances better than that turned in by students taking this same course in the past. Performance on the midterm and final examinations resulted in higher class averages than experienced with previous students. Finally the content, quality and depth of the project reports were substantially better and more professionally prepared than previously experienced. Since there is no evidence that these students as a group were any more exceptional than those in past offerings of the course it seem reasonable to assume that this improved performance was a consequence of a more effective educational experience whether totally recognized by the students or not.

However, there remain many unanswered questions about both the academic and cost effectiveness of this delivery method that will require further investigation. From a cost perspective development of the CD takes a great deal of time and energy. However, there are production shortcuts that could reduce the actual cost of creating or modifying the final product. Part of this cost could be recovered by selling the CD much like a text book. It certainly has text book value to the student who can keep it in his library like other resources. Use of the CD and reducing class meetings certainly reduced significantly the overhead burden of video tape production and distribution as currently practiced in the VBEE program. Once the class meetings have been recorded their content can be placed on CD for subsequent use completely eliminating the need for video tapes for another offering of the course. This has in fact been done for a special summer offering of the course.

Academically it would appear that the improved performance of the students in this experimental offering and their general acceptance and successful use of the CD as a replacement for classical class room lectures are sufficient incentives to continue to experiment with the delivery technique. There are those that would raise concerns about what will become of the classic class room teacher if their lecture are "canned". Might they not become obsolete? Unfortunately, these individuals are not looking ahead to the potential advantages of the burgeoning advances in communication technology that can and will lead to more effective educational processes. These opportunities and advancements will permit instructors to become the developers of information and knowledge content and serve as coaches and mentors to students rather than class room lecturers.