

Chemical Engineering Fundamentals -- Better Learning Through Computer-Based Delivery

**B.L. Crynes, Y-K Lai and W.S. Chung
School of Chemical Engineering
University of Oklahoma
Norman, Oklahoma 73019
crynes@ou.edu**

I. Introduction

Use of information technology unquestionably, when done properly, leads to better learning. The evidence is building to a compelling level (1). Unfortunately, there are still too many “experimental” projects that poorly match learner needs, subject, and technology, resulting in questionable returns in learning/teaching for the time and dollar investment. Then, too, much of the evidence is only anecdotal, lacking statistical data.

The purpose of our project, which began a year and a half ago, is three fold:

- develop a different way for our chemical engineering students to learn fundamentals
- design an instrument and process to obtain statistical evidence
- find a better use of faculty time and effort compared to traditional lecturing methods

The changes of this Chemical Engineering Fundamentals course are only a small part of the major changes in our Engineering College that includes:

- all new students owning laptop computers (Fall '98)
- use of a wireless network for connectivity
- conversion of engineering core courses for laptop instruction
- formalized training for faculty on use of new information technologies in the classroom
- integration of the use of information technology in the schools

II. Our Process

Our initiative was seeded several years ago when our School of Chemical Engineering Advisory Board challenged us to consider technologies for better use of faculty time. To them it was a matter of faculty time and efficiency. Over four years ago, our college-wide initiatives were developing. This encouragement from our external board and from a college-wide program led naturally to addressing what we should do with the first full or “pure” chemical engineering course. At the University of Oklahoma we call this course ChE 2033, Fundamentals of Chemical Engineering. It has been completely traditional in text, delivery format, and results year upon year. Except for a few changes like team projects for collaborative learning, this course was just about like the one I took almost 40 years ago and had taught for many years. To be fair, we know that basic laws, concepts, and principles -- fundamentals, don't change; however, the context in which they are presented should and the format of delivery must.

Sabbatical time was set aside to design the content, approach, and philosophy of the course.

1. It would be CDROM-WEB based.
2. It should be delivered either synchronously or asynchronously.
3. Students may progress as rapidly through the course as they are able but take no longer than the traditional semester interval.
4. Students have a required once-a-week group meeting, with the professor.
5. The CDROM-WEB modules must accommodate various learning styles.
6. Mastery of each module concept must be demonstrated before advancing to the next module.
7. The final examination for the course must be taken in front of the professor when the student has passed all module mastery tests, electronically.
8. Traditional multimedia “rules” were to be addressed -- good user interface, ease of navigation, minimal distractions, content is king.
9. During first few offerings, a test section and a traditional section would be used to obtain controlled statistics.
10. The content would be consistent with and merge with the two or three commonly used textbooks.

The project team consisted of the following persons:

- three students, graduates and undergraduates, who were the CDROM-WEB page designers/developers,
- one undergraduate student whose purpose was to develop new problems and check calculations,
- Professor Gramoll, consultant on engineering multimedia CDROM and WEB page,
- Professor Connie Dillon, College of Education, pedagogy expert and design of assessment instrument,
- Myself, subject matter expert and module script writer.

The student designers had extensive training and experience, and had developed sophisticated WEB pages already. These students worked 10 to 20 hours per week, paid on an hourly basis. Professor Gramoll was the overall consultant and reviewer. He is recognized as among the top engineering professors in engineering educational multimedia design and has been recognized by several awards:

- 1998 Oklahoma Academy Excellence Award for expanding the use of technology in Oklahoma.
- Premier Courseware Award, "Mars Navigator CD-ROM," John Wiley Publishing and "Synthesis" NSF Coalition, November 1997.
- Georgia Institute of Technology Ector Teaching Award for 1996.
- Invision Bronze Award for Best Multimedia Program, "Multimedia Engineering Dynamics," Higher Education Division, presented by New Media Corporation, June 1996.
- John A. Curtis Lecture Award for Best Paper at ASEE Annual Conference, Computers in Education Division, June 1996.

My job was that of scriptwriter, story-boarder and general project manager. I was fortunate to have huge blocks of time during my sabbatical to focus on this project. One rather surprising time demand was that of problem preparation. Not requiring a text and offering our material over the WEB (with thoughts to offer beyond our campus) meant that all copy write regulations had to be strictly addressed (of course, they should always be, anyway). Translated -- all example problems, practice problems, and assigned problems had to be new; hence, the need for a student working 10 to 20 hours a week to help develop and test new problems.

The course modules have been tested and demonstrated before several student groups and critically reviewed by the consultant. Recommended changes have been incorporated in rewrites. The full test will begin in the Fall 1999 semester when 40 students will use the new electronic format and I will teach a VERY traditional group of 40 students. I will be the “teacher” or coordinator of the electronic section, as well.

Professor Connie Dillon, of our College of Education, has assisted us with issues of pedagogy, and she has developed the assessment instrument by which we will gather statistical data comparing the two formats.

III. The Product

The product course is developed in such a way as to combine the assets of both the CDROM and the WEB. We wanted CDROM material that is basic, fundamental, and little changing. We have tried to present this in a context that will not date itself -- like photos of people or use of slang or jargon unique to period or fad (like the now popular “sag” look). The CDROM is prepared so that students can still learn the basic, little changing fundamentals without having to connect to the Internet.

With our laptop computer program, the students are able to learn anywhere or anytime. The WEB provides links to many supporting, expanding sites, an electronic bulletin board, course WEB page, module mastery submission, problem submission, course management tools, and e-mail communications.

The course has been developed using Microsoft FrontPage 98, Flash and Macromedia’s Director.

The module demonstration shows the structure format:

- Each principle or concept is introduced with minimal word texts.
- Links and side notes are available for those students who wish to go deeper into the topic.
- Small animations and pictures are used to focus attention and amplify a point.
- Full animations are included to give the student a feel for or understanding of a physical phenomena and its abstract representation with symbols. For example, physical behavior changes for water are shown as temperature, pressure, and volume changes. This then leads to its phase diagram, which is more abstract. Names like “dew point,” “bubble point,” and “triple point” are shown in a physical context.
- Critical items are highlighted with a flashing “remember logo” (Figure 1) or with the cartoon characters, Bill or Maria. These are notes or items significant for successfully mastering the course (Figure 2).
- Clear example problems are worked step-by-step.

- Practice problems are provided with answers given on the third try.
- Assigned problems are provided, but without answers.
- Each module concludes with a statement of what should have been learned
- A course map is always available showing where each module fits in the overall course structure and on which module the student is presently working.
- The left menu bar (Figure 2) contains a tool box with:
 - units conversion software
 - R (gas constant) calculator
 - atomic weights
 - calculator pad
 - selected physical properties data.
- The left menu bar also contains course management tools like:
 - bulletin board
 - e-mail
 - submission (of answers)
 - students grades/performance data.
- Of course, the first WEB page introduces the course and has all the usual syllabus details.
- Audio and video are often merged to amplify important points.

By nature of the subject, the modules and their content are mostly linear. However, students may move in a nonlinear manner if they are capable. The mastery tests are strictly linear, the concepts in Chemical Engineering Fundamentals courses build steadily upon each preceding segment.

IV. Conclusion

The mix of video, voice, text, animation, and interactivity accommodates variable learner styles, lacking only the opportunity for students to pick up, inspect, and manipulate a real object. Research suggests that computer-based learning is more effective in skill level subjects like industry training or basic concepts as in a fundamentals class (2). The combined CDROM and WEB format provides for mobility yet can always be current in both subject and context. The WEB has been useful for overall course management such as with records, submissions, and communications.

We must await the Fall, 1999 offering of our course to know detailed results of our efforts. Undoubtedly, experience in full delivery will reveal much more than our prototype testing done to date. However, our experience in the College of Engineering in developing and delivery of other courses in somewhat similar formats and our tests thus far convince us that the benefits will justify the effort and cost. During the fall semester we do expect to find a number of problems to fix and many ways to improve the course.

We wish to free those students who are capable and able from the painful, traditional, lecture-laboratory-faculty format. Students, who are able, should be free to complete the class in less than the scheduled semester. Faculty should turn from lecturing their expertise to helping students understand by doing and using concepts. Those who need more teacher contact should have it. Learning Chemical Engineering Fundamentals should not necessarily be easy nor always fun; but it does not have to be boring, uninspiring, and unmotivating toward our profession.

Bibliography

1. Crynes, B.L. (with Kadiyala, M.), "Where's The Proof? A Review of Literature On Effectiveness Of Information Technology In Education," Frontiers In Education Conference, FIE '98, Tempe, AZ, November 4-7, 1998.
2. "A Review of Literature Investigating the Effectiveness of Computers and Technology In Education," M. Kadiyala and B.L. Crynes, submitted for publication, *J. Engineering Education*, November 1998.

B.L. CRYNES

B.L. Crynes, Dean, College of Engineering for 11 years and currently Professor, School of Chemical Engineering and Materials Science, at the University of Oklahoma. Dr. Crynes is a registered Professional Chemical Engineer. For 20 years he served in engineering education as associate and full professor and director of the School of Chemical Engineering at Oklahoma State University. Dr. Crynes areas of expertise include kinetics, catalysis, pyrolysis, and reaction engineering. In the last five years he has emphasized computer and other forms of information technology applied to engineering education. He moved the College of Engineering at the University of Oklahoma into a position to require student computer ownership beginning in the Fall of 1998 in order to better enhance their education and to greatly change the course material delivery format in that college.

WEI SHUNG CHUNG

Wei Shung Chung is a senior in the School of Chemical Engineering and Materials Science at the University of Oklahoma. Mr. Chung is from Malaysia and has worked on developing WEB pages and multimedia modules for one year. He expects to graduate August 1999.

YIN KEI LAI

Yin Kei Lai is a junior in the School of Chemical Engineering and Materials Science at the University of Oklahoma. Ms. Lai is from Malaysia and expects to graduate August 2000. Ms. Lai has worked on developing WEB pages and multimedia modules for one year.

ChE 2033
Fundamentals of Chemical Engineering
Dr. Billy L. Crynes

Room : T 217 SEC Phone : (405) 325-3700
e-mail : crynes@ou.edu Fax : (405) 325-5813



tools
submit
e-mail
grade

MODULE 2 UNITS - DEVELOPING A LANGUAGE

Solution :

$$n \text{ (lbmol)} = \frac{PV}{RT}$$

$$= \frac{1}{R} \left(\frac{82 \text{ lb}}{\text{in}^2} \right) \frac{(237 \text{ gal})}{(167 + 460)^\circ\text{R}}$$



Ideal gas law must always use absolute temperature. Add 460 to °F or 273 to °C to get °R or °K

We need value of R (universal gas constant). Many values can be found. Sometimes, in the units we read. In the [R link](#) , you'll find a table to get nearly any combinations of units. From this table,

$$R = 10.73 \frac{\text{lb}}{\text{in}^2} \text{ft}^3 \frac{1}{\text{lbmole}^\circ\text{R}}$$

replay



1 2 3 4 5



FIGURE 1

ChE 2033
Fundamentals of Chemical Engineering
Dr. Billy L. Crynes

Room : T 217 SEC Phone : (405) 325-3700
 e-mail : crynes@ou.edu Fax : (405) 325-5813

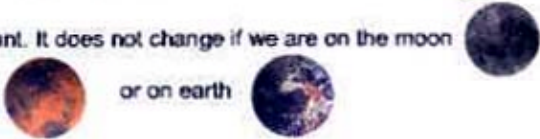


tools
 submit
 e-mail
 grade

MODULE 2 UNITS - SYSTEM OF UNITS



g_c is a constant. It does not change if we are on the moon
 or on Mars or on earth



$$a = 32.2 \frac{\text{ft}}{\text{s}^2} \quad = \text{standard acceleration}$$

$$g_c = \frac{32.2 \text{ ft} \cdot \text{lb}_m}{\text{s}^2 \cdot \text{lb}_f} \quad = \text{a fudge factor}$$

replay



1 2 3 4 5

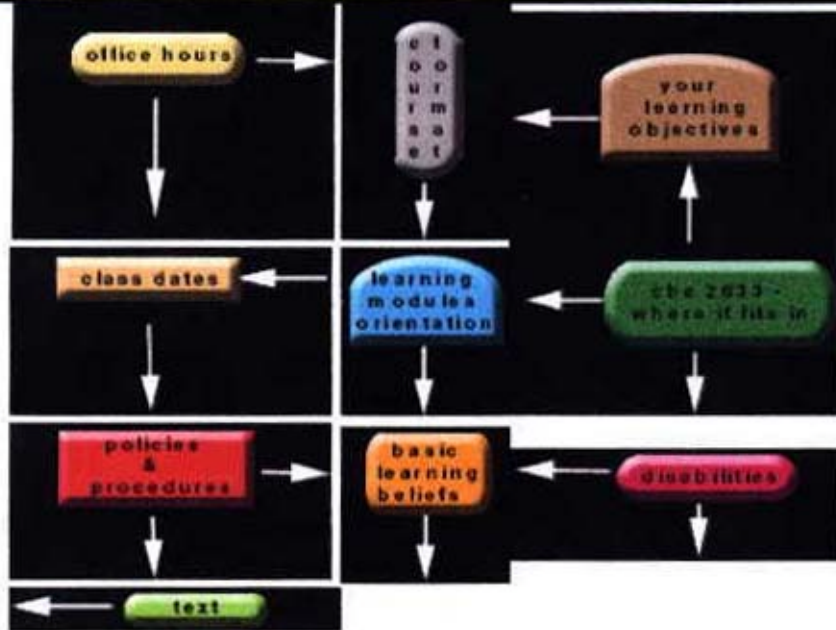


FIGURE 2

ChE 2033

● Fundamentals of Chemical Engineering ●

Room: T 217 SEC
e-mail: crynes@ou.edu
Dr. Billy L. Crynes
Phone: (405) 325-3700
Fax: (405) 325-5813



The presentation at ASEE will demonstrate the module and not focus so much on the paper itself.