

Novel Use of the World Wide Web for Undergraduate Process Control Instruction

Francis J. Doyle III
Dept. of Chemical Engineering, University of Delaware

Abstract

It is becoming common practice to use the World Wide Web (WWW) as a vehicle to communicate valuable course-related information to the student (see, *e.g.*, [1]). In this paper, the author describes first-hand experience with the Serf (Server-side educational records facilitator) package, an environment which exploits a Web interface to access a collection of databases. The particular classroom application explored is a senior level required course: CHEG 401 Chemical Process Dynamics and Control.

1. Background

In earlier offerings of an undergraduate process control course, this author relied on traditional Web-based pages for general course information (*e.g.*, syllabus, office hours, solutions, bulletin board). Such an interface, while more effective than hard copy handouts in many respects, is still limited in terms of overall course management. In other words, it is still a very passive environment, where the students download information. Two key issues arose in recent offerings of this course that motivated a more effective medium for course management. The first was the enrollment of off-campus professionals in the course (from local industry), and second was the need to automate the management of the gradebook and roster. The presence of off-campus students suggested a distance learning-like tool was needed, and while Excel and other spreadsheet packages are available for easy management of course grades, this author was looking for a seamless interface to the Web that allowed easy access for both the grader and the student. One solution, described in this paper, is the use of a relational database package (specifically Serf) to manage the course. It addresses the two previously mentioned concerns, and offers many additional capabilities that are particularly relevant for distance learning.

The Serf package was originally developed by Fred Hofstetter at the University of Delaware for Web-based distance education [2,3]. More details about the origins of this package can be found from the Serf Web page [4]. A notable endorsement of this package is the fact that the Public Broadcasting Service (PBS) will use Serf as the vehicle for its first offering of a world-wide Web-based course (Internet Literacy) in 1998 [2]. In effect, Serf is a Java-based environment where one can manage a relational database (written in SQL). According to the Serf Users Manual [5], some typical software and machine requirements are: (i) SQL server, (ii) 32-bit Java Virtual Machine, (iii) ~100 MB RAM for optimal performance, and (iv) 250 MB disk space (recommended). The applications at the University of Delaware have been with the Windows NT operating system.

2. CHEG 401 Course Management Using Serf

In this section, several features of the Serf package are briefly described which have been successfully utilized in CHEG 401. The emphasis in this summary will be on developmental issues from the instructor's perspective. It is important to note that there are many "perspectives" on using Serf (administrator, instructor, teaching assistant (TA), and student). Administrator access is restricted to the administrator responsible for running the Serf server. The instructor and TA interfaces are essentially identical, with the exception that the TA cannot modify the syllabus. Finally, the key customer is the student.

Student Interface

A good starting point for this exposition is the interface that the students encounter upon logging into the Serf account for CHEG 401 (Figure 1). Note the large course banner at the top of the screen, which can be customized with any standard graphics package (in this case, using a .gif file generated from Powerpoint). In addition, there are several icons above the banner which



Figure 1: Student View of CHEG 401 Course Syllabus Using Serf

provide links to various course and Serf resources (from left-to-right: generic e-mail template, CHEG 401 bulletin board, CHEG 401 Course Policy page, CHEG 401 MATLAB documentation page, initial Serf login, and Serf logout). The various buttons and links are incorporated into the Course page via a convenient and user-friendly table of stylized options.

Syllabus

Also evident in Figure 1 is the first entry for the CHEG 401 course syllabus. The data in each of the boxed entries are accessed through an editor that allows insert, edit, move or delete functions. Each of syllabus events is categorized (*e.g.*, class item, class title, generic item, assignment, etc.) and consists of a text entry. There is no prerequisite knowledge of HTML programming, however, one can exploit such knowledge when available for customized formatting such as the hot links for the instructor's e-mail in Figure 1.

A typical syllabus event for a class meeting may look like Figure 2. Key elements which are present include the date, a title for that class meeting (Process Modeling), a reading assignment for that class meeting, and announcement that a quiz will take place that day (including the weight fraction assigned to the quiz). The observational assignment (quiz) indicates that the

The screenshot shows a web browser window with the following content:

Chemical Process Dynamics and Control

Current Class

Process Modeling Class 5: Tue 24 Feb 1999

Reading: Chapter 4 in Oguztorkk & Kay

In-class quiz: covering material up through Chapter 3

Quiz #1

- This is an observational assignment, meaning that the instructor will assign a grade based on an observation of your performance on the task assigned.
- This item counts 5 points (20%) toward your grade in the course.

Navigation buttons: [loc link](#) [all loc](#)

You are working on the course CHEG-401-800-838: Chemical Process Dynamics and Control.

Syllabus	Assignments	Calendar	E-Mail	System
Current Class	Insert	Daily	Instructor	Login
Brief Index	Submit	Weekly	Assistant	Logout
Detailed Index	Grades	Monthly	Classmate	Personal
Dynamic		Add Event	Register	C/D-ECM/Setup
Search		Delete Event		Search Courses
View Calendar		Change Event		Discussion Forums

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Logos for UNIVERSITY OF DELAWARE, Serf, and a globe icon are visible at the bottom.

Figure 2: Typical Class Entry in Syllabus

instructor will assign a grade based on the performance. Other assignment categories include Web portfolio assignments (*e.g.*, Word document for report) and Web query assignments (*e.g.*, Web-page quiz).

Calendar

An excellent feature of the Serf syllabus management is the ability to connect a list of syllabus events with a course calendar. In this manner, the instructor can design the syllabus independent of the specific calendar schedule, facilitating easy updating of the course syllabus from semester-to-semester or year-to-year. A related feature of the Serf package is the personal calendar which each user (Students, TA, and Instructor) can individually maintain in their account.

Additional features

One can see at the bottom of Figure 2 the range of options available to the student as they "surf" through Serf. The first column indicates functions associated with the syllabus. The second column gives them an interface to the course assignments, including a summary of all assignments, a running tally of their current grades, and the chance to submit an assignment electronically (not employed in CHEG 401, but of critical importance in a distance learning application). The next column indicates the personal calendar feature mentioned before, and the fourth column offers several convenient options for e-mail communication. Finally, the last column allows them to log in and out, change a password, access a CD-ROM, jump to another Serf course, or enter a discussion forum. The latter feature, while very convenient in Serf, was bypassed in favor of the bulletin board described later.

Instructor Interface

Having enumerated the options available to the student, it is useful to contrast that with the interface that the instructor encounters (Figure 3). The latter two columns are identical in function to the options in the student interface. The first column contains the resources to construct and edit a syllabus, as well as the function to connect the syllabus to the course calendar. In the second column, the instructor is able to generate a Student interface to evaluate that perspective on the syllabus structure. Finally, some rather valuable administrative features are contained in the middle column of the Instructor menu. The gradebook, roster, and export options allow the instructor to manage most of the essential administrative duties electronically. One can import a student roster from certain formats, export course grades in various formats, modify the roster, and manage the grading for the course. The import/export options are usually set by the system administrator, but can be adjusted to accommodate a variety of database file formats. Two grading options are presently available (letter or percent), and once the instructor has entered the grades, the student is able to call up a window to inspect their individual grades. This alleviates many of the issues of proprietary handling of student identities and public posting of grades. Furthermore, it affords the student an option to inspect their assignment/exam grades from the privacy of their dorm room if they so chose (see Figure 4). Using the stylized options, an instructor can program a grading "curve" so that numerical values are automatically converted to letter grades. In addition, the export features support a backup mechanism for the database.

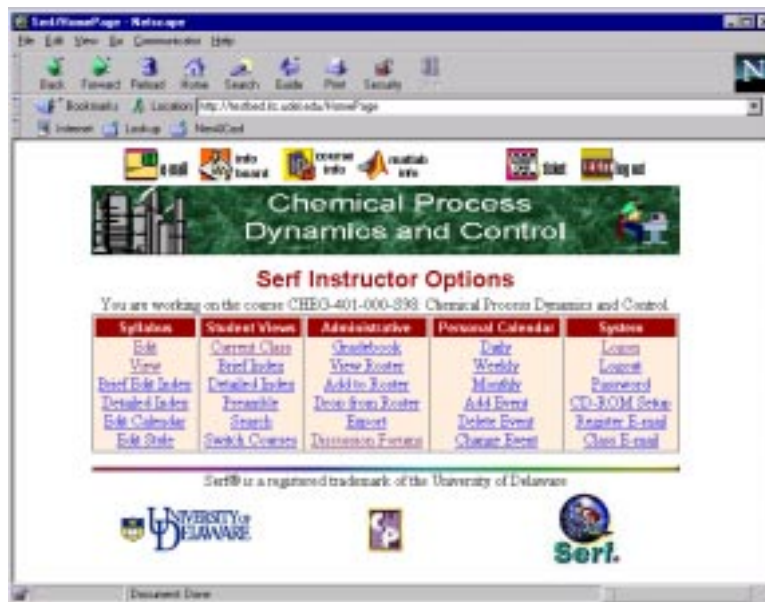


Figure 4: Instructor Menu Options



Figure 5: Student Access to Personal Grades

Teaching Assistant

The functionality of the TA interface to Serf is not very different from the instructor's interface. Notable differences include the fact that the TA cannot edit the syllabus for the course, they cannot delete students from the roster, and they cannot access a student's view of the syllabus.

Additional features

Other features that one can incorporate into a Web-based education environment (such as Serf), that were not utilized in CHEG 401 include:

- chatroom options (such as ParaChat network)
- links to listserv and newsgroups
- multimedia CD-ROM

Summary

In summary, this instructor (although somewhat versant in HTML) found the Serf utility to be tremendously user-friendly for the instructor, and generated a document of high professional quality. The complete CHEG 401 Web page consists of 12 HTML files, and 150 syllabus elements in the Serf database. It took approximately 3 long afternoons of coding, with the rate limiting step being the actual typing of syllabus entries. Of utmost importance in an application of this nature is security, in particular for dealing with course grades. The gradebook feature of Serf addresses this issue directly, as students can only view their own grades. Other security-related features include a time-out on the login (commonly encountered as users move their browser to another URL without logging out of Serf), and a warning to indicate when multiple logins to the same account have been attempted.

3. Additional Components of CHEG 401 Web page

The motivating vehicle for this paper is the author's direct experience with undergraduate instruction in CHEG 401. In addition to the Serf package, a traditional Web page was maintained for this course [6], the elements of which are briefly reviewed here.

Bulletin Board

The bulletin board, shown in Figure 6, served several roles: (i) it allowed general questions to be posed by students (such as MATLAB printing), and the answers to be broadcast in a convenient forum by the TA or instructor, (ii) it enabled the instructor or TA to post current announcements for the class (*e.g.*, homework hints, changes in assignments, etc.), and (iii) it allowed the students in the class to vent their frustrations or share social communications with the entire class (including the TA and the instructor).



Figure 6: CHEG 401 Course Bulletin Board

Connection with Serf

The central Web page for the course allowed two points of interface with the Serf package. First, a "mirror" of the course syllabus was maintained to enable convenient access to the assignment schedule (bypassing the Serf login) and also to provide back-up access in case the Serf server machine was off-line. Second, the main course page provided a link to the login page for the Serf package.

Interface to MATLAB Help for Lab Component

A central component of this particular course is the use of MATLAB & Simulink for process simulation and control design. The package PCM (Process Control Modules) [7], developed by the author, has been used as both a required laboratory component of the course (at Purdue University), and as a take-home exercise (at the University of Delaware). In addition, many of the homework exercises require the use of MATLAB and/or Simulink. Consequently, the course

Web page contains a variety of links to useful MATLAB and Simulink documentation in a variety of formats (.ps, .html, .pdf).

Course Policy

Another important component of the CHEG 401 Web page was a detailed course policy. It is strongly recommended to lay out as many details as possible, up front and in a public forum such as the Web page, so that future "issues" can be easily resolved. Useful issues to address include exam/homework regrading policy, examination format, "cheating" policy, independent lab policy, etc. In the experience of this instructor, students are generally appreciative of the fact that many of these potentially touchy issues are addressed directly. More importantly, the new ABET Criteria 2000 guidelines stress the importance of defining objectives early in the course, in collaboration with the constituents, and the assessment of whether these goals were achieved at the end of the course. Posting the objectives on the Web invites the students into this process at a minimal level, future offerings of the course will allow student feedback on the objectives page.

4. Student Response

At the time of this writing, our pilot offering of the CHEG 401 Serf page was only half completed. However, a number of very useful comments have been generated by the students. The bulletin board and discussion forum utilities have been used with moderate frequency, suggesting that they are convenient to use, and they are valuable for communication of announcements. The personal grade access has been uniformly praised by students for the ease of access, 24 hours a day. Positive feedback on the syllabus and course assignment reflect the fact that the students are not merely printing the entire syllabus to hard copy in week 1, but are using the Web as it was meant to be: as a dynamic and interactive medium.

5. Summary

In this paper, one instructor has related his first-hand experiences with the setup of Web-based tool for education, using an existing package (Serf). With a minimal amount of prior knowledge, one can easily construct an environment that is rich in information content for the students to use to complement the classroom instruction. An educational package, such as Serf, takes the programming issues out of the instructors hands, and allows them to concentrate on content. Furthermore, as demonstrated in this paper, one can combine standard Web pages with such database packages to completely customize the environment.

6. Acknowledgments

The author gratefully acknowledgements the support of George Mulford and Fred Hofstetter in the Instructional Technology Center at the University of Delaware for help with the the Serf package.

7. How to learn more about Serf

Additional information about the Serf package, including details on obtaining a demo login, and details on purchasing a copy, can be obtained from the Serf Web page [4].

8. References

[1] Frymier, P., "Tutorial: What You Can Do with the World Wide Web Today - Locating and Using Teaching and Research Resources on the Web", *ASEE Summer School for Chem. Eng. Faculty*, Snowbird, August 1998.

[2] Internet Literacy, The First PBS TeleWEBCourse. PBS Agenda (Fall/Winter 1997-98), 12-13.

[3] Serf's Up! Teaching and Learning with Serf: Your Servant on the Internet. AACRAO Proceedings (in press).

[4] <http://www.udel.edu/serf>

[5] Hofstetter, F.T., **Serf User Guide Version 1.0**, University of Delaware, 1997

[6] <http://fourier.che.udel.edu/~cheg401>

[7] Doyle, F.J., Venkatasubramanian, V., and Kendi, T.A., "Process Control Modules: A Flexible Set of Software Modules for an Undergraduate Process Dynamics and Control Laboratory", *Comp. Appl. Eng. Educ.*, **4**(3), 179-190, 1996.

8. Biographical Information

Dr. FRANCIS J. DOYLE III is an associate professor in the Dept. of Chemical Engineering at the University of Delaware. He received his B.S.E. from Princeton (1985), C.P.G.S. from Cambridge (1986), and Ph.D. from Caltech (1991), all in Chemical Engineering. His research interests are in nonlinear process and biosystems control. He is the recipient of several research awards (NSF NYI, ONR Young Investigator) as well as teaching awards (ASEE Section Outstanding Teacher Award, Tau Beta Pi Teaching Award).