2006-816: ELECTRONIC PORTFOLIOS FOR ENGINEERS

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Electronic Portfolios for Engineers

What is a portfolio? The Oxford English Dictionary [1] defines a portfolio as "a) A receptacle or case for keeping loose sheets of paper, prints, drawings, maps, music, or the like; usually in the form of a large book-cover, and sometimes having sheets of paper fixed in it, between which specimens are placed or b) the collection of securities held by an investing institution or individual." Most people with a 401k or other retirement account are familiar with financial portfolios that summarize their investments. Portfolios are typically associated with artists and photographers who use them to showcase their work in order to generate business. English students may maintain an educational portfolio of their writings for their classes.

Educational portfolios are useful tools for learning. They may be used for both summative and formative activities within the classroom. Instructors may require students to collect their work over the semester and turn it in at the end for a grade. With formative portfolios, students include reflective statements with their portfolio artifacts. This process of self-evaluation leads to a higher quality of education[2]. The ultimate goal of the educational portfolio is to provide a record of the student's educational history that emphasizes the learning outcomes of the student above and beyond the actual diploma while giving the student a greater sense of accomplishment.

Traditionally, these portfolios have been paper-based with artifacts stored in folders, binders or other suitable container. With the wide spread use of computers and other technology, the evolution of portfolios from an all-paper to an all-digital format seems natural. Electronic portfolios are still in the early stages of development but many advances have been made in the last five years. This has led to a consortium of academic institutions and private educational software developers to further develop standards as well as design and test software systems[3].

Longtime advocate, Harriet Barrett defines electronic portfolios as "an organized collection of digital and/or analog artifacts and reflective statements that demonstrate growth over time[4]." The American Association of Higher Education takes this a step further by emphasizing purpose stating that the electronic portfolio is for collection, reflection and assessment[5]. With the technological tools that are available, electronic portfolios have the capability of moving well beyond traditional paper-based ones.

The University of Minnesota has made great strides in developing software for electronic portfolios. Recognizing the potential of such applications and the high demand, the University has donated the code to the open source market[6]. The application conforms to the JSEE 1.3 standard for web applications which allows access regardless of computer platform. The software can also be integrated with existing administrative systems like PeopleSoft which would allow certain educational artifacts, such as transcripts, to be automatically added.

The electronic portfolio (Portfolio) envisioned by the University of Minnesota is more than just a digital equivalent of the paper version. The system was designed so that students would have lifelong ownership of their portfolio. To assist in this process, all students within the University of Minnesota system are given a Portfolio when they begin their college career. 25

Mb of memory is allocated for storage with potential for expanding to 100 Mb. After graduation, students can continue to access their Portfolio indefinitely. Costs for this system are derived from existing technology and computer fees. Besides students, the University of Minnesota also supports Portfolios for all faculty and staff for their own professional development.

Students are able to store and selectively share information with anyone at any time. The capability defines the owner's "virtual identity." The level of detail provided by Portfolio helps to define the personality and accomplishments of the student in ways not possible with popular biographical and network online systems such as Facebook.com and Myspace.com. Students are entitled to easy, full, and direct access to their personal records and have control over their distribution and use. Portfolio demands more active input from the student compared to other database systems, such as health records, where information is gathered passively.

To ensure the proper and continued use of the Portfolio system, students must be introduced to it early in their academic career. Curriculum should be adjusted to accommodate the training of the student. A one hour lecture is adequate time to teach the student how to responsibly record and manage personal information in their Portfolio. In our department, students receive training as part of their first year introduction to chemical engineering course. During this time, the students learn the basics of Portfolio data entry and sharing. The main activity is to upload their resume.

To ultimately succeed, Portfolio needs the support of the administration, from the individual faculty to the Deans and the University President or Chancellor. Within our department, the faculty and Chair have eagerly decided to adopt the use of Portfolio within our curriculum. The Dean supports our endeavor and views it as a pilot with potential use in the other engineering departments. Our Chancellor has also allocated funds to help support department utilization of the Portfolio system.

The features of the University of Minnesota Portfolio system can be broken down into three basic areas: entering information, storage, and sharing information

Entering Information

Artifacts that are entered into the University of Minnesota Portfolio system are called elements. Elements are the smallest bit of information that cannot be divided into subcategories. There are currently 81 defined elements in the system. These elements may be entered into Portfolio automatically or by the user. Table 1 lists several examples.

Because the Portfolio system can be integrated with administrative systems, certain information can be added automatically to the student's Portfolio. Examples include personal information on record such as name and address as well as educational records like transcripts. The interaction between the systems is dynamic so that as the administrative records are updated, Portfolio is automatically updated.

Table 1: Organization of Portfolio

Categories	Subcategories (partial list)	Elements (Partial list)
Personal Information	Identification Data	Name of Record
		University ID Photo
	Contact Information	Home Address
		Work Phone Number
	Personal Interests	Fishing
	Mentors	Thesis Advisor
	Personality Inventory	Myers-Briggs
Education	Academic Record	Unofficial Transcript
		Registration Record
	Professional Development	University Training Record
	Learning Inventories	Kolb Learning Style Inventory
	Academic Plan	Fall semester courses
Career	Career Interest Inventory	Strong Interest Inventory
	Work History	Current employment
	References	Thesis Advisor
	Career Documentation	Resume
Skills	Communication Skills	Oral presentations
	Language	Spanish Literacy
	Leaderships Skills	Organization Officer
Professional Practices	Professional Memberships	ASEE
	Publications	Recent Journal Article
	Presentations	ASEE Conference
	Teaching	Courses
Recognition	Academic Honors	Dean's List
	Awards	Teacher of the year award
	Grants	NSF grant

The remaining elements require input from the user. Certain elements are tailored to provide a standard format for all individuals. For example, the education history elements provide sections for the user to enter specific data such as institution name, dates attended, and degree obtained. Another example is the work history element which provides space for place of employment, position, name of supervisor, address, dates of employment, job description and accomplishments. Students can tailor these elements to their own particular educational and professional experiences. Faculty may also use certain elements, such as awards, grants, and publications, to describe their own achievements. Faculty members can use the elements in Portfolio for developing their own tenure package.

The categories also contain specific elements but give flexibility for the types of information that may be entered. For example, educational documentation is an element used for entering artifacts such as class project reports, presentations, etc. For these elements, the user can upload files or provide URL links to other locations. These elements provide space for a title and general description of what is contained within the element.

To assist users in developing their Portfolio, tips are provided on each element page to help in entering information. Tips include the types of information to enter into the element and the formats of files to upload. Files can be in any digital format; but, the user must make sure that others viewing Portfolio will be able to download and look at them. Common formats include Microsoft Office files and PDF files for documents, JPEG for images, and QuickTime or MPEG for digital audio and video.

For all elements, space is allocated for comments. This is the means by which the user can reflect on their Portfolio artifacts. This reflection may be for the user's personal use or can be share with others to demonstrate their self-assessment. The self-assessment process is always a work in progress.

Storing information

The overall structure of the elements used within Portfolio following a tree format with elements divided into categories and subcategories (Figure 1; Table 1). The categories are similar to general sections one would find in a resume or curricula vitae. Personal information contains identifying data but may also include elements that fit the student's unique personality (interests, personality inventory, etc). The education category includes the academic record of the student. In this section, students can also plan their course schedule and upload documents from courses that represent their accomplishments. In the career category, students maintain their work history as well as their career plans and areas of expertise. The skill category includes elements for describing abilities ranging from computer literacy and communication to foreign languages and leadership. Professional practices may include activities outside of the regular work and school environment that relate to professional development. Examples include committee work, conference presentations, courses taught, and organizational membership. Finally, the recognition section includes space for documenting awards, grants, scholarships and other honors that have been earned.

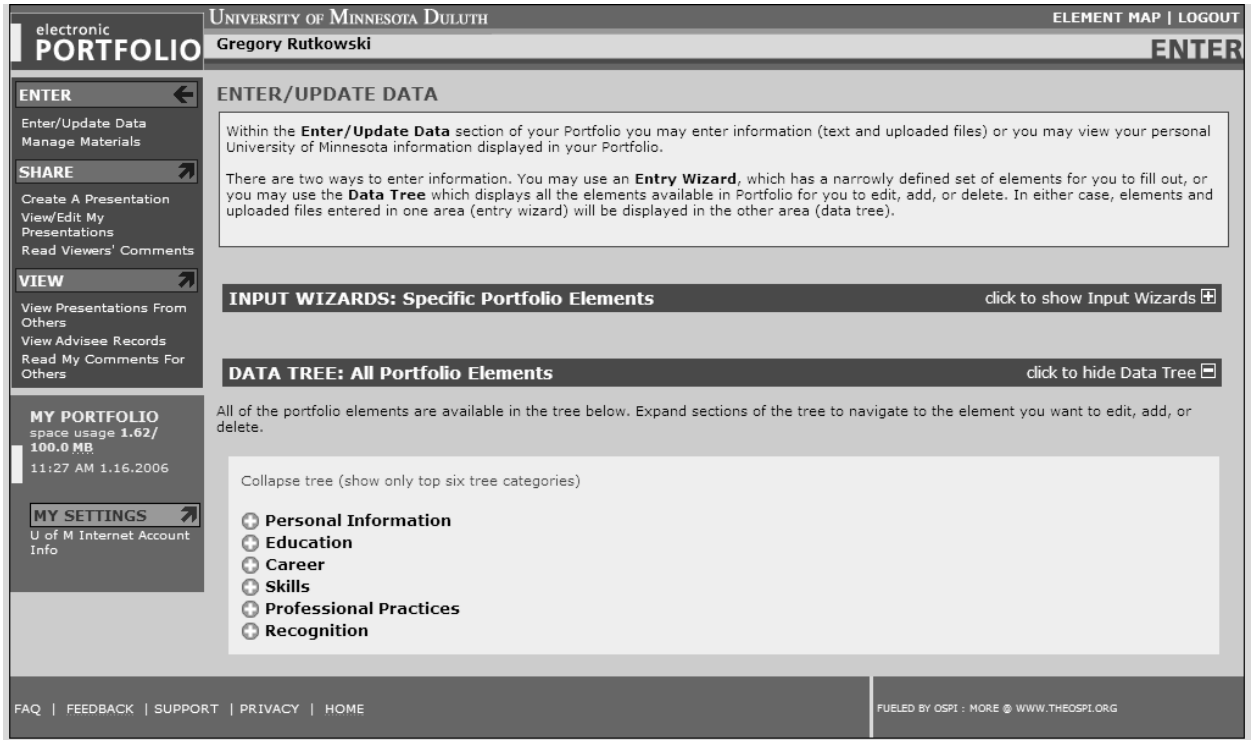

Figure 1: Elements may be added to Portfolio using predefined templates or directly into the data tree structure. From the main entry page, students may utilize predefined general and departmental specific wizards or access the data tree directly.

Due to the large number of items that can potentially be included in Portfolio, enough physical storage space must be allocated. Currently, all students are given 25 Mb of storage space. Students who want require more space may petition to have their capacity upgraded to 100 Mb. This is especially useful for users that would like to include digital video in their Portfolio. Possibilities span anything from performances for a student in the fine arts to the oral presentation of an engineering capstone design project.

Sharing Information

Once a Portfolio created, the student may wish to share information with some audience. To accomplish this task, the user would create a folder of elements by using one of the predefined templates or customizing it from all available elements. Examples of general templates include an employment portfolio to showcase work history and elements in which a company may be interested or a learning portfolio to represent the students learning experience, skills and outcomes (Figure 2). Faculty may also use templates to put together information for promotion and tenure.

The sharing folders generated by the user are highly individualized. They can be tailored for a specific purpose (job search) or for a specific audience (class instructor). As with the automatic elements, the sharing folders are also dynamic. As Portfolio is updated, any folder being shared is automatically updated. The individuals having viewing access of the folder can immediately see the changes without doing anything else.

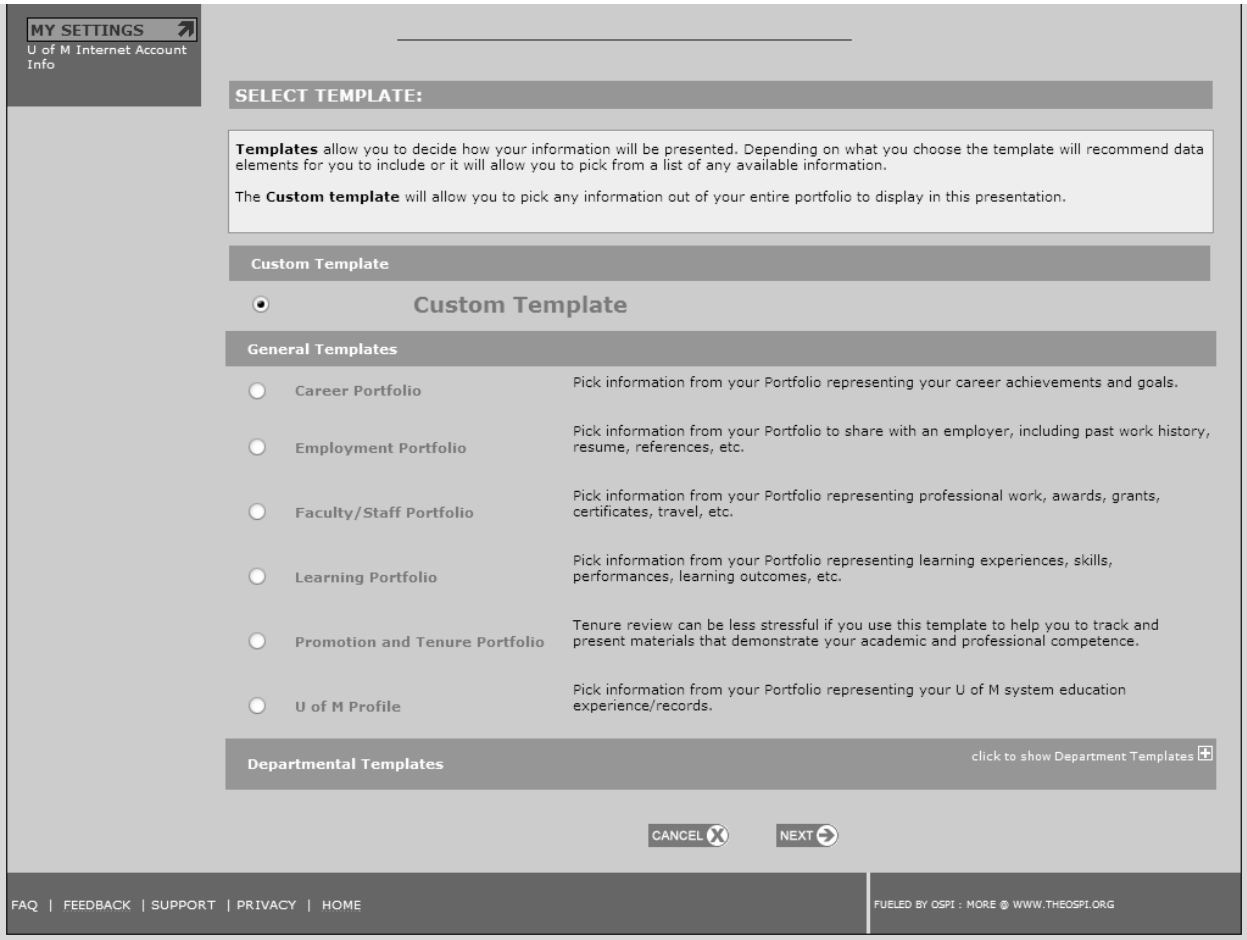

Figure 2: Sharing folders can be created using predefined general and departmental templates or be completely customized.

The Java environment in which the software operates allows users to access their Portfolio from an internet computer, regardless of platform. This has the additional benefit of providing shared access to anyone with internet access. The user may select others within the University with whom to share their Portfolio. These individuals are able to view shared Portfolios through their own Portfolio. For those outside of the University, the user can just add the e-mail address of anyone with whom they wish to share. The individual is sent an email message with a link to the Portfolio site and guest login password. Individuals viewing Portfolio can provide typed comments directly to the student for each element of the shared folder.

Department Implementation

With support from the Chancellor and Dean, our department is piloting a program to implement Portfolio throughout our curriculum. The Portfolio system was already being used for advising purposes. All faculty members have information from their advisees Portfolio automatically shared with their own that can be viewed in a separate advising section. The

student does not have to initiate this sharing. Students are required to discuss their academic plan each semester prior to registering for class. The faculty has found Portfolio a very useful tool to track the academic information of their advisees all in one place.

Our department is expanding the use of Portfolio to create a more personalized advising session with the students. The academic plan element can be entered directly into Portfolio prior to or during the advising session. This will give a more permanent record viewable by student and advisor throughout the student's academic career. We are encouraging students to reflect on their various activities so that they gain a better understanding of their accomplishments and may see areas for improvement. This self-assessment will help to facilitate the advising session.

Students are introduced to Portfolio during their first year introduction to chemical engineering course. They receive a one hour training session during which they take an online Myers-Briggs style personality inventory test as well as upload their resume. This information is shared with the instructor as part of their grade. Transfer students that do not take the introductory course are encouraged to at least attend one of the general training sessions that are provided each semester by IT services.

To tailor Portfolio to fit the needs of the student, we have developed an element template that contains the information that we as a department would like to utilize (Table 2). Certain elements are automatically entered into the template (Adm) while others require student input. Of these elements, some are required by the department (Stu-Req) and some are optional (Stu-Opt). This template contains the personal identification and contact data, general educational information as well as departmental specific elements (Figure 3). The departmental specific elements correspond to many of the courses found within the traditional chemical engineering curriculum. Laboratory reports, case studies, design projects can be easily entered using this template. The elements can be found within the educational subcategory of the data tree. Within the template, students are reminded of the required elements and a checklist is provided for those elements already added.

As the students continue with their coursework, their instructors will request that they upload certain items from the class into their Portfolio and share it with the instructor. Points will be assigned accordingly to ensure full participation. This will help to reinforce the use of Portfolio.

Since the faculty will have to make special accommodations to include the use of Portfolio within their course, we are considering a few options to make it worthwhile. Additional sharing templates have been developed to provide feedback to the department about the accomplishments of the students (Table 2). We have created a departmental Portfolio account to which the students can share their own Portfolio.

After their sophomore year, students must apply for upper division (UD) after meeting certain minimum requirements. Currently, this is accomplished by filling out paperwork. The application is taken by the department office administrator who pulls up transcript information and other records in order evaluate the student. All this information can be packaged together using Portfolio. With just a few clicks, the information is shared with the department system and

the office administrator is immediately alerted. This will speed the time it takes to perform the evaluation as well as create a digital record.

Table 2: Department Specific Template

Category	Elements	Input	Sharing		
			UD	Grad	ABET
Personal Information	Name of Record	Adm	X	X	
Contact Information	E-mail Address of Record	Adm	X	X	
	Additional E-mail Address	Stu-Opt	X	X	
	Address of Record	Adm	X	X	
	Additional Addresses	Stu-opt	X	X	
Education Information	Transcript	Adm	X	X	
	APAS	Adm	X	X	
	Myers-Briggs	Stu-Opt	X	X	
	Advisors		X	X	
	College and Major		X	X	X
ChE Information	Resume	Stu-Req	X	X	
	Material Energy Balance Case Study	Stu-Opt	X	X	
	Lab I Report	Stu-Req		X	X
	Lab II Report	Stu-Req		X	X
	Capstone Design Project	Stu-Req		X	X
	Multidisciplinary Team Project	Stu-Req		X	X
	Ethics Project	Stu-Req		X	X
	Heat and Mass Transfer Project	Stu-Opt		X	
	Fluid Mechanics Project	Stu-Opt		X	
	Reactor Design Project	Stu-Opt		X	
	Separations Project	Stu-Opt		X	
	Chemical Engineering Research	Stu-Opt		X	

Stu-Req: Required data entered by student
Stu-Opt: Option data entered by student
Adm: Information entered automatically by administration

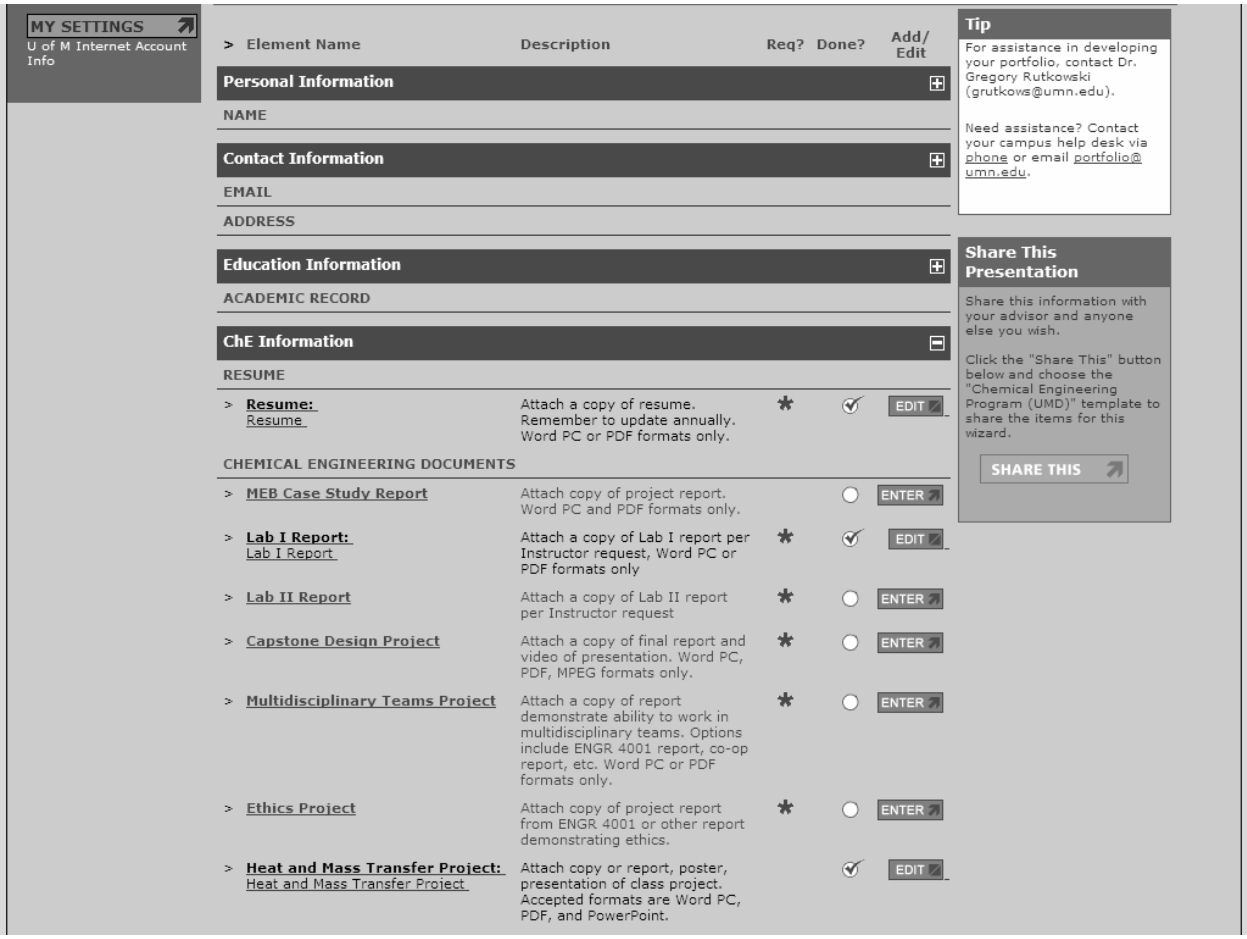

Figure 3: Chemical Engineering template for Portfolio data entry. Elements required for graduation are noted as well as a checklist to ensure items have been added.

The graduation sharing template (Grad) gathers much of the information to track the progress of the student toward graduation. It is meant to supplement the Academic Progress Audit System (APAS) which is used to make sure the students are meeting departmental and university requirements for graduation. We are encouraging students to share these records with their advisor. Also, students will share these records with the department Chair to facilitate discussion during the exit interview prior to graduation.

Similar to the Grad template is the ABET template which contains much of the same information but has been stripped of identifying data. This information will be shared with the departmental Portfolio as part of our accreditation process. Currently, the department faculty spends at least one day at the end of each semester performing a self-assessment of the curriculum for accreditation purposes. Rubrics have been created to evaluate the work submitted by the students and ensure our learning outcomes are being met. Future versions of the Portfolio software may include methods for archiving shared elements within the department account as well as providing tailored evaluation rubrics that can be tied to specific element types. Faculty would be able to logon to the department Portfolio and evaluate documentation in their own time from their own office. These advances will help to reduce the workload of the accreditation process and eliminate the sheer volume of paperwork.

The information shared using the ABET template has been stripped of any personal identifying information in order to preserve confidentiality. The only information currently shown is the name of the student who has shared the information. Names are included in the documents that are normally available to the accreditation team. Currently, the department collects reports and exams for accreditation; but, these contain the evaluation of the instructor. Since the electronic documentation shared with the department is the original version, the student grades are also kept confidential. This also has the added benefit of reducing bias in the departmental self assessment since the rubrics have been designed to evaluate certain criteria that are independent of grades. The information archived within the departmental Portfolio is kept hidden behind the password protected computer system. The department can select the information to share with the accreditation without compromising the student's confidentiality.

To assist the students in the development of their Portfolio, a departmental website has been created to provide information tailored to the needs of our students. A timeline has been developed based on the typical four year plan when students can be expected to update and share their Portfolio. The timeline is summarized in Table 3. After uploading their resume during their first year, students are encouraged to regularly update it and share their information with their advisor. Once they are accepted into upper division, students will encounter Portfolio during many of their engineering classes. Prior to graduation, students are expected to share their Portfolio using the Grad and ABET templates.

Table 3: Portfolio Activities

Activity	Schedule
Take Myers-Briggs Test	First year (Introduction to ChE Course)
Resume	First year and then as needed
Course reports, presentations, etc	As required for courses
Sharing with Advisor	Spring semester
Applying for Upper Division	Second year
Sharing with Department Chair	Last Semester
ABET Information	Last Semester

Though portfolios have traditionally been considered the domain of writers and artists, engineers can take advantage of them to showcase their accomplishments and provide a means of reflection. With advances in information technology, electronic portfolios can now be used as a repository for any digital artifact that the user may create from basic reports to digital video. The ability to share any of the information with anyone at any time provides several avenues for personal enrichment and professional advancement. Engineering students can take better control of the educational progress. Professional engineers can maintain their accomplishments beyond what is listed in a resume in order for purpose of personal and career advancement. Engineering faculty can take advantage of Portfolio integration and sharing to provide better advising. Future versions that expand the archival capabilities and permit tailored assessment tools will greatly

enhance the department's ability to assess curriculum. Taken all together, electronic portfolios have the potential to revolutionize the way we handle our personal, educational, and professional information in ways previously not possible.

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