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DEVELOPING ELECTRONIC PORTFOLIO SOFTWARE

FOR PROGRAM ASSESSMENT

By

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Bachelor of Science, Montana Tech of The University of Montana, Butte, Montana, 1996

Thesis

presented in partial fulfillment of the requirements
for the degree of

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Developing Electronic Portfolio Software for Assessment Purposes

Chairperson: Dr. Yolanda Reimer

 This paper describes how user-centered design methodologies were employed to create a software prototype used for outcomes assessment of e-portfolios. Designed to be used by faculty, university administrators and accreditation users, the prototype standardizes, aggregates and displays e-portfolio data in novel ways. Results of evaluating the prototype indicate that e-portfolios can be an effective means of outcomes assessment at the program level.

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CHAPTER I: INTRODUCTION AND RESEARCH OVERVIEW

1.1 Introduction

In the current political climate where accountability for student learning is expected at all educational levels, assessment has become a central part of the teaching and learning process.   In higher education, academic assessment is a dynamic, ongoing and continuous process that evaluates the knowledge and abilities of students at various points in their progression toward a degree, and then uses that information to improve the quality of instruction, student learning, and program design. Ultimately, assessment can impact the overall effectiveness of an academic department or unit in that it helps departments affirm what is going well in their curricula and courses, and also helps to pinpoint specific changes that might be needed.

Portfolios have become a popular and well-publicized assessment methodology. Portfolios are a collection of selected samples of a student's work. They have been used for years to document and demonstrate achievement in disciplines such as art and writing. With the advent of technology comes resources such as databases and the World Wide Web, providing a means to easily store, share and index portfolio contents according to learning standards. Because of this, electronic portfolios (or e-portfolios) have become increasingly popular as a means of student and program assessment in a wide variety of disciplines. This paper explores electronic portfolios as a means of assessment and their potential for program assessment, and includes the development of a software program in order to evaluate the efficiency and effectiveness of using e-portfolios to assess an academic program.

1.1.1 Climate of accountability

"In God we trust, all others bring data" (Green, 2005). This statement has been used widely to describe the climate of accountability that exists in American education. *No Child Left Behind*, the current renewal of the Elementary and Secondary Education Act (www.ed.gov/nclb), has an unprecedented assessment component that creates an expectation for data and accountability. *No Child Left Behind* requires data collected from standardized tests to make decisions about school quality and funding to public K-12 educational institutions who receive federal funding. This climate of evidence and accountability also extends into post-secondary education. Institutions of higher education are increasingly subject to demands from internal and external governing boards as well as institutional and program-based accreditation bodies for proof of students' knowledge and abilities.

1.1.2 Designing and assessing student learning

Educational programs are designed around a set of standards that is threaded through the curriculum. In K-12 education, state standards specify levels of knowledge and skills expected at 4th, 8th, and 12th grade levels, and then test these grades each year to determine whether students, and therefore, the school, has achieved Adequate Yearly Progress (AYP). In higher education, standards are set by the university itself with regard to general education requirements, and individual programs are governed by standards and policies promulgated by program faculty as well as by professional associations for the content areas. For example, a program standard may stipulate that students must "demonstrate the ability to communicate accurately and effectively using various media formats." Courses in the program, then, must require writing, speaking, media presentations, and so on such that students can demonstrate their ability to meet

the standard. As an individual student progresses through a program, s/he collects

required competencies by successfully completing course requirements.

Academic programs assess individual student performance in a variety of ways.

Homework, exams, classroom participation, writing, presentation and other activities can

all be used to assess student how well a student is performing in a class. Different types

of activities, or products, give us different information about student performance. A

timed exam, for example, provides an instructor with a snapshot of how well a student

can perform at a single point in the class in a high-pressure situation. On the other hand,

a project completed by the student over time in a more natural situation may provide a

deeper picture, or story, of his or her learning. A combination of techniques is generally

used; multiple measures are considered optimal.

1.1.3 Assessing a program

As student work is assessed by programs, programs are assessed by institutions

and accreditation bodies to ensure that students enrolled in the program are receiving a

high quality education. A program must provide good inputs (teaching, courses and

advising) to ensure good outputs (strong student performance indicators.) Programs use a

variety of data for assessment that may include graduate GPAs, test score averages,

observations of performance, self-assessment information from exit surveys, or

performance evaluations from employers of graduates. Some of the data are directly

related to student learning, while some are used to measure other indicators of program

quality. Data used to assess an entire program are generally aggregated or sampled.

The process of comparing student performance data to program standards is

called *outcomes assessment*. "The movement of accreditation – both regional and

specialized – toward outcomes assessment is creating positive changes in academe"

(Rogers, 2005, p. 6).   Outcomes assessment data can be used to evaluate the

performance of a single student at one point in time or across several semesters; it can

also be aggregated or sampled to assess an entire program based on the performance of

all students in a given time period.

Assessment becomes more difficult outside of an individual class. It is important

to assess student performance in a program using more than snapshot data provided by

GPAs and test scores.   Portfolios are one tool that can be used to demonstrate student

learning, growth and performance throughout an entire program of study. A portfolio is a

collection of artifacts, which in an academic setting may include items such as project

descriptions or completed projects, writing samples, artwork, video clips or any other

articles that a student compiles to document his or her academic performance. A

portfolio provides evidence of an individual student's growth and achievement through a

program of study. A collection of portfolios, with a rich and diverse assortment of

artifacts, may provide evidence for a program to show the quality of its student outputs.

Further, portfolios are a popular, well-established means of authentic assessment.

"Authentic assessment is any type of assessment that requires students to demonstrate

skills and competencies that realistically represent problems and situations likely to be

encountered in daily life" (web site, 2007). Unlike a standardized test score, authentic

tasks require students to produce ideas, integrate knowledge and complete tasks with

real-world applications such as writing a paper or journal, designing a computer program

or completing a large project.

While a substantial body of literature suggests that portfolios provide significant

benefits in terms of student self-assessment and assessment within an individual course

(Barrett, 2003; Batson, 2002; Estell, 2001; Ury, 2001), there are some drawbacks associated with using portfolios for program assessment. Some researchers have suggested that portfolios are not practical for assessing an entire program because of implementation issues including storage, maintenance, security and clarity of integration into curricula (Estell, 2001; Penta, 2002; Sanders and McCartney, 2003).

1.1.4 Leveraging the benefits of technology

Electronic formats help address problems of storage, maintenance, and security, and during the past several years, portfolios have progressed to electronic format. Students, faculty, administrators, and accreditation bodies can use e-portfolios to monitor an individual student's performance, and many see promise in using e-portfolios to determine how well student work measures up to a program's standards and learning outcomes. In other words, a portfolio, traditionally a means of individualized authentic assessment, can also be used to provide the evidence for conducting outcomes assessment showing student development across time and aggregating student performance across programs.

While most commercially-available software is designed for students to create and maintain e-portfolios, a few packages provide the capability of directly linking e-portfolio artifacts to the standards for which they demonstrate achievement. It is not clear, however, how widely these techniques are used or if they are effective. This paper describes the design, implementation and evaluation of a software prototype that allows users to attach outcomes data to e-portfolio contents and then analyze the data at the program level. The software standardizes, aggregates and displays student work in an expandable matrix format. Users may view a snapshot of aggregate program data, and then quickly drill down to see the individual pieces of work that comprise the aggregate.

The software provides a means for programs to "bring the data" while also exhibiting authentic examples and collections of individual student work.

1.2 Research Overview and Methodology

1.2.1 Problem

The purpose of this study is to explore whether e-portfolios can be an efficient and effective means of program outcomes assessment. While portfolios contain a wealth of information that is quite useful for evaluating a program, they can be difficult to assess consistently over time due to a lack of standardization. If e-portfolio contents are not specifically linked to program goals and objectives, it is cumbersome, unreliable, and impractical to extract and aggregate key data from individual e-portfolios.

1.2.2 Solution

A software prototype was developed to support this study. The prototype was designed specifically for faculty members, university administrators and accreditation experts to aggregate, query and view e-portfolio data, comparing it to program goals and objectives. A noteworthy feature of the software is the ability to display e-portfolio data in a matrix format. Faculty and accreditation users are able to use the software to construct matrices of student projects, by a variety of assessment factors, in a highly customizable and visual manner. The matrix facilitates efficient and consistent evaluation of all represented e-portfolios, allowing faculty and assessment experts to determine, at a glance, whether the number, variety and diversity of projects are sufficient, whether all desired competencies are represented, and whether the program's learning outcomes have been met.

1.2.3 Hypothesis

The e-portfolio assessment software developed for this study will provide an effective way to use e-portfolios for outcomes-based assessment by helping overcome some of the drawbacks associated with using e-portfolios for program assessment.

1.2.4 Research Questions

To attempt to illustrate that e-portfolios are an effective means of program assessment, we will address five research questions that are important for evaluating an academic program: Will the software enable faculty and accreditation experts to …

- track and aggregate student work efficiently, and compare results with departmental objectives?
- evaluate the program outside the confines of an individual course?
- evaluate the breadth and diversity of projects?
- monitor change in complexity and diversity of student work?
- monitor individual student growth?

1.2.5 Methodology

User-centered design (UCD) methodologies incorporate data gathered from users throughout the design and development of an interactive system (Gould, 1988). Users of the system, along with the tasks they will perform, are identified prior to system design. User feedback is gathered early and often. Prototypes, from low-fidelity (screen sketches and storyboards) to high-fidelity (fully-operational software) are created and evaluated throughout system development. Some UCD methodologies use an iterative process, where the initial design is evolved and improved over several iterations, incorporating feedback from the users into each successive iteration. The UCD approach provides

opportunities to eliminate design flaws and identify additional necessary functionality while the prototype is still easy to change.

An iterative UCD methodology was employed to develop the e-portfolio software prototype described in this study. Initial screen sketches on notebook paper evolved into static Web pages, then finally into a fully interactive Web database application. User feedback was gathered after each increasingly functional prototype to be sure that the design accommodated user needs. A greater number of users, with a wider variety of computer skills, evaluated the software following each design iteration. Six phases of software design and research activities are described below.

1.2.6 Research Activities

1. Definition of Problem and Software Requirements. The first phase of research included identifying exactly what problem was to be solved and how to approach it. Current literature was reviewed, and the knowledge gained from it was integrated into the design process where appropriate. The users of the software were identified, along with the tasks they would perform. The user tasks led to a list of functional requirements, which were defined and prioritized.

2. Low-fidelity prototypes. The second phase of the research began with the initial software design process. In this conceptual stage, screen sketches and storyboards were drawn on paper and evaluated. State-transition diagrams were created to illustrate program flow and user interactions. In this early design phase, student functionality was considered in order to conceptualize the interactions that would occur as e-portfolios and artifacts would be created in the system. One faculty user evaluated these low-fidelity prototypes and the feedback gathered was integrated into the next design phase

3. Preliminary Design. The preliminary software prototype was constructed using static Web pages. Macromedia Dreamweaver and standard UM Web templates were used for development. The preliminary prototype was evaluated by three Computer Science faculty members. Feedback gathered during this evaluation was substantial and helped to identify confusing interface design in some areas of the software. Feedback gathered was carefully considered and integrated into the next design phase.

4. High-Fidelity Prototype. A high-fidelity software prototype was implemented using Microsoft Active Server Pages (ASP) and Microsoft SQL in a Windows 2003 Server environment. Macromedia Dreamweaver was used for Web site development. This prototype would undergo rigorous usability testing.

5. Usability Analysis. The high-fidelity prototype was tested by six users, four of which were Web developers with well-developed technical skills. Users tested the software using a list of tasks. Results of usability testing, surveys and interviews were compiled and analyzed. Based on the feedback, minor interface modifications were completed and the high-fidelity prototype was ready for evaluation for assessment.

6. System Evaluation. Thirteen faculty users were identified for participation in a final evaluation of the system. An empirical evaluative study was designed and conducted to evaluate the effectiveness of the software for program assessment. Experiment data was analyzed and conclusions drawn from the findings.

1.3 Conclusion

Assessment is an ongoing, continuous process aimed toward improving student learning. Outcomes assessment allows programs to compare student achievement against standards developed by an academic program and required by accreditation bodies. Authentic assessment, however, may provide a more complete picture of student learning by requiring students to complete real-world tasks over a longer period of time. Portfolios are a popular and well-established means of authentic assessment. Technology provides a means to index portfolio artifacts according to program standards. Those who assess programs see promise in leveraging the benefits of portfolios by using the data they contain to conduct outcomes assessment. This study attempts to illustrate that we can do this by utilizing a well-designed software prototype. The next chapter discusses an overview and history of portfolios and current research in using e-portfolios for assessment.

CHAPTER II: BACKGROUND AND LITERATURE REVIEW

This chapter reviews literature describing the history and types of portfolios, their use in assessment, and current trends in e-portfolio research. Background information is provided to describe how e-portfolios have been used in the Department of Computer Science at The University of Montana.

2.1 Literature Review

The body of e-portfolio research is vast and spans a variety of disciplines. A literature review of e-portfolios reveals that articles were written in the early 1990s on the benefits and use of electronic portfolios in education (Sweet, 1993). Today, several consortia and initiatives, including the ePortconsortium (www.eportconsortium.org) and the Open Source Portfolio Initiative (www.opsi.org) actively support and encourage e-portfolio research and development in K12 and higher education.

A *Handbook of Research on E*-Portfolios (Jafari and Kaufman, 2006) contains 51 case studies and research papers documenting e-portfolio research conducted in K12 and higher education environments. Papers written by faculty and university administrators describe a variety of e-portfolio research topics including integration into curricula, enhancing pedagogical effectiveness, formative and summative assessment, student and faculty perceptions, implementation issues and e-portfolio software.

While portfolios have been used for years to document achievement in disciplines such as art, architecture and writing, they are now recognized as a valuable assessment tool in many other disciplines. The use of portfolios by accreditation agencies is encouraged as an acceptable means for documenting and assessing student outcomes.

2.1.1 Going Digital

The traditional format of a portfolio is a physical document, such as a ring binder (Estell, 2001). Using a ring binder, students select and package their best work, which may include project descriptions, writing samples, artwork, a resume, and photographs, with reflections upon each piece. Students may further develop the package by decorating the exterior of the binder and ensuring that the binder and its artifacts have the same color scheme, decorative elements and theme.

While a binder is portable and allows for easy insertion and removal of documents, it fails to capture the essence of "modern" student work which may include video, audio, interactive multimedia pieces and computer programs. A binder also forces the organization of the portfolio to be sequential when it may be undesirable to present one's ideas in sequential order (Estell, 2001). Further, the binder format can make it difficult or impractical for students to share the portfolio with external evaluators, prospective employers, parents and others. In terms of program assessment, binder portfolios can be difficult to store and evaluate consistently over time.

Some of the drawbacks of binder portfolios may be overcome by simply converting the portfolio and its artifacts to Web documents. The Web site replaces the binder while Web pages are used to represent individual artifacts. Web sites may be viewed widely, making it easy for students to share their portfolios with friends, parents, prospective employers, and, indeed, the world. Institutions of higher education can share student portfolios with outside evaluators for accreditation purposes. Hypertext makes it possible to order the artifacts in any number of different ways, even within the same portfolio.

While portfolios implemented as static Web pages provide benefits over traditional, ring-binder portfolios, they retain many of the drawbacks: they can be difficult to assess due to a large amount of data generated, and inconsistent in the way that the work is packaged and presented. Static Web pages do not enforce a mapping of student work to learning outcomes, skills and goals. A database, however, can provide this mapping. Storing artifacts in a database and then linking each artifact to appropriate assessment standards will allow interested users to query portfolios in any number of ways, providing the potential means to assess a program, a single class, even a single instructor.

2.1.2 Benefits of Using Portfolios for Assessment

Portfolios are just one of several methods that may be used for assessing student outcomes, one that adds a measure of breadth and depth of information that is not available via other methods (Estell, 2001). Many forms of assessment test and evaluate the output of students at a single moment in time, which provides only a snapshot of performance. Methods much closer to narrative are needed to show where a student stands with respect to the long arc of learning (Worthington, 2000). Electronic portfolios can provide this narrative: the construction, or "packaging," of the portfolio provides insight into a student's ability to synthesize his or her work, while portfolio artifacts are authentic examples of the student's work, along with his or her reflections upon that work.

> "Students learning the process of electronic portfolio development identify relationships and establish linkages between their education and career goals. It is not a compilation of artifacts, but a thoughtful collection of work and experience that leads to a desired outcome or educational goals. The electronic portfolio requires the student to think critically about what to include, why to include it, and how to draw adequate attention to included items. The electronic portfolio provides a visual window to the

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student's progress and critical thinking. It is this attention to organizing, reorganizing and reacting to included items that precludes the educational and self-evaluative process. The visual nature of the electronic portfolio provides employers with a snapshot of the student's ability to organize data and reason" (Ury, 2001, p. 354).

One study (Boughton, 2004) reports that students are highly motivated to create electronic portfolios, stating that "students are excited about viewing their work on screen, are more willing to record reflective comments (so useful for understanding their thinking and value judgments), are interested in working further with their images once digitized, and can more readily see their own progress" (p. 268). Another study (Brown, 2002) reported that students who created electronic portfolios expressed increased recognition of all they had accomplished, reported enhanced communication and organizational skills, and recognized the importance of reflection on learning.

Creating a portfolio helps a student to assess his or her own growth and achievement, as well providing a way to share his or her accomplishments. When a portfolio is created as part of a departmental assessment plan, students become more aware of the department's assessment goals and outcomes as well as how their own work meets the desired outcomes. "An electronic portfolio that allows for the documentation of the program outcomes enables each student to be aware of the intended outcomes for every program in which the student participates" (Bresciani, 2005, p. 72). Students are able to "construct their own meaning of the evaluation process and to make assessment part of the learning process" (Worthington, 2000, p. 242).

2.1.3 Drawbacks of Using Portfolios for Assessment

Despite many benefits, a number of difficulties have been identified in using portfolios for assessment at the program level:

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- Portfolios can be time-consuming to store and assess because a large amount of data is generated (Rogers, 2005).

- Evaluation can be subjective and questionable in terms of reliability, validity and consistency.

- It can be challenging to assess performance outside of an individual course.

While the drawbacks are significant, they are problems that lend themselves well to being solved using technology. Computers and databases provide a means to store, organize and filter large amounts of data. A database can enforce standardization of data, allowing it to be stored consistently over a long period of time. The format and even the appearance of e-portfolios and their artifacts can be standardized, making assessment more consistent and reliable. Finally, the e-portfolio package, with artifacts from several years of study, provides opportunities for assessing performance outside of an individual course.

2.1.4 Types of Portfolios

The National Learning Infrastructure Initiative (NLII, 2003) defines an electronic portfolio as "a collection of authentic and diverse evidence, drawn from a larger archive representing what a person or organization has learned over time on which the person or organization has reflected, and designed for presentation to one or more audiences for a particular rhetorical purpose."

The available literature roughly identifies three "types" of portfolios, based on the purpose of their creation: professional portfolios used to market oneself, process portfolios to tell the story of learning, and documentation portfolios for accountability.

1. A *professional* (also called s*howcase*) portfolio is a collection of best work, selected by the student and including the student's reflections upon the work (Arter, Spandel and Culham, 1995; Abernica, 2003). An example of a professional portfolio is one assembled by a photographer specializing in wedding photography.

> "By constructing a portfolio photographers have the opportunity to reflect upon work as they select the best results from their photographic sessions; similarly, the couple looking to hire someone for their wedding can use the portfolios to evaluate the ability of each photographer. Thus, it allows for assessment by both the person assembling the portfolio and those who must pass judgment on that person's work" (Estell, 2000, p. 55).

   Barrett and Carney (2005) describe professional portfolios as "complex resumes" used to highlight competencies for marketing purposes. Professional portfolios are often assembled for the author to use while seeking employment, and students are highly motivated to create professional portfolios.

2. *Learning* (or *process*) portfolios focus on student reflections. They document the phases of the learning process as a student progresses toward the mastery of standards. For example, a student may describe how one project evolved from the brainstorming phase to the finished result (Arter, Spandel and Culham, 1995). "This type of portfolio is primarily a device for teacher and learner to assess skills, reflect upon one's learning, and establish new learning plans. The emphasis is on process rather than product, and assessment is formative in nature. A portfolio that is truly a story of learning is owned by the learner, structured by the learner, and told in the learner's own *voice* (literally and rhetorically)" (Barrett

and Carney, 2005). Learning portfolios are used to help the author understand her own learning process and help teachers "form" and enhance the learning process. When a learning portfolio is well-managed, students are motivated to engage in this ongoing process of learning and reflection.

3. *Documentation* portfolios are often mandated by the institution. Portfolio data is collected, and then "aggregated to reflect the performance of a particular educational or professional organization" (Barrett and Carney, 2005). This assessment method can be used in conjunction with other assessment techniques such as work sampling. "The collection becomes meaningful when specific items are selected out to focus on particular educational experiences or goals. It can include the best and weakest of student work" (Zoetewey and Staggers, 2003, p. 133). Documentation portfolios are used by programs and institutions to conduct outcomes assessment.

2.1.5 A Conflicting Paradigm

So, not all portfolios are alike. According to Barrett and Carney (2005) "An adjective must be used to describe the purpose for implementation since these purposes are founded on different paradigms and result in portfolios with rather different characteristics" (p. 2). An author of a professional portfolio may not want to include institutionally defined assessment data, honest reflection and critique, or examples of her weakest work in a portfolio used to seek employment. The selective nature of professional portfolios may not provide an accurate representation of student competencies for accountability.

The three types of portfolios, it would seem, may be philosophically at odds with one another. The purpose for creating each type is distinct from each of the others. So is

the level of student motivation. Barrett and Carney (2005) state that while students may be extremely motivated to create a professional portfolio, they often think of documentation portfolios as something being "done to them." Barrett and Carney also caution against referring to software system used exclusively to collect (documentation) portfolio data as "e-portfolios" or saying that these systems lack the student-centeredness, the story and the voice of true portfolios.

An ideal e-portfolio software implementation would provide an ongoing means for students to tell the story of their learning while collecting institutional data and associating it with artifacts. It would provide a means for a student to select particular pieces of work to present to employers and others. It would encourage communication between faculty and students, involving students in the assessment process. Finally, it would provide the means for an academic program or institution to look at e-portfolio data in a number of different ways for use in assessment and accreditation.

The development of such a program is far beyond the scope of this study. The goal of the study is to explore whether e-portfolios can be an efficient and effective means of outcome-based assessment at the program level. The remainder of the literature review discusses selected software and e-portfolio implementations that were designed to conduct outcomes-based assessment at the program or institution level.

2.1.6   e-Portfolios for Outcomes Assessment

Using e-portfolios to conduct outcomes assessment at the program level has become more commonplace thanks to databases and Web technologies. Though many e-portfolio software packages only provide tools for students to create and maintain e-portfolios, some commercial and open-source packages provide a means to compare e-portfolio artifacts to outcomes at the program level.

LiveText (www.livetext.com), TaskStream (www.taskstream.com) and the Blackboard

Outcomes System (www.blackboard.com/outcomes) are all commercial software

packages that promote the ability to assess student e-portfolios. LiveText and

TaskStream provide student tools for creating e-portfolios as well as a means to view,

aggregate, and report outcomes data.

The Blackboard Outcomes System is an assessment management system, but not

an e-portfolio system. It uses e-portfolio data and other data garnered from the

Blackboard Content System (where students create e-portfolios) and the Blackboard

Learning Management System (used to deliver online courses) to perform outcomes-

based assessment at the course, program, department and institution level.   TaskStream,

LiveText and the Blackboard Outcomes System all claim to provide reports that address

accreditation requirements for agencies such as ABET and NCATE.

Due to the often high cost and lack of control that accompanies commercial

software applications, some campuses have decided to adopt and customize open-source

software. One such package is Sakai (www.sakaiproject.org). Initially developed as a

learning management system, Sakai has expanded to provide support of many academic

endeavors, including e-portfolios.

Epsilen (www.epsilen.com) software, which has a significant e-portfolio

component, was created by the Purdue School of Engineering and Technology at Indiana

University Purdue University Indianapolis (IUPUI). IUPUI is a founding member of the

ePortconsortium. Institutions license the Epsilen software when they join the

ePortconsortium, an association whose goal is to further the "development of academic e-

Portfolio software systems and the establishment of interoperability standards for such systems" (www.eportconsortuim.org).

Similar to the software developed for this study, Epsilen provides a "developmental framework" – a matrix – to illustrate a student's learning through his course of study. The matrix is customizable and displays an individual student's e-portfolio artifacts by ability and level.

UIPUI, an urban university serving about 30,000 students, began their e-portfolio initiative in 1995 (Hamilton, 2006). After some reasonably successful pilot projects, which led to a three-year grant from the Pew Charitable Foundation (www.pewtrusts.com), UIPUI defined six Principles of Undergraduate Learning (PULs) that exist within each academic program. The six PULs are: Communication; Critical Thinking; Integration and Application of Knowledge; Intellectual Depth, Breadth and Adaptiveness; Understanding Society and Culture; and Values and Ethics. An institution-wide e-portfolio project was launched to document, demonstrate and evaluate growth and achievement in relation to the PULs. Student work related to PULs is evaluated at four levels: Introductory (26 credit hours), Intermediate (56 credit hours), Advanced (junior and senior level) and Experiential (extracurricular and work experiences.) The PULs and levels led to the matrix design in the IUPUI student e-portfolios and the Epsilen software.

While the academic community defined the principles, UIPUI's Cyberlab was innovating in the realm of technology. UIPUI began to develop e-portfolio software for students in 1995. The effort was stepped up considerably with the Pew grant award in 1998. During this time, two UIPUI e-portfolio project directors considered the PULs,

levels of achievement, and portfolio work at other schools including the use of student reflection at Alverno College. During a single three-hour meeting, the project directors collaborated to envision the various ideas graphically. The created, on a conference napkin, a matrix that would become the basis for the Epsilen software and later the Open Source Portfolio Initiative (OSPI) framework (Hamilton, 2006).

IUPUI is recognized as a leader in e-portfolio research. They are members of several e-portfolio initiatives including the ePortconsortium, OSPI, and the National Coalition for Electronic Portfolio Research (www.ncepr.org). After ten years and several software implementations, IUPUI decided in 2005 to adopt the Sakai infrastructure for their e-portfolios effort.

Bowling Green University (www.bgsu.edu), a university of 22,000 students, is a developing member of the ePortconsortium. Bowling Green adopted e-portfolios with the goal of improving learning. An institution-wide implementation, Bowling Green first collected learning outcomes from each of it's academic programs. "Analysis of these several hundred outcomes identified seven underlying skills now known as the university learning outcomes: inquiry, creative problem solving, valuing in decision making, writing, presenting, participation, and leadership" (Haskel, Gromko and Blackburn, 2006, p. 389). Bowling Green utilizes the matrix feature of the Epsilen software to describe student learning based on university outcomes and four years of study. Bowling Green provides rubrics for students to use to determine where to place their artifacts and reflections in the matrix structure.

In implementing their e-portfolios, Bowling Green relied heavily on the research and success of Alverno College (www.alverno.edu). Alverno College is described by

EduCause (www.educause.edu) as an early adopter of e-portfolios. Alverno has, in fact, been creating video portfolios and writing portfolios for some 25 years. Alverno has developed its own e-portfolio software called the Digital Diagnostic Portfolio, or DDP (ddp.alverno.edu).

Alverno initiated their e-portfolio program in 1999 with the goal of "helping students analyze patterns in their learning based on Alverno College's unique ability-based education system (Lorenzo, Ittleson, and Oblinger, 2005, p. 3). E-portfolios were implemented to enhance student learning and are also used to analyze program effectiveness. Like Epsilen, Alverno's DDP software provides a matrix of institutionally-defined "key performances" and years of study. The DDP software goes one step further by enabling students to create multiple matrices in their e-portfolios. For example, an e-portfolio belonging to a student in a writing program may display a matrix for the program as well as a university matrix.

Screenshots of e-portfolio matrices implemented at Bowling Green and Alverno College are available in Appendix I.

Johns Hopkins (www.jhu.edu) began using paper-based portfolios as an exit requirement of the Master of Arts in Teaching program in the mid-1990s. Johns Hopkins developed the Digital Portfolio (DP) software (olms.cte.jhu.edu), a standards-based e-portfolio system, based on their paper portfolios. The DP was piloted by 25 students in 2001 before being rolled out to over 800 students in 2002. The goal of Johns Hopkins e-portfolio implementation was to replace a rigorous master's thesis process and to "require students to assemble a set of digital artifacts and reflections that demonstrate competencies related to the Interstate New Teacher Assessment and Support Consortium

(INTASC) principles" (EduCause, 2003, p. 9). The DP interface allows students to compare their own work to standards that have been pre-loaded into the e-portfolio system.

California Lutheran University (CLU) is a small private school serving about 3000 students (www.clu.edu). CLU has adopted a Webfolio system for its students. Students create Web-based e-portfolios consisting of HTML pages. Students have considerable creative freedom. The Webfolio artifacts are associated with assessment data, which is then imported into data-mining software for aggregation and further analysis. Compared to the e-portfolio implementations discussed previously, CLU's outcomes-based e-portfolio assessment is fairly "low-tech." It is mentioned here because the process of assigning and collecting assessment data is similar to the process used for this study.

This concludes the review of literature. The next section describes the e-portfolio implementation in the Department of Computer Science at The University of Montana. These Web-based presentation portfolios are used to evaluate the software developed for this study.

2.2 Computer Science e-Portfolios at The University of Montana

Following its 2002 accreditation review, The Department of Computer Science (CS) at The University of Montana (UM) decided to pursue e-portfolios as a means of conducting assessment. An initial rollout occurred during Spring 2003, in CS415 Computer Ethics, a course required for all graduating seniors. E-portfolios continue to be a requirement for the course. Dr. Yolanda Reimer, the instructor for the course, prepared the e-portfolio requirements and guides students through the process each semester.

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The goals for the e-portfolios are to:

- have CS undergraduates engage in self-assessment.

- showcase accomplishments and growth of undergraduates throughout their years at The University of Montana.

- illustrate the diversity of projects completed.

- use portfolios for accreditation purposes; for example, to showcase during accreditation reviews.

- understand and work out issues in the implementation of portfolios.

- have undergraduates learn or hone Web programming skills.

Each student is given space on a departmental Web server. Students have their choice of Web site development tools (Dreamweaver, FrontPage, HTML) Each e-portfolio is required to contain a table of contents, four to five computer science projects (from different years and semesters if possible), a reflective essay on the student's undergraduate experience, and a current resume.

For each project contained in the e-portfolio, students are asked to reflect upon the work by answering the following questions:

1. What was the project assignment?

2. What did you learn from the project?

3. What would you do differently next time?

Students are also required to present their e-portfolios to the class. Dr. Reimer reports that the presentations are fun and enlightening, students enjoy learning about their peers' experiences, and that the presentations seem to unite the class. Dr. Reimer feels that the e-portfolios were good for assessment, stating, "They [are] a fantastic way to see

the diversity of projects that students completed, as well as the complexity and general concepts covered."

The e-portfolios developed as part of the Computer Science programs are presentation portfolios. While they have some characteristics of learning portfolios, the work was reflected upon after the fact, sometimes several years later, so the assessment that occurs is more summative than formative. Outcomes data was attached to the artifacts in these 2002-2003 e-portfolios, and then used to evaluate the software product developed for this study.

2.3 Conclusion

Considerable research is being conducted in the area of e-portfolios. Technology provides a new "vehicle" to present the e-portfolios, providing potential means to eliminate some of the difficulties associated with assessing portfolios while leveraging the benefits. Three types of portfolios were identified, based on their purpose and other characteristics. The three types have some competing characteristics, suggesting that it may be difficult to accomplish all three purposes in a single e-portfolio implementation.

Again, the goal of the study is to explore the efficiency and effectiveness of e-portfolios for outcomes assessment at the program level. A software product, which provides a novel way to aggregate and display e-portfolio data and artifacts, was developed to illustrate a solution. The work employs a UCD that specifically targets faculty and accreditation users, and a software prototype was designed with significant input from that audience. Chapter 3 describes the initial design and evaluation of the software prototype.

CHAPTER III: PRELIMINARY DESIGN

3.1 Introduction

The e-portfolio software prototype described in this study was developed using an iterative UCD methodology. Beginning with crude screen sketches on notebook paper, the software underwent three design iterations before evolving into a fully interactive Web database system. Following each design phase, a greater number of users, with a wider variety of computer skills, evaluated the software for program assessment purposes.

This chapter describes the first stages of the e-portfolio software development: requirements definition, preliminary design (low-fidelity prototypes), and preliminary usability evaluation. The final product focuses on a prototype that is suitable for faculty and accreditation users, but other users, including students, system administrators and guests were considered at the initial stage to understand the interactions that may occur between users as the e-portfolios are created, maintained and assessed. Thus, the goals for all users are described along with faculty requirements in this chapter.

3.2 The Software Development Process

The development process described in this chapter includes:

    I. Requirements Analysis

        A. System goals

        B. User analysis

        C. Task analysis (functional requirements)

    II. Design

        A. Conceptual model

      B. Low-fidelity prototypes

          1. Screen sketches

          2. Program flow diagram

      C. Preliminary screen designs

III. Implementation of Preliminary Design

      A. HTML Prototype developed using Dreamweaver and UM Web Templates

IV. Preliminary Evaluation

      A. Usability testing

      B. User feedback analyzed and incorporated into next level prototype

3.2 System Requirements

3.2.1 System Goals

The goal was to create a functional prototype that enabled faculty and accreditation users to evaluate e-portfolio data. The system is a proof-of-concept, designed to evaluate the usefulness of such a system for assessment activities. While student functionality was not implemented, it was thought that eventually students would have a means to maintain their e-portfolios, upload artifacts, and with faculty feedback and approval, link their work directly to program goals and objectives.

3.2.2 User Analysis

Potential users of an e-portfolio system include students, faculty members, accreditation professionals (including outside evaluators), system administrators and guests. Table 3.1 describes each of these types of users along with their goals.

Table 3.1 Types of users and their goals

User Type	Goals for using the system
Faculty, university administrators and accreditation experts	• Aggregate and assess student work against program goals and objectives • Assess the breadth and diversity of student work • Monitor change in diversity and complexity of aggregate student work • Monitor individual student growth • Add assessment information and comments to student artifacts (faculty only) • Approve artifacts for inclusion in assessment data (faculty only)
Students	• Maintain portfolios as required by the department • Use portfolios while seeking employment • Assess their own learning (self-reflection)
System administrators	• Manage user accounts • Initiate e-portfolios • Grant system permissions • System maintenance functions including backup, archival, network, etc.
Guests	• View portfolios

3.2.3 Task Analysis (functional requirements)

Functional requirements describe the tasks that users must be able to perform with the software. Functional requirements that will be implemented for Faculty, University Administrators and Accreditation users are listed in Table 3.2.

Table 3.2 Functional Requirements

User Group	Should be able to:
Faculty, University Administrators and Accreditation Professionals	▪ View list of all student portfolios. ▪ View individual student portfolios. ▪ Query portfolios by assessment factors, including learning outcomes, core Computer Science skills, communication skills, group versus individual projects and year of study. ▪ Determine what type of Matrix will be constructed. ▪ Filter (refine) the projects that will appear in the matrix. View a Matrix populated with icons that represent project types and skills. ▪ View a Matrix populated with project abstracts, or abstracts and icons. (only icons implemented) ▪ Change Personal Settings, such as password and contact details. ▪ Query portfolios to view projects associated with a particular course. (not implemented) ▪ Switch rows and columns in the Matrix. (not implemented) ▪ Remove a column of the Matrix. (not implemented)
Faculty only	▪ Attach assessment information and comments to student artifacts ▪ Approve artifacts for inclusion in the assessment matrix

Table 3.3: Mapping of Users to Goals to Functional requirements

System Goal	Functional Requirements
Aggregate and assess student work against program goals and objectives	▪ Query portfolios by assessment factors, such as learning outcomes, core Computer Science skills, communication skills, group versus individual projects and year of study. ▪ Determine what type of Matrix will be constructed. Filter (refine) the projects that will appear in the matrix. ▪ View a Matrix populated with icons that represent project types and skills. ▪ View a Matrix populated with project abstracts, or abstracts and icons. ▪ Query portfolios to view projects associated with a particular course.
Assess the breadth and diversity of student work	▪ Query portfolios by assessment factors, such as learning outcomes, core Computer Science skills, communication skills, group versus individual projects and year of study. ▪ View a Matrix populated with icons that represent project types and skills.
Monitor change in diversity and complexity of aggregate student work	▪ View a Matrix populated with icons that represent project types and skills.
Monitor individual student growth	▪ View individual student portfolios
Add assessment information and comments to student artifacts (faculty)	▪ Electronically approve student projects so that they will appear in the matrix.
Approve artifacts for inclusion in assessment data (faculty)	▪ Electronically approve student projects so that they will appear in the matrix.

3.3 System Design

3.3.1 Conceptual Model

In a fully developed, "closed" system, students would maintain their e-portfolios by logging on and creating descriptions of their work (artifacts.) The system would allow students to link their artifacts directly to the departmental goals and objectives that are represented. It would also allow students to reflect upon the work and interact with

professors about their work and the learning process. As students maintained their e-portfolios, data about artifacts would be made available to faculty and accreditation experts.

The faculty assessment portion of the system, the focus of this research project, has three main functions:

1. To provide a means for users to view individual student portfolios.

2. To provide a means for faculty to approve student artifacts for inclusion in the assessment matrix, as well as add assessment information to and provide feedback for each artifact. This functionality facilitates interaction between the instructor and student.

3. To aggregate and display e-portfolio data by assessment factors, which include learning objectives, core Computer Science skills, communication skills, and group versus individual work. This is accomplished via the assessment matrix.

The first low-fidelity prototypes consisted of screen sketches and flow charts. Iterations of low-fidelity prototypes helped to refining system requirements. They were used to identify and describe faculty and student functionality. They also helped to define the interactions that must take place in order to populate the system with individual student e-portfolio data, then aggregate and assess the data.

3.3.2 The Matrix Design Challenge

We knew we wanted to be able to view matrices of assessment factors, such as learning outcome by Year of Study. The e-portfolio implementations at IUPUI, Bowling Green and Alverno demonstrate that the matrix is a good way to display an individual student's work. But matrix construction for a program, as opposed to an individual, proved to be a particularly difficult design problem. What "groupings" or configurations

of information are useful and meaningful for faculty and assessment professionals? How can information be displayed so that users can efficiently and consistently assess the Computer Science (or other) program? How much data is needed? The volume of data will grow significantly over time, making it cumbersome and perhaps undesirable to view all of the data at once. How might so much information be presented without overwhelming the user? It may be desirable to view data by a single class (i.e. all senior projects), a single learning outcome or a subset of skills. A means of filtering data will be necessary.

The preliminary solution was to create a series of three screens, as illustrated in Figure 1, below. First, the user will select the type of matrix she wants to create (Figure 8). After clicking the Next button, the user is presented with a screen with filtering options (Figure 9). After selecting the appropriate filters, the user clicks the Next button to view the Matrix that he or she has created (Figure 10).

Construct Matrix	**Filter Projects**	**View Matrix**
• Choose row and column headings • Click Next	• Filter the projects that appear in the matrix • Click View Matrix	• View matrix • Expand second Learning Outcome • Contract second Learning Outcome
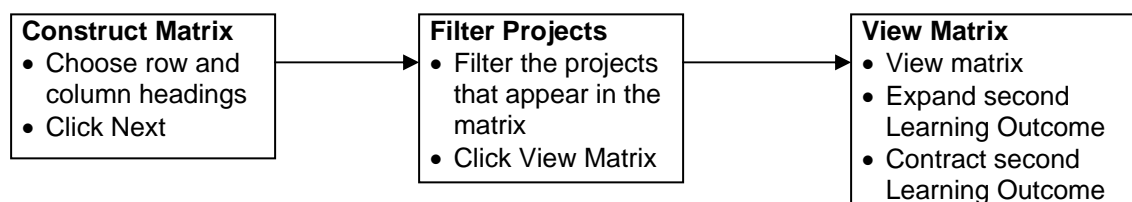
Figure 1: The matrix creation process

3.3.3 Low-fidelity prototyping

Low-fidelity prototypes include screen sketches and flow diagrams. Screen sketches are often used during the user-centered design process because they can be created quickly and are easy to change as a result of user feedback. Since so little time is invested in sketching screens (as opposed to creating Web pages or writing software)

they are also easy to throw away.   Student screens were sketched during this early phase, but higher-fidelity prototypes were not created for student functionality. Figure 2 depicts an early screen sketch.

Figure 2: Example of a low-fidelity screen sketch

3.3.4 Preliminary Screen Design

While most of the content displayed in the final prototype is dynamically generated, the preliminary design screens were represented with static Web pages. The Web pages provided navigation and the look and feel of the final prototype. Macromedia Dreamweaver was used for development. Standard University of Montana Web templates, headers and styles were used. Database connectivity and dynamic generation of content were not implemented during this phase.

Usability testing was conducted on the preliminary design. The purpose of conducting usability testing at this early stage was twofold: to evaluate the soundness of the design before beginning to program, and to collect early data on the effectiveness of the system for assessment. It was important to gather user feedback at this stage to identify and fix any user interface issues and to try to ascertain whether the user interface, even at this early stage, will support the research questions and hypothesis.

Three Computer Science professors were enlisted to use the prototype to perform

several assessment-related tasks. The feedback provided was incorporated into the next

design phase – the high-fidelity prototype that is described in Chapter 4. The preliminary

design prototype screens are presented here, followed by a description of the usability

testing and results. The task list used is provided in Appendix B.
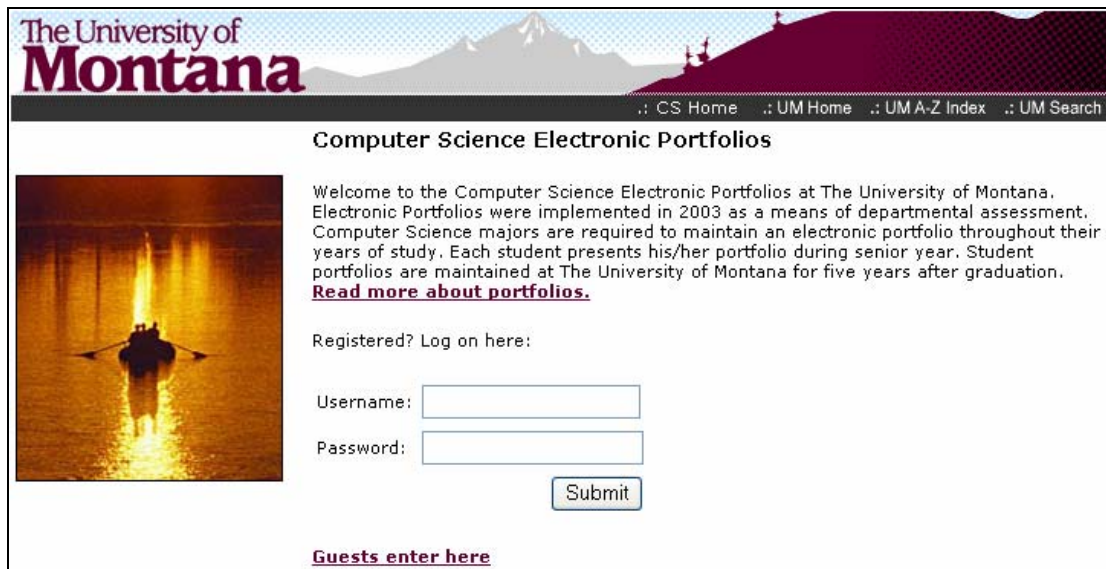
3.3.5 Screen Shots: Logging On

Figure 3: Log on screen.

The log on screen provides a form where users may log on. All users will browse to this
page to log on to the system. A link is provided for guest users.

Figure 4: Faculty welcome screen.

Faculty members who have logged on successfully are presented with the faculty welcome screen. All functionality provided to faculty members may be accessed from the welcome screen.

3.3.6 Screen Shots: Viewing Individual Student Portfolios
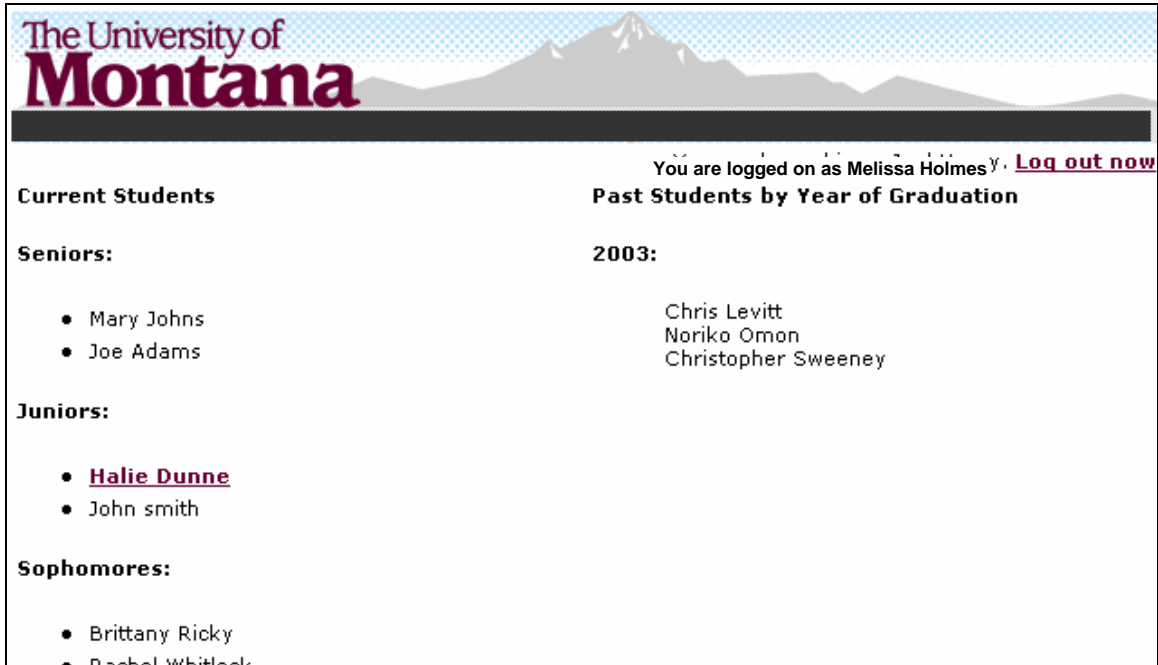
Figure 5: Portfolio list screen. This screen provides a list of e-portfolios for current students and those who have graduated.

Figure 6: Student e-portfolio welcome screen. This is the Welcome page for a "typical" student e-portfolio.

3.3.7 Screen Shots: Approving Student Projects

Figure 7: Faculty approval screen. This screen provides a list of projects that are awaiting a faculty member's approval. Only approved projects will be included in the aggregate assessment data.

3.3.8 Screen Shots: Constructing an Assessment Matrix

Figure 8: Matrix construction screen. The first matrix construction screen allows the user to select row and column headings for the matrix that will result.

Figure 9: Matrix filter screen. The second matrix construction screen allows the user to filter out projects by assessment factors, and select how projects will be viewed.

Figure 10: The Assessment Matrix. This screen displays the matrix populated with actual student projects. The row and column headings are learning outcomes and year of study, respectively, which were selected in the first matrix construction screen (Figure 8).

Figure 11: Result of expanding the second learning outcome of the Matrix

Figure 12: Matrix Legend

3.4 Preliminary Evaluation: Usability Testing and Feedback

Three Computer Science professors, which will be referred to as users, agreed to evaluate the preliminary design and provide feedback. Each user was instructed to complete four sets of tasks and to answer the questions at the end of each set.

The five sets of tasks were as follows:

1. Log on to the system.

2. Use the Project Approval tools to view and approve projects.

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3. View a student's portfolio.

4. Construct and use an assessment matrix.

5. Log off.

The following sections describe the tasks, screens, user feedback gathered and the

changes made based on feedback, for each set of tasks described in the list above.

3.4.1 Task I: Logging On

Users were first asked to log on to the system and view the welcome page. The

log on screen is depicted in Figure 3.

Tasks:

1. Open Internet Explorer

2. Browse to [Web address provided]

3. Log in using Username [username provided] and Password [password provided]

4. Answer Question 1: What is the first thing you noticed after logging on?

After successfully logging on to the system, users are presented with the welcome

screen, depicted in Figure 4.   The functions of the Welcome screen, in order of priority,

are to:

▪ greet the user by name, providing a sense of accomplishment, indication of

progress and a personalized feel;

▪ present a menu of options, and information about the options, appropriate for the

user; and

▪ establish the canonical for the system by providing consistent and familiar

graphical and navigational elements.

Whether the user is a faculty member or a student, he or she will be greeted by name

and provided with appropriate information and the *Log off now* link at the top right-hand

portion of the screen. Although the UM branding still exists via the UM logo and header, the standard UM navigation has disappeared in an attempt to keep users inside of the e-portfolio application.

Figure 4 depicts the Welcome screen when the user has successfully logged on as a faculty member. The menu items presented are: Project Approval, Assessment Tools, Personal Settings and Student Portfolios.

Task I Results

All users were able to navigate to the log on screen and use the provided username and password to log on. All users were able to log on to the system quickly without reporting any problems or confusion. In general, the users did not seem to pay attention to the text or navigational elements on the log on screen. One user did inquire about the *Read more about portfolios* link. All users noticed the personalized greeting, the *Log off now* link and the menu items on the welcome screen.

3.4.2 Task II: Project Approval

After logging in and viewing the Welcome screen, users were asked to "View the list of projects awaiting your approval." Specific tasks are as follows:

1. View the list of projects awaiting your approval.

2. View Mary Johns' Ethics Paper.

3. Approve Mary Johns' Ethics Paper and Joe Adams' Ethics Paper.

4. Answer Question 2: How many projects are now awaiting your approval?

All users knew that they should click on the Project Approval link on the Welcome screen to enter the project approval area.

Task II Results

This part of the evaluation was far less successful than expected. This was due to a number of factors:

- Users did not know why they were approving projects, and therefore did not understand the purpose or goal of this functionality.

- Screen elements and program flow were confusing, as described below.

- The task list seemed to be unclear and only one user followed the steps in order. The one user that completed the tasks successfully expressed confusion about what had been accomplished.

- Due to the static nature of the prototype, feedback was inconsistent if users did not follow the task list in order.

Prior discussion indicated that faculty members think this is an important part of the system. The project approval process forces faculty members to be involved in the portfolio process and enforce standards. The interaction between faculty members and students will be important for the students to assess their own learning.

The project approval screen (Figure 7) allows faculty members to approve projects so that they will appear in the assessment matrix. All users expressed that they did not understand the purpose of the screen or the goal of approving projects. This information is at the top of the page, the users read the text only after failing to understand what was expected.

There were a number of specific comments about the Project Approval screen:

- While users understood that the green icon with the question mark was a help icon, they didn't understand its purpose here.

- All users clicked on the project title to view the project, but again, the goal wasn't readily apparent. It took 2-3 seconds for each user to figure out what to do. One user commented that the link text didn't really look like a project title, and that perhaps "View Project" would be a better header for this column of links.

- The Approve button caused some confusion. Users weren't sure if after clicking the button, only checked projects would be approved, or if all projects would be approved. Also, there is no functionality that allows the user to "disapprove" a project or to contact the student as stated in the instructions.

Problems with program flow were as follows:

- Clicking the project link opens the project in a new window. In general, this broke navigation, forcing users to first understand that they were viewing a new window, and then figure out how to get back to the Approval screen. Since the project being viewed is part of a student's individual portfolio, it looks much different than the other screens and the familiar graphical and navigational elements were missing.

- The users did not know what they were supposed to do after viewing a project and returning to the approval screen. While all users checked at least one box and clicked on the Approve button as the task list directed, they were clearly confused about *why* they were doing this.

Positive comments were made about the text on the Welcome screen that indicates how many projects are awaiting approval. After approving projects, the user is returned to the Welcome screen, where the updated number of projects awaiting approval is displayed. Despite the navigational problems related to the process, the user that noticed

the change observed that it was clear and visible, and provided good feedback and indication of progress.

3.4.3 Task III: Viewing Student Portfolios

The third set of tasks involved viewing a specific student's portfolio. Tasks were as follows:

1. View Halie Dunne's portfolio.

2. Read Halie's biography.

3. Go back to your Welcome Page.

4. Answer question 3: What is in the photo in Halie's biography?

Each user found and clicked on the link to Student Portfolios. In each case, there was a very brief (1-2 seconds) period of searching before clicking on the link. A list of student e-portfolios is presented (Figure 5) providing links to e-portfolios created by current students and those who have graduated. The users commented that this screen is very straightforward, but one observed that the lists will be very long after a number of years, and there should be a way to filter each list by year of study or year of graduation. It was also observed the task was directed because the link to Halie Dunne's portfolio was the only "clickable" text on the page.

Each user clicked on the appropriate portfolio page, and then read the biography. All users were able to complete the tasks quickly without confusion. After completing the task of viewing the student's biography, users were directed to return to the Welcome page. Each user had to hit the back button multiple times to do this. It was noted that in the context of a faculty user viewing a student portfolio, the faculty navigation should remain present on the screen and that a link to the Welcome page would be helpful.

Task III Results

All users made positive comments about the portfolio page and observed that the portfolios were attractive and easy to locate and navigate.

After returning to the Welcome page, the users were asked, "What is the photo in Halie's biography?" Responses were as follows:

1. Halie snowboarding

2. Someone [snowboarding] in front of Mount Everest

3. I don't recall

The responses to the question indicate that in two out of three cases, users remembered a specific visual detail about the student. While this is not in the scope of this research, it has interesting implications for assessment.

3.4.4 Task IV: Using the Assessment Matrix

The final set of tasks required users to configure and view the assessment matrix. This set of tasks was presented last because the matrix contains the most complex operations and it seemed helpful, to understand the context of the entire e-portfolio system before using the matrix.

The user must navigate through a set of three screens to construct and view a matrix. The first screen allows the user to select row and column headings. The second screen allows the user to filter the projects that will appear. The third screen allows the user to view the matrix, and also provides a means to change the matrix view.

User tasks were as follows:

1. Construct an assessment matrix in which the rows are made up of Learning Outcomes and the columns are Year of Study. View all projects.

2. View the matrix.

3. Expand the second Learning Outcome.

4. Contract the second Learning Outcome.

5. Answer questions 4 – 6.

Users were given the somewhat broad task of "Construct an assessment matrix in which the rows are made up of learning outcomes, and the columns are year of study. View all projects." The task was designed to be open-ended to see whether users were able to work their way through the various screens involved in creating a matrix.

All users clicked on the Assessment Tools link on the Welcome page, while observing out loud that the Assessment Matrix must be part of the Assessment Tools. Users were presented with the screen depicted in Figure 8. In the final prototype, the combinations of row and column heading choices will enable the construction of fourteen different matrix configurations. The static nature of the preliminary design prototype limited the functionality of this screen. The matrix displayed was static and therefore not affected by changing the row and column options here.

After clicking the Next button, users are presented with the Project Filter screen depicted in Figure 9. This screen allows users to filter, or limit, the projects that appear in the Matrix. The content of the filter screen is generated dynamically based on row and column headings selected in the previous screen. In general, the user can filter projects by assessment factors that were not selected as row or column headings. For instance, if a user constructs a Matrix of learning outcomes by year of study, he or she will be allowed to filter the matrix by difficulty level, project type and skills. The only exception

of this is the case of learning outcomes, which may never be used as a filter. All options are checked, and therefore all projects are included, by default.

After completing the Project Filter, users must click the View Matrix button to view the matrix screen. The learning outcomes by year of study (the configuration selected in Figure 8) matrix is displayed in Figure 10. Each project is indicated by a class number and icons representing skills and project type. The Matrix screen provides the following functionality:

- Limit by Computer Science course the projects that appear in the Matrix

- Switch rows and columns

- Change views:

    o View icons (shown)

    o View project abstracts with icons

    o View project abstracts without icons

- View individual projects by clicking on the class number

- Expand Learning Outcomes

Expanding the learning outcomes enables users to view work completed within each learning outcome broken into key Computer Science skill areas, types of communication, and individual and group projects. An example of the expanded matrix is depicted in Figure 11.

Task IV Results

Overall, users seemed to be impressed with this part of the system. While the first two screens did not help to make clear the goal of the process, the users indicated that the matrix provided a good visual representation of the portfolio data.

After completing the fourth set of tasks, users were required to answer questions 4 – 6, which are assessment-related:

4. Based on the matrix data, what conclusions do you draw about the number of oral presentations a "typical" student completes as he/she progresses through his/her study?

   Response: Students are completing at least one in all years except Year 2; more towards the end of the degree, which is good.

   Response: More as [students] go on – Senior "capstone" involves presentations

   Response: More each year – from freshman to senior

5. Based on the matrix data, what conclusions do you draw about the number of group projects a "typical" student completes as he/she progresses through his/her study?

   Response: Lots in Year 4; not enough in other years.

   Response: Heavy in last year(s), starts with programs, then to software engineering [the faculty member went on to say that this was very appropriate – students should learn programming fundamentals and work alone during the early years.]

   Response: Again more starting junior year to senior

6. Based on the matrix data, what can you ascertain about the diversity of projects represented?

   Response: No conclusions. The user explained that there was no context for the icons that populated the matrix. Since the user did not know what the icons represented, or how many total project types and skills were available, and

therefore could make no conclusions about how many project types and skills were being utilized. After the first user session, the experiment was changed slightly. The icon legend (Figure 12) was added, and users were instructed to evaluate the matrix as if the icons in the legend made up *all* available project types and skills.

Response: More individual stuff early, more group later.

Response: Very diverse across classes – three different classes [shown]

3.5 Design changes based on user feedback

A number of screen changes and program flow changes were implemented as a result of the initial feedback of the project approval process.

Project Approval changes:

- A better help icon was created for the Project Approval screen (Figure 7.)

- Instructions were added to the Project Approval screen indicating how the user may view a particular project.

- A column of checkboxes was added so that users can disapprove projects as well as approve them.

- The Approve button became a Submit button. Short instructions were provided to indicate what will happen when this button is clicked.

- Since "undoing" the approval or disapproval of projects cannot be easily accomplished, an "Are you sure" box appears when the user clicks the Submit or Cancel buttons on the Project Approval screen.

- Projects will open in a new window and the window will have a Close button.

- The opportunity to approve or disapprove projects (via Approve and Disapprove buttons) appears on the screen that displays the actual projects.
  - If the user approves a project in the project window, the window closes and the approved checkbox for the project will be checked.
  - If the user disapproves a project in the project window, a form appears that allows the user to email the student with comments. When this form is submitted, the project window also closes and the disapproved checkbox for the project is checked.

View student portfolios changes:

- The list of portfolios (Figure 5) will include drop-down lists that allow users to limit the list of portfolios to a single year of study for current students, or to a single graduation year in students who have graduated.
- Student portfolios, when being viewed by faculty members, will include faculty bread crumbs navigation and Log Out link.

Assessment matrix changes:

The process of constructing an assessment matrix will change somewhat. Since most users are familiar with the concept of software wizards, the wizard model will be utilized for construction of an assessment matrix.

The screen depicted in Figure 8 will undergo minor aesthetic changes. The *view definitions* link will pop up a new window rather than sending users to an anchor on the same window. This new, smaller window will include a Close button. Visual borders will be added, along with instructions indicating what will happen when the user clicks the Next button.

The Project Filter screen (Figure 9) will change very little. A Back button will replace the *Go Back* link. Instructions will be re-worded.

The View Matrix screens will not change. All users seemed to feel that these screens were very user-friendly and good for assessment. One user commented that "anyone can sit down for 15 minutes and understand how to this system."

3.6 Methodology: Lessons Learned

The evaluation methodology affected the results of the usability experiment:

- Specific tasks provide more specific information. Open-ended tasks had more varied results, making it difficult to identify patterns and compare responses.

- Open-ended tasks tended to not "lead" the user, therefore producing perhaps a more authentic evaluation of usability.

- Specific questions generate more specific responses than do open-ended questions. Questions such as "what was in the picture in Halie's biography" told us exactly what the user remembered.

- Open-ended questions, such as the assessment questions, produced more varied responses, but in some cases, more thoughtful and detailed responses.

- Users tended to be more successful completing tasks that used familiar (in the context of software usage) terminology, such as "browse to" or "log on / off" as opposed to unfamiliar terminology, such as "approve projects" and "filter projects." It is observed that if faculty were involved throughout the portfolio process, as they will be, terminology will not create a barrier to understanding what is expected of the system.

These factors will be considered when designing the usability experiments for the high-fidelity prototype.

3.7 Conclusion

Despite some specific usability issues, the system design appears to be sound and seems to have promise as an effective means of program assessment. All faculty users indicated that the Matrix was a good way to display portfolio data. Responses to questions related to assessment indicated that the matrix enables faculty to quickly and visually assess student growth in terms of the numbers, types and diversity of projects that are completed.

Chapter 3 presented the preliminary design and evaluation of the e-portfolio software. Chapter 4 presents the redesign based on user feedback and describes the implementation and usability evaluation of the high-fidelity prototype.
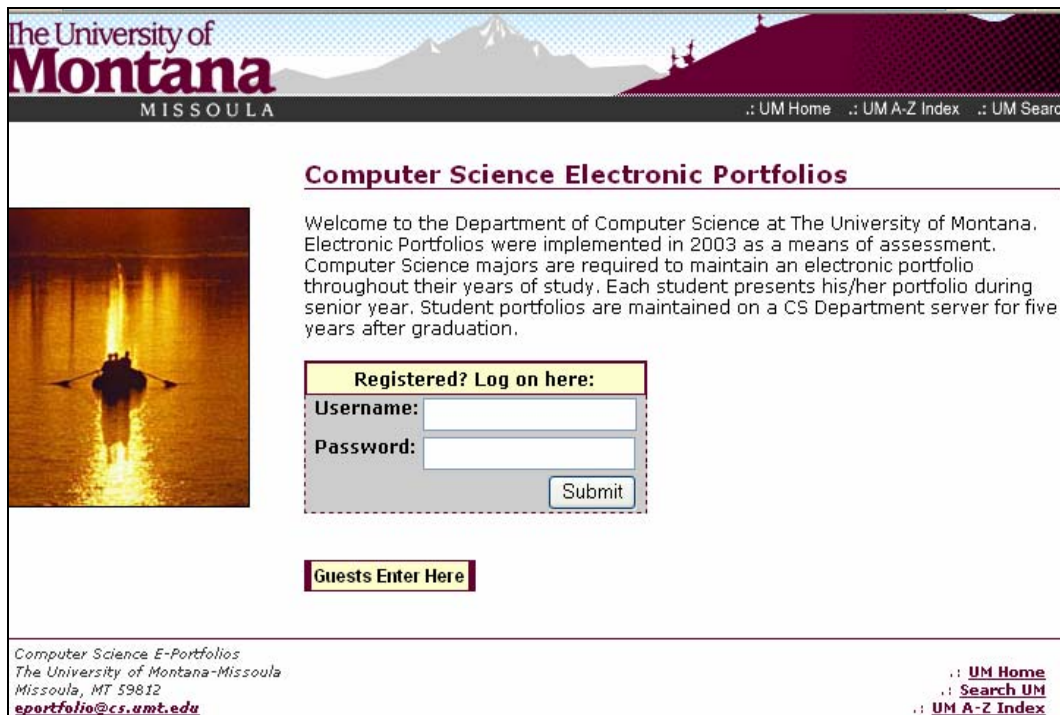
CHAPTER IV: IMPLEMENTATION AND TESTING

The user feedback gathered during the first phase of usability testing was carefully evaluated and where appropriate, incorporated into the next level design. This chapter describes the system redesign based on user feedback, the details of the high-fidelity prototype implementation and database design, and the second round of usability testing and results.

4.1 Redesign and Implementation

A number of changes were made, based on user feedback, to improve the usability of the system. The new screens are presented here along with a description of the changes that were made and implementation details.   The database design and data elements are described in the section that follows.

4.1.1 Logging On

Figure 13: Log on screen

The new log on screen (Figure 13) was aesthetically enhanced by framing the log on area and making the *Guests Enter Here* link look more like a button. These changes were accomplished using cascading style sheets (CSS). This system uses database authentication, which means that the usernames and passwords are stored in a database within the system (as opposed to, say, an LDAP where the user account information exists separately from the system.) When the user types in his or her username or password and clicks the Submit button, a script is called that compares the username and password to those stored in the Microsoft SQL database. If a valid username and password pair are entered, the log on is successful and the Welcome screen is displayed. Otherwise, the log on screen is displayed with the message "Invalid username or password. Please try again."
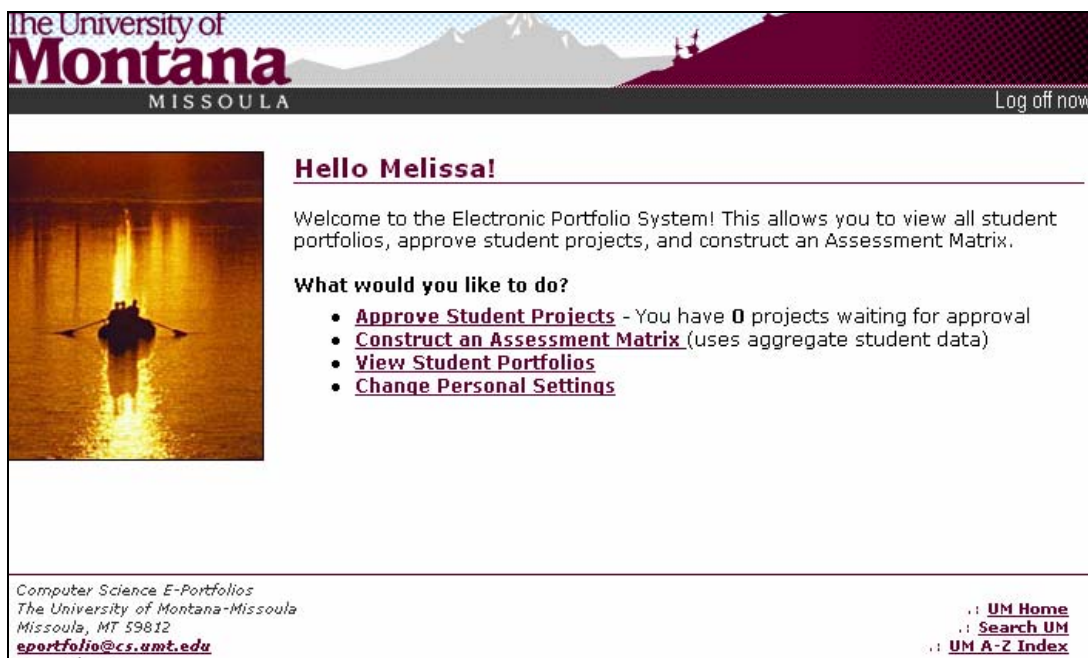

Figure 14: Faculty Welcome screen

The text on the Faculty Welcome screen (Figure 14) was shortened and a brief explanation of the Construct an Assessment Matrix menu item was added. The menu

items were changed to reflect actions, i.e. Project Approval was changed to Approve

Student Projects, Assessment Tools to Construct an Assessment Matrix, etc. These

changes were made in an attempt to better instruct the user about what he or she will

accomplish.

The user's first name is stored as a session variable during the log on process.

The session variable remains active until the browser is closed, the user logs out, or it

expires. The number of projects awaiting approval is generated by counting the number

of projects in the approval queue (a table in the database) for the user.

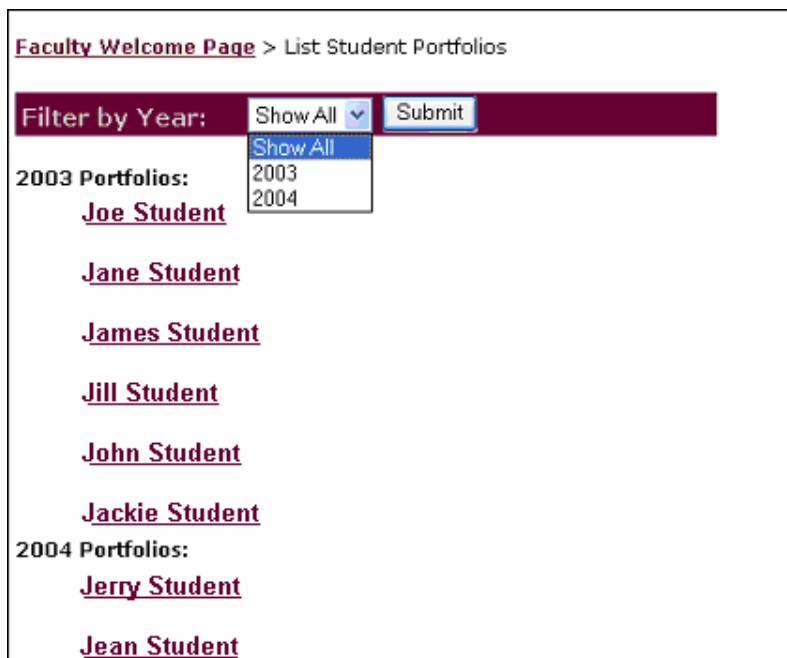### 4.1.2 Viewing Individual Student e-Portfolios

Figure 15: Student Portfolios List

The new student portfolios list screen provides a means to filter by year. Again,

names have been changed for privacy. The lists of student names are generated

dynamically via ASP using information that is stored in the database. Breadcrumbs

navigation was added to the top of this page for ease of navigation.

4.1.3 Approving Student Projects

Figure 16: Project Approval screen

The new project approval screen (Figure 16) provides information about the class and student as well as the project title. It also provides the faculty user with more instructions, opportunities to approve and not approve projects, and an opportunity to cancel or submit changes. Breadcrumbs navigation was added to the top of this page for ease of navigation.

Other than the Approve Student Projects title bar, this entire screen is dynamically generated. If there are no projects awaiting approval, a message stating "There are no projects waiting for your approval" is displayed. Otherwise, the table, as shown above, is generated dynamically using content obtained from the database. The class, student name, project title, and all project details are stored in the database. When the project title is clicked, a database key is passed to a JavaScript function that opens a new window that displays the appropriate project details.

The new individual project approval screen (Figure 17), which opens in a new window, provides a means to approve or disapprove the project on the same screen where it is being viewed. It provides all of the pertinent project information, including assessment factor icons (which are the same icons that would appear for this project in the assessment matrix.) All of the project information that appears on this screen is stored in the database.

If the user clicks on the Cancel button, the window simply closes. If the user clicks the Approve button, the window closes and the Approve checkbox on the Approve Projects screen (Figure 16) is checked. If the Do Not Approve button is clicked, the user is prompted to send email to the student (Figure 18) to provide feedback about the project.

Joe Student : CS435 Midterm Project

Abstract:

Jane Student and I developed an online contact manager. This contact manager implemented: Data Entry functionality (Append or Update) Keyword search Data Entry with selection.

Description:

Create a Web application with database integration using Microsoft ASP and Access.

Reflective Statement:

In doing this project, pobzeb and I learned many lessons. I Learned just how difficult it is to work in groups, due to schedules, and meeting times. However I did learned that if you can work through scheduling issues, you can produce a higher quality product in less time. I learned a lot about ASP, and group management by doing this project as well.

Long Description or Link to File

Create an ASP application that provides authentication, plus three of the following: Statistics displayed using Totals (Group By query) Data Entry functionality (Append or Update) Data Entry with selection Keyword search Category search Search tracking Smart search Dynamic graphics (such as charts) Database Requirements A Microsoft Access database will be used for the back-end. The database must consist of at least four tables. Two tables will be used for authentication, and at least two for associated data. You should use Access (Forms) to prototype your database functionality and to test your SQL.

Assessment Factors:

- Written Component
- Oral Presentation
- Group Project
- **DS** Data Structures
- **SE** Software Engineering
- **P** Programming
- **Ar** Architecture
- **AI** Algorithms
- **Db** Database Systems

| Cancel | Approve | Do Not Approve |

Figure 17: Individual Project Approval Screen

Figure 18: Disapproved project email screen

The disapproved project email screen appears when the Do Not Approve button is clicked on the individual project approval screen (Figure 17). This screen was added to provide feedback to students if the project artifact is not yet suitable for inclusion in aggregate assessment data.

Figure 19: Project Approval Feedback

The project approval feedback screen was added to provide immediate feedback to the faculty member who approved or disapproved projects. All projects that were approved or disapproved will be listed here along with their approval status. When projects are approved (or not approved) they are removed from the approval queue and the approval information including the data and faculty member is stored with the project information in the database.

4.1.4 Using the Assessment Matrix

Figure 20: Assessment Wizard: Select Rows and Columns screen

As described in the Changes section of Chapter III, the wizard model was applied to the matrix construction process. The Select Rows and Columns screen, above, is the first of a series of three screens in the wizard. The wording on this screen was changed slightly, and heavy borders were placed around the row and column heading selections.

The user must first select row headings. The five assessment factors are available for row headings:

1. Learning Outcomes

2. Year of Study

3. Level of Difficulty

4. Computer Science skills

5. Communication skills

After the row heading is selected, the column heading dropdown list is populated with appropriate assessment factors. For example, for a matrix in which the rows consist of learning outcomes, the column headings can only be year of study or level of difficulty. JavaScript was used to dynamically populate the column headings list based on what was selected for row heading.

Figure 21: Assessment Wizard: Filter Projects screen

The second screen in the assessment wizard allows the user to filter projects. This screen was only changed aesthetically by adding instructions and heavy borders. The groups of information displayed on this screen are dynamically generated based on what was selected on the previous screen (Figure 20). Column and row headings are never used as a filter. The Uncheck All functions were implemented with JavaScript.

Faculty Welcome Page

Click the class number to view project details. Expand the Learning Outcome to view more detail.

There are currently 18 student portfolios in the system.

View Icon Legend

Learning Outcomes	Year 1 (Freshman)	Year 2 (Sophomore)	Year 3 (Junior)	Year 4 (Senior)
Prove Compentency in the Key Areas of Computer Science + Expand	CS132: Database (1) P AI DS	CS232: Assembly Language Program(3) P	CS365: Design and Implement a Database (1) P DS Db CS435: Web Database Implementation(3) P Ar AI DS Db UI	CS415: Ethics Paper(5) E CS435: Web Database Implementation(3) P Ar AI DS Db UI CS441: Rational Rose Design and Implementation(3) P UI Ar AI DS SE CS442: Capstone Project for CS442(8) P UI Ar AI DS SE CS476: User Interface Design, Implementation and User Testing(5) P UI Db SE CS495: Visualization Problem(3) P AI DS
Prove Competency with both Written and Oral Communication Skills + Expand	CS132: Database (1) 📄 📽		CS365: Design and Implement a Database (1) 📄 📽 CS435: Web Database Implementation(3) 📄 📽	CS415: Ethics Paper(5) 📄 CS435: Web Database Implementation(3) 📄 📽 CS441: Rational Rose Design and Implementation(3) 📽 CS476: User Interface Design, Implementation and User Testing(5) 📄 📽
Demonstrate an ability to work effectively with groups + Expand	CS132: Database (1) 👤	CS232: Assembly Language Program(3) 👤	CS365: Design and Implement a Database (1) 👤 CS435: Web Database Implementation(3) 👥	CS415: Ethics Paper(5) 👤 CS435: Web Database Implementation(3) 👥 CS441: Rational Rose Design and Implementation(3) 👤 👥 CS442: Capstone Project for CS442(8) 👤 👥 CS476: User Interface Design, Implementation and User Testing(5) 👤 👥 CS495: Visualization Problem(3) 👤

Start Over

Icon Legend - Microsoft Internet Explo...

Computer Science Skills:

P Programming
AI Algorithms
Ar Computer Architecture
DS Data Structures
OS Operating Systems
Db Database Systems
SE Software Engineering
Th Theory of Computer Science
E Ethics
UI User Interface Design

Communication:

👤 Individual Project
👥 Group Project
📽 Presentation Component
📄 Written Component

Close Window

Figure 22: Assessment Matrix with Icon Legend displayed

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The assessment matrix screen was changed aesthetically by adding heavy borders and an indication of how many total e-portfolios are represented in the matrix. The count is generated dynamically. The View Icon Legend text was made more prominent, and a more detailed icon legend was added.

Information about each project is more detailed in this prototype. While the preliminary design matrix included only the class number and icons for each project, this version provides the class number, project title, icons and in parentheses, the number of actual student projects that are represented by the entry in the matrix. Clicking on the project provides a description of the predefined project (again, this is one of the baseline projects) along with a list of students who have actually completed that project.

Figure 23: Project Description

Individual student projects can be accessed by clicking the student name. This new design gives faculty members and assessment experts the ability to see an overview of the aggregate work that is produced by students in the program (via the matrix), and the ability to quickly drill down to see authentic individual student work.

The database design will be described next, followed by the usability testing and results.

4.2 System Implementation

The high-fidelity prototype described in this chapter was developed using Macromedia Dreamweaver and the same templates that were used for the preliminary design described in Chapter 3. While the preliminary design screens were static Web pages, the high-fidelity prototype is fully functional.

The system resides on a Microsoft 2003 Internet Information Server (IIS) Web server. Microsoft Active Server Pages (ASP) is used to generate screen content dynamically and to interact with the database. The database is a Microsoft SQL Server database. JavaScript functions are used for client-side functionality, such as unchecking groups of checkboxes and handling pop-up windows.

4.2.1 Database Design

The back-end database for the prototype was implemented using Microsoft SQL Server. Figure 24 depicts the tables within the database and the relationships between the tables. Table 4.1 provides a description of each table.

Table 4.1: E-portfolio Database Tables

Table Name	Description
dbo_Users	Stores the user information. Used to authenticate users during the log on process and to determine user type (i.e. faculty, accreditation professional, student, or system administrator.)
dbo_Portfolios	Stores e-portfolio information, including owner information, greeting text, biography text, resume text, and a link to an image file. Each data record represents an individual student's e-portfolio.
dbo_Projects	Stores project information. Each data record represents a single e-portfolio project within the system. This table can store any project that a student wants to include in his or her portfolio, even those that are not baseline projects.
dbo_Port_Proj	Used to cross-reference an individual students e-portfolio (stored in the dbo_Portfolios table) with the projects in that e-portfolio (stored in the dbo_Projects table.)
dbo_Assessment_Factors	Stores information about the assessment factors (learning outcomes, skills, etc.), including a link to the icon image file, used in the assessment matrix and on the individual project screens.
dbo_Proj_Assess	Used to cross-reference a project (stored in the dbo_Projects table) with the appropriate assessment factors (stored in the dbo_Assessment_Factors table.)
dbo_Approval_Requests	Provides the data representation of the approval queue used in the project approval process. Cross-references the User ID in the dbo_Users table with the Project ID in the dbo_Projects table.
dbo_Predef_Projects	Used to store the baseline projects that are displayed in the assessment matrix.
dbo_Predef_Proj_Assess	Used to cross-reference a project (stored in the dbo_Predef_Projects table) with the appropriate assessment factors (stored in the dbo_Assessment_Factors table.)
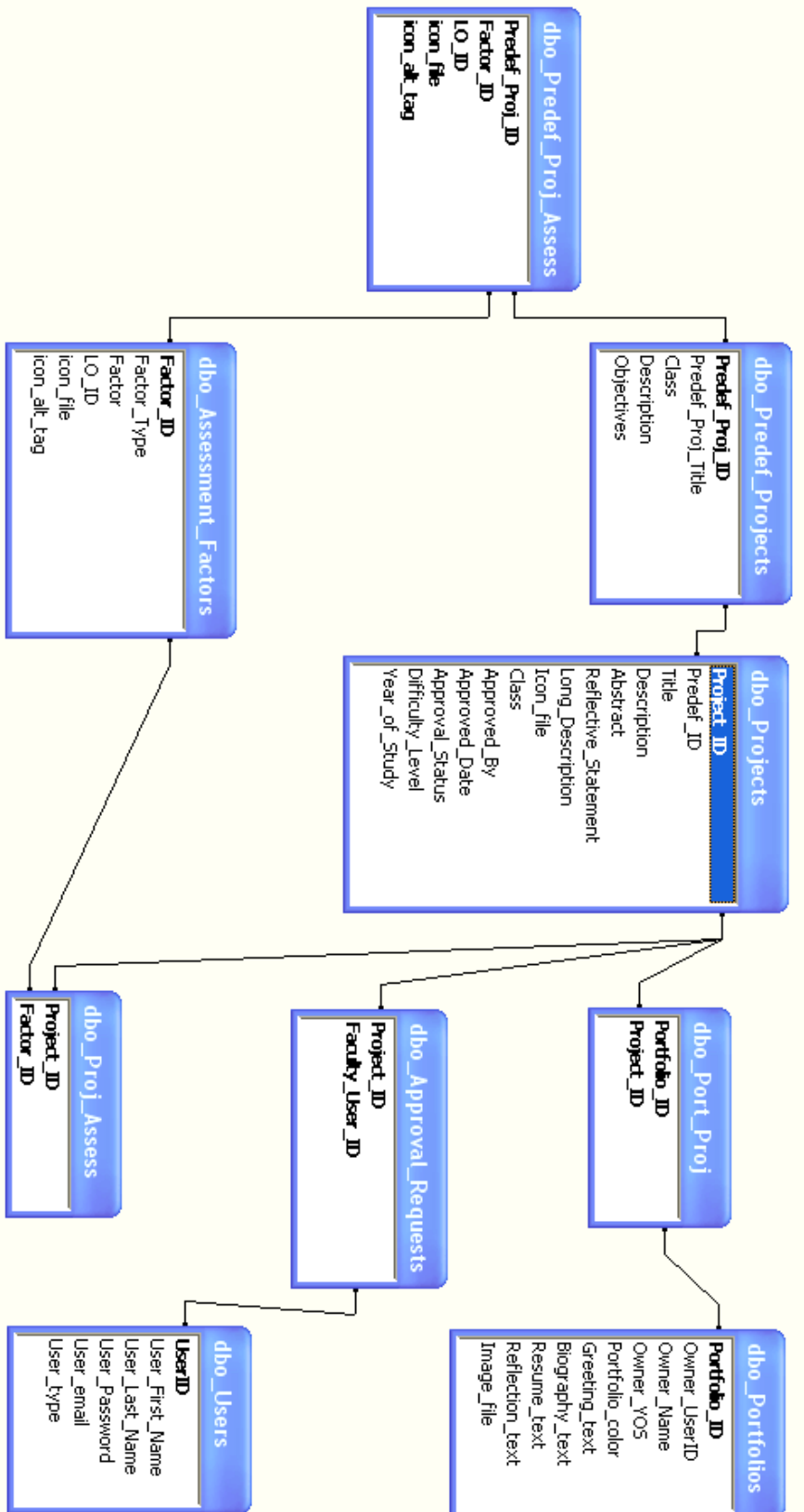
4.3 System Evaluation: Usability Testing

Two Computer Science professors and three university technical staff members (systems administrators, two with a high level of Web programming skills) agreed to evaluate the system and provide feedback. Each user was instructed to complete five sets of tasks and to answer the questions at the end of each set. The technical staff member users were a mixed blessing: they were extremely thorough in testing the functionality (one stated that his goal was to "break this system!") but didn't have a good understanding of the assessment focus. Although each of the technical staff members had completed an undergraduate program in a technical field, none were former Computer Science students and they were not familiar with the Computer Science program.

In an attempt to see whether usability has indeed improved, the tasks used in this round of testing are identical or similar to those used in the first round of testing, but all of the users were new to the system. The same data that was displayed on the screens for the first round of testing was entered into the database for the second round of testing. Therefore, the users were looking at the same assessment data within the new design. Users were asked to use the system to perform specific tasks, and then answer assessment-related questions at the end of each tasks. Questionnaires and usability testing materials are included in Appendices C - F. The sections that follow describe the tasks, user feedback and recommendations for changes, for each of the following sets of tasks:

The five sets of tasks were as follows:

1. Log on.

2. View student e-portfolios (one directed, one user's choice).

3. View the list of projects awaiting approval and approve a project.

4. Construct assessment matrices (one directed, two user's choice).

5. Log off.

4.3.1 Task I: Logging On

The tasks and results were identical to Task 1 of the first round of testing. While this task wasn't being evaluated, users had to log on to the system in order to complete the rest of the tasks.

4.3.2 Task II: Viewing Individual Student e-portfolios

Users were asked to view a specific portfolio, read through the biography, and then view another student's e-portfolio.

Tasks:

1. View Halie Dunne's portfolio

2. Read Halie's biography

3. Go back to your Welcome page

4. Complete Question 2 on the next page

5. View another portfolio

6. Go back to your Welcome page

Task II Results

All users were able to locate Halie's e-portfolio quickly and easily. Each user located and read the biography. Two users seemed to enjoy the biography; one exclaimed "oh, cool picture!" while another mused "shop, shop, shop!" (referring to a statement in the biography text.)

Each user navigated back to the list of e-portfolios to view an additional e-portfolio. Two selected Nick Mareno's e-portfolio, stating that they wanted to "check out

a freshman." All users browsed quickly through the e-portfolios and returned to the Welcome page. Three of the five users used the new breadcrumbs navigation to return to the Welcome page.

After viewing Halie's e-portfolio and returning to the Welcome screen, users were asked to answer briefly describe the photograph in Halie's biography. Four of the five users were able to describe the photograph.

4.3.3 Task III: Approving Student Projects

Users were asked to view the list of projects awaiting approval, then view and approve a specific project.

Tasks:

1. View the list of projects awaiting your approval.

2. View Rachel Peterson's Ethics Paper.

3. Approve Rachel Peterson's Ethics Paper.

4. Complete Question 3 on the next page.

Task III Results

The project approval process in the preliminary design suffered a number of usability issues, as described in Chapter 3. These problems were largely solved in the redesign. All of the users were able to navigate to the project approval screen. Each user was able to view the project specified, and each user noticed that the project opened in a new window. Four of the five users clicked the Approve button on the Individual Project Approval Screen (Figure 16), while one user simply closed the screen and checked the Approve checkbox on the Project Approval Screen (Figure 15.)

Despite considerable improvement in this process, a significant usability issue remained. Three of the five users navigated away from the screen, using the breadcrumbs

navigation or the browser's back button, without clicking the Submit button to save changes. It is recommended that a function be programmed so that users are prompted to submit changes before navigating away from the screen.

After approving a project, users were asked to complete Question 3: How many projects are now awaiting your approval? Despite the fact that only 60% of the users saved the changes and actually approved the project, all users (100%) responded with "3", which would be the correct answer if the changes had been saved.

4.3.4 Task IV: Using the Assessment Matrix

The final set of tasks required the users to configure assessment matrix, then answer a set of assessment-related questions while viewing the matrix.

Tasks:

1. Construct an assessment matrix in which the rows are made up of Learning Outcomes and the columns are Year of Study. View all projects; do not filter any out.

2. View the matrix that you have created.

3. Expand the second Learning Outcome.

4. Contract the second Learning Outcome.

5. Complete Questions 4 – 6 on the next page.

6. Construct an assessment matrix of your choosing. View all projects; do not filter any out.

7. Complete Question 7.

8. Construct an assessment matrix of your choosing. View all projects; do not filter any out.

9. Complete Question 8.

Task IV Results

All users were able to complete the tasks quickly and successfully, but the resulting matrices were virtually meaningless to the technical staff. While the professors had favorable comments about the value of the assessment matrix for assessment, some responses to the assessment-related questions did not seem as promising as did the responses to similar questions asked in the first round of user testing. However, even though the technical staff lacked the background in assessment, most were able to observe patterns in the data and use the patterns to draw some conclusions about the assessment data.

Responses to Question 4: Based on the [Learning Outcome X Year of Study] matrix data, what conclusions can you draw about the number of oral presentations completed by the "average" CS student as he/she progresses through his/her study?

1. 3

2. Oral presentations don't start until junior year, more done in senior year

3. Oral presentations are not spread out over course of study, only in junior year

4. None until junior year

5. Focus is junior year

Responses to Question 5: Based on the [Learning Outcome X Year of Study] matrix data, what conclusions can you draw about the number of group projects completed by the "average" CS student as he/she progresses through his/her study?

1. 1

2. Many projects done in the first year, then the number is the same for 2nd – 4th years

3. Only one group project in the junior year

4. Mostly freshman projects

5. Concentrated in the junior year

Responses to Question 6: Based on the [Learning Outcome X Year of Study] matrix data what can you ascertain about the diversity of projects represented?

1. Individual projects make up the majority – 8/15, followed by oral – 1/3, written – 1/3 and group – 1/15.

2. Second and third years have many diverse projects

3. Not enough written and oral exercises in freshman and sophomore years. Not enough group projects throughout

4. Seven different icons, ethics [have the] fewest [projects represented]

5. Four types of projects [represented] – individual, group, written, oral

Responses to Question 7: Based on the matrix data (note that each participant constructed a matrix of his or her choosing) what conclusions can you draw about the diversity of projects represented and the growth of the "typical" student?

1. That it depends strongly on which data is [filtered out in the filter screen].

2. The typical student does progressively more projects until their senior year.

3. Junior year is diverse, seemingly more intense than other years. Other years not diverse enough.

4. No conclusions.

5. Student progresses from easy, individual projects to overview of all [skills], back to concentration on individual, oral and written in senior year.

Responses to Question 8: Based on the matrix data (note that each participant constructed a matrix of his or her choosing) what conclusions can you draw about the diversity of projects represented and the growth of the "typical" student?

1. That it depends strongly on which data is [filtered out in the filter screen].

2. Easy projects are all individual, harder projects involve group, written and oral presentations on a broad array of subjects.

3. Junior year is diverse, seemingly more intense than other years. Other years not diverse enough.

4. Easy to track number of projects in each category, but I don't know what you mean by "typical student" [user did not understand how the aggregate data displayed by the matrix related to a "typical" student.]

5. From individual, progresses to emphasis on group and oral, then heavily on written in senior year.

4.4 Conclusion

Overall, there were significant improvements in usability. None of the users were able to "break the system" even though some deviated from the task list to explore the various options. Although the technical staff members lacked assessment knowledge, most were able to observe patterns in the data and use the patterns to draw some conclusions about the assessment data. After completing this round of usability testing, I felt that the system was robust and usable enough to conduct the final experiment.

This concludes the description of how the e-portfolio system prototype was designed and implemented using the user-centered design methodologies. Again, user feedback was gathered after each design phase, from low-fidelity prototypes that included

pencil sketches and flowcharts, to the high-fidelity prototype that was described in this chapter. Incorporating user feedback early and often made it possible to avoid implementing a poor design, and I feel that the final prototype was of high quality to use it for an assessment experiment.

Chapter 5 describes how an empirical evaluative study was conducted to compare the system to the existing method of assessing e-portfolios in the Department of Computer Science, critiques the software and methodologies, and provides recommendations for future work.

CHAPTER V: SYSTEM EVALUATION AND FUTURE WORK

An informal experiment was conducted to assess the effectiveness of the e-portfolio software for outcomes assessment purposes. The experiment was designed to compare the e-portfolio software to the existing method of assessing the Computer Science e-portfolios. Thirteen UM faculty members and administrators were recruited for the between-subjects test, and the final prototype was seeded with data from 18 individual student e-portfolios that were completed in CS415 in 2002 and 2003. Each participant used either the student e-portfolios or the software prototype to answer a number of assessment-related questions.

The study led to a number of interesting and significant results that indicate that after linking assessment data to e-portfolio artifacts, the software prototype minimizes some of the drawbacks associated with using e-portfolios for program outcomes assessment. The results support the hypothesis that e-portfolios can be an effective means of program assessment.

5.1 Experiment Design

The between-subjects experiment was designed to compare software prototype to the current method of assessing the e-portfolios. The e-portfolios completed by CS415 students are essentially static Web pages. It is important to note that when the students created their e-portfolios, they were given a set of core requirements, along with substantial artistic and creative freedom. Therefore, while the content is often similar, the look and feel is quite unique for each e-portfolio.

Eighteen of the current e-portfolios were included in the experiment. The e-portfolios used in the experiment were selected based on whether or not we had

permission from the student; that is to say, selection was not on based quality or how well they would "fit" into the software. Each individual e-portfolio project was carefully reviewed to determine the course number, project description, learning outcomes and skills associated with the project. These parameters were then entered into the database. When this was finished, the software prototype represented the same information that was displayed in the individual e-portfolios.

Thirteen University of Montana faculty members were recruited to participate in an evaluative study. The participants included former Associate Provosts, a Dean and a former Dean. Participants came from four schools and seven academic programs: Information Systems (School of Business Administration); Curriculum & Instruction and Educational Leadership (School of Education); Media Arts (School of Fine Arts); and Anthropology, Communications Studies, and Computer Science (College of Arts and Sciences). Ten of the participants were male and three were female. Twelve were tenured or tenure-track. All were between the ages of 30 and 60. None of the participants had viewed or used the software prior to the experiment.

Of the thirteen participants, six were randomly chosen for the control group and seven for the experimental group. The control group had access only to the 18 e-portfolios that were created by the CS415 students. The control group was provided with a list of links to the e-portfolios. The experimental group had access only to the e-portfolio software.

When they arrived for testing, participants were told that the goal of the study was to evaluate the effectiveness of the software prototype compared to the existing portfolios in terms of program assessment. Participants were asked to approach the study as though

they were external reviewers looking at the e-portfolios for assessment purposes. They were given a questionnaire and asked to evaluate the e-portfolios. A time limit of 45 minutes was imposed on all participants. Although the experiment was not designed to evaluate system usability, participants in the experimental group were not assisted or directed in any way while using the software. Thus, they were required to learn how to navigate the software as well as how to use it effectively to answer the assessment-related questions. When participants were finished, they were asked to speak frankly about the system that they used.

5.2 Results

5.2.1 Quantitative Results

The questions were divided into three groups for analysis. The questions listed in Table 5.1 have a clearly correct or incorrect answer. The questions in Table 5.2 are more subjective in nature. The goal of these questions was to find out whether the participants could draw a firm conclusion, even though the conclusion may be somewhat based on opinion. Questions about assessing individual students are listed in Table 5.3. The last set of questions, listed in Table 5.4, had multiple parts and they were analyzed by looking at overall percentages of correct responses. The questionnaire and related materials may be viewed in Appendices G - I.

Again, the questions listed in Table 5.1 have a correct answer. The questions are listed here, along with the percentages of each group that answered them correctly, and the percentages of each group that responded "Cannot Determine." The percentages of incorrect answers are not included in the table since they can be derived easily from the other numbers.

Table 5.1: Questions with a correct answer

	Correct Response		Cannot Determine	
Question	**Control group**	**Exp group**	**Control group**	**Exp group**
1. Based on the data, do you feel that the number of group projects increases during each year of study?	0%	71%	67%	14%
2. How many projects that involve programming are represented during each year of study?	8%	0% *	83%	0%
3. Are oral presentations represented during each year of study?	0%	71%	100%	0%
4. Are projects with a written component represented during each year of study?	50%	71%	33%	0%

* When answering Question 2, users in the experimental group failed to understand that the parenthetical number listed next to each project indicated the total number of projects represented. They correctly answered this question in terms of recognizing the programming projects, but they were incorrect in the overall numbers.

A quick scan of the data in Table 5.1 confirms that the experimental group answered the questions correctly more of the time, while the control group answered "Cannot Determine" most of the time.

In the case of Question 2, all of the experimental group members selected the incorrect response due to what might be considered a usability issue. In this case, the users failed to understand that the parenthetical number listed next to each project indicated the total number of projects represented. While all of the users answered this question correctly in terms of recognizing programming projects, they were incorrect in the actual number of programming projects that were represented.

The questions listed in Table 5.2 do not necessarily have a correct or incorrect answer. Responses to these questions are highly subject to the opinion of the participant and the parameters are not well defined. For instance, what is a "good mix" of skills? What is adequate breadth and variety? Since the questions are subjective, they have been analyzed based on whether the participants could strongly respond Yes or No as opposed to cannot determine. Although the differences aren't as striking as the questions in Table

5.1, the experimental group, overall, responded with "Cannot Determine" less often than

did the control group.

Table 5.2: Questions with results that may be subjective: Percentage of participants that responded *Yes* or *No*

Question	Control group	Experimental group
5. Can you strongly state that there is a good "mix" of Computer Science skills and communication skills represented in the data?	67%	100%
6. Can you strongly state that there is a good "mix" of individual and group projects represented in the data?	67%	86%
7. Based on the data, can you strongly state that there is a change in the complexity of student projects as students progress through their study?	50%	86%
8. Based on the data, can you strongly state that the breadth or variety of projects is adequate?	50%	100%
9. Based on the data, can you strongly state that the breadth or variety of projects increases throughout an individual student's years of study?	50%	100%

Questions about assessing individual students are listed in Table 5.3. These

questions are analyzed separately since one of the primary research questions addresses

individual student growth. Just over two-thirds (67% and 71%) of the members of each

group felt that the e-portfolios could be used to assess the growth of an individual

student.

Table 5.3: Questions that address individual student assessment

Question	Yes		No or Cannot Determine	
	Control group	Experimental Group	Control group	Experimental Group
10. Based on the data, do you feel that you can assess the growth of an individual student?	67%	71%	33%	29%
11. For an individual student, can you get a sense for what projects he/she has completed?	83%	100%	17%	0%

Table 5.4 contains questions with multiple parts. These questions have multiple

right or wrong answers, and have been analyzed by determining the percentage of

participants in each group who got the answer 100% correct. About half of the

experimental group, and none of the control group, answered these questions

successfully.

Table 5.4: Questions with multiple parts: results show the percentage of participants who got the answer 100% correct

	Control group	Experimental group
12. Check any Computer Science skills you see represented in (all—the aggregate or combination of all) electronic portfolios? If unsure, leave unchecked. *This question was followed by 15 core Computer Science skills.*	0%	43%
13. Assuming you don't know much about our Computer Science program, can you guess what learning objectives are important to us? Please list.	0%	57%
14. Assuming that you don't know much about our Computer Science program, can you guess what skills are important to us?	0%	43%

5.2.2 Hypothesis and research questions

Overall, the quantitative results strongly support the hypothesis: The software enables faculty members, administrators and accreditation professionals to efficiently and consistently:

- track and aggregate student work to compare the results with program objectives,

- evaluate the breadth, diversity and complexity of student work, and

- monitor individual student growth.

Clearly, the software aggregates e-portfolio artifacts and links them directly to program objectives. Without necessarily knowing what the learning objectives were, 57% of the experimental group members were able to list the objectives while using the software. In terms of evaluating breadth, diversity and complexity of student work, all (100%) members of the experimental group indicated that the software prototype could be used to determine whether the breadth and variety of student projects is adequate, and whether breadth and variety increases through a student's years of study. All (100%) of the experimental group members were able to state an opinion about whether a good mix of Computer Science and communication skills are represented in the e-portfolio data. Data from the control and experimental groups (67% and 71%, respectively) suggests that e-portfolios are a good way to assess individual student growth.

The research questions are addressed individually here.

Can e-portfolio software be developed that will enable faculty and accreditation experts to …

- track and aggregate student work efficiently, and compare results with departmental objectives?

    Yes. The e-portfolio software allows the user to quickly and efficiently construct a matrix that aggregates student work and maps the data directly to departmental learning objectives.

- evaluate the program outside the confines of an individual course?

    Using the e-portfolio software, experiment participants were able to assess four years of study for 18 students. Users were able to count projects that involved specific skills for all four years of study. They were also able to detect whether particular skills (i.e. oral and written communication) were (or were not) represented during each year of study. Users were also able to evaluate changes in complexity, variety and diversity of student projects throughout the four-year program. All of these factors are related to assessment outside of the confines of an individual course.

- evaluate the breadth and diversity of projects?

    As indicated by the responses to Questions 8 and 9, all (100%) of the experimental group members indicated that the software prototype can be used to determine whether the breadth and variety of student projects is adequate and whether or not breadth and variety changes throughout a student's four years of study.

- monitor change in complexity and diversity of student work?

    Users of the e-portfolio software are able to monitor change in complexity and diversity of student work by looking at the icons associated with the student projects. A greater number and variety of icons associated with a particular project suggest that more skills have been integrated into that project. The projects in the third and fourth years of study incorporate many of the skills learned early on. Of the experimental group members, 86% reported that they could detect a change in project complexity over four years of study, and 100% reported that they could recognize change in breadth and diversity (variety) of projects. Only half (50%) of the control group members could report changes in complexity, breadth and diversity.

- monitor individual student growth?

    Data from the control and experimental groups (67% and 71%, respectively) suggests that the e-portfolios provided a means to monitor individual student growth. All (100%) members of the experimental group and most (83%) of the control group reported that they could get a sense of what projects an individual student had completed.

The quantitative data supports the hypothesis and research questions. Quantitatively, the experiment was a success and indeed, e-portfolios are a viable means of program assessment. Beyond the quantitative data, though, there were numerous qualitative and anecdotal comments and suggestions that are significant and quite interesting.

5.2.3 Anecdotal Observations

A number of anecdotal observations were made during testing and in post-test interviews. First, members of the control group clearly enjoyed going through the individual student portfolios, spent a lot of time looking at them, and made a number of favorable comments about the individuality and creativity of each one. Control group members also seemed to read through the contents of the e-portfolios, and noticed more details in each one. Some of the comments were as follows (all are verbatim):

- "I like the way this one is layed out."

- "This one is hard to read [due to color choices]. The layout is cool though."

- "Oh, the beer recipe must've been a group project. I noticed it in some of the others."

- "Were the projects self-selected? It makes sense that the later projects were selected."

- "Hmmm, some of the spelling in these essays is…… creative."

- "I like that he has 'things I would have done differently' – this gives them the ability to be reflective and reflexive."

- "The first program I wrote, oh, I love it!"

- "Each portfolio is different."

- "I like the way she describes these also – more clear, written in plainer English."

- "I like this because it doesn't say it was done for a class, but focuses on what he has done."

The experimental group, on the other hand, did not seem to enjoy the individual e-portfolios as much, nor did they spend a lot of time looking at them. This suggests that

standardizing the project strips many of the benefits of presentation portfolios. However, a number of favorable comments were made about the operation of the software. Participants were generally quite impressed with how the matrix mapped the student projects directly to the assessment factors. They were impressed with the variety of possible matrix configurations, and with the way the learning outcomes can be expanded to display individual skills. Some comments made by members of the experimental group are as follows:

- "I like the way you can expand the rows."
- "It's easy to look across the matrix to see that some projects are meeting many outcomes, particularly during the senior year."
- "You really need a baseline of projects for more effective assessment."
- "It seems like there is a big gap in the sophomore year, but I can't determine why. Is it due to the curriculum or due to the fact that students take classes outside of the CS department during the sophomore year?"
- "The icons give you the cue." [in reference to the question about complexity]
- "I can't see the quality of the work that was done. This is a good way to see descriptions of the projects, but not necessarily the result of the project. I need to see the assessment that the instructor made of the project."
- "Bad is as important as good in assessment."
- "This is pretty slick. It is easy to use once you figure out what it does."

5.3 Lessons Learned

The participants in the final system evaluation were a much larger and more technically diverse group than any of the usability testing participants. This group

uncovered numerous usability issues in the software prototype. Since the final experiment was not focused on usability, the issues were not adequately documented and certainly won't be explored in this short chapter. However, usability testing with a technically diverse group should be conducted during any future work.

Several lessons were learned in terms of methodology and experiment design. A few of the participants criticized the experiment, remarking that it is difficult to assess a program without first knowing the assessment criteria, and therefore the study was geared toward the success of the software prototype. This problem may have been alleviated by providing each participant with a copy of the CS department's learning objectives, which the experimental group could easily identify while viewing the matrix. For many of the questions, though, participants from both groups were at an equal disadvantage in this regard. Still, the criticism is valid. Certainly an external reviewer would not be asked to assess a program without first having a chance to review the assessment criteria.

Another criticism is that the existing e-portfolios look more like "professional" portfolios and are probably not adequate for assessment. The projects in the current e-portfolios were self-selected by students, and in many cases, represent the students' best work. Some participants would like to see a baseline of projects, or the ability to show all projects. One participant noted that the current e-portfolios show no indication that the students understand the criteria against which they are being assessed. Additionally, some of the participants would like to see instructor comments and assessment information included with the student work.

The last criticism underscores the purpose of the e-portfolio software. As described in the literature review, there are a number of different types of portfolios with

different purposes. Since the software prototype was designed for program assessment, it is appropriate to define a baseline of projects, and then assess those projects consistently over time according to a standard set of criteria.

5.4 Future Work

There are a number of implications for future work in terms of system development and research activities. Based on comments from the experiment participants, a number of changes might be made to the existing system. For instance, while the approval of artifacts is probably necessary, this process should be expanded to include assessment comments and information from the faculty members who evaluate the student projects. Grading information may also be included with each artifact. While instructor comments and certainly grades should not be publicly available in student e-portfolios (or even necessarily available to the student who completed the project) this information should be available to faculty and accreditation experts.

Additionally, the level of difficulty assessment factor is fairly meaningless in the current context. What is difficult for a freshman probably isn't difficult for a senior. It would be interesting to replace this with an assessment factor that is more focused on the assessment of the completed project, such as proficiency level.

In terms of system development, an important next step is to implement the student and system administrator functionality. It is recommended that the software include a means for students to create and maintain all three types of portfolios, especially a professional (showcase) e-portfolio that may be made available (or unavailable) to guests as desired. The system should provide students with a high level of customization for their own e-portfolios, while still maintaining a structure in which

they can be assessed objectively. A means to customize, individualize and present his or her best work in the e-portfolio is motivating to the student, and based on the anecdotal comments, seems important to the assessment process.

5.5 Conclusion

Authentic assessment of student work is beneficial students, academic programs and to the University. While other forms of assessment, such as test scores, provide a snapshot of student performance, e-portfolios have the potential to provide a long-term picture of student, instructor, and program performance.

This paper described one way that e-portfolios can be used for authentic assessment of student work and to provide the data necessary for outcomes assessment. While a software system is helpful in streamlining these tasks, however, the real challenge may be in integrating e-portfolios into the curricula and culture of programs and schools. An e-portfolio program has the potential to improve the assessment process, and to involve students and faculty, more than ever, in the assessment process. While the challenges are great, so may be the benefits.

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APPENDIX A: MATRIX SCREENSHOTS FROM E-PORTFOLIO SOFTWARE

Figure25: Alverno College *My Portfolio* student matrix.

Figure 26: Bowling Green University student e-portfolio matrix.

APPENDIX B: HTML PRELIMINARY PROTOTYPE USABILITY TESTING TASK LIST

Please complete the tasks in order following tasks in order.

1. Open Internet Explorer
2. Browse to http://cs295.cs.umt.edu/~mholmes/thesis/
3. Log on using Username **xxxx** and Password **xxxx**
4. Complete Question 1 on the next page.

5. View the list of projects awaiting your approval.
6. View Mary Johns' Ethics Paper.
7. Approve Mary Johns' Ethics Paper and Joe Adams' Ethics Paper.
8. Complete Question 2 on the next page.

9. View Halie Dunne's portfolio
10. Read Halie's biography
11. Go back to your Welcome Page
12. Complete Question 3 on the next page.

13. Construct an assessment matrix in which the rows are made up of Learning Outcomes and the columns are Year of Study. View all projects.
14. View the matrix.
15. Expand the second Learning Outcome
16. Contract the second Learning Outcome
17. Complete Questions 4 – 6 on the next page.

18. Log off

APPENDIX C: USABILITY TESTING PARTICIPANT CONSENT FORM

You are invited to participate in a research study conducted by Melissa Holmes of the University of Montana, Department of Computer Science.

During the first session, you will be presented with a series of tasks that involve locating information in the Electronic Portfolio software and drawing conclusions about the information presented. You will be requested to complete a questionnaire while performing the tasks.

We estimate that the test session will take 15-20 minutes.

It is important that you realize that during these studies, *it is the design of software that is being tested, not your data manipulation skills*. There is no time limit imposed, and it is not critical for you to finish any of the tasks. In many places, the instructions are purposefully abstract because my goal is to design intuitive interfaces that don't require complex training or manuals to operate. I ask that you try to complete each task as best as you can. If you get really stuck on any particular task, and it appears that you are unable to continue, I will let you know when it's okay to move on. Please remember that it's okay if you get stuck – this just means that the interface needs more work!

Your interaction with the software will be videotaped (including audio) for later analysis. Only your voice and keyboard activity will be recorded during these sessions.

The risks associated with participating in this study are deemed to be minimal. That is, you will not be subjected to any pain or stress beyond that normally encountered in everyday life. Any information that is obtained in connection with this study that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Subject identities will be kept confidential by assigning each subject a code number. All data will be marked and identified using this code number. No personal information for any participant will be attached to the data. All videotapes will be kept in a secure location at all times during and after the study. The tapes will be destroyed after our group presents our results in class. Only my advisor, Dr. Yolanda Reimer, and I will be allowed to view the videotape. In no case will the data be made further available without your additional prior consent.

Your participation is voluntary. Your decision whether or not to participate will not affect your relationship with the University of Montana in any way. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without penalty.

If you have any questions, please feel free to contact Yolanda Reimer (243-2883) in the Computer Science Department at any time.
You will be offered a copy of this form to keep. Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation without penalty, that you will receive a copy of this form, and that you are not waiving any legal claims, rights or remedies.

Signature _____Date_____

Addendum: Express Consent for Videotaping
I have received an adequate description of the purpose and procedures for videotaping sessions during the course of the proposed research study. I give my consent to allow myself to be videotaped and audiotaped during my participation in both sessions of this study, and for those videotapes to be viewed by persons involved in the study, as well as for other academic purposes as described to me. I understand that all information will be kept confidential and will be reported in an anonymous fashion. I understand that the videotapes will be kept on file only through the end of the current semester. I further understand that I may withdraw my consent at any time.

Signature _____Date_____

APPENDIX D: USABILITY TESTING TEST SCRIPT

Hello. My name is Melissa Holmes, and my goal today is to conduct usability testing on a software product that will be used to evaluate a Computer Science program based on its students' electronic portfolios. Thank you for volunteering your time to help me test this new this software product. I will be reading from this script to ensure consistency between all of our participants.

Now a little about the software. The Electronic Portfolio software that you see today is a key component of a much larger system that may be developed. The product has been developed specifically to evaluate its usefulness in assessing a Computer Science program, based on electronic portfolios created by students.   The software that you look at today does not provide functionality for students to create portfolios; only for faculty members and accreditation experts to evaluate them. The software will allow you to look at student work a variety of different ways to attempt to determine whether, overall, students are meeting the learning objectives set out by the department. Specifically, we want to answer the following questions:
- Will the electronic portfolio software enable faculty and accreditation experts to evaluate how well the Computer Science department is measuring up to stated learning outcomes?
- Will the software enable faculty and accreditation experts to track and aggregate student work and compare results with departmental objectives?
- Will the software enable faculty to evaluate and monitor individual student growth over time?
- Will the software enable faculty to determine whether there are "gaps" in the program?

Understand that this exercise is to test the product and its usability and in no way implies your abilities. If at any time you feel uncomfortable, please inform us and we will terminate the exercise immediately. (We will be recording this exercise so that we can gather as much information as possible from this session.)

Your opinion and ideas are important to me. Whenever possible, please speak your thoughts freely. Do not be concerned about offending me. If you forget to think aloud, I'll remind you to keep talking.

As you're working through the software, I won't be able to provide help or answer questions. This is because we want to create the most realistic situation possible. Even though I won't be able to answer your questions during the exercise, please ask them. We'll note your questions and answer them at the end of the exercise.

Do you have any questions before we begin?

APPENDIX E: USABILITY TESTING TASK LIST AND QUESTIONNAIRE

Please complete the tasks in order following tasks in order.

1. Open Internet Explorer
2. Browse to http://mtod211.gs.umt.edu
3. Log on using Username _____ and Password _____
4. Complete Question 1 on the next page.

5. View Halie Dunne's portfolio
6. Read Halie's biography
7. Go back to your Welcome Page
8. Complete Question 2 on the next page.
9. View another portfolio
10. Go back to your Welcome Page

11. View the list of projects awaiting your approval.
12. View Rachel Peterson's Ethics Paper.
13. Approve Rachel Peterson's Ethics Paper.
14. Complete Question 3 on the next page.

15. Construct an assessment matrix in which the rows are made up of Learning
    Outcomes and the columns are Year of Study. View all projects; do not filter any
    out.
16. View the matrix that you have created.
17. Expand the second Learning Outcome
18. Contract the second Learning Outcome
19. Complete Questions 4 – 6 on the next page.

20. Construct an assessment matrix of your choosing. View all projects; do not filter
    any out.

21. Complete Question 7.

22. Construct another assessment matrix of your choosing. View all projects; do not
    filter any out.
23. Complete Question 8.

24. Log off

Questions:

1. What is the first thing you notice after you log in?

2. Briefly describe the photograph in Halie's biography.

3. How many projects are now awaiting your approval?

4. Based on the matrix data, what conclusions can you draw about the number of oral presentations completed by the "average" CS students as he/she progresses through his/her study?

5. Based on the matrix data, what conclusions do you draw about the number of group projects that the "average" student completes as he/she progresses through his/her study?

6. Based on the matrix data, what can you ascertain about the diversity of projects represented?

7. Based on the matrix data, what conclusions can you draw regarding the diversity of projects represented and growth of the "typical" student?

8. Based on the matrix data, what conclusions can you draw regarding the diversity of projects represented and growth of the "typical" student?

APPENDIX F: USABILITY TESTING DATA CAPTURE LOG

Participant #	Date	Time
Scenario #/Task #	Task Description	Comments
1/1	Open Internet Explorer	
1 /2	Browse to site	
1 /3	Log in	
2 /1	View Halie's portfolio	
2/ 2	Return to Welcome Page	
2 /3	View another portfolio	
2 /4	Return to Welcome Page	
3/1	View list of projects awaiting approval	
3/2	View Rachel's Ethics paper	
3/3	Approve Rachel's Ethics paper	
4/1	Construct matrix – lo-x-yos	
4/2	Expand Learning outcome	
4/3	Contract Learning outcome	
4/4	Construct another matrix	

APPENDIX G: FINAL EXPERIMENT IRB APPROVAL

PROPOSAL #_203—04_
Form RA-108
(Rev. 11/03)

The University of Montana
INSTITUTIONAL REVIEW BOARD (IRB)
CHECKLIST

Submit one completed copy of this Checklist, including any required attachments, for each project involving human subjects. The IRB meets monthly to evaluate proposals, and approval is usually granted for one year. See *IRB Guidelines and Procedures* for details.

Project Director: _Melissa Holmes_ Dept.: _Computer Science_ Phone: _4556_

E-mail: _melissa.holmes@umontana.edu_

Signature: _____ Date: _11/3/04_

Co-Director(s): _Yolanda Reimer_ Dept. _Computer Science_ Phone: _4556_

Project Title: _Developing Electronic Portfolio Software for Assessment Purpose..._

Project Description: _Electronic portfolio software has been developed to standardize_
(in non-technical language) _students' electronic portfolios and assess them against_
...ed learning outcomes. This experiment will compare existing portfolios that
...e publicly available on the Web to the same portfolio data entered into
...e software.

All investigators, including faculty supervisors, on this project must complete the self-study course on protection of human subjects, available at the UM IRB website: http://www.umt.edu/research/irb.htm.
Certification: I/We have completed the course - (Use additional page if necessary)

Signature	Date	Signature	Date
[signature]	_11/3/04_		
Yolanda J. Reimer	_11/4/04_		

Students Only:
Faculty Supervisor: _Dr. Yolanda Reimer_ Dept. _Computer Science_ Phone: _x4618_
Signature: _Yolanda J. Reimer_
(My signature confirms that I have read the IRB Checklist and attachments and agree that it accurately represents the planned research and that I will supervise this research project.)

For IRB Use Only

IRB Determination:

_X_ Approved Exemption from Review —— Exemption #_2_

___ Approved by Expedited/Administrative Review

___ Full IRB Determination:
___ Approved
___ Conditional Approval (see attached memo)
___ Resubmit Proposal (see attached memo)
___ Disapproved (see attached memo)

Signature IRB Chair: _Sheila Hoffland_ Date: _11/12/04_
(over)

APPENDIX H: CONTROL GROUP QUESTIONNAIRE

Thank you for taking part in this study. Unless otherwise specified, please answer the questions while considering *all* students, not just one particular student (i.e., in most cases we are looking for aggregate student data rather than data representing one individual). Please be truthful when responding to each question. If you cannot determine the answer to a question, check Cannot Determine. Although we may not be able to help you in all cases, please do not hesitate to ask if you have questions.

1. Based on the Electronic Portfolios, do you feel that the number of group projects increases during each year of study? Why or why not?
    ☐ Yes
    ☐ No
    ☐ Cannot determine
    Comments:_____

2. How many projects that involve programming are represented during each year of study?
    Year 1: _____
    Year 2: _____
    Year 3: _____
    Year 4: _____
    ☐ Cannot determine
    Comments:_____

3. Check any Computer Science skills you see represented in (all – the aggregate or combination of all) electronic portfolios? If unsure, leave unchecked.
    ☐ Programming
    ☐ Algorithms
    ☐ Architecture
    ☐ Data Structures
    ☐ Operating Systems
    ☐ Artificial Intelligence
    ☐ Networking
    ☐ Data Visualization
    ☐ Scientific Computing
    ☐ Data Modeling
    ☐ Theory of Programming Languages
    ☐ Database Systems
    ☐ Software Engineering
    ☐ Computer Ethics
    ☐ User Interface Design
    ☐ Cannot determine
        Comments:_____

4. Based on the Electronic Portfolios, can you strongly state that there is a change in the complexity of student projects as students progress through their study? Why or why not? If so, please comment on the change you see.
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

5. Can you strongly state that there is a good "mix" of Computer Science skills and communication skills represented in the Electronic Portfolios? Why or why not?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

6. Can you strongly state that there is a good "mix" of individual and group projects represented in the Electronic Portfolios? Why or why not?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

7. Are oral presentations represented during each year of study?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

8. Are projects with a written component represented during each year of study?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

9. Based on the Electronic Portfolios, can you strongly state that the breadth or variety of projects is adequate? Why or why not?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

10. Based on the Electronic Portfolios, do you feel that there are "gaps" or areas that need improvement? Why or why not?
 ☐ Yes
 ☐ No
 ☐ Cannot determine
 Comments:_____

11. Based on the Electronic Portfolios, can you strongly state that the breadth or variety of projects increases throughout an individual student's years of study? Why or why not?
 ☐ Yes
 ☐ No
 ☐ Cannot determine
 Comments:_____

Please answer the next two questions based on individual students.

12. Do you feel that you can assess the growth of an individual student based on the Electronic Portfolio? Can you give an example for any one particular student?
 ☐ Yes
 ☐ No
 ☐ Cannot determine
 Comments:_____

13. For an individual student, can you get a sense for what projects he/she has completed?
 ☐ Yes
 ☐ No
 ☐ Cannot determine
 Comments:_____

14. Assuming that you don't know much about our Computer Science program, can you guess what learning objectives are important to us? Please list.

15. Assuming that you don't know much about our Computer Science program, can you guess what skills are important to us? Please list.

16. Based on the electronic portfolios, what conclusions can you draw regarding the diversity of projects represented and growth of the "typical" Computer Science student?

APPENDIX I: EXPERIMENTAL GROUP QUESTIONNAIRE

Thank you for taking part in this study. Unless otherwise specified, please answer the questions while considering *all* students, not just one particular student (i.e., in most cases we are looking for aggregate student data rather than data representing one individual). Please be truthful when responding to each question. If you cannot determine the answer to a question, check Cannot Determine. Although we may not be able to help you in all cases, please do not hesitate to ask if you have questions.

1. Based on the Matrix data, do you feel that the number of group projects increases during each year of study? Why or why not?
   ☐ Yes
   ☐ No
   ☐ Cannot determine
   Comments:_____

2. How many projects that involve programming are represented during each year of study?
   Year 1: _____
   Year 2: _____
   Year 3: _____
   Year 4: _____
   ☐ Cannot determine
   Comments:_____

3. Check any Computer Science skills you see represented in (all – the aggregate or combination of all) electronic portfolios? If unsure, leave unchecked.
   ☐ Programming
   ☐ Algorithms
   ☐ Architecture
   ☐ Data Structures
   ☐ Operating Systems
   ☐ Artificial Intelligence
   ☐ Networking
   ☐ Data Visualization
   ☐ Scientific Computing
   ☐ Data Modeling
   ☐ Theory of Programming Languages
   ☐ Database Systems
   ☐ Software Engineering
   ☐ Computer Ethics
   ☐ User Interface Design
   ☐ Cannot determine
   Comments:_____

4. Based on the Matrix data, can you strongly state that there is a change in the complexity of student projects as students progress through their study? Why or why not? If so, please comment on the change you see.
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

5. Can you strongly state that there is a good "mix" of Computer Science skills and communication skills represented in the Electronic Portfolios? Why or why not?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

6. Can you strongly state that there is a good "mix" of individual and group projects represented in the Electronic Portfolios? Why or why not?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

7. Are oral presentations represented during each year of study?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

8. Are projects with a written component represented during each year of study?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

9. Based on the Matrix data, can you strongly state that the breadth or variety of projects is adequate? Why or why not?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

10. Based on the Matrix data, do you feel that there are "gaps" or areas that need improvement? Why or why not?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

11. Based on the Matrix data, can you strongly state that the breadth or variety of projects increases throughout an individual student's years of study? Why or why not?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

Please answer the next two questions based on individual students.

12. Do you feel that you can assess the growth of an individual student based on the Electronic Portfolio? Can you give an example for any one particular student?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

13. For an individual student, can you get a sense for what projects he/she has completed?
☐ Yes
☐ No
☐ Cannot determine
Comments:_____

14. Assuming that you don't know much about our Computer Science program, can you guess what learning objectives are important to us? Please list.

15. Assuming that you don't know much about our Computer Science program, can you guess what skills are important to us? Please list.

16. Based on the electronic portfolios, what conclusions can you draw regarding the diversity of projects represented and growth of the "typical" Computer Science student?