AC 2008-1374: USING ELECTRONIC PORTFOLIO REPOSITORIES AS A STUDENT RESOURCE FOR MSE APPLICATIONS

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"Aaron Blicblau graduated as materials engineer and worked in the manufacturing and steel industry for ten years. He then commenced lecturing at Swinburne University of Technology specialising in materials science and engineering to students ranging form first year to final year. . He has been involved in implementing novel teaching procedures to improve the learning aspects of students as well as his own teaching processes. Over the past few years he has adopted and implemented active learning measures including problem based and project based learning. During 2007, he was awarded a Carrick Citation for Outstanding Contributions to Student Learning ranging across first to final year engineering."

Using Electronic repositories as a student resource for MSE applications

Abstract

In the majority of engineering disciplines, MSE provides resources and applications with many other areas of engineering, e.g., design, structures, mechanics, and manufacturing. For the students to transfer and implement their MSE knowledge, they must have easy access to all their information. The eportfolio is a repository of the student's entire academic MSE content and provides a wealth of knowledge applicable to all engineering disciplines. This repository combines not only lecture and textbook material, but also every assignment (in assessed format), all quizzes (with answers) laboratory activities (in audiovisual format), student oral presentations (podcast), and lectures in asynchronous format. This allows all of the data and information accumulated by students throughout their varying MSE course collected in one place, and is able to act as a quick resource and information kit for future use as the eportfolio is quickly accessed. Student and graduate responses have been positive especially for those in the workforce who require immediate and correct information.

Introduction

The work outlined in this paper provides details of the activities involved with the design and development of an electronic portfolio (eportfolio) approach to the implementation of a repository of both work undertaken in the area of materials science and engineering (MSE) information retrieved in relevant areas by students of engineering at the university at which I teach. Materials science and engineering (MSE) forms a thread throughout many engineering courses, weaving amongst different subjects and interlacing across different year levels. The course content is often delivered in a variety of modes involving lectures, tutorials, presentations, and laboratory experiments. With the implementation of high capacity electronic storage systems, the retention and retrieval of pedagogical documentation has removed the necessity by students to preserve their academic work in paper format. In the MSE course which I teach, I am implementing an eportfolio of all student work and associated reference material.

The field of MSE is ever increasing with a comprehensive amount of resource information. Access to this information is vital for productive outcomes. The days of the traditional published and written material as the only major source of information has been supplemented by requirements of industry. They now expect graduates with skills (outcomes) not only in their areas of training, but who are also are adept with electronic, (e-forms) of communication and presentation. Electronic-portfolios, commonly referred to as eportfolios are a necessary part of an engineer's toolkit[1, 2]. The eportfolios discussed here are not specifically designed for assessment, but as a repository of information for current and future implementation.

Details are given of an electronic-portfolio, eportfolio, which was developed for use by both junior and senior student. The portfolio encompassed digital, electronic, audio/visual, oral and paper based content. Utilising a variety of portfolio content would enable the student to both learn how to communicate in different media as well as self assess their work in different

contexts[2-5]. Interviews and informal feedback from students and graduates are included in the eportfolio for reflection.

What is a Portfolio?

A portfolio is derived from…*portfolio*…Italian portafoglio : porta-, from *portare*, to carry, from Latin portāre + foglio, sheet (from Latin folium, leaf).…a portable case for holding material, such as loose papers, photographs, or drawings[6, 7].

A portfolio may be considered as a sampling of the breadth and depth of a person's work conveying the range of abilities, attitudes, experiences, and achievements. A student portfolio has been commonly defined as a purposeful collection of student work that exhibits the student's efforts, progress, and achievements in one or more areas[8]. However, a more appropriate definition is that a portfolio is a collection of evidence that is gathered together to show a person's learning journey over time and to demonstrate their abilities. This is the approach taken in the work developed in the materials science and engineering subjects to understanding and implementing engineering concepts[9]. When extending the definition to the graduate experience, the portfolio is considered as a way of documenting all aspects of professional and personal growth when progressing through university and their career. However, not all portfolios are the same. Recent work done in developing portfolio concepts for mathematics education, defined three types of portfolios: showcase (which focused on the student's best and most representative work.), teacher-student (the "working portfolio") and teacher alternative assessment (specific portfolios items are selected for assessment). Each served a different purpose. Selections from each portfolio concept can further be incorporated to design a "holistic" portfolio for engineering applications[10].

Furthermore, other workers in various fields of education, [2, 11]maintain that portfolios provide information about student progress and encourage students to be responsible for their own learning, in the area of music education portfolios are utilised as a resource and learning process. [12, 13]. In this way they feel as though they take more responsibility in their learning and assessment processes. Portfolios are seen to assist students is developing skills necessary for life-long learning; and enable thinking skills with multidimensional forms of evaluation.

Especially in the engineering field, portfolios are produced for a variety of purposes. A well designed portfolio serves four main purposes[14, 15]: it allows academic staff to employ it as a tool for assessment and feedback, it assists prospective employers to evaluate the quality of their new employees, it supports students in developing an ongoing understanding of their achievements, and importantly, it utilises the portfolio as a lifelong resource of information and knowledge garnered over the students' learning experience.

Electronic Portfolios

By collecting electronic versions of various forms of text, video, audio and graphic material into one electronic repository, the *e*collection or eportfolio, becomes a digital container designed to support a variety of educational and industrial purposes within different spheres of education and industr[5, 16]. In particular, electronic portfolios are a creative means of organizing, summarizing, and sharing artefacts, information, and ideas about teaching and/or learning, along with personal and professional growth.[17] When the British Educational Communications and Technology Agency (Becta) commissioned a study to investigate the potential of eportfolios to support learning[18], they concluded that eportfolios benefit learning most effectively when considered as

part of a joined-up teaching and learning approach to include online repositories of data. In Australia, the Carrick Institute for Learning and Teaching (a government funded body to improve and assist the learning and teaching in the tertiary sector) commissioned a study, commencing in May 2007 and ending in June 2008, with the objective to examine the different approaches to portfolios for students[19]. Their research brief is *to investigate eportfolios, in Australian higher education with a view to identifying the scope, penetration and reasons for their use and the potential risks associated with different approaches*. This project has only recently commenced and the results will be available about the middle

Implementation of eportfolios for First Year studies

Of the over 400 students enrolled in first year engineering at Swinburne University of Technology (SUT) approximately three quarters are enrolled in the subject HES1230 Materials and Processes, a first year course in materials science and engineering. The engineering disciplines at SUT comprise mechanical, civil, electronic & electrical (EE).and product design engineering (PDE). Only the students enrolled in EE do not have MSE as a compulsory subject (but is available as an elective). This subject, HES1230, is only one of eight which the students must complete to pass their first year. In this context, it may not appear to be important to the students.

The subject content is based on a traditional mechanical properties approach which is common to most disciplines of engineering, and most importantly, easily understood and grasped by the students. The subject delivery mode incorporates both assessable material in the form of test or quizzes (computer based) laboratory work (background information and experimental results), and a variety of information sources involving lecture, laboratory and tutorial material, together with assorted assignments involving project based work.

All of the students' ongoing work and assessable content within the materials subject is uploaded onto a computer website or learning management site, e.g., BLACKBOARD®. The contents of the Blackboard site comprise the basis of the eportfolio. They are able to both transmit and retrieve their information electronically, and have a complete copy of all their subject material The students are also able to download and store the information for later referral and retrieval.. Although the eportfolio is used for assessment by faculty, it is finally employed by students as a storage and data bank for information retrieval in MSE.

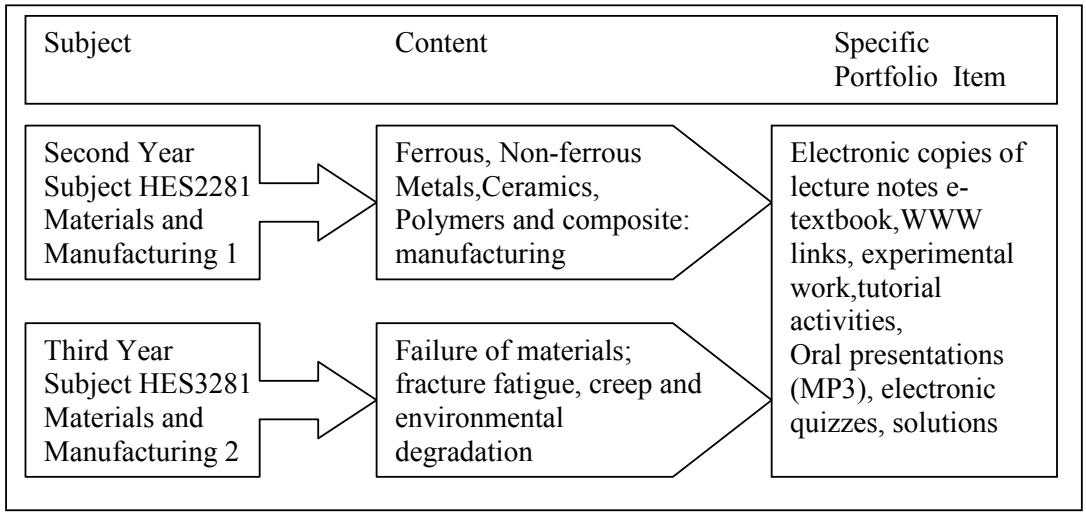
At the end of first year, the contents of the MSE subject disappear, and often are not accessible for future implementation. During the second and later stages of the engineering course many other subjects are taken by the students which have both large and small references to application and implementations of MSE.

Examples of Implementation of eportfolios in Later Year Engineering Studies

Mechanical engineering (ME) and product design engineering (PDE) students complete a subject in materials and manufacturing during both second year (HES2281) and third year (HES3281). Shown in Figure 1, is the relation amongst subjects' content and the variety of information and data sources available. Much of the content relies heavily on previous knowledge. This is where the students' eportfolio or repository of information comes into its own. The basic resources need for understanding the topics in second and third year MSE are grouped and available as an electronic resource for all students to access. For example in the second and third year subjects, HES2281 and HES3281 topics associated with steels, polymers and ceramics experiments on

heat treatment and tensile testing are available in the form of notes and WWW resources and a variety of electronic information and data sources, not only on the Blackboard site. Since all Blackboard sites are erased after the completion of a subject or unit, the students are required to collect all their information save it their own data storage facility via a DVD, USB, or portable hard disk. In this way the information is not lost once the students complete these studies and students have access to the I formation in their own time. For example kinks to materials information databases are collected for future access (although subscriptions will be required for professional database sights). .

Figure 1. Relation amongst subjects, content and a variety of information and data sources



Eportfolio for Materials Information Applications.

The majority of engineering subjects require input from a MSE database. By effectively organizing their eportfolios students access their information efficiently and can demonstrate its relevance to a particular topic or theme. For example, design can be construed a mechanical design (mechanical engineering, civil engineering) or product design which may be considered as industrial design with its human centred approach to design. In both instances having a resource of materials design information stored in an eportfolio with quick access, enhances the knowledge base of students and may be utilised as an auxiliary from of prerequisite data for further design considerations.

In the area of Mechanical Engineering design, for example, students are expected to develop procedures for fatigue design based purely in mechanical or civil structural principles. However, their previous work in MSE triggers an alternate approach utilising principles of fatigue based fracture mechanics. This information is stored in their eportfolio, so acting as a resource for additional approaches to machine and structural design. The students are often unaware of these resources, and when they are reminded of their storage in their own electronic repository, they are often amazed and surprised at the amount and variety of information which they have at the press of a mouse key!

Similarly, in Civil Engineering subjects which is concerned with design of concrete and steel structures, it is assumed that students have an understanding of the concepts of various strength definitions of materials, especially concrete and reinforced concrete. The recommend practice handbook of Reinforcement Detailing by the Concrete Institute of Australia, assumes many strength definitions, and detailed design criteria, all of which are available and stored as electronic resources and are collected by students in their eportfolio..

In the senior subjects of the mechanical engineering course, all the areas listed in Table 1 require input of some form of MSE data. These include basic concepts of modulus of materials, glass transition temperatures of polymers, surface engineering characteristics of tribological materials and a host of other materials and manufacturing characteristics. Fortunately, for the students, this information is stored in their electronic repository and can be retrieved (in the form of notes, electronic resources, class exercises, laboratory results, or assignment based material). Often the students are unaware of their resources and their fast path to information retrieval.

Table 1. Senior Mechanical Engineering Subjects requiring MSE knowledge.

MSE concept implementation	Senior Mechanical Engineering Subjects
	HES4330 Thermodynamics 2
Manufacturing Processes	HES5320 Solid Mechanics
Mechanical properties	HES4350 Mechanical Systems Design
Physical Properties	HES4250 Design for Manufacture
Environmental Properties	HES5102 Research Project
Electrical Properties	HES5310 Machine Dynamics 2
Chemical Properties	HES3360 Human Factors
Aesthetic properties	HES5103 Advanced Research Project
	HES5340 Fluid Mechanics 2
	HES5350 Product Design

Capstone Project Work and MSE Resources Implementation

Within the mechanical engineering course, in the subject concerned with the capstone project (HES5103), there may be as many as 30 individual research projects spread over a variety of topics. An example of some of the topics requiring major and minor input for the MSE eportfolio repository for the 2007academic year is shown in Table 2. Within the majority of the research topics, there again has been considerable implementation of MSE knowledge. From the requirements of the capstone project the students come to realise that utilising their eportfolio, which contains links to WWW materials, design and manufacturing databases, they students can access current, important, and relevant published information. This is available via their university computer network which they can open and download onto their own desktop. This information can be saved to the students' own electronic repository (e.g. R/W DVD, USB key, portable hard disk, etc.).

The students slowly realize the benefits of collecting information, storing it in electronic form, learning to access these resources, and then utilising them when appropriate for academic or work related purposes. This eportfolio is portable and can be taken with them when they graduate and commence employment.

Table 2. A selection of mechanical engineering capstone projects requiring MSE data and information.

Formula SAE - Design of Chassis, Anti-Roll Bar
Analysis of DFSS and MDO to Design of Crash Structures
Bonding trials using Paralyne
Burr formation in grinding
Coronary artery bypass grafts
Design of Bubbling Unit for CSIRO Aluminium Cold Model
Femoral neck prosthesis stress analysis and modelling
Investigate the use of different shaped WC particles in laser cladding
Laser Hardening
Multiple Recycling of ABS
Study of Scaffold Conformal Cooling Channels for Moulds using Thermal

Benefits of the Electronic Portfolio

Electronic portfolios help students document their learning achievements, as well as their other scholarly activities including research and community involvement. The reflective process of portfolio development can promote better understanding, develop fresh thinking about their life, and encourage personal and professional growth[17].

The benefits associated with an electronic portfolio have longevity way beyond the end of the engineering course or the student's university studies[9]. The payoff with utilising eportfolios includes[11, 20, 21]:

- the development of skills in electronic/digital technology, so important for today's graduates;
- evidence of learning and competency; improved tracking of student performance for purposes of accreditation and program improvement.
- increased opportunities for students to reflect and learn, better student understanding of teaching standards
- better staff/faculty access for assessing student work
- increased communication between staff and students
- incorporation of digital artefacts to take advantage of work already completed; as well as allowing the repository to be portable in the form of digital media

- portability storage of portfolio data and information allowing transport and usability in a work environment
- giving students a chance to compare their reflections to the standards and performance indicators, and set learning goals for the future, i.e. what is required for students to have achieved the purpose off an eportfolio This is the stage which turns eportfolio development into professional development and supports lifelong learning.

It is these last two points which are of most significance. The portability and storage lends itself to data retrieval in any situation, both within the academic environment and at a later stage in the workforce. The development of lifelong learning skills carries over into both the work environment and the student's personal environment. Moreover, in the academic environment, student feedback on the usefulness of the eportfolio has ranged from ignorance of its usefulness to definitive comments about providing a seed for knowledge in many other areas of engineering

As just one example of the usefulness of the eportfolio, was the situation recently when an ex pupil, wanting specific information about mechanical/fatigue behaviour of metals, contacted a faculty member for specific knowledge. The ex-pupil acknowledged that their eportfolio proved a useful starting point, and avoided many pitfalls, but they now required specific information. The ex-pupil was directed to one of their experiments on fatigue which gave a WWW resource for specific guidance and information. This is just one of many such examples. In other instances, students who are employed during their vacation often are involved in design or manufacturing industries. The feedback comments from their employers often emphasise how quickly and accurately the students employ their MSE knowledge for design, specifications or manufacturing process. The students attribute this in part, to their easy and quick access to information from their eportfolio required in the relevant industry.

Concluding Remarks

Activities have been described which implemented an electronic portfolio for materials science and engineering. The students are able to utilise these resources throughout their academic career, calling up information and relevant to a host other courses which they take and require relevant information. This repository of MSE data proves to be of great use when the students undertake and complete their mechanical engineering capstone projects, many of which require MSE information.

The eportfolio has proved useful after they graduate and are part of the workforce as first step in obtaining relevant information fore their particular work environment. The overall feedback from the students has been positive in the sense that they now have a portable electronic repository of information, data, and WWW links, which they can quickly and easily access both for their university studies and work environment.

Informal feedback from staff and students indicate that when the students approach their project supervisor about obtaining information, they are guided to their eportfolio as a repository of information to start their work. The students are often amazed and surprised at the wealth of data and electronic resources which they have accumulated over the course of their studies which are available to them. To formalise the unofficial feedback, future work will develop exit surveys which involve a formal assessment of the relevance of eportfolios to the graduating students,

their employers, and the students as employees after a two or three year time period-similar to a graduate program implemented by many large organizations..

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