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Reflections on Teaching Enterprise Architecture to Graduate Students

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ABSTRACT

This paper presents a reflection on using an Enterprise Architecture approach to develop in graduate students a holistic and integrated view of complex enterprises. It presents the unit rationale and design. The paper details the authentic assessment used to engage the students in the learning process. Student performance results are shown. Changes to the unit design are presented, emphasizing the need for students to have a good understanding of enterprise system functionality and deployment.

Keywords

Enterprise Systems Education, Enterprise Architecture

INTRODUCTION

There is an ongoing debate on the skills and capabilities required of Information Technology graduates in the 21st century. In Information Technology, identifying these skills has led to the Information Systems Centric Curriculum 1999 (Lidkte et al 1999), the IS2002 (Longenecker et al 1999) and CS2002 (IEEE and ACM taskforce) curriculum documents, which specify personal, interpersonal and discipline-specific skills. The importance of encouraging independence, autonomy, the ability for self-direction (Ball, 2002) as well as adaptability, resourcefulness, and enterprise (Manidis, 2001:27) is seen as integral to student educational experience. The Engaging Learning Experience report (2003) suggests that students need an opportunity to set personal goals and undertake self assessment. It also suggests that learning should occur in contexts which are as authentic as possible. We thus conclude that learning environments must develop this wide range of capabilities, link with the real world through engaging in learning based on authentic tasks, namely those tasks that junior analysts or consultants would be expected to undertake in their professional employment.

The post-graduate curriculum at this University includes research degrees (PhD and Masters), advance course work masters and a conversion masters degree. It is the latter conversion masters programs that the unit in Enterprise Architectures is situated.

Conversion masters students either have a degree in another discipline or a sub-degree qualification plus many years experience as an IT professional. In the previous design of this degree, all students had to have successfully completed a unit of programming. This new award removed this pre-requisite. Student enrolment has traditionally been high (though now reduced with the downturn in the ICT industry), with the majority of students coming from overseas. This trend is changing, but with about 45% of students sampled in this study coming from overseas.

The degree is designed around three modules of four units. The first module (called the Basic module) gives all students an introduction to the ICT environment. Students are introduced to programming (using C#), networks (using sponsored curriculum from CISCO), database (covering design and application development in ACCESS) and Enterprise Architectures. This latter unit is to provide an integrated and holistic understanding of the ICT phenomenon in an organisational setting.

Following successful completion of these four units, students select four units from a list of intermediate units. Though these units are based on second and third year units within the bachelor's program of the faculty, the units must complement the advanced standing of the students and realistically leverage off the prerequisites covered in the basic module.

A new masters degree in Information Management was developed in 2005. Students in this degree are more constrained in studying professional units leading to registration as a professional librarian. All students in this degree now must study Enterprise Architectures in their foundation semester.

Catering for these two disparate populations (Information Technologist and Information Managers) in the one unit has been and continues to be a challenge. The technology oriented students have difficulty in appreciating a business orientation while the information managers and librarians are often fearful of technology.

There are two schools within the Faculty of Information Technology: the School of Information Systems (SIS) and the School of Software Engineering and Data Communications (SEDC). SIS provides students with the following options: Web Application Development, Application Development in VB.net, Enterprise Systems, Business Systems Analysis and Design, 4 GL Programming, Programming in an E-commerce environment. SEDC allows the students to select from any second or third year unit, or select from specialist units in cryptology and security. On successful completion of four units in the Intermediate strand, students must select four advanced level 1 units from a total of fourteen units offered in the two schools.

This paper presents the design of the unit, its assessment and provides some reflection on the efficacy of this approach. The next section details the design of the unit Enterprise Architectures and then evaluates how it supports the development of systemic thinking in post-graduate students.

UNIT DESIGN

A foundation unit in Enterprise Architectures was developed to be part of the first module taught in a Master of Information Technology or Master of Information Management degree. Its purpose was to provide an integrated and holistic view of the role of Information and Communication Technologies that support the strategic objectives of business. It was to present a framework and development methodology from which students could make sense of the process-centric world into which they would soon take a professional role.

The unit was framed upon using authentic tasks: those activities which junior consultants could be expected to undertake. Work on learning styles of first year IT students has shown that they are predominantly procedural learners, who prefer fact-based and hands on learning experiences (Stewart, 2006). This study raises serious questions about how to frame a learning experience for this diversity of types. This work has led to the trapping of learning style data of graduate students, which has shown similar distributions.

One strategy is to provide students with authentic tasks, which clearly articulate the industry and university expectations of graduates. Most universities have captured these elements in policy documents which describe the graduate capabilities. The tasks need to be explicit in how they exercise the graduate capabilities. Furthermore, the unit has been designed with the inverted curriculum approach recommended by the ISCC'99 curriculum document (Longnecker et al 1999). In this, the students learn through understanding the contextual aspects of the task. This approach is also designed using the constructivist pedagogy. These elements of curriculum design are shown in figure 1.

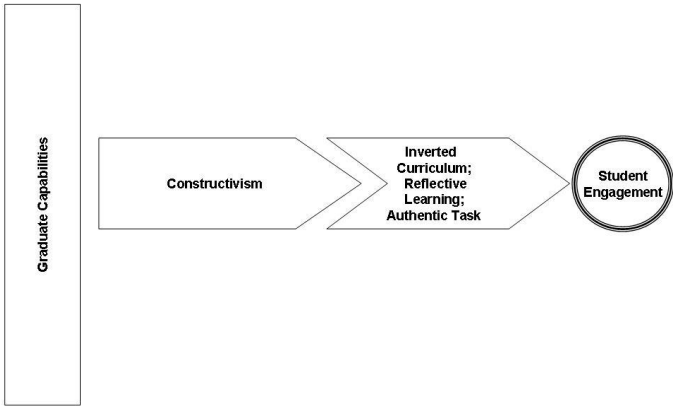

Figure 1 Orienting Educational Approaches leading to Student Engagement

The aim of this unit was to provide the student with a broad awareness of various systems and models providing a complete solution to the information needs of an organization. It was also to provide linkages with other units that students would be undertaking later in their degree. The Zachman Framework was selected as an orienting framework, from which students

would identify the four principle domains architectural domains: the Business Architecture, the Application Architecture, the Information Architecture and the Technology Architecture. These components are shown in figure 2.

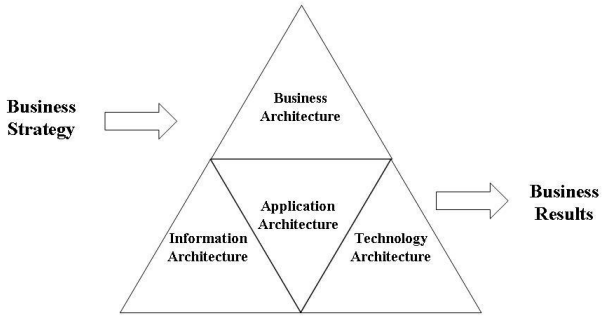

Figure 2: 4 Domains of Enterprise Architecture

From this framework, an Enterprise Architecture development methodology was presented. A commercial methodology (that used in the Fujitsu Corporation) was used, as it gave students a practical and structured means to undertake one of the key tasks set in the assessment schedule: the development of an Enterprise Architecture level one analysis for a target organization. This methodology is shown at a high level in figure 2.

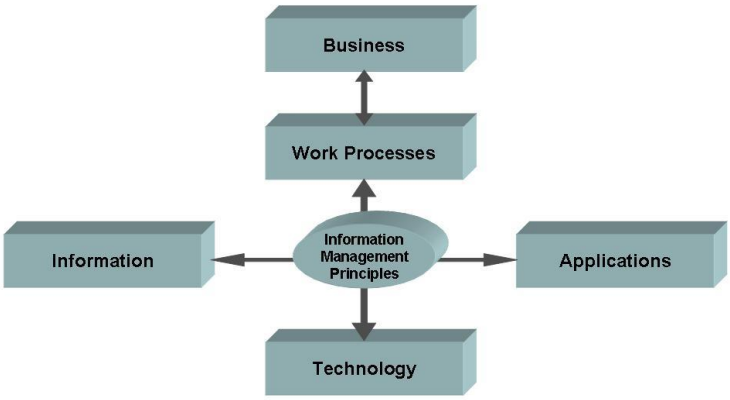

Figure 3: The Fujitsu Enterprise Architecture Views

These frameworks and methodologies were designed to introduce the issues involved in aligning business and IT strategy, thus showing the inter-connectedness of systems: how the technology architectures supports the applications which provide the information needed to achieve business objectives.

The unit was strongly supported by industry through guest lecture from Fujitsu, local vendors, private sector organizations and the local government library.

The unit program is shown in table 1.

Week	Lecture Topic
1	Introduction to unit, the Zachman Framework & the 4 Domains
2	Case Study 1: A Technology Innovation RFID
3	Guest Lecture 1: Finding and referencing resources
4	Case Study 2: The Fujitsu Methodology
5	Case Study 3: City Council Library Information Systems
6	Business Architecture Development; Case Study 4: Industry Example
7	Process Modeling
8	Information Architecture Development
9.	Data Architecture Development and DBMS
10.	Application Architecture Development Process; Case Study 5 Industry Example
11.	Business-IT alignment
12	Technical Architectures: Service Oriented Architectures; Client Server Architectures
13	Future Enterprise Architecture and Unit review

Table 1 Unit Program

UNIT ASSESSMENT

There were two assignments set in this unit, each constructed as an authentic task. Students worked individually to find and describe a technology innovation that would be of relevance to their target organization. The second assignment was a group project in which students developed Enterprise Systems Level 1 document for this target organization. Teams were to be established early, in order for the technology innovations to be synergistic.

Grover et al (1998) describe the different issues in technology adoption as a function of technology type. They distinguish between Communication technologies, Shared Infrastructure Technologies, and Shared knowledge or information technologies. Students teams were formed so that each of these types of technologies were understood. Communication technologies included Bluetooth and 3 G. Shared Infrastructure focused on wireless networks. Shared resource infrastructure include collaborative project software. Applications that could be assessed include RFID applications, Customer Relationship Management, or Integrated Supply Chain Management software.

Student reported their findings in a formal report which had the following components: description of the technology; description of the possible uses of the technology in the targeted industry setting. description of the technology infrastructure required to make use of the technology innovation; description of the innovative business applications that can make use of the technology in this industry setting; identification of the Information Systems required to work with this technology and supporting the business applications; identification of change management issues associated with the introduction of this technology in terms of new business processes and practices, new information systems requiring training and issues associated with the adoption of new organizational structures; and discussion of how an Enterprise Architecture approach can benefit the organization in adopting the technology innovation.

This is a real task that ICT professional are often required to undertake. A high standard of report presentation and effective communication is demanded of the students. This assignment assists the student to work effectively in a team setting for the major assignment, in which students are expected to develop a level 1 Enterprise Architecture report for a real target organization, which is next described.

Enterprise Architecture Level 1 Report

Students first form teams based on friendship groups or being assigned according to team profiles. To obtain the information for the team profile, students access an external web site where they can obtain their Myer-Briggs Type Indicator and also access an internal web site where they can complete a De Bono 6-hat profile (Jensen, Feland, Bow and Self (1999). These two inputs are then used to form a balanced team in terms of creativity, control, information gathering and team harmony.

The students commence through developing a Business Architecture. This includes defining the purpose of the business and the business and social drivers dominating the business environment. Student resources include annual reports and the strategic plan which are available for the target organizations. From this data, students identify the vision for the organisation, its resultant goals, strategies and objectives. Students model the current organisational structure and the products and services supported by the organization and do so, using a Process Engineering approach supported by the ARIS toolset (see IDS Scheer web site for details).

From this perspective, the student teams are to summarise the business primary and secondary problems and the resultant need for systems and technologies. Students are encouraged to develop a high level value chain for the organisation from which they identify support application systems. The organisational view and the products and services view are modelled using the ARIS toolset and approach to process engineering. These models are appended to the report and they provide a means of clearly identifying the application domain (the IS portfolio) in place in the current system. Reference sites for packaged software solutions provide students with information on the application portfolio. Interviews with organizational staff provide further information on the actual systems in place.

Students are then required to identify the architectural principles that will guide subsequent development. In particular, they are to specify any relevant data, application and technology principles. Students use an Australian government enterprise architecture document supporting a federal government initiative called HealthConnect (Architectural Principles 2003). As part of this process, students have to research technology innovations pertinent to the target organisation, the impact of new organisational forms (e.g. ambient organisations) and the expectation of pervasive computing. In the first semester of offering, for example, students were developing models of future libraries at university. Inputs into this process were presentations by the university chief technical librarian and the faculty reference librarian. This was followed by an interview session with students and staff. Students had to develop a set of focus questions, which were then asked of the staff in a semi-formal setting. For other target enterprises, students arrange and conduct interviews with relevant staff. Guest lectures have also been arranged. Recent target enterprises have included a distributed city council library; the national blood bank, a regional hospital.

From this input, students develop system concepts, integrating the societal expectation of that organisational setting, the business drivers for that sector, together with the emerging technical and organisational innovations impacting the target sector. The enterprise architecture level 1 analysis was informed by the FEAF methodology.

Students finally complete a professionally presented report which addressed the following elements: selected Architectural Framework and Methodology; the Current Systems Environment; the Design Drivers in terms of technology innovations impacting on the enterprise; the current Business Context in terms of its business and social drivers; the target business architecture highlight business opportunities and need for different structures, and finally the intended application architecture, information architecture and application architecture required to achieve the desired business objectives.

STUDENT PERFORMANCE

The unit has been conducted for 5 semesters, with 249 students completing the unit. Student enrolments are shown in table 2.

Year	High Distinction	Distinction	Credit	Pass	Fail	Total
2003 summer	1	4	8	7	0	22
2004 1st semester	6	11	9	10	3	40
2004 2nd semester	5	5	14	10	3	37
2004 Summer	4	6	2	8	2	23
2005 1st semester	3	6	9	22	1	43
2005 2nd semester	5	13	9	22	5	55
2005 summer	5	9	6	5	4	29
Totals	29	54	57	84	18	249

Table 2 Enrolments and Grade Distribution

Though all sections of the Enterprise Architecture report were presented, not surprisingly students had difficulty in visualising the target organisation's technology environment and business environment five years hence. Students had variable understanding of the evolution of various standards impacting on the target organisation. Architectural principles

were at a very high level as a result. The pragmatic outputs of current systems, organisational view and product and service view of the organisation were all well done. Students were able to communicate an understanding of the inter-relatedness of the business environment, the social environment, the emerging technology and organisation innovations and link these elements to a level 1 Enterprise Architecture.

Student teams had worked reasonably well. The team structures, the expectation that students form a team compact governing their behaviours and outputs were well received. Students were genuinely interested in their individual profiles and the meanings of these strengths. A detailed study of the effectiveness of the application of the team formation algorithm is now being undertaken.

The unit has developed strong competencies in students who have business experience and good analytical skills. Many students have struggled with the material, as its strategic approach is not that usually found in technology degrees or those interested in developing technological skills. Information management students have performed best at the strategy level, whereas technology focused students have performed worst. Changes to the unit have been implemented in 2006 to reflect changes in student profile.

CHANGES TO THE UNIT

The key change to the unit is the requirement to ensure that students have better understanding of the functional characteristics of application systems and how these relate to business structure. Students will be introduced to the functionality of packaged software, such as found in SAP, Microsoft Axapta or an Integrated Library Management System. The group assignment is now offered as an extension project to those students that have demonstrated excellence in analysis and communication. The authentic task approach has been useful to many students, with several students applying their skills and knowledge in real business problems for real organizations. A companion reader (Bernard 2004) has been employed to provide students with further case material and an alternative Enterprise Architecture development methodology. This has been well received by the students.

CONCLUSION

This paper has presented the rationale and design of an approach to teach about complex organizational systems through the lens of Enterprise Architecture. The assessment has been shown to be framed as an authentic task; those tasks that professionals will undertake in their professional life. The unit has produced graduates with strong analytical and communication skills, many of whom are now working as junior consultants or business analysts. This paper has identified engaging approaches to graduate student education in Business Systems Engineering.

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BIBLIOGRAPHY

1. ARIS ™ at http://www.ids-scheer.com/ last accessed 1 February 2006
2. Australian Government (2003) HealthConnect http://www.healthconnect.gov.au last accessed 16 February 2004
3. Bernard, S. (2004); Introduction to Enterprise, Architecture Author House
4. De Bono, E. (1986) Six Thinking Hats, Key Porter Books, Ontario
5. Federal Enterprise Architecture Framework (FEAF) http://government.popkin.com/frameworks/feaf.htm last accessed 16 February 2005
6. Gorgone, J.T., Davis, G.B., Valacich, J.S., Topi, H., Feinstein, D. and Longenecker, H.E. (2002) IS 2002: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems *Communications of the Association for Information Systems*
7. Grover, V., Teng, J., Segars, A., Fiedler, K. (1998) The influence of information technology diffusion and business process change on perceived productivity: The IS executive's perspective *Information & Management*, Vol 34, 1998
8. Jensen, D. Feland, J, Bowe, M., Self, B.(1999) A 6-Hats Based Team Formation Strategy: Development and Comparison with an MBTI-base Approach at www.usafa.af.mil/dfem/research_info/ ed_research/6hats.pdf last accessed 16 February 2004

9. Lidtke, D.K. and Stokes, G.E. (1999), ISCC'99 [Information Systems Centric Curriculum]: Preparing Students to Work with Large Systems, in Haseman, W. D. and Nazareth, D. L. (eds.) *Proceedings of the 5th Americas Conference on Information Systems* Milwaukee

10. Longenecker, H.E., Davis, G.B., Feinstein, D.L. and Gorgone, ,J.T. (1999) IS '2000: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems: Update Progress from IS '97, in Haseman, W. D. and Nazareth, D. L. (eds.) *Proceedings of the 5th Americas Conference on Information Systems*, Milwaukee

11. Manidis, M. (2001) Creating a position: Education, training and cultural industries, *CREATE Australia*, Surrey Hills

12. Queensland University of Technology (2003) Issues Paper 1: Engaging Learning Experiences http://qut.edu.au last accessed 24 September 2003

13. Stewart, G. (2006) MBTI Distributions for First Year IT Students in Christine Bruce, George Mohay, Glenn Smith, Ian Stoodley and Robyn Tweedale (Eds) Transforming IT Education: Promoting a Culture of Excellence *Informing Science Press* pp 371 – 390 Santa Rosa California

14. Zachman, J. (2003) http://www.zifa.com last accessed on 16 February 2004