

ENTERPRISE ARCHITECTURE – BRIDGE THE GAP BETWEEN BUSINESS, IT AND UNIVERSITIES

A. Sutharshan, S P Maj, D Veal

Department of Computer Science, Edith Cowan University, Perth, Australia
Email: anu.sutharshan@dli.wa.gov.au, s.maj@ecu.edu.au

Introduction

Advancing technologies, emergent software development approaches, and economic conditions influencing corporate budgets are creating new challenges for the Application Services manager [4]. In one of the studies [10], Enterprise Architecture (EA) was ranked near the top of the list of issues considered important by the chief information officers. Enterprise Architecture is a distinct and developing discipline in the Information Technology (IT) profession [15]. The alignment of an organisation's information technology to its business strategies is a recurrent theme in IS research [6]. The increasing complexity of today's business and IT environments makes it more difficult for organisations to design an Enterprise architecture that supports the company's business objectives and enables the IT staff to deliver applications that align with business goals.

Enterprise Architecture is about understanding all of the different elements that go to make up the Enterprise and how those elements interrelate. The Information Technology Management Reform Act of 1996, better known as the Clinger-Cohen Act, refers to Enterprise architecture as "an integrated framework for evolving or maintaining existing information technology and acquiring new information technology to achieve the organization's strategic goals and information resources management goals" [5]. It can be a critical component of IT alignment that ensures that organization's goals are met, and that IT can scale with every new business demand. IT enterprise architecture can help with architectural process, but ultimately the IT-centric approach must give way to a business process-centric approach. An enterprise architecture that is organized around business process value chains provides a direct link between IT resources, corporate goals, and a process that generates products and satisfied customers.

Growth of Business and Technical Complexities

It is a known fact that organisations have to deal with increased complexity. Increased complexity is being driven by many factors: new technologies, shorter application development life cycles, iterative development, more geographically distributed projects and resources, increased tool diversity and higher risks [7]. In addition, business executives are placing increased emphasis on making sure that the solutions developed by IT are aligned with the business' needs.

EA issues, Changing needs, and Challenges

Enterprise Architecture groups exist to nurture enterprise assets and to support other groups, such as development teams, within the organization. These enterprise groups should act in a manner that reflects the expectations of their customers and the ways in which their customers work.

The authors suggest the following key points for developing and improving the EA process:

- Focus on People, Not Technology - The quality of the people on a project, and their organization and management, are much more important factors in success than are the tools they use or the technical approaches they take [18].
- Keep it Simple - A critical concept is that enterprise architecture models and documents just need to be good enough, they don't need to be perfect. It is naive to assume that one can produce perfect artifacts [10].
- Work Iteratively and Incrementally - Enterprise architects work in an iterative and incremental manner [8]. Modelers also follow the practice 'Model in Small increments' modeling just enough to fulfill the purpose at hand and then moving on to the next task.
- Be part of the team - Although an important part of the job of an enterprise architect is modelling and documentation, the primary focus is supporting the architecture within project teams and coaching developers in the architecture and architecture skills. The best way to do this is to get involved with project teams, to work with them to understand the enterprise architecture and to try it out in practice [1].
- Look at the Whole Picture - Enterprise architectures in general believe in the principle *Multiple Models* and thus strive to look at the whole picture. The system architect's design functions enlist a broad, global, whole-system view [13]. All applications are different in some ways, and there is rarely, if ever, a one-size-fits-all' product match [9].

Given the increasing set of technological option, enterprise architecture is no longer a simple task. This is becoming an important issue for IS managers as reliance on information technology increases [6].

Skills required for Architects

The role of an enterprise architect is relatively new. The idea of an architect has evolved from an older profession: systems engineering [17]. In the late 1980s it was perceived that something was missing from systems engineering, an attention on the up front part of the process. Specifically, it was perceived that the source of failure in many systems was that no one was explicitly focusing on the overall architecture. The job of architect isn't so much thinking up new architectures but getting them accomplished [17].

Continuous learning and skill development is one of the hallmarks of the effective enterprise architect. The learning process continuously restocks the toolkit, allowing the architect to bring the right tool to bear during each phase of the system's design [15].

The types of activities for which the enterprise architect is responsible drives the kinds of competencies that the architect needs to have or to develop to succeed in the role. Following have been compiled based on [17, 13] and other authors who have identified the activities that architect are responsible of.

As an architect, one would need a thorough knowledge of the organization's product domain, relevant technologies and development processes. But even in the technical area, key activities are different than those of the developers [17]. To succeed in this aspect of the enterprise architect's role, one must understand not only the organization's business strategy and the rationale behind it but also the company or division's business practices, planning cycles, and decision making processes. Architects also need to understand business context of organization: competitors, their products, strategies and product generation processes [17]. Architectures almost always have many and diverse stakeholders, and will ultimately be used by many developers. Often they are used across divisions and by developers in other companies. Actual users of enterprise architecture are development teams creating products or components. Their goal is not to make architecture successful, but rather to satisfy their specific functionality, schedule and quality requirements. The domain of competency that organizes all the others and gives them dynamic force, is leadership. An architecture team without leadership goes nowhere.

An Enterprise Architect's Domains of Competency is further expanded in table 1.

Table 1 Enterprise Architect's domain of Competency

Job Description	Knowledge	Skills
Build relationships	Elicitation techniques	Empathetic, approachable
Understand stakeholders need from the architecture	Consulting frameworks	Effective change agent
Help stakeholders see the value of the architecture and understand how to use it successfully		Good mentor
Influence business strategy		Visionary
Translate business strategy into technical vision and strategy	Organization's business strategy and rationale	Entrepreneurial
Understand customer and market trends		Leadership
		Charismatic and credible
		Committed, dedicated,

Capture customer, organizational and business requirements on architecture	Company's business practices	passionate
Set team context and build team	Team building knowledge	See the effort in a broader business context
Motivate		Able to see from and sell to multiple viewpoints
Communicate		Confident and articulate
Listen, network, influence		Ambitious and driven
Modeling	Who the key players are in the organization and what they want, both business and personal	Patient
Tradeoff analysis		Creative
Prepare architectural documents and presentations	In-depth understanding of the domain and pertinent technologies and understand what technical issues are key to success	Investigative Practical/pragmatic Insightful
Technology trend analysis/roadmaps		Technically sound and continuous learning
	Development methods and modeling techniques	Tolerant of ambiguity, willing to backtrack, seek multiple solutions
		Good at working at an abstract level

The Architects must be outstanding communicators and leaders, and possess proven skills related to the lower level component design and construction tasks [15].

Should Universities teach Enterprise Architecture (EA)?

Academics need to constantly evaluate their curricula and hence develop new courses to address the needs of the industry [14]. In addition to traditional class lectures, techniques such as problem based training and case method are the essential approaches to students at Universities [14]. Many people who are in charge of developing the enterprise architecture for their organizations were unexpectedly thrown into the role without any form of training [11]. It was also identified that Enterprise Architecture is the first discipline that has a government act backing it (Clinger Cohen Act). Some of the Universities in US that have introduced this unit include National Defense University, University of North Texas, and U.C Berkeley. It has become as a general trend for more and more universities to consider enterprise architecture as a core curriculum [19].

Organizations in US that offer courses dedicated to enterprise architecture [19]:

- The National Defense University Information Resources Management College offers a course
- The Federal Enterprise Architecture Certification Institute's five-course program leads up to a certification
- George Mason University offers a certificate in architecture-based systems engineering, which covers enterprise architecture.
- General Services Administration officials worked with seven universities to develop CIO University, which covers CIO's core competencies, including enterprise architecture.

The authors conducted a study of Australian Universities to identify if Enterprise Architecture (EA) is part of the curriculum at the undergraduate level (Table 2). Details were gathered from individual university web sites.

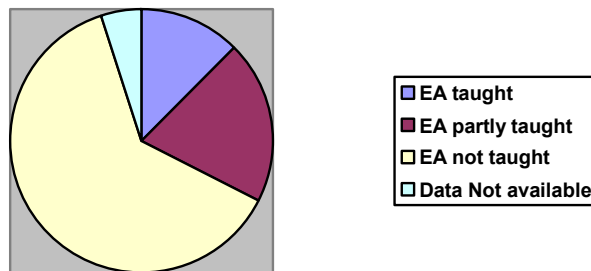
Table 2 Analysis of Enterprise Architecture as a curriculum in Australian Universities

University	UG Courses	PG Courses	EA taught?
Australian Catholic University [ACU] Email sent	√	√	No
Australian Defence Force Academy [ADFA]	√	√	No
Australian Graduate School of Management [AGSM]	√	√	No
Australian National University [ANU]	√	√	No
Bond University [Bond]	√	√	No
Central Queensland University [CQU]	√	√	No
Charles Darwin University [CDU]	√	√	** Elective – Architectural concepts
Charles Sturt University [CSU]	√	√	No
Curtin University of Technology [CURTIN]	√	√	No
Deakin University [Deakin]	√	√	No
Edith Cowan University [ECU]	√	√	No
Flinders University [FLINDERS]	√	√	No
Griffith University [GRIFFITH]	√	√	** Software Architecture
James Cook University [JCU]	√	√	No
Macquarie University [MACQUARIE]	√	√	No
Monash University [MONASH]	√	√	Yes - computer architecture and systems
Murdoch University [MURDOCH]	√	√	** Software Architecture

Queensland University of Technology [QUT]	√	√	Yes – Enterprise Architecture – good syllabus
RMIT University [RMIT]	√	√	Yes – Enterprise Systems Architecture – Good syllabus
Southern Cross University [SCU]	√	√	No
Swinburne University of Technology [SWINBURNE]	√	√	No
University of Adelaide [ADELAIDE]	√	√	No
University of Ballarat [BALLARAT]	√	√	No
University of Canberra [CANBERRA]	√	√	No
University of Melbourne [MELBOURNE]	√	√	** Information Architecture
University of New England [UNE]	√	√	<i>Details Not Available</i>
University of New South Wales [UNSW]	√	√	<i>Details Not Available</i>
University of Newcastle [NEWCASTLE]	√	√	Enterprise Architecture
University of Notre Dame Australia - The [UNDA]	√	√	** Information Architecture
University of Queensland [QUEENSLAND]	√	√	No
University of South Australia [UniSA]	√	√	** Computer Systems Architecture
University of Southern Queensland [USQ]	√	√	No
University of Sydney [SYDNEY]	√	√	No
University of Tasmania [TASMANIA]	√	√	No
University of Technology Sydney [UTS]	√	√	No
University of the Sunshine Coast [USC]	√	√	** Architecture and Systems Integration
University of Western Australia [UWA]	√	√	No
University of Western Sydney [UWS]	√	√	Enterprise Information Architecture – good syllabus
University of Wollongong [UOW]	√	√	No
Victoria University [VU]	√	√	** Computer Systems and Architecture

Number of Universities in Australia	40
Number of Universities that don't teach EA	25
Number of Universities that teach EA	5
Number of Universities that teach partly **	8
Number of Universities that don't have data available online	2

Figure 1 Representation of Enterprise Architecture as a curriculum in Australian Universities



The results (Table 2, Figure 1) strongly suggest that the majority of Australian Universities do not explicitly teach enterprise architecture. It has been an acceptable factor that there are many reasons for integrating industry's software technology into the university system at the graduate level [20]. Looking at the growing importance of enterprise architecture [10], more interest will need to be given to be taught at Universities.

Syllabus for Undergraduate students for Enterprise Architecture

It can be concluded that, within the USA and Australia the majority of universities do not teach EA. Furthermore, from a survey done by IFEAD [22], it has been identified that only 17% of the staff have been trained in Enterprise Architecture before they have been appointed as Enterprise Architects. Also Only 7% of the organizations provide coaching or training to the Enterprise Architects [22].

Based on the analysis of existing course structure at Universities and some educational institutes, the authors propose the following course structure.

Course Title: Principles of Enterprise Architecture

Module 1

IT Challenges

Root causes of IT failures

Risk fundamentals, Risk Planning, Risk tracking and Control

Module 2

Definition of Enterprise Architecture

Barriers and problems of an Enterprise Architecture

Benefits of an EA

EA – best practices

Module 3

EA Framework contents

Governance

EA Blue print

Overview - Federal Enterprise Architecture Framework (FEAF), Zachman,

Department of defence's Architecture framework (DoDAF), Treasury Enterprise

Architecture framework (TEAF), The Open group architecture framework (TOGAF)

and others.

Module 4

Detail Analysis of TOGAF / Zachman

Module 5

Enterprise Architecture tools

Module 6

HR Issues for EA and managing politics

- Evaluating HR practices for EA team
- Key Architecture roles
- Staffing the Architecture team
- Organisational structure
- Putting it together

Workshops

Involve industry experienced Architects to share their knowledge related to EA issues, solution and comments

Practice [sample]

- Design simple enterprise models in all domains of an enterprise architecture
- Compare and contrast different enterprise architecture framework

Assessment

- Technology innovation and the effect on EA

Description: This assignment requires the individual to identify and discuss a recent technology innovation and its impact on the EA.

Conclusion

This paper has identified what the current enterprise architectural thinking is. A characterization of how enterprise architecture is perceived in practice has been identified. These results will provide a starting point for assessing architecture maturity and alignment within organizations, and can be used to help harmonize different architectural tunes played within organizations for a great project success.

The development and effective implementation of an Enterprise Architecture is a major challenge for organisations [2]. Researchers have not fully covered all the issues related to architecture [12]. The effective application of all skills forms a mental framework from which the Architect may drive the software project to success. In practice this adds significant value to an organisation, and is important to the growth and development of our profession, and represents the essence of the effective architect [15].

Though EA related seminars and conferences have sprouted which allow practitioners to share best practices and receive updates, formal classroom training has been slower to catch on and only a handful of universities offer classes that touch on the topic and even fewer offer courses dedicated to it [19]. With the study done at Australian Universities, it is clear that more and more universities will need to begin to realize that enterprise architecture is a core curriculum for computer science and information management theory.

References

- [1] Ali Bahrami, Deborah Sadowski and Soheila Bahrami, 1998. 'Enterprise Architecture for Business Process Simulation'. *Proceedings of the 1998 Winter Simulation Conference*.
- [2] Carla Marques Pereira and Pedro Sousa, 2004. 'A Method to define an Enterprise Architecture using the Zachman Framework'. *Proceedings of the ACM SAC 2004 conference*, Nicosia, Cyprus.
- [3] David Garlan and Dewayne Perry, 1994. 'Software architecture: practice, potential, and pitfalls', *International Conference on Software Engineering, Proceedings of the 16th international conference on Software engineering*, Sorrento, Italy, Pages: 363 – 364, IEEE Computer Society Press Los Alamitos, CA, USA
- [4] Deborah G Coleman and Stephen J. Zilora, 2003. 'Dynamic enterprise demand advanced curricula in Software development and management'. *Proceedings of the 2003 ACM CITC4 Conference*, Lafayette, Indiana, USA.
- [5] Enterprise Architecture Tools. Computer science Corporation, Frederick McCullough, 2003.

- [6] George S. Nezelek, Hemant K. Jain, and Derek L. Nazareth, 1999. 'An Integrated approach to Enterprise Computing Architectures', *Communications of the ACM*, Vol 42, No. 11, November 1999.
- [7] Hamilton Hayes, *Demystifying Enterprise Architecture*. CA, white paper. 2003.
- [8] Ian Gorton and Jereme Haack, 2004. 'Architecting in the Face of Uncertainty: An Experience Report'. *Proceedings of the 26th International Conference on Software Engineering*, ICSE 2004.
- [9] Ian Gorton and Anna Liu, 2004. 'Architecture and Technologies for Enterprise Application Integration'. *Proceedings of the 26th International Conference on Software Engineering*, ICSE 2004.
- [10] James C. Brancheau, Larry Schuster and Salvatore T. March, 1989. 'Building and Implementing and Information Architecture'. *ACM SIGMIS*, Volume 20, Issue 2 Summer, pp 9 – 17, ACM Press New York, NY, USA
- [11] James McGovern, Sep 21, 2004. 'thinking out Loud: Thought Leadership from and Enterprise Architect'.
<http://blogs.ittoolbox.com/eai/leadership/archives/001607.asp>
- [12] Jim Q.Ning, 1996. 'Where does Architecture Research Meet Practice?', *ACM SIGSOFT 96 Workshop*, San Francisco, CA USA.
- [13] John A Mills, 1985. 'A pragmatic view of the system architect'. *Communications of the ACM*, Volume 28 , Issue 7 (July 1985), Pages: 708 – 717.
- [14] Kimfong Lei, Julie R Mariga, Benjamin R Pobanz. 2003, 'From Theories to Actions: A proposal for a new course on Enterprise Information Systems for Integration'. *Proceedings of the CITC4'03*, Lafayette, Indiana, USA, October 16–18.
- [15] Matthew R. McBride, 2004. 'The Software Architect: Essence, Intuition and Guiding Principles'. *Proceedings of the ACM OOPSLA '04*, Vancouver, British Columbia, Canada, Oct 24 – 28.
- [16] Mohamed E. Fayad, Lincoln David S. Hamu. 2000, 'Enterprise Frameworks: Guidelines for Selection'. *ACM 00360-0300/00/0300es*, Volume 32, Article No.4, March 2000.
- [17] Rebecca E. Grinter, 1999. 'Systems Architecture: Product Designing and Social Engineering'. *Proceedings of the international joint conference on Work activities coordination and collaboration*, San Francisco, California, United States, Pages: 11 – 18.
- [18] Roger Evernden and Elaine Evernden. 'Third-Generation Information architecture'. *Communications of the ACM*, Volume 4, No. 3, March 2003.

- [19] Sara Michael, Sep 6, 2004. 'EA University: Agencies seek to improve architectures by taking advantage of training'.
<http://www.fcw.com/fcw/articles/2004/0906/feat-easch-09-06-04.asp>
- [20] Walker Royce, Barry Boehm and Cathy Druffel, 1994. 'Employing UNAS Technology for Software Architecture Education at the University of Southern California'. *Proceedings of the eleventh annual Washington Ada symposium & summer ACM SIGAda meeting on Ada*. McLean, Virginia, United States, Pages: 113 – 121.
- [21] Wesley P. Melling. 'Enterprise Information Architectures - They're Finally Changing'. *Proceedings of the SiGMOD 94- 5/94* Minneapolis, Minnesota, USA, 1994.
- [22] 'Trends in Enterprise Architecture – How are Organisations progressing?' IFEAD Survey, 2004.
<http://www.enterprise-architecture.info/Images/EA%20Survey/EA%20Survey%202004%20IFEAD.PDF>

Biographical information

A SUTHARSHAN has completed MSc. Software Engineering, MSc Computer Science and currently studying PhD. A Sutharshan is a Systems Architect at Department of Land Information, WA, Australia and has 15 years experience in IT industry in the software engineering area.

Dr.S P MAJ [PhD], Associate Professor, Edith Cowan University, Australia. In 2002, Dr S P Maj was invited to participate as a grant application reviewer for the National Science Foundation (NSF) in the USA. Published in the Australian Computer Journal, and was awarded University Researcher of the year in 2000.

Dr. D VEAL received an honours degree in theoretical physics from the University of York in England. After completing a Post Graduate Certificate in Education from the University of Keel after which he lectured in physics at South Devon College UK for 10 years. He has taught computing, mathematics and physics at high school level. And now lectures in computing science at ECU in Perth, Western Australia.