Reprinted from:

2005 3rd IEEE International Conference on Industrial Informatics (INDIN) Perth, Australia 10-12 August 2005

IEEE Catalog Number ISBN 05EX1057
ISBN 0-7803-9094-6

Multi-site Project Management
Ontology System Development Methodology

Chan Cheah & Prof. Elizabeth Chang

School of Information Systems, Curtin University of Technology, Western Australia
chancheah@optusnet.com.au, Elizabeth.chang@cbs.curtin.edu.au

***Abstract*— This paper examines how ontology principles can be applied in the design of a semantic web service system for supporting multi-site project management (MSPM) in Industrial Automation. It reports work in progress views of what constitute the MSPM ontology system development methodology, which is currently revealing to be best practice and standards driven. The methodology requires linking conventional SDLC processes with semantic MSPM knowledge standards development and change management, and it fosters the inclusion of semantic knowledge standards (in addition to ICT standards) in governing the design of systems.**

***Index Terms*—ontology based software engineering and ontology system development methodology.**

I. Introduction

Project management is required in the creation of ICT infrastructures in all industries, including that of Industrial Automation. Ironically, over the past 30 years Australian businesses have been exposed to growing high costs and failure risks of projects [5, 9, 14, 23]. Today the situation is worsening as businesses increasingly conduct and outsource their project activities to different organisations and in different locations. One of the causal problems of multi-site project management (MSPM) is the inability to manage distributed project knowledge, which is created and accessed by various people in different locations, and maintained in distributed computing resources. This inability limits knowledge sharing, hence hindering project collaboration and consensus decision making in distributed project environments.

This research takes on the mandate to design a system solution for supporting MSPM. It aims to apply the philosophic principles of ontology to design the system architecture and in doing so evolves a new systems development approach in software engineering.

II. Ontology Application in Systems Design

Ontology is the study of what exists [2, 6-8, 22, 24, 25]. It describes the conceptualisation of human knowledge by domain categories, where consensus agreement is integral in setting semantic and syntactical language rules. Because these knowledge expressions are set by consensus agreement, they are the foundation of shareable knowledge. Domain ontologies can be consolidated to evolve a universal ontology that could give insights in developing the mother of all open systems. Because ontologies can help standardize knowledge constructs, they are of value in system design. They provide common and multiple knowledge meanings that correlate with the appropriate syntactical structures and usage contexts. In doing so, ontology descriptions can be readily used to structure and modularise system components and service packages. The inclusion of knowledge semantics is instrumental in transforming current web services into becoming the next generation of semantic web services.

III. Justifying Ontology Based System Development

As such, it is no surprise that much research and development (R&D) to date focuses on integrating the vocabulary rich metadata elements, domain entity relationship structures and application rules, to construct system objects and services. In these R&D applications, metadata, and sometimes functional methods, are classified as domain ontologies. This highlights that ontology principles are being used to categorise and modularise system objects and services. In this context, many R&D applications tend to focus on:

- Using machine oriented Resource Description Framework (RDF) and open source scripting system languages such as XML, to cross-refer and process many application specific metadata sets such as Learning Objects, Dublin Core, and Australian Government Service Locator (AGSL).
- Developing semantic metadata standards that can be reused and extended in domain metadata sets, for example Dublin Core, which underpins the definition of Learning Objects and AGSL metadata elements.

Critics drawing inferences from these R&D discoveries often conclude that ontology software engineering is no longer innovative today, and PhD studies in this area are unlikely to add new knowledge. What these critics fail to realise is that new knowledge is built from existing knowledge, especially comprehending that

- Underpinning these already viable developments, developing as many domain ontologies is still required to provide a rich and diverse R&D knowledge base of domain ontologies for other researchers and developers to work out future cross-domain and universal ontologies. These ontologies give more insights into enhancing the development of more open source and semantic knowledge sharing capabilities of future systems. Therefore, every current and immediate future domain ontology R&D is a valuable contribution to the progressive development of these cross-domain and universal ontologies.

- Taking an ontology system methodology approach requires redesign of conventional system development lifecycle methodologies to:
  - Interlink with semantic knowledge standards development and change management
  - Extend enterprise architecture modelling to integrate both semantic knowledge and ICT standards.

As a result, the whole system development methodology becomes semantic knowledge and ICT standards centric, facilitating tighter governance of system development to design systems that readily fuse and unify knowledge, activity based functions and technology. In doing so, the ontology system development approach, unlike today's software development methodologies, produces a seamless meta-operational system.

IV. Research Scope

How exactly we develop this ontology system development methodology and use it to develop the MSPM ontology architecture is the focus of this research. This project was initiated in late 2003 to find a knowledge system solution for helping Australian Project Managers better manage distributed project knowledge in multi-site project environments. The research not only provides empirical data regarding the definition, issues, risks and workflow requirements of MSPM (which is currently lacking in literature), but it develops an ontology system development methodology for producing a MSPM semantic web service system tools. As this research is under one and a half years old, the reader needs to be tolerant that many of the work in progress ideas and critical analysis are still in development, and, therefore, any emerging theory development and recommendations are not final or rigorously substantiated.

The research adopts a qualitative research methodology, but applied in a science and engineering context. It uses case study methods to collect the data, which would be analysed and combined with grounded theory inferences from international business management, e-business and communications disciplines to conceptualise the MSPM requirements. The inferred MSPM requirements then become the basis for developing the ontology based MSPM system architecture. This approach is also what ISWorld [13] calls design research, where:

- Knowledge is generated and accumulated through action
- There is prior knowledge awareness of the problem/s, and the research tends to improve problematic situation/s
- The forms of knowledge created can be constructs, models, methods, implementation instances and theories.

The research progresses incrementally in iterative cycles, which intertwines data collection and the ontology system methodology and architecture product design process, focusing at '*making something work*' at three levels [1, 17]:

- Conceptual level where new ideas and concepts are generated through analysis of existing literature and empirical knowledge
- Perpetual level where design and implementation forms are developed
- Practical level where design and implementation forms are evaluated and validated with real life examples.

Exercising this research methodology has brought us to the progress of ontology system methodology, which will next be discussed in part V.

V. Work In Progress Ontology System (Development) Methodology Design

Gruber's infamous claim that '*ontology is an agreement about shared conceptualisation*' [10-12] indicates that ontology development is characterized by consensus agreements and the generation of shareable knowledge constructs, where knowledge sharing can be domain specific or universal. According to Poli and Corazon [6-8, 18-21], ontology development is usually domain knowledge specific, and there are three processes involved:

- Descriptive ontology development, which focuses on defining the meanings of knowledge constructs
- Formal ontology development, which defines the syntactical entity-relationship structures of domain knowledge expressions
- Formalised ontology development that defines the functional uses and conditions of semantic and syntactical knowledge expressions for meeting the knowledge needs and wants of domain knowledge users.

Establishing process consistency is the critical success factor of ontology development [3, 4, 6-8, 18-21], because it enforces consistency in the construction and formats of knowledge semantics, structures and application rules.

How we engineer these three ontology processes constitutes the development of the MSPM ontology system development methodology, especially in understanding the implementation implications of ontology standards adoption, together with their development and change management execution.

The ontology system methodology design to date proposes that we use:

1. The Project Management Institute's (PMI) PMBOK standards, which is a global best practice, to:
   - Govern the research process itself. Subsequently, we adopt a project management approach in executing the research, which gives a very clear plan of action that is also revisable as more understanding develops in the course of doing research.
   - Engineer the general requirements of project management, and using grounded theory inferences from international business management and e-business and communication disciples to work out the multi-site implications

- Work out the ontology standards development and change management process make-up, and its integration with a whole of SDLC management methodology.

2. The UK Government's Office of Government Commerce (OGC)'s SDLC methodology, which is a grounded best practice standard that covers comprehensive aspects of conventional whole of SDLC management. This SDLC standard covers more than software development and is independent of software development methodologies such as Agile Software Development, Extreme Programming, etc.
3. The Object Management Group (OMG)'s Model Driven Architecture (MDA) methodology to model the enterprise architectures of MSPM, which involves specifying the data, process and information architecture frameworks that constitute the boundaries of the ontology system architecture. As such, the architectures will be spec in UML conventions.
4. Program evaluation methods to quality assure the ontology system methodology and architecture forms. Program evaluation is best practice methodology of evaluation research, which is a recognised post-modern qualitative research methodology that probes into determining whether a program (which can be a project, research, etc) works, and why it works or didn't work [15-17]. Program evaluation is very much adopted by consortium agencies such as in United Nations Educational Scientific and Cultural Organisation, World Bank and many developed countries' Governments. For example, those in the USA, UK and Australia.

From these recommendations, a unique characteristic of the MSPM ontology system methodology is emerging to be best practice and standards centric. Current research concentrates on investigating how all these recommended elements hang together as one seamless ontology system methodology.

VI. Conclusion

Multi-site project management is eminent in every industry, including Industrial Automation, as firms continue to outsource their ICT projects and operations. One cause of multi-site project failure is the inability to manage distributed project knowledge created and accessed by different people in different locations and at different times, and which is maintained in distributed computing servers and databases. Solving this inability requires common MSPM knowledge semantics, structures and application rules to be defined and maintained, and development of an ontology system development approach for integrating these ontology descriptions in web service system design.

The research in progress is revealing that this methodology:

- Is emerging to be best practice and standards centric, where semantic knowledge and ICT standards are important in shaping the MSPM system architecture forms
- Requires interlinking the SDLC processes with semantic knowledge standards development and change management, where both semantic knowledge and ICT standards are integral in governing system design to produce semantic web service systems.

References

[1] Burstein, F., Gregor S., 'The Systems Development or Engineering Approach to Research in Information Systems: An Action Research Perspective' presented at 10th Australasian Conference in Information Systems, 1999.

[2] Clark, R., 'Knowledge', 2001. Retrieved 10 Dec 2004, from http://www.anu.edu.au/people/Roger.Clarke/SOS/Know.html/.

[3] Cocchiarella1, N., 'Formal Ontology', 2004. Retrieved 10 May 2004, from http://www.formalontology.it/cocchiarella.htm.

[4] Cocchiarella2, N., 'Conceptual realism as formal ontology.' P. Simons, Ed.: Nijhoff International Philosophy Series, 1996, pp. 27 - 60.

[5] Coplien, J., Coplien, J.;, 'Organizational patterns: Beyond technology to people' presented at 6th ICES - 2004, Porto, 2004.

[6] Corazzon1, R., 'Descriptive and Formal Ontology - A resource guide to contemporary research', 2004. Retrieved 10 May 2004, from http://www.formalontology.it/.

[7] Corazzon2, R., 'What is ontology? Definitions by leading philosophies from Christian Worlff to Edmund Husserl', 2004. Retrieved 25th Sep 2004, from http://www.formalontology.it/section_4.htm/.

[8] Corazzon3, R., 'Ontologies for knowledge sharing', 2004. Retrieved 28th Sep 2004, from http://www.cs.umbc.edu/kse/ontology/.

[9] Gilb, T., 'Evolutionary project management: Multiple performance, quality and cost metrics for early and continuous stakeholder value delivery (keynote paper)' presented at 6th ICEIS 2004, Porto, 2004.

[10] Gruber1, T.R., 'A translation approach to portable ontology specifications.' *Knowledge Acquisition*, vol. 5, pp. 199-220, 1993.

[11] Gruber2, T.R., 'Toward principles for the design of ontologies used for knowledge sharing.' *International Journal of Human-Computer Studies*, vol. 43, pp. 907-928, 1995.

[12] Gruber3, T.R., 'What is an ontology?' 1999. Retrieved 5 January 2004, from http://www-ksl.stanford.edu/kst/what-is-an-ontology.html.

[13] ISWorld, 'Design Research in Information Systems', 2005. Retrieved 6 May 2005, from http://www.isworld.org/Researchdesign/drisISworld.htm.

[14] Loucopoulos, P., 'Engaging stakeholders in the definition of strategic requirements.' Manchester, UK.: UMIST, 2004.

[15] McBride, R., Schostak, J., 'An Introduction to Qualitative Research.' 2003. Retrieved Dec 2003, from URL http://www.aepro.org/inprint/conference/rothman.html.

[16] Neuman, W.L., '*Social research methods.*' Fifth. ed: Pearson Education Inc., 2003.

[17] Nunamaker, J.F.J., Chen, M. and Purdin, T. D. M., 'Systems Development in Information Systems Research'. *Journal of Management Information Systems*, vol. 7, pp. Pg 89-106, 1991.

[18] Poli1, R., 'Proposals about the structure of ontology.' 2004. Retrieved 25th Sep 2004, from http://www.formalontology.it/section_5.htm.

[19] Poli2, R., 'Framing Ontology - First & Second Part', 2004. Retrieved 25th Sep 2004, from http://www.formalontology.it/polir.htm.

[20] Poli3, R., 'Levels', 2004. Retrieved 25th Sep 2004, from Http://www.formalontology.it/levels.htm.

[21] Poli4, R., 'What is Ontology?' 2004. Retrieved 25th Sep 2004, from http://www.formalontology.it/section_4.htm.

[22] Siegfried, F.P., 'Ontology.' 1911. Retrieved 21 Sept 2004, from http://www.newadvent.org/cathen/11258a.htm.

[23] Standish Group, 'Chaos Reports', 2004. Retrieved Jul 2004, from http://www.standishgroup.com/chaos.

[24] Vokey, J.R., Higham, P.A., 'Implicit Knowledge as Automatic, Latent Knowledge', 1999. Retrieved 10 Dec 2004, from http://people.uleth.ca/~vokey/pdf/Dienes.pdf.

[25] Wikipedia.org, 'Wikipedia, the free encyclopaedia.' 2004. Retrieved May 2004, from http://en.wikipedia.org/wiki/Ontology.