THESIS SUMMARY

dr Katalin Ternai
The metamorphosis of ERP Systems
Ph.D. thesis

Supervisor

Dr. András Gábor

Budapest, 2008

Department of Information systems

THESIS SUMMARY

dr Katalin Ternai
The metamorphosis of ERP Systems
Ph.D. thesis

Supervisor

Dr. András Gábor

Table of Contents

I. Research Motivations and Goals

In our days organisations face many challenges. Besides price and cost pressures, businesses are becoming global and new markets are developing rapidly. The success of a company in micro and macro level is increasingly determined by how quickly it can react to changing market conditions with adequate products and services. Furthermore, there is rapid technological development and product lifecycles are shortening. It is no longer enough to define customers by market segment. There is increasing expectation that products will be configured for individual customer needs. On top of all these trends there are country-specific or industry-specific regulations and compliance issues to which companies must respond.

Companies look for techniques and methods, which can help them to improve their capabilities in effective organisational management. It is almost impossible to run a competitive business without computerized information systems. Providing a computerized solution to a business problem may require integrating a lot of information systems. The rapidly increasing use of the web has changed the manner in which business is done in almost all organizations.

ERP (Enterprise Resources Planning) systems have been the most popular enterprise applications, and have presented new model of enterprise-wide computing since 1990. They allow enterprises to replace their legacy systems with a single, integrated system, in which it is possible to plan and manage the use of the resources of an entire enterprise.

IT infrastructure that has grown organically and chaotically over the years to handle focused issues as they arose, with no recognizable roadmap or process in place. Connections between pieces of this infrastructure tend to be inflexible and very difficult, expensive, and time-consuming to change.

Custom Point-to-Point Integration is expensive to maintain and very expensive for new business requirements. Any change to either endpoint is likely to break it. Changes to internal components will break it also. EAI is less brittle, changes to endpoints may require some changes but they don't ripple through the entire infrastructure like Point-to-Point Integration. Changes to internal components may force changes to other components since internal broker components are typically tightly coupled. Initial costs are higher than Point-to-Point Integration, but maintenance is much lower.

As the business transforms, the IT systems implementing transformations have to be agile enough to change quickly and cost effectively while still performing current business function. Business agility is the fundamental business requirement – The ability to respond to changing requirements is the new meta-requirement for business. The entire enterprise architecture must support the business agility requirement.

The desire to make IT more flexible is not new. It is as old as the IT industry itself. Early initiatives involved making monolithic architectures more flexible by breaking them into callable subroutines and procedure calls. The idea was then built upon by the concept of business objects – discrete pieces of code which included data and its behavior which could change depending on context. Object technologies were mostly tightly coupled and so messaging technologies were developed to loosely couple applications from one another. Various EAI techniques were then developed to make applications even more modular and loosely coupled. Enterprise Application Integration is defined as the use of software and computer systems architectural principles to integrate a set of enterprise computer applications.

EAI encompasses methodologies such as object-oriented programming, distributed, cross-platform program communication using message brokers with Common Object Request Broker Architecture and COM+, the modification of ERP to fit new objectives, enterprise-wide content and data distribution using common databases and data standards implemented with the Extensible Markup Language (XML), middleware, message queuing, and other approaches.

Information sources change every day and consumption of sources change every day. Therefore, to make business flexible, and not based on a specific integration project but a flexible information architecture. Today, Service Oriented Architecture is the culmination of all of these architectures. SOA builds upon previous integration techniques but does not replace them. SOA blends the best of all these concepts into one new architecture that promises to make the notion of applications even more flexible. SOA is not the end of the road, it's the next step in the evolution of flexible enterprise infrastructures. I think this evolution will continue into the future.

Hypotheses and Relating Research Questions

Main research questions of my thesis were the next: what kinds of methodologies exist for integration application development in the literature and how these paradigms can be extended, modified, integrated and customized for a new domain in ERP-centric enterprises. Nowadays companies are to survive in a dynamic environment. New business models will be an even greater source of competitive advantage than new products and services. Organizations are trying hard to continuously align their actual business processes, as executed by the multiplicity of systems, with the should-be processes as derived from managerial needs. My research topics have been dealing with the role of BPM and the possibilities in application integration problems in ERP-centric enterprises. The importance of business driven approach especially in

integrated business architectures is obvious. Process models are the core elements of the integrated enterprise architecture.

Common and unified interpretation is fundamental in data and information processing. Managing the organizational resources and integrated systems development are strategic issues in many companies. They require a common platform to integrate business and IT architecture. Business driven SOA environment could offer an alternative solution to satisfy these needs, as I have discussed in my thesis.

The following research questions were discussed in my thesis:
- how can we use ERP systems in agile dynamic business environment
- what are the decisive methodologies for integrated systems development in the literature;
- what are the most frequently cited business modelling methods;
- what kind of business modelling methods and tools are in use;
- how can these business models be extended, modified and transformed support integrated systems development?

I.1.1. Hypotheses

The Main Research Statement:

*The key of the solution of integration problems in the conglomerated environment of the organisations that implement ERP system also in middle-distance to make capital out of the **sinergy** of the collaborative use of the modern application development paradigms and methods - like BPMS, SOA and MDA.*

The First Research Statement:

With the use of ARIS method and tools realizable the model of business integration of the organisation that implement ERP system.

The Second Research Statement:

With the collaborative use of the principles of BPM, SOA and MDA the integration problems of an organisation can be solved in business driven way.

The Third Research Statement:

An ERP – centric organisation that develops and optimises its BPMS process models quickly and cost effectively can follow the changes of its environment with its integrated information systems and applications.

II. The realization of the research

II.1.   Research Methodology

My research area is on the borderline of information technology and social sciences. This interdisciplinarity influences the methodology of my research.

Regarding the approach this research is a deductive one, since it focuses on the verification of already existing theories by the application of business modeling and software engineering methodologies, modeling languages and relating model transformation methods on a new field. In the initial phases of the research questionnaires cannot be applied for proving the statements of

hypothesizes, neither statistical samples are available. The most adequate solution for the verification or disproval of the applicability of this approach is the use and thorough analyzes of case studies.

II.2.   The Applied System of Paradigms and Tools

Many techniques are used for modelling enterprise architectures. I have summarized the most promising modelling approach and toolset. ARIS has become market leader; therefore I applied the widely accepted ARIS methodology and framework in my research. I have also summarized the business integration framework.

I proposed the ARIS method to provide the model of business integration of an organisation that implement ERP system because:

1. The ARIS - Architecture of Integrated Information Systems - provides a structured approach to modelling, and also an Architectural Framework that provides a specification of how to organise and present all of the information that comprises an enterprise's architecture.

2. ARIS is market leader also in Hungary.
3. ARIS models are in use at organisations for BPR purpose.
4. The ARIS reference models of remarkable ERP systems (eg. SAP) are available.
5. The principles of ARIS concept (views and layers) make available to provide the integration between the vertical and horizontal layers of the model of business integration.
6. ARIS method uses top-down approach for the development of the process structure of an enterprise.

To make business able for change dynamic and based on flexible information architecture, I offered to develop using SOA foundations.

I followed business process management methodology for business driven development of my SOA application because business process management is a discipline combining software capabilities and business expertise to accelerate process improvement and facilitate business innovation.

The first step in the business driven development of a SOA application - applying the BPM principles - is to create the model of the business process. Models can be used for documentation and compliance purposes - providing a visual and textual representation of the processes, organization, resources, collaborations and business measurements.The next step is to turn business processes into models that can be analyzed, simulated, refactored, and ultimately turned into software applications.

I applied the IBM WebSphere tools during the development. WebSphere Integration Developer's tools are based on a service-oriented architecture. The tools allow both a top-down design approach to building an integrated application, where the implementation for one or more components does not exist and is added later; or a bottom-up approach, where the components are already implemented and the developer assembles them by dragging and dropping them in a visual editor and then creates a logical flow amongst them by joining them with lines. A debugging and test environment means full testing before the applications are deployed to a production server. Setting monitoring points lets see how an application is used in real time in order to fine tune it for optimal performance.

I refined the high-level business process model - the EPC process model from the ARIS repository - in the ARIS SOA Architect. Business processes are transformed into technical processes using the '10-step' methodology.

II.3.   The Verification of Thesis

First Research Statement's Verification

I proposed the ARIS method and toolset to provide the model of business integration of an organisation that implement ERP system. I demonstrated the ARIS support in the implementation of the business integration model by assigning the model types from ARIS views and layers to the elements of the business integration model.

Second Research Statement's Verification

The first step in the business driven development of a SOA application - applying the BPM principles - is to create the model of the business process. To turn business processes into models that can be analyzed, simulated, refactored, and ultimately turned into software applications i used IBM WebSphere Business Modeler. Modeler can be used for documentation and compliance purposes - providing a visual and textual representation of the processes, organization, resources, collaborations and business measurements. Modeler includes a simulation tool that allows to analyze and optimize the process. Modeler is built on the Eclipse tool framework making it easy to share information about the business design with other parts of the organization and tools. I exported the design into WebSphere Integration Developer so that – this means a model transformation from BPMN to BPEL - I can use that as a blueprint for designing process flows for automating the business design.

I demonstrated how to develop service oriented architecture by imlementation of a complex business process using model driven methods for the transformations from high abstraction level business processes to executable business processes.

Third Research Statement's Verification

I assumed that the observed enterprise had applied the ARIS method during the implementation of its ERP system and development of its business architecture; also maintens process models in a common repository. In this mental experiment I had a lot of organisations becouse of the marcet position of the ARIS.

I assumed that the enterprise makes its applications work on the Websphere platform. With this assumption I narrowed the experimental set but because of the marcet position of the IBM I had considerable amount of organisations.

I looked at a change that needed quick reaction in strategic standpoint. This should be a frequent case in the enterprise's life not to be empty the experimental set.

The main enterprise's business objectives:

- Use automation to enhance the performance of the "Purchase order" process

- Document the process

- Make the process easy to integrate

- Make the process easy to update and modify

Business processes were transformed into technical processes using ARIS SOA Architect and the '10-step' methodology.

I have proved by the described deduction that in a SOA environment - that implements the proposed process management method and toolset; the ERP system developed by the proposed method and toolset; and some other applications - a quick and cost effective solution can be provided for a new

business challenge with the use of model transformations, that suits both the strategic and high abstraction level business models and on the implementation level suits the business integration architecture of the organization.

III. The Results of the Research

On the field of methodologies for integrated application development and business modelling the most influential approaches applied in my thesis were building business driven SOA environment, BPM and MDA methodology. Business driven SOA development has a new approach for integrated application building based on partly BPM methods. There are not so many implementation descriptions available in the literature for the verification of their method. They published mainly research experiences. I modified and customized these methodologies in order to satisfy the requirements of my research tasks. Therefore my approach concerning the methodology for integrated application building and implementation is new.

Most important results of my work are the following: modification of integrated application methodology for building business driven SOA environment using the results of the assessed methodologies and the application of the modified methodology for a new domain to produce a prototype.

Research is timely and up to date because of the constantly increasing use of e-business, emphasizing enterprise agility and business flexibility issues. One of the practical importances, applications of my research is that the results can be used in teaching and in further researches of my department. It seems that the outcome can be used at the graduate level in business informatic courses, in diploma consultation, and at postgraduate level. Achievements could be useful for organizations also, because there are not so many research projects with the same subject in Hungary. It can serve as a base, as a prototype of projects for integrated system development and analysis.

I continue the research in a common researching project with IBM, SAP and IDS in the topic of business driven SOA development.

IV. References

van der Aalst, W.M.P.; Pesic, M.: Specifying, Discovering, and Monitoring Service Flows: Making Web Services Process-Aware. BPM Center Technical Report, No. BPM-06-09, 2006.

Berners-Lee, T. – Hendler, J. – Lassila, O. (2001): *The Semantic Web*, Scientific American, May

Bertrand Portier: Service, architecture, governance, and business terms, May 2007, http://www.ibm.com/developerworks/webservices/library/ws-soa-term1/

Bieberstein, N. Bose, S. Fiammante, M. Jones, K. Shah, R., Service-Oriented Architecture Compass: Business Value, Planning, and Enterprise Roadmap. Pearson Education, 2006.

Booch, G.: Object-Oriented Design, Benjamin/Cummings, Redwood City, Calif., 1991.

de Bruijn, Jos et al.: D16.1v0.21 The Web Service Modeling Language WSML. WSML Final Draft. http://www.wsmo.org/TR/d16/d16.1/v0.21/, retrieved November 7, 2005.

Chandra., J., et al.: Information Systems Frontiers, Communications of the ACM, January 2000.

McCarthy, William, Geerts, Guido. : An Accounting Object Infrastructure for Enterprise Models, IEE Intelligent Systems, 1999, www.msu.edu/user/mccarth4.

McCarthy, William és Geerts, Guido. 2000. The Ontological Foundation of REA Enterprise Information Systems, www.msu.edu/user/mccarth4/alabama.doc.

Chalmeta, R., C. Campos, R. Grangel. (2001) References Architectures for Enterprise Integration, Journal of System and Software, 57(3), 175-91.

Davenport, T. H.,: Putting the Enterprise into the Enterprise System, Harvard Business Reviev, 1998.

Dellarocas , C. (1996) A Coordination Perspective on Software Architecture: Towards a Design Handbook for Integrating Software Components. MIT, Cambridge.

Dietz, Jan L. G.: Enterprise Ontology. Springer, Berlin / Heidelberg 2006.

Scheer, A.-W.: ARIS - Vom Geschäftsprozess zum Anwendungssystem. 3rd. Aufl., Springer, Berlin etc. 1998.

Dutta, S., et al.: Designing Management Support Systems, Communications of the ACM, 1997.

Edvard A. Stohr , Jeffrey V. Nickerson (2003) Intra Enterprise Integration. Competing in the information Age. Second edition. Oxford Universiti Press

Eisenhardt, K. M.: Building Theories from Case Study Research. Academy of Management Review, 1989.

Esteves, J., & J. Pastor. (2001) Enterprise Resource Planning Systems Research: An Annotated Bibliography, Communications of AIS, 7.

Fenn, J., Gartner's Hype Cycle Special Report for 2007, Gartner, Aug. 2007. Letöltve: 2008. április 8. http://www.gartner.com/DisplayDocument?id=511189

Fensel, Dieter; Bussler, Chris: The Web Service Modeling Framework WSMF. In: Electronic Commerce Research and Applications 1 (2002) 2, pp. 113-137.

Fox, Marc S.; Gruninger, Michael: Enterprise Modeling. In: AI Magazine (1998) Fall 1998, pp. 109-121.

Fox, Marc S. et al.: An Organisation Ontology for Enterprise Modeling. In: M. Prietula; K. Carley; L. Gasser (Hrsg.): Simulating Organizations: Computational Models of Institutions and Groups. AAAI/MIT Press, Menlo Park CA 1998, pp. 131-152.

Gruninger, Michael et al.: Ontologies to Support Process Integration in Enterprise Engineering. In: Computational & Mathematical Organization Theory 6 (2000) 4, pp. 381-394.

Guarino, N. (ed.), „Formal Ontology in Information Systems", Amsterdam, Berlin, Oxford: IOS Press. 1998.

Hart, C.: Doing a Literature Review – Releasing the Social Science Research Imagination, Sage Publications, London, 1998.

Hepp, Martin et al.: Semantic Business Process Management: A Vision Towards Using Semantic Web Services for Business Process Management. IEEE International Conference on e-Business Engineering (ICEBE 2005).

High, R. Kinder, S. Graham, S., An Architectural Introduction and Overview, IBM's   SOA   Foundation,   Nov.   2005.

http://download.boulder.ibm.com/ibmdl/pub/software/dw/webservices/ws-soa-whitepaper.pdf

Hollingsworth, D. – The Workflow Management Coalition (1995): *The Workflow Reference Model*. http://www.wfmc.org/standards/docs/tc003v11.pdf,

S. Holloway: The Distributed Development Environment, Chapman and Hall, 1990.

Ibbotson, J. (Ed.) (2001) XML Protocol Usage Scenarios. W3C. http://www.w3.org/TR/2001/WD-xmlp-scenarios-20010217/

Jensen, M. C., W. H.Meckling, (1973) Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure, Journal of Financial Economics, 3(3), 305-60.

Johnson, R. A.: The Ups and Downs of Object-Oriented Systems Development, Communications of the ACM, 2000.

Kenny, L. F. _ Plummer, D. C., Magic Quadrant for Integrated SOA Governance Technology Sets, Gartner RAS Core Research, Dec. 2007. Letöltve: 2008. április 13. http://www.softwareag.com/Corporate/Images/REPRINT-Magic% %20SOA%20Governance%20Technology%20Sets,%202007_tcm16-37108.pdf

Koch., C., et al.: The ABCs of ERP, CIO Magazine (cio.com), December 22, 1999.

Lawler, J. P., Howell-Barber, H., Service-Oriented Architecture: SOA Strategy and Methodology and Technology. Auerbach Publications, 2007.

O'Leary, D., et al.: Artificial Intelligence and Virtual Organizations, Communications of the ACM, 1997.

Lederer. A. L., et al.: Using Web-based Information Systems to Enhance Competitiveness, Communications of the ACM, July 1998.

Lenat, D. B., and Guha, R. V., „Building large knowledge-based systems.Representation and inference in the Cyc project", Addison-Wesley, Reading, Massachusetts,1990.

Malone, T.W., K. Crowston, et al. (1999) Tools for inventing Organizations: Toward a Handbook of Organizational Processes. Management Science, 45(39, 425-43.

Malone, T.W., K. Crowston, et al. (1999) Tools for inventing Organizations: Toward a Handbook of Organizational Processes. Management Science, 45(39, 425-43.

Markus, M.L. (2000) Paradigm Shifts: E-Business and Business/Systems Integration, Communications of AIS 4(10).

M. Lynne Markus, Cornelis Tanis, Paul C. van Fenema: Enterprise resource planning: multisite ERP implementations, Communications of the ACM, Volume 43 , Issue 4 (April 2000) , Pages: 42 – 46,ACM Press   New York, NY, USA

Miles, B. M., Huberman, A. M.: Qualitative Data Analysis (2nd ed.). London: Sage Publications, 1994.

Robin Milner: Communicating and mobile systems: the pi calculus, ISBN 052164320, Cambridge University Press 1999.

Nonaka, I., Takeuchi, H.: The Knowledge-Creating Company, New York: Oxford University Press, 1995.

Oberle, Daniel: Semantic Management of Middleware. Springer, New York 2006.

MetaObjectFacility(MOF)Specification,Version1.4,http://www.omg.org/docs/formal/02-04-03.pdf

Palaniswamy, R., and T. Frank: Enhancing Manufacturing Performance with ERP Systems, Information Management Journal, 2000.

Parr AN and Shanks G. 2000. A taxonomy of ERP implementation approaches. 33rd Annual Hawaii International Conference on System Sciences, Sprague RHJ (ed) Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Los Alamitos: IEEE Computer Society. ISBN 0-7695-0493-0.

Peppers, D., and M. Rogers: Enterprise One to One: Tools for Competing in the Interactive Age. New York: Doubleday, 1999.

Recker, Jan et al.: How Good Is BPMN Really? Insights From Theory And Practice. 14th European Conference on Information System (ECIS 2006)

Roman, Dumitru et al.: D2v1.2 Web Service Modeling Ontology (WSMO). WSMO Final Draft April 13, 2005. http://www.wsmo.org/TR/d2/v1.2/, retrieved Nov 30, 2005.

Davies, Islay G and Rosemann, Michael and Green, Peter (2004) Exploring proposed ontological issues of ARIS with different categories of modellers. In: Proceedings of the Australasian Conference on Information Systems, Hobart,.

Sassi, G., SOA e Business Flexibility, IBM, 2007. Letöltve: 2008. áprlis 8.

Scheer, A.-W. (1993): Handbuch Informationsmanagement. ARIS-Architektur integrierter Informationssysteme. Gabler, Wiesbaden.

Scheer, A.-W. - Abolhassan, F. - Jost, W. - Kirchmer, M. (szerk.) (2002): Business Process Excellence - ARIS in practice. Springer, Berlin.

Smith, B, „Ontology and Information Systems", 2001.13 http://ontology.buffalo.edu/ontology.doc(http://www.vtt.fi/tte.staff.publications/ontologies_ho.pdf)

Howard Smith & Peter Fingar Workflow is just a Pi process, V2.1, November 2003.

Thomas Erl: "Service-Oriented Architecture: Concepts, Technology, and Design", PRENTICE HALL, ISBN 0-13-185858–0, 2005.

Thomas Erl: SOA Principles of Service Design, PRENTICE HALL, ISBN 0132344823, 2005

E.Turban, E. McLean, J. Wetherbe: Information Technology for Management 3rd edition, John Wiley & Sons, 2002.

E.Turban: Electronic Commerce 2nd edition, Upper Saddle River, NJ: Prentice – Hall, 2002.

Mike Uschold, Martin King, Stuart Moralee and Yannis Zorgios: The Enterprise Ontology, The University of Edinburgh, 1997.

Yin, R.K: Case Study Research (2nd ed.). London:Sage Publications, 1994.

Wahli, U., Business Process Management: Modeling through Monitoring Using WebSphere V6.0.2 Products, IBM International Technical Support Organization, Aug. 2007. Letöltve: 2008. április 24. http://www.redbooks.ibm.com/redbooks/pdfs/sg247148.pdf

Weber, R. (1997) Ontological foundations of Information Systems. Coopers & Lybrand Accounting Research Methodology. Monograph No. 4. Melbourne

Wand, Y. and Weber, R. (1993). On the ontological expressiveness of information systems analysis and design grammars. Journal of Information Systems. 3(4), 217-237.

Wand, Y. and Weber, R. (1995) On the deep structure of Information Systems. Information Systems Journal. 5, 203-223.

WFMC. (1995) The Workflow Reference Model, Version 1.1., http://www.wfmc.org/standards/docs/tc003v11.pdf

W3C: OWL Web Ontology Language Guide. W3C Recommendation 10 February 2004. http://www.w3.org/TR/2004/REC-owl-guide-20040210/, retrieved Nov 30, 2005.

Zachman, J.A., "A Framework for Information Systems Architecture", IBM Systems Journal Vol 26, No 3, 1987.

Zachman, J.A., and Sowa, J.F., "Extending and Formalizing the Framework for Information Systems Architecture", IBM Systems Journal, Vol 31, No 3, 1992.

V. Relevant Publications of the Author

Katalin Ternai; Mateja, Podlogar (2008): ERP Systems in Higher Education from Regional Perspective, Handbook of Research on Enterprise Systems, Information Science Reference, Edited By: Jatinder N. D. Gupta , The University of Alabama in Huntsville, USA; Mohammad A. Rashid, Massey University, New Zealand; Sushil Sharma, Ball State University, USA, ISBN 978-1-59904- 859-8

Ternai, Katalin (2007): 'Vállalatirányítás Integrált rendszerrel', Üzleti informatika (Business Informatics), pp. 55 -77, ISBN 978 963 9698 19 2, Aula , Budapest.

Ternai, Katalin (2005): 'Integrált gazdálkodás - nem középiskolás fokon.' Vezetéstudomány (Management Science) - february, pp. 31-37.

Katalin Ternai (2004): Excellence Center and its Role of International Cooperation of Education and Knowledge. Strategy of development of Russia and East-European countries under the conditions of transformation of socio-economic system. StolypinVolga Region Academy for Civil Service, p: 236-240. ISBN 5-8180-0176-8.

Katalin Ternai (2003): Integrated Systems in the Role of Integration of Education. Informatics in Education, 2003, Vol. 2, No. 3, 1. 2003 Institute of Mathematics and Informatics, Vilnius.ISSN 1648-5831

Ternai Katalin (2003): 'Az ERP-rendszerek metamorfózisa.' Vezetéstudomány (Management Science), 2003. July, pp 35-38