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The emerging role of corporate information systems: An example from the area of business process-oriented learning

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Abstract

Emerging business requirements, stemming from a holistic view over an organisation's activities, place additional pressure on technical infrastructures and call for operational agility and a better alignment between business and technology. Business process oriented learning unites corporate training and business process management. Given the importance of an organisation's human capital to business success, aligning individual training with business priorities, becomes a key challenge. The implementation of this new business service entails integrating learning into daily working tasks and putting in place mechanisms for the effective management of business processes, organisational roles, competencies and learning processes, to reduce the time to fill competency gaps and to build proficiency according to evolving business needs. In this paper we outline the main characteristics of this approach and provide insights regarding the changing role of the involved corporate information systems and the multiple aspects of the integration work.

Keywords: information systems integration, service-oriented architectures

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1 INTEGRATION OF CORPORATE INFORMATION SYSTEMS

Traditionally, corporate information systems (IS) were built to support specific business functions, and had thus to be developed in complete alignment with the organisation's functional breakdown. This has resulted in a wide range of systems being deployed within a single organisation, each relying on different technologies, serving a specific purpose within a specific functional area (e.g. logistics, human resources, customer relationship management, supply chain management etc) and not necessarily "communicating" with neighbouring applications. Early systems were often difficult to customise and/or extend, and it was practically impossible to replace or evolve parts of them. Their platform- and technology-dependency resulted in committing organisations to long term technology decisions. In cases where information exchange among systems was needed, tight coupling had to be pursued. Developing interfaces between such systems was often associated with significant technical challenges.

Nowadays, in most business sectors increased market competition and customer expectations create a growing need for:

- value-added customer services and quality of service over multiple delivery channels;
- reduction of the time-to-market of new products and services;
- containment of operational costs (e.g. for IS maintenance and operation) and operational inefficiencies (e.g. through internal re-engineering);
- rapid responsiveness to the business's strategic priorities. Adaptation of corporate structures and work methods to a constantly changing business environment, including re-engineering in response to large-scale strategic decisions (e.g. mergers and acquisitions).

Organisations have evolved from being vertical, isolated and business unit-centric during the early years, to horizontal business-process-focused structures during the 1980's and 1990's, and towards a new ecosystem business paradigm (Moore, 1993) that features componentised and distributed business services (Endrei et al, 2004). According to Soren, Elena, Jeremy, Gustavo and Joseph (2001) this new business ecosystem is characterised by the creation of virtual organisations, as opposed to vertically integrated structures, the formation of cross-organisational partnerships and the outsourcing of non-core activities.

Emerging business requirements put additional pressure on technical infrastructures, calling for operational agility and a better alignment between business and Information Technology (IT). The rising complexity and dynamism of the business environment calls for more robust IT infrastructures to provide intelligent resource sharing and dynamic service creation and distribution.

Realising the full potential of corporate IS infrastructures is not merely about drilling down to add new vertical services to existing systems, but more about cross-border integration, i.e. about strengthening the interoperability of "departmental" applications, so as to support business functions that cut across traditional functional areas. This has given rise to a strong need for wider intra- and even inter-organisational co-operation and over the years has led to the development and diffusion of systems that view technical, business and administrative applications in a corporate wide perspective. This approach favours open system architectures as opposed to closed monolithic systems.

Under the weight of emerging needs and with organisations increasingly striving to streamline and improve their operations, the adoption of an even more comprehensive IS integration strategy becomes an imperative, namely one that combines corporate activities that traditionally are completely disjoint to propose new services. IS should allow organisations to quickly respond to business changes. The IS integration strategy should speed up the application development process. Traditional system integration techniques are unable to solve the problem. Building from scratch new IT infrastructure in response to a new business requirement is not a feasible solution. Equally ineffective is the development of direct software interfaces between collaborating legacy systems, department-specific and/or business partner applications.

In the following sections we discuss critical aspects of integration, the advent of service-oriented architectures and look into the new role Information Systems are called to play in the context of business process-oriented learning, using the case of the PROLIX project (Process-oriented Learning and Information Exchange [PROLIX], 2005). PROLIX is an EU-funded FP5 integrated project addressing the needs of modern organisations for increased competitiveness, by aligning training with business processes. The principal objective is to reduce the time needed to improve the competencies of employees and build proficiency according to continuous changes in business requirements. We present the building blocks of the architecture proposed by the PROLIX project and discuss some early conclusions from the integration process.

2 SERVICE-ORIENTED VS. COMPONENT-BASED ARCHITECTURES

Corporate needs call for information systems that aggregate and add value to disparate resources. As a result, the design process needs to take into consideration multiple viewpoints: the technology stack (or physical) view, the object (or data) model, and the use case (or behavioural) view (Albin, 2003). In order to support the seamless delivery of value-added services to their intended customers, the joining-up of IS goes beyond the mere technical linking of disparate corporate applications and/or networks to include the sharing of information, the establishment of joint workflows and the re-organisation of administrative operations within the involved functional areas. Yet, while in a component-based design, components are created to closely match business entities, service-oriented design features services that go beyond administrative segmentations within the organisation (cross-border services).

The need for integration translates into new requirements on related software applications and their integration, including the incorporation of existing legacy applications and commercial off-the-shelf products in the formation of new business processes. Overall, there are three critical aspects in system integration (Albin, 2003; European Commission, 2003):

- technical interoperability, which is concerned with the technical issues of linking up IS, the definition of open interfaces and telecommunications;
- semantic and functional interoperability, which is concerned with the content of the exchange (e.g. ensuring that the precise meaning of exchanged data is understandable by any other application in the system even if not initially developed for this specific purpose) and with the challenge of functionally integrating different software modules into one comprehensive system that meets the user needs.
- organisational interoperability, which is concerned with adapting the corporate environment to this new integrated model of work.

2.1 Technical interoperability: software integration

Primarily applications need to be interoperable, in order to provide complete, transparent and real-time access to data and information and to allow for their seamless exchange and processing across IS and/or functional areas.

The use of proprietary technologies can lead to the creation of information silos within departmental borders, which in turn can obstruct the seamless exchange of data. During the early years of systems development, integration was regarded as a mere technical issue, a "manual" process of developing point-to-point interfaces between applications (Al Mosawi, Zhao, & Macaulay, 2006). Direct linkage has several limitations (Gulledge, 2006) as it tends to connect components in a customised way, via proprietary application programming interfaces (APIs), which were particularly effort-demanding to build, maintain and/or extend. It results to components being typically tightly-coupled with changes in one requiring changes in other components as well. In this context, change is difficult and component replacement an often practically impossible total process. Additionally, the number of interfaces grows exponentially related to the number of interconnected components.

Similarly middleware software can provide broker services between the different information resources involved, using the message bus paradigm (Hohpe & Woolf, 2003). Middleware integration is therefore an advanced form of interfacing, which uses a spoke-and-hub architecture instead of point-to-point links to add an intermediary communication layer between interoperating units.

While efforts were being made in the direction of better systems integration, the idea of Enterprise Resource Planning systems (ERP) emerged, as a way to overcome the problems created by application segmentation. The objective was to develop organisation-wide ERP systems, which would integrate all data and processes of an organisation into a unified system and realise concrete financial and operational competitive advantages. Integration and interoperability would be guaranteed within these "all-encompassing" packaged applications. Yet, in reality ERP solutions failed to completely support the organisation's IT needs in the majority of cases (Themistocleous, Irani, O'Keefe & Paul, 2001).

The agreement on common communication standards among software components is critical for achieving information sharing and interoperability. As integration efforts continued, the need to simplify the process of integrating existing applications and data lead to Enterprise Application Integration (EAI) technologies. EAI defines a standard methodology for applications and data sources to communicate. It thus pursues the creation of robust business solutions by combining applications using common middleware and other viable technologies (e.g. data transformation services, process management services etc) (Ring & Ward-Dutton, 1999; Al Mosawi et al., 2006). According to the level in an application it addresses, there are mainly four types of EAI: data level, application interface level, method level, and user interface level EAI.

The current trend towards service-oriented architectures (SOA) builds on the development of loosely coupled, independent services to support the requirements of business processes and users. This paves the way for novel user services that span several formerly isolated functional areas, in terms of both the information systems employed and the allocation of executive responsibilities. Corporate IS are gradually evolving from self-contained, single-purpose "black-box"-type applications, that operate as isolated islands of automation, to become interoperable modules of organisation-wide system architectures, capable of serving multiple users and multiple applications.

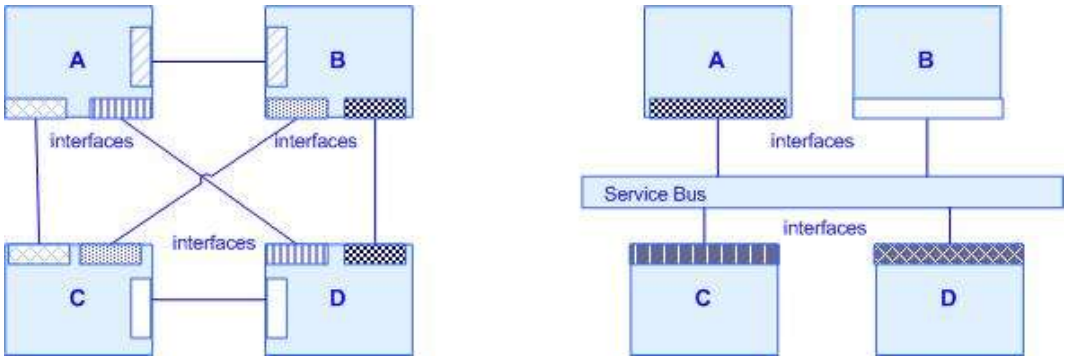
SOA differs significantly from point-to-point and EAI, as it is business process driven as opposed to being data driven.

Web services technologies allow for applications/services that are self-contained and self-describing to be published, located and invoked over the message bus. Resources are made available in the form of independent web services (using SOAP, WSDL and UDDI). A service represents an autonomous unit of automated business logic. No prior knowledge of the underlying platform, technologies, or implementation is required in order for a service to be consumed. Interlinked IS "publish" and make their services available to other participants in the network over a service bus. Similarly, service consumers can invoke services that are made available by others. Based on the service's WSDL file, they can build the client and uses the provided service. Joined services relying on complex workflows can thus emerge. (Channabasavaiah, Holley & Tuggle, 2003; Hohpe & Woolf, 2003).

Standards like the Web Services Description Language (WSDL) normalises the description of web services, defining them as collections of endpoints that exchange information about each others' capabilities thus allowing for inter-applications communication. Existing applications can be transformed into web services, while more sophisticated web services can be created from the combination of multiple back-end operations based on defined operations flows.

In order to become part of a SOA, a component needs to have a clearly defined interface and to conform to a prescribed behaviour common to all components within an architecture (W3C, 2004).

Figure 1: System integration: direct interfacing vs. Service Oriented Architectures



2.2 Semantic and functional interoperability

2.2.1 Data integration

Data integration stands at the foundations of integration. While early attempts were mainly based on information mapping and direct linkage to databases, the emergence of standards for representing the semantics of information has enabled a new level of integration of information resources. Data standardisation and semantic interoperability are key enablers for achieving integration and portability of information between the system modules. It supports a joined view of the data used by multiple business entities. For those concepts used by more than one module of the system, shared definitions, notions, formats, etc must be identified.

As IS and integration technologies gradually shifted from single-purpose, legacy applications and data-oriented point-to-point interfaces, integration became more than a mere technical connectivity to include functional and even organisational integration.

2.2.2 Functional integration

Integration is not limited to standardising data exchange models. On a functional level, interoperability involves the sharing of business processes among modules (process integration).

Services from different providers (i.e. sectoral IS transformed into modules of the integrated architecture) can be joined together according to specific operational flows in order to produce integrated services that correspond to more complex user requirements.

In a service-oriented architecture, basic business policies or rules from applications can be extracted and implemented in the middleware system, allowing individual modules to maintain their individual methods, as long as they do not affect the overall system landscape, in terms of data exchanged and web services provided (e.g. the interfaces to other modules). In this sense, the internals of any given module are free to change and off-the-shelf modules can be replaced with others provided the later conform to the same interfaces. This allows solutions to be vendor independent, and enhances their flexibility and applicability.

2.3 Organisational interoperability

According to the socio-technical perspective on organisational change and development, organisations are complex socio-technical entities (Hirschheim, Heinz & Lyytinen, 1995; Leavitt, 1965). The social ramifications of the development and operation of any information system are critical to its success and should not be overlooked. Organisational and cultural issues need to be addressed, in order to achieve interoperability among the involved functional entities and maximise the corporate advantage from the use of the system. This includes a clear definition of roles and responsibilities, which eventually may involve reorganisation, changes in the structure, standardised redesign of workflows and streamlining of processes and patterns of strategic change, identification of organisational, institutional and cultural barriers etc.

3 THE CASE OF BUSINESS-PROCESS ORIENTED LEARNING

With market complexity constantly increasing and compromising productivity and organisational performance, enterprises are confronted with a number of vital business challenges to improve their operational efficiency. New approaches are needed, in order for companies to effectively plan, structure and manage their activities to gain or maintain their competitive advantage. The quality of a company's workforce and its ability to adapt to changes is vital for business success. Particularly in knowledge intensive business environments, employees represent the organisation's "intellectual asset", being the carriers of knowledge (Nonaka & Takeutchi, 1995; Davenport & Prusak, 1998). Ensuring that employees have the right skills for the job is essential for the growth and success of an organisation. The continuous investment in human resource development is critical in the present economic context (Accenture, 2006). The goal of training services is to transfer to employees all the knowledge needed to cover any deficits that could hinder the independent fulfilment of their daily business tasks. Accelerating skills acquisition ("Time2Competency") can improve the way organisations handle changes in processes, products and organisational structures.

Within an organisation, learning (Nonaka & Takeutchi, 1995; Senge, Kleiner, Roberts, Ross & Smith 1994; Grace & Butler 2005) essentially complements business process improvement activities (Hammer & Champy, 1993; Davenport & Short, 1990; Davenport, 1993) aimed at improving the operational effectiveness of the organisation. Nonetheless, traditionally, organisations have handled learning management and business process management as two completely disjoined activities. The systems for planning and executing training processes (Horton & Horton, 2003) are not coupled with business processes modelling and business information systems and the respective executive responsibilities are assigned to different administrative entities. The task of training management is part of the work of human resource managers, who rely on traditional methods in order to assess the training needs of the employees, and often lack a full overview of the actual corporate context in which training is applied. As a result, in many organisations there is a mismatch between the training provided and the actual business needs: training in not provided on time and/or does not fully address the training needs of the employees with respect to their changing business duties. It is clear that the two activities (business process improvement and training) are complementary and the benefit for organisations can be enhanced if they are applied in a coordinated fashion. Aligning individual training with business priorities, so as to reduce the time to fill competency gaps and to build proficiency according to evolving business needs and daily work processes, emerges as a key challenge for corporate success. Business process-oriented learning can enable organisations to adapt to changes in their organisational structure, effectively introduce employees to new tasks, streamline business operations etc.

Essentially, business process-oriented learning entails integrating learning into the daily working tasks and putting in place mechanisms for the effective management of business processes, organisational roles, competencies and learning processes. This calls for an integrated view over

corporate information systems to support the complete life cycle from the business need that triggers learning to the assessment of the actual impact learning made on business performance.

3.1 The PROLIX approach

Learning management and business process management are two formerly isolated business areas that are brought together in the context of business process–oriented learning. At present, several applications are used for the purposes of either one of these functional areas (Learning Content Management Systems, Learning Management Systems, Skill Management System, Knowledge Management Systems etc), yet complete overview in the form of cause-and-effect is lacking on both sides.

The EU Integrated Project PROLIX (Process-oriented Learning and Information Exchange, IST-FP5-IP) (PROLIX, 2005) aims at the development of an interoperable service-based architecture for business process oriented learning, to interlink e-Learning to corporate knowledge management and business-intelligence systems, so as to reduce the time to fill competency gaps and to build proficiency according to business needs and daily work processes.

PROLIX is building a system to enable business process driven learning at the workplace. Linking business processes and learning is a particularly complex task. Business processes define organisational roles and associated functions, each with its own specific competencies requirements (i.e. the competencies profiles of organisational roles). Learning processes are defined based on the lacking competencies of individual employees assigned to specific organisational roles. Whenever there is a gap between the competencies profile of the individuals assigned to a specific role and of the role itself, organisations need to design suitable training plans, in order to close it.

The learning need is either driven by a corporate decision to improve the profile and capacities of the organisation by training employees (e.g. in response to an identified market challenge) or by the employee wishing to further qualify themselves, when faced with a new business task or when in pursuit of a better work position (work advancement).

The PROLIX approach to business process-oriented learning covers the complete life cycle from the business need that triggers learning to the assessment of the actual impact learning made on business performance. PROLIX adopts a process-oriented approach to allow the translation of process changes into adapted learning based on competency-matched mediation. Business processes define organisational roles and associated functions, each with its own specific competencies requirements (i.e. the competencies profiles of organisational roles). The competency refers to the ability of an individual to successfully master a certain business task.

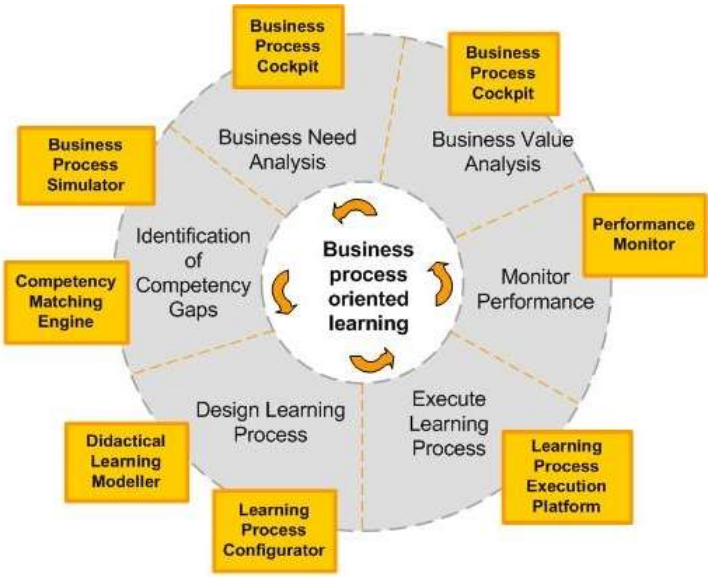
Learning processes can be defined based on the lacking competencies of individual employees assigned to specific organisational roles. Whenever there is a gap between the competencies profile of the individuals assigned to a specific role and of the role itself, organisations need to design suitable training plans, in order to close it. Business situations that may cause such changes include business engineering, recruiting and staffing, regulatory compliance and personal competency development (employee-initiated learning process).

Under the term business process-oriented learning a new collection of business processes can be found, each spanning a number of sectoral applications and traditional business processes. The typical life-cycle of business process-oriented learning (the PROLIX Learning Life Cycle, PLLC) (PROLIX, 2006a) and the software tools required for each step of the process are depicted in Figure 2. Starting point is a complex business situation, i.e. a situation that translates into significant competencies deficiencies and creates the need to train employees.

- Business need analysis comprises the modelling or optimisation of business processes and the identification of competencies or roles required to carry out the functions of a business process (Business Process Cockpit) (Scheer, 2000).
- The identification of competency gaps includes the calculation of overall competency gaps (by comparing employee's as-is and required competency profiles in the Competency Analyzer) and the prioritization of the competency gaps to be filled by means of learning (by simulating how the performance of the business process improves once specific competencies are acquired).
- The design of the learning process involves the selection or development of a didactically suitable learning process template (Didactical Learning Modeller) and the assignment of learning resources to this template to create a learning process (Learning Process Configurator) (Britain, 2004; Milligan, Beauvoir & Sharples, 2005; Morrison, 2003).

- The execution of the learning process consists in employees being trained to fill the selected competency gaps (Learning Process Execution Platform).
- Performance monitoring involves an evaluation of the impact of the learning process both on learning outcomes and on business process performance (Performance Monitor) (Kaplan & Norton, 1996; Symons, 2003; Kirkpatrick, 1959; Kirkpatrick, 1998).
- During business value analysis the business outcome of the competency improvements is compared against the initial business need. Unless the results are satisfactory, business processes and / or learning processes are adapted and optimized according to the analysis before restarting the PLLC.

Figure 2: PROLIX Learning Life-Cycle for business process-oriented learning and solution map



In practice, the development of a corporate system like PROLIX implies that existing applications have to be extended, and joined together (Learning Management Systems, Content Management Systems, Skills Management Systems, Business Process Modelling systems, Business Performance Management Systems etc) and that new tools have to be developed to fill out specific functional gaps along the process (e.g. competence-oriented process simulation tool). This all adds up to a multilayer, multidimensional integration scheme.

3.2 Integration

3.2.1 Technical interoperability: software integration

PROLIX builds on a distributed component-based service oriented system, combining loosely coupled and interoperable Web Services over an Enterprise Service Bus. Modules interact by exchanging messages (data) via standardised web service interfaces (PROLIX, 2006b; PROLIX, 2006c).

3.2.2 Semantic and functional interoperability

A common "language" had to be agreed and adopted by components that deal with the same concepts (e.g. competencies). Data specifications and standards that exist in areas addressed by the system are the ideal candidates for this. In some cases the ones that were selected had to be enhanced with additional parameters, in order to meet the specific needs of business process-oriented learning. Overall, the PROLIX architecture features three system-wide data formats:

(a) the *competency format*, that is used to store competency-related information, namely the competency profile format and the competency gap (actual profile, desired profile). The applied

model is based on the data model for Reusable Competency Definition (RCD) as defined in the draft IEEE standard.

(b) the *business process format*, is used for representing the business processes and is the output of the Business Process Cockpit (Figure 2). Existing business process description languages (XPDL) are enhanced to include competency-related information for each task in the business processes.

(c) the *learning process format* is used for representing a complete learning process: (a) the content, (b) the resources, and (c) the possible execution order. It complies with the IMS Learning Design Specification.

3.2.3 Organisational interoperability

Business process-oriented learning has a wide impact on how an organisation functions: the technological means, the business processes and the human resources. This entails a profound change within the administration, involving the reinvention of its internal processes and organisation and the coherent integration of infrastructure, systems, processes and services.

Furthermore, in accordance to the business ecosystem paradigm, different partnerships may emerge around business process-oriented learning, to result in parts of the life-cycle being outsourced to third parties. This creates a need for cross-organisational border interoperability.

4 LESSONS LEARNED AND FUTURE DIRECTIONS

SOA has been characterised as the "technology of the future", promising interoperable and reusable services that enable organisations to develop flexible and scalable software systems that are "just right" for them. Larger systems can be composed from small, less complex building blocks, without having to reinvent everything each time a new functionality is requested. In this sense, service-orientation is an enabler of business automation, allowing organisations to execute complex business processes.

Its wide list of benefits make it an ideal candidate for supporting the combination of business process intelligence tools with knowledge management and learning applications in the context of business process-oriented learning, which is a challenge for organisations striving to increase their overall performance. This approach can allow an organisation in turn, to document and study its business needs as they stand after a significant business change, to identify and prioritise the competency gaps of the affected personnel, to design suitable learning processes, to train the personnel accordingly, to measure the performance improvements achieved and to analyse the results to identify actions for achieving further operational improvements. By coordinating business process management and learning management activities, organisations can achieve a smooth transition to the new business process and reduce the time needed for the revised business process to become operational. At the same time, employees can assimilate new knowledge, improve their competencies and adapt to their new duties more easily.

This holistic approach is currently being investigated by the European integrated project PROLIX. The PROLIX architecture integrates existing concepts, practices, and tools of business process management, learning management, competence management. The adopted integration approach promotes the loose coupling and the exchangeability of modules. The development of service-oriented systems can be a complex process, particularly when in combination with and in support of the creation of novel user services, as is the case of the PROLIX system. The project is developing a prototype by enhancing and integrating existing commercial software systems and developing additional modules that are not presently available.

Early findings reveal the benefits of modern integration methodologies and draw attention on aspects that could hinder the success of this endeavour:

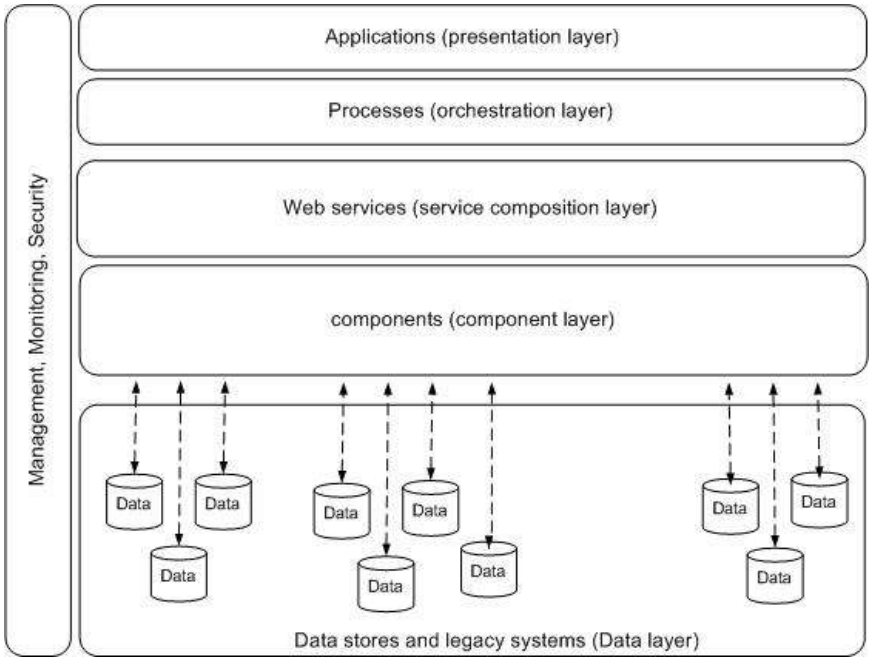
The adopted service-oriented integration methodology implies an ideal IT environment in which resources are cleanly partitioned and consistently represented. Therefore it is critical to establish a common understanding of data models across IT components. In theory, data models can be proprietary, as long as they are agreed upon and supported by all related modules in the architecture. In reality, this would result in service-oriented solutions that operate well in isolation from others, but cannot easily interoperate with external applications if this is required (e.g. due to incompatible data representation), or in modules that cannot be easily replaced. For this reason the enforcement of internal design standards should be pursued to ensure consistency in design and proper interaction of services. The PROLIX project is taking this principle a step further by developing an open reference architecture with standardised data formats that will eventually facilitate the integration of solutions from different providers.

Furthermore, service-based integration is not just about technology. It establishes a framework for IT architectures, in which automation logic and business logic have to conform. Alignment with specific business requirements is a critical success factor. As each organisation and business area have their specific characteristics, not all aspects of the business-process oriented learning life cycle are equally important. For this reason both the generic PLLC and the PROLIX system have to be customised to fit the application domain.

The adoption of service-oriented principles can affect several areas inside an organisation, namely: organisational structure, people, workflow processes and technologies (Pereira & Sousa, 2004). SOA adoption is an evolutionary process that can be described in terms of levels (according to SOA maturity models, such as SOAMM (Sonic Software Corp. et al. 2005), SIMM (Arsanjani & Holley 2005c) etc), starting with the wrapping of legacy functionalities in web services and exposing them for invocation by third-parties, proceeding to change the corporate culture to better support SOA and then discovering additional business capabilities from the exploration of new technologies. Undertaking SOA requires commitment from all levels of the organisation and significant investments (people, process, and tools). Planning and stakeholder commitment are prerequisites in order for a system like PROLIX to blend with other processes of the organisation.

It is particularly important to hide away complexity and improve user experience. SOA-based integration promotes the development of an environment that abstracts back-end processing so that it can execute and evolve independently within each application. New services can combine many component-specific services, possibly across multiple organisations. As a result users may have to navigate from one component to another, in order to execute a single business process. This calls for a joint front-end, i.e. a common entry-point to the system and a user-centric service delivery. When composite services are channelled through individual components, users risk being overflown with details about the systems business logic and/or the functionalities of individual components. In reality they need not be aware of the allocation of "work" among the system modules in order to perform a task. While the implementation of a set of web services can help put into place the requested functionalities, achieving usability requires additional effort. Service orchestration in the form of usage-and user-specific workflows (e.g. creation of a learning unit by a learning expert) can hide away the complexity of the underlying modules improve the users' interaction with the system. Figure 3 depicts the logical architecture of a one-stop service-oriented system.

Figure 3: One-stop service-oriented architectures



Another critical element is service management and particularly issues of federated identity management and security policies. Enabling secure interactions between services and applications implies role-based access to services, user data propagation and synchronisation etc.

The PROLIX approach will be evaluated with the use of four real-life test beds, each taken from a different field of application: “Social care”, “Telecom”, “Educational Publishing” and “Banking”. The conclusions drawn during the system validation phase, combined with new insights from the ongoing requirements analysis work will serve as input for the refinement, enhancement and overall improvement of both the concept and the system during two subsequent iteration phases, providing advanced versions of the PROLIX system in the next two years (till 2009).

REFERENCES

Accenture (2006). Accenture High-Performance Workforce Study 2006. Retrieved March 26, 2008, from
http://www.accenture.com/Global/Services/By_Subject/Workforce_Performance/R_and_I/HighPerformaceStudy2006.htm

Albin, S.T. (2003). The Art of Software Architecture—Design Methods and Techniques. Wiley Publishing, Inc., Indianapolis, 2003

Al Mosawi, A., Zhao, L. & Macaulay, L. (2006). A model driven architecture of enterprise application integration. Hawaii International Conference on System Sciences, HICSS-39, January 4-7, 2006

Arsanjani, A. & Holley, K. (2006). The Service Integration Maturity Model: Achieving Flexibility in the Transformation to SOA. IEEE SCC 2006, 515

Britain, S. (2004). A Review of Learning Design: Concept, Specifications and Tools (JISC E-learning Pedagogy Programme Report). Retrieved March 26, 2008, from
http://www.jisc.ac.uk/uploaded_documents/ACF83C.doc

Channabasavaiah K., Holley K. & Tuggle E, (2003). Migrating to a service-oriented architecture. (IBM DeveloperWorks). Retrieved March 26, 2008, from http://www-128.ibm.com/developerworks/library/ws-migratesoa/

Davenport T. H. & Prusak L. (1998). Working Knowledge: how organizations manage what they know. Harvard Business School Press

Davenport, T.H. (1993) Process innovation: reengineering work through information technology. Harvard Business School Press, Boston, MA, 1993

Davenport, T.H. & Short, J.E. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. Sloan Management Review, pp. 11-27.

Endrei, M., Ang, J., Arsanjani, A., Chua, S., Comte, Ph., Krogdahl, P., Luo, L. & Newling, T. (2004). Patterns: Service-Oriented Architecture and Web Services. (IBM Redbook). Retrieved March 26, 2008, from http://www.ibm.com/redbooks

Erl T. (2004). Service-oriented architecture. A field guide to integrating XML and Web Services. Prentice Hall, 2004

European Commission (2003). Linking up Europe: the importance of interoperability for e-government services. (Commission Staff Working Document). Retrieved March 26, 2008, from http://ec.europa.eu/idabc/servlets/Doc?id=1675

Grace, A. & Butler, T. (2005). Learning Management Systems: A new beginning in the management of learning and knowledge. International Journal of Knowledge and Learning (IJKL), Vol. 1, Nos. 1-2, pp.12–24.

Gulledge, T.G. (2006). What is integration? Industrial Management & Data Systems, 106(1). pp 5-20.

Hammer, M. & Champy, J. (1993). Re-engineering the Corporation: a Manifesto for Business Revolution. HarperCollins, New York, NY

Hirschheim, R, Heinz, K, Lyytinen, K (1995). Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations. Cambridge University Press, UK.

Hohpe, G. & Woolf, B. (2003). Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions. Addison-Wesley Professional, ISBN 0321200683

Horton, W. & Horton, K. (2003). E-learning Tools and Technologies. Wiley Publishing, Inc.

Kaplan, R.S., & Norton, D.P. (1996). The balanced scorecard: translating strategy into action. Harvard Business School Press, Boston, Massachusetts.

Kirkpatrick, D.L. (1959). Techniques for evaluating training programs. Journal of the American Society of Training Directors, Vol 33, No 11. pp3-9.

Kirkpatrick, D.L. (1998). Evaluating Training Programs: The Four Levels. 2nd Edition Berrett-Koehler Publisher, Berkley, USA.

Leavitt, H.J. (1965). Applied organizational change in industry: Structural, technical, and humanistic approaches. In March J (ed). Handbook of Organizations. Chicago: Rand McNally & Co; 1965 (March). pp 1144-70.

Milligan, C., Beauvoir, P. & Sharples, P. (2005). The Reload Learning Design Tools. In Colin Tattersall, Rob Koper (eds.),Journal of Interactive Media in Education Special Issue on Advances in Learning Design, 2005.

Moore, J.F. (1993). Predators and Prey: A New Ecology of Competition. Harvard Business Review. Vol. 71 (3), pp. 75-86

Morrison, D. (2003). E-Learning strategies. John Wiley & Sons Ltd., England

Nonaka, I. & Takeuchi, H. (1995). The Knowledge-Creating Company. How Japanese companies create the dynamics of innovation. Oxford University Press, New York.

Pereira, C. M. & Sousa, P. (2004). A method to define an enterprise architecture using the zachman framework. In SAC'04: Proceedings of the 2004 ACM symposium on Applied computing, ACM Press, New York, NY, USA, pp. 1366–1371.

PROLIX Integrated Project (2005). Process-oriented Learning and Information Exchange, IST-FP6-027905 (http://www.prolixproject.org/)

PROLIX Integrated Project (2006a). PROLIX Requirements Analysis Report. Deliverable D1.1. Herrmann, K., Leyking, K., Ackema, R. and Faltin, N. (Eds.)., IST-FP6-027905 PROLIX (Process-oriented Learning and Information Exchange)

PROLIX Integrated Project (2006b). PROLIX Technical Architecture. Deliverable D2.1. Siberski, W. (Ed.), IST-FP6-027905 PROLIX (Process-oriented Learning and Information Exchange)

PROLIX Integrated Project (2006c). PROLIX Functional Architecture. Deliverable D2.2. Siberski, W., Lofi, C., Papapetrou, O. (Eds.), IST-FP6-027905 PROLIX (Process-oriented Learning and Information Exchange)

Ring, K. & Ward-Dutton, N. (1999), Enterprise Application Integration: Making the Right Connections, Ovum, London.

Scheer, A.W. (2000). Aris - Business Process Modeling (3rd edition) Springer-Verlag, New York.

Senge, P., Kleiner, A., Roberts, C., Ross, R. & Smith, B. (1994). The Fifth Discipline Fieldbook: Strategies and tools for building a learning organization. New York, Doubleday Currency.

Sharma, R., Stearns, B., & Ng, T. (2001). J2EE Connector Architecture and Enterprise Application. Prentice Hall PTR; 2001

Sonic Software Corp., AmberPoint Inc., BearingPoint Inc. & Systinet Corp. (2005). A new service-oriented architecture (SOA) maturity model. Retrieved March 26, 2008, from http://www.omg.org/soa/Uploaded%20Docs/SOA/SOA_Maturity.pdf

Soren, P., Elena, D., Jeremy, O., Gustavo, P. & Joseph, S. (2001). B2B Collaborative Commerce with Sametime, QuickPlace and WebSphere Commerce Suite. (IBM Redbook). Retrieved March 26, 2008, from http://www.ibm.com/redbooks.

Symons, C. (2003). The Balanced Scorecard - Metrics That Count. (Forrester Research, Planning Assumptions Report) August 22, 2003 (RPA-082003-000015)).

Themistocleous, M., Irani, Z., O'Keefe, R. & Paul, R. (2001). ERP Problems and Application Integration Issues: An Empirical Survey. Proceedings of 34th Hawaii International Conference on System Sciences (HICSS), pp.3775-84.

Wangler, B. & Paheerathan, S.J, (2000). Horizontal and Vertical Integration of Organizational IT Systems. In Information Systems Engineering: State of the Art and Research Themes. Springer, 2000.

W3C Working Group (2004) Web Services Glossary, W3C Working Group Note 11 February 2004. Retrieved March 26, 2008, from http://www.w3.org/TR/ws-gloss/