

SUPPORTING NETWORKED PRODUCT DEVELOPMENT WITH BUSINESS-TO-BUSINESS INTEGRATION

Recognizing a New Phase in the Integration Implementation

Hannu Laesvuori, Paavo Kotinurmi, Katrine Jokinen

Software Business and Engineering Institute, Helsinki University of Technology, Espoo, Finland

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Abstract: Networked product development is becoming an important topic for many industrial companies due to the need to improve the performance of product development processes. In product development, product data management (PDM) systems are typically used to store and manage the information related to the developed products and thus business-to-business (B2B) e-commerce in this context requires integration of heterogeneous PDM systems located in different companies. In this paper, we describe the characteristics of B2B integrations (B2Bi) that enable e-commerce in the context of networked product development. The basis for this paper is a set of semi-structured interviews conducted among the representatives of PDM and B2Bi personnel in three companies, and the experiences gained on constructing a laboratory prototype of PDM systems integration using the RosettaNet standard. We argue that there is a unique phase in the B2Bi implementation process in the context of networked product development that we call project-level integration. This phase arises from the project-oriented nature of product development, and recognizing it seems important for the successful implementation of B2Bi in the context of networked product development.

1 INTRODUCTION

E-commerce in business-to-business (B2B) environment means automation of business processes by using electronic networks (Turban et al., 1999). The automation of a single business process such as order fulfilment may require interoperation of several heterogeneous information systems (IS), such as Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems from different vendors. These systems need to be integrated with each other to enable the exchange of information without human involvement (Nurmilaakso and Kotinurmi, 2004).

The current experience with business process automation between enterprises is mostly limited to certain type of business processes. If we divide business processes into continuous and project-oriented business processes, we find that B2B e-commerce has mostly been limited to continuous business processes such as order fulfilment (Laesvuori and Kotinurmi, 2004). With project-oriented business processes we mean business

processes such as new product development (NPD) that are temporary and non-routine in nature, and are typically organized in projects (Eloranta et al., 2001; Turner, 1999). There are indications that several project-oriented business processes, such as the NPD, would benefit considerably from business process automation (Eloranta et al., 2001; Borgman and Sulonen, 2003; Laesvuori and Kotinurmi, 2004). This is also indicated in a study by Brunnermeier and Martin (2002) who discovered that interoperability costs due to poor communication of product data during NPD are one billion US dollars a year in the US automotive supply chain. In this respect it seems important to consider what the project-oriented nature of NPD would mean to the integration of the information systems.

In this paper, we describe characteristics of B2B integrations (B2Bi) in the context of networked NPD. To pursue this objective, we chose to use the case study methodology. Case studies provide a rich methodology for studying the organizational context in which the technology resides and case studies are good for answering questions like how and why (Benbasat et al., 1987). We conducted semi-

structured interviews in three companies, which all had experience with networked NPD projects and B2B integrations. The size of the companies varied from one thousand employees to tens of thousands employees. We interviewed 18 people altogether responsible for B2Bi in general or Product Data Management (PDM) systems integrations. All the interviews were taped and transcribed. The results were validated by presenting them to the representatives of the case companies in a workshop. We have also experiences gained by constructing a laboratory prototype of PDM systems integration using the RosettaNet standard (Kotinurmi et al., 2004). Based on the interviews and the prototype experiences, we illustrate how the project-oriented nature of NPD would affect their B2B integrations.

The rest of this paper is organized as follows. In section 2, we present previous research and our findings from the semi-structured interviews concerning B2Bi conceptualization. In section 3, we briefly discuss business process automation and B2Bi in the context of networked product development and engineering change (EC) management. In section 4, we illustrate based on the experiences gained in building and evaluating a B2B e-commerce prototype system (Kotinurmi et al., 2004), what the project-oriented nature of product development projects could mean to B2Bi in the context of networked product development. In section 5, we discuss project-level integration and in section 6 we position our work in regards to related work on B2Bi. Finally in section 7, we present our conclusions and need for future research.

2 B2B INTEGRATION MODELS

2.1 Models in the Literature

There are few reports or case studies concerning implementation activities of actual B2B integration (Gunasekaran and Ngai, 2004; Chan and Swatman, 2003). In addition, the few existing articles have different perspectives on the implementation process activities.

Chan and Swatman (2003) analyzed 10 Australian companies and their e-commerce initiatives and found that an organization's change process to e-commerce consists of four stages: initiation, systems development, utilization and routinisation, and diffusion and expansion. In this model the change process initiation stage follows the decision to adopt the e-commerce technology and it

would typically include experimentations and feasibility study. Systems development stage would include systems design and testing, and utilization and routinisation would mean deploying the technology to real use through user training etc. Diffusion and expansion would mean introducing the technology to new trading partners and new business units within the organization.

Nurmilaakso and Kotinurmi (2004) see B2B integrations as a one-time activity that consists of business document, messaging and business process issues.

Ousterhout (2003) presented that B2Bi implementations consist of three stages: business process modelling, back-end integration, and trading partner integration. Business process modelling would mean agreeing on business documents and their exchange sequence, an activity largely standardized by standards such as RosettaNet. Back-end integration would mean getting the existing enterprise information systems such as PDM and ERP systems to exchange information according to a set of business rules, typically defined in an EAI system. Partner integration would mean getting the agreed on business processes to operate with new trading partners.

2.2 Models in the Case Companies

In the interviews we performed in the B2Bi teams of three companies, we asked what kind of classification to different B2Bi cases the interviewees used. The interviewees in the two companies that had hundreds of B2B integrations had very homogenous view on the B2Bi cases: they were either mass deployment or pilot cases. Pilot cases were the times when a new business process was being automated for the first time with a new business document. Pilot cases were usually rather complicated and they required considerable amount of time and effort. The reasons for this included need for building back-end system integrations, need for modifications in the company's internal way of working, and the lack of experience with that particular business document. Mass deployment cases were straightforward B2B integrations on business processes on which a pilot case had already been finished. Mass deployment cases mainly required exchange of B2B connectivity details such as IP addresses of B2B gateways and digital certificates, and the configuration of these details into the B2B gateways.

In addition to the mass deployment/pilot cases explicitly mentioned by the interviewees, two other

differentiating cases became evident: B2Bi towards companies that were in customer role were uniformly thought much more difficult than B2Bi towards companies that were in supplier role. The reason for this was that despite using standards such as RosettaNet for the B2Bi, companies typically used the standards slightly differently. This caused need to somehow align the differences in the use of the standards by, e.g., designing rules that use conversion tables and Extensible Stylesheet Language Transformations (XSLT) to translate the differences. Typically the companies in customer role could demand that their suppliers do this work.

Another type of B2Bi that arose in the interviews was the need to somehow change existing B2B integrations. The need for change could arise from many different reasons, including the simple technical reason that digital certificates used in the secure messaging expire periodically. A perhaps more important observation was that when customer company changed the internal business unit with which supplier company was operating, it typically meant changes to the business message used between the two companies and thus typically the creation of new transformation rules. The reason for the change in the business message was believed to originate due to the new business unit having a slightly different business process and/or back-end information system.

2.3 NPD Project Differences in the Case Companies

The PDM experts were asked to describe the differences between the ongoing NPD projects in their companies. One major difference was that typically each NPD project had their own way of working, i.e. they had different processes e.g. for EC management. The back-end information systems supporting the processes could also vary. Another difference was that NPD project could be working either on a totally new product or the new product could be based on an existing product. NPD projects based on existing products were typically smaller and shorter in duration than NPD projects developing new products from scratch, which were overall considered much more complex and dynamic. The amount, nature and partners with which the NPD project collaborated varied, as varying parts of the NPD were outsourced to varying business partners.

Differences between NPD projects were often tied to the physical location, or site, where they were executed. It was typical for each NPD site to have

their own way of doing NPD. A major difference related to NPD project sites was also that NPD projects could be either done within a single site, or the NPD project could be collaborative work between several different sites.

3 B2B INTEGRATIONS IN NEW PRODUCT DEVELOPMENT

In order to describe the context for this paper, we present an example scenario of B2Bi, and discuss its implementation. Consider the case of NPD for consumer electronics, which is nowadays increasingly being done collaboratively in a network of independent companies (Borgman and Sulonen, 2003). The development of new products is driven by the exchange of design documents such as CAD models, which are typically stored inside the company's PDM system (Kotinurmi et al., 2004). When a company participating in a networked NPD wants to suggest a new feature to the product, it means initiating engineering change request (ECR) business process. This means that the company initiating the ECR sends specifications of the suggested engineering change (EC) to the other companies involved in the networked NPD, which can then respond to the ECR by stating how the change would affect them in terms of e.g. expenses.

In order to automate the above ECR process with B2Bi, all companies participating in the ECR process must act uniformly on three separate levels (Nurmilaakso and Kotinurmi, 2004):

- The companies must have shared understanding of the business process. This involves agreeing on the different roles that the companies have in the ECR process such as which company can initiate the ECR process, and the sequence of the interactions such as that engineering change request is always followed by a related response to the request.
- The companies must agree on business documents that contain the information needed to execute the business process, such as identification codes that specify to which product this ECR is related to. This involves using uniform format, structure and semantics in the business documents.
- The ECR specifications need to be somehow communicated to the other companies. Typically this is accomplished by packaging the business document and necessary routing into a single message, which can then be sent to the other companies securely over the Internet.

Uniform agreement on the business process, business document, and messaging may be difficult even inside a single company. Companies have different ways of working internally, and it is unrealistic to assume a uniform way of working in a dynamic company network with changing members. However, a collaborative business process involving multiple companies can be divided into private and public sub processes. The private processes are executed within a single company, and the public processes are interfaces between companies. The companies have the freedom to execute the private processes in any way they wish and only the public processes need to be standardized. Standards, such as RosettaNet, already exist for this purpose (Nurmilaakso and Kotinurmi, 2004).

A high-level architecture to support the above ECR scenario with B2Bi is illustrated in figure 1, which is a simplified version of the architecture presented by Medjahed et al (2003).

This architecture consists of several isolated back-end applications that are internal to the trading partners, such as PDM and ERP systems. The back-end applications are connected to Enterprise Application Integration (EAI) layer that controls internal business processes and provides services such as workflow management and data transformation facilities. The EAI layer is also connected to the B2B Gateway that handles the public process, typically according to some B2Bi standard such as RosettaNet or EDI.

After successful B2B integration, the flow of events in the ECR business process would be similar to the following using our prototype system

described by Kotinurmi et al. (2004), and adjusting it to the figure 1. The ECR process is initiated when a designer, e.g. a mechanical engineer working in Trading partner A fills an ECR template in the PDM system, and links it with a drawing illustrating the suggested engineering change to the product. This creates a new document of type ECR to the PDM system. When the lifecycle state of this ECR document is changed to 'approved' in the PDM system, a new inter-company ECR process is initiated. The PDM system notifies the EAI system about the state change, which starts a predefined workflow in the EAI system. The workflow has rules for deciding what events originating from the PDM system require further processing. In this case, there is a predefined rule in the workflow defining that when a document of type ECR is changed to 'approved' state in the PDM system, a new inter-company ECR business process using RosettaNet is initiated. Thus, the workflow retrieves the drawing and metadata describing it from the ECR document, and creates based on them a RosettaNet business document. The workflow then passes this business document to the B2B gateway, which sends the business document to the trading partner B securely over the Internet, as specified by RosettaNet. After this, trading partner A starts to wait for a response message to the ECR.

Trading partner B receives the business document at its B2B business gateway and unpacks the received message into two parts: the drawing and information about the related EC request. These are sent to the EAI system, which creates ECR on trading partner B's PDM system. After this, a

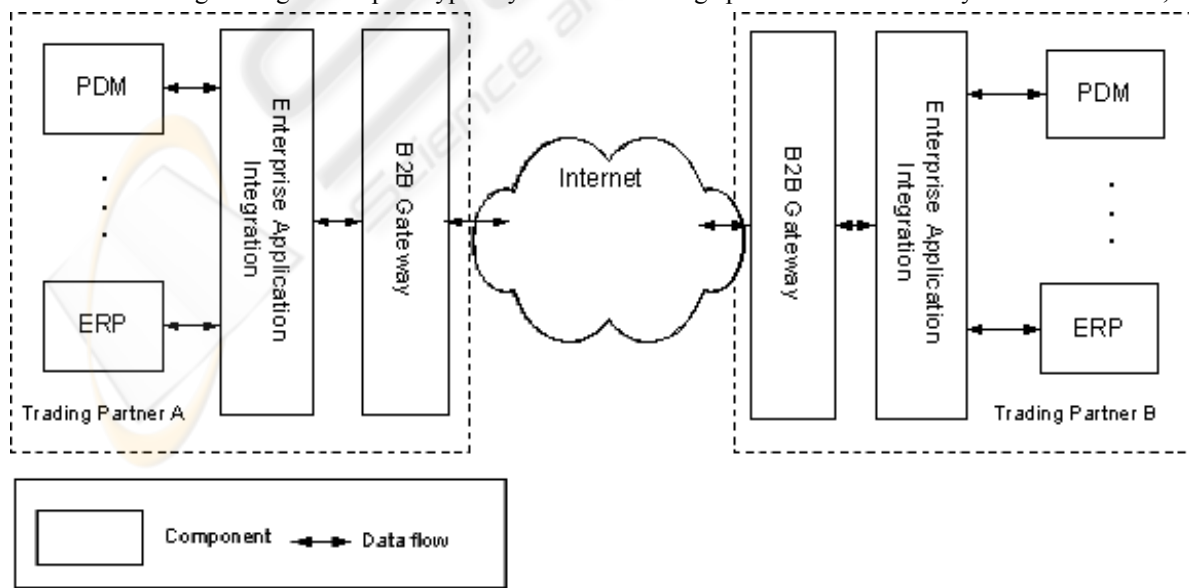


Figure 1: B2B Integration architecture.

designer at trading partner B can review the suggested EC using the drawing and a textual description, and respond to the ECR with the estimated impact of the EC using their own PDM system. This initiates sending of a response business document back to the trading partner A similarly through EAI systems and B2B gateways.

Trading partner A then receives the ECR response message through their B2B gateway, which associates it with the related ECR request message, and extracts the business document from it. B2B gateway passes the business document to the ECR workflow instance in the EAI system. The ECR workflow then extracts the ECR reply from the business document and notifies PDM system to create a new document to the PDM system of the type 'ECR response', and changes the lifecycle of the original ECR document to 'ready to process' state. This completes the B2B integration of the ECR process, and it is now up to the organization to decide how to act on the received ECR response.

4 PROJECT-LEVEL IN B2B INTEGRATIONS

When a new NDP project starts between companies that have previously collaborated in NPD, there is a certain amount of information system implementation work caused by the initiation of the new project. The companies have agreed on the business processes to use, and have successfully done the back-end system integrations necessary for the automation of the business processes during earlier collaboration. The new project, however, requires work on top of the existing business process automation between the two companies.

We call this additional information system implementation work the project-level integration work, as the source for it is the need to accommodate the requirements of new projects. We argue that the vast heterogeneity of NPD projects even within a single organization causes variability in the requirements for the business process automation, and that it is unlikely that any single configuration in the business process automation between two trading partners could sufficiently satisfy the requirements of all different projects.

The project-level integration work due to the start of a new NPD project consists of several tasks that are very different from each other. Moreover, the project-level integration work can affect several parts of the B2Bi between two trading partners. To get a better understanding, we can divide the modification work caused by the initiation of a new

NPD project in three groups based on the software architecture presented in figure 1: project-level integration work in the PDM system, EAI system, and the B2Bi system.

4.1 Project-Level in the B2B Integration System

The B2Bi system is responsible for implementing the messaging, business document, and business process specifications as specified by RosettaNet. The B2Bi system must be configured with details on how to use the standard, such as what IP addresses to use in the messaging etc. Based on the interviews, these details are mostly relatively stable and that the B2Bi work used for one NPD project could be used in the following NPD projects, as there is no need to change for instance the IP address of the B2Bi system just because a NPD project was started. However, there appears to be a few exceptions.

Different NPD projects can require different response times from the B2Bi. At early phases of NPD projects ECs are often frequent and there is possibility to use light-weight ECR process with short response time. As the NPD project approaches production stage, ECs become less frequent but they can have severe impact on the NPD, which typically leads to more thorough internal evaluations and thus to longer response times. In addition, depending on the nature of the collaboration and on the product being developed, the project may or may not want to use additional security such as non-repudiation mechanism on the messaging to avoid possible later disagreements. As RosettaNet specifications can be ambiguous and leave room for interpretation regarding these settings, we expect that different NPD projects would choose these settings differently. This would create need to change them upon the initiation of a new NPD project.

4.2 Project-Level in the PDM System

The EC and design documents, such as CAD models, bills of material, etc., are usually stored in a PDM system. The system handles the documents as a file with the actual contents of the document (e.g., a CAD file) and its metadata. The metadata includes information, such as the creator, version, and lifecycle status of a document. In addition, it describes the relation to other PDM objects, such as users, projects, and other documents. A subset of this metadata has to be sent to the other companies with the actual document file, because the receiving system has to be able to store the document so that it

can also be found from the system. This subset might vary depending on the NPD project and their internal way of working, and the modifications due to this variability are assumed to be handled by the EAI system as described later in this section.

The PDM system controls the access rights to documents within the company. At the beginning of each project it has to be decided who is allowed to view the documents received from trading partners. These access rights have to be added to the documents when they are received and stored in the PDM system, and they can vary from project to project. For example, some projects can assign access rights on a team level, meaning that each team member working on a specific component is allowed to see all documents related to that component, whereas in other projects access rights are assigned on a person level, i.e., it is separately defined what documents each person is allowed to access.

4.3 Project-Level in the EAI System

As noted in the interviews, different NPD projects even within a single company typically have different processes and back-end information systems which lead to differences in the used business message. Thus, even if two companies have automated the inter-company ECR process with transformation rules aligning the company-specific differences in the ECR process business message, a new transformation rule is needed to align the differences in the business message between the NPD projects. An example of such difference is the distribution of access rights either on team level, or on person level, as mentioned earlier in this chapter. This kind of alignment work is common in B2B integrations, but in our experience it is typically rather stable and the need to do it repeatedly on the start of every new NPD project would be unique to NPD. This transformation logic could be rather complex as there are many potential differences in the business message. For example, the transformation rule might need to include logic to retrieve and insert data in the PDM system: some fields in the RosettaNet business message are optional, so some NPD projects may require their use, whereas others allow the fields to be left empty. An example of such a field could be the identifier the trading partner uses for a product: in some projects these might be required, in others they might not even be known by the trading partners. Moreover, companies often use internally different identifiers for products, projects, etc. These company-specific identifiers have to be mapped to commonly agreed identifiers used in the message

exchange between the trading partners. Similarly, RosettaNet uses unique identifiers, called DUNS numbering, to identify companies and their different locations. However, PDM systems can represent this information differently, so conversion tables and transformations to take care of the differences would likely be required.

Another functionality of the EAI systems is the creation and management of workflows that describe activities and decision points in business processes. The decision points describe what events result in sending documents to trading partners, and what should be done when documents are received from trading partners. These workflows have to be defined or at least checked at the beginning of each project, to make sure that confidential documents are not sent to wrong recipients, and that all relevant documents are sent to those who need them. For example, if a document version is approved, this could mean that it has to be sent to those trading partners who work with the same component. An example for a receiving workflow is that the person responsible for the corresponding component is always notified by e-mail when a document related to that component arrives.

The workflows can also take care of the business message delivery timing which can be configured per each NPD project (Jokinen et al., 2004). For instance, some NPD project might want to have two weeks time to implement previous ECs before accepting new ECRs. The EAI system has to keep track of the documents that should be sent to this trading partner and then send the documents to them at the right time.

4.4 Other Project-Level Issues

In addition to the changes to the PDM, EAI and B2Bi systems, there is other B2Bi work that may need to be done upon the initiation of a new networked NPD project. The B2B integration must be tested to see that the whole chain from the initiating back-end system to the receiving back-end system works as intended.

5 DISCUSSION ON PROJECT-LEVEL IN B2BI

In this paper we argue that the vast heterogeneity of NPD projects even within a single organization causes variability in the requirements for the business process automation, and that it is unlikely that any single configuration in the process automation between two trading partners could

sufficiently satisfy the requirements of all different projects. Therefore, we believe that in a dynamic company network with changing business relationships there must be project-specific differences that need to be aligned with project-level B2Bi work upon the initiation of every new NPD project. However, neither the existing literature on B2Bi, nor our interviewees in the B2Bi teams explicitly recognized this 'project-level' integration. The reason for this, we believe, is that existing B2Bi concern continuous business processes such as order fulfilment. This is true also for the three companies on which we performed interviews, as these companies are only now starting to plan extending their B2B integrations to concern also NPD.

A weak point in our argument for unique phase in the B2Bi work in the context of networked NPD is the somewhat loose connection to a concrete business process. We described ECR business process in general terms, but real B2B integrations use more detailed business process specifications such as Partner Interface Process (PIP) specifications in RosettaNet. Using a specific ECR PIP as the basis for our analysis would have given it more credibility, but RosettaNet PIPs for ECR are not yet in mature state (Laesvuori and Kotinurmi, 2004). Thus, rather than using work-in-progress for our analysis we chose to use a higher-level abstraction of the process that we believe is generally acceptable.

The usefulness of our identification of project-level B2Bi work in the context of networked NPD is limited because we do not propose any solution to problems we identified. Nevertheless, we believe that recognizing these differences is an important starting point for the solution proposition, which remains future work.

Same functionality that in our example was handled in, e.g., PDM and EAI could be implemented also in other systems. For example, workflow management tools for defining and implementing business rules can exist in all PDM, EAI and B2Bi systems. Moreover, it would be possible to implement the business rules in a separate software component. Thus, the grouping we presented was somewhat arbitrary and affected by what was considered the typical location of functionality in the software architecture of our case companies. It is meant to serve for illustrating the typical case and for showing that typically several components in the software architecture are affected by the project-level related integration work.

6 RELATED WORK

Chan and Swatman (2003) analyzed 10 Australian companies and their e-commerce initiatives and found that an organization's change process to B2Bi consists of four stages: initiation, systems development, utilization and routinisation, and diffusion and expansion. Project-level integrations would be done in their "diffusion and expansion" stage. They did not identify project specific differences in their work.

Ousterhout (2003) separated business process automation between different business processes, and different trading partners. In this division project-level integration would reside on top of existing business process automation in a certain business process between two trading partners.

Nurmilaakso and Kotinurmi (2004) discussed business process automation in more general terms, and the project-dimension could be seen as a special case of the one-time business process automation that reuses existing integration work consisting of agreements on business document, messaging and process issues.

Altogether, in regards to the existing work on the information implementation system activities, project-level integration could be considered a special case that was not previously explicitly recognized. Moreover, the few existing articles about the implementation activities of B2B e-commerce implementations have different perspectives on the process. Although the project-level integration was not explicitly recognized in the literature that concerns the implementation activities of B2B integration, it has been recognized elsewhere. Attempts to support networked NPD projects through portals that can be reached over the Internet exist, and in their context the project-level has been recognized (Hameri and Puittinen, 2003). In regards to this paper, Hameri and Puittinen (2003) have different approach as instead of B2B integrations they focus on the use of WWW as a communication medium.

The need for flexible B2B integrations has also been recognized in the context of virtual enterprise (VE) research. VEs are enterprises that exist only for a brief time and that are created by several independent organizations to cooperate on a specific business opportunity, and then dissolve when the operational phase for the business opportunity has been completed (Camarinha-Matos and Afsarmanesh, 2003). VEs have many similarities in their requirements for business process automation with project-based business processes, as both require flexible and dynamic B2B integration that must be setup repeatedly and quickly. As VE

research is not focused on the support for the special characteristics of networked NPD, we did not discuss VE research in this paper.

7 CONCLUSIONS AND FUTURE WORK

There is increasing demand to extend business process automation also to project-based business processes like new product development (NPD). This drives the integration of product data management (PDM) systems located in different companies. On the basis of a set of semi-structured interviews and the experiences gained on constructing a prototype of PDM system integration, we argued that there is a unique phase in the B2B integration implementation process in the context of NPD. We motivated this by describing the engineering change request business process, which is typical to NPD, and showing how this business process would be automated in a typical B2B integration architecture. Then, we showed what parts of the B2B integration supporting the business process automation would require further work upon the initiation of new NPD projects.

We suggest that taking this project-level B2B integration work into account when planning B2B integrations for NPD context would be useful, as otherwise there is risk that the B2B integration would not fully support the project-oriented nature of NPD. The lack of support for the project-level B2B integration work could lead to unnecessarily small breadth and scope for the B2B integrations, which would cause unnecessary manual work.

It would be useful to target more research on integration of project-based processes to propose solutions to handle these differences. The different project-specific aspects should be identified better so that the B2B integrations would be agile to the changes needed in different projects. As this project specificity is not necessarily only NPD related concept, it would be good to gain more experiences in other business process automations that are organised in projects.

REFERENCES

- Benbasat, I., Goldstein, D. K., and Mead, M., 1987. The Case Research Strategy in Studies of Information Systems. In *MIS Quarterly*, Vol. 11, No. 3, pp. 369-388.
- Borgman, J., Sulonen, R., 2003. A Case Study of the Impacts of Preliminary Design Data Exchange on Networked Product Development Project Controllability. In *Proc. of the International Conference on Engineering Design*.
- Brunnermeier, S. and Martin, S., 2002. Interoperability costs in the US automotive supply chain. In *Supply Chain Management: An International Journal*, Vol. 7, No. 2, pp. 71-82.
- Camarinha-Matos, L., Afsarmanesh, H., 2003. Elements of a base VE infrastructure. In *Computers in Industry*, Vol. 51, pp. 139-163.
- Chan, C., Swatman, P., 2003. International Examples of Large-Scale Systems - Theory and Practice IV: B2B E-Commerce Implementation in the Australian Context. In *Communications of the AIS, Volume 11 Article 23, March*.
- Eloranta, E., Hameri, A-P., Lahti, M., 2001. Improved project management through improved document management. In *Computers in Industry*, Vol. 45, No. 3, pp. 231-243.
- Gunasekaran, A., Ngai, E., 2004. Information systems in supply chain integration and management. In *European Journal of Operational Research*, Vol. 159, No. 2, pp. 269-295.
- Hameri, A-P., Puitinen, R., 2003. WWW-enabled knowledge management for distributed engineering projects. In *Computers in Industry*, Vol. 50, pp. 165-177.
- Jokinen, K., Borgman, J. Sulonen, R., 2004. Support for Managing Design Document Exchange in Business-to-Business Networks. In *Proc. of 10th International Conference on Concurrent Enterprising*.
- Kotinurmi, P., Laesvuori, H., Jokinen, K., Soininen, T., 2004. Integrating Design Document Management Systems using the RosettaNet E-business Framework. In *Proc. of the International Conference on Enterprise Information Systems*.
- Laesvuori, H., Kotinurmi, P., 2004. Towards Integrated Document Management in Networked Product Development. In *Proc. of International Conference on Electronic Business*.
- Medjahed, B., Bouguettaya, A., Ngu, A., Elmagarmid, A., 2003. Business-to-Business Interactions: Issues and Enabling Technologies. In *The VLDB Journal*, Volume 12, Number 1.
- Nurmilaakso, J.M., Kotinurmi, P., 2004. A review of XML-based supply-chain integration. In *Production Planning & Control, Volume 15, Number 6*.
- Ousterhout, J., 2000. Managing Trading Partners. In *EAI Journal*, pp. 89-92, October 2000
- Turban, E., King, D., Lee, J., Viehland, D., 1999. *Electronic Commerce, a Managerial Perspective*. Pearson Education, Inc., New Jersey
- Turner, R. 1999. *The Handbook of project-based management: improving the process for achieving strategic objectives*. McGraw-Hill, London, 2nd edition.