BUSINESS ENGINEERING BUILDING BLOCKS

Boris Shishkov
Faculty of Information Technology and Systems
Delft University of Technology, The Netherlands
Shishkov@IS.TWI.TUDelft.nl

Abstract

In order to utilize the contemporary advanced technology, business processes need sound software support. With respect to this, one frequent cause of software project failure is the mismatch between the business requirements and the actual functionality of the delivered software application. To solve this problem, it is necessary to build software stemming out from a business process model. Aiming at aligning business process modeling and software design in a component-based way, the proposed research investigates the identification of generic business engineering building blocks and their use for building ICT applications which effectively support business processes.

1. INTRODUCTION

In the past few years there have been major developments in the field of Information and Communication Technology (ICT). Indicative for this are the contemporary global telecommunications and digital multimedia [LauLau02]. Business processes also underwent development – examples of this are business process re-engineering [Die94] and distribution [BET02,ShiBar00]. By creating new possibilities for the business area, this great progress increases dramatically the demands towards business – high level of speed and quality, low level of errors, etc. are already required by users. These increasing demands could be met if business activities are put on advanced technological foundation [Jac95,Liu00]. Crucial in this respect are ICT (software) applications. They should let business processes utilize ICT.

One frequent cause of software project failure, in this regard, is the mismatch between the business requirements and the actual functionality of the delivered ICT application. Actually, we observe two opposite phenomena [Shi01].

On one hand, we observe software being developed without prior (consistent) investigation of the (business) processes to be supported by it. This means that the business requirements are poorly determined and the software design model does not have its roots in a business process model. Therefore, the developed software would support the business processes inadequately to their needs; and although its quality might be high from a software point of view, the effectiveness of the support it realizes to the target business processes would remain low.

On the other hand, although (in many cases) sound business process modeling is conducted prior to the design of software, the business process model is only partially used, since it is not straightforwardly transformable into a relevant input for the software design. This does not allow for full employment of the software and ICT possibilities in solving the particular business problem(s).

Therefore, the two outlined tasks need to be aligned in a better way. The business process modeling and the development of ICT applications for the support of the business processes should be considered as one integrated task.

Different researchers address issues related to the outlined problem. Dehnert and Rittgen present a formal representation for describing business processes [DehRit01]. This is a promising step and could be especially useful if further related to software design. Olivera, Filho and Lucena have also contributed in this direction, by investigating the design of software on the basis of business requirements analysis [OlFiLu01]. Their suggested approach is a step ahead even though it does not still offer a straightforward mapping of a business process model into a software design model. Hikita and Matsumoto have studied how the appearance of additional requirements could be reflected in the system's construction [HikMat01], which is also a promising result achieved so far (although not completely solving the problem). Krutchen suggests (based on the existing use case concepts [Jac92]) a "Business use case" – considered useful in bridging business process modeling and software design [Kru99]. But it is still a question how to consistently identify such use cases. Therefore, it might be concluded that further knowledge is still required in the direction of consistently basing application design on business process modeling.

With respect to this, a promising contemporary approach for application development is the component-based development [Jac92], founded on the principles of object-orientation (OO). As it is well known, OO (characterized by the fundamental concepts of encapsulation, classification, inheritance and polymorphism) is widely considered as a special approach to the construction of models of complex systems, in which a system consists of a large number of objects. This applies not only to software systems but also to business systems [Jac95]. Thus, it seems feasible to expect that software design and business process modeling could be bridged by basing the design on software components which are derived from some business components (business engineering building blocks[*]). Building blocks should fill the gap between the two mentioned tasks. If generic building blocks are identified, they could be re-used for designing different applications. Next to that, component-based development seems beneficial for the application design itself. By basing application development on encapsulated, individually definable, reusable, replaceable, interoperable and testable components, developers could build applications which possess durable configuration and a high degree of flexibility and maintainability. The process of application development would also be improved because building new applications would include using already developed components. This reduces development time and improves reliability. The performance and maintenance of developed applications would be enhanced because changes could occur in the implementation of any component without affecting the entire application. All this makes the component-based application development much more effective than the traditional way of application development.

For all these reasons, the proposed research focuses in general on aligning software design and business process modeling, and in particular - on realizing this on the basis of (generic) building blocks identified from target business processes. By basing the design of applications on such building blocks, it is expected that the application support to business processes can be improved considerably.

[*] The "building block" concept is introduced further on in this paper.

2. RESEARCH GOAL AND QUESTIONS

As concluded in the introduction, the principles of OO seem useful to be applied for aligning software design and business process modeling. With respect to this, the main research goal is summarized as follows:

Main Research goal:
To investigate the identification of generic business engineering building blocks and their use for building ICT applications which effectively support business processes.

In order to achieve the main goal, four basic ***sub-goals*** have to be realized:

sub-goal 1 To develop a framework for identification of business engineering building blocks on the basis of business requirements.

sub-goal 2 To develop a methodology for reflecting a business process model into software design.

sub-goal 3 To investigate the characteristics of business processes in a chosen domain and identify from them generic building blocks according to the developed framework.

sub-goal 4 To demonstrate, using the developed methodology, how a model(s) of any of the identified building block(s) could be reflected into software design.

These goals serve as a basis for formulation of the research questions.

In order to grasp correctly the concepts which are fundamental for the current research, the following four research questions (derived out of the research goal) need to be answered:

question 1 What are the characteristics of a “business process”?

question 2 What must be understood by “building block”?

question 3 What are the characteristics of an “ICT application”?

question 4 What must be understood by “software component”?

The final result of the investigations within the PhD research should bring answer to the main research question:

question 5 How can (generic) business engineering building blocks fill the gap between software design and business process modeling?

In relation to this question as well as to sub-goals one and two, respectively, are the following two research questions:

question 6 How to correctly address user requirements in a repository of identified (generic) business engineering building blocks and interfaces?

question 7 How to consistently reflect business engineering building blocks into a software design model?

In answering these questions, knowledge of two main research disciplines should be acquired – Business Processes and Software Design. Figure 1 represents them together with the particular questions related to each of them. It is seen also that a synthesis between these disciplines should be accomplished, in answering questions 5 and 7.

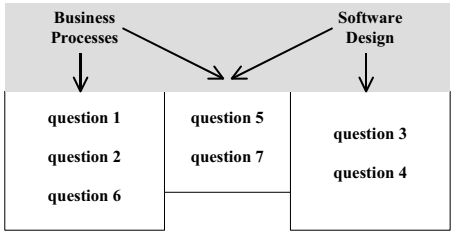

Figure 1: Addressed research areas

3. RESEARCH STRATEGIES AND APPROACH

In order to find answers to the research questions and accomplish the research goal, it is essential to base the research activities on sound methodological foundation. This means to delimit the research domain and select appropriate strategies to be applied in accordance with the adopted approach. All this is discussed below; the research strategies and approach are considered in sub-sections 3.1 and 3.2, respectively.

As noted in Section 2, the current research is characterized by a synthesis between two disciplines - Business Processes and Software Design, reflected in the identification of business engineering building blocks and their use for building software. The direction is towards a better understanding of what should be the role of a (business) process model in software design. Next to that, it appears that the research is characterized by yielding theories that are themselves constructions, generated from an insider perspective (as opposed to yielding objective and independent theories generated from an outsider perspective). Hence, the research should be positioned as interpretivistic (as opposed to positivistic) [Ber02].

3.1 Research Strategies

There are several ways of doing scientific research, e.g. literature study, case study, field experiment, etc. These are called “research strategies” in the terminology of Yin [Yin94]. Each strategy represents a different way of collecting and analysing (empirical) evidence, following its own logic, and possesses peculiar advantages and disadvantages. Each of the mentioned strategies could be used for all three purposes – exploratory, descriptive, or explanatory.

However, it is not always easy to decide which strategy to use for any particular purpose, basing the decision on clear criteria. Even though each strategy has its distinctive characteristics, there are large areas to overlap among them [Sie73]. Thus, the goal should be to avoid “gross misfits”: when one type of strategy is planned to be used but another is really more advantageous.

According to Yin, there are three conditions, distinguishing the strategies: the type of research questions; the control the explorer has over actual behavioral events; the degree of focus on contemporary as opposed to historical events. This could determine the choice of proper strategies in planning a research.

Considering the taxonomies of scientific research strategies, introduced and discussed in [Gal92,Gal87,Yin94], and taking into account the characteristics of the current research project, it is suggested to base it on a compilation of several research strategies which complement each other:

* literature study
* survey research (interviews with experts)
* case study
* archival research.

Due to the limited scope of this paper, the mentioned strategies are not further discussed; for more information, interested readers are referred to [Gal92,Yin94].

3.2 Research Approach

A key element to a successful development in any study is a sound and precise step-by-step outline of the research activities to be realized. It is essential to identify a set of interrelated tasks which need to be performed for fulfilling the research goal.

The suggested research approach is depicted in Figure 2, in a flow-chart like diagramming technique. It is suggested, as shown in the figure, the research tasks to be realized in five phases which are outlined below.

Phase 1 is devoted to theoretical study of the considered research area; in particular, the two disciplines, fundamentally essential for the research, are addressed, namely: Business Processes and Software Design. The basic purpose is to become familiar with the area of study. Analysis of the two mentioned disciplines should provide the answers to research questions 1, 2, 3, and 4. As proper research strategies for this phase are suggested literature study and interviews with experts.

In **Phase 2**, a target domain should be investigated in order to further apply the created deliverables in it, in validating the research results. Also, based on the results of Phase 1, Phase 2 should provide two important research outputs (reflected also in sub-goals 1 and 2, respectively):

1) Framework about how to identify (generic) business engineering building blocks, addressing properly some user requirements.

2) Integrated methodology allowing software design based on business process modeling (within this task, the focus is on the synthesis between the two disciplines of the research area). In particular, the current research considers the UML-based design of software, not only because of the completeness of Unified Modeling Language [OMG00,BoRuJac99,Kru99] but also because it turns out to be *de facto* the standard language for modeling software systems [MaDiHo01], widely accepted by both researchers and practitioners.

With respect to founding UML-based software design on business process modeling, a fundamental goal should be to find out how to consistently derive use cases from a business process model (it is well-known that use cases are modeling constructs that serve to link the application domain (the business world) to the software domain, regarding UML-based software development). It should be taken into consideration that the software community still misses consistent guidance in identifying use cases. Methods for construction of UML Use case diagram [Jac92,FowSco99,ShiDie01] on the basis of business process modeling are still needed. Therefore, an essential issue to be provided by the methodology should be derivation of use cases from business processes.

As seen from the figure, the three outlined tasks are carried out in parallel, and only after each of them is completed, Phase 3 could be entered. By realizing the tasks within Phase 2, answers to questions 5, 6, and 7 will be found. Basic research strategies to be applied are literature study and interviews with experts.

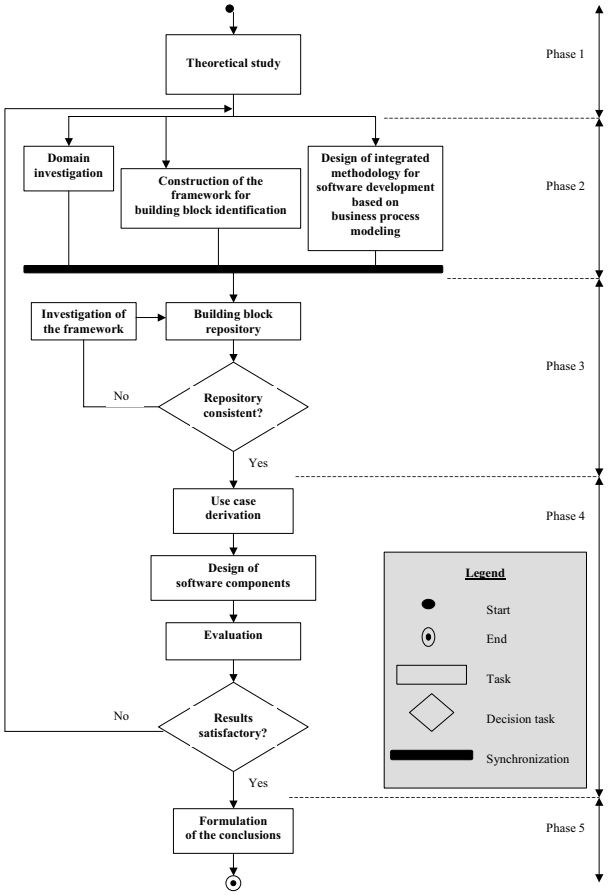

Figure 2: Overview of the research approach

Phase 3 should provide a repository of generic business engineering building blocks and interfaces. The building blocks should be identified from business processes within the domain investigated in Phase 2 (refer also to sub-goal 3). The identification process should be guided by the framework, constructed in Phase 2, and based on several case studies. The purpose is to validate the framework and demonstrate how it could be applied in practice.

The repository of building blocks and interfaces needs to undergo analysis resulting in conclusions about its consistency. If the repository proves to be inconsistent, the constructed framework should be investigated and improved. All this is important because of the crucial role of the building blocks for aligning software design and business process modeling. Basic research strategies to be applied are literature study, interviews with experts, case study, and for some specific information concerning the target domain, archival research might be applied as well.

Phase 4 is about realizing software design based on the identified business engineering building blocks (refer to sub-goal 4). In particular, following the methodology created in Phase 2, use cases should be derived on the basis of the building blocks. They should found the design of software components, as a final step in the process of aligning software design and business process modeling. The resulting software should be evaluated.

And finally, after the results have proven the usefulness of basing the design of software on generic business engineering building blocks, in the last phase (**Phase 5**), conclusions should be drawn.

4. PRELIMINARY RESEARCH

This section considers work that has already been done following the approach.

Within **Phase 1**, the existing knowledge concerning Business Processes and (component-based) Software Design has been studied, aiming at building up the theoretical foundation for the further research activities. This was helpful in defining a Building Block (BB) (Def. 1), relating that concept to the concept of a Software Component, and positioning it in the research framework to be followed.

Another important activity realized was an analysis of the contemporary use case theories – including the fundamental concepts, introduced by Jacobson and reflected in UML [Jac92,OMG00,FowSco00], as well some other concepts adding elicitation value, e.g. the concept of Cockburn [Coc00]. Use cases were studied because of their fundamental role in (OO) software design [BoRuJac99]. A useful idea was suggested, namely: to further elaborate any particular use case(s) of interest, using the concept of Cockburn and, based on this, to model the dynamics regarding the particular use case(s). These results were reported to [ShiDie01]. They are considered useful for the methodology to be developed in Phase 2.

Taking into consideration that several BB (which should be related to a particular business domain) are to be identified and reflected in the design of software, in order to validate the current research, it is important to choose a target domain and explore it from this perspective. The domain of e-business (EB) (Def. 2) was chosen not only because it is crucial for the contemporary business development but also because it is a good example of a domain which is completely dependent on ICT application support.

Definitions

Definition 1: A BB is a part of a system that has a clearly defined interface to the other parts, possesses a clearly defined function and has the ability of being proactive. A BB requires co-operation with other BB of the system to fulfill its actions. It is independent of its implementation and is described by its function and interface with other BB [Shi01,BET02].

Definition 2: EB is a business conducted using to a large extent the possibilities of ICT, including Internet. EB encompasses such diverse activities as: identifying relevant partners, negotiating with them, and conducting business transactions [BET02].

One of the tasks realized in **Phase 2** was to thoroughly study the chosen domain and identify an actual problem(s) there whose solution (by the means of business engineering BB) should validate the research results. Such a problem (valid not only for EB but also for most of the contemporary businesses which rely on Internet and thus face the consequences of globalization) is the ineffective partner and/or goods searching, which in many cases prevents businesses from being successful. Evidence of the existence of this problem is the fact that currently a number of projects, e.g. [MALL00,MEMO01] concentrate on exploration of brokerage systems, e.g. for EB. With respect to this, several cases were studied, related to EB brokerage systems. The problems were similar – matching data regarding: 1) sellers of goods / buyers of goods; 2) hotels offering accommodation / persons requiring accommodation, etc. Hence, if the deliverables of this research allow us to identify a business engineering BB that is generic for the EB domain (e.g. “Generic Broker”) as well as to (re)use this BB for building different ICT applications (e.g. “e-Trading Brokerage System”,

"Hotel Reservation Brokerage System", etc.), then the research results would be properly validated and demonstrated.

The realized activities regarding Phase 2 cover not only study of the target domain but also work on the other two tasks (Figure 2). This is focused in the following sub-sections.

4.1 From user requirements to business engineering BB

The work on the framework for BB identification is being carried out. Some fundamental ideas (rooted in the theoretical study) are already available, represented in Figure 3:

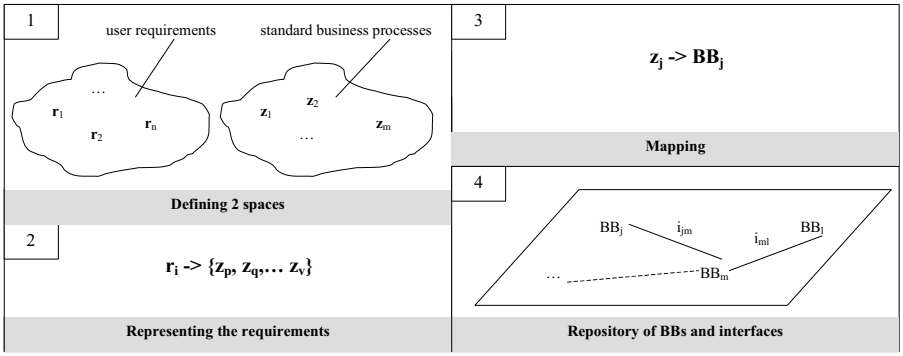

Figure 3: Identifying generic business engineering BB

As seen from the figure, the starting point (according to the suggested framework) should be to determine the user requirements ($r_1..r_n$) as well as to define a set of business processes which are standard for the considered domain ($z_1..z_m$). It should be then possible to represent any particular user requirement(s) in terms of combination(s) of standard business processes (SBP). SBP should be mapped into a repository of business engineering BB and interfaces. Since the BB identification is based on SBP, the BB are going to be generic for the considered domain. These BB are going to realize the link between particular business process models (corresponding to particular SBP) and software design. In this way, by supporting a particular set of SBP, the developed ICT application(s) will respond to the user requirements. Of course, in real life, situations might get exceptionally complex and it might be required to elaborate on some of the SBP (or even add completely case-specific business process(es)), affecting the BB set. However, this does not change the consistency of the model which is fundamentally based on generic BB.

Basing the framework on generic BB is beneficial since once identified, such BB could be reused in designing different applications. For example a BB "Generic broker" could found the design of an e-trade system, hotel reservation system, etc.

The essential issues regarding the reflection of the identified BB in software design are considered in the following sub-section.

4.2 Software design based on a business process model

Having got some identified BB(s), they need to be reflected in the design of software. Thus, a methodology is required (as shown also on Fig. 2) that allows for (software) system design, consistently based on a business process model (corresponding to a BB). Such a methodology was developed and demonstrated.

A detailed example that clarifies the methodology path is studied in [ShiDie02]. Due to the limited scope of this paper, the example is not considered in it.

The suggested methodology focuses on the modeling and elaboration of the functionality of the system under development, consistently basing this on business process modeling. The further software design and implementation steps are not covered since they do not relate directly to the addressed research problem.

The methodology provides an original way of combining several investigation tools (DEMO [Die99], Use cases (UC), UML diagrams and Simulation tools). The methodology steps and corresponding tools are represented on Figure 4:

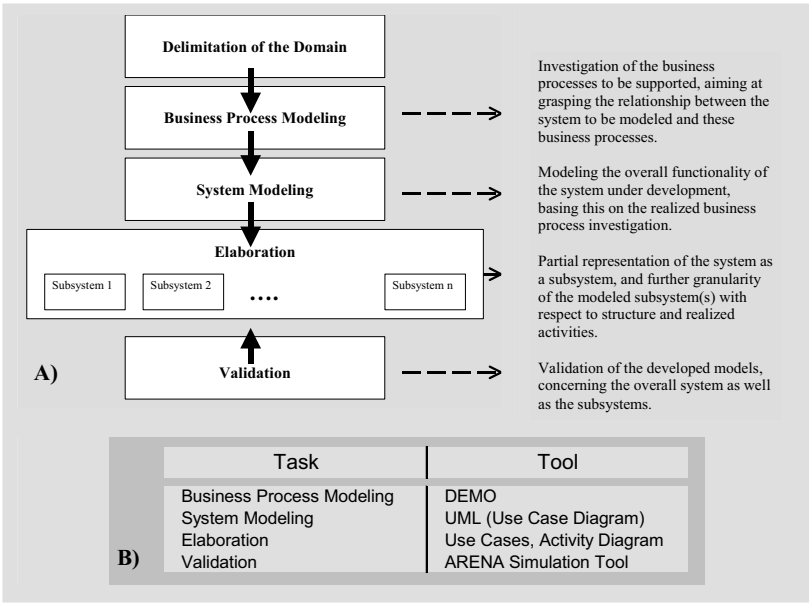

Figure 4: A) Methodology steps; B) Tools and their tasks

Taking into account that the methodology aims at aligning software design and business process modeling, it is considered crucial that the essence of the target business processes is grasped, in order to build a consistent business process model which is fully abstracted from all realization issues. Hence, if the developed software model stems from such a business process model, the software designer would have the right (re)design freedom [Die99,MaDiHo01].

Another essential issue is the usefulness of elaborating on the overall system model by representing it in terms of a set of pieces of functionality (subsystems) and their interrelations. Looking inside subsystems is useful since it would allow the modeler to get an extended insight regarding their structure and dynamics.

A third essential issue regarding the methodology is validation. It is useful to know if the source business process model is consistently reflected in a (software) system model as well as to validate the constructed subsystems making sure that their structural and dynamic models are relevant to the needed system functionality.

Regarding the choice of appropriate tools: DEMO provides an abstract business process model (e.g. of a BB) as an input for the system design and the UC diagram plays the role of interface towards it. The diagram allows grasping the system as a whole and subsequently the Activity diagram considers the dynamics in any parts of it. UC bridge these two elements of the methodology. All this was demonstrated with a case example [ShiDie02].

Since the methodology is based on UML as a system modeling tool (this choice is argumented in Section 3) UC play a crucial role for linking the application domain to the software domain. Thus, it is important to consistently derive UC based on a business process model (of a BB). Taking into account the lack of consistent guidance for identification of UC, it was studied how business process models developed using DEMO [Die99], Semiotics [Liu00], or Petri nets [Ago98] could be reflected into a UC model [ShiDie02], [ShiXieLiuDie02], [ShiBar02]. DEMO proved to be the most appropriate tool in this respect because of its completeness and capability of capturing the essence of business processes. Actually, deriving a UC diagram on the basis of DEMO Coordination structure diagram appears to be straightforward and consistent. Actors are directly mapped from DEMO actors; UC which reflect essential actions are directly mapped from DEMO transactions. The completeness of DEMO guarantees to a large extent the completeness of the discovered UC. However, the UC diagram considers also the actions which represent information providing (but are not essential transactions), e.g. adding data to a database. These actions are additionally identified in building the diagram and are important for the application design. Due to its limited scope, this paper does not consider this issues (studied in [ShiDie02]) in more detail.

DEMO was chosen as a basic business process modeling tool within the methodology not only because of its usefulness in deriving UC diagram but also because it allows to correctly grasps the relationship between the system to be modeled and the corresponding business processes.

> Dynamic Essential Modeling of Organizations - DEMO is a modeling tool that is meant for understanding, analyzing, (re)designing and (re)engineering business processes. It is characterized by capturing the essence of the business processes under study, fully abstracting from all realization issues. Because of this full abstraction, a DEMO model offers the right (re)design freedom for the system designer.

Hence, based on a DEMO model, a UML UC diagram is constructed. UC diagram is a helpful starting point for system modeling, providing elicitation in relation to identification of processes and requirements specification. It is of particular benefit that the diagram consists of a number of UC, which allows analysts to choose any desired UC(s) for further study. It is essential to consistently elaborate on any of the derived UC, with regard to processes and activities within them - very often it is required in software design to strictly define logical relations between processes. The suggested idea (mentioned at the beginning of Section 4) – to solve this using the UC concept of Cockburn in order to build an Activity diagram model based on a particular UC, is considered useful for this purpose. After completely analyzing a chosen UC (following Cockburn's theory [Coc00], where action steps are described within a scenario, supported by extensions), it is straightforward to build an Activity diagram model which helps represent and visualize the action steps within a UC in sound graphical notations.

Such a model could be easily simulated, using different tools (this was studied in [BarShi01]). Proceeding with computer simulation (if further elicitation is necessary), using e.g. Arena [ARE96], would be useful for visualizing processes, providing a dynamic perspective to the information available from modeling tools, providing easily understandable view over branching, choice and other complex structures. This could be used to validate the developed Activity diagram models.

In conclusion, the suggested methodology is expected to be helpful not only for the current research on business engineering BB but also for other research

activities related to development of software which should support business processes in different domains. Regarding the proposed research, the methodology should be smoothly combined with the BB identification framework, in the process of identifying (within the EB domain) several generic business engineering BB and subsequently reflecting them in a consistent software model (according to the research approach). Afterwards, as shown on Figure 2, these results need to be evaluated and if they prove to be inconsistent then both the framework and methodology would be investigated and improved.

5. RELEVANCE OF THE RESEARCH

Correct reflection of business requirements in the development of ICT applications appears to be essential for building software that adequately supports business processes, allowing them to properly utilize ICT. This is crucial especially for contemporary business processes which become more and more complicated and dependent on advanced technological support.

In order to realize such correct reflection of business requirements, it is necessary to consistently align software design and business process modeling. An important (scientific) contribution of this PhD research is to fill in this gap.

Following the principles of object-orientation is considered most beneficial in approaching the mentioned research problem. In this way, by basing the research framework on (generic) building blocks which are identified from target business processes and further reflected in the design of software, some additional benefits would be brought about. The building blocks themselves, identified in a domain (e.g. e-business), would be useful for other investigations and research activities related to the particular domain. Next to that, the developed knowledge concerning the identification of business engineering building blocks could be used in identifying building blocks also in other domains. And also, the study concerning building blocks would demonstrate how software design and business process modeling could be aligned in such a way that component-based application development is straightforwardly supported. Achieving results in this direction would be particularly helpful for contemporary software development since this promising way of developing software applications is comparatively new and still not enough explored.

And finally, by adding to the knowledge on how to realize effective software support to business processes, this research is expected to be a useful (societal) contribution to contemporary business.

REFERENCES

[Ago98] Agostini, A.; Michelis, G. De. (1998). Simple Workflow Models. In Proc: Workshop on Workflow Management: Net-based Concepts, Models, Techniques and Tools; 19th International Conference on Applications and Theory of Petri Nets, Lisbon, Portugal, June 22.

[ARE96] ARENA User's Guide, Sewickley: Systems Modeling Co., 1996.

[BarShi01] Barjis, J.; Shishkov, B. 'UML Based Business Systems Modeling and Simulation'. In the proceedings of the 4th International Eurosim 2001 Congress, June 26-29, 2001, Delft, The Netherlands. ISBN: 90-806441-1-0.

[Ber02] Bernard, H.R., 2002. 'Research Methods in Anthropology: Qualitative and Quantitative Approaches'.

[BET02] 'BETADE project', Volume 1, Pre-pub Draft; TU Delft, 2001.

[BoRuJac99] Booch, G., Rumbaugh, J., Jacobson, I., 1999. 'UML, User Guide'.
[Coc00] Cockburn, A., 2000. 'Writing Effective Use Cases'.
[DehRit01] Dehnert, J., Rittgen, P. 'Relaxed Soundness of Business Processes'. In Proc: CAiSE 2001, June 4-8, Interlaken, Switzerland.
[Die94] Dietz J.L.G., 'Business Modelling for Business Redesign'. Proc: 27th Hawaii Int. Conference on System Sciences, IEEE Computer Society Press, Los Alamitos CA, 1994.
[Die99] Dietz, J.L.G., 'Understanding and Modelling Business Processes with DEMO'. Proc: 18th International Conference on Conceptual Modeling (ER'99), Paris, 1999.
[FowSco00] Fowler, M., Scott, K., 2000. 'UML Distilled, Second Edition – a Brief Guide to the Standard Object Modeling Language'.
[Gal92] Galliers, R., 1992. 'Information Systems Research: Issues, Methods and Practical Guidelines'.
[Gal87] Galliers, R., Land, F., 'Choosing Appropriate Information Systems Research Methodologies', CACM Journal, November 1987.
[HikMat01] Hikita, T., Matsumoto, M.J. 'Business Process Modeling Based on the Ontology and First-order Logic'. In Proc: ICEIS 2001, July 7-10, 2001, Setubal, Portugal.
[Jac92] Jacobson, I., Christenson, M., Jonsson, P., Overgaard, G., 1992. 'Object-Oriented Software Engineering: A Use Case Driven Approach'.
[Jac95] Jacobson, I., Ericsson, M., Jacobson, A., 1995. 'The Object Advantage, Business Process Reengineering with Object Technology'.
[Kru99] Krutchen, P., 1999. 'The Rational Unified Process'.
[LauLau02] Laudon, K.C.; Laudon, J.P, 2002. 'Management Information Systems – Managing the Digital Firm'.
[Liu00] Liu, K., 2000. 'Semiotics in Information Systems Engineering'.
[MaDiHo01] Mallens, P., Dietz, J.L.G., Hommes, B.J., 'The Value of Business Process Modeling with DEMO Prior to Information Systems Modeling with UML. In Proc: EMMSAD 2001, June 4-5, Interlaken, Switzerland.
[MALL00] MALL 2000, project web site: http://www.we-trade.org.
[MEMO01] MEMO, project web site: http://abnamro.com/memo.
[OlFiLu01] Olivera, T.C., Filho, I.M., Lucena, C.J.P. 'Using XML and Frameworks to Develop Information Systems'. In Proc: ICEIS 2001, July 7-10, 2001, Setubal, Portugal.
[OMG00] Object Management Group, 2000. 'UML, Version 1.3'.
[Shi01] Shishkov, B. 'Business Engineering Building Blocks'. Res. Proposal, TU Delft, 2001.
[ShiBar00] Shishkov, B.; Barjis, J. 'Analysis of a System of Telecenters as a Distributed Network'. In the proceedings of the 14th International Conference on Systems for Automation of Engineering and Research (SAER 2000), September 18-20, 2000, Varna - St. Konstantin Resort, Bulgaria, pp. 108-112. ISBN: 954-8329-22-0.
[ShiBar02] Shishkov, B.; Barjis, J. 'Modeling of e-Business Brokerage Systems Using UML and Petri Net'. To be published in the proceedings of the 17th IFIP World Computer Congress, August 25-30, 2002, Montreal, Canada.
[ShiDie01] Shishkov, B.; Dietz, J.L.G. 'Analysis of Suitability, Appropriateness and Adequacy of Use Cases Combined with Activity Diagram for Business Systems Modeling'. In the proceedings of the 3rd International Conference on Enterprise Information Systems (ICEIS 2001), July 7-10, 2001, Setubal, Portugal, pp. 854-858. ISBN: 972-98050-2-4.
[ShiDie02] Shishkov, B.; Dietz, J.L.G. 'Integrated Methodology Allowing Design of ICT Applications Based on Business Process Investigation'. To be published in the proceedings of the IASTED International Conference on Applied Simulation and Modelling (ASM 2002), June 25-28, Crete, Greece.
[ShiXieLiuDie02] Shishkov, B.; Xie, Z.; Liu, K.; Dietz, J.L.G. 'Using Norm Analysis to Derive Use Cases from Business Processes'. To be published in the proceedings of the 5th Workshop On Organizational Semiotics, June 14-15, 2002, Delft, The Netherlands.
[Sie73] Sieber, S.D.,'The Integration of Fieldwork and Survey Methods', American Journal of Sociology Vol 78, September 1973.
[Yin94] Yin, R.K., 1994. 'Case Study Research: Design and Methods'.