The process of developing a business processes assembler

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Abstract: Organizations require material resources, human resources, and business processes to produce goods and services. There is an available market for material resources as well as human resources. The key problem is however the availability of business processes. This paper discusses the development of the requirements for the process assembler, a system that we are going to develop, that will support its users to carry out the key activities regarding business processes. Furthermore, the paper introduces the heuristics for a process selection tool that guides the selection of a development methodology. The process assembler development process is then applied using a prototype of the selection tool, based on those heuristics. The prototype then provides guidance for selecting a suitable development process.

1 Introduction

Non-profit organizations as well as enterprises need to optimize the creation of goods or services. Various process characteristics might be affected, such as cost, time to market, and reliability. In general process optimization finally shall impact competitiveness and value delivered to business partners, i.e., product quality, cost and availability etc., see, e.g. ([El99],[Sc96]). Usually the various measures that might be used compromise each other and so a trade off is needed. These tradeoffs and in general the attitude of staff regarding the organization, its products or services, and business partners is a consequence (and precondition) of the culture in the organization. This culture not only impacts the way the job is prepared and done, which goals are set up and which projects are started. Rather the culture also impacts the way new staff is prepared for their job and how in the end performance is defined, measured and analysed. Such a culture can be put in place, by providing and then using reasonably chosen tools since these (more or less) standardize the things that are done and the way they are done. Organization culture also is related to excellence of work, punctuality, devotion to the job and others. Clearly the used tools in these respects must support staff.

The process assembler, a tool that we are going to develop, is a business process repository that will allow its users to associatively specify, retrieve, and modify business processes as well as executing these on workflow engines that have been registered under the process assembler. However, we are not dealing with all of these in this paper. We focus on selecting a process and methodology for designing and developing business process assembler.

The task of developing information systems is known to be difficult. A very strong focus is being placed on process-oriented aspects of information systems development for obtaining high quality systems, [KN04]. If non-suited processes are used the quality, in particular the utility, of the information system under development is likely to be unsatisfactory, [No88].According to [Bu03] many issues in the development of non-Web information systems are also present in the development of Web-information systems.

The use of the Web varies from businesses to business. E-commerce, which includes the purchasing and selling of goods electronically as well as the execution of financial processes, is a more advanced use of the Web. Web development and e-commerce information system (eCIS) development, requires quick completions of the project, while delivering quality software, [Pf03].

This paper uses the business process assembler project as a case study for applying the development process selection prototype to help select a suitable web development process.

Paper structure: The paper is organized as follows: in the next section related work is discussed. After that in section 0 we work out the key functional requirements for the process assembler and represent these as a use case diagram. Section 0 introduces the Process selection methodology and uses well-known Processes to exemplify several characteristics and scales. This section also briefly explains the architecture of the tool. In section 0 the tool is applied on the supplied development factors to guide in process selection. This paper concludes in section 0 and the references are listed in section 0.

2 Related work

To obtain an overview of the papers that might be related to our work we classify the key functions of our process assembler as:

1. Searching and modifying process specifications, i.e., semantic process descriptions;
2. Storing and retrieving business processes that match a specification at hand;
3. Modifying business processes according to a specification at hand;
4. Mapping business processes from a source business process meta model onto a target business process meta model;
5. Registering and deregistering of business process meta models.

According to sound system development principles we intend implementing these key functions using main modules or components. We therefore respectively expect the process assembler to have the components: Business process repository (dealing with 1 and 2 above), business process modeller (dealing with 3 above), business process mapper (dealing with 4 and 5 above). Several business process repositories are available see, e.g.([As04],[eb01],[HH03],[Ma03],[Sc04],[SP04],[TP04],[WB00],[XD04]). However, we are not going to use one of these since they lack support for adding to business processes the semantic descriptions we need for enabling associative access. The MIT Process Handbook Project (see, e.g.[Ma03],[Pe99]) has implemented a process repository that deserves particular attention since it comes with thousands of process definitions that could help staff in organisations to create new ideas for business processes, goods, services or business models. The repository implements a simple and unsatisfactory search function, i.e., only search for names is supported. However, the repository implements a navigation function. It, firstly, comprises a drill up and –down function with which levels of abstraction regarding a given business process can be crossed. It, secondly, comprises a process link traversal function that allows navigating between linked processes. Our items 4 and 5 from the above list are not supported by the MIT Process Handbook Project. Business process modification is available but only via a tool, the process recombinator, which is discussed in [Ma03] but is not publicly available. The process recombinator enables system administrators modifying certain high-level process chunks. At current we are not fully aware of how far this chunk modification actually goes. The ebXML initiative (see [eb01]) has provided a number of business processes that could be used for the purposes mentioned above. However, these processes simply are available as an indexed list and no machine support regarding searching or retrieval is given. Modifications are not permitted and (clearly) no mapping facility is available. However, the offered processes intentionally are that generic that they could be used within various industry branches.

Van der Aalst et al (see, e.g.[AH02],[Aa00],[Aa00a] and [Aa02]) have studied workflow patterns (see also [DG00]), i.e., frequently occurring operators for combining new workflows from given ones. This work contributes to assessing process characteristics based on characteristics of the pattern used and the processes being combined by the pattern. These authors neither were concerned with retrieving processes nor did they so far attempt constructing a tool that would allow process construction based on patterns and given processes. Rather they investigated available process modelling tools regarding the degree to which these supported using the identified workflow patterns. The patterns they analysed were categorized as: Basic Control Patterns, Advanced Branching and Synchronization Patterns, Structural Patterns, Patterns Involving Multiple Instances, State-based Patterns, Cancellation Patterns. The process assembler, i.e., the tool we are going to build may use some of these patterns.

The Workflow Management Coalition (WFMC) - an international non-profit, organization committed to the development of standards in the fields of workflow technology - predefined in its workflow reference model (for details see e.g. [AH02],[WM99]) interfaces for data exchange between different components of workflow management systems. Among others, interfaces 1 and 4 related to our work. Interface 1 connects a workflow enactment service, i.e. workflow engine, with a modelling tool. This interface is relevant if processes from a repository are shipped to a workflow engine in its internal format. Interface 4 is relevant if prior to shipping a translation into the internal format of the target workflow engine has to be performed. The former sometimes is called design-time interoperability and the latter run-time interoperability. The WFMC did not develop a special translator; rather they proposed several standard languages such as WPDL (WFMC's process definition language, see e.g. [WP03]) for interface 1 and Wf-XML (see e.g. [WF03]) for interface 4 respectively. IBM BPEL4WS (Business Process Execution Language for Web Services, for details see e.g. [BP03]) also provides specification for business process interaction, and therefore supports interface 4. In the business process mapper – the process assembler component responsible for key functions 4 and 5 – we foresee a using these standards as an alternative in cases when either direct exchange is not possible or too complicated and target WFMS supports one of languages mentioned.

There seems to be limited research published that deals with selecting an appropriate web development and/or e-commerce development process. A taxonomy regarding various classification features of methodologies for workflow systems development is targeted at in [AR03]. E-Processes selection is targeted in [Kn03]. The selection approach taken relies on identification of situation patterns best supported with a particular process. This qualitative approach may become inconclusive as at the same time several patterns might apply to a lesser or higher degree. To cope with such situations we introduce quantification as the guiding idea to web development and e-commerce development process selection.

The papers ([Ta02], [Vi02], [Vi02a] emphasize that e-Commerce Information Systems (eCIS) development requires a mix of web site development techniques (such as user profiling) together with traditional IS development competencies, such as database design and program design. Refer to [Ka04] for an attempt to conceptualize the term WIS as opposed to IS.

3 Requirements for the process assembler

We envisage a usage model for the process assembler an abstract representation of which is depicted in the state chart in Figure 1. As is the case with software reuse in general, see, e.g. [Mi02] process reuse aims among others at increasing quality and development productivity. As Figure 1 indicates process reuse can be understood as utilizing processes that were derived by the one or another means or technique from already available processes. According to our usage model a user would first attempt describing a business process. S/he would perhaps navigate the available business process specifications for, at a semantic level, identifying the processes that best match actual needs. Once the best matching specification is found the user would retrieve the respective processes. In case s/he believes that adaptation is not needed for the current purpose or that adaptation is possible and would pay off the user would come up with a version of the process that meets his needs. Otherwise the user might give up and decide for creating a new business process from scratch or would go back to describing business processes.

Locating a suitable business process specification and modifying a retrieved business process, such that it fits the actual needs, would be supported by heuristics we are going to provide. According to [Kr00] issues regarding process repositories, and in particular process reuse, have not received satisfactory attention and still offer some riddles to be solved. At a high level of abstraction we propose use cases, i.e., key functions offered by the process assembler to its users or to its administrator. For a pictorial representation of these see Figure 2. The figure shows that the administrator has only the key functions available. With these s/he can register or deregister users. S/he further can register or deregister workflow engines and install drivers for mapping processes from a source process meta model to a target process meta model. These sub-functions are grouped together in the interoperability use case. Finally the administrator has access to an approval use case, which has three sub-use cases for approving the deletion of a process from the repository, the modification of a process in the repository, and for creating a new process in the repository. Being registered, users have access to use cases for import, export, description, retrieval and modification of business processes. This is so because the respective functions here are understood as not affecting the repository contents. We ignore possibility of introducing limited read access to repository contents. Regarding functions that could affect the repository contents the user can request approval to execute these. These functions are: Create, delete and overwrite a business process. Approval requests regarding these functions are grouped together in the use case approval request. To actually affect the repository contents the use case delete and store could be used. The latter of these has the obvious two sub-use cases.

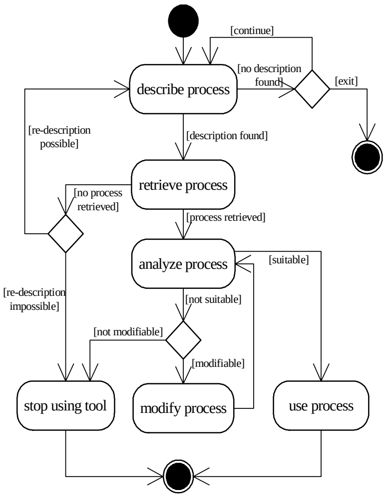

Figure 1: Process reuse state chart

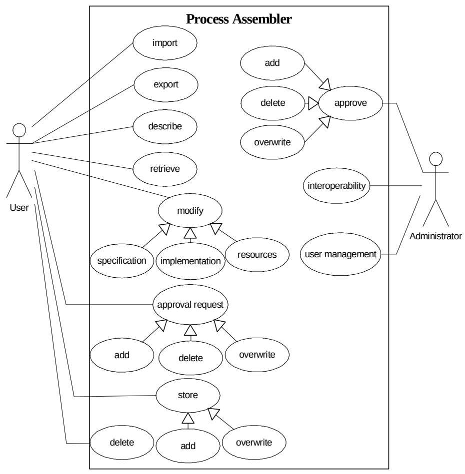

Figure 2: Process assembler use cases

4 Processes selection methodology

4.1 The Process Ontology

We consider ontology to be a specification of a conceptualisation that is shared by a number of people, ([Wa99],[Op01],[FL03]). In order to assess the Development Processes, the characteristics of Web development processes are specified in the form of a list of concepts with their definitions. We propose to use the structured list of quality aspects (characteristics) to specify DevelopmentProcesses (see related work). Obviously one could refine or add to our characteristics, and group or name them differently. This could change the recommendation for a specific development task, as obtained by our selection method, but will not invalidate our method.

I. **Application**,

- *Quality*, targeting the intended system quality..

- *Economics***,** targeting the available development budget, the expected running costs, benefit, and amortization time.

II. **Conception**,
   - *DoMA*, targeting the domain of method application.
   - *Process*, i.e., what activity and artifact life cycles are recommended.

III. **Documentation**,
   - *Material*, targeting the availability and quality of teaching- and documentary material, including case studies, adequate definitions and explanations.
   - *Publicity*, targeting the likelihood with which new staff can be expected to be capable of applying the methodology.

IV. **Methodology**,
   - *Artifact analysis*, targeting at the support given for analyzing development artifacts.
   - *Team support*, targeting at the support given for group-wise development.
   - *Design primitives*, targeting at the support for controlled artifact evolution based on using elementary artifact transformations.

V. **Modeling system**, targeting at the concepts offered for systems development, how to apply and represent these.

VI. **Organization**, targeting the enterprise **c**ulture, the business strategy followed, the employed technology, and in particular:
   - *Project*, targeting Objectives, requirements, users and implementation.
   - *Team*, targeting skills, education, experience of the development team as well as its composition and load due to involvement in other projects.
   - *Time***,** targeting the intended development time.

VII. **Tool support**, targeting the availability, quality (including the degree of coverage of the modelling system and utility of the tool), and trustworthiness of the tool vendor.

Our Process Selection Methodology will associate with each Development Process profile a vector of numbers and for each characteristic a weighting factor. This will enable us to quantitatively compare Web and eCIS development Processes and chose the one with the largest weighted sum. We further propose using weak-point analysis (see, e.g. [BW96] for more detail about how to apply this method in general) for analysing what kind of improved Development Process would be reasonable with respect to a development task at hand.

Table 1 lists the characteristics within each of the seven groups listed above. A detailed description (and extent to which it is met) of each characteristic will not be provided in this paper because of size restrictions. A scale value (a number between 0 and 1) is also included in table 1. The scale expresses the degree that that specific characteristic has to meet and the sum adds up to 1. (The first number between brackets is the scale and the second the development factors provided by the developer – see section 0)

Table 1: Subset of characteristics

Groups	Characteristics (c1…c54 see section 4.2)
Application	*Quality*: Adaptability (0.001,8), Availability (0.002,8), Completeness (0.002,7), Correctness (0.002,9), Cost (0.001,5), Ergonomics (0.002,7), Interoperability (0.003,9), Maintenance (0.001,5), Performance (0.002,7), Precision (0.002,8), Safety (0.001,7), and Security (0.002,8). *Economics*: Development Budget (0.005,6), Running Costs (0.005,6), and Amortization Time (0.003,5).
Conception	*DoMA*: Domain of method application (0.005,3). *Process*: Recommended life cycle activities.(0.005,3)
Documentation	*Material*: Documents(0.015,3) *Publicity*: New users capable to apply the methodology (0.015,8)
Methodology	*Artefact analysis*: Maturity (0.018,3), Accuracy (0.018,6), and Reliability (0.018,7). *Team support:* Understandability (0.018,3), Ease of Use (0.018,3), Ease of Learning (0.018,8), Acceptable (0.2,3) *Design primitives:* Change Management(0.02,4)
Modelling system	Development for re-use (0.01,6), Documentation (0.01,4), and Deliverables(0.01,4).
Organization	*Organization*: Infrastructure (0.03,3), Enterprise Culture (0.02,3), Technology (0.03,7), Current level of Business (0.02,5), External Exposure (0.03,5), Current Client Base (0.02,4), Personnel Internet Experience (0.03,4) and Geographic interaction (0.04,3). *Project*: IT Strategy (0.04,5) and Business Strategy (0.02,6), Future Plans (0.01,7), Objectives (0.04,8), Requirements (0.04,8)and Implementation Strategies (0.035,3). *Team*: Skills (0.025,5), Education (0.025,7), Team Experience (0.034,7), Knowledge (0.03,6), and other Project Involvement (0.02,5). *Time*: Development time (0.04,3).
Tool Support	Availability of tools (Possession) (0.04,7), Modelling tool quality (0.045,7), Vendor support (0.045,3), Robustness of the tool (0.039,5).

4.2 Development Processes Selection Tool

The heuristics we present here does not have the purpose of guiding its users to make the decision. It rather aims to introduce a terminology that can be used to make the respective decision and to document the reasons for deciding in a particular way. The architecture of our tool is such that the heuristics applied in a case at hand can easily be chosen out of a list of heuristics. We propose a heuristic that appears reasonable to us and provide expert users of our tool the capability of adding and documenting new heuristics.

The architecture of the prototype Development Process selection tool is outlined in this section. The selection tool assist managers and e-commerce site developers or web developers to make a decision on the type of development process to use. In order to ensure that a quality e-commerce system (eCIS) or Web site is delivered, site developers need to decide on an appropriate development process. The tool will assist in deciding the most suitable development process for developing the business process assembler.

The prototype uses the subset of characteristics {c1….c54}. Refer to table 1 for a list of the characteristics. The prototype uses 4 Development Processes {Rational Unified Process (RUP), Agile modelling with extreme programming (AM/XP), Open Source System Development (OSP), Storyboarding with user profiling (SBU)}. For each characteristic c_i, $i \in \{1, \dots, 54\}$, and each process P_j, $j \in \{1, \dots, 4\}$, an enterprise staff, who is an expert in the field, are asked to determine the weight w(1), …, w(54) of characteristics c(1), …, c(54). In the prototype tool we used the scale as specified in Table 1 as weight. The expert in the field specifies the performance p(1,j), …, p(m,j) with respect to this process for each characteristic. We chose the numbers w(i) such that w(1) + … + w(n) = 1. We however allow $w(k) \neq w(l)$, for all $k \neq l$. A third factor namely a factor specified by the developer specifying importance of that characteristic to that enterprise d(1),…,d(54) is also brought into the equation.

The following sequence of stepwise procedures is followed:

1. $C := \emptyset$
2. Chose $J \subseteq \{1, \dots, n\}$ such that for $j \in J$ the number $S(j) = .\sum_{i \in \{1, \dots, n\}} w(i)*p(i,j)*d(i)$ is maximal and define C : = J, observe to chose J maximal. Set $C := C \cup J$.
3. For all $j \in \{1, \dots, n\} \setminus J$, $k \in \{1, \dots, m\}$ perform a sensitivity analysis, i.e.,
    a. Calculate $S(k,j) = \sum_{i \in \{1, \dots, m\} \setminus \{k\}} w(i)*p(i,j)*d(i)$
    b. Chose sets W, P, D such that $w(k) \in W$, $p(k, j) \in P$, $d(k) \in D$ and determine $T(k,j) = \max\{w*p*d \mid w \in W, p \in P, d \in D\}$. It will often be convenient to chose W and P such that $W = \{c_W + h_W*\Delta_W \mid h \in \{0, \dots, r_W\}\}$, $P = \{c_P + h_P*\Delta_P \mid h \in \{0, \dots, r_P\}\}$.
    c. If S(k, j) + T(k, j) > S(j), then the values w, p, d for which the maximum T(k, j) was achieved need to be investigated. If they are reasonable, then redefine $C := C \cup \{k\}$, w(k) : = w, p(k,j) : = p, d(k) := d.
4. Do a weak point analysis for each candidate in $j \in C$, i.e., determine those characteristics with high impact (weight higher than for, e.g. 70 % of the characteristics) and low performance (performance lower than for, e.g. 70 % of the characteristics).
    a. For each of the weak points consider the performance assessment and weight. If one of these should be corrected then do so.
    b. If weak points remain after a. then either $C := C \setminus \{j\}$ or replace P_j by an improved version Q scoring no less than P_j, and assess it.

5. If the weak point analysis in 4 does not change anything then chose among the candidates in C according to a predefined strategy. Otherwise go back to 3.

The developer using this tool is thus assisted to make a decision on the Development Process that will best suit their needs. This tool is just used to assist and not make the final decision. The final decision will still lay with the actual decision-makers e.g. developer or manager.

5 Applying the selection tool

In order to determine a suitable development process for developing a web site for the process assembler the development process selection tool was applied. An expert has assigned scales for each characteristic. This is specified in Table 1. An expert on development processes assigned performance factors for each characteristic for each development process. All these numbers are stored as part of the tool.

The selection tool was then applied on the development factors supplied by the process assembler developer (see second number between brackets for each characteristic in Table 1). The development factors are entered as the tool is applied. The numbers entered are between 1 and 10 where 10 indicate a high degree of suitability for that characteristic and 1 a low degree of suitability for that characteristic. The numbers are adjusted in the prototype to between 0 and 1.

A sensitivity analysis and weak point analysis was applied after the initial calculations. The end result was that the selection tool recommends storyboarding with user profiling as a development process that can be considered as suitable when a web site is developed for business process assembling.

The developer of the process assembler will need to finally decide whether to use the recommended development process.

6 Conclusions

In this paper the requirements for the business process assembler were analysed and defined. The heuristics for prototype development process selection tool were defined and the tool was then applied to determine which development process can be recommended. The development process recommended was storyboarding with user profiling.

It is hoped that this paper provided researchers in the area of business process assembling an insight into the direction the author is following in the development of these processes. The developer of the business process assembler will need to develop a storyboard for the web site and do profiling of the user of the business process assembler. The storyboard will show the decisions and logical pathways that determine the next page to be visited in the website. A hierarchical diagram may also form part of this documentation. This documentation will include basic layout of all pages the user will encounter within the website [Ta02]. User profiling will consist of identifying the target audience in order to focus the resulting web site in their preferences.

Furthermore the paper has used the business process assembler project as a case study for applying the development selection tool prototype. Developers aim to maximize the quality of the finished process. The development process used impacts on the quality of the resulting system. Future research of the development process selection will focus on different approaches to the classification process. The tool will also be refined for use in the e-Commerce Development area. Other further work includes: further refinement of the architecture of the selection tool, application of the tool in a number of real life scenarios and then incorporating feedback received from the users to improve the features of the tool.

References

[As04] Activate! Process Repository, URL: http://www.activus.co.uk/REPOS.htm

[AR03] Al-Humaidan, F; Rossiter, B.N.: A taxonomy and Evaluation for System Analysis Methodologies in a Workflow Context: SSADM, UML, SSM, OPM, Newcastle University. 2003, URL: http://www.cs.ncl.ac.uk/research/pubs/trs/papers/751.pdf

[AH02] van der Aalst, W.M.P.; van Hee, K.: Workflow management: Models, Methods, and Systems, The MIT Press, 2002

[Aa00] van der Aalst, W.M.P.; ter Hofstede, A.H.M.; Kiepuszewski, B.; Barros, A.P.: Advanced Workflow Patterns. In O. Etzion and P. Scheuermann, editors, 7th International Conference on Cooperative Information Systems (CoopIS 2000), volume 1901 of Lecture Notes in Computer Science, pages 18–29. Springer-Verlag, Berlin, 2000

[Aa00a] van der Aalst, W.M.P.; ter Hofstede, A.H.M.; Kiepuszewski, B.; Barros, A.P.: Workflow Patterns. BETA Working Paper Series, WP 47, Eindhoven University of Technology, Eindhoven, 2000

[Aa02] van der Aalst, W.M.P.; ter Hofstede, A.H.M.: Workflow Patterns: On the Expressive Power of (Petri-net-based) Workflow Languages, Proc. of the Fourth International Workshop on Practical Use of Colored Petri Nets and the CPN Tools, Aarhus, Denmark, August 28-30, 2002

[Ar03] Arkin, A.: Business Process Modeling Language, BPMI Proposed Recommendation, Business Process Management Coalition, URL: http://www.bpmi.org, 2003

[BW96] Böhm, R; Wenger, S.: "Methoden und Techniken der System-Entwicklung", vdf Hochschulverslag AG and der ETH; 2nd. ed. Zürich, 1996

[BP03] Business Process Execution Language for Web Services Version 1.1, Specification, 05 May, 2003

[Bu03] Butler, T.: An institutional perpective in developing and implementing intranet- and internet-based information systems, Info Systems Journal, 2003 (13): pp. 209-231

[DG00] Dobrovnik, M.; Groiss, H.: Workflow patterns, URL: http://www.groiss.com, 2000

[eb01] ebXML Catalog of Common Business Processes v1.0, URL: http://www.ebxml.org/specs/bpPROC.pdf, 2001

[El99] Elzinga, D.J.; Gulledge Th.R.; Lee, Ch-Y.: Business Process Engineering: Advancing the State of the Art, Kluwer Academic Publishers, 1999

[FL03] Fettke, P.; Loos, P.: Ontological evalution of reference models using the Bunge-Wand-Weber model. Ninth Americas Conference on Information Systems, 2003

[HH03] Hartwig, R.; Herczeg, M.: A Process Repository for the Development of E-Learning Applications, URL: http://csdl.computer.org/comp/proceedings/icalt/2003/1967/00/19670346.pdf

[Ka04] Kaschek, R.; Schewe, K.-D.; Wallace, C; Mathews, C.: Story Boarding for Web-Based Information Systems. Chapter 1, In: Taniar D., Wenny Rahayu J.: Web Information Systems.(Eds), IDEA Group Publishing. Hershey, PA, 2004

[KN04] Kautz, K.; Nielsen, P.: Understanding the implementation of software process improvement innovations in software organizations, Info Systems Journal, 2004 (14):pp. 3-22

[Kn03] Knight, L.; Steinbach, T.; Kellen, V.: System Development Methodologies for Web-Enabled E-Business: A Customization Paradigm, 2003, URL: http://www.kellen.net/SysDev.htm

[Kr00] Kradolfer, M.: A Workflow Meta-model Supporting Dynamic, Reuse-based Model Evolution, Dissertation, Der Wirtschaftswissenschaftlichen Fakultät der Universität Zürich, 2000

[Ma03] Malone, T.W.; Crowston, K.; Herman, G.A.: Organizing Business Knowledge, The MIT Process Handbook. The MIT Press, Cambridge, Massachusetts, 2003

[Mi02] Mili, H.; Mili, A.; Yacoub S.; Addy E.: Reuse Based Software Engineering, John Wiley & Sons, Inc., 2002

[No88] Nosofsky, R.M.: Exemplar-based account of relations between classification, recognition, and typicality, Journal of Experimental Phycology: Learning, Memory and Cognition 14, 1988, pp. 700 - 708

[Op01] Opdahl, A.L.; Henderson-Sellers, B.; Barbier, F.: Ontological analysis of whole-part relationships in OO-models, Information and Software Technology 43, 2001, pp. 387 – 399

[Pe99] Pentland, B.T.; Osborn, C.S.; Wyner, G.; Luconi, F.: Useful Descriptions of Organizational Processes: Collecting Data for the Process Handbook, Massachusetts Institute of Technology Sloan School of Management, 1999

[Pf03] Pflughoeft, K.; Ramamurthy, K.; Soofi, E.; Yasai-Ardekani, M.; Zahedi, F.: Multiple Conceptualizations of Small Business Web Use and Benefit." Decision Sciences 34, 2003, pp. 467 – 512

[Sc96] Schael, Th.: Workflow Management Systems for Process Organisations, Lecture Notes in Computer Science 1096, Springer, 1996

[Sc04] Sciforma Process Repository, URL: http://www.sciforma.com/products/Process/sp_process_repository.htm

[SP04] Standards Process Respository, URL: http://www.sea.uni-linz.ac.at/Teaching/ws20002001/KVSoftEngin1/projects/spr.htm

[SL04] SystemicLogic's Process Repository, URL: http://www.processrepository.com

[Ta02] Taylor, M.J.; McWilliam, J.; Forsyth.H.; Wade, S.: Methodologies and website development: a survey of practice Information and Software Technology (44), 2002, p.381-391

[TP04] The Phios Process Repository, URL: http://repository.phios.com/InsightExec/

[Vi02] Vidgen, R. Constructing a web information system development methodology, Info Systems Journal, (12):pp. 247-261, 2002

[Vi02a] Vidgen, R.; Avison, D.; Wood, B.; Wood-Harper, T.: Developing Web

Information Systems, Butterworth-Heinemann 0-7506-57634, 2002

[Wa99] Wand, Y.; Storey, V.; Weber, R.: An ontological analysis of the relationship contruct in conceptual modeling, ACM Transactions on Database Systems 24 (4):pp. 494 – 528, 1999

[WB00] Web-Based Software Process Improvement Repository, URL: http://www.stsc.hill.af.mil/crosstalk/2000/03/groarke.html

[WF03] Wf-XML 2.0: XML Based Protocol for Run-Time Integration of Process Engines, URL: http://www.wfmc.org, October 2003

[WM99] Workflow Management Coalition Terminology & Glossary, Document Number WFMC-TC-1011, February 1999, URL: http://www.wfmc.org

[WP03] Workflow Process Definition Interface -- XML Process Definition Language, Document Number WFMC-TC-1025, URL: http://www.wfmc.org

[XD04] Xaraya Development process: repository model and tool usage, URL: http://docs.xaraya.com/docs/rfcs/rfc0028.html