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A ROLE-BASED FRAMEWORK FOR INFORMATION SYSTEM SELF-DEVELOPMENT

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Abstract

This paper presents an approach to information systems development based on contemporary business and organization models. Business organizations are changing very quickly and their information systems must evolve dynamically with them. We have developed a concept of IS self-development where the information system is treated as an active information view or a level of a business organization providing and mediating not only the information and communication services but also the development services of the organization and its IS. This makes it possible for IS development processes to be handled in the context of the organizational roles of the business organization, allowing specialized development organizations to focus on services for IS development. A meta-model of the architecture of the IS development process and a general methodological framework for modeling and organizing such subject-centered development processes have been developed. The paper reflects the current status of an ongoing project (Estonian Science Foundation grant G3765).

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: [10.1007/978-0-387-35489-7_33](https://doi.org/10.1007/978-0-387-35489-7_33)

N. L. Russo et al. (eds.), *Realigning Research and Practice in Information Systems Development*
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1. INTRODUCTION

1.1 Background

The global information society generates virtual subjects and their organizations. These organizations form, function, and develop as a result of system work that cooperative subjects perform on the level of information systems (IS). The success of such organizations depends on their ability to adapt to the environment and learn.

In this environment, the information system is the main organizational interface for embracing the world and one's immediate functioning and learning environment. Development of this environment has to be a central role of the learning virtual organization. To perform this role, the organization needs a methodology that enables subjects to develop the IS in their natural work environment, which is the IS under development. This concept, the self-advancing information system, contains the subject as well as the environment of development (Roost 1996). We call the development process of such an information system *IS self-development*. How can it be accomplished? The key problem here is building adequate space for development (Roost et al. 1998), based on decentralized models of system work and development (Lyytinen et al. 1998).

1.2 Problem Statement

Businesses and the environment in which they operate are changing very quickly, and organizations and their IS must evolve dynamically with these changes (Russo 2000; Roost 2000). New technologies make it possible for organizations to develop IS directly in their work environments (e.g., Web-enabled ERP [Russo 2000] and patterns-based development approaches [Robertson and Robertson 1999], especially in combination with CRM [Davydov 2000]). Information systems development (ISD) frameworks and methodologies do not yet give full support to such development processes (Iivari and Lyytinen 1998; Marshall 1999). The main questions for current research are:

- How do we develop a methodological framework for ISD that is applicable in a virtual learning organization?
- How do we manage (model and organize) IS self-development in virtual learning customer organizations?
- How are such subject-centered ISD spaces and processes planned and built?

- How do we perform the stage of IS strategic development, in the course of which these spaces and processes are planned (and built) in the context of IS self-development?

1.3 Motivation

The main idea behind the IS self-development concept is to perform the main phases or sub-processes of ISD (sequential stages in the classical approach) in a maximally balanced, parallel, and synchronized manner within the customer/developer relationship. The customer directs such customer-centric processes as strategic and detailed (business) analysis and application of solutions developed by the developer organization. The developer organization (which could be a specialized IT firm) holds responsibility for simultaneous architecture-centric processes: design (strategic/architectural and detailed) and implementation.

Initiating such a process in a particular organization requires some difficult preliminary work, which includes obtaining or designing a methodological framework and its components as well as preparing the development/project organization and supporting systems, training, etc. For this reason, a well-developed methodology to systematically carry out IS self-development is needed.

We have developed a role-based meta-model (Roost 1996, 2000; Roost et al. 1998, 1999) for the construction of a subject- or customer-centered ISD process. On the basis of the meta-model, we have developed a general methodological framework and a more detailed framework for the “top-level” processes of the IS strategic development phase.

2. THEORETICAL AND PRACTICAL FOUNDATIONS: AN APPROACH TO INFORMATION SYSTEMS SELF-DEVELOPMENT

In this section, some theoretical and practical foundations of our development approach are discussed. The starting point is IS definition. According to Davis (2000), an information system is “a part of an organization that provides information and communication services required by the organization.” The IS function provides and mediates the development services of the organization and its IS. This makes it possible to handle IS development processes in the context of organizational roles in the business. Specialized development organizations can then focus on developing services for (IS) development. According to our interpretation, IS is an active information level

of a subject in an information society, defined by and generated from models of the subject. An IS is a virtual model-system that generates the actual/virtual environment (development space) of the subject (Roost 2000).

The bases of the concept of self-development are hidden in traditional conceptual frameworks for IS/ISD (see Sowa and Zachman 1992). These frameworks are tables, the cells of which contain models of certain types according to abstraction level and aspect of IS/ISD. Actually, each modeling level is “business modeling” from the perspective of a particular role. This means that each model is a business model or a part of a business model for someone.

ISD is a process that takes place in some space, determined by strategic relationships between a customer organization (as the subject of development) and the developing organization(s) (representing the environment for development). Modeling and organizing this space of development is a matter of strategic system development.

In the subject-centered approach, analysis and design of the development space is based on the role model (Roost et al. 1998). Here ISD is handled in the framework of organizational roles of the customer organization, which form the basic (self-advancing) structure (architecture) for the space of development (see Figure 1).

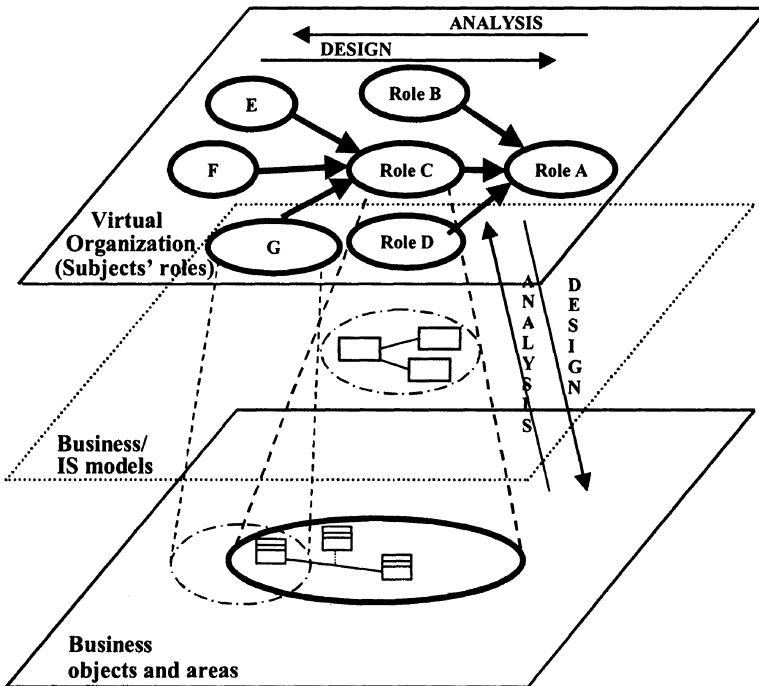


Figure 1. The General Role-Based Architecture for the Space of ISD

On the upper level of the figure, we see a virtual business organization, including its subjects and their roles in this organization (subjects of IS/ISD). Developer organizations and roles also will be handled as subjects of this virtual organization. This corresponds to the model of the IS community in Hirschheim and Klein (2000).

On the lower level, we see business objects which form business areas (the circles). An area belongs to a role responsible for the management and development of this business area. In the organizational context, we refer to a business area as an area of competence. In the ISD context, the business objects are also objects of system work and (IS) development.

The intermediate level represents IS models and services that make it possible to manage and develop the objects and to perform ISD. IS models are also business models from the perspective of some members in this virtual organization.

3. ANALYZING OUR INFORMATION SYSTEMS DEVELOPMENT PRACTICES

In this section, we describe and analyze some central processes and activities of a methodology developed and applied by our team in several ISD projects during the last five years on more than 20 significant projects, all of which have been deemed successful.

The methodology is elaborated for the first phase of ISD, termed here *strategic development*, and includes customer role-based *strategic analysis* and developer role-based *strategic design* processes. The aim of IS strategic development is to define the system under development and to design its space of development.

The objects (artifacts and results) of strategic development are organized into three main views:

- Business view
- Architecture view
- Development view

The *business view* of IS covers the main decompositions (subsystems) of the *subject of development*: the customer organization's business model and underlying high-level (organizational, functional, and information) services (subsystems) of IS. The business view belongs to the customer organization. The business view defines the customer organization's requirements for IS/ISD services.

The *architecture view* covers the main decompositions (components) of the *environment of development*: architectural views and/or levels including busi-

ness architecture and technical architecture, functional and data architecture, hardware and software infrastructure, patterns and services of development (analysis, design, etc.) and their providers, etc. The architecture view belongs to the IS unit of the customer organization and/or to an independent “architecture firm.”

The *development view* covers the main decompositions of the *process of development*: strategies and risks, projects and tasks, development/project organization, budgeting, problems of development. This view belongs to the development/project organization, which includes teams and roles from the customer and the developer organization. Its main goal is to optimize customer-developer cooperation.

In this paper, we concentrate on strategic development of the business view of IS, that is, (strategic) business engineering (Marshall 1999). The customer-centric and architecture-centric sub-processes of strategic business engineering are labeled strategic business analysis and strategic business design, respectively. The business view of IS/ISD uses the business architecture that is the highest level of the entire IS architecture.

3.1 Business Architecture and IS Strategic Subsystems

Business architecture in our methodology is defined as decomposition of the business model of the customer organization into strategic subsystems of the organization’s IS. In the strategic development phase, we identify three levels of IS subsystems:

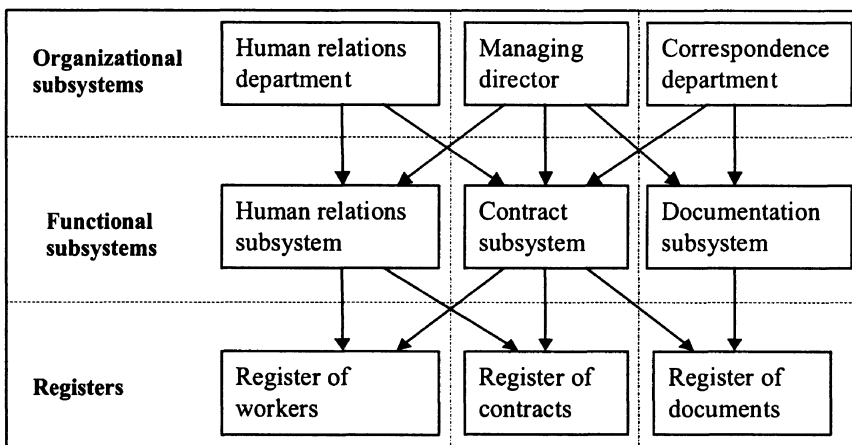


Figure 2. An Example of the Business Architecture in IS Strategic Development Phase

- *Organizational subsystems*, corresponding to managers' areas of competence;
- *Functional subsystems*, abstractions of particular business processes;
- *Registers*, data-centric abstractions of particular business objects.

Organizational subsystems are customer roles in the virtual customer organization and its IS. They apply services and resources provided by functional subsystems. Typically an organizational subsystem is based on one functional subsystem but uses services from several functional subsystems.

Functional subsystems are in principle independent from particular organizational structures. They are stable modeling patterns for particular business processes. Functional subsystems apply services and resources provided by registers. Typically a functional subsystem is based on one register but uses resources and services from several registers.

A register is a logical data-centric view of a business object that holds the state and transactions data of the object and provides related recording and query services. A register can be composed of sub-registers.

3.2 Customer Role-Based Business Analysis

The customer-centric sub-process of strategic business engineering in our methodology is called strategic business analysis. The aim of the process is to gather, coordinate, and generalize the visions and requirements of all parties (roles) of the customer organization and/or IS. The process is customer role-based, wherein any subject of the customer organization acts according to the following general behavior pattern:

1. Models and analyzes its area of competence as a whole;
2. Models and analyzes its own role as a manager and developer of this whole/system;
3. Designs and builds an IS to support this role.

This analysis begins with answering a questionnaire about an area of competence. The questionnaire has the following structure (see Figure 3):

1. Five questions about key aspects of the *area of competence* as a system (a circle on the lower level in Figure 1);
2. Five questions about key aspects of the manager or business worker role in managing and development of this system (a circle on the upper level in Figure 1).

AREA OF COMPETENCE	MANAGER ROLE
<ol style="list-style-type: none"> 1. Scope 2. Aims 3. Processes 4. Objects 5. Events 	<ol style="list-style-type: none"> 6. Aims 7. Actions 8. Problems, constraints 9. Cooperation, communication 10. Other viewpoints

Figure 3. The Structure and Keywords for a Questionnaire about a Worker's or Manager's Area of Competence

The main steps in role-based business analysis are the following:

1. The business architect and customer organization's top management create an initial list of key areas of competence and their representatives;
2. Each representative answers all the questions;
3. The analyst performs an initial analysis of the answers and updates a special repository in the supporting software environment;
4. The business worker and/or analyst compose initial models;
5. The business worker and/or analyst coordinate their answers, models and repository elements "horizontally" with the answers and models of other related subjects mentioned in the answer to the question about cooperation and communication with other subjects;
6. The business worker and/or analyst coordinate their models "vertically" with models of related functional subsystems and registers. (Note: The order of the horizontal and vertical coordination steps may be reversed.)

3.3 Developer Role-Based Business Design

The architecture-centric sub-process of strategic business engineering in our methodology is called strategic business design. The aim of the process is to identify and customize existing models/patterns and related services of functional subsystems and registers for the context of the customer organization as a whole or its particular areas of competence as the customer-centric business analysis evolves. The process is developer role-based. In a developer organization, each functional subsystem can be handled as an area of competence that generates a related developer role which is responsible for development of this subsystem as a whole and managing its strategic development in the context of several customer organizations (e.g., the Web-enabled ERP concept).

3.4 The Key Concepts and General Structure of the Role Model

In this section, we present a general structure view of the meta-model behind our methodology. This abstract meta-model of IS/ISD (named a role model) is semi-formally described in Roost (2000) and Roost et al. (1999) as a composite pattern using unified modeling language (UML) diagrams. Here we give only one of the main diagrams.

The central architectural unit of the development space is called subject's role—a system modeled by the sentence “Subject develops his environment” (or “Environment develops the subject,” in the dual view). This is a profile of development activities oriented to identification and development of some static requirement on the level of the whole system. The global space of development divides into open local development spaces according to named profiles/roles.

On the basis of the role model, an IS/ISD has three main views (see Figure 4):

- *Subject view* as the “closed” view of the system, embracing its environment. Subject is an active intelligent component (view) of the system having requirements and capabilities to develop the environment.
- *Environment view* as the “open” view of the system to all one's subjects/developers, consisting of components and services decomposed into multiple levels and shared by different roles.
- *Role view* as the central, integrating, development view of the system, a dynamic interface between the subject and environment views and synchronizing their (business) models.

For example, in our methodology, in the context of the three main views (business, architecture, and development), the business view can be considered as the subject view, the architecture view as the environment view, the development view as the role view.

All components/views of the role model can be modeled as classes in UML notation. The model has a recursive structure. The same pattern, as to the whole view, can be applied to each of three main views. For example, for the business view, the organizational sub-view can be handled as the subject view, the functional sub-view as the role view, and the registers sub-view as the environment view.

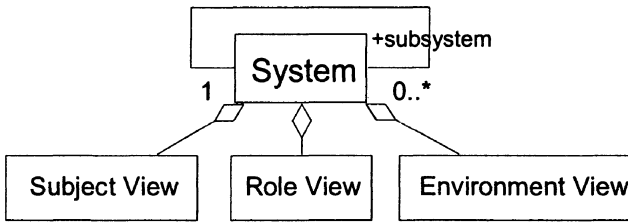


Figure 4. The General Structure of the Role Model (UML Class Diagram)

5. CONCLUSION

An ISD approach, developed by the authors over several years, has been described in this paper. Theoretical and practical foundations have been discussed, ISD processes within the customer/developer relationship have been analyzed, and the concept of IS self-development was introduced. A role-based methodological framework for handling IS self-development in virtual learning organizations was also described. A customized framework for the IS strategic analysis and design phase of our methodology was then analyzed, and the application of the framework in the development of IS in several organizations was described.

6. REFERENCES

- Davis, G. B. "Information Systems Conceptual Foundations: Looking Backward and Forward," in *Organizational and Social Perspectives on Information Technology*, R. Baskerville, J. Stage, and J. I. DeGross (eds.), Boston: Kluwer Academic Publishers, 2000, pp. 61-82.
- Davydov, M. M. "ERP Going Forward," *Intelligent Enterprise*, March 20, 2000.
- Hirschheim, R., and Klein, H. K. "Information Systems Research at the Crossroads: External Versus Internal Views," in *Organizational and Social Perspectives on Information Technology*, R. Baskerville, J. Stage, and J. I. DeGross (eds.), Boston: Kluwer Academic Publishers, 2000, pp. 233-254.
- Iivari, J., and Lyytinen, K. "Research on Information Systems Development in Scandinavia – Unity in Plurality," *Scandinavian Journal of Information Systems* (10:1/2), 1998, pp. 135-186.
- Lyytinen, K., Rose, G., and Welke, R. "The Brave New World of Development in the Internetwork Computing Architecture (InterNCA): Or How Distributed Computing Platforms Will Change Systems Development," *Information Systems Journal* (8:4), 1998, pp. 241-253.
- Marshall, C. *Enterprise Modeling with UML: Designing Successful Software through Business Analysis*, Reading, MA: Addison-Wesley, 1999.
- Robertson, S., and Robertson, J. *Mastering the Requirements Process*, Reading, MA: Addison-Wesley, 1999.

- Roost, M. *An Approach to Information Systems Self-Development*, unpublished MSc. Theses, Department of Informatics, Tallinn Technical University, 2000.
- Roost, M. "Information Systems Development on the Basis of the Role-Model," Proceedings of the Second International Baltic Workshop on Databases and Information Systems, June 12-14, 1996, Tallinn, pp. 37-47.
- Roost, M., Kuusik, R., and Elmik, L. "A Subject-Centred Framework for Information System and Organisation Development: Analysis and (Re)Design," Proceedings of the INFORS Special Conference on Organisation Structures, Management, Simulation of Business Sectors and Systems, Kaunas, Lithuania, September 10-12, 1998, pp. 222-228.
- Roost M., Kuusik, R., Elmik, L., Veskioja, T., and Rava, K. "The Role-Model: An OO Framework for Information Systems Self-Development," Poster Abstracts, Second International Conference on The Unified Modeling Language (UML'99), Fort Collins, CO, October 28-30, 1999.
- Russo, N. L. "Expanding the Horizons of Information Systems Development," in *Organizational and Social Perspectives on Information Technology*, R. Baskerville, J. Stage, and J. I. DeGross (eds.), Boston: Kluwer Academic Publishers, 2000, pp. 103-112.
- Sowa, J. F., and Zachman, J. A. "Extending and Formalizing the Framework for Information Systems Architecture," *IBM Systems Journal* (31:3), 1992, pp. 590-616.

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