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Business Process-Driven Information Requirements Engineering[1]

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ABSTRACT

Business process models are often used by companies to pursue a business process orientation. Originally, these models were used for organizational design purposes. However, because information systems are used to support business processes, business process models can also be used to specify these systems. Nevertheless, the definition of required information during the development of information systems is a highly complex issue which even may lead to project failure if information requirements have been captured inadequately. Our approach will demonstrate how to use business process models to identify required information from a non-technical perspective and derive information spaces that will help the IT-staff to implement supporting data structures.

INTRODUCTION & RELATED WORK

In order to introduce our approach to a business process-driven Information Requirement engineering, the structure of the paper is as follows: Firstly, we give a brief introduction to the concept of Business Process Management (BPM), currently a key driver of organizational management. Information modeling supports BPM and is widely perceived as a fundamental means of successful information system implementation. Thus, two methods for modeling dynamic and static aspects of organizations are introduced in the following section. The theoretical problem of information requirements engineering is addressed subsequently.

Static and dynamic conceptual modeling techniques for business processes and information requirements have to be identified and integrated, in order to specify information requirements based on business processes. In the second section the integration of both modeling techniques is discussed from a conceptual perspective. The following section demonstrates the approach by means of an example. Additionally, the advantages of the approach are illustrated. Finally, the paper is concluded with a short summary and outlook for the future.

Business Process Management

Beginning in the 90's, business process orientation has become a major topic for most companies (Davenport, Beers, 1995; Davenport, Short, 1990), even though process orientation originated even earlier. One of the early examples of process thinking was provided by Taylor in 1911, when he revolutionized industrial engineering with ideas on work organization, task decomposition, and job measurement (Davenport, Beers, 1995; Davenport, Short, 1990; Taylor, 1911). In 1934 Nordsieck was the first to argue that the structure of a company should be process-oriented (Nordsieck, 1934, p. 77). He compared the structure of a company to a stream, because it is an "uninterrupted value chain" (Nordsieck, 1972, p.9).

Based on these ideas, Business Process Reengineering (BPR) became an independent research area (Davenport, 1993; Gaitanides, 1983; Hammer, 1997; Hammer, Champy, 1993; Porter, 1985). The main objective was organization-wide optimization, even at the cost of local optima caused by functional organizational structures. Thus, BPR focused on enabling improvements in work processes and outputs (Davenport, Beers, 1995). Whereas BPR improves work processes in a bounded timeframe, BPM can be seen as a continuous approach with the same objectives (Davenport, Beers, 1995).

Information Modeling & Information Systems Engineering

Business process models facilitate management by means of reengineering business processes. Additionally, visualized business processes can be used for several different purposes in an organizational context, such as documentation, certification, benchmarking, and knowledge management (Rosemann, 2003). The notion of Business Process Management must be supported by information systems, which, in general, are perceived as the vital backbone of an organization, and not mere simple business support tools (Henderson, Venkatraman, 1999; Li, Chen, 2001; Venkatraman, 1994). Workflow Management (WFM) systems are established tools for enacting automated and semi-automated components of business processes. However, each business process contains manual functions that often require organizational members to make decisions based on information.

Usually, information systems engineering is based on information models (Karimi, 1988; Kottemann, Konsynski, 1984). Business process models are an essential model type for modeling *dynamic* aspects (processes) within organizations or for specifying WFM systems. Examples of business process modeling techniques are: Petri Nets (Petri, 1962), Activity Diagrams (Booch, Rumbaugh, Jacobson, 1999), or Event Driven Process Chains (EPCs) (Scheer, 2000). EPCs model business processes from a conceptual perspective, which can easily be communicated to technicians, management, or business users. Business process models facilitate selecting of-the-shelf software such as Enterprise Resource Planning (ERP) or Workflow Management Systems and its company-specific customization. Furthermore, information models enable the development of individual software or running simulations (Rosemann, 2003).

However, especially the manual activities within business processes and the information requirements that accompany the necessary decisions are addressed insufficiently within process models. Modeling techniques such as UML class diagrams (Booch, Rumbaugh, Jacobson, 1999) or Entitiy-Relationship diagrams (Chen, 1976) focus on modeling *static* aspects (structure) within information systems. Hence, they need to be integrated within process modeling techniques. Whereas ERDs or UML class diagrams are generic approaches to data modeling, specific information-requirement modeling techniques such as the MetaMIS approach (Becker et al., 2003c; Holten, 2003b; Holten, Dreiling, Becker, 2004; Holten, Dreiling, Schmid, 2002) provide relevant and structured information to several user groups to aid decision making. The MetaMIS approach necessarily features more modeling constructs at the cost of generalizability, but the modeled information requirements can easily be communicated to technicians as well as targeted users and management.

Information Subset Model

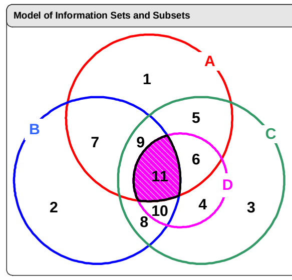
The identification of relevant information is one of the major problems confronting information modeling. In case of BPM, one of the problems is identifying the relevant information needs of business process participants. Complex problems are limited mostly to manual parts of business processes. Accordingly, the information needs of organizational members are also complex. Information systems such as data warehouses or intranets, play an important role in information delivery, because they focus on task and/or role-specific information delivery to certain individuals. Thus, Information Requirements Engineering (IRE) for such information systems becomes increasingly important (Ormerod, Richardson, Shepherd, 1998). From an information systems engineering perspective, a proper identification and definition of information needs is essential for successful implementation. Accordingly, the identification and specification of information needs, has been a major issue in information systems research over the last few decades (Berthel, 1992; Davis, Monroe, 1987; Szyperski, 1980). Several IRE methods and approaches (especially in the MIS domain) have been developed and evaluated (Martin, 1983; Munro, Davis, 1977; Sethi, Teng, 1988). Some widely adopted methods are: the Critical Success Factors method (Rockart, 1979), document analysis, task analysis, and input-output analysis (Holten, 1999). Nevertheless, information requirements engineering is considered to be hampered by theoretical deficiencies (Bea, 1995).

According to Szyperski (Szyperski, 1980), these deficiencies arise from the complex nature of information requirements analysis (see Figure 1). Circle A represents the amount of information available in an organization. Circle B represents the amount of information a person needs "objectively", to make a decision or to perform a specific task. Usually, these two sets of information are partly overlapping, indicating information that is not necessary, but deliverable and information that is necessary, but not yet deliverable. Circle C comprises the amount of information a user considers to be relevant to her task or problem. Since users deploy different strategies to solve problems and have different cognitive styles, this set of information changes constantly (Davis, Monroe, 1987; Grescher, Zahn, 1992; Szyperski, 1980). Circle D contains the information the user actually requests in order to make a decision. This amount of information may be significantly smaller, because of the complex structure of the problem confronting the user and the users' inability to express and identify her information needs (Davis, Monroe, 1987). Moreover, the information requested by the user comprises the objective information need only partially. Thus, the set of information which is relevant, requested and deliverable, contains only a small subset of information (indicated by the shaded area in Figure 1).

With respect to the information set model, two issues arise for information systems engineers. Firstly, the information supply should resemble the objective information need as closely as possible (convergence of circles A and B). Secondly, information that is requested by an organizational member should overlap substantially with the objective

Figure 1: Model of Information Sets and Subsets

Model of Information Sets and Subsets



Main Information Sets
A: Information Supply
B: Objective Information Need
C: Subjective Information Need
D: Information Request

Information Subsets											
Property	1	2	3	4	5	6	7	8	9	10	11
Objectively Relevant		X					X	X	X	X	X
Objectively Irrelevant	X		X	X	X	X					
Subjectively Relevant			X	X	X	X		X	X	X	X
Subjectively Irrelevant	X	X					X				
Deliverable	X				X	X	X		X		X
Not Deliverable		X	X	X				X		X	
Requested				X		X				X	X
Not Requested	X	X	X		X		X	X	X		

Source: compare to (Szyperski, 1980, column 906)

information need (convergence of circles D and B). Because of the central role of BPM, we propose a process-driven approach to IRE to improve the alignment between business and IT (enlarge area 11 by [possibly large parts of] area 9 in Figure 1). Moreover, we propose a conceptual modeling of information requirements to foster communication between information systems engineers and users, thus improving information supply (convergence of circles B and C). The overall objective of organizations must be the convergence of circles A, B, C, and D.

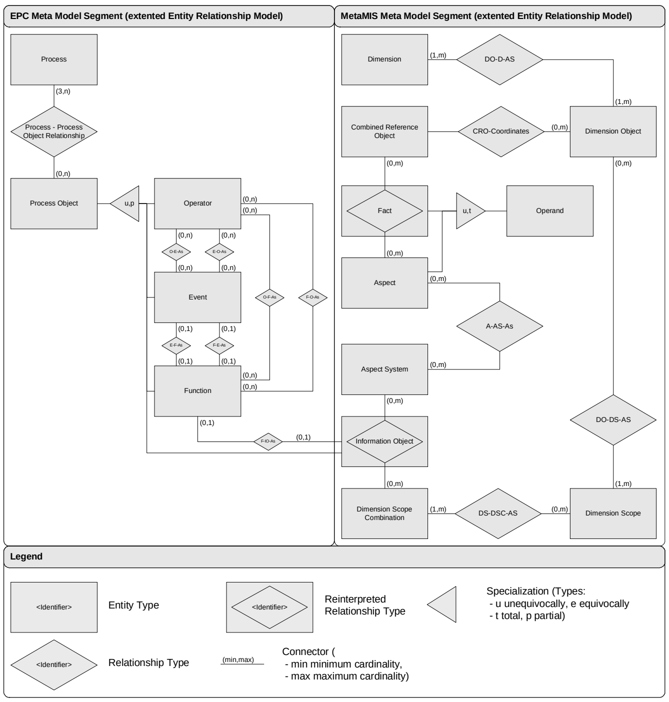
CONCEPTUAL INTEGRATION

Both EPC and MetaMIS feature a language for modeling organizational aspects (EPCs for dynamic and MetaMIS for static aspects). A conceptual integration of these languages can be achieved by integrating the language models (Becker et al., 2003c; Holten, 2003a; Holten, Dreiling, Becker, 2004). In relation to the subject about which the language makes statements, language models are in fact language-based meta models.

The MetaMIS modeling technique has been established by introducing a meta model (Holten, 1999, 2003a), through a detailed ontological foundation of its single language constructs (Holten, 2003b; Holten, Dreiling, Becker, 2004), and by applying it successfully in practice (Becker et al., 2004; Holten, Dreiling, Schmid, 2002). A segment of the meta model underlying MetaMIS is shown in Figure 2. The MetaMIS approach has been developed to specify the information requirements of managers from a business perspective. A successful data warehouse project leads to a management information systems environment, which meets business requirements precisely and works efficiently from a technical perspective. The MetaMIS approach aims at closing the communication gap between business departments and the IT department, by providing an easily communicable, but still formal language and guidelines for modeling information spaces. Its main constructs for structuring the relevant information space are *dimension* (e.g. by weekday, by month), *dimension-grouping* (e.g. time), *dimension-scope* (e.g. Mondays in 2003), *dimension-scope-combination* (e.g. Mondays 2003, region A, product B,). In order to structure ratios that are relevant for certain tasks, the language construct *aspect system* is used (e.g. turnover, costs). The combination of dimension-scope-combination and aspect system is the so-called information object (e.g. turnover of product B in region A on Mondays in 2003). For a comprehensive description of MetaMIS language constructs see (Becker et al., 2003c; Holten, 1999; Holten, Dreiling, Schmid, 2002). The information underlying MetaMIS models can be used to create logical data warehouses or data mart schemas. The problem of objective information requirements (see Figure 1) which we explained earlier and the investigation of which we justified, have been addressed by examining managerial objectives in order to assist the information requirements process (Becker et al., 2003c).

The modeling approach focuses exclusively on static aspects of information systems. Even though it has originally been developed as a conceptual specification approach for management information systems environments, the approach is also applicable to other domains, where information requirements need to be modeled. Adaptations of the approach have been used to specify information requirements for the

Figure 2: Integration of MetaMIS and EPCs by integrating language-based meta models



Source: for the entire meta model of EPCs, see (Rosemann, 1996). For the entire MetaMIS meta model and the MetaMIS approach, refer to (Holten, 2003a, 2003b; Holten, Dreiling, Becker, 2004)

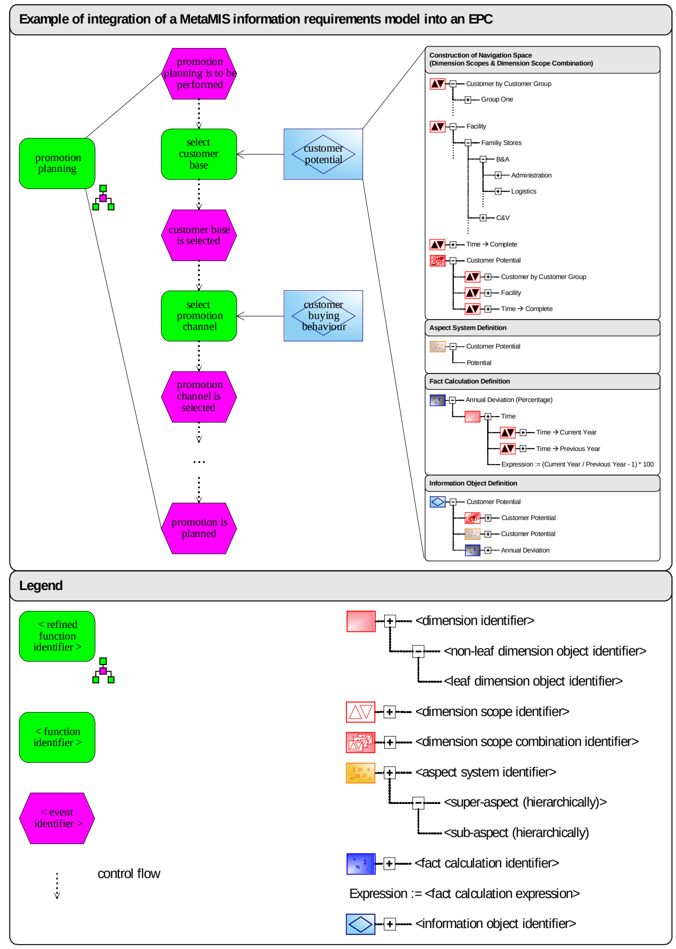
purposes of Customer Relationship Management (Becker, Ribbert, Dreiling, 2002) or Content Management (Becker et al., 2003a; Becker et al., 2003b).

Event Driven Process Chains address dynamic aspects within organizations and information systems (Scheer, 2000). In contrast to Petri Nets and UML activity diagrams, EPCs focus exclusively on conceptual business process modeling. As MetaMIS models for static aspects within organizations and information systems, EPCs can easily be communicated between business and IT personnel. EPCs are bipartite graphs where functions (operation carried out on an object to support one or many goals) and events (occurrence at a specific time) follow each other (Scheer, 2000). Several other object types can be used for modeling EPCs such as organizational units, information systems, or documents. EPCs can split up into several branches and subsequently be rejoined. A segment of the EPC meta model is shown in Figure 2.

The leading modeling environment for business process modeling, IDS Scheer's ARIS collaborative suite (IDS Scheer AG, 2003), is based on EPCs. If one considers IDS Scheer's customer base around the world (IDS Scheer AG, 2003), it is evident that EPCs have been adapted successfully in practice. The modeling technique, as well as its supporting tool, allow explicitly for extensions, out of which our approach is one.

One of the key constructs of EPC is *function*. Functions can be manual, semi-automated, or automated. An organizational member performing a manual or semi-automated function within a business process requires information for making complex decisions. These complex information requirements can be expressed with one of MetaMIS key concepts, an *information object*. In order to integrate the two concepts, a new relationship type needs to be defined between function (as part of EPC's language-based meta model) and information object (as part of MetaMIS' language-based meta model). Furthermore, an information object is seen as an extended process object which is expressed through the specialization of process object into the reinterpreted information object of MetaMIS. The integration of both meta models is shown in Figure 2.

Figure 3: Example of integration of a MetaMIS information requirements model into an EPC



Business Process-driven Information Requirements Engineering

As stated above, an appropriate definition of information requirements is crucial for the successful implementation of information systems. Any improvement in information delivery for manual or semi-automated functions, results in improved business process performance (e.g. reduced error rate, faster processing times, and more accurate decisions).

In order to improve information delivery for efficiently performing business processes, we propose a process-driven approach to IRE. Static (structure) and dynamic (process) facets of an information system are visualized by easy-to-use graphical notations. As mentioned above, these notations improve the communication process and support system engineers in gathering the right information requirements during workshops with prospective users. Thus, a holistic view of the information system and its integration into an organization is provided to users and information systems engineers.

The EPC provides a framework for information systems engineers which can be used to structure information requirements analysis appropriately. Figure 3 demonstrates process-driven IRE. A function ("select customer base") is carried out manually. Obviously, an organizational member confronted with this task, has a specific (objective) information requirement: all relevant pieces of information for specifying an optimal set of customers to be included in the promotion. Thus, an information object containing the necessary information needs to be provided so as to perform that specific function. The information object is described in detail in due course with all information necessary to retrieve the desired information (e.g. which dimensions are affected, which figures are to be calculated).

The data may be provided by an external resource (market research institute), a data warehouse, or directly by an ERP-System. In combination with a workflow management system implementing this process, the documents may be delivered automatically whenever this work-item is processed. In conformity with the process structure, the information requirements of users within this process can be specified step by step.

A process-driven requirements engineering integrates some of the methods for IRE that were mentioned above. Hence, some of the inherent deficiencies (Holten, 1999) of these methods are avoided.

- Since business processes are established to achieve the overall goal of an organization, it is reasonable to argue that process-driven information supply will also support these goals. Moreover, a business process orientation usually entails a customer orientation (Customer Relationship Management). This ensures an alignment with the overall goals of an organization, conforming to the basic idea of the Critical Success Factors method.
- Task analysis aims at identifying the objective information needs by means of a thorough analysis. Tasks resemble functions in EPCs. Thus, business processes provide a sound framework and guideline for the analysis of tasks or functions. Moreover, interdependencies between tasks are recognizable. The visualization of tasks and their integration into a process greatly improves overall comprehension by users and engineers. This comprehension is extremely helpful in the context of IRE, because users or organizational members are generally unable to articulate their (subjective) information needs. Process-driven IRE helps users and engineers to explain *why* and *how* they perform a certain task and *what* exactly they do.
- In order to improve the overall quality of EPCs, very strict naming conventions are usually enforced in order to avoid different naming of the same task (e.g. "select customer base" and "select base of customers"). Moreover, important objects (e.g. invoice, delivery receipt, order) are identified during process modeling. These objects can be used as "candidates" for identifying information modeling dimensions.
- Other methods (document analysis, interview) can easily be integrated into this approach.

SUMMARY AND OUTLOOK

BPM is currently one of the key drivers of organizations. Business process models facilitate an effective handling of the inherent complexity of BPM. However, business process models address only the dynamic aspects of organizations. In order to support business processes efficiently (especially complex manual activities within business processes), complex structured information needs to be provided to organizational members. For this purpose, static and dynamic modeling languages for an organization need to be integrated from a conceptual information systems engineering perspective. Readily usable and understandable models are needed to overcome the communication problems between business and IT.

Based on the modeling techniques of EPCs and MetaMIS, we propose a meta-model-based integration of both languages. Moreover, we have introduced a process-driven approach for analyzing information requirements, in order to overcome a number of theoretical weaknesses in existing methods.

An integration of the modeling tools supporting EPC and MetaMIS models is currently underdeveloped. The availability of a modeling tool that integrates both modeling tools, greatly improves the applicability of our approach to information systems engineering. Our further work will focus on an extension of the approach to include subsequent implementation steps. Furthermore, the semi-automated customization of information delivery tools such as intranets, Content Management Systems, and OLAP-Tools, will be addressed.

REFERENCES

Bea, F.-X. (1995). Führungsinformationssysteme zur Bewältigung des dynamischen Umfeldes. In U. Grimm & P. Sokolowsky (Eds.), *Strategische Führungsinformationssysteme. Theoretische Grundlagen, praktische Erfahrungen.* (pp. 15-24). Wiesbaden.

Becker, J., Brelage, C., Klose, K., & Thygs, M. (2003a). *Modeling Semantic Navigation Structures for the Semantic Web.* Paper presented at the 5th Workshop on Web Information and Data Management, New Orleans, LA, USA.

Becker, J., Brelage, C., Thygs, M., & Ribbert, M. (2003b). *Conceptual Design of WWW-Based Information Systems.* Paper presented at the 11th European Conference on Information Systems (ECIS), Naples, Italy.

Becker, J., Dreiling, A., Holten, R., & Ribbert, M. (2003c). Specifying Information Systems for Business Process Integration - A Management Perspective. *Information Systems and e-Business Management, 1*(3), 231-263.

Becker, J., Dreiling, A., Ribbert, M., & Klug, T. (2004). Optimizing Managerial Analysis - A ContiTech Business Case. *work in progress*.

Becker, J., Ribbert, M., & Dreiling, A. (2002). *Contribution of Meta-models to Systems Engineering: A CRM Example.* Paper presented at the Information Systems Foundation: Building the Theoretical Base, Canberra, ACT, Australia.

Berthel, J. (1992). Informationsbedarf. In E. Frese (Ed.), *Handwörterbuch der Organisation* (Vol. 3., pp. 872-886). Stuttgart: Poeschel Verlag.

Booch, G., Rumbaugh, J., & Jacobson, I. (1999). *Unified Modelling Language User Guide*. Boston, MA, USA et al.: Addison-Wesley Professional.

Chen, P. P. (1976). The Entity-Relationship Model: Towards a Unified View of Data. *ACM Transactions on Database Systems, 1*(1), 1-36.

Davenport, T. H. (1993). *Process Innovation: Reengineering Work Through Information Technology*. Boston, MA, USA: Harvard Business School Press.

Davenport, T. H., & Beers, M. C. (1995). Managing information about processes. *Journal of Management Information Systems, 12*(1), 57-80.

Davenport, T. H., & Short, J. E. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. *Sloan Management Review, 31*(4), 11-27.

Davis, G. B., & Monroe, M. C. (1987). The Problem of Information Requirements For Computer Applications. *Accounting Horizons, 1*(4), 105-109.

Gaitanides, M. (1983). *Prozessorganisation. Entwicklung, Ansätze und Programme prozessorientierter Organisationsgestaltung.* München: Vahlen.

Grescher, J., & Zahn, E. (1992). Strategischer Erfolgsfaktor Information. In H. Krallmann, J. Papke & B. Rieger (Eds.), *Rechnergestützte Werkzeuge für das Management* (pp. 9-28). Berlin: Erich Schmidt.

Hammer, M. (1997). *Beyond Reengineering: How the Processed-Centered Organization is Changing Our Work and Our Lives*. New York, NY, USA: HarperBusiness.

Hammer, M., & Champy, J. (1993). *Reengineering the Corporation. A Manifesto for Business Revolution*. New York, NY, USA: HarperBusiness.

Henderson, J. C., & Venkatraman, N. (1999). Strategic Alignment: Leveraging Information Technology for Transforming Organizations. *IBM Systems Journal, 38*(2/3), 472-484.

Holten, R. (1999). *Entwicklung von Führungsinformationssystemen. Ein methodenorientierter Ansatz*. Wiesbaden, Germany: Gabler.

Holten, R. (2003a). *Integration von Informationssystemen. Theorie und Anwendung im Supply Chain Management.* Unpublished Habilitation, University of Münster, Münster, Germany.

Holten, R. (2003b). Specification of Management Views in Information Warehouse Projects. *Information Systems, 28*(7), 709-751.

Holten, R., Dreiling, A., & Becker, J. (2004). Ontology-Driven Method Engineering for Information Systems Development. In P.

Green & M. Rosemann (Eds.), *Ontological Analysis, Evaluation, and Engineering of Business Systems Analysis Methods*: IDEA Group Publishing.

Holten, R., Dreiling, A., & Schmid, B. (2002). *Management Report Engineering - A Swiss Re Business Case.* Paper presented at the Data Warehousing 2002 Conference, Friedrichshafen, Germany.

IDS Scheer AG. (2003). Retrieved 2003-10-01, from www.ids-scheer.com

Karimi, J. (1988). Strategic Planning for Information Systems: Requirements and Information Engineering Methods. *Journal of Management Information Systems, 4*(4), 5-24.

Kottemann, J. E., & Konsynski, B. R. (1984). Information Systems Planning and Development: Strategic Postures and Methodologies. *Journal of Management Information Systems, 1*(2), 45-63.

Li, E. Y., & Chen, H.-G. (2001). Output-driven information system planning: a case study. *Information & Management, 2001*(38), 185-199.

Martin, E. W. (1983). Information Needs of Top MIS Managers. *MIS Quarterly, 7*(3), 1-11.

Munro, M. C., & Davis, G. B. (1977). Determing Management Information Needs: A Comparision of Methods. *MIS Quarterly, 1*(2), 55-67.

Nordsieck, F. (1934). *Grundlagen der Organisationslehre*. Stuttgart: Poeschel.

Nordsieck, F. (1972). *Betriebsorganisation. Lehre und Technik*. Stuttgart, Germany: Schäffer Verlag.

Ormerod, T. C., Richardson, J., & Shepherd, A. (1998). Enhancing the usability of a task analysis method: A notation and environment for requirements specification. *Ergonomics, 41*(11), 1642-1663.

Petri, C. A. (1962). *Kommunikation mit Automaten.* Unpublished Dissertation, University of Bonn, Bonn.

Porter, M. E. (1985). *Competitive Advantage*. New York, NY, USA: The Free Press.

Rockart, J. F. (1979). Chief Executives define their own Data Needs. *Harvard Business Review, 30*(Mar-Apr), 81-93.

Rosemann, M. (1996). *Komplexitätsmanagement in Prozeßmodellen*. Unpublished Dissertation, University of Münster, Münster, Germany.

Rosemann, M. (2003). Preparation of Process Modeling. In J. Becker, M. Kugeler & M. Rosemann (Eds.), *Process Management. A Guide for the Design of Business Processes* (pp. 41-78). Berlin et al.: Springer.

Scheer, A.-W. (2000). *ARIS - Business Process Modeling* (3 ed.). Berlin: Springer.

Sethi, V., & Teng, J. T. C. (1988). Choice of Information Requirements Analysis Method: An Integrated Approach. *INFOR, 26*(1), 1-16.

Szyperski, N. (1980). Informationsbedarf. In E. Grochla (Ed.), *Handwörterbuch der Organisation* (pp. 904-913). 2. Aufl. Stuttgart.

Taylor, F. W. (1911). *Principles of Scientific Management.* New York, NY, USA: Harper and Row.

Venkatraman, N. (1994). IT-Enabled Business Transformation: From Automation to Business Scope Redefinition. *Sloan Management Review*, 73-87.

FOOTNOTES

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