

The Development of Reference Models for the RENISYS Specification Method¹

Nardo B. J. van der Rijst
Department of Information Systems
Delft University of Technology
P.O. Box 356, NL-2600 AJ Delft
The Netherlands
E-mail: vdrijst@is.twi.tudelft.nl

Aldo de Moor
InfoLab
Tilburg University
P.O. Box 90153, NL-5000 LE Tilburg
The Netherlands
E-mail: ademoor@kub.nl

Abstract

New trends in globalization encourage firms to consider new forms of organizational structures and supporting information system infrastructure. Information systems for these emerging global business networks are hard to specify because of their complexity and changeability. A problem with current specification methods is that they are not sufficiently capable of capturing the context of the information system. To address this problem, we examine the role that reference models can play in increasing the context-sensitivity of such methods. In this paper we present the reference framework from the RENISYS approach to help in the specification of more adequate information system infrastructure for business networks. Within this framework we distinguish between three modeling levels: the problem domain, human network, and information system level. To further refine the problem domain we apply the roles-linkage model from the area of network analysis. This model is used to represent the actors and links between those actors as the basis for the exact definition of the communication patterns between the participants of the network. A small case study shows how such a context-sensitive specification method could be implemented.

1. Introduction

Current interest in business networks follows almost naturally from the developments in the structure and the conditions under which the global market economy functions. More and more companies strive for a restructuring of their core business, while needing to create ever more complex webs of cooperative links with competitors, suppliers, and customers on a worldwide scale [20]. The success of these restructured organizations

will come from the ability to couple to, and decouple from, the networks of knowledge nodes [18]. This shift from traditional, rigid hierarchical organizational structures is often described as moving towards a dynamic network form [10].

Research on business organizations used to be focused on the competition between firms and the relationships between these firms, their suppliers and customers. In the current dynamic situation, however, a significant shift is taking place in the nature of business interactions, with the focus changing to more cooperative, longer term relationships [8]. This change has proven important in the competitive dynamics of many IT applications, such as airline reservations systems [9]. It is also in line with the results reported by Axelrod [3], in which in long term relationships, cooperation instead of pure competition, mostly is the better strategy, resulting in the highest benefits for all parties.

Next to the globalization of the relationships between firms we can also identify changes in the organizational structure (and their supporting IT) of the globally interacting firms themselves. Especially large European and American firms show new types of (IT-supported) coordination between the departments in different countries (see e.g., [17]). The operations of these large webs of organizational units require new kinds of IT support to facilitate group processes, like the Task/Team Support systems proposed by Mannheim [24].

Despite these trends, the new insights in the social nature of cooperation between organizational units have not yet resulted in information system specification methods that are particularly suitable for professional networks. Past interest and research in information technology comes from a tradition of techno-centred thinking, language and methods. This approach often leads to poor mutual understanding between technical specialists, managers and system users. It results in many isolated information tools and data sets rather than

¹ This paper has been published in: Nunamaker, J.F. Jr., and Sprague, R.H. (1996) Proceedings of the Twenty-Ninth Annual Hawaii International Conference on System Sciences, IEEE Computer Society Press, Los Alamitos, CA.

customized, integrated information systems that are tailored to real user information needs. Therefore, to be truly useful, information technology has to support organizations in their core activities (business processes) and different organizational forms in which these activities are carried out (teamwork, organization-wide cooperation, and global business networks). In order to adequately apply information technology, the paradigm of organizational information as a resource to be managed is too restrictive for the new organizational forms, and should be replaced by that of communication and information sharing. This paradigm shift is most clearly expressed in the language/action approach, which interprets organizations as patterns of linguistic action by which people coordinate and structure their work with others [21]. This view reflects the idea that organizations can be viewed as complex, integrated patterns of cooperative work processes ultimately aimed at satisfying the needs of customers. In relation to this, Kambil and Short [19] studied changes in business networks and their electronic integration. They identified important shifts in the functioning of these networks and recognized two problems related to coping with the change in these networks. The first problem deals with the question of how to model these networks, while a consistent language to characterize network phenomena is lacking. The second problem is concerned with the design of the network supporting information systems. Both problems will be addressed in this paper.

A business network can be characterized as a goal-oriented, dynamic, and complex professional human network. To develop more integrated and customized information systems for business networks, a dynamic and context-sensitive network information system specification method is required. Such a method, based on the language/action approach, RENISYS, is already being developed for the closely related research network information systems [12,13]. Our thesis is that this method can also be applied for the specification of business network information systems. Both networks are examples of professional networks, in which some form of cooperation takes place that needs to be supported by the accompanying information system. Of course, there are differences in terminology and approaches used by the participants in these two types of networks. Nevertheless, we assume that the basic types of communication patterns modeled around core cooperation concepts are the same in both domains, and so need to be defined only once. For maximum flexibility, we need a method that allows us both to analyze the domain-specific context, and to translate the discovered entities into various combinations of relatively similar abstract system specification primitives. Our expectation is that this dual approach will considerably increase the effectiveness and efficiency of the system specification process, permitting a wide variety

of domains to be systematically analyzed while resulting in adequate information system specifications.

The usefulness of a context-sensitive method will be further increased if it includes reference models which contain standard translations of domain-specific terms into generic specification method constructs. They can be seen as the missing link between the semantically very rich, yet formally poorly described domain concepts present in users' terminology, and the semantically meager, but formally well-defined concepts from the average generic specification language. The purpose of this paper is to explore the role of such reference models and how they can be integrated with RENISYS. We will do this especially for the problem domain. To build these reference models, we will try to adapt and formalize existing network analysis theory (see e.g., [6]). More precisely, we will concentrate on the roles-linkage theory [19], which is aimed at analyzing business networks.

We will first give a brief overview of RENISYS. Then, we will discuss the role of reference models. After that, we will introduce the theory of network analysis and show how its concepts can be incorporated in a RENISYS reference model. Finally, we will use a real life example to illustrate the potential of this approach.

2. An Overview of RENISYS

RENISYS is a dynamic and context-sensitive research network information system specification method. It is dynamic because it allows for the easy evolution of system specifications. It is context-sensitive because it takes into account the characteristics of the context in which the information system is situated. In this way, the method can help system developers to ask more relevant questions than possible with generic specification methods. RENISYS consists of two parts: a network-specific reference framework, combined with a generic dynamic modeling method. In this section, we will briefly describe the basic concepts of the reference framework, the dynamic modeling method DEMO, and how they are integrated in RENISYS.

2.1 The RENISYS framework

The RENISYS framework consists of three levels: the problem domain, the human network, and the information system. In the problem domain, the network goals are described and the activities that the network participants need to carry out in order to achieve these goals. In the human network the organizational structure is defined in which the activities are performed. The human network consists of four sub-levels: the individual, the group, the network and environment level.

Each activity from the problem domain is represented at the human network level as a combination of human

information and communication processes (I/C processes), such as decision making, negotiation, co-authoring and so on.

Finally, the information system level describes the high level specifications of the actual network information system. Each human information and communication process from the human network level is translated into a number of human-machine and machine-machine information and communication processes, such as retrieving and filtering of information. In our framework, we currently refrain from describing the information technologies implementing the information system level. Figure 1 shows the relationships between the three levels.

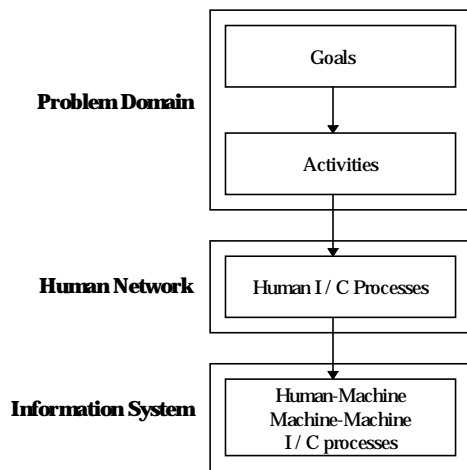


Figure 1: The RENISYS Framework

2.2 Dynamic Essential Modeling of Organizations

DEMO is an acronym for Dynamic Essential Modeling of Organizations. It is the name of a cross-disciplinary theory about the dynamics of organizations, as well as an analysis method. The disciplines on which it draws are the philosophical branches of semantics and scientific ontology [4], and the social theory grounded in language philosophy [16,28]. Related modeling approaches are SAMPO [2] and Action Workflow [25].

In DEMO three levels of abstraction are identified [14,15]. At the lowest level, called the documental level, an organization is viewed as a system of actors that produce, store, transport, and destroy documents. At the informational level, one abstracts from the substance in order to focus on the semantic aspect of information. At the highest level of abstraction, the essential level, the essence of the organization is captured by viewing actors carrying on performative conversations resulting in original new things. These conversations represent the essence of an organization.

The core modeling concept of DEMO is the concept of the (essential) transaction. A transaction is considered

to be the basic pattern of organizational behavior. It evolves in three phases: actagenic, action and factagenic. During the actagenic phase agreement is reached between actor A and actor B about the future execution of an action by actor B. This phase consists of an actagenic conversation, initiated by actor A. The result is an agendum (singular of agenda) for the execution of an essential action by actor B. During the action phase this essential action is executed by actor B. During the last phase actor A and actor B reach agreement about the facts that have been accomplished as a result of the execution by actor B. It consists of a factagenic conversation. Actor A is called the initiator of the transaction and actor B the executor. The behavior of a business (or any organization) thus is conceived as consisting of carrying through transactions. Every (essential) action is embedded in a transaction and every established fact is the result of the successful carrying through of a transaction.

The essential model of an organization is an integrated whole of several partial models. The communication model (CM) of an organization is the specification of the interaction structure and the interstriction structure between actors. By interaction structure is understood the mutual influencing through being initiator or executor of transactions. By interstriction structure is understood the mutual influencing by means of created facts that play a role in the condition part of the behavioral rules that are executed in carrying through transactions. A CM is graphically represented by means of a communication diagram. The object world (or things actors communicate about) is defined in the facts model (FM), while the behavior of the actors is specified in the action model (AM) by means of a procedural language. Furthermore, low level transaction process models describe the specific steps in individual transactions and high level transaction process models describe the relation between the different transactions in time [33].

In this paper, we only focus on defining the essential communication models as they form the core of any DEMO analysis. In future work we will extend our analysis to the other possible models as well. An example of a complete specification can be found in [32].

2.3 Toward an operational specification method

From this short introduction into the basic concepts constituted by RENISYS and DEMO, we can conclude that the following starting points are important for developing a method that models professional networks and their supporting information systems:

1. Participants in the network are viewed as responsible subjects performing tasks in the network. Tasks in the network are called actors. Conducting tasks is performed in the role of either executor or initiator of

the tasks at hand (e.g., a customer is the initiator of the process of the delivery of certain items. The executor is the supplier of the goods. In our example case study we can think of a taxpayer or a banker).

2. Each activity and I/C process can consist of sequences of, sometimes conditional or repeated, subprocesses. Every subprocess is modeled by defining a number of interlinked transactions, each of which is determined by (A) a set of actors responsible for carrying out individual actions and (B) the communicative actions taking place between actors. The aim of the transactions is to coordinate the individual actions carried out by actors in the real world. The sequence of these transactions in time is represented in a high level transaction process model.
3. Every transaction has an equivalent representation of a combination of speech acts in a low level transaction process model.
4. Next to the definition of the interaction structure between actors, constituting the transactions, we also represent the interstriction structure as informative conversations (e.g., obtained by consulting a database).

These concepts incorporated in RENISYS form the basis for the definition of the reference models. Before we show an example application of the RENISYS framework, we more accurately define the notion of a reference model and its role in information system development.

3. The Role of Reference Models

One of the most important theoretical contributions that we hope to make with the development of RENISYS, is to increase the context-sensitivity of present information system development methodologies. Many of the current dynamic methods, such as DEMO or semantic analysis [29], are too generic to be useful for the adequate definition of information systems for complex organizations like business networks. However, their great advantage is that they are formal: the basic concepts and techniques that form the method allow, at least theoretically, for the complete and consistent definition and modification of system concepts and their relations.

The lack of such a formal approach is a serious deficiency in many of the more management- and socially oriented network information system development approaches, such as hinted at in [18] and [1]. Still, their power stems from the many issues unique to business networks that they help to clarify and relate to one another. They help the information system developers to concentrate on potential problems, and provide solutions in terms of reengineering business processes, organizational structures, and information technologies.

Thus, what we need is a way to combine the formal

power of dynamic modeling methods with the context-sensitivity of business network specific theories. This is where we would like to introduce the concept of reference models. Such models in general contain (stereo)typical knowledge about specific aspects of the phenomenon of interest. Reference models, like ISO standards, allow professionals to reduce conceptual confusion and provide them with solid common ground for future work. However, in our view reference models have an extra function, in that they help to translate domain-specific knowledge into information and communication modeling primitives. This reference knowledge can be used by system developers to ask interesting questions, by knowledge base creators to define concept classes, and by network theorists to discuss differences in perspective. Moreover, one of the most interesting applications of reference models is in their ability to help automate the specification process. Reference knowledge can be used to drive the specification process, by giving the method the means to ask the users of the system questions about possible changes in the information system context formulated in the users' own terminology. This is a prerequisite for normal users to be able to specify and maintain their own information systems, as now they can express themselves in their own (semi)natural language, instead of having to descend into abstract and cryptic low-level system modeling concepts. Such a reference model-based specification method can prove to be indispensable, as business environments, like their research counterparts, are prone to change, the users of information systems in such domains are often not well versed in the intricacies of system development, and users often need to be closely involved in the specification of their own, customized information systems. The RENISYS framework forms the backbone that can contain and combine many different types of reference models, at the various problem domain, human network, and information system levels.

Several important questions need to be asked before such models can be developed: How are reference models structured? How are they implemented? How can they be embedded within and used by the specification method? Who has the authority to create and modify the models? What information can be considered uniform reference information and what information is to be considered case-specific? How and by whom are they to be used?

Surprisingly few literature sources and operational methods deal with these important questions. We will try to address most of them in future work. In this paper, we mainly focus on the question of how to obtain high-quality reference information. Some specification tools allow for libraries of concepts to be stored and reused in other applications. However, this more often than not results in a chaotic set of ad hoc defined concepts, of which the importance and relevance is only known to their creators. For more meaningful context-knowledge to be stored in

really useful reference models, it is important to translate insights from existing theoretical work relevant to the various RENISYS levels into formal concepts understandable by methods like DEMO. The translation of theoretical insights into reference communication models of DEMO has already proven to be possible in the domain of production control [31].

In this paper, we intend to show that concepts from the terminology of actual participants in business networks can be translated into formal concepts that can be easily understood and processed by information system developers and the methods that they use. In this way, formal specification methods can be made much more context-specific, while not losing their completeness and consistency properties. We will take one example from the literature of network analysis. Very interesting work has been done on this, which will be briefly described in the next section. One specific example, of particular interest to business networks, is the roles-linkage model developed by Kambil and Short [19], part of which we will translate into RENISYS reference models.

4. Network Analysis

Before we can define the functionality of the supporting tools mediating the communication process between the members, we have to analyze the network activities and organizational structure. A useful approach to perform this task is network analysis [5,6,27]. This is a systematic approach for modeling networks. In the view of network analysis, a network is defined by nodes and connections. Nodes can be individuals, offices, documents, machines or any other entity capable of having a relationship with other (combinations of) entities. Connections can likewise take virtually any form that the analyst can define to be meaningful. In our case connections will be used for describing economic exchange relations.

A distinction is generally made between positional analysis (the assessment of positions which individuals or units hold in a social structure) and relational analysis (the assessment of interactions among those units) [5]. The two models of analysis are complementary, but not overlapping; this means that both are of help in gaining an appreciation of the network structure. The analyst must define the nature of the behavior which is of interest, the level of aggregation of that behavior (across time and units) which is meaningful, the level of interaction necessary to constitute a significant relationship, and the bounds to be placed on the system under investigation. Bounds, nodes, connections and behavior describe a network. These concepts are then used to identify the types of cooperation in the network (coordination, collaboration and co-decision).

The roles-linkage approach [19] has been developed

specifically for the purpose of analyzing and modeling business networks. In terms of general network analysis techniques, the roles-linkage approach is a typical positional analysis instrument. The two terms, roles and linkage are defined as follows. Roles are distinct, technologically separable, value-added activities undertaken by firms or individuals in a given business network (e.g., a customer or a banker). A linkage is defined as the way that firms or individuals manage economic interdependence across value adding roles in the network. On the basis of the work of Williamson [35], six different types of linkages are defined, reflecting the different models of coordinating and economic exchange relationships between firms or individuals in the network (simple market exchange, standard linkage, specialized linkage, alliance, hierarchy and mandate).

Although the roles-linkage approach provides us with a useful classification of cooperation patterns in business networks, it does not indicate what characteristics of these patterns should be incorporated in the supporting information systems. On the other hand, a generic information system specification method does not pay attention to the possible effects that various types of linkages have on the ultimate information and communication process specifications. Therefore, in this paper an attempt is made to create a mutually beneficial integration of a domain modeling theory and a generic specification method.

5. Modeling an Example Network

By means of a case we want to show the ease with which complex domain specifications can be created and modified with the RENISYS approach. To do so, we will show how participants in a business network can model in an evolutionary way a specific network activity, and of course the resulting changes in the information system. The selected case is adapted from Kambil and Short [19], and discusses the developments in the tax return preparation marketplace. The activities in this case show a high degree of dynamism due to the introduction since 1990 of new technologies in the form of electronic tax return filing of the Internal Revenue Service (IRS).

The purpose of this case is not to discuss the general effects of globalization but rather to show a mechanism via which business networks can define and maintain their theoretically enriched information system specifications. As this particular case has already been used by Kambil and Short to explain the roles-linkage model, we are using it for clarifying its integration with the RENISYS approach, thus simplifying comparisons. Business cases more specifically dealing with the issue of globalization are currently being developed.

In the discussion of the case two situations are presented in order to show how the network dynamism is

handled. The first situation describes the tax preparation market prior to the introduction of electronic filing, while the second one describes the situation after its introduction. Here, only the problem domain will be modeled. The roles-linkage analysis results as an initial model of the problem domain. Then, RENISYS translates these domain descriptions into formal information system specifications.

5.1 Tax Return Preparation Prior to Electronic Filing

In the pre electronic filing situation, the basic network consists of linkages among six distinguishable roles: taxpayer, return preparer, mail carrier, banking services, Internal Revenue Service, and retailer. Individuals in the role of taxpayer file returns with the IRS who undertakes the role of processing the return and issuing refunds. Taxpayers may use the tax return preparation service to prepare the return and an organization in the mail carriage service to mail the return to the IRS. Once the tax return has been processed, a refund check is mailed. The individual in the role of customer may deposit the money for later use, by using the services of the banker role, or cash the check and purchase goods from a retailer.

The roles-linkage perspective focuses on the type of relationships between the different roles. For example, between the taxpayer and the return preparer exists a simple market exchange linkage (see table 1 for the different linkages between the roles). However, as a typical positional analysis instrument it does not clearly identify what types of communication processes take place between network participants, and as such the roles-linkage model is not sufficiently powerful for information system specification purposes. Here it is where the application of the RENISYS approach is useful. The domain-specific knowledge described and represented in the roles-linkage model is translated into RENISYS terms in order to develop context-sensitive reference models.

Table 1: Some roles and linkages identified in the tax preparation business (adapted from [19])

Roles	taxpayer	return preparer
taxpayer		
return preparer	M, SC	
mail carrier	M, SC	
banker	M, SC	
IRS	MD	MD
retailer	M	SpC

M=simple market exchange; SC=standard contract; MD=mandate; A=alliance; SpC=specialized contract.

If we extend the model with the RENISYS approach, we are more interested in the kinds of communication

links between the participants in the network. Another important addition is that in RENISYS transactions, representing complex negotiation patterns, are the basic unit of analysis, while in the roles-linkage perspective these patterns are left implicit in the various classification categories. Table 2 represents some of the transactions identified in the case study:

Table 2: Some transactions in the tax preparation business

Transaction	Initiator	Executor
T1 prepare the return	taxpayer	return preparer
T2 mail the return to IRS	taxpayer	mail carrier
T3 deposit money	customer	banking services

The transactions are represented in the communication diagram of figure 2. Each actor is represented with a box, while transactions are depicted as a combination of a disk and a diamond. Now communication and information needs can be represented more precisely. For example, one important addition to the roles-linkage analysis of the case are the two distinct roles for taxpayer and customer. In the DEMO analysis these two actors are distinct because they have different responsibilities (it is the customer asking for services from banking services, not the tax payer). In DEMO these responsibilities and other characteristics are further refined in the facts and action model.

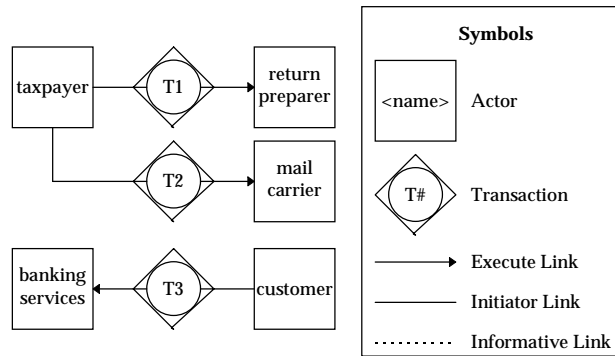


Figure 2: Partial communication diagram of the pre-electronic filing situation

We just showed that the roles-linkage perspective can benefit from a DEMO analysis. However, the real focus of this paper is finding ways to improve the context-sensitivity of this specification method. While in DEMO-based RENISYS only low level analysis instruments represent the procedural and formal representation of the communication patterns (see paragraph 2.2), the roles-linkage perspective on the case provides us with an easy to use informal classification of these linkages. More important, the roles-linkage analysis gives insight in the typical terminology used, simplifying the selection and

combination of basic communication concepts in RENISYS.

5.2 Electronic Filing of Tax Return Preparation

In the second situation the IRS allows electronic filing in the tax preparation business, resulting in two obvious transitions in the network: an expansion of relevant roles as well as linkages. Furthermore, these linkages become more specialized and customized. This results in linkages changing from, for example a specialized contract to an alliance between the roles credit provider and return preparer.

Most new roles are created by the introduction of new information technology in the business network. In practice these different roles (e.g., network provider and software provider) are often performed by a single entity combining the roles (in this case together with the electronic filer role). The next table shows some of the roles in the new situation.

Table 3: The introduction of new roles in the tax preparation business (adapted from [19])

Roles	taxpayer	return preparer
taxpayer		
return preparer	M, SC, SpC	
mail carrier	M	
banker	M, SC	
IRS	MD	MD
electronic filer	M	A, SpC
credit provider	SC, SpC	A, SpC
retailer	M	A

Next to the new roles, some of the linkages that have been defined with the roles-linkage approach have also changed. For example, some return preparers are implementing customer databases to improve service and change the linkage between the firm and its customer. The traditional market exchange is changed to a more specialized linkage. Another example of a new linkage is the credit provider who offers customers credit while the tax form is being processed. As a result of these new links we can identify a number of new actors in the communication diagram performing new jobs in the network. Table 4 shows, among old transactions, the new transaction T4, between a customer and a customer credit provider in the electronic tax preparation business.

Table 4: Some transactions in the electronic tax preparation business

Transaction	Initiator	Executor
T1 prepare return	taxpayer	return preparer
T2 mail return to IRS	taxpayer	mail carrier
T3 deposit money	customer	banking services
T4 provide credit	customer	customer credit provider

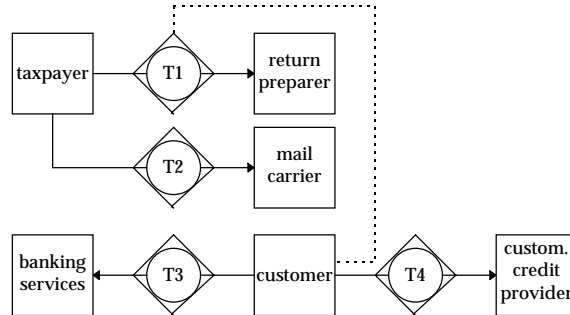


Figure 3: Communication diagram of the electronic tax preparation network

The extended communication diagram (see figure 3) of the new electronic preparation business shows for example the customer credit provider as a new participant in the network. The customer uses information from the transaction T1 to know whether it is possible to apply for credit (represented by the dotted line). While the offer may come from the credit provider, the request still has to come from the customer, in order to set the right commitments between the parties in the transaction.

The communication diagram provides a stable model with a high level transaction-based representation of the ongoing business processes. When new business processes are introduced only parts of the communication model will change. The difference will be reflected in either new transactions or modifications of existing transaction links, however the communication primitives used will remain the same. In this way the communication model can serve as a reliable reference model in the RENISYS framework. In other words, changes in the network that have an equivalent in the roles-linkage analysis will not always result in a change in the communication model. Only if new communication patterns are created in these networks will we identify new types of transactions.

6. Related Research

Professional networks, both business networks and research networks, as a focus of information system support have not received much attention yet. The RENISYS framework presented in this paper is an attempt to provide structured support for obtaining such network information system specifications. In de Moor [11] a case is described of the GRNSD network, which aims to

improve the effectiveness and efficiency of the sustainable development research process. De Moor and van der Rijst [13] describe an application of RENISYS to model the report writing process that takes place in one of the network groups studying the deforestation crisis in British Columbia in Canada.

In other work related to research networks and their information systems, Kraut, Galegher and Egido [22] for example, describe different stages of scientific cooperation and how coordination can be achieved. Rechenman [26] proposes a distributed knowledge base architecture by means of which researchers can share knowledge at different consensus levels. This architecture is a formal equivalent of the reviewing process rather than the business process we described in this paper. In Wan and Johnson [34] a system called CLARE has been developed that aims at collaborative learning through collaborative knowledge construction. So, although the emphasis is on learning, the process is very similar. A major difference is that our goal is the development of a framework by means of which the participants of the network can choose and adapt different ways of working, whereas the above systems typically support one way. For that reason, we have started with a general communication modeling method DEMO.

More related to business networks, the transaction cost economics [35] has focused on the determination of the boundaries of firms, and as such has been a source of inspiration for research of new organizational forms. The traditional dichotomy between markets and hierarchies has been replaced by electronic markets and electronic hierarchies [23]. A major problem with the research in this direction is that the attention is focused on modeling organizations and economic exchange relations rather than the analysis and development of network supporting information systems, and as such has the same drawbacks as identified in the area of research networks.

An interesting example of related research not aimed at professional networks is the negotiation protocol described in Chang and Carson [7]. This protocol is based on speech acts. Negotiation by means of speech acts is also part of the Transaction Process Model in DEMO. However, DEMO highlights the commitments of the participants resulting from successful transactions, making this approach more suitable for business communication modeling.

7. Conclusions

Many professional networks share the characteristic of dynamism, resulting in difficulties when supporting information systems have to be developed. It is often not possible to precisely represent important domain-specific subtleties in the final information system design. One approach to overcome this important problem has been

presented as the extended RENISYS framework. As an example we showed the analysis of a case study applying the RENISYS framework using concepts from network analysis theory, in order to deal with two important issues identified in the introduction.

The first issue concerned the definition of a rich set of modeling concepts, or a consistent language to characterize network-level phenomena. Such a language, capable of capturing not only the general concepts but also the domain-specific elements is the first step in the development of a specification method for network information systems. The RENISYS framework forms the foundation for such a language. To fill in the framework we applied the DEMO approach, which is not only consistent but also formally defined. Above all, it incorporates the speech act theory, which has already proven to be a strong frame of reference for explaining organizational behavior and communication [30,36]. To increase the context-sensitivity of the modeling language the DEMO analysis was preceded by an analysis with the roles-linkage model. We showed that concepts from this network analysis theory could be translated into RENISYS terms, without losing the expressive power of these concepts. The combined use of both approaches results in a better representation of concepts in RENISYS.

The second issue concerned the design of business network information systems, which of course makes use of the constructed modeling language. The design stage of network information systems should be preceded by the analysis of the current situation. Because of the dynamic nature of business networks, most analysis instruments or system analysis techniques are not capable of capturing these features in the analysis. The roles-linkage approach showed the representation of the example study on two moments in time. Both situations have been translated into a core RENISYS representation, in order to define the communication structure between the participants in the network. Information from the roles-linkage analysis was used to identify actors and transactions between those actors. The resulting communication model of the problem domain layer can serve as a reference model for future implementations or modifications of the network information system infrastructure.

The most important contribution made by the integration of network analysis concepts with the RENISYS communication models stems from the stability of these models in time as they are now based in sound domain modeling theories. They can serve as reliable reference models for future users of information systems that are implemented on basis of these communication structures. The resulting information systems can be more easily customized and extended by users to better match their specification needs.

Research in the future will be aimed at a further development of the RENISYS framework. Empirical

testing will result in a robust approach enabling participants in professional networks to define and adapt their own supporting information systems. But even more important, attention will be more directed to studying the cooperative nature of these new network organizations and finding new and creative ways to support these networks in order to realize the greatest benefits for all involved.

References

- [1] Agre, P. (1994) Networking on the Network, *Technical Report*, University of California, San Diego.
- [2] Auramäki, E., Lehtinen E., and Lyytinen K. (1988) A Speech Act Based Office Modeling Approach, *ACM Transactions on Office Information Systems*, Vol. 6, No. 2, pp. 126-152.
- [3] Axelrod, R. (1984) *The evolution of Cooperation*, Basic Books Inc. Publishers, New York.
- [4] Bunge, M.A. (1979) *Treatise on Basic Philosophy*. Vol. 1, Vol. 2, Vol. 3 and Vol. 4, D. Reidel Publishing Company, Dordrecht.
- [5] Burt, R.S. (1982) *Toward a Structural Theory of Action*, Academic Press, New York.
- [6] Burt, R.S., and Minor, M.J. (1983) *Applied Network Analysis*, Sage Publications, Beverly Hills, California.
- [7] Chang, M.K., and Carson, C.W. (1994) A Speech-Act based Negotiation based Protocol: design, implementation and test use, *ACM Transactions on Information Systems*, Vol. 12, No. 4, pp. 360-382.
- [8] Clemons, E.K., and Row, M.C. (1992) Information Technology and Industrial Cooperation, *Proceedings of the 25th Hawaii International Conference on System Sciences*, IEEE Computer Society Press, Los Alamitos, CA, pp. 644-653.
- [9] Copeland, D.C., and McKenney, J.L. (1988) Airline Reservations Systems: Lessons From History, *MIS Quarterly*, September, pp. 353-370.
- [10] Davidow, W.H., and Malone, M.S. (1992) *The Virtual Corporation*, Harper Collins, New York.
- [11] de Moor, A. (1994) The Global Research Network on Sustainable Development: Working Together on Our Common Future, *Research Report Tilburg University*.
- [12] de Moor, A. (1995) Toward a More Structured Use of Information Technology in the Research Community, Submitted for publication.
- [13] de Moor, A., and van der Rijst N.B.J. (1995) Toward a Dynamic, Context-sensitive Research Network Information System Specification Method, *Proceedings of the 13th International Association of Management Conference*, Vancouver, pp. 108-117.
- [14] Dietz, J.L.G. (1994a) Business Modelling for Business Redesign. *Proceedings of the 27th Hawaii International Conference on System Sciences*, IEEE Computer Society Press, Los Alamitos, CA, pp. 723-732.
- [15] Dietz, J.L.G. (1994b) Modelling Business Processes for the Purpose of Redesign. *Proceedings IFIP TC8 Open Conference on Business Process Redesign*, Australia, North-Holland, pp. 249-258.
- [16] Habermas, J. (1981) *Theorie des kommunikativen Handelns*. Erster Band, Suhrkamp Verlag, Frankfurt am Main.
- [17] Holland, C.P., Lockett, G., Richard, J., and Blackman, I. (1994) The Evolution of a Global Cash Management System, *Sloan Management Review*, Fall, pp. 37-47.
- [18] Jarvenpaa, S.L., and Ives B. (1994) The Global Network Organization of the Future: Information Management Opportunities and Challenges, *Journal of Management Information Systems*, Spring, Vol. 10, No. 4, pp. 25-57.
- [19] Kambil, A., and Short, J.E. (1994) Electronic Integration and Business Network Redesign: A Roles-Linkage Perspective, *Journal of Management Information Systems*, Spring, Vol. 10, No. 4, pp. 59-83.
- [20] Karimi, J., and Konsynski, B.R. (1991) Globalization and Information Management Strategies, *Journal of Management Information Systems*, Vol. 7, No. 4, Spring, pp. 7-26.
- [21] Kensing, F., and Winograd, T. (1991) The Language/Action Approach to Design of Computer-Support for Cooperative Work: A Preliminary Study in Work Mapping, in: Stamper, R.K. et al, (eds.), *Collaborative Work, Social Communications, and Information Systems*. Elsevier Science Publishers B.V., IFIP.
- [22] Kraut, R., Galegher, J., and Egidio, C. (1987) Relationships and tasks in scientific research collaboration, *Human-Computer Interaction*, 3 (1), pp. 31-58.
- [23] Malone, T.W., Yates, J., and Benjamin, R.I. (1987) Electronic Markets and Electronic Hierarchies, *Communications of the ACM*, June, Vol. 30, No. 6, pp. 484-497.
- [24] Mannheim, M. (1993) Integrating Global Organizations through Task/Team Support Systems, in: Harasim, L.M., *Global Networks: Computers and International Communication*, MIT Press.
- [25] Medina-Mora, R., Winograd, T., Flores, R., and Flores, F. (1992) The Action Workflow Approach to Workflow Management Technology. *Proceedings of the Conference on Computer Supported Cooperative Work*, ACM, pp. 281-288.
- [26] Rechenmann, F. (1993) Building and sharing large knowledge bases in molecular genetics, *Proceedings*

- KB&KS workshop*, Tokyo, pp. 291-301.
- [27] Rice, R., and Richards, W. (1985) Network Analysis Methods, In: Dervin, B., and Voigt, M.J. (eds). *Progress in Communication Sciences*, Ablex, Norwood, New Jersey.
- [28] Searle, J.R. (1969) *Speech Acts: An Essay in the Philosophy of Language*. Cambridge University Press, Cambridge.
- [29] Stamper, R.K. (1993) Social Norms in Requirements Analysis: an outline of MEASUR, in: Jirotko, M., Goguen, J., and Bickerton, M. (eds.), *Requirements Engineering: technical and social aspects*, Academic Press.
- [30] Taylor, T.J. (1993) *Rethinking the Theory of Organizational Communication*, Ablex, Norwood, New Jersey.
- [31] van der Rijst, N.B.J., and Dietz, J.L.G. (1994). Expressing Production Control Principles in the DEMO Communication Model. In: Verbraeck, A., Sol, H.G., and Bots, P.W.G. (eds.), *Proceedings of the Fourth International Working Conference on Dynamic Modelling and Information Systems*, Delft University Press, pp. 171-186.
- [32] van der Rijst, N.B.J., and van Reijswoud V.E. (1995) Comparing speech act based modeling approaches for the purpose of IS development, *Proceedings of the 3rd European Conference on Information Systems*, Athens, pp. 353-365.
- [33] van Reijswoud, V.E., and van der Rijst, N.B.J. (1995) Modelling Business Communication as a Foundation for Business Process Redesign: A case of production logistics. In: *Proceedings of the 28th Hawaii International Conference on Systems Sciences*. IEEE Computer Society Press, Los Alamitos CA, pp. 841-850.
- [34] Wan, D., and Johnson, P. (1994) Computer Supported Collaborative Learning Using CLARE: the approach and experimental findings, *Proceedings of the Conference on Computer Supported Cooperative Work*, ACM, pp. 187-198.
- [35] Williamson, O.E. (1979) Transaction-cost economics: the governance of contractual relations, *Journal of Law and Economics*, 22, pp. 233-261.
- [36] Winograd, T. Flores F.M.(1986) *Understanding Computers and Cognition*, Ablex, Norwood, New Jersey.