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UNDERSTANDING ORGANIZATIONAL COORDINATION AND INFORMATION SYSTEMS – MINTZBERG'S COORDINATION MECHANISMS REVISITED AND EVALUATED

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Abstract

This paper investigates organizational coordination and its relationship to computer-based information systems. As a basis for understanding organizational coordination and information system use, Mintzberg's well-known set of coordination mechanisms is used as a point of departure in this paper. The set of coordination mechanisms is evaluated by applying it in an interpretive case study of a house building firm and confronting the set of mechanisms with other theories of coordination. The result of the evaluation shows that the applied set of coordination mechanisms does not sufficiently cover important aspects of organizational coordination and information system use, such as more dynamic issues (e.g. coordination history, external influence, emergent processes, concurrency and variation, and communication). The set of coordination mechanisms is, however, more sufficient when it comes to understanding formal division of labour, stable organizational structures and roles, and planned coordination.

Keywords: Information systems, coordination, coordination mechanisms.

1 INTRODUCTION

This paper investigates organizational coordination and its relationship to computer-based information systems. Coordination is a fundamental activity in organizing work and a classical term in the organizational vocabulary (Groth, 1999; Kärreman, 1996). Coordination can be seen as action performed in order to: "Bring different elements of a complex activity or organization into a harmonious or efficient relationship" (Oxford Concise Dictionary, 1999). Coordination can also be described in terms of mechanisms. Well-known sets of mechanisms are for example proposed by March and Simon (1958) and Mintzberg (1983, 1998). The latter set of mechanisms from Mintzberg which put forward mutual adjustment, direct supervision, and standardization of skills, work processes, results, and norms, have a large impact on organizational theory literature. These are considered to be the most well-known sets of coordination mechanisms and have therefore been chosen in this paper.

Coordination can be studied jointly with communication (e.g. March and Simon, 1958), and more recently jointly with the organizational use of information systems as an example of information technology (e.g. Groth, 1999; Malone and Crowston, 1994; Winograd and Flores, 1986). Information systems are also closely associated with the coordination of work. Information systems are implicated in work routines through information storage, retrieval, and transmission capabilities, through

providing a tool to accomplish tasks, and by imposing a rhythm and schedule on work processes. (Orlikowski, 1991).

Based on the argument that information systems are implicated in the accomplishment of tasks, and imposing a rhythm and schedule on work processes (*ibid.*) and Malone and Crowston's work (1994), one argument in this paper is that a thorough understanding of organizational coordination can provide a fruitful perspective when focusing on information systems and their potential benefits for organizations. However, in order to do this we need a suitable framework to understand coordination. Organization theory provides us with a number of conceptualizations of coordination, but can we rely on organizational theory, and the wide spread set of coordination mechanisms by Mintzberg (1998), when we try to understand information systems used for coordination activities in organizations?

The purpose of this paper is to evaluate, by revisiting, the coordination mechanisms from Mintzberg as a basis for an understanding of information systems use and organizational coordination. This examination is performed using the coordination mechanisms in a case study and then evaluating the mechanisms. The evaluation of the coordination mechanisms will answer the question: is Mintzberg's set of coordination mechanisms a sufficient base for understanding information systems and coordination in an organizational setting? And if not: is it possible to present additional aspects and issues?

The paper is arranged in the following sections; in section 2 we will present the research approach, and discuss theoretical work on coordination and information systems (sections 3 and 4). In the following section we will present the case study where we evaluate the set of coordination mechanisms studying coordination and information systems use (section 5). Finally, a concluding discussion of the evaluation follows together with an exploratory set of aspects and issues to focus when understanding information systems and coordination, and finally a discussion of limitations and further research (section 6).

2 RESEARCH APPROACH

The work performed, especially in the case study (serving as an empirical illustration), corresponds to central concepts and ideals in interpretive and qualitative research, such as interpretation, pre-understanding and the use of multiple methods and perspectives (Denzin and Lincoln, 1994; Stake, 1994; Walsham, 1995). The case is based on a longitudinal study (from 1998 until 2001) of a "house building firm", their organizational coordination and information systems strategies and use. One type of information system that is highlighted in this empirical illustration is an application for product design (AUTOCAD ADT[®]). The case study is based on more than fifteen interviews (with employees in different positions in the company), working seminars, and studies of documents (business- and IT-strategies, and internal documents, order handling, etc.). The case company is a part of an organizational network also studied; this setting is not focused on in this paper. The network is mainly used as a context when analyzing information systems use and coordination.

An important point of departure in the interpretation of coordination and information systems is that reality is a social construction by a human actor, and that there is no objective reality to observe (Berger and Luckmann, 1967; Walsham, 1993). Interpretivism can be seen as an epistemological position concerned with understanding reality and a position that all knowledge is a construction and therefore subjective.

The analysis of coordination that is performed in this paper is grounded both in theory and empirical work (case). One important methodological issue to highlight is that the empirical data is gathered in an open-minded, inductive way, avoiding Mintzberg's (1983, 1998) coordination mechanisms as a perspective in the phase of an analysis. This was done in order to be able to test and evaluate the mechanisms and encounter these with empirical data, not gathered using the same framework.

3 ORGANIZATIONAL COORDINATION

3.1 Coordination as a Vital Part in Organizing

The concept of *organizing* is an important verb in describing major actions taken by humans in firms in order to generate appropriate outcomes: “To organize is to assemble ongoing interdependent actions into sensible sequences that generate sensible outcomes.” (Weick, 1979, p. 3)

When people act in organizations, they also create and recreate fundamental elements of social interaction: meaning, power, and norms (Giddens, 1979). These concepts make an important contribution to the understanding of organizing, an organization and its information systems. An organizing act can also be viewed as coordination. One important purpose of coordination is to formalize actions thereby reducing undesired variation, and to control and to anticipate actions (March and Simon, 1958; Mintzberg, 1983; Thompson, 1967).

However, to reduce variation in organizations by formalizing action, can be in conflict with the demands for flexibility that are highly ranked in the organizational agenda. It is probably a question of reducing undesired flexibility and allowing and encouraging desired variation. Time and actor play a pivotal role in desired and undesired variation which poses another challenge. Organizing is also a question of accessing one’s own or other organization’s resources. Stability is consequently an important aspect of organizing and organizations. (Melin, 2003)

Actions are mutually dependent, and one important part of coordination is to handle these dependencies (Malone and Crowston, 1994; Thompson, 1967). Several definitions of coordination (e.g. according to Schiefloe and Syvertsen, 1993; Weiseth, 1993) also contain key words and phrases such as; the acts of dividing goals into tasks, the allocation of resources to completion of actions, (and) the migration of different actions into a whole, and evaluation of actions compared to goals.

As stated in the introduction of this paper, mechanisms for coordination are discussed by March and Simon (1958) and Mintzberg (1983, 1998). The first two researchers identify three activities that are necessary in order to perform coordination: coordination through standardisation, coordination through planning, and coordination through feedback. The latter researcher also identifies a set of coordination mechanisms, partly based on March and Simon’s (1958) work, mutual adjustment (1), direct supervision (2), standardisation of skills and norms (3), work processes (4), and results (5) (Mintzberg, 1983, 1998). See Figure 1.

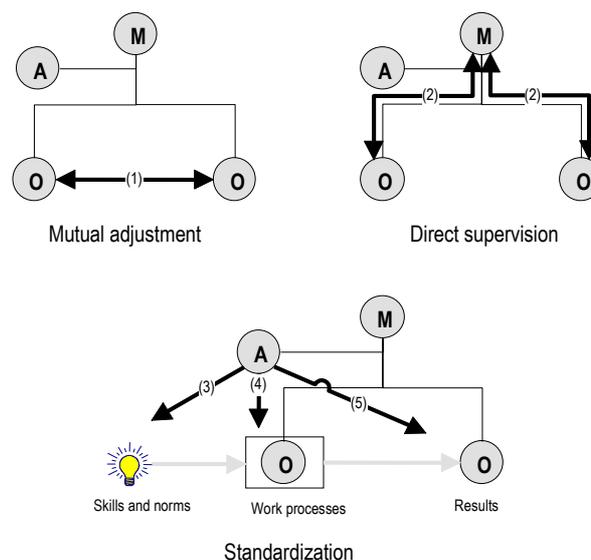


Figure 1. *Coordination mechanisms (Mintzberg, 1983, p. 6; revised)*

Mutual adjustment (1) achieves coordination of work by the process of informal coordination. The control of the work rests in “the hands of the doers” on an operative organizational level (“O” in Figure 1). Direct supervision (2) achieves coordination by having one person responsible for the work of others (“M”, manager, in Figure 1), issuing instructions to them and monitoring their actions. Work can also be coordinated (often by an analyst, “A” in Figure 1) with standardization (3, 4, and 5). Work processes (4) are standardized when the contents of the work are specified, or programmed. Outputs are standardized when the results of the work (5), for example the dimensions of a product, are specified. Skills (3) are standardized when the kind of training required to perform the work is specified (commonly the worker is trained before joining the organization) (Mintzberg, 1983). Norms (3) are standardized in order to have an influence on human action – and is a form of indirect coordination (Mintzberg, 1998) (cf. organizational culture).

Some critique concerning the dominant view of coordination as a formal phenomenon is found, for example, in Larsson (1990). The critique in short is the dominant notion that coordination is performed before work is undertaken (on the drawing board), through planning, oriented towards design issues and that division of labour is related to material flows and dependencies. The critique concerning coordination will be further developed in the last section.

4 INFORMATION SYSTEMS AND COORDINATION

As indicated in the introduction of this paper, information systems are closely associated with the coordination of work. Information systems are implicated in work through information storage, retrieval, and transmission capabilities, through providing a tool to accomplish tasks, and imposing a rhythm and schedule on the work processes. Information systems accomplish this by providing technical vocabularies to mediate meanings ascribed to events, objects, and relationships, and through coordinating activities over time and space (Orlikowski, 1991). Information systems present an array of social structures for possible usage in interpersonal interaction, communication and coordination.

Certain research schools in the information systems area have especially highlighted coordination issues. Computer-Supported Co-operative Work (CSCW) is an example (Keen and Knapp, 1996; Tapscott and Caston, 1993). THE COORDINATOR[®] is an application based on Winograd and Flores’ (1986) basic ideas, which definitely takes the issues of commitment and coordination in work situations seriously, and operationalizes these in an IT system. The development of information systems for group work (e.g. LOTUS NOTES[®]) is a way to keep abreast with the demands that distributed cooperation in time and space result in, together with an increasing number of more or less independent actors, activities and resources (Carstensen, 1996).

There is, however, a tendency to view information systems only as containers or tools purely for the transformation of information. In contrast to this, it is stated that what can be done based on the information (action through information systems) is the most central aspect (e.g. Denning and Winograd, 1996; Ljungberg, 1997) in an organizational context, and from a coordination perspective. Information systems can be viewed as having an ability to perform and memorize actions, and to permit, promote and facilitate the performance of actions by users, both through the information system and based on information from a system (Goldkuhl and Ågerfalk, 2002). Goldkuhl and Ågerfalk (ibid.) also argue that information system actions need to be well integrated into activity games in organizations; information systems, as artefacts need to be congruent to the actions of humans and to the overall objectives of an organization. From a coordination perspective of information systems, action is central. To coordinate is to act and to communicate, and acts are performed by and through information systems. The need for information systems to be congruent to coordinated actions is also present.

5 THE HOUSE BUILDING FIRM – AN EMPIRICAL ILLUSTRATION

This section presents the case called “The House Building Firm”, aspects of its organizational coordination (analyzed with Mintzberg’s coordination mechanisms as a perspective) and use of an information system.

5.1 The House Building Firm

The firm studied is a part of an industrial network with 12 firms and three house customers. The most significant unit of analysis presented in this paper is the House Building Firm. The other core firms in the network are a sawmill and a carpentry firm. All the firms are small and medium sized companies (SMEs) located in the southern part of Sweden.

Results from the overall empirical analysis of all the firms in the network show that a high level of flexibility, customer orientation, emergent work processes, active owners in operative work, and dynamic work roles are present. This is not unusual for SMEs in general. The firms’ use of information systems is centred on a self-contained (disparate) application for order handling, construction and manufacturing. Standard applications are predominant in all system categories. The use of information systems in planning and follow-up activities is limited, as well as in an inter-organizational context. The firm illustrated in this paper is a clear example of the organization and information system characteristics just mentioned. They make it clear that they cannot afford large, integrated information systems (cf. ERP systems). This kind of system can also have a counter-productive effect on their strategy of being a highly flexible and customer oriented company, according to their CIO.

5.2 The Case - Coordination and Information Systems

When using Mintzberg’s (1983, 1998) coordination mechanisms (mutual adjustment, direct supervision and standardization) to understand the coordination and information systems use that takes place in the firm, a number of important activities and situations were chosen representing core processes. The result of the analysis is summarized in Table 1.

Table 1. Coordination mechanisms – analyzing the case company

Mechanism / activity	Mutual adjustment	Direct supervision	Standardization
Purchasing	One person responsible for contract negotiations. The purchaser and the constructors/designers have an informal communication, sometimes based on POST-IT NOTES®, concerning product suborders.	Not identified.	Norms: Product specialization based on customer needs. Process: not identified. Results: not identified.
Design and Construction	Between constructors/designers and the architect, and between the constructors/designers and production personnel (informal communication concerning production, continuous improvement, control on an operative level), and between constructors/designers and customers.	Exercised by a predominant construction manager (CM), allocates assignments, has an overall responsibility, and makes several approvals.	Norms and skills: training constructors/designers using the CAD system. Process: most constructors/designers use pre-defined routines for documentation. Results: an increased use of standard components in design and construction. The use of a CAD system supports standardization.
Production	Between production personnel in daily work.	Production planning performed by the construction manager. The management (also acting as salesmen) sometimes ignore this planning document and give priority	Norms: Product specialization is an important part of the business strategy. A permanent overbooking of objects in production. Process: a new production line with

		to "their" houses in production in order to satisfy particular customers.	pre-defined stations used. Results: quality- and product dimensions pre-defined rules.
Administration and Finance	Between administrators (sales assistants etc.) within emergent processes (based on informal communication). An arena for mutual adjustment in financial issues is missing. This results in several misunderstandings.	Sometimes exercised by the top management concerning administrators work with customer inquires (prioritizing). This coordination logic (use of parallel mechanisms, or an unexpected change) clashes with the mutual adjustment between administrators and results in states of uncertainty.	Norms: mostly set by administrators. Weak for finance. Process: not identified. Results: not identified.
Sales	Between salesmen within emergent processes (based on informal communication). Everybody is familiar with who knows and does what.	The CEO manages the overall sales activities and the establishment of new sales offices and markets.	Norms: an outstanding quality, customer oriented product. Process and results: common forms used when offering products to customers.
Information Systems Strategy	Not identified.	Not identified.	Norms: not identified. Process: not identified. Results: avoid information systems that standardize processes and restrain desired flexibility.
Overall Business Management	A high degree of informal cooperation and communication in production, administration and sales activities.	The CEO and the managing group sometimes directly supervise administration. The CM directly supervises design and construction and "global" production planning.	Norms: a strong business concept (market orientation, the use of high quality and eco friendly materials) and brand (Swedish wooden houses). Process: not identified. Results: not identified.

The house building firm uses an application for product design (AUTOCAD ADT[®]). From a coordination perspective this system use implies that rules are manifested when designing houses (Figure 2). The system use is also combined with training to standardize designers' (users') skills. This means of coordination (used by the firm's CEO) has an influence on the use of the CAD system when designing houses. The information systems carry both possibilities and obstacles (support and restraining actions) when performing design/construction activities.

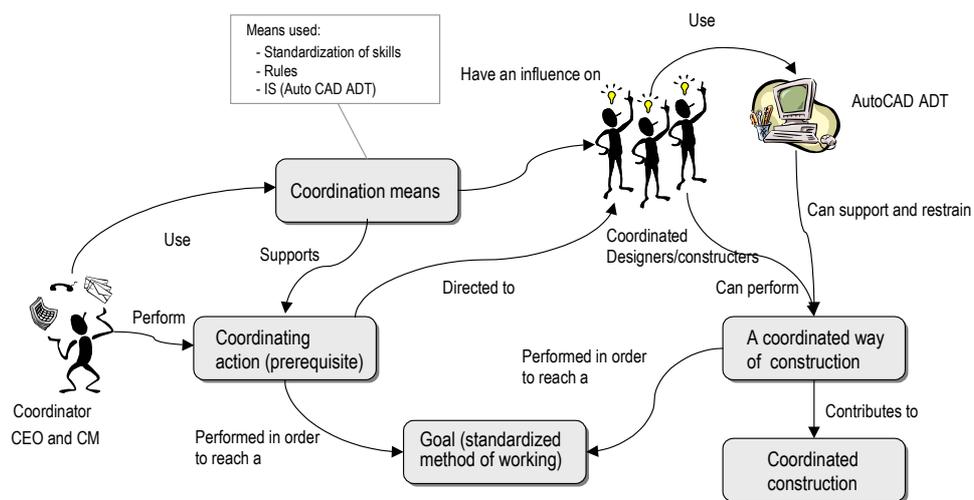


Figure 2. A coordination perspective on product design (the use of AUTOCAD ADT[®])

An interesting observation is that the CAD system gives a wide range of possibilities when designing houses – and at the same time standardization is required (a kind of competing coordination force). One of the goals the CEO wishes to achieve when designing houses is a uniformed and integrated way of working (oriented towards the work process and information system use). This coordinated (and standardized) way of working should also result in a higher level of standardization in manufactured houses (e.g. by using standardized wall elements in order to lower production costs and undesired variation). The uniformed way of working is also motivated by the CEO as a way to increase the possibility to exchange one designer/constructor for another. However, this set of goals does not have to be realized as intended by the CEO – as observed, a gap between his intention and the designers/constructors goals can be the case.

5.3 Coordination Mechanisms – Evaluation and Identified Limitations

Based on the case study presented above, and Table 1, a set of limitations is discussed in this section.

1. *Actors and their actions; past and present* – Mintzberg’s coordination mechanisms gives a stereotyped apprehension of who (actors in roles) is coordinating and being coordinated in organizations (note for example “Administration and Finance” [direct supervision] or “Overall Business Management” [mutual adjustment and direct supervision] in Table 1, several actors in different roles are involved in coordination). There is a need to be more specific as to who is coordinating, being coordinated, and what actions are performed when taking part in coordination situations. The actions of immediate interest also need to be related to previous actions (coordination history).
2. *External influence* – actors in the firm studied are often referring to external phenomena (from an organizational point of view, see e.g. “Production” [direct supervision] and “Administration and Finance” [direct supervision] in Table 1) that restricts their freedom of action. Mintzberg’s coordination mechanisms do not seem to take other organizations’ actions (of coordinating and coordinated character) into account.
3. *Emergent processes* – many processes and routines in the company studied have developed over time as a result of daily practise that has been institutionalized (see e.g. “Administration and Finance” [mutual adjustment] and “Sales” [mutual adjustment] in Table 1). Mintzberg’s coordination mechanisms do not take this emergence into account concerning e.g. standardization (see e.g. “Construction” in Table 1). This is more referred to as a kind of mutual adjustment.
4. *Concurrency and variation* – this limitation can, as the first one above, be related to dynamics in an organization (e.g. “Administration and Finance” [direct supervision] in Table 1) and its relationship to the context (actors and companies etc. outside a firm). Even if Mintzberg discusses changes in mechanisms in relation to changes in the context, the issue of concurrency and sometimes competing forces in coordination (directed towards an actor, from e.g. an information system, a manager, and a customer, cf. “Design and Construction” and the use of AUTOCAD ADT[®] in Table 1) is not highlighted.
5. *Communication, information systems, and information* – communication and information of an informal type is only included in the mechanism called “mutual adjustment”. Informal communication is not discussed together with the other mechanisms (for example standardization of norms in “Production”, and “Sales”, in Table 1 that are institutionalized by informal communication). The informal communication is also considered a simple process by Mintzberg (1983, 1998). “Simple” is however not defined and can be questioned. A communication process can be subtle, be based on trust, and history and is consequently complex to study. Communication related to actions that should be coordinating or coordinated is not dealt with in Mintzberg’s mechanisms. For example information before action (e.g. announcements) or after action (e.g. feedback) is not present either. Explicit

reasoning concerning information system roles and functions in coordination situations is not present.

6 CONCLUDING DISCUSSION AND FURTHER RESEARCH

In this section we turn back to the initial research question: Is the set of coordination mechanisms from Mintzberg a suitable basis for an understanding of information systems use and organizational coordination?

6.1 Coordination Mechanisms – Summary of the Evaluation

Even if Mintzberg's set of coordination mechanisms is criticized in this paper, several of the mechanisms can be included when understanding information systems and coordination. Mutual adjustment can occur, as well as direct supervision, and different kinds of standardization (the design process, designer's skills, norms, and the result). The main point in this paper is that these mechanisms are not sufficient on their own to help us to understand coordination in dynamic, and interactive, organizations with emergent processes, and access to information systems. We need to expand our view of coordination.

Mintzberg's coordination mechanisms, revisited and evaluated when analyzing the firm above, tend to focus on a formal division of labour, stable organizational structures and roles, and planned coordination. This is also identified by Larsson (1990) in a study not focusing on information systems. There is also a need to include more *dynamic issues and perspectives*, as well as the issue of *concurrency and competing forces* in coordination, when understanding this complicated phenomenon. Such issues are identified in the case study presented above. We also need to take e.g. actors' past and present coordination actions, external influence (from outside the firm), emergent work processes, variation, and communication into account when looking at coordination and information systems (further elaborated below).

6.2 Coordinating with Information Systems – from a Particular to a Systemic Situation

When discussing coordination and the use of information systems in organizations, it is important to consider that information systems possess the potential to perform coordination of actions that are important when organizing firms (assemble interdependent actions into sensible patterns that generate sensible outcomes, cf. Weick, 1979). The use of information systems in coordination can imply that certain coordination is allocated from a particular coordination situation to a systemic situation. This allocation can result in a higher share of pre-defined, stable and formal coordination thereby forfeiting an inter-personal, and sometimes more flexible, coordination.

The movement from a particular situation to a systemic one can be viewed both as positive and negative. If coordination on a systemic level is increasing, the need for inter-personal communication and coordination can be reduced, and be a complement to the systemic one (e.g. when different breakdowns occur). Coordination therefore changes from a direct mode to an indirect (separate actors in time and space possible) one (Melin, 2003). A high share of standardisation (pre-defined, stable and formal), as a result of coordination on a systemic level, however, does not need to be negative for users of an information system in the sense that the system restricts possible actions. It can guide and support organizational action.

6.3 An Expanded View of Coordination Needed – Exploratory Aspects and Issues

In order to include more dynamic issues than Mintzberg's coordination mechanisms can offer and reduce the limitations numbered 1 to 5 above (section 5.3), an expanded view of coordination needs to be elaborated. Some exploratory aspects and issues are suggested below.

There is a need to focus on the *process of coordination*. In doing that, one needs to focus on: prerequisites of coordination, human action and results (cf. limitation 1 and 3 above).

Structures are also present, including information systems, other actors (inside or outside a firm; (cf. limitation 2 and 4 above)), *action memories* (Goldkuhl and Ågerfalk, 2002) (cf. limitation 5 above) etc. Human actors are also subjects to *concurrent and competing forces in coordination* (e.g. from other coordinating actors and structures; cf. limitation 4 above). It is also identified that the *roles, sometimes shifting* (cf. limitation 3 above), of the coordinated and coordinating human actor and/or artefact, as well as adjusted coordinated actions/activities that can end in a coordinated result.

Communication, information and information systems are certainly related to coordination. To *coordinate is to act and to communicate*, and acts are performed by and through information systems. The need for information systems to be congruent to coordinated actions is also present as stated before. Information systems (and their ability to perform and memorize actions, and to permit, promote and facilitate the performance of actions by users, both through the information system and based on information from a system) need to be coordinated with actions, and actions need to be coordinated with other actions.

This study shows that it is important to understand the logic, principles and patterns of coordination in firms and their relationship to external actors in order to understand information systems and to identify information system functionality and use that are harmonious with the desired coordination from an organizational point of view. It is important to understand the principles of coordination already built in, in existing information systems (e.g. in CAD systems or ERP systems) or in future information systems to reach this state of harmony. If an information system or an organization contains a coordination logic, principle or pattern not harmonious with each other, competing forces, for example, can be a part of human actors' use of information systems. When looking at information systems as systems for coordination, an action oriented view of information systems (Denning and Winograd, 1996; Goldkuhl and Ågerfalk, 2002; Ljungberg, 1997) is obvious. From a coordination perspective, information systems cannot be containers purely for the transformation of information.

6.4 Limitations and Further Research

The exploratory suggestions made above in order to expand the view of coordination to understand information systems has not yet been tested (e.g. in a system development project), and that of course can be criticized. Another important question left unanswered in this paper is how significant the company size is when studying information systems and coordination. The set of coordination mechanisms from Mintzberg that has been evaluated seems to have a large company as a blueprint, but the empirical illustration in this paper is an SME.

The discussion concerning the relationship between different kinds of information systems and coordination can of course be made more thoroughly than in this paper. One taxonomy to use as a point of departure in doing this is presented by Groth (1999, p. 165 ff.) This is a question for further research. The CSCW area (e.g. Bannon, 1993; Malone and Crowston, 1990; Taylor et al., 2001) has for example dealt with information systems for coordinating group work, that can be further studied in order to elaborate on the presented view of coordination and information systems. THE COORDINATOR[®], briefly mentioned in the introduction can also be an object for further studies.

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