# Structural effects on inter-unit knowledge sharing:

# The role of coordination under different knowledge sharing needs.

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**Abstract.**

This paper aims to develop an analytical model of the effects of organisation structure on the sharing of knowledge within organisations. The importance of such effects has been identified in a number of different studies which have stressed the difficulty of sharing knowledge across internal organisational boundaries (Szulanski, 1996; Teece, 1998). We draw on a review of the existing literature to analyse the interplay between structure and knowledge sharing. Three major perspectives are identified which reflect different epistemological assumptions and disciplinary perspectives; business strategy (Cohen & Levinthal, 1990; Grant, 1996b; Van den Bosch, Volberda, & de Boer, 1999), organisational network (Hansen, 1999; Nohria & Eccles, 1992) and community of practice (Brown & Duguid, 1991; Lave & Wenger, 1991) perspectives. These identify several structural effects on knowledge sharing, including; the impact of knowledge specialisation and absorptive capacity; the distribution of inter-personal networks; the distributed nature of participation in the work process.

We draw on these existing perspectives to develop a synthetic model of the interplay between knowledge sharing and structure. Knowledge sharing is defined as a reciprocal process of understanding, influence and exchange which is embedded in the activities of the organisation. The interplay between structure and knowledge sharing is thus defined in terms of the relative interdependencies between people resulting from the differentiation and coordination of organizational activities (Mintzberg, 1979; Simon, 1997). The dispersion of knowledge (Grant, 1996b; Tsoukas, 1996) and the requisite integration of activities (Duncan, 1972; Galbraith, 1973; Van De Ven, Delbecq, & Koenig, 1976) produce important effects (opportunities and constraints) on knowledge sharing. These effects are analysed using a classification of integration mechanisms between units based on the two dimensions of formal-informal coordination and personal-impersonal coordination. This analysis produces a typology of integration based on four modal forms; norms, systems, informal networks and formal networks. Norms refer to the existence of common knowledge, mental models and shared identity. The systems mode is formed by procedures and processes. The third modal form relies on personal networking, while formal networks, e.g. teams and liaisons, are enabling the formal (official) relationships between units. Our analysis highlights the characteristics of each of these modal forms in terms of the amount of knowledge, complexity of knowledge and flexibility in the knowledge that can be shared. We observe that each modal form is associated with distinctive constraints for particular kinds of knowledge needs (Hansen, 1999). Some modes, such as informal networks and norms are able to deal with the need for sharing complex knowledge but do not allow enough flexibility in the knowledge sharing possibilities.

*1. Introduction.*

While knowledge is commonly seen as an important, unique and difficult to trade asset that can be the source of a competitive advantage (Conner & Prahalad, 1996; Spender, 1996; Teece, Pisano, & Shuen, 1997), increasing attention is being paid to the role of organization structure in valorising knowledge. As some writers note, it is not knowledge itself that generate a competitive advantage but the application of that resource in combination with other resources (Spender, 1994). Thus, the mediating role of structure in the exploitation of the firm's knowledge-base is increasingly recognised. Teece, for example, notes that: "*A proper structure, incentives and management can help firms to generate innovation and build knowledge assets. ...firms provide physical, social and resource allocation structures so that knowledge can be shaped into competencies*" (Teece, 1998). More specifically, we can say that knowledge exploitation requires knowledge sharing, including the integration of knowledge held by one or more individuals (Grant, 1996b; Van den Bosch et al., 1999), the transfer of knowledge between different parties and the development of organisational knowledge (Argyris & Schon, 1996; Kim, 1993; Nelson & Winter, 1982). Moreover, barriers to exploiting and sharing knowledge are not only caused by the nature of knowledge – as highlighted by debates on tacit knowledge - but also by the misunderstanding of that nature and the lack of adaptiveness of management and organisational forms to this intangible asset (Teece, 1998). It is our objective in this paper to investigate in-depth the latter aspect, namely the structural barriers caused by non-adapted organisational design. As will become clear, the existing organisation design literature provides only limited insights into the relationship between structure and knowledge in organisations.

In an attempt to fill this gap, an analytical model of the effects of organisation structure on sharing knowledge between units in organisations will be developed. The importance of such effects has been identified in a number of different studies, which have stressed the difficulty of sharing knowledge across internal organisational boundaries (Szulanski, 1996; Teece, 1998). We build on the existing literature to analyse the interplay between structure and knowledge sharing. In particular, we highlight the perspectives from business strategy (Cohen & Levinthal, 1990; Grant, 1996b; Van den Bosch et al., 1999) and organisational network (Hansen, 1999; Nohria & Eccles, 1992) as especially relevant. These different perspectives identify a range of potential effects on knowledge sharing, such as the impact of knowledge specialisation and absorptive capacity and the distribution of inter-personal networks. In particular, we focus on the following research questions: "How does coordination between subunits affect knowledge sharing?" and "Which kind of linkages between subunits are best suited to the knowledge sharing needs of these units?"

To begin with a brief definition of our terms (and acknowledging the limited space available to reflect extensive literatures on these issues), we will seek to provide summary definitions of both knowledge

and knowledge sharing. Thus, we begin from the premise that knowledge in organizations is multi-faceted and may take a number of different, but inter-related forms (Blackler, 1995). In this paper, therefore, we adopt a broad and inclusive definition of knowledge; that is, we will follow the definition of Nonaka and Takeuchi (1995) that is generally accepted: *"Knowledge is a dynamic human process of justifying personal belief toward the truth (Nonaka & Takeuchi, 1995:85)"*. Other authors follow this cognitive approach (e.g. Cabrera & Allen, 1999; Davenport & Prusak, 1989; Grant, 1996a; Sanchez, Heene, & Thomas, 1996; Szulanski, 1998; von Krogh, Roos, & Slocum, 1994). In relation to knowledge sharing, our concern here is with knowledge sharing at the inter-unit rather than interpersonal level. Such sharing will be defined here in processual terms following Argote and Ingram's (2000)definition as *"the process through which one unit is affected by the experience of another"*. Importantly, our processual view defines knowledge sharing not in terms of a source-receiver model but as a recursive and interactive phenomenon; a reciprocal process of understanding, integrating, reconfiguring and sense-making, which is embedded in the activities of the organisation (de Boer, Van Den Bosch, & Volberda, 1999; Grant, 1996b; Hislop, Newell, Scarbrough, & Swan, 1997).

In the next section, we undertake a discussion on the fundamental organisation design paradigm and on the differences between market and firms. This reveals the importance of organisational structure to optimising knowledge exploitation. The following section discusses the knowledge integration needs in organisations. The third section then presents a framework for analysing coordination as a knowledge integrator. Next, old and new organisation theory literature and perspectives are reviewed; allowing the development of hypotheses concerning the relationships between structure and knowledge sharing. Finally, the model and further research are discussed.

## *2. The fundamental organisation design principle.*

The classic authors in organisation theory recognise differentiation and integration as the two main principles in organising (Lawrence & Lorsch, 1967; March & Simon, 1958; Mintzberg, 1979; Simon, 1997). According to the contingency theory, this fundamental choice is determined by the level of stability, variety and complexity in the environment (Burns & Stalker, 1961; Mintzberg, 1979). Dawson (1992) argues that also the activities of the company are determining this choice. In addition, several other influencing factors, from the population theory, resource-based theory and institutional theory perspectives, are mentioned in relation to the fundamental organisational choice. In every approach a balance between differentiation and integration in the organisation structure is aimed.

It is the firm's task to create benefits by job specialisation and combine groups of people with similar tasks to obtain optimal local learning within the group (Levinthal & March, 1981). To obtain learning and economies of scale effects between specialists in similar fields, differences within units are minimised and differences between units maximised. Moreover, specialisation and differentiation cause also the development of specific knowledge uniquely held by an individual or group, the development of different languages and different views between the units. Those differences among the units create boundaries around these units. Sharing knowledge requires crossing the boundaries, which are developed to optimise specialisation (Grant, 1996b). These boundaries are physical and structural due to geographical dispersion and departmentalisation, as well as mental due to unique jargon and dispersed views on the environment developed by the specialists. The firm is in a paradoxical situation with a need for specialisation and differentiation on the one hand and a need for integration on the other hand. This dilemma requires a trade-off based on the organisational needs and strategic choices. There is no optimum, the more specialisation the harder to integrate and the more difficult to share knowledge but too much integration is costly and low specialisation reduces the benefits for firms.

The fundamental organisational choice between differentiation and integration is a classic firm problem. Specialisation, causing differentiation but allowing organisations to economise on knowledge, is a major rationale for the existence of the firm (Grant, 1996b). Moreover, organisations also have advantages over the market in the integration dimension because of the possibilities of developing alternative integration mechanisms, such as hierarchy and social identity (Grant, 1996b). Social identification with the organisation helps to overcome self-interested behaviour, such as in agency relations or when goal discrepancy exists (Ashforth & Mael, 1989). Identity determines rules of procedural and distributive justice (Kogut & Zander, 1996). Those rules deviate from pure rational behaviour where individual objectives are maximised whatever the consequences for others in the group.

Differentiation between units has become larger by the development of multinational companies which consider their units as independent businesses trading with each other at arms-length. Determining the boundaries of the firm becomes difficult, especially in large divisionalised companies, situations with close long-term relationships with suppliers or when aspects of the business are outsourced. Scarbrough (1995) motivates that there is a continuum of transactional relationships (from markets to hierarchy) with different levels of economic control mechanisms and social control mechanisms. Adler (2001) recognises comparable organisational modes, in particular, market, hierarchy and communities. The latter combines hierarchy and market relations but relies also heavily on trust and is therefore superior in knowledge exploitation and sharing. Organisations are better viewed as combinations of transactions with different levels of socialisation. Therefore, studying

organisations from a knowledge point of view requires redefining the boundaries of organisations. Knowledge only fits within a specific context own to a certain company or network (Argote & Ingram, 2000). This specific knowledge can not pass the borders of the organisation. Knowledge in organisations is firm specific and can therefore hardly be copied by other firms outside the network of transactional relations. Therefore we can define the boundaries of the organisation as the area where sharing firm specific knowledge is possible. Consequently, the network of transactional relations is from a knowledge point of view more relevant to determining organisational boundaries. The social dimension of all transactions helps to share knowledge within those transactions (Scarbrough, 1995). Socialisation is a major integration mechanism that can overcome the natural barriers to knowledge sharing in organisations and transactional relationships. Despite the social dimension with the development of trust and social control, inter-unit knowledge sharing remains difficult due to the fact that units have different contexts and unit specific knowledge that can hardly be articulated and transferred (Lam, 1997). Therefore, we should emphasise that even within the newly defined boundaries of the organisations, inter-unit knowledge sharing faces substantial barriers (Szulanski, 2000; Von Hippel, 1994).

Overall, these arguments suggest that a knowledge-based view of organisations demands a review of the fundamental choice between differentiation and integration. Differentiation between units should be considered in terms of differences in knowledge, knowledge contexts and the need to combine knowledge stocks of specialists and units. Integration choices must take into account the possibilities to integrate the different types of knowledge and to build a common ground for knowledge sharing. The basic organisation design dilemma needs to be revised in order to develop new design principles to optimise knowledge exploitation. In this paper, we will focus mainly on the integration side of the differentiation-integration dilemma. In particular, we search for adequate integration given the level of differentiation in the organisation.

### 3. Knowledge integration needs.

In the 1970's, organisation theories paid increasing attention to organisation design in function of an optimal processing of information in the organisation (Galbraith, 1973; Khandwalla, 1977; Lawrence & Lorsch, 1967; Pugh & Hinings, 1976). They took a systems view on organisations emphasising contingency and environmental fit (Barley & Kunda, 2001). According to this contingency theory, the limitations to knowledge and information sharing are the result of misfits between strategy, technology, environment and organisational design. Especially the work of Galbraith explains the importance of information sharing and the required design and coordination. The central idea is that information can reduce uncertainty; *"the greater the task uncertainty, the greater the amount of*

*information that must be processed among decision makers during task execution in order to achieve a given level of performance* (Galbraith, 1973)". He did not distinguish between information and knowledge but from his analysis it is clear that only information and explicit knowledge is considered. Thompson (1967) explains that the need for sharing knowledge and information between units is a function of the interdependency between the units. Interdependency can be reciprocal, sequential or pooled. Consequently, certain interdependency requires a particular need for knowledge sharing that can be achieved with specific types of coordination. In addition, Lawrence and Lorsch (1967) emphasize that the coordination needs are depending on the differences between the units, which are based on differences in the environment. The differences in the relationship to the environment and in the sub-environments are resulting in differences between units in level of formalisation, personal relationships, time-horizon and goals. The more differentiation the harder integration and coordination of activities between units and the more complex integration mechanisms are required (Lawrence & Lorsch, 1967).

However, most of the studies discuss information sharing instead of (tacit) knowledge sharing. Knowledge differs from information and is much harder to integrate and to manage. Difficulties in managing knowledge are generally held to be related to the nature of knowledge, such as tacitness, non-observability, embeddedness in systems and fragmentation (Teece, 1998; Tsoukas, 1994). Knowledge in organisations is a very broad mix of experiences, values and insights that people have and that can be embedded in practices, actions, routines and any kind of product, service or asset available in the organisation (Davenport & Prusak, 1989). Szulanski (1996) explains that knowledge is sticky and therefore hard to share and transfer. However, there are some common classifications of knowledge types unpacking the concept knowledge. These classifications give insight into the complexity of knowledge and the differences with information.

A first common distinction is between explicit and tacit knowledge (Nelson & Winter, 1982; Polanyi, 1962). Tacit knowledge - knowledge that has not been expressed or codified in any way- is difficult to share or to replicate. Polanyi (1962) who was among the first to describe this distinction, considers tacit knowledge as knowledge that cannot be expressed or shared. The concept of tacit knowledge is mostly used in a broader context with tacit knowledge as all knowledge that is not made explicit (Nonaka & Takeuchi, 1995). The tacit versus explicit dimension has been profoundly discussed in the literature and often used as the basis to explain knowledge processes in organisations (Nelson & Winter, 1982; Nonaka, Byosiere, & Toyama, 1999). It is also important to explain the difficulties in inter-unit knowledge sharing (Argote & Ingram, 2000; Lenox, 1998; Rueylin, 1999; Szulanski, 1996). However, the distinction is hard to make because there is a continuous interchanging between the two knowledge forms. Weiss (1999) makes a more practical distinction between rationalised and

embedded knowledge, with rationalised knowledge as general, widely accepted depersonalised knowledge and embedded knowledge as context-specific and personalised.

A further distinction can be made between codified knowledge and non-codified knowledge (Zander & Kogut, 1995). Codified knowledge is knowledge restructured into codes and signs according to specific rules and is especially used to store knowledge in databases and other IT applications. However, the question of whether codified knowledge is still knowledge or rather information or data is still subject to discussion. Nonetheless, the level of codification of knowledge is important in the discussion on how to facilitate knowledge sharing between units. Another classification, based on knowledge location or possession, is the distinction between individual and organisational (or collective) knowledge (Spender, 1996). Hansen (1999) combined the level of codification with the embeddednes of knowledge to determine the level of complexity of knowledge. He uses this more overall concept in his study on the role of networks in knowledge sharing. Complex knowledge is non-codified knowledge, highly embedded in other components and mostly tacit. The more complex knowledge is, the harder to share (Zander & Kogut, 1995).

Attention in the organisation theory literature shifted from the processing of information in order to reduce uncertainty towards a concern with learning processes. The latter is concerned with embedding individual learning, based on environmental responses, into organisational memory and structures (Kim, 1993). In contrast to the information processing view, the 'learning' literature paid attention to implicit and impersonal knowledge. Individual learning received attention from, among others, Senge (1994) and Argyris (1996). They recognise two types of learning; single loop learning versus double loop learning (Argyris & Schon, 1996) or adaptive versus generative learning (Senge, 1994). Ordinary learning or single loop learning, which is the most frequently applied form of learning, is about reacting to responses, negative or positive feedback, from the environment. Double loop learning goes much further by questioning the underlying models, norms, objectives and habits of actions or decisions. By questioning these underlying models real innovation and creative behaviour can occur. The first type of learning can be negative when it reinforce existing behaviour and leads the company to status quo (Argyris & Schon, 1996). An important contribution of theories on learning is the emphasises on problems with unlearning and change. Knowledge sharing will urge people to use new knowledge and to unlearn old knowledge and routines. This causes uncertainty and a natural barrier to change and unlearning (Hislop, Newell, Scarbrough, & Swan, 1997). Hence, unlearning resistance limits sharing new knowledge (Levitt & March, 1988). Flexibility in knowledge sharing is required when the task environment is frequently changing- and so new knowledge or knowledge from different parts in the organisation is required (Gargiulo & Benassi, 2000)- or when existing knowledge needs to be reconfigured (Grant, 1996b). Hence, changing task environments require knowledge sharing flexibility which is accompanied with change and unlearning problems.

## 4. Integration mechanisms.

Before further discussing the relationship between structure and knowledge sharing, we will outline the main integration mechanisms existing in organisations. An organisation structure, adapted to the knowledge needs, is necessary to guide the sharing, use and creation of knowledge (Asakawa & Noda, 1998; Lam, 1997; Marengo, 1993; Szulanski, 2000; Van den Bosch et al., 1999). As mentioned, such structure fitted for knowledge sharing requires choices concerning work deviation and integration, or choosing the right coordination mechanism (Grant, 1996b; Lam, 1997). Several authors have highlighted the importance of coordination to provide communication and integration channels between units of large organisations (Burckley & Carter, 1999; Egelhoff, 1990; Ghoshal, Korine, & Szulanski, 1994; Gupta & Govindarajan, 2000; Martinez & Jarillo, 1989). Coordination can be described as tuning the activities to reach a common goal (Alexander, 1998; Daft, 1995; Duncan & Weiss, 1979; Jones, 1998; Keuning, 1996; Thompson, 1967; Van De Ven et al., 1976). Coordination is achieved with specific mechanisms, among others described by Mintzberg (1989), Galbraith (1995) and Grandori (1997b). Coordination mechanisms are mainly considered as information processors to allow people perform tasks in accordance with the organisations' objectives. March and Simon (1958) were one of the first to describe this. They state that part of the behaviour in organisations is routine or subject to performance programs while other activities can be coordinated by plans and feedback providing extra information during the performance of uncertain tasks. Thompson adds the coordination mechanism standardisation of rules and procedures, which is different from routine behaviour and performance programs as defined by March (Thompson, 1967:56). The latter has more similarity with the concepts individual and organisational routines or organisational memory as described by Nelson and Winter (1982). Culture is also part of the organisational memory (Walsh & Ungson, 1991) and a mechanism to coordinate action at a distance by several symbolic means (Weick, 1994). Galbraith (1973) considers goal setting combined with delegation of decision-making to the place were the information is gathered and the actions occur as an alternative mechanism when planning and authority are insufficient. Integrating devices, such as individual coordinators, teams and integration roles are extra coordination mechanisms to achieve a high level of integration among people and departments (Lawrence & Lorsch, 1967). The coordination mechanisms of March and Simon (1958), Thompson (1967), Lawrence and Lorsh (1967) and Galbraith (1973), summarised by Mintzberg (1989), result in the following basic mechanisms; mutual adjustment (or feedback), direct supervision (or authority), standardisation of work processes (or procedures and plans), skills and output, standardisation of norms (or culture).

Most authors writing on coordination made attempts to categorise these using several dimensions. The task-interdependency described by Thompson (1967) is often used as basis for classifying coordination. Further classifications are based on the function of coordination, namely the amount and

complexity of information that can be processed (Galbraith, 1973; Sobrero & Schrader, 1998) and the overall richness of the mechanisms (Daft & Lengel, 1986; Martinez & Jarillo, 1989). Egelhoff (1982; 1990) elaborates on this to build the categories routine versus non-routine and sequential versus reciprocal information processing capabilities.

Other dimensions emphasise more the characteristics instead of the function of coordination. March and Simon (1958) used the dimensions programmed versus feedback, referring to the moment of coordination in relation to the moment of task performance (Argote, 1982; Van De Ven et al., 1976). Namely, are the tasks specified before these are performed or is there tuning of the tasks during the performance. Van de Ven (1976) further uses the distinction personal versus impersonal and horizontal versus vertical. These are also used by Adler (1995) and Nidumolu (1996). The dimension personal-impersonal results in the same classification as programmed versus feedback with programmed as impersonal and feedback as personal coordination (Van De Ven et al., 1976). Barnard (1948) mentions formal and informal mechanisms, which were further applied in research by Ghoshal (1994) and in the review article of Martinez and Jarillo (1989). Ghoshal (1994) combined coordination types with communication among subsidiaries and headquarters. The dimensions based on type of interdependencies and amount and complexity of information exchange are taking an information processing perspective. However, the nature of the relationship between people and units determined by coordination are more important when studying implicit knowledge and knowledge sharing processes. Hence, we choose to classify the coordination mechanisms for the purpose of this study according to the dimensions personal-impersonal and formal-informal; resulting in the following matrix (see table 1). We hereby follow the classifications based on the characteristics that are most widely accepted in the literature. The basic coordination mechanisms can be classified under each of the two dimensions. Informal personal coordination has rarely been mentioned in the classic organisation theory literature, but the network literature proves the relevance of this coordination type as an integration mechanism.

Table 1: The coordination mechanisms.

| coordination mechanisms | Formal | Informal |
|---|---|---|
| Impersonal (programmed) | Systems: Planning, procedures, manuals, standards, rules, goals, policies, schedules, hierarchical decision-making | Norms: Cultural values, implicit norms, routines, mental models, social identity |
| Personal (feedback) | Formal Networks: Teams (incl. Projects), mutual adjustment, integration roles, liaisons, direct supervision | Informal Networks: Personal networking |

It can safely be assumed that the great majority of formal organisations use more than one mechanism and that most imply all four types . Moreover, it is important to recognise that while specific tasks and inter-unit cooperation might be based primarily on one mechanism, these mechanisms do not operate in a discrete fashion, but are interdependent and intertwined. Thus, we consider these different mechanisms rather as characteristics of linkages between units. To simplify we labelled these types as systems, norms, formal networks and informal networks. These are the possible ties between units in organisations. Barley and Kunda (2001) explain that 'configurations of interactions' are appropriate to explain relationships between organisation structure and work practices. Consequently, the four types of cooperation and ties are a useful proxy for studying the effects of structure on work practices and here in particular on knowledge sharing during those work practices.

Traditionally, the selection of coordination mechanisms is based on the level of task uncertainty and task interdependency (Galbraith, 1973; Thompson, 1967; Van De Ven et al., 1976). Coordination mechanisms coordinate but also control, communicate, divide power and integrate knowledge in organisations. Therefore the relationship between coordination and knowledge also demands a selection based on knowledge sharing needs (Turner & Makhija, 1999). *"…the primary role of the firm is integrating the specialist knowledge resident in individuals…; the primary task of management is establishing the coordination necessary for this knowledge integration"* (Grant, 1996b). Coordination serves as a 'transmission channel' for knowledge transferring and sharing. The type of coordination mechanism determines what and how much information and knowledge will be exchanged (Egelhoff, 1990; Galbraith, 1973; Makhija & Ganesh, 1997; Turner & Makhija, 1999). A second influence on knowledge sharing is the fact that coordination determines who should cooperate and interact with whom. The personal coordination mechanisms, such as teams, mutual adjustment and integrating roles, also bring people with different knowledge stocks together (Grant, 1996b; Nonaka & Takeuchi, 1995; Wathne, Roos, & von Krogh, 1996). Nonetheless, questions remain on sharing tacit knowledge and the knowledge integration possibilities of the different kinds of coordination. Moreover, the classic organisation theory literature did not come to more comprehensive and integrated theories on the relationship between structure and knowledge sharing.

## 5. Coordination to integrate knowledge.

The classic organisation theory literature explains the importance to use adequate structures and integration mechanisms in function of the difference (Cohen & Levinthal, 1990; Lawrence & Lorsch, 1967) and interdependency between departments (Thompson, 1967), the complexity and amount of information to be shared (Galbraith, 1973; Van den Bosch et al., 1999) and the need for flexibility and change (unlearning) (Levitt & March, 1988; Senge, 1994). Galbraith (1973) mentions several

coordination mechanisms, which can help to share information and knowledge. The higher the need for information, the more different coordination mechanisms are required. Each coordination mechanism differs in its possibilities to share information and explicit knowledge. When information needs remain after all basic coordination mechanisms are applied, information needs should be reduced or information processing capacity should be extended through other more complex mechanisms, such as vertical information systems and lateral relations (Galbraith, 1973). According to Thompson (1967) information needs depend on the interdependency between units. Pooled interdependency requires rules, procedures and supervisory hierarchy; sequential interdependency requires programming and hierarchical decision making; reciprocal interdependency requires integration roles, liaisons and arbitration; and more intensive interdependency requires group decision making and mutual monitoring (Grandori, 1997b). Hence, the formal networks are better suitable for more intense sharing and sharing complex knowledge (Galbraith, 1995; Grant, 1996b; Van den Bosch et al., 1999).

**Hypothesis 1: Formal networks are suitable when the sharing of large amounts of complex knowledge is required.**

Grant (1996b) builds on the classic organisation theory literature to explain that formal and impersonal coordination is not fit for sharing tacit or complex knowledge. The systems mode of integration, with planning, standards etc as coordination mechanisms, allows sharing small amount of simple knowledge (Galbraith, 1973). This mode allows only more codified forms of knowledge. We can make the assumptions from the mentioned literature that higher complexity in the task and the knowledge, higher differences between units and higher needs to share knowledge require more complex and flexible ways of coordination, such as lateral relations and teams.

**Hypothesis 2: The use of systems mode of integration is suitable to share knowledge between units when knowledge sharing need is low and knowledge is simple.**

Some authors also discussed the problem of knowledge sharing between hierarchical levels, concluding that knowledge sharing is difficult and sometimes impossible in such situation (Jensen & Meckling, 1992; Mintzberg, 1989; Senge, 1994). Therefore, the use of hierarchy and direct supervision are less fit to share tacit knowledge in general (Grant, 1996b; Spender, 1996). These mechanisms can be defined as decisions taken by a superior concerning actions to be executed by a subordinate who does not autonomously evaluate the decisions (Barnard, 1948; Simon, 1997). This definition refers to the fact that the superior is best fit to take the decisions. However, both parties possess tacit knowledge that can not be shared completely (Conner & Prahalad, 1996). When

individual tacit knowledge is required in decision making, decentralisation of decision rights -avoiding the need for knowledge sharing- is more appropriate (Jensen & Meckling, 1992).

In further developing the learning organisation literature, Cohen and Levinthal (1990) introduced the concept 'absorptive capacity'. They define the concept as*: "the ability of a firm to recognise the value of new, external information, assimilate it and apply it" (Cohen & Levinthal, 1990)*. Van den Bosch et al. (1999) elaborated on this concept to evaluate the extent to which a company is able to absorb new knowledge in order to adapt to its evolving environment. They include organisational forms and combinative capabilities in the concept absorptive capacity. Organisational forms are described by their method of grouping, hierarchy, organisational chart and functional dividing of management. The combinative capabilities include systems capabilities (such as direction, policies, procedures and manuals), coordination capabilities (especially lateral coordination) and socialisation capabilities (culture, identity). Van den Bosch et al. (1999) explain that certain structures and forms are better fit to allow for broader scope or more flexibility in knowledge absorption. The more flexibility is required in the tasks and in the knowledge, less systems or systematic coordination should be used. However, Van den Bosch et al. (1999) did not find evidence in their empirical research for a relationship between system coordination and absorbing new knowledge on the organisational level. Nonetheless, there might be inflexibility in knowledge sharing between units, when the relation is based on programmed systems, due to unlearning (Levitt & March, 1988; Senge, 1994). This coordination mode only adapts slowly. The hierarchical aspects in this mode enforce the length of the adaptation process and might create resistance to change. The latter often occurs when such change lacks communication (Kotter, 1995).

**Hypothesis 3: Systems are insufficient for inter-unit cooperation requiring high knowledge sharing flexibility.**

The network literature has paid attention to knowledge sharing as well (Araujo, 1998; Hansen, 1999) and can provide further insight into the relationship between structure and knowledge sharing. Networks are an important means to integrate diffused expert knowledge in organisations and to cross internal and external organisational boundaries (Hislop et al., 1997). These are mechanisms to coordinate actions (Cohendet, Kern, Mehmanpazir, & Munier, 1999; Grandori & Soda, 1995). This coordination occurs in two ways; by directly informing each other and by creating common knowledge and understanding (Suk-Young Chwe, 2000). The latter can be seen as a form of sense-making between the parties in the network (Weick, 1995). Networks develop among people who trust each other (Newell & Swan, 2000). This trustworthiness and common understanding developed in the network is the basis for higher approachability and therefore for more intense knowledge sharing (Andrews & Delahaye, 2000).

There are different types of network relationships. Two often mentioned classifications are weak versus strong ties (Granovetter, 1973; Hansen, 1999) and formal versus informal ties (Macdonald, 1995). However, formal and informal ties are enhancing each other (Hislop et al., 1997). Hansen (1999) tested the effects of strength of ties and type of knowledge on the time used in projects to obtain the required knowledge. He found that weak ties are helpful to provide project teams with necessary knowledge but that these are insufficient when complex knowledge needs to be shared. In other words it is most efficient to have weak ties between units to share codified knowledge and strong ties to share non-codified complex knowledge. This is because weak ties exist among groups who have few knowledge in common, while strong ties are existing in groups with a lot of knowledge in common and therefore also with more redundant knowledge (Hansen, 1999). Moreover, strong ties might reduce flexibility for a unit to behave independent and might impose too much social obligations. According to structural hole theory, tight networks hinder coordination because of the lack of autonomy of the actors in the network (Burt, 1992). Moreover, networks might also be the source of power. In particular knowledge about the network and power relationships make some people more powerful than others (Krackhardt, 1990). Asymmetric power relationships can result in the abuse of power. The more powerful can not only protect his position by protecting his knowledge (Berman Brown & Woodland, 1999) but can also, when convenient, impose his knowledge on others, e.g. in the development of new routines. Gargiulo and Benassi (2000) show that strong ties might impede coordination of complex tasks, especially when changes in task requirements are demanded. Taking into consideration the important differences between weak and strong network ties in knowledge sharing (Granovetter, 1973; Hansen, 1999), we confine our assumptions to strong network ties.

**Hypothesis 4: Informal networks between units reduce the flexibility in knowledge sharing, resulting in unsatisfactory knowledge sharing.**

On the other hand, strong ties might result in a greater willingness to go through the high effort to share highly complex knowledge (Granovetter, 1973). As mentioned, networks also develop common understanding among the parties. The stronger the ties, the higher this understanding and the easier sharing complex knowledge. Strong network ties can reduce opportunism, settle trust, develops norms, ease cooperation and coordination (Burt, 1992; Gargiulo & Benassi, 2000; Pfeffer & Salancik, 1978). Strong personal network ties allow sharing complex and large amounts of knowledge (Gargiulo & Benassi, 2000; Granovetter, 1973; Hansen, 1999). Nahapiet and Ghoshal (1998) also explain how social capital facilitates the creation and exchange of intellectual capital.

**Hypothesis 5: Informal networks facilitate the sharing of knowledge when the knowledge is complex and extensive.**

Gargiulo and Benassi (2000) further argue that structural holes are important to discover new knowledge but that cohesive networks are having advantages in exploiting this knowledge further. This network literature provides us the insights that strong ties between people and units in the organisations are important to increase exploitation of existing complex knowledge that might be hard to share in the absence or weakness of network relations. However, those strong ties are less fit when more flexibility in knowledge sharing is required (Burt, 1992; Gargiulo & Benassi, 2000). In contrast to findings from these studies, the literature on organisation theory and organisational learning explains that network modes allow knowledge flexibility (Grant, 1996b; Senge, 1994; Van den Bosch et al., 1999). There is evidence in the learning organisation literature on the importance of teams and in particular self-regulated teams to allow knowledge sharing and learning (Ayas & Foppen, 1996; Senge, 1994). However, the latter are especially concerned with formal networking. We might therefore assume that inflexibility is especially a problem in informal network modes of inter-unit coordination. Nonetheless, such assumption needs further study.

**Hypothesis 6: The need for flexibility in knowledge sharing between units requires the use of formal network modes.**

Within the broader organisation literature stream attention has been paid to the concept 'community of practice' (Brown & Duguid, 1991, 2001; Lave & Wenger, 1991) with knowledge sharing as the transfer of 'good practices' to other communities (Argote & Ingram, 2000; Szulanski, 1996). Lave and Wenger (1991) studied the important role of apprenticeship in learning and sharing tacit knowledge. They emphasise that all learning is situated in communities of practice. The situational character makes it hardly possible to capture knowledge; instead knowledge is shared by story telling and narratives (Barley & Kunda, 2001). As long as the community remains stable the organisation can use the knowledge sufficiently but as soon as people leave the community, knowledge is lost. To become a member of such community requires learning, often by apprenticeship, and socialisation (Barley & Kunda, 2001). The identity with the group and absorbing the culture of the practice is very important in the learning process (Lave & Wenger, 1991). However, learning is situated in the community. Learning between communities is only possible when such learning is embedded in another overlapping community. Organisations are formed of several partly overlapping communities of practices within and crossing boundaries of the organisation (Araujo, 1998). Hence, complex knowledge can also be shared through linkages between units based on the norms mode (Cohen & Levinthal, 1990; Kogut & Zander, 1996). Whether norms are able to cope with large knowledge sharing needs is not specified in the literature. We consider it as low because norms do not directly bring people together. Knowledge is shared through the development of common understanding, which develops only slowly. Therefore, we assume that it will not allow intense knowledge sharing.

Norms are also less fit when there is a high need in flexibility in knowledge sharing (Van den Bosch et al., 1999). Walsh (1995) mentions that knowledge structures are necessary to process information and take decisions but meanwhile these can limit the information processing of new external information and decision making. Processing new knowledge often causes abandoning obsolete routines and mental models. In other words, unlearning is required but this needs time. Therefore, unlearning is a major limitation on knowledge sharing (Levitt & March, 1988; von Krogh & Roos, 1996).

**Hypothesis 7: The use of norms as linkages between units in organisations will result in adequate sharing of complex knowledge when low flexibility and low intensity in the knowledge sharing is required.**

The norms mode is formed by the collective knowledge base. This gives people implicit organisational knowledge that serves as guidelines for behaviour and inter-unit cooperation. Successful changes in individual's knowledge can become incorporated in routines and become part of the collective or organisational knowledge (Blackler, 1995; Levitt & March, 1988; Nelson & Winter, 1982; von Krogh & Roos, 1996). Levitt and March (1988) describe routines as follows: *"routines are independent of the individual actors who execute them and are capable of surviving considerable turnover in individual actors"*. Culture that determines the basic principles of how to behave in the organisation (Handy, 1993; Schein, 1988) is also included in organisational knowledge. Culture is a shared social reference existing of (implicit) knowledge that has been socialised by incorporating this knowledge into cultural elements (Blackler, 1995). It is also an important part of organisational memory (Kim, 1993; Lyles & Schwenk, 1992; Olivera, 2000; Walsh & Ungson, 1991; Weick & Roberts, 1993). Consequently, organisational knowledge is developed through coordination but is also embedded in the norms form of coordination and therefore also a coordination mechanism (Marengo, 1993).

This connection between people in organisations is also referred to in the literature as social identity (Ashforth & Mael, 1989; Kogut & Zander, 1996). In their review article, Ashford and Mael (1989) describe social identity as the perception of oneness with a group of persons. Such identity is described in literature on organisational commitment (Alvesson, 2000; Ashforth & Mael, 1989; Kärreman & Alvesson, 2001) and in the strategic literature as a kind of common set of rules (Kogut & Zander, 1996; Nahapiet & Ghoshal, 1998). According to Kärreman and Alvesson (2001), all interactions affect the identity people develop in relation to others or the group. Such identity develops social rules and trust making future cooperation easier (Alvesson, 2000; Ashforth & Mael, 1989). A powerful person e.g. might be reluctant to share knowledge because this might reduce his own powerful position in the organisation and might increase the positions of others. A strong identity might prevent people from abusing their specialist knowledge as power.

Within the already mentioned concept 'absorptive capacity', the role of a common knowledge base is highlighted. Knowledge sharing is impossible without a kind of knowledge base allowing the absorption of the shared knowledge and the application of knowledge in a new context (Cohen & Levinthal, 1990; Duncan & Weiss, 1979). Such related knowledge is knowledge that the parties in the knowledge sharing process have in common. It is the necessary excess knowledge to be able to share knowledge; a useful redundancy (Nonaka, 1994). It makes it possible to integrate new knowledge with existing knowledge stocks in people's heads, to understand the messages shared and to be able to use the written knowledge in procedures, databases and reports (Asakawa & Noda, 1998; Kim, 1993; Kogut & Zander, 1996).

Whatever coordination mode is used there is always a need for a minimum amount of such common (shared) knowledge e.g. in the forms of identity, mental models or culture (Marengo, 1993). Differences between units should not be too large to allow still a minimum common knowledge base making knowledge sharing possible. Therefore, the norms mode can be considered as the fundamental coordination form allowing the working of other forms of coordination (Grant, 1996b; Kogut & Zander, 1996; Marengo, 1993). Consequently, norms are integrating knowledge through developing organisational knowledge which in turn leverages the working of systems and networks. Especially, the two network modes, building on more voluntarily cooperation, require such commun understanding. Common understanding builds trust and willingness to share knowledge (Newell & Swan, 2000). Hence, a combination of strong norms with the network modes will leverage the positive effects of these modes on knowledge sharing.

**Hypothesis 8: The stronger the norms mode in combination with a network mode, the more intense complex knowledge can be shared between units.**

To assess how inter-unit coordination should be organised to optimise knowledge sharing, we combined the coordination classification with the knowledge sharing needs based on the relationships between structure and knowledge provided by the broad organisation theory literature. A few hypotheses relevant for further empirical study were formulated. We summarise these hypotheses and relationships in table 2.

Table 2: The knowledge sharing possibilities of the four coordination modes.

|  | Systems | Informal networks | Formal networks | Norms |
|---|---|---|---|---|
| Intensity of knowledge sharing | low | high | high | low |
| Flexibility in knowledge sharing | low | low | high | low |
| Complexity of knowledge shared | low | high | high | high |

## *7. Discussion.*

## 7.1. Contributions

We reviewed the classic literature on organisation theory and design and the literature on learning organisation and networking to discover to role of coordination as mechanisms for facilitating knowledge sharing. With this article we seek to contribute to this body of work by developing further the relationship between structure and knowledge. In particular we intended to give an overview of the basic integration modes and their potential to enhance knowledge sharing between units. This is proposed as an attempt to review the classic organisation design principles. In particular, we were able to identify four different linkages between units based on the way their common tasks are coordinated; and combined those with the characteristics of knowledge and knowledge sharing needs between units. Argote and Ingram (2000) emphasise that there is a lack of research on human interactions as the primary source of knowledge transferring. This paper gives also new insight in the main task of organisations, namely obtaining advantages over market contracting by differentiation, specialisation and alternative integration mechanisms (Grant, 1996b). Therefore, we also seek to contribute to the knowledge theory of the firm and the knowledge management literature in general with its roots in business strategy.

In a recent paper of Haas and Hansen (2001) the negative effects of knowledge sharing are empirically studied in a consulting firm. The disadvantages of knowledge sharing lack theoretical and empirical study. Haas and Hansen strongly emphasise the need for research addressing the issue of whether knowledge sharing between units actually benefits the performance of these units. They analysed several types of costs related to knowledge sharing and found that experienced teams -who did not really need other teams' knowledge - were performing less well rather than better due to knowledge sharing. Those teams incurred unnecessary search costs and even used knowledge from other units while having the knowledge already in their team. The shared knowledge replaced their own valid knowledge and actually reduced creativity in searching and combining knowledge to create new and better insights (Haas & Hansen, 2001). Although our discussion did not emphasise the negative effects of knowledge sharing, this is implicit in our focus on optimal knowledge sharing.

Therefore, throughout this paper it was suggested that structure should be fit to 'optimise' knowledge sharing instead of 'maximising' knowledge sharing. However, this approach should not be classified as a traditional contingency approach. Duncan and Weiss (1979) criticised a pure contingency approach for the reason that this approach does not provide insight in how the organisation can adapt to changes in its task environment. We did look for a fit by combining knowledge sharing needs with

structural knowledge sharing possibilities. However, such a fit is very situational and should evolve with changes in tasks (Sobrero & Schrader, 1998). Coordination results in information sharing, which in turn results in a feedback learning process with consequently a need for adapting the tasks and therefore the structure, in particular the coordination mechanisms. Therefore, tasks and structure are involved in a mutual learning process making both unstable and hence, impossible to determine the optimal coordination and integration structure (Brown & Duguid, 2001; Sobrero & Schrader, 1998). Consequently, our work should not be used as a manual to develop the optimal knowledge sharing structure but as general indications of the relationships between structure, in particular inter-unit coordination modes, and knowledge sharing.

Moreover, there is a continuous interplay between structure and knowledge. The development of coordination modes, knowledge and knowledge sharing is a process in which those develop simultaneously and not sequentially. We explained that the impersonal and informal coordination mode norms, is both cause and effect of knowledge sharing. First, because these coordination mechanisms are organisational knowledge, such as routines, and in those sense the outcome of the knowledge sharing process. Second, organisational knowledge embedded in coordination mechanisms is the basis for further knowledge sharing. The mode we called 'norms' plays a special part in the knowledge sharing process. Coordination by norms is often the only alternative to achieve sufficient integration of complex knowledge because of the difficulty to impose more formal networks and the lack of sufficient informal networks. Also the development of the personal networks is closely related to the development of norms (Nahapiet & Ghoshal, 1998). Personal relationships are developed during interactions together with the construction of social identity and both are part of what Nahapiet and Ghoshal call 'social capital'. Social and intellectual capital coexist. Intellectual capital consists of socially and contextually embedded forms of knowledge (Nahapiet & Ghoshal, 1998:246).

## 7.2. Limitations.

Some authors also mention other coordination mechanisms, such as the market (Ouchi, 1980), gaming, voting and negotiating (Grandori, 1997a). We excluded those for the following reasons. The market differs from the coordination forms mentioned in this study in its property right structure (Grandori, 1997a). Sobrero (1998) calls the classic coordination modes 'procedural' coordination as opposed to 'contractual' coordination. We excluded forms of pure contractual coordination. Gaming is considered as a lack of coordination. In so far the sequencing of rounds in the game leads to an optimal solution without communication, we can consider it as the formation of implicit norms (Kogut & Zander, 1996). Voting is more a decision-making action, which does not integrate actions but only selects those actions. Negotiating takes a special place. It is a form of direct interaction but its role is much

broader than coordinating. This coordination mechanism can also be seen as a special form of mutual adjustment and feedback. Hence, our paper is limited to the very classic forms of coordination. However, many modern variants of this classic coordination, such as e-mail, intranet, etc can still be categorised under one of our four main modes.

We have emphasised the importance of norms as basic coordination mode. However, other authors have emphasised the situational character of the norms mode and the fact that its presence in the organisation at large or on a level transcending unit barriers should not be taken for granted. Larger companies rarely possess one culture but consist of several temporarily and permanent cultures and identities hold by sub-units or related to tasks (Alvesson, 2000; Araujo, 1998; Ashforth & Mael, 1989; Fiol, 2001). Some of these sub-units might have an identity closer related to other external units than to sub-units of the same company (Brown & Duguid, 2001). The social identity within the sub-unit will also be larger than the identity with the larger unit or organisation (Ashforth & Mael, 1989). Moreover, identity gives the firm also a common filter to look to the environment, called 'dominant logic' in the literature (Bettis & Prahalad, 1995). It filters information from the environment when converted to firm specific knowledge (Boisot, 1998). The filter might make the firm blind for certain opportunities and alternatives in the market. In addition, people tend to communicate about things they have in common. Knowledge sharing is therefore often limited to common knowledge (Paulus & Yang, 2000; Stasser & Titus, 1987; Stasser & Vaughan, 2000).

## 7.3. Further research.

We explored one part of the relationship between structure and knowledge sharing, in particular, how to obtain knowledge sharing under given conditions of differentiation and knowledge characteristics. Interesting further research might be to explore reducing differentiation to reduce integration needs and complexity of knowledge sharing. There has been some research on the use of more codification to facilitate inter-unit knowledge sharing. Winter and Zollo (1999) explain that when practices or routines in organisations occur less frequently and are less homogeneous, the benefits of articulation (sharing routines with others) and especially of codification (writing down or literally codifying routines) become larger. Routines are more or less often developed, depending on the frequency of activities potentially using the routine (Singh & Zollo, 1998; Winter & Zollo, 1999). Companies are traditionally writing down the most frequent processes in procedural manuals. However, everybody knows these routines by heart and does not use the manuals (Singh & Zollo, 1998). To make implicit knowledge useful in other contexts it is required to abstract the causal relations between the conditions and performance from the implicit knowledge (Singh & Zollo, 1998). Consequently, it is necessary to codify the knowledge relevant to 'rare activities' that hardly ever occur in similar contexts (Singh &

Zollo, 1998). More codification will reduce complexity of knowledge and as a consequence, ease knowledge sharing and allow more systems based coordination. The issue how to reduce knowledge sharing needs has not yet been addressed in the literature.

Further research has of course to be done in empirically testing the mentioned assumptions. Since, no measurement instruments are available for such testing, further research will also include the development of such instruments. Although differentiation and interdependency were not the object of our study, these should be included as control variables in such empirical study. The influence of these variables on coordination and knowledge sharing needs might be extensive.

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