LEVELS OF PROCESSES, INTERTWINING ACTIONS AND NETWORK CHANGE

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Abstract

Studies on network dynamics are analyzed from the viewpoint of alternative conceptual and methodological approaches provided for research on network change. The paper emphasizes particularly two definitional and methodological challenges; business network is never a single unit or a one-dimensional phenomenon and networks change as a result of human action and interaction. Therefore, conceptual and methodological tools are sought for the capture of various levels of processes without losing the holistic understanding, and the agency of individuals in network change. The study presents a typology of network change that can be used by other researchers in explicating their research approaches. It concludes by discussing different conceptual and methodological solutions to understand multi-level processes and get access to change generating actions over time to offer a basis for further research on network change.

Keywords: network change, levels of analysis, acting, process

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INTRODUCTION

The present study is about the dynamics and behavioral aspects of business networks; these have become of increasing interest to network researchers but have also proven to set specific research challenges (see e.g. Halinen & Törnroos, 2005). Regardless the early notions of the inherent dynamism and intertwinedness of stability and change in business networks (e.g. Johanson and Mattsson, 1988; Easton, 1992), knowledge of network change and the underlying forces behind the changes is seen as limited (e.g. Halinen, Salmi & Havila 1999; Knoben, Oerlemans & Rutten, 2006). One important reason for the scarcity of research and the scattered knowledge lays in the definitional and methodological difficulties (Holmlund, 2004; Johnston, Peters & Gassenheimer, 2006). The questions "What is change?" and "What is network?" are simple at the surface but actually fundamental questions that beg for definitional and methodological answers from researchers interested in network dynamics.

The study approaches network change relying on two primary claims about its nature and related research complexity. Firstly, business network is never a single unit or a one-dimensional phenomenon (Halinen & Törnroos, 1998; Halinen & Törnroos, 2005; Håkansson & Ford, 2002; Provan, Fish & Sydow, 2007). When studying change in networks researchers inevitably need to deal with several levels of analysis (Brass et al., 2004; Provan et al., 2007) and multiple elements that actually undergo change over time (Havila & Salmi, 2000; Hedaa & Törnroos, 2008). Still, a change process should be captured holistically and the drivers of development over time understood at the level of their generative mechanisms (Easton, 2000). Secondly, studying networks of firms is complicated because they change as a result of human interaction (Borch & Arthur, 1995). Interactions, which consist of acts and counter acts by the parties (Ford & Håkansson, 2006), are the primary drivers of network change and therefore it is the actions of individuals that should be examined. These actions can be suggested as the ones that intertwine the process levels and various process elements in the developments over time.

This paper examines network change as a multilevel phenomenon in which actions by individuals are driving processes. To do justice to the interconnected and embedded nature of networks it is important to distinguish different levels of analysis (see e.g. Hertz, 1998; Möller & Halinen, 1999; Ritter & Gemünden, 2003; Provan et al., 2007). Different constructs can be seen built at different levels but also the levels of theory, levels of data collection (measurement) and levels of analysis should match with each other (Klein et al., 1994). Previous research presents different views to the levels of analysis in network research as well as different ways to distinguish and categorize these levels. For example, Möller and Halinen (1999) discuss four levels of network management; dyadic relationships, relationship portfolios, firms in networks and industries as networks. Ritter and Gemünden (2003) separate management levels of analysis (i.e. individual, group, organization, cluster) and

interorganizational levels of analysis (i.e. episode, dyad, portfolio, net, network). Brass et al. (2004) classify organizational network research on the basis of their focus on interpersonal, inter-unit or inter-organizational level of analysis. The different classifications are connected to the objective of each study and therefore naturally include some differences as well as similarities. For the purpose of classifying previous research with respect to network change we distinguish individual, firm, relationship, net/network and industry levels of analysis.

Our approach emphasizes research that provides an opportunity "*to explore dynamic qualities of human conduct and organizational life and to embed such dynamics over time in the various layers of context in which streams of activity occur*" (Pettigrew, 1997). We search for both conceptual and methodological tools to make better sense of change processes in networks and to get access to actions and interactions in time. This search is based on analysis of choices made in previous research on business network dynamics.

The paper is constructed as follows: We review previous research studying dynamics of business networks to uncover what network change has actually meant to researchers. As a result we present a typology of network change that can be used by other researchers in explicating their research approaches. This is combined with analysis of the conceptual bases and methodological choices in the reviewed studies in relation to their levels of analysis and consideration of agency of individuals. In the end, conceptual and methodological solutions to understand multi-level processes and get access to change generating actions over time are discussed to offer a basis for further research on network change.

RESEARCH ON CHANGE PROCESSES IN BUSINESS NETWORKS

Business networks are expected to be stable but not static: they will constantly change in response to changes both external and internal to the network (Johanson & Mattsson, 1988; Easton, 1992). Change in some part of a network seems to require stability in other parts or other areas of activity (Håkansson & Johanson, 1992). To stabilize a business unit and its operations the development of the relationships with other actors in the market is relied on. Simultaneously the interaction processes in the relationships lead to incessant change in the networks (Håkansson & Snehota, 1995). So we cannot leave without attention the inherent dynamism of networks.

But how can we study dynamism of a multi-unit subject, such as business network, that consists of separate but interrelated networks of actors, resources and activities (Håkansson & Johanson, 1992) and can be seen either as relationships, structures, positions or processes (Easton, 1992)? Part of the solution to the complexity of research on network change is in the delimitation of the aspects of the real-life phenomenon to be studied. Simultaneously, we inevitably need to make levels-of-analysis choices and acknowledge their influence on the conclusions drawn with respect to network change (cf. Klein et al., 1994). Different approaches are likely to involve different views to change and we need to build our research on different elements accordingly. As researchers of network change typically aim to maintain as much as possible of the holistic understanding of the phenomenon, these delimitations need to be done through careful conceptual and methodological choices. We turn to review of previous research on network change for assistance in that.

METHODOLOGY FOR THE REVIEW

For an analysis of the alternative conceptual bases and methodologies for research on network dynamics a review of previous research on the topic is conducted. The reviewed articles were selected through a stepwise process. The search was delimited to articles published between the years 1991 and 2010, which is hoped to encompass the time of most intense interest in business network dynamics. The first round of selection was based on search for key words 'network change', 'network dynamics' and 'network and process

research' in the *Science Direct*, *Ebsco Econlit* and *ProQuest* databases. As a result 246 articles were identified. The second round of selection was a review of the titles and abstracts of the papers to evaluate if they really handled business networks and their dynamics and 60 articles were selected. In further reading, still some articles were rejected because the research approach proved to be static and in the end 49 articles, as presented in Table 1, were examined. It is to be acknowledged that the search for the articles is significantly limited due to lack of any manual search procedures. Because the sample was collected only through computer based key word search it can be seen as close to random. Therefore, we shouldn't pay too much attention to numbers between Journals or amount of articles in each category.

Table 1. Reviewed articles on network change and dynamics on the period 1991–2010.

Journal	Theoretical	Empirical	Methodological	Total
Industrial Marketing Management		9		9
Scandinavian Journal of Management	2	3		5
Journal of Business Research	2	1	1	4
Administrative Science Quarterly		2		2
International Journal Production Economics		2		2
Journal of Business to Business Marketing		2		2
Journal of International Business Studies		2		2
Organization Science		2		2
Research Policy		2		2
Strategic Management Journal	1	1		2
Academy of Management Journal	1			1
American Journal of Sociology		1		1
Computational Mathematical Organization Theory		1		1
International Business Review	1			1
International Journal of Research in Marketing		1		1
Journal of Business Venturing		1		1
Journal of Intellectual Capital	1			1
Journal of Knowledge Management		1		1
Journal of Management Studies	1			1
Journal of Purchasing and Supply Management		1		1
Journal of Strategic Marketing		1		1
Management Learning		1		1
Organizational Research Methods			1	1
Project Management Journal		1		1
Technology Analysis & Strategic Management		1		1
Technovation		1		1
Qualitative Market Research			1	1
	9	37	3	49

The analysis of the articles started with overview to their topics. Next the theoretical approaches and general methodological choices were documented. Then attention was directed to the conceptualizations of network change in the articles (see Table 2 and Figure 1). Finally, we aimed to define the levels of change that are under study and the concepts and methods that are primarily related to the four different conceptualizations of network change (see Table 3). For these the articles were divided between the three authoring researchers to be classified. Since the explicit definition of network change or dynamics in the articles was rare, researcher triangulation was used to validate the individual interpretations and several discussions between the researchers about unclear classification cases were held.

OVERVIEW OF RESEARCH AND CONCEPTUALIZATIONS OF NETWORK CHANGE

The articles selected to be reviewed focus on different topics ranging from management of organizational change (Kragh & Andersen, 2009) and knowledge and learning in network

context (e.g. Knight & Pye, 2004; Smedlund, 2006; Swart & Henneberg, 2007; Walter et al., 2007) to analyses of network dynamics in new venture development (Coviello, 2006; Mainela & Puhakka, 2008) and organizing of MNCs (Malnight, 1996; Marschan et al., 1996). Several studies are about network strategies (e.g. Andersson & Mölleryd, 1999; Beckman et al., 2004; Jüttner & Schlange, 1996; Kamp, 2005; Rowley & Baum, 2004) and, for example, strategies for partner selection (Hallikas et al. 2008; van de Bunt & Groenewegen, 2007) or governance of exchange (Larson, 1992) are covered. The examinations of interrelatedness of evolution of whole industries or industry events with technological changes and varying network structures provide clearly layered views to the network processes (Gay & Dousset, 2005; Gemser et al., 1996; Gupta et al., 2010; Madhavan et al., 1998; Hertz & Mattsson, 2004; Orsenigo et al., 2001; Pagani & Fine, 2008; Powell et al., 2005).

A general overview of the articles tempts to a conclusion "*Everything is change and change is everywhere*". On one hand, change is an everyday concept that can be used in numerous of different connections. On the other hand, change is connected with several other concepts that seem to have a more specific meaning, such as evolution (e.g. Ford & Redwood, 2005; Orsenigo et al., 2001), dynamics (e.g. Taylor & Levitt, 2007; Coviello, 2006) and process (e.g. Andersson & Mölleryd, 1999). The common idea is that something is different after change has occurred.

In practical realization of the studies, some concentrate on the factors that cause change (e.g. Beckman et al., 2004; Hameri & Paatela, 2005), some on the consequences of change (e.g. Orsenigo et al., 2001). Brass et al. (2004) examine both antecedents and consequences of network change at interpersonal, inter-unit and inter-organizational levels. Some studies describe change as a longitudinal process over time and discuss evolution of networks (e.g. Andersson & Mölleryd, 1999; Ford & Redwood, 2005). Knoben et al., (2006) note that networks as such may be conceptualized as an answer to market dynamics, as a source of change and as an object affected by change.

Despite the complexity of the task, it is fundamental for research on network change to define what change is and what is observed or analyzed to know that change has taken place. We combine the different approaches to organizational change presented by Van de Ven and Poole (2005) with our analysis of the concept of change in the reviewed 49 articles and summarize four conceptualizations of network change as illustrated in Figure 1.

On one hand, we can differentiate between two types of network change. Several studies that we reviewed primarily analyzed change in some other element than the network itself. Network could be a context for studying change in some internal organizational or relationship process. For example, strategy researchers may look at mechanisms of relationship control (Larson, 1992) or strategy formation (Jüttner & Schlange, 1996) and that strategic process is the one that develops over time. Their primary level of analysis is not the network but the dyadic interactions that move the internal or relationship processes forward in time. Research may also deal with variation in organizational and environmental factors that are studied with reference to network-like contexts. For example, social capital is studied as an independent variable influencing network formation seen as structural changes (Walker et al., 1997). This type of network change we call "*change in networks*" type. In "*change of networks*" type, then, question is of research for which the network level changes are of primary interest. This is seen as explicit descriptions and analyses of changes in network level structures and positions. It may deal with behaviors and decisions in internal MNC networks (e.g. Malnight, 1996) or with focal net of a single firm (e.g. Kamp, 2005; Mainela & Puhakka, 2008). Several studies are about variation in structural characteristics of networks whose influence on organizational decisions and actions are examined. For example, Baum et al. (2000) study influence of composition of the founding network on the early performance of the start-ups.

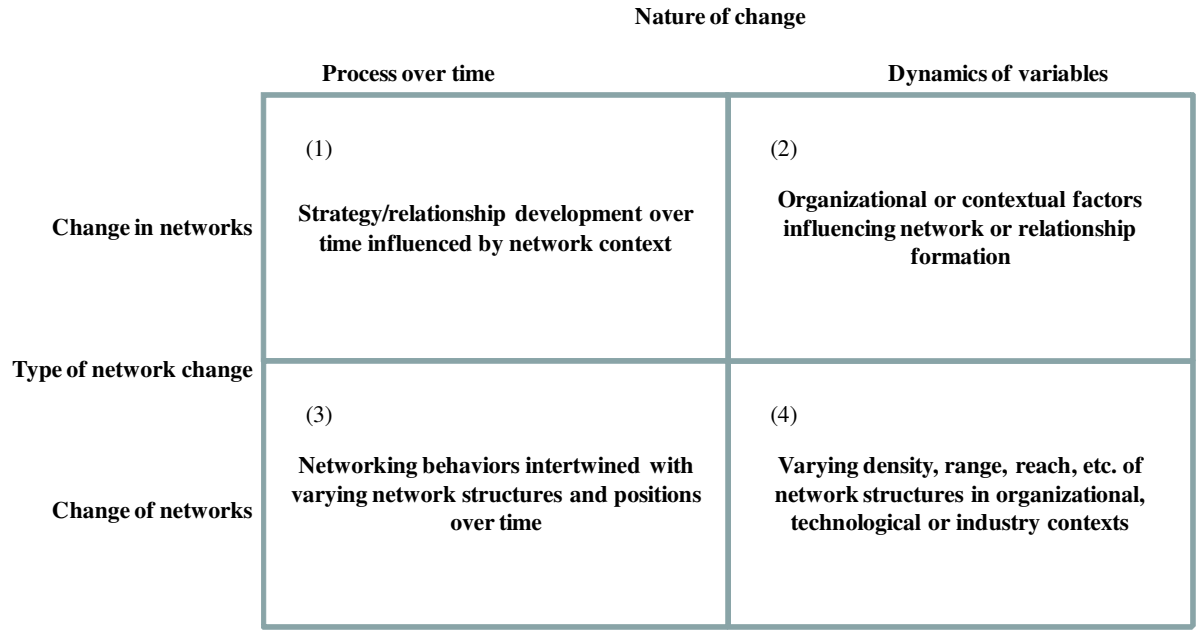

Figure 1. Conceptualizations of network change.

On the other hand, studies differ on the basis of their depictions of the nature of change and the related ontological and epistemological approaches (see Van de Ven & Poole, 2005). When change is depicted as a "*process over time*" the behavioral aspects, such as acts and interacts, attributions and justifications, sense-making and sense-giving by actors are studied. From the ontological viewpoint stability and change of networks may be depicted primarily as judgments, not real things because the organizations and networks are in themselves seen as processes that are continuously being constituted and reconstituted through human interpretation. Methodologically narratives describing a sequence of events on how development and change unfold are primary types of data or products of analysis. Other studies accept processes as critical to the understanding of business but reduce them to things that can be described as "*dynamics of variables*". Thus change is actually examined as different values of variables that are compared at two or more time points. Methodologically it is question of statistical analysis of relationships between certain independent and dependent variables.

In sum, research in Cell 1, *change in networks as a process over time*, is typically about organizations recognizing a need for internal or relational change and then changing the state of the internal issue or a dyad through moving over certain phases of development over time under some influence from the network. Research in Cell 2, *change in networks as dynamics of variables*, is about determinants of firm's strategic decisions and actions in their attempts to change their relationships or networks. Research in Cell 3, *change of networks over time*, is about relating behaviors and interactions between firms that are studied in connection to varying network structures or positions. Research in Cell 4, *change of networks as dynamics of variables*, focuses on observed differences over time in selected dimensions of networks (typically characteristics of network structures) in the context of some decisions and actions of the firms or the development of firms, technologies or industries.

Table 2. Reviewed research on network change.

Study	Theoretical approach	Methodology	Concept of change
[1]Larson, 1992	Network organizational form/governance	Ethnographic case study on 7 alliances by 4 high-growth firms	Building, controlling network form over time, evolution of dyads
[1]Gemser et al., 1996	Interfirm linkages as a source of competitive advantage	Descriptive historical analysis of linkages in three industries	Evolution of industry level interfirm relationships over time
[1]Jüttner & Schlange, 1996	Firm-environment alignment from interactions in networks	Illustrative case example of applying the strategy framework	Strategy process over time
[3]Malnight, 1996	Network-based MNC model	Longitudinal single case study over a 15-year period	Transition from decentralized to network-based MNC
[1]Marschan et al., 1996	Decentralized MNC model	(Primarily theoretical; notions from a single case study)	Mutual influences of structural changes, personal networks and informal communication flows
[3]Low, 1997	Industrial network approach	An embedded single case study	Evolution of network position and relationships of a focal firm
[2]Walker et al., 1997	Social capital, social network and structural holes theories	Data on 114 biotechnology firms and their cooperation	Influence of social capital on network formation (structure)
[3]Anderson et al., 1998	Industrial network approach	(Primarily theoretical; some secondary case analysis)	Network dynamics as a social process with stability and change
[3]Halinen & Törnroos, 1998	Industrial network approach, social, regional networks	(Primarily theoretical; some secondary case analysis)	Embeddedness as a force for change in the evolution of networks
[3]Hertz, 1998	Industrial network approach, internationalization in networks	2 case studies from European goods transport industry	Prerequisites, triggers, sequences, time and speed of connected changes
[4]Madhavan et al., 1998	Social network theory	Archival data on 130 steel industry firms on their alliance networks in 1977-1993	Structural evolution of networks as a response to key industry events
[3]Alajoutsijärvi et al., 1999	Industrial network approach	30-year case study on three international corporations	Strategic level developments in a business dyad and focal net
[3]Andersson & Mölleryd, 1999	Interorganizational network approach	Longitudinal case study on a mobile telephony distribution network change for 1971-1994	Evolution of a marketing channel as a longitudinal network process, changing actor patterns
[3]Halinen et al., 1999	Industrial network approach	-	Alteration of structure and nature of actor relationships
[2]Ahuja, 2000	Resource-based view, social network theory	Archival data on 97 firms in chemical industry 1979-1991	Influence of technical, commercial social capital on number of interfirm linkages
[4]Baum et al., 2000	Social network theory	Secondary data on 142 biotechnology firms 1991-1996	Influence of founding network on performance of start-ups
[3]Havila & Salmi, 2000	Industrial network approach	18 interviews in 4 graphic industry firms 1997-1999, analysis mainly on one firm	Critical events interpreted by managers result to actions and trigger change
[2]Orsenigo et al., 2001	Networks as organization form	Graph tools to analyze 3973 relationships of 1709 pharmaceutical firms 1978-1997	Technological conditions as inducers of change in industry structure and evolution
[2]Beckman et al., 2004	Organizational networks, network of relationships/ties	Data on interlock and alliance networks of the 240 largest U.S. firms during the 1988-1993	Partner selection, alteration of network structure with new ties/relationships
[4]Brass et al., 2004	Social network theory, organizational networks	-	Antecedents and consequences of networks at various levels
[3]Hertz & Mattsson, 2004	Industrial network approach	2 qualitative cases from freight-forwarding industry	Strategic actions undertaken by firms, alliance process
[3]Knight & Pye, 2004	Interorganizational networks, organizational learning	Secondary cases of firms in English prosthetics service	Relations between change and learning in networks
[1]Meijboom & Vos, 2004	Organizational network approach	4 cases on Eastern European factories of Dutch MNCs	Strategic factory roles
[2]Rowley & Baum, 2004	Social network analysis, structural holes	Data on all underwriting syndicates by investment banks in Canada 1952-1990	Influence of partnering decisions on network positions over time

[4]Verspagen & Duysters, 2004	Strategic alliances as network of actors, structural holes, social capital, social network	Alliances from CATI database between 1980-1996	Relative efficiency of a network as generator of social capital or transmitter of knowledge over time
[3]Coviello, 2005	Social networks, network research methods	-, (primarily methodological; retrospective interview data)	Evolution of business idea and network involved to the business idea implementation
[3]Ford & Redwood, 2005	Industrial network approach	Single case study of a firm in a leather network over a decade	Evolution of a firm in a changing network
[4]Gay & Dousset, 2005	Social network approach	Data on 739 alliance by 557 biotechnology firms 1990-2004	Co-evolution of technological change and network structure
[3]Gupta et al., 2005	Innovation network, diffusion of innovation research	Single case study on an on-line firm	Diffusion process in creation of start-up firms in b-to-b e-markets
[3]Halinen & Törnroos, 2005	Industrial network approach, social network theory	-	Character of networks over time, network processes
[1]Hameri & Paatela, 2005	Supply networks research	Qualitative action research on two industries and one firm	Factors causing change in supply networks
[3]Kamp, 2005	Industrial network approach	2 longitudinal cases on supplier networks around car assembly plants in Spain	Actor composition evolution in supply networks
[2]Powell et al., 2005	Social networks	Data on cooperation agreements of 482 biotechnology firms 1988-1999	Logics of attachment as explanation to structures and dynamics of interfirm networks
[4]Coviello, 2006	Social network theory, international entrepreneurship	Multiple case study on 3 international new ventures	INV network characteristics, compositional ties over time
[3]Johnston et al., 2006	Industrial network approach	- , (examples from UK construction industry)	Network characteristics, interactions, structures, their associated dynamics
[2]Smedlund, 2006	Production, development and innovation network research	-, (example from medical technology cluster)	Role of intermediaries in regional network dynamics
[1]Windahl & Lakemond, 2006	Industrial network approach	Comparative multiple case study, 65 interviews	Development process of integrated solutions in network context
[3]Swart & Henneberg, 2007	Social network, industrial network, new venture network	Grounded theory	Development of knowledge networks over 3 new venture phases
[1]Taylor & Levitt, 2007	Organizational, project network research	Cross-national diffusion data/3 technological innovations, implementation data/82 firms	Two stage model for innovation diffusion in project networks
[4]van de Bunt & Groenewegen, 2007	Social network approach	-, (illustrative analysis on the collaborative agreements in genomic industry)	Influence of network configuration, firm goals, characteristics on partner selection and network position
[4]Hallikas et al., 2008	Value net approach, supply chain management	26 companies from different industries in 2 time points	No. of alliances, shift of structural position, impact of R&D inputs
[3]Lukkari & Parviainen, 2008	Institutional networks, institutional entrepreneurship	Comparative multiple case-study	Institutional change in environment, network change
[3]Mainela & Puhakka, 2008	Industrial network approach, social network approach	Single case study on an IJV's focal net over years 1989-2000	Evolution of IJV's focal net relationships through acting
[2]Pagani & Fine, 2008	Supply chain management, value net	Scenario analysis	Scenario analysis of forces affecting evolution of 3G wireless network
[2]Zhiang et al. 2008	Strategic network research	Actor based computer simulation	Change of events, inputs and outputs
[3]Harrison & Prenkert, 2009	Industrial network approach, strategy process management	Single case study	Strategy development process and changes in ARA-layers
[3]Kragh & Andersen, 2009	Change management, organizational change	Single case study	Change in relationships and partnership strategy
[4]Weber & Weber, 2009	Social network theory, social capital, knowledge transfer	Grounded theory building, multiple case study, 12 triads	Influence of network configuration and social capital on knowledge transfer and creation
[3]Gupta et al., 2010	Industrial network approach	Qualitative research	Evolution of a cartel

**Numbering [1,2,3,4] denotes to the classification of research approaches presented in Figure 1.*

At the general level (see Table 2), when the primary interest of the study is in some internal or dyadic process in a network context, this discussion is naturally emphasized in the theoretical framework. Models on, for example, exchange governance, decentralized MNCs, subsidiary roles or project networks are either combined with the industrial network approach or form the primary discussion contributed to (e.g. Larson, 1992; Marschan et al., 1996; Meijboom & Vos, 2004; Taylor & Lewitt, 2007). The process research on networks is most likely to rely on the industrial network approach and single case study as the primary methodological strategy (e.g. Andersson & Mölleryd, 1999; Mainela & Puhakka, 2008). The variables studies typically rely on social network theory or organizational network theory and then statistically test through data from big databases produced either by various institutions or collected by the researchers from secondary sources. Extensive study of collaborative agreements through various alliance databases are often conducted was the network change a dependent variable (e.g. Ahuja, 2000; Powell et al., 2005; Walker et al. 1997) or an independent variable (e.g. Gay & Dousset, 2005).

CAPTURING LEVELS OF CHANGE AND MANAGERIAL ACTIONS

We chose to deepen the analysis of the different conceptualizations of network change by examination of the levels of analysis and managerial acting as the driver of change. Several researchers have seen change processes in networks as always intertwined with processes at other levels (Hoang & Antoncic, 2003; Coviello, 2005). All social processes are context embedded and therefore processes occur simultaneously at different levels and even multiple processes occur at single levels of analysis (Pettigrew, 1997). Furthermore, it is the flow of actions by individuals that move to higher levels of social activity when they become parts of relations (Johnston et al., 2005) and these actions shape the processes (Pettigrew, 1997).

On the basis of our review, the network level analysis is most often connected to relationship and firm levels of analysis. However, the studies are not often very explicit about which are the theoretical and empirical levels used in the study and the multiple levels are not treated on equal terms. There is seldom in-depth discussion about the relevant levels of analysis in relation to the study's aims. The idea of managerial actions as drivers of change and individuals as the interacting actors in the business networks has also received quite little attention (see also Mainela & Tähtinen, 2007). Still, we are able to see differences in the research depending on which of the four conceptualizations of network change they have adopted, as discussed next.

In the conceptualization of "*change in networks as a process over time"* typically some strategic level phenomena, such as operations management (Hameri & Paatela, 2005) or development of integrated solutions (Windahl & Lakemond, 2006), is seen connected to the internal organization and the relationships and interactions between the actors in the network. The dominant level of analysis is relationship level with exception of Gemser et al. (1996) that combines relationship and industry levels of analysis. The studies are primarily about interactive behaviors in firm level dyads to exchange, control, communicate and cooperate with external or internal parties. Amount of hierarchy, actor roles, vertical and horizontal linkages, strength of relationship and trust are determining features of the relationships. Some of these primarily interfirm dyad studies take into account the nature of interpersonal relationships and interactions (e.g. Larson, 1992).

Agency intertwining the levels may be depicted as firm behavior to control the exchanges (Larson, 1992; Marchan et al., 1996) or various strategic activities in network context (Jüttner & Schlange, 1996). When Jüttner and Schlange (1996) want to combine network context with perception and behavior of individuals in study of strategy process, they use the strategic activities of relating, named mobilizing and positioning, as the primary type of action intertwining these levels.

In research with "*change in networks as dynamics of variables*" conceptualization new relationship formation is an action to be quantified (e.g. Walker et al., 1997; Beckman et al., 2004). The studies in this group can be seen to utilize firm, relationship and network levels of analysis. In the end, studies may also aim to describe or explain the evolution of industries. However, as typical in variable based research, the levels are not parallel to each other but, for example, firm or relationship characteristics, or numbers of alliances are the independent variables used to explain variation in network level variables. For example, Walker et al. (1997) study social capital as a firm level variable and its influence on number of relationships in a firm's network. Orsenigo et al. (2001) similarly combine firm and network levels when they study influence of knowledge and technology dynamics on network level patterns of structural evolution. Existence or non-existence of relationships (structural holes) may also be seen as determinants of network positions (Rowley & Baum, 2004). As the data is typically about collaborative agreements between firms the managerial questions deal with issue whether managers can use collaborative arrangements to improve their firm's network positions (Rowley & Baum, 2004; Orsenigo et al., 2001; Walker et al., 1997).

The "*change of networks as a process over time*" approach typically combines firm level analysis with net level analysis. The challenge of delimiting the network under study is the most relevant here. One rough solution is to study a specific part of a network, such as supplier net (Kamp, 2005; Knight & Pye, 2004). Another alternative is to study a focal net, which is defined from a single firm viewpoint meaning that the firm level of analysis tends to be emphasized. The focal nets are described as structures that involve network ties with varying quality or nature, for example, strong vs. weak, family vs. business (e.g. Mainela & Puhakka, 2008; Swart & Henneberg, 2007). Firm level changes are depicted through analysis of firm's network position (Andersson & Mölleryd, 1999; Ford & Redwood, 2005; Kamp, 2005; Low, 1997), which can over time be seen to change the network.

With this network change conceptualization, in-depth managerial interviews as the primary data support bringing in the individual level of analysis. It allows for depicting the change of networks through networking behaviors and their intertwinedness with varying network structures and positions over time. Individual level analysis, thus, focuses on the acts of individuals that change the network (Gupta et al. 2005; Harrison & Prenkert, 2009; Mainela & Puhakka, 2008). These networking behaviors include firm level confronting, conforming, creating, consolidating, coercing and conceding (Ford & Redwood, 2005) or convincing, compromising and resourcing to influence dyadic relationships and internal organizing and legitimizing in order to influence wider networks (Mainela & Puhakka, 2008). For maintenance of network structures the actors may use buffering to adapt to requirements of existing partners or alternate the cooperation intensity either geographically or temporally (Andersson & Mölleryd, 1999). Network pictures have also been seen as both conceptual and empirical tools for combining individual, firm and network levels. According to Kragh and Andersen (2009) they are the basis on which the managers interpret the change possibilities in a network context. Ford and Redwood (2005) see it as a concept that depicts both firm level exchanges and the individual level beliefs and attitudes of managers about them. Several interesting ideas about change of networks as a process over time are put forward theoretically with only illustrative examples or secondary cases. For example, types of network embeddedness (Halinen & Törnroos, 1998), role and position conceptualizations (Anderson et al., 1999) and types of network change (Halinen et al., 1999) could be further explored empirically with intentional collection of network level data.

Studies with "*change of networks as dynamics of variables*" conceptualization focus especially on network level of analysis. The question is primarily of change in network structures described as the number of ties, network density and size, connectedness and reach of actors in networks (e.g. Coviello, 2006; Madhavan et al., 1998). Some studies discuss

network structures as configurations describing only the type of actors belonging to the network in different phases of knowledge transfer and creation (e.g. Weber & Weber, 2009). Gay & Dousset (2005) count correlations between firm's network centrality and innovation capability. Managerial action or other mechanisms that intertwine the levels are not under examination in the studies although, for example, Brass et al. (2004, 808) conclude that "understanding network change requires understanding cross-level pressures". Classifying studies between Cells 2 and 4 was sometimes difficult because they study very similar kinds of phenomena with similar kinds of data and change network features as either independent or dependent variables.

CONCEPTS AND METHODS IN RESEARCH ON NETWORK CHANGE

The research methods which are used to study network dynamics vary quite consistently according to the different conceptualizations of network change (see Table 3). When studying "*change in networks as a process over time"* the conceptual building blocks are dynamic but primarily dyadic by their nature. They include often processual depictions of relationship level phenomenon through stages, life cycles or time periods. The aim of the research is to study change as a process constructed by interaction and to gain holistic view of some internal or relational process. Processes are built either through historical descriptions, mapping specific activities or by longitudinal data which is collected over time. Data triangulation is emphasized. This kind of approach provides rich description to gain the holistic understanding of certain processes taking place within networks.

The research with "*change in networks as dynamics of* variables" approach focuses on factors that cause change in network structures and positions. The conceptual part deduces measurable variables such as innovation (e.g. patents), number of network ties, actor roles and resources whose influence on network structures or firm positions can be statistically analyzed. Quantitative methods through which different scenarios and random effects of the variables are researchable are applied. Longitudinal data as presented by yearly collected large public databases of agreements or firms are typically used.

Embeddedness of actors in networks is emphasized in the "*change of networks as a process over time*" approach. The approach focuses on the dependencies, connectedness, cooperation and patterns of interaction between actors in a specific net. Two types of processual concepts are typically used. Concepts in which change and development are inherent like learning, resource configuration, adaptation, relationship building and knowledge exchange are central. Secondly is used concepts which denote to network level continuums or causalities such as activity patterns, process models and domino effects. Methodologically the studies use single case studies with intensive, in-depth data covering processes in real-time or retrospectively through historical reconstruction of significant events. Data is collected through various methods often combining interviews, observations and questionnaires from which events are mapped and contents analyzed.

In studies with "*change of networks as dynamics of variables*" the influence of changes in network structures on firm, technology or industry level developments is of primary interest. Features of external networks and industries receive the primary attention as determinants of firm behaviors or performance. The approach often focuses on the kind of external influences that change the network from the company's point of view, using variables such as rivalry in the network, directions of change, power relations, industry position, actor similarity, antecedents and consequences of networks and betweenness. The data analysis typically aims at mapping, visualizing and measuring the networks and relationships and their co-existence or co-evolution with industries, technologies or firms.

Table 3. Typical conceptual and methodological choices in approaches to network change.

Approach	Typical conceptual choices	Typical methods choices	Studies
1. Change in networks as a process over time (8)	Primarily relationship and firm levels of analysis Stages and life cycle models of process Relationship/ exchange processes/characteristics in a business network context Network horizons Sets of actors/actor roles	Multiple case study Interfirm dyad as the unit of analysis Numerous interviews with managers at both sides Data triangulation Various data collection methods	Larson, 1992; Gemser et al., 1996; Jüttner & Schlange, 1996; Marchan et al., 1996; Meijboom & Vos, 2004; Hameri & Paatela, 2005; Windahl & Lakemond, 2006; Taylor & Levitt, 2007
2. Change in networks as dynamics of variables (9)	Primarily relationship level of analysis, variables from firm and network levels too Industry growth/development Networks as structures and positions New relationship formation/ selecting partners/entry into networks in focus Types of attachment and collaboration between firms Technological collaborations, technological knowledge transfer/implementation	Regressions of social capital on relationship formation Hundreds of firms from published lists Graph theory, numerical presentations of networks Network visualization tools Computer simulation Data on interlock changes/ alliance changes from public databases over years	Walker et al., 1997; Ahuja, 2000; Orsenigo et al., 2001; Beckman et al., 2004; Rowley & Baum, 2004; Powell et al., 2005; Smedlund, 2006; Pagani & Fine, 2008, Zhiang et al. 2008
3. Change of networks as a process over time (23)	Primarily firm and network levels of analysis Networks as positions and structures Actor and resource networks, organization of activities/ activity patterns Evolution of network position/ expectations Radical, incremental changes, change forces/ triggers Networking behaviors, acts of individuals/firms that change the network	Single case study/ historical case study Longitudinal data collection/ interviews Triangulation of data and data collection methods Historical reconstruction of significant events Content and event analysis Cases as illustrative examples, use of secondary data	Malnight, 1996; Low 1997; Anderson et al., 1998; Halinen & Törnroos, 1998; Hertz, 1998; Alajoutsijärvi et al., 1999; Andersson & Mölleryd, 1999; Halinen et al., 1999; Havila & Salmi, 2000; Hertz & Mattsson, 2004; Knight & Pye, 2004; Coviello, 2005; Kragh & Andersen, 2009; Ford & Redwood, 2005; Gupta et al., 2005; Halinen & Törnroos, 2005; Kamp, 2005; Johnston et al., 2006; Swart & Henneberg, 2007; Lukkari & Parviainen, 2008; Mainela & Puhakka, 2008; Harrison & Prenkert, 2009; Gupta et al., 2010
4. Change of networks as dynamics of variables (9)	Primarily network and industry levels of analysis Networks as structures (size, efficiency, centrality, path strengths, number of alliances, type of partners) Nature of change (centrality, centralization, interblock relations) Sets of actors, sets of ties, industry events Antecedents and consequences of networks Network interaction (contents, direction, duration)	Reconstruction of key industry events from secondary data on alliances/collaborative agreements Industry life histories through yearly measures from company databases Large-scale topology Maps/ visualization tools/ network matrices Statistical analysis Network algorithms	Madhavan et al., 1998; Baum et al., 2000; Brass et al., 2004; Verspagen & Duysters, 2004; Gay & Dousset, 2005; Coviello, 2006; van de Bunt & Groenewegen, 2007; Hallikas et al. 2008; Weber & Weber, 2009

DISCUSSION

In the present study we reviewed recent research to examine the different conceptualizations of network change and developed a typology of the conceptualizations. We used type of network change, defined either as change in or change of networks, and nature of change, defined either as process over time or as dynamics of variables (see Van de Ven & Poole, 2005), to deduce different approaches that could be used to classify the 49 studies under review. We developed the classification further through examination of the levels of analysis and actions intertwining them in accordance with the two basic claims of the present study about the primary challenges of research on network change. In the end, the previous research was discussed in relation to the conceptual and methodological tools they could provide for future research.

In the beginning of the study we asked the question of "what is change?" seeing the definitions of change as the first challenge for research interested in network dynamics. Based on our review, many studies do not explicitly define change. Change seems to be either everything from learning to doing and going and saying or not really researched when the antecedents and consequences of change are actually under examination. One conclusion could be drawn that change is something that just happens and it is only the outcome of it that can be observed. This makes us wonder how well we are actually able to examine the incremental evolution of networks that is likely to be the main form of network change (Halinen et al., 1999) when only radical change is seen in adding or deleting relationships from the networks.

Our second starting question was "what is network?" with which we referred to the specific challenge of defining network boundaries. Easton (1992) already differentiated between networks as relationships, structures, positions and processes. Halinen and Törnroos (2005), in turn, emphasized the challenge because networks are in reality connected to various geographical levels from local to global, to different vertical levels in the value chain and various levels in the business setting. In the reviewed studies we found quite a variety of solutions to the challenge that varied from focal net approaches to definition of industry networks from collaboration agreement databases. Quite many of the reviewed studies were not explicit in their approach and did not provide a definition of network. Definition of network should of course be connected to the definition of change.

According to Van de Ven and Poole (2005) "an increasingly popular method is to study change at multiple levels of analysis". According to our analysis, it is a necessity to study also network change through several levels of analysis. However, the research designs are not often explicitly discussed through different levels of analysis. Knoben et al. (2006) are more critical and claim that studies which concentrate on dyadic level change, do not consider the consequences in the network level, nor does the research on network-level connect the phenomenon to dyadic level.

The definition, role and importance of network level in the previous research differ according to the conceptualization of network change. "*Change in networks*" research recognizes network as important contextual issue that directs or affects the phenomenon under study, but it's not the main focus. Instead "*change of network*" research always considers change at the network level – even in situations where the primary level of analysis is the firm the network level is used as a secondary level of analysis. In the "*change of networks over time*" research our two main claims (the connectedness of individual, firm and network levels of processes and actions of firms or individuals over time driving the change of networks) are best taken into account. The variable studies do often well in accounting for several levels of change. However, in general, researchers should be more explicit with respect to the levels of analysis used both theoretically and empirically to conduct consistent

research. Researchers could also dig deeper into the actions that intertwine the levels to achieve holistic understanding of the change processes.

Easton's (1992) metaphors of networks intrigued us to consider the views to networks as relationships, structures, positions or processes. *Change in networks as a process over time* research views networks primarily as relationships. Also the used level of analysis is compatible with this when concentrating on relationship level of analysis. *Change in networks as dynamics of variables* research can be seen to approach network primarily as relationships and positions. *Change of networks as a process over time* research is typically about networks as positions or structures whereas the relationship level of analysis is not focused. Same applies to *change of networks as dynamics of variables* research. Networks as processes is a tricky issue as we can consider it both as an ontological question of the nature of networks as inherently processual phenomena or use of process research approach (see Van de Ven & Poole, 2005). There is some amount of process research on change of networks over time but the processual nature of networks as such is not well seen.

For future research, the results of the review suggest certain concepts and certain methods that seem to be especially relevant in relation to the four conceptualizations. Research on "*change in networks as a process over time"* can be built especially on stages and life cycle models describing dyadic processes and their determinants in network-like contexts. Most researchers have seen it well appropriate to rely on multiple case studies in which dyadic, typically qualitative data are collected from multiple sources. Research on "*change in networks as dynamics of variables***"** is about influences of knowledge bases, network strategies, types and rules of attachment on relationship formation and network positions. Various graph and visualization tools are commonly used to support statistical random effects and other analyses that base on large secondary databases. Research with "*change of networks as a process over time"* approach is conceptually rich. ARA layers as well as various types of embeddedness, change forces, network pictures, adaptations and interactions are utilized to make sense of the net level processes. Longitudinal single case study either in real-time or retrospectively but allowing the study of events and actions in their contexts is the primary methodological choice. Triangulation of both data sources and data collection methods is of critical importance. Research on "*change of networks as dynamics of variables*" is typically about the nature of change, various industry events, directions of change, rivalry, and sets of ties in networks. Amount of the dynamics, structural features of networks and network positions are counted and tested in relation to developments in industries, technologies or firm decisions. There is a great variety of methodological tools used but quite effective seem to be the various network visualization tools and maps that allow for mathematical and statistical analysis of the change in network features over time.

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