White Rose Research Online

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk
Universities of Leeds, Sheffield and York

Deposited via The University of Leeds.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/id/eprint/138955/

Version: Accepted Version

Article:
Jaspersen, LJ and Stein, C (2019) Beyond the Matrix: Visual Methods for Qualitative Network Research. British Journal of Management, 30 (3). pp. 748-763. ISSN: 1045-3172

https://doi.org/10.1111/1467-8551.12339

© 2019 British Academy of Management. This is the peer reviewed version of the following article: Jaspersen, L. J. and Stein, C. (2019), Beyond the Matrix: Visual Methods for Qualitative Network Research. Brit J Manage., which has been published in final form at https://doi.org/10.1111/1467-8551.12339. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving. Uploaded in accordance with the publisher's self-archiving policy.

Reuse
Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

UNIVERSITY OF LEEDS
University of Sheffield
UNIVERSITY of York

Running Head: BEYOND THE MATRIX

Beyond the Matrix: Visual Methods for Qualitative Network Research

Lena J. Jaspersen, University of Leeds

Christian Stein, Stockholm Environment Institute & University of Osnabrück

Dr Lena Johanna Jaspersen
Leeds University Business School
University of Leeds
Maurice Keyworth Building
Leeds, LS2 9JT, United Kingdom
L.J.Jaspersen@leeds.ac.uk
0044 7551938297

Dr Christian Stein
Stockholm Environment Institute
University of York
Wentworth Way
York, YO10 5NG, United Kingdom
christian.stein@ecointerfaces.net
0049 15774714730

About the authors:

Dr Lena Jaspersen is University Academic Fellow in Innovation Management at the University of Leeds. Her research focuses on technology innovation in complex innovation ecosystems and participatory methods and visual tools for the collection of network data.

Dr Christian Stein is a research associate with the Stockholm Environment Institute. His research focuses on the role of social networks in the contexts of natural resources governance.

Acknowledgements:

We are greatly indebted to everyone who participated in the research reported in this article. We would like to thank Hinrich Voss, Andrew Gouldson, Likimyelesh Nigussie, Birhanu Gedif, Tadesse Amsalu, Jennie Barron and Simon Langan for their support in conducting this research and Catherine Cassell, Jean Clarke, Jan Fuhse, Andreas Herz, Eleanora-Hope Humana, Emmanuella Plakoyiannaki, Jörg Sydow and Tom Töpfer and three anonymous reviewers for helpful comments on previous drafts of this article. We gratefully acknowledge financial support from University of Leeds, its Sustainability Research Institute, the ESRC Centre for Climate Change Economics & Policy, the Society for Latin American Studies, and the CGIAR Research Program on Water, Land and Ecosystems (Innovation Fund 2013).

Author Accepted Manuscript (AAM). Forthcoming in the *British Journal of Management.*

Beyond the Matrix: Visual Methods for Qualitative Network Research

Abstract

Network research remains dominated by approaches involving the analysis of numerical data stored in data matrices with the aim of identifying the effects of hidden social structures. While such research has advanced our understanding of social networks at the inter-personal, inter-unit and inter-organizational level, repeated calls have been made for network research to attend to the situated meanings attached to both relationships and network structures. In this article, we advance a nascent literature on qualitative methods for social network analysis by drawing together developments in visual network research from across the social sciences. We introduce a typology of three visual methods for the collection of network data using network maps: *participatory network mapping*, *network map interviews* and *visual network surveys*. Drawing on three empirical examples from our research in the inter-organizational domain, we demonstrate how these methods can be used for the collection of qualitative and quantitative relational data, and how they can be triangulated with other qualitative methods and Social Network Analysis. We evaluate the merits and limitations of the presented methods and conclude that visual network research is a useful addition to existing methods for network research in business and management studies.

Keywords: Qualitative research methods; visual methods; embeddedness; network governance, inter-organizational networks; social network analysis

Introduction

Given the increased attention the management of alliances, partnerships and meta-organizations has received in recent times, it is not surprising that the literature on networks in business and management has grown exponentially (Oerlemans *et al.*, 2007; Kilduff and Brass, 2010). Whereas, in the past, concepts such as 'network' and 'embeddedness' were used as metaphors for the interdependent nature of organizations, since the 1990s these concepts have become constructs in empirical research (Bergenholtz and Waldstrøm, 2011). In the absence of a coherent theoretical framework for network research, different research programmes have emerged. 'Structuralist' approaches such as Social Network Analysis (SNA) have advanced our understanding of the structural formation of relationships in networks (Borgatti and Foster, 2003).[1] 'Connectionist' studies have delivered important insights into the content of inter-personal, inter-unit and inter-organizational relationships (Borgatti and Foster, 2003; Oerlemans *et al.*, 2007). A separate branch of research examines how actors make sense of relationships and networks (Abrahamsen *et al.*, 2016; Geiger and Finch, 2010).

The fragmentation of the literature has left gaps in our understanding of how organizations, and their members, are embedded in, and strategically navigate, complex networks of relationships (Balkundi and Kilduff, 2006). In order to address this research gap, methods are needed for a simultaneous investigation of the content of different kinds of *relationships*, of their structural configuration in *networks*, and of the *meanings* attached to both relationships and networks (Fuhse and Mützel, 2011; Jack, 2010). In this article, we examine the potential of visual methods for closing this methodological gap. We focus on the use of network maps for the collection of both qualitative and numerical relational network data and demonstrate how visual network research, as an emerging paradigm comprising a wide range of innovative tools and methods, can advance qualitative and mixed-method network research in management research.

Network illustrations have a long history in network research, where advances in software development enable sophisticated graph visualizations. Qualitative methods for visualizing and analysing hand-drawn 'sociograms' or network maps, once prominent among the founders of social network analysis, for a long time received comparatively little attention (Freeman, 2004; Tubaro *et al.*, 2016). Despite drawing on a rich tradition of mapping methods, seminal studies in the field of business and management research have failed to established a canon of methods for qualitative network research (Allen, 1977; Roethlisberger and Dickson, 1939). Over the past decade, a small number of social scientists have developed innovative visual methods for investigating personal networks, in particular migrant networks (Gamper *et al.*, 2012; Lubbers *et al.*, 2010; McCarty *et al.*, 2007; Ryan and D'Angelo, 2018; Stark and Krosnick, 2017). Only a few scholars have experimented with visual methods in research on the inter-organizational domain, and they have been largely inattentive to each other's work (Conway and Steward, 1998; Ramos and Ford, 2011; Schiffer and Hauck, 2010). The purpose of this article is to synthesize and extend their work and to introduce it to a broader audience of management scholars. By demonstrating how visual methods can advance both qualitative and mixed-methods research on embeddedness, relationships and networks, we contribute to an emerging interdisciplinary discourse on how qualitative network research can complement quantitative SNA (Berthod *et al.*, 2017; Ryan and D'Angelo, 2018; Schönhuth and Gamper, 2013; Tubaro *et al.*, 2016; Williams and Shepherd, 2017). While we focus in particular on the application of visual methods for research into (inter-)organizational embeddedness and networks, the methods we present are equally suitable for network research on the personal, team, or group level.

The article proceeds as follows. After a brief review of some of the methodological challenges of network research in management research, we provide an introduction to visual network research, which we define as involving the use of network maps in both data collection and data analysis. We present a new typology of three visual methods for the collection of relational data on the individual, organizational and inter-organizational levels: *participatory network mapping*, *network map interviews* and *visual network surveys*. This sets the scene for three empirical examples from our own research into organizational embeddedness and network governance. Following a discussion of the potential and the limitations of the presented methods, we conclude that methods for visual

network research make for a powerful addition to the methodological toolbox of management researchers.

Researching embeddedness and networks

When studying networks, management researchers tend to focus on how the ways in which actors *relate* to other actors enable or constrain them in their activities or operations. This may involve (a) an inquiry into the quality or interactional content of the different relationships that connect one actors to others (*relational embeddedness*); (b) an analysis of the structural configuration of such relationships and the relative position a person or organization occupies in a given network (*structural embeddedness*); and (c) an investigation of the *meanings* of relationships and network structures (Fuhse and Mützel, 2011; Jack, 2010; Kilduff and Tsai, 2003).

Inter-organizational relationships are intertwined with interpersonal relations (Geiger and Finch, 2010). They evolve along trajectories of interactions between members of different organizations, but they are 'storied' as relationships between organizations that give meaning to past interactions and prescribe rules for future engagement (Crossley, 2011; White, 1992). Interactions across boundaries are often presented as being determined by the embeddedness of a given actor, yet they also amount to *agency* in that they can be purposeful and infused with strategy (Abrahamsen *et al.*, 2016; Emirbayer and Goodwin, 1994). The very notion of embeddedness points to a tension between structural and agentic accounts, which characterizes this field of research (Granovetter, 1985; Gulati and Srivastava, 2014; Tasselli *et al.*, 2014).

Networks exist as patterns of inter*actions* but also as cognitive maps of relationships (Conway, 2014; Knox *et al.*, 2006). This gives rise to a number of conceptual and methodological challenges when we investigate them empirically (Fiol and Huff, 1992; Mehra *et al.*, 2014; Swan, 1997). Relationships may be seen as equivocal (i.e. subject to a variety of interpretations) and their management involves processes of 'sense-making' (Weick, 1995). Whether data on relationships are derived from observations or documents, or are reported in interviews or questionnaire surveys, they are always vulnerable to criticism regarding the accuracy and completeness of the sources they are based on and the judgements made in their abstraction (Conway, 2014). As we will see below,

methods for collecting relational data vary in the degree of control researchers have over the process of abstracting and standardizing relationships, in the degree of complexity they can accommodate and also in their sensitivity to context.

Approaches to studying networks

Network research lacks a unifying theoretical framework (Knox *et al.*, 2006). The dominant tradition of SNA aims at the structural analysis of whole networks (e.g. an entire organizational field) and ego-centric networks (e.g. the network of an individual or organization). Adopting an outsider or 'Copernican view' (Jack, 2010, p. 120), SNA identifies structural features of networks through the analysis of adjacency matrices that record whether or not a particular type of relationship connects a given set of actors. SNA is based on the assumptions that all existing (and potential but non-existing) relationships are recorded, and that all instances of a given relationship are sufficiently similar to be treated as if they were the same. These assumptions are not without problems (Bearman and Parigi, 2004; Conway, 2014).[2]

As a formalist research programme, SNA is concerned with structural patterns rather than the relationships themselves (Erikson, 2013; Oerlemans *et al.*, 2007).[3] Empirical research on social networks has been labelled '*connectionist*' (as opposed to *structuralist*) when it focuses on the content or quality of relationships or 'flows' between actors (Borgatti and Foster, 2003; Oerlemans *et al.*, 2007). Structuralist and connectionist researchers differ in their theoretical lens and corresponding methods. For example, a structuralist may argue that two actors are more likely to adopt the same point of view if they occupy structurally similar positions. A connectionist would examine whether actors become more alike because they share a connection, and they would focus on what this connection entails. From a connectionist perspective, an organization can be seen as being embedded in a complex and dynamic network of interconnected and interdependent relationships with other organizations (Uzzi, 1997). From a structuralist perspective, an organization is embedded not in one but in multiple networks – each of them composed of a different type of relationship recorded in a different matrix (Kilduff and Brass, 2010). These multiplex networks may overlap to some extent but they are unlikely to be fully congruent: a firm may have a collaborative relationship with some, but

not all, of its suppliers; an employee may be close friends with some of her colleagues but not all of them.

Structuralist research has been criticized for missing the tree (i.e. the content of relationships) for the wood (i.e. the network structure), whereas connectionist research has been condemned for missing the larger picture of the 'wood' by focusing on the individual 'tree' of relational content (Jack, 2010; Stinchcombe, 1990). The two traditions can be seen as offering two alternative responses to a practical problem: while the high number of relations connecting large networks makes it difficult to examine each relationship in detail, small networks are by definition limited when it comes to the investigation of more complex structural features. Qualitative data that could inform a structural analysis of a large inter-organizational network can be difficult to collect, store and analyse in a systematic way. In in-depth interviews there is a tendency that the conversation focuses on one relationship after another and not one *in relation to* the other (Schönhuth and Gamper, 2013). This problem has limited the contribution of qualitative methods to our understanding of network structure to an extent that some have questioned whether qualitative social network analysis actually exists (Diaz-Bone, 2008).

There have been repeated calls for network research that attends to the structure of links between organizations while examining 'what flows across the links, who decides on those flows in the light of what interests, and what collective or corporate action flows from the organization of links' (Stinchcombe, 1990, p. 381). Such research would require an analysis of network *structure*, of the content of *relationships and* of the *meaning* of both relationships and networks. By focusing on generalizable social forms, and viewing context mainly as a distraction, SNA has by and large ignored questions of culture, agency and meaning (Emirbayer and Goodwin, 1994; Fuhse, 2009). Rejecting the essentialism that characterizes SNA, the *relationalist* tradition of social network analysis conceptualizes relationships as shaped and (un)made by social context (Erikson, 2013; White, 1992). Relationalist scholars tend to adopt an interpretive stance when examining networks from the perspective of an insider (Erikson, 2013; Jack, 2010). For them 'meaning is inseparable from the study of social networks because relationships are created out of meaning' (Erikson, 2013: p. 227). However, whereas SNA has developed a canon of methods for the structural analysis of

adjacency matrices, there is no systematic overview of methods for relationalist network research (Bellotti, 2015; Schönhuth and Gamper, 2013).[4]

Persistent gaps between connectionist/structuralist and formalist/relationalist research programmes and corresponding methods have limited our understanding of the ways in which actors are embedded in – but also navigate strategically – configurations of different kinds of relationships (Jack, 2010). This is of particular concern to management scholars. In order to better understand the increasingly complex governance arrangements of inter-organizational networks and how they are navigated, how interdependent partnership portfolios are developed and managed, or how teams collaborate within and across organizational boundaries, we need to study the structural configurations of relationships that give rise to interactions and relationships, yet we also have to attend to the meanings that constitute these relationships in order to examine how agency is derived from (and constrained by) them. In the remainder of this article, we examine the potential of *visual methods* for conducting such research and enabling a social network analysis that goes beyond the analysis of adjacency matrices. While we focus on the use of network maps in research on the inter-organizational domain, the three methods we present may also be applied in research on inter-personal relationships and networks, or multilevel research examining nested patterns of relationships.

Visual network research

Visual methods for the mapping of social networks form part of an emerging dialogical approach to visual data in management research (Garreau *et al.*, 2015; Vince and Warren, 2012). They are related to established techniques for cognitive mapping (Geiger and Finch, 2010; Ramos and Ford, 2011; Swan, 1997). What sets visual network research apart from other forms of network research is the use of visualizations in both data collection and data analysis (Schönhuth and Gamper, 2013). Researchers and research participants (co-)create network maps, which can then be analysed in conjunction with associated qualitative and quantitative data, such as interview records and data matrices. In this way, methods for visual network research open up opportunities for investigating the

content of different types of relationships along with their structural configuration in networks, and the meanings attached to both relationships and networks.

Network maps enable the collection of relational data through the simultaneous visualization of visual variables such as actor attributes (different icon shapes, sizes, colours and labels), relational attributes (lines varying in strength, colour and indicators of direction) and some context-related attributes, for example through the use of pre-structured templates compartmentalizing a network into different social spheres (Conway and Steward, 1998; Gamper *et al.*, 2012). Network maps can be created using paper-based or digital tools (Straus, 2013). They have been found to be just as accurate but more engaging than conventional tools for the collection of network data, and they reduce the problem of exaggerated numbers of network connections commonly caused by mechanical responses to network surveys (Hogan *et al.*, 2007; Stark and Krosnick, 2017; Tubaro *et al.*, 2013). Figures 1–3 below show examples of different types of network maps.

Network maps may be created for the collection and verification of relational data or, as an analytical tool, for the analysis of patterns of interdependent or multiplex relationships and networks. Network maps focus exclusively on actors and relationships between actors and in this way differ from *network pictures*, which visualize what research participants 'see in their business surroundings' (Ramos *et al.*, 2012, p. 958), including policies, discourses and institutionalized processes (Geiger and Finch, 2010; Ramos and Ford, 2011). Network maps also differ from *visual network scales*, as introduced by Mehra and colleagues (2014), which are stylized network images of structural features shown to research participants who then evaluate their resemblance to a given network, often using a Likert scale.

Typology of mapping methods

The collection of relational data using network maps generally involves a four-stage procedure, which corresponds to other methods concerned with the generation of visual material and the collection of network data (Vince and Warren, 2012). First, *actor-generating questions* are used for identifying the actors constituting a given network, in this way determining its boundaries. Second, network maps are created by *placing actors on a template map* on paper or on a screen. Third, *relationships are drawn*

in with different lines representing different types of relationships. This may be accompanied by *follow-up questions* on characteristic features of actors, the content or quality of the relationships, and how they compare to one another. Fourth, an initial *interpretation and validation* of the map complete the data collection process.

While these four steps appear relatively straightforward, a review of visual network research reveals important differences in approach and paradigmatic stance, the role of the researcher, the visualization process, the nature of the maps created and their role in both data collection and data analysis (Conway and Steward, 1998; Geiger and Finch, 2010; Hauck and Schiffer, 2012; Hogan *et al.*, 2007; Schönhuth and Gamper, 2013; Straus, 2013; Tubaro *et al.*, 2016). Based on this review, and drawing on our own experiences of conducting visual network research on inter-organizational partnerships and networks, we have devised a typology of three methods involving the use of network maps: *participatory network mapping*, *network map interviews* and *visual network surveys*. In the following sections we introduce each of the three methods, present an empirical example and discuss their respective merits and limitations.

Participatory network mapping

Predominantly used in group settings, participatory network mapping involves the (co-)creation and joint interpretation of network maps (Schiffer and Hauck, 2010). A low degree of structuration and standardization enables a flexible yet focused mapping process (Schiffer and Hauck, 2010). Participatory network mapping is particularly useful for the investigation of (perceptions of) issue-related networks and network governance (Hauck *et al.*, 2015). Participants discuss who influences a certain issue or outcome, and they reflect on relationships they consider important, challenging or in need of improvement. Network maps can be analysed in conjunction with records of the mapping process, which, depending on the research question and paradigmatic stance, may be deemed more important than the map itself (Hauck *et al.*, 2015). With its emphasis on meaningful engagement, participatory network mapping is committed to the principles of participatory research in management and organization studies (Burns *et al.*, 2014; Vince and Warren, 2012).

Figure 1. Participatory network mapping

Network map interviews

In a network map interview, a network map is drawn by either the participant or the researcher in the context of a semi-structured interview (Conway and Steward, 1998; Hogan *et al.*, 2007). Without a visual aid, it can be difficult to reconstruct a complete social network as both interviewer and interviewee can easily lose oversight. Network maps assist with the articulation and verification of patterns of relationships (Straus, 2013). They also increase rapport as the development of a conversation tends to be 'easier when there is some*thing* to talk about' (Vince and Warren, 2012, p. 285, emphasis in original). Guidelines for the mapping process form part of the interview schedule. Network maps may be created as free network drawings or using template maps featuring structured or even standardized elements. For example, the interviewee's organization ('ego') is often shown at the centre of concentric circles representing the relative closeness or importance of contacts – a technique that was originally developed for the analysis of personal support networks (Kahn and Antonucci, 1980; see Figures 2 and 3). Software packages like GENSI, Network Canvas or VennMaker support the (co-)creation of digital network maps (Gamper *et al.*, 2012; Hogan *et al.*, 2016; Melville *et al.*, 2015; Stark and Krosnick, 2017). Depending on the type of network under investigation, network map interviews may be conducted as one-on-one interviews (e.g. in the case of a personal network or a network of a small organisation) or as group interviews (e.g. when mapping the network of a larger organisation).

Network map interviews lend themselves for the in-depth exploration of relational embeddedness. Interviewees may be asked to reflect on similarities, differences and interdependencies between relationships (McCarty *et al.*, 2007). This opens up an analytical point of entry for the comparison of 'storied relationships' and investigations into the interconnectedness of different relationships and how actors draw strategically on different relationships when pursuing certain objectives. Network maps are usually analysed in conjunction with interview transcripts. The narrative data obtained during the drawing process is often considered the most important outcome of a network map interview (Tubaro *et al.*, 2016).

Visual network surveys

Visual network surveys involve the creation of *standardized* network maps through 'sociometric questioning' (Zwijze-Koning, 2005). Data are collected through a questionnaire survey, which combines elements of a conventional network survey with visual elements (Gamper *et al.*, 2012). Software packages such as EgoNet.QF, E-NET, GENSI, Network Canvas and VennMaker translate survey responses into network maps, which are then presented to respondents for verification (Gamper *et al.*, 2012; Halgin and Borgatti, 2012; Melville *et al.*, 2015; Stark and Krosnick, 2017). Most packages aim at the creation of numerical network data (i.e. matrices) on ego-centric networks but some also record responses to open questions. Visual network surveys have been used for formal cross-sectional but also longitudinal investigations of embeddedness. For example, Lubbers and colleagues (2010) used a visual network survey to investigate how the personal networks of migrants change over time. While respondents seem to experience visual network surveys as more engaging than conventional network surveys, the structured procedure and use of predetermined templates limit identification with the map (Hogan *et al.*, 2007; Stark and Krosnick, 2017).

Using network maps in research on (inter-)organizational embeddedness and networks

Drawing on two different studies, we present three empirical examples to illustrate the use of the three methods. In the first study, participatory network mapping and network map interviews complemented SNA in a two-stage investigation of natural resource management in the Upper Blue Nile region of Ethiopia. A conventional questionnaire survey was used to collect data on a diverse

inter-organizational network of 85 organizations. SNA revealed key structural features. Participatory network mapping and network map interviews were then used as two complementary methods for contrasting the structural insights gleaned from SNA with an inquiry into the meanings attached to different relationships and network configurations.

Participatory network mapping was conducted using Net-Map, a tool for mapping multi-actor governance arrangements in focus groups (Schiffer and Hauck, 2010). Groups of eight to ten research participants created network maps. First, they wrote on sticky notes the names of organizations that in their view influenced a governance issue at hand (for example, 'who influences agricultural water management in the Upper Blue Nile region?'). The notes were placed on a large sheet of paper. In a second step, the participants drew in and discussed relationships between the actors. In a third step, they placed stacks of draughts pieces on the map to indicate the relative power of different actors. A joint interpretation of the network map completed the mapping process, which stimulated narrative accounts of how the structure of network (e.g. structural holes), influential actors and difficult relationships impacted on agricultural water management. The map encouraged active participation and kept the discussion focused. Participants examined the embeddedness of their own organizations and reflected on their objectives, strategies and activities in the context of what was being done by others. Figure 1 above depicts such discussion. Key findings, such as tensions between centralized planning and more self-organized governance mechanisms, emerged during the mapping process. After the workshop, the network maps were digitalized using the software package Visone. Organizations that were connected were visualized as closer to one another, whereas unconnected organizations were pushed apart. Another algorithm positioned actors according to their relative influence. An ex post analysis of the observational records of the mapping process and digitalized maps yielded deeper insights into barriers to effective cross-sector coordination.

The second visual method – *network map interviews* – aimed at obtaining rich data on the networks of seven governmental organizations that had been identified as key actors. Three to four representatives of the same organization were interviewed in a group interview using a semi-structured interview guide and network map template on which the respective 'ego' organization was marked at the centre of three concentric circles, which indicated the relative importance of an alter

organization to the respondents' organization (i.e. the closer, the more important). The template map was further divided into four sub-sectors representing the four most relevant policy domains: agriculture, energy, environment and water (see Figure 2 below). Interviewees placed sticky notes with the names of actors on the template. One by one, relationships were then drawn in that represented flows of funding, information exchange, and collaboration. Alter–alter relations were considered where interviewees deemed them important. The narratives elicited during the drawing process provided deep insights into the meanings of relationships and challenges associated with cross-sectoral collaboration (Stein and Jaspersen, 2018). The finalized maps informed a discussion of how the embeddedness of the organization affected its operation and ability to coordinate activities with others. After the interview, the multiplex network maps were digitalized and disaggregated using a software package (in this instance VennMaker), which facilitated comparative analysis across networks (see Figure 2 below).

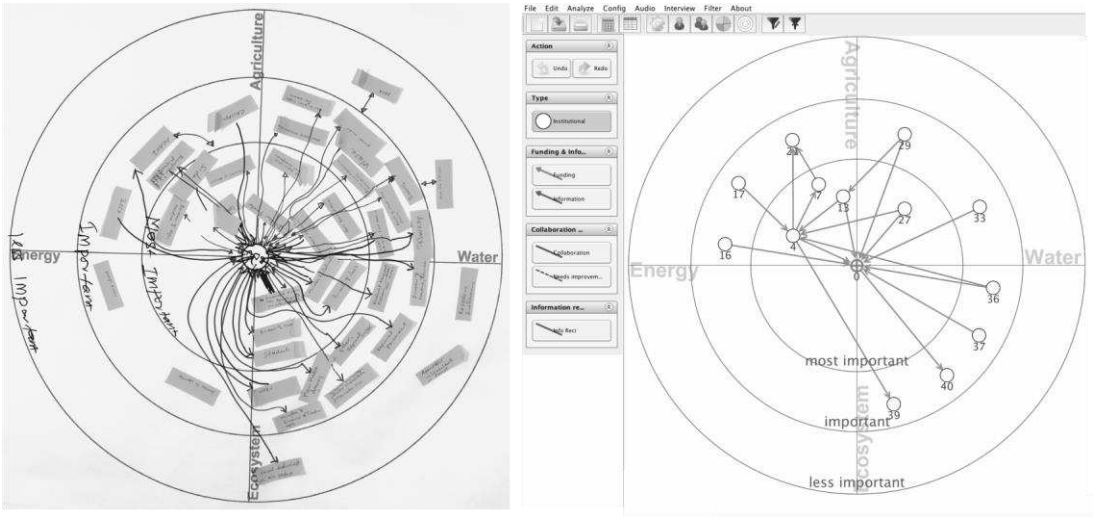

Figure 2. Paper-based ego-centric network map created in network map interview and digitalized and disaggregated map created with software package VennMaker

In a second study, a *visual network survey* complemented a qualitative inquiry into partnerships for renewable energy in international development assistance. In-depth interviews, participant observation and document analysis pointed to the important role of social enterprises in the delivery of off-grid renewable energy, but it had been difficult to gain an overview of how these small enterprises navigate complex and diverse networks (Kruckenberg, 2015). The visual network survey

facilitated an inquiry into the relative importance of different types of relationships for transferring and co-creating technical and non-technical expertise. The survey was conducted with either owner-managers or experienced project managers in an interview setting using a laptop and the software package VennMaker, which combines survey elements with drawing (Gamper *et al.*, 2012; Kronenwett and Schönhuth, 2011).

First, respondents were asked to name all organizations their organization had worked with in the past three years. Follow-up questions helped to determine attributes of these alter organizations including type, size, area of operation and main expertise, as well as their relative importance to the enterprise ('ego'). Based on the responses entered by the interviewer, the software generated an ego-centric network map, which was then presented to the interviewee for discussion and verification. After having been presented with vignettes of a networking relationship, a market relationship and a collaborative relationship, respondents were asked to identify how their organization (i.e. 'ego') related to each of the organizations in the network. Follow-up questions elicited more detailed explanations. Once all relationships had been drawn in, respondents were asked to indicate flows of technical and non-technical knowledge. The survey concluded with a series of questions about the ego organization, about challenging and rewarding relationships, and about relationships between alter organizations. Each step in the mapping process was recorded by the software. Notwithstanding some technical issues, the richness of the qualitative network data obtained during the mapping process exceeded all expectations. When compared to the in-depth interviews that had been conducted in the previous phase of this research, responses were both richer and more focused.

Data analysis proceeded in three steps. In the first step, audio recordings of the interviews were analysed using the QDA software package Atlas.ti and then triangulated with other qualitative data (previous interviews, observational records of meetings and project documents). This process facilitated verification and fed into a structured case record on each network. In a second step, a bespoke template for visual analysis was developed using a vector graphic editor. The template was based on the initial map but enabled the simultaneous visualization of up to five organizational and ten relational attributes (as illustrated in Figure 3). The tool allowed the researcher to overlay and compare different sets of relations (e.g. knowledge flows and types of relationship). The comparative

analysis of ties within networks was accompanied by the retrieval and re-examination of the case records and coded material, and by memo-writing. The memos and analytical network maps fed into a comparative case study of how hybrid organizations strategically navigate partnership networks for renewable energy assistance.

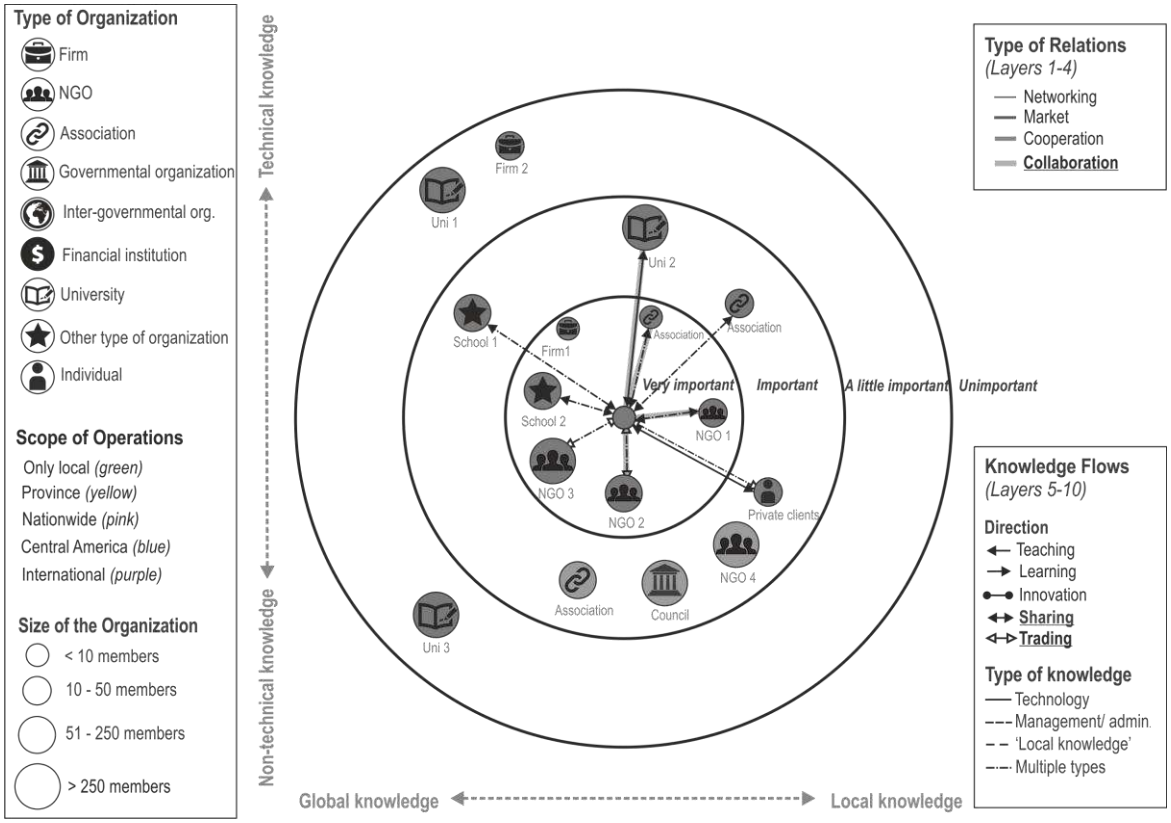

Figure 3. Analytical network map created in vector graphics editor (activated relations: collaboration; knowledge sharing and knowledge trading of multiple types of knowledge)

Discussion

The three examples demonstrate how methods for visual network research open up opportunities for investigating inter-organizational relationships and networks, and the meanings that actors attach to them. The two studies also illustrate how mapping methods can be triangulated with other qualitative methods and how they can contribute to mixed-method research involving SNA. Table 1 below provides an overview of the three methods. In this section, we examine more closely the assumptions underlying participatory network mapping, network map interviews and visual network surveys before turning to five more general design choices to be considered when working with network maps.

Table 1. Mapping methods for visual network research

	Participatory Network Mapping	**Network Map Interview**	**Visual Network Survey**
Methodological approach	*Participatory*: Participants produce network maps in an interactive process	*Interview*: Network maps are created within the context of a semi-structured interview	*Survey*: Software/researcher creates map based on responses to questionnaire
Paradigmatic stance	Subjectivist–inter-subjectivist	Subjectivist–objectivist	Objectivist–subjectivist
Analytical focus	Perception and negotiation of complex issue-related networks	Relational embeddedness and 'storied relationships'	Comparative study of patterns of multiplex relationships
Role of the map in data collection	Mapping process engenders reflection and discussion among participants and with researcher	Network map as boundary object that helps to elicit detailed accounts of relationships in context	Map facilitates systematic collection and verification of quantitative and qualitative relational data
Network map	Some structuration and standardization; whole network or ego-centric network map	Free network drawing up to high degree of structuration and standardization; ego-centric network or whole network map	High degree of structuration and standardization; ego-centric network map
Role of the researcher	Collaborator, facilitator, (participant) observer	Interviewer or participant observer	Administrator of survey or interviewer
Average time required	One to three hours depending on topic of the map and extent of participatory analysis	One to three hours depending on size of the network and number of follow-up questions	One to two hours depending on size of the network and number of relationships and attributes
Data analysis	Network maps interpreted by research participants and embedded researcher (*reflexive hermeneutic*), or researcher may analyse maps in conjunction with observational records of the mapping process (*double hermeneutic*)	Interview recordings/transcripts are analysed in conjunction with network maps (depending on stance *double hermeneutic* or *single hermeneutic*)	Mixed-methods: SNA and qualitative methods. Network maps can facilitate comparative analysis as an analytical tool (depending on stance *single hermeneutic* or *double hermeneutic*)
Strengths	Captures multiple and situated perceptions of complex organizational fields and how actors navigate such fields, can be used in multilevel study and cooperative enquiry	In-depth exploration of (interdependent) relationships, relational embeddedness and organizational strategy/strategic fit	Standardization facilitates comparisons across cases, collection of both quantitative data and qualitative data. Online delivery can facilitate access
Contexts of application (examples)	Governance of complex organizational fields such as innovation (eco)systems	Relational embeddedness, organizational networks and strategy	Organizational networks, partnership portfolios, knowledge flows and learning

Paradigmatic viewpoints

Relationships are by definition subject to a variety of interpretations and processes of 'sense-making' (Weick, 1995). What network maps actually represent and how they can be interpreted depend not only on the respective research question and the research participant's sense-making but also on the researcher's paradigmatic stance. This has important implications for the opportunities and limitations afforded by each of the three methods.

Participatory network mapping involves an open discussion among participants and researchers. It is therefore particularly well-suited to research that adopts an inter-subjectivist paradigmatic stance (e.g. dialogic action research or reflexive auto-ethnography) or a subjectivist stance (e.g. grounded theory or discourse analysis).[5] In the case of inter-subjectivist research, researchers and research participants collaborate in the creation and interpretation of a network map and in a reflexive analysis of the process (*reflexive hermeneutic*). A subjectivist stance implies a two-stage interpretation process or *double hermeneutic*: research participants create a visualization of their perception of a given network, and the researcher then investigates both the map and records of how it has been created (see the first example above). The strength of participatory network mapping lies in the triangulation of situated and interconnected perceptions of (whole) networks, which opens up exciting opportunities for research into how actors engage with complex organizational fields such as innovation (eco)systems or governance networks.

Network map interviews aim at capturing storied accounts of (interdependent) relationships and networks. As such, the method is more closely aligned with the connectionist research agenda. Network maps are seen as part of the concomitant production of meaning and meaning-making within a research process (*double hermeneutic*) or they may be analysed by a detached researcher seeking to discover generalizable laws (*single hermeneutic*). In the first instance, network maps have the function of 'boundary objects' helping to elicit rich data on how interviewees make sense of patterns of relationships in a more systematic way. In the second instance, network maps are visual representations of concrete relational structures that inform behavioural patterns. Either way, network map interviews enable

investigations of patterns of interdependent and/or multiplex relationships that are difficult to capture without the use of visual aids. They also lend themselves to investigations into relational embeddedness with a view to strategic fit and strategy development, for example when examining how a manager or firm sources new ideas from external contacts or orchestrates the input of suppliers.

Visual network surveys enable a systematic collection and validation of relational data but the high degree of structuration and standardization of the network map reduces the potential contribution of the method to relationalist investigations of how respondents perceive and make sense of relationships and networks. Visual network surveys tend to be used by researchers adopting an objectivist stance to network research, and who seek a more engaging data collection tool that supports mixed-methods network research from the perspective of an outsider (*single hermeneutic*). The standardization of both maps and process facilitates comparative research into multiplex relationships, the composition of organizational networks, partnership portfolios or patterns of knowledge flows.

As illustrated by the second study (third example) presented above, visual network surveys can also provide an analytical point of entry for comparative case studies that draw on a wide range of data sources (two-stage interpretation process or *double hermeneutic*). However, composite network maps such as the one illustrated in Figure 3 are *analytical tools* rather than primary data.[6] Like multidimensional matrices, they allow for a simultaneous visualization of multiple actor-related, relational and structural features aiding data verification, pattern recognition and theorizing.

Designing and analysing network maps

This takes us to five more fundamental issues to be considered when working with any one of the three methods. The first relates to the decision whether to map an *ego-centric network* (e.g. an organizational network) or a *whole network* (an inter-organizational network or organizational field). This decision depends on the research interest, but it has important methodological implications. As the accuracy of perceived relationships decreases with social distance (Krackhardt and Kilduff, 1999), network maps of whole networks are likely to include relationships that are merely assumed. Graph visualizations based on aggregated data sets are considered to be more complete and hence superior by those conducting

structuralist network research, and in particular SNA. From a relationalist perspective, network maps can be just as valuable as they visualize how actors *envisage* a given network when they engage with it. Network maps of whole networks therefore can be very useful when investigating phenomena like network governance, in particular when they can be compared to network visualisations based on aggregated data, which may reveal a much more complex but 'hidden' structure. Ego-centric network maps enable a more integrated approach to mixed-methods network research in that they allow for the simultaneous collection of both quantitative and qualitative data.

Second, there are design choices that relate to the *medium*. Researchers can choose between pen and paper, (digital) whiteboards and different software packages. Digital tools can facilitate data collection and data management, but they also limit the design choices available to researchers. For participatory network mapping in particular, we recommend the use of paper-based techniques or a large digital whiteboard, which make the mapping process both more accessible and more flexible. However, paper-based mapping processes can be more difficult to record. Researchers who wish to analyse the mapping process will require video documentation or the assistance of several observers and note-takers. Software packages such as VennMaker record both the interview and mapping process, in this way enabling a micro-analysis of sense-making processes. In the case of the visual network survey, software packages that translate responses into network maps speed up an otherwise tedious data entry and visualization process (Hogan *et al.*, 2007; Stark and Krosnick, 2017).

Third, researchers have to decide about the *degree of structuration and standardization* of both the mapping process and the network map. Free network drawings offer unique insight into how research participants envisage their environment or perceive certain relationships in relation to other relationships. However, some degree of structuration can facilitate communication between researcher and research participants (Schönhuth and Gamper, 2013). Structured and (semi-)standardized maps lend themselves to comparative analysis; fully standardized network maps may be converted into connection matrices. It is important to be clear, however, about the degree of influence the researcher exerts through the provision

of templates and rules for the mapping process: a standardized network map cannot be interpreted in the same way as free network drawing.

This takes us to the fourth issue – the *analysis* of network maps. As we have discussed above, the research interest as well as the paradigmatic stance determine what a network map can (or cannot) represent. This is important to bear in mind when analysing network maps, and it is one of the main reasons as to why we cannot prescribe a set of dedicated procedures for the analysis of network maps. A range of analytic methods are being developed that involve the triangulation of narrative, visual and quantitative relational data (Berthod *et al.*, 2017; Herz *et al.*, 2015; Tubaro *et al.*, 2016). For example, Herz and colleagues (2015) propose a method for 'qualitative structural analysis' that integrates elements of structural analysis based on SNA with established techniques for the analysis of qualitative data, such as sequential analysis, sensitizing concepts and memo-writing. With the advancement of visual network research, we hope to see such analytic methods gain traction and mature, benefitting from cross-fertilization with literatures on social network analysis, visual methodologies and methods for qualitative network research (Bellotti, 2015; Berthod *et al.*, 2017; Kilduff and Tsai, 2003). Visual methods for the analysis of qualitative data, such as Situational Analysis (Clarke, 2005), may inform new methods involving the use of composite maps in the theorizing process.

Finally, we would like to address some of the challenges relating to *access* and *sampling*. While there are software packages that enable an online administration of a visual network survey, most mapping processes require direct engagement with research participants, in particular when rich narrative data are to be collected. This limits the potential application of participatory network mapping and network map interview to research settings where participants are prepared to engage in face-to-face meetings and are willing to commit at least one or two hours of their time, ideally more. Depending on their positions within the organization, research participants are also more or less likely to be aware of certain relationships or they may 'story' them in different ways. Some may consider this a potential source of bias, others a research opportunity in its own right as we still know relatively little about individual differences in network perception and how they are negotiated (Calori *et al.*, 1994). While the

positionality of respondents also affects survey-based SNA in the inter-organizational domain, network mapping (in particular when conducted with groups) can give researchers more insight into the process of abstracting relationships and its sensitivity to context.

Conclusion

Persistent divides between research programmes and corresponding methods for social network analysis have left gaps in our understanding of how individuals, teams and entire organizations are embedded in, and strategically navigate, networks of inter-organizational relationships. In this article, we have examined the potential of network maps for addressing these gaps. We have shown how visual methods enable network research that attends to the situated meanings attached to both relationships and network structures. We conclude that network maps are particularly useful for researchers interested in perceptions of (patterns of) relationships – whether on the individual, group, organizational or inter-organizational level – and who are intending to collect relational data directly from research participants.

Challenges that limit the usefulness of network maps mainly relate to access and network size. There is still a need to calibrate requirements for depth and detail with the size of the network one wishes to study. In a network map interview, the documentation of ten in-depth accounts of relationships can easily take up an hour. Researchers collecting data on ego-centric networks using visual network surveys face similar trade-offs when deciding whether or not to include alter–alter relations. Given that a network of just ten organizations can be connected by up to 45 ties (90 if one considers directed relationships), the collection of data on alter–alter relationships can require a significant amount of time (McCarty *et al.*, 2007). This suggests that mapping methods remain somewhat limited in their contribution to structuralist network research. However, the completion of a visual network survey can take just as long as a conventional questionnaire, with the added benefits of an immediate verification of responses (Stark and Krosnick, 2017).

The (more or less implicit) focus on how ‘storied’ relationships inform agency makes visual network research appear particularly promising for management research. If we really want to understand ‘what flows across […] links, who decides on those flows in the light of what interests, and what

collective or corporate action flows from the organization of links' (Stinchcombe, 1990, p. 381), then the analysis of (hidden) network structures will only ever tell us part of the story. We also need to address questions of culture, agency and meaning (Emirbayer and Goodwin, 1994; Fuhse, 2009). We have shown how participatory network mapping, network map interviews and visual network surveys allow us to do that in different ways. The three methods are flexible enough to accommodate a wide range of research interests and research domains and, as our three examples have illustrated, they can be triangulated with other qualitative methods and lend themselves to mixed-methods network research.

We would like to close by noting that relationalist and formalist approaches to the study of social networks differ on a number of core premises, which can make it difficult to bring them into a constructive dialogue. Network researchers pursuing a formalist research agenda are likely to question the use of different criteria for evaluating the content, appropriateness and accuracy of network visualizations. It is our view that methods for collecting relational data have always varied in their sensitivity to context and in the degree of control that researchers have over the process of abstracting relationships. With their focus on a priori social forms, formalist traditions have by and large side-stepped such concerns (Conway, 2014), whereas visual network research requires researchers to face them head-on. It has been argued that the beauty and rigour of qualitative research 'lie in crafting our research carefully and persuasively, being open and responsive […] and understanding and enacting the relationship between our metatheoretical position, our methods, our theorizing, and their practical consequences' (Cunliffe, 2011, p. 667). We believe that this article testifies to the potential of participatory network mapping, network map interviews and visual network surveys to help researchers succeed on these accounts (and more), and hope that it encourages some of our readers to join us in the further development of visual methods for network research *beyond the matrix*.

Footnotes

1 'Social Network Analysis' (SNA) is an umbrella term widely used for methods associated with the formal analysis of quantitative relational data on patterns of social relationships (whether at the personal, organisational or even societal level), whereas 'social network analysis' and 'social network research' may draw on both quantitative and qualitative relational data.

2 In their seminal paper 'Cloning Headless Frogs and Other Important Matters: Conversation Topics and Network Structure', Peter Bearman and Paolo Parigi (2004) demonstrate the scope of relationships covered by one of the principal questions used to generate interpersonal networks ('From time to time, most people discuss important matters with other people. Looking back over the last six months, who are the people with whom you discussed matters important to you?'). Their findings highlight the importance of questioning the underlying assumptions associated with the collection of standardized relational data.

3 Comparative research into dyads and organizational networks as 'social capital' often treat the presence of particular (standardized) ties and structural features as *attributes* of organizations, and employ statistical methods to analyse how performance measures (or other organizational features) vary between organizations that differ in these attributes. Such variable-centred approach differs from the network perspective adopted in this article.

4 A search on Google Scholar for 'qualitative network' and 'management research' yielded just 58 results, whereas 8770 publications refer to 'Social Network Analysis' and 'management research' (string searches conducted in September 2018).

5 Our three 'paradigmatic leanings' correspond to Cunliffe's typology of three problematics – intersubjectivism, subjectivism and objectivism (Cunliffe, 2011).

6 In the case of Figure 3, a process of triangulation and verification transformed what had been a visual tool for data collection into an *analytical device*. Depending on the kind of research that is being undertaken, such procedure and 'ontological oscillation' may or may not be deemed problematic (Weick, 1995).

References

Abrahamsen, M. H., S. C. Henneberg, L. Huemer and P. Naudé (2016). 'Network picturing: An action research study of strategizing in business networks', *Industrial Marketing Management*, **59**, pp. 107–119.

Allen, T. J. (1977). *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization*. Cambridge Mass.: MIT Press.

Balkundi, P. and M. Kilduff (2006). 'The ties that lead: A social network approach to leadership', *The Leadership Quarterly*, **17**, pp. 419–439.

Bearman, P. and P. Parigi (2004). 'Cloning Headless Frogs and Other Important Matters: Conversation Topics and Network Structure', *Social Forces*, **83**, pp. 535–557.

Bellotti, E. (2015). *Qualitative networks: Mixed methods in social research*. Abingdon, Oxon: Routledge.

Bergenholtz, C. and C. Waldstrøm (2011). 'Inter-Organizational Network Studies—A Literature Review', *Industry & Innovation*, **18**, pp. 539–562.

Berthod, O., M. Grothe-Hammer and J. Sydow (2017). 'Network Ethnography: A Mixed-Method Approach for the Study of Practices in Interorganizational Settings', *Organizational Research Methods,* **20**, pp. 299–323.

Borgatti, S. P. and P. C. Foster (2003). 'The Network Paradigm in Organizational Research: A Review and Typology', *Journal of Management*, **29**, pp. 991–1013.

Burns, D., P. Hyde, A. Killett, F. Poland and R. Gray (2014). 'Participatory Organizational Research: Examining Voice in the Co-production of Knowledge', *British Journal of Management*, **25**, pp. 133–144.

Calori, R., G. Johnson and P. Sarnin (1994). 'CEOs' cognitive maps and the scope of the organization', *Strategic Management Journal*, **15**, pp. 437–457.

Clarke, A. E. (2005). *Situational analysis: Grounded theory after the postmodern turn*. Thousand Oaks: Sage.

Conway, S. (2014). 'A Cautionary Note on Data Inputs and Visual Outputs in Social Network Analysis', *British Journal of Management*, **25**, pp. 102–117.

Conway, S. and F. Steward (1998). 'Mapping Innovation Networks', *Journal of Innovation Management*, **2**, pp. 223–254.

Crossley, N. (2011). *Towards relational sociology*. London: Routledge.

Cunliffe, A. L. (2011). 'Crafting Qualitative Research', *Organizational Research Methods*, **14**, pp. 647–673.

Diaz-Bone, R. (2008). 'Does Qualitative Network Analysis Exist?', *Historical Social Research-Historische Sozialforschung*, **33**, pp. 311–343.

Emirbayer, M. and J. Goodwin (1994). 'Network Analysis, Culture, and the Problem of Agency', *American Journal of Sociology*, **99**, pp. 1411–1454.

Erikson, E. (2013). 'Formalist and Relationalist Theory in Social Network Analysis', *Sociological Theory*, **31**, pp. 219–242.

Fiol, C. M. and A. S. Huff (1992). 'Maps for Managers: Where are we? Where do we go from here?', *Journal of Management Studies*, **29**, pp. 267–285.

Freeman, L. C. (2004). *The development of social network analysis: A study in the sociology of science*. Vancouver, BC, North Charleston, S.C: Empirical Press; BookSurge.

Fuhse, J. and S. Mützel (2011). 'Tackling connections, structure, and meaning in networks: quantitative and qualitative methods in sociological network research', *Quality & Quantity*, **45**, pp. 1067–1089.

Fuhse, J. A. (2009). 'The Meaning Structure of Social Networks', *Sociological Theory*, **27**, pp. 51–73.

Gamper, M., M. Schönhuth and M. Kronenwett (2012). 'Bringing Qualitative and Quantitative Data Together: Collecting Network Data with the Help of the Software Tool VennMaker'. In M. Safar and K. A. Mahdi (eds), *Social networking and community behavior modeling: Qualitative and quantitative measures*, pp. 193–213. Hershey, PA: Information Science Reference.

Garreau, L., P. Mouricou and A. Grimand (2015). 'Drawing on the Map: An Exploration of Strategic Sensemaking/Giving Practices using Visual Representations', *British Journal of Management*, **26**, pp. 689–712.

Geiger, S. and J. Finch (2010). 'Networks of mind and networks of organizations: The map metaphor in business network research', *Industrial Marketing Management*, **39**, pp. 381–389.

Granovetter, M. (1985). 'Economic Action and Social Structure: The Problem of Embeddedness', *American Journal of Sociology*, **91**, pp. 481–510.

Gulati, R. and S. B. Srivastava (2014). 'Bringing agency back into network research: Constrained agency and network action'. In D. J. Brass, G. Labianca, A. Mehra, D. S. Halgin and S. P. Borgatti (eds), *Contemporary perspectives on organizational social networks*. First edition, Volume 40, pp. 73–93. Bingley, England: Emerald Group Publishing Limited.

Halgin, D. S. and S. P. Borgatti (2012). 'An introduction to personal network analysis with E-Net', *Connections*, pp. 37–48.

Hauck, J. and E. Schiffer (2012). 'Between intuition and indicators – Using Net-Map for visual and qualitative social network analysis'. In M. Gamper, L. Reschke and M. Schönhuth (eds), *Knoten und Kanten 2.0: Soziale Netzwerkanalyse in Medienforschung und Kulturanthropologie*, pp. 231–257. Bielefeld: transcript.

Hauck, J., C. Stein, E. Schiffer and M. Vandewalle (2015). 'Seeing the forest and the trees: Facilitating participatory network planning in environmental governance', *Global Environmental Change*, **35**, pp. 400–410.

Herz, A., L. Peters and I. Truschkat (2015). 'How to do 'Qualitative Structural Analysis': The Qualitative Interpretation of Network Maps and Narrative Interviews', *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research; Vol 16, No 1 (2015)*.

Hogan, B., J. A. Carrasco and B. Wellman (2007). 'Visualizing Personal Networks: Working with Participant-aided Sociograms', *Field Methods*, **19**, pp. 116–144.

Hogan, B., J. R. Melville, G. L. Philips, P. Janulis, N. Contractor, B. S. Mustanski and M. Birkett (2016). 'Evaluating the Paper-to-Screen Translation of Participant-Aided Sociograms with High-Risk Participants', *Proceedings of the SIGCHI conference on human factors in computing systems. CHI Conference*, **2016**, pp. 5360–5371.

Hollstein, B. (2011). 'Qualitative approaches'. In P. J. Carrington and J. Scott (eds), *The SAGE handbook of social network analysis*, pp. 404–416. London: Sage.

Jack, S. L. (2010). 'Approaches to studying networks: Implications and outcomes', *Journal of Business Venturing*, **25**, pp. 120–137.

Kahn, R. L. and T. C. Antonucci (1980). 'Convoys of life course: Attachment, roles, and social support'. In D. L. Featherman, R. M. Lerner and M. Perlmutter (eds), *Life-span development and behavior*, pp. 253–286. Hillsdale, NJ: Erlbaum.

Kilduff, M. and D. J. Brass (2010). 'Organizational Social Network Research: Core Ideas and Key Debates', *The Academy of Management Annals*, **4**, pp. 317–357.

Kilduff, M. and W. Tsai (2003). *Social networks and organizations*. London, Thousand Oaks, Calif: Sage.

Knox, H., M. Savage and P. Harvey (2006). 'Social networks and the study of relations: networks as method, metaphor and form', *Economy and Society*, **35**, pp. 113–140.

Krackhardt, D. and M. Kilduff (1999). 'Whether close or far: Social distance effects on perceived balance in friendship networks', *Journal of Personality and Social Psychology*, **76**, pp. 770–782.

Kronenwett, M. and M. Schönhuth (2011). *VennMaker 1.2 Anwenderhandbuch*. Trier; available at http://vennmaker.uni-trier.de/dl/VennMaker_1_2_Anwenderhandbuch.pdf.

Kruckenberg, L. J. (2015). 'Renewable energy partnerships in development cooperation: Towards a relational understanding of technical assistance', *Energy Policy*, **77**, pp. 11–20.

Lubbers, M. J., J. L. Molina, J. Lerner, U. Brandes, J. Ávila and C. McCarty (2010). 'Longitudinal analysis of personal networks. The case of Argentinean migrants in Spain', *Social Networks*, **32**, pp. 91–104.

McCarty, C., J. L. Molina, C. Aguilar and L. Rota (2007). 'A Comparison of Social Network Mapping and Personal Network Visualization', *Field Methods*, **19**, pp. 145–162.

Mehra, A., S. P. Borgatti, S. Soltis, T. Floyd, D. S. Halgin, B. Ofem and V. Lopez-Kidwell (2014). 'Imaginary Worlds: Using Visual Network Scales to Capture Perceptions of Social Networks'. In D. J. Brass, G. Labianca, A. Mehra, D. S. Halgin and S. P. Borgatti (eds), *Contemporary perspectives on organizational social networks*. First edition, Volume 40, pp. 315–336. Bingley, England: Emerald Group Publishing Limited.

Melville, J., B. Hogan, M. Birkett, G. Phillips II, N. Contractor and B. Mustanski (2015). *Netcanvas: designing a research Instrument for Greater Reliability and User Experience: Conference Talk.* International Sunbelt Social Network Conference XXXV, Session: Egocentric Networks 2. 25 June 2015, Brighton.

Oerlemans, L., T. Gössling and R. Jansen (2007). 'Inside Networks - A Process View on Inter-organisational Relationships and Networks'. In T. Gössling, L. A. G. Oerlemans and R. Jansen (eds), *Inside networks: A process view on multi-organisational partnerships, alliances and networks*, pp. 1–12. Cheltenham: Edward Elgar.

Ramos, C. and I. D. Ford (2011). 'Network pictures as a research device: Developing a tool to capture actors' perceptions in organizational networks', *Special Issue on Industrial Marketing Strategy and B2B Management by SMEs*, **40**, pp. 447–464.

Ramos, C., S. C. Henneberg and P. Naudé (2012). 'Understanding network picture complexity: An empirical analysis of contextual factors', *Industrial Marketing Management*, **41**, pp. 951–972.

Roethlisberger, F. and W. J. Dickson (1939). *Management and the worker*. Cambridge, Mass: Harvard University Press.

Ryan, L. and A. D'Angelo (2018). 'Changing times: Migrants' social network analysis and the challenges of longitudinal research', *Social Networks,* **53**, pp. 148-158.

Schiffer, E. and J. Hauck (2010). 'Net-Map: Collecting Social Network Data and Facilitating Network Learning through Participatory Influence Network Mapping', *Field Methods*, **22**, pp. 231–249.

Schönhuth, M. and M. Gamper (2013). 'Visuelle Netzwerkforschung: Eine thematische Annäherung'. In M. Schönhuth and M. Gamper (eds), *Visuelle Netzwerkforschung: qualitative, quantitative und partizipative Zugänge*, pp. 9–32. Bielefeld: transcript.

Stark, T. H. and J. A. Krosnick (2017). 'GENSI: A new graphical tool to collect ego-centered network data', *Social Networks*, **48**, pp. 36–45.

Stein, C. and L.J. Jaspersen (2018). 'A relational framework for investigating nexus governance', *The Geographical Journal*, in press.

Stinchcombe, A. L. (1990). 'Weak Structural Data', *Contemporary Sociology*, **19**, pp. 380–382.

Straus, F. (2013). ''Das Unsichtbare sichtbar machen': 30 Jahre Erfahrungen mit qualitativen Netzwerkkarten'. In M. Schönhuth and M. Gamper (eds), *Visuelle Netzwerkforschung: qualitative, quantitative und partizipative Zugänge*, pp. 33–58. Bielefeld: transcript.

Swan, J. (1997). 'Using Cognitive Mapping in Management Research: Decisions about Technical Innovation', *British Journal of Management*, **8**, pp. 183–198.

Tasselli, S., M. Kilduff and J. I. Menges (2014). 'The Microfoundations of Organizational Social Networks', *Journal of Management*, **41**, pp. 1361–1387.

Tubaro, P., A. A. Casilli and L. Mounier (2013). 'Eliciting Personal Network Data in Web Surveys through Participant-generated Sociograms', *Field Methods*, **26**, pp. 107–125.

Tubaro, P., L. Ryan and A. D'Angelo (2016). 'The Visual Sociogram in Qualitative and Mixed-Methods Research', *Sociological Research Online*, **21**, pp. 1–18.

Uzzi, B. (1997). 'Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness', *Administrative Science Quarterly*, **42**, pp. 35–67.

Vince, R. and S. Warren (2012). 'Participatory Visual Methods'. In G. Symon and C. Cassell (eds), *Qualitative organizational research: Core methods and current challenges*, pp. 275–295. London: Sage.

Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks, London: SAGE Publications.

White, H. C. (1992). *Identity and control: A structural theory of social action*. Princeton, N.J: Princeton University Press.

Williams, T. A. and D. A. Shepherd (2017). 'Mixed Method Social Network Analysis', *Organizational Research Methods*, **20**, pp. 268–298.

Zwijze-Koning, K. H. (2005). 'Auditing Information Structures in Organizations: A Review of Data Collection Techniques for Network Analysis', *Organizational Research Methods*, **8**, pp. 429–453.