CIRCLE

LUND UNIVERSITY

Papers in Innovation Studies

Paper no. 2014/28

Combinatorial knowledge bases: integrating cognitive, organizational and spatial dimensions in innovation studies and economic geography

Jesper Manniche (jesper@crt.dk)
Centre for Regional and Tourism Research (CRT), Bornholm, Denmark

Jerker Moodysson (jerker.moodysson@circle.lu.se)
Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, Sweden

Stefania Testa (stefania.testa@unige.it)
Polytechnic School, University of Genova, Italy

This is a pre-print version of a paper that has been submitted for publication to a journal.

This version: December 2014

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications

WP 2014/28

Combinatorial knowledge bases: integrating cognitive, organizational and spatial dimensions in innovation studies and economic geography

Jesper Manniche, Jerker Moodysson and Stefania Testa

Abstract

This paper has three aims. Firstly, to provide a critical review of previous conceptualizations of the knowledge base approach in the research fields of innovation studies and economic geography. Secondly, to propose a broadened interpretation of the knowledge base approach which allows for considering combinatorial knowledge bases within and across industries, regions and time periods and for analytically integrating the cognitive, organizational and spatial dimensions of innovation and learning. Thirdly, to provide methodological suggestions for how to apply such broadened interpretation of the knowledge base approach in empirical innovation studies, regardless of industrial, geographical or temporal context. The paper thereby dismisses the wide-spread taxonomical application of knowledge base conceptualizations in innovation studies and economic geography for classification of firms, industries and economies into fixed categories based on their knowledge base characteristics. Instead it proposes a typological approach and a conceptual and methodological basis for explaining the shifting dynamics of innovation processes in firms, industries and economies. In addition to highlighting limitations and strengths of the knowledge base approach, the paper thus targets investigation of unexploited potentials of knowledge base conceptualizations and provides suggestions for future research.

JEL codes: L20, O31, O32

Keywords: Biographies, economic geography, innovation, knowledge, learning

Combinatorial knowledge bases: integrating cognitive, organizational and spatial dimensions in innovation studies and economic geography

Jesper Manniche*, Jerker Moodysson[#], Stefania Testa[¤]

* Centre for Regional and Tourism Research (CRT), Bornholm, Denmark (jesper@crt.dk)

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, Sweden (jerker.moodysson@circle.lu.se)

¤ Polytechnic School, University of Genova, Italy (stefania.testa@unige.it)

Abstract

This paper has three aims. Firstly, to provide a critical review of previous conceptualizations of the knowledge base approach in the research fields of innovation studies and economic geography. Secondly, to propose a broadened interpretation of the knowledge base approach which allows for considering combinatorial knowledge bases within and across industries, regions and time periods and for analytically integrating the cognitive, organizational and spatial dimensions of innovation and learning. Thirdly, to provide methodological suggestions for how to apply such broadened interpretation of the knowledge base approach in empirical innovation studies, regardless of industrial, geographical or temporal context. The paper thereby dismisses the wide-spread taxonomical application of knowledge base conceptualizations in innovation studies and economic geography for classification of firms, industries and economies into fixed categories based on their knowledge base characteristics. Instead it proposes a typological approach and a conceptual and methodological basis for explaining the shifting dynamics of innovation processes in firms, industries and economies. In addition to highlighting limitations and strengths of the knowledge base approach, the paper thus targets investigation of unexploited potentials of knowledge base conceptualizations and provides suggestions for future research.

JEL codes: L20, O31, O32,

Keywords: biographies, economic geography, innovation, knowledge, learning

1. Introduction

During the last couple of decades, innovation studies scholars from various disciplines have paid abundant attention to explaining differences with regard to organization and outcome of innovation processes between different economic activities. It is often claimed that certain industries in which interpersonal relations and applied learning processes are of crucial importance for innovative capacity tend to organize large parts of their interaction and knowledge exchange on a local scale (Storper and Venables, 2004). On the contrary, networks of industries in which innovation processes are more formalized, regulated and research based tend to be more globally distributed (Asheim and Gertler, 2005; Gertler and Levitte, 2005). Typical examples of the former would be creative industries like media, advertisement and design, while the latter could be illustrated by science-based industries like pharmaceuticals, software and ICT (Martin and Moodysson, 2012). These observed patterns are often explained by the differing degree of transferability of knowledge used as crucial input in the respective innovation process, but empirical evidence as well as theoretical arguments for such explanations seems still underdeveloped (Bathelt et al, 2004).

While not dismissing these established views on transferability of knowledge and the way they have been used for explaining spatial patterns of innovation, this paper provides a complementary perspective by also focusing on how the crucial knowledge of innovation processes is created, applied and diffused within and between organisations involved in the innovation process. This means that the transferability of knowledge in space remains an important dimension but it has to be complemented with other dimensions assessing the underlying rationale for knowledge creation, interpretation and adoption of knowledge by various actors involved in the process and, not least, how this varies over time. This also means that the focus of analysis is on activities carried out by firms, rather than on firms as a whole, groups of firms or even sectors, which is common in the literature (e.g. Pavitt, 1984).

A focus on activities rather than firms and sectors is justified by findings from recent studies which have confirmed that modes of innovation differ substantially between firms within the same sector and that there are large categories of firms with similar modes of innovation across different sectors (Leiponen and Dreijer, 2007; Shrolec and Verspagen, 2012). In other words, it can be argued that while sector-based analyses still may be useful for understanding the composition of economies at various territorial scales, such approaches face limitations when it comes to explaining the organization of innovation activities. Thus, there is a need for alternative approaches to understand how innovation activities are organized within and between firms, regardless of which sector they belong to.

The approach applied and developed in this paper is referred to as the combinatorial knowledge base approach (CKB). It was first introduced by Laestadius (2000) and further developed by Asheim and Gertler

(2005) and various followers during the last decade (e.g. Asheim and Mariussen, 2003; Coenen et al., 2003; Hansen et al., 2005; Moodysson, 2008; Manniche, 2012; Mattes, 2012; Aslesen and Freel, 2013). Early contributions applied the approach for classifying and comparing industries and aggregates of firms more or less as an alternative to more traditional sector-taxonomies (Asheim and Coenen, 2005), while more recent studies have explored the possibility of assessing the shifting role of various knowledge bases throughout the same innovation processes within the same firm and industry (e.g. Moodysson, 2008; Moodysson et al, 2008; Manniche and Testa, 2010; Manniche, 2012; Strambach 2012; Testa, 2014).

These more recent contributions, upon which this paper builds further, strongly emphasize that the same actors (firms, project groups, individuals) may be influenced by and draw upon several knowledge bases and describe learning approaches at the micro level of learning groups and communities. The aim of the paper is threefold:

1) to clarify the definition and scope of the CKB approach as applied in the literature,
2) to provide a broadened interpretation of the CKB approach and explain its usefulness,
3) to suggest a research method for effectively applying the approach in innovation studies and economic geography

The remainder of the paper is organized as follows. Section two presents a critical review of the definition and scope of the CKB approach as applied in the economic geography literature hitherto. Section three provides a broadened interpretation of the CKB approach as applied in the present paper. Section four provides methodological suggestions for effectively applying the CKB approach in innovation studies. The paper ends with conclusions which intend to further our understanding of the organisation of innovation within and between firms and related organisations in different industries and sectors.

2. The definition and scope of the knowledge base typology: a critical review

The typology according to seminal contributions

In recent years, many typologies of knowledge have been suggested and applied in innovation studies and economic geography (for an extensive review, see Kakabadse et al., 2003). One example is the typology of 'knowledge bases'. This typology distinguishes three different knowledge bases: analytical, synthetic and symbolic which, in the words of its proponents, are defined as follows: "The analytical knowledge base comprises (predominantly scientific) knowledge that is geared to understanding and explaining features of the (natural) world. The synthetic knowledge base refers to the (predominantly engineering) knowledge involved in the design and construction of solutions to human problems, which is often instrumental,

context specific, and practice related. The symbolic knowledge base deals with the creation of cultural meaning through transmission in an affecting sensuous medium." (Asheim et al., 2007b, pp. 660-661).

As suggested by Asheim and Gertler (2005), the distinction between knowledge bases takes into account that innovations may rely not only on varying knowledge contents but also on varying learning modes, approaches to reasoning and criteria for validation of knowledge, specific innovation challenges and pressures, as well as different types of interplays between actors in the processes of creating, transmitting and absorbing knowledge (Moodysson et al., 2008). This, in turn, contributes to explaining the different sensitivity to geographical distance and, accordingly, the varying importance of spatial proximity between networked actors for generation, application and diffusion of new sets of knowledge in different types of economic activities (Martin and Moodysson, 2012).

As underlined by Asheim et al. (2011, p. 1135), the rationale of this new typology resides in the fact that "Knowledge processes have become increasingly complex in the globalizing knowledge economy. The binary argument of whether knowledge is codified or tacit becomes too simplistic to accommodate this increased complexity and provide an adequate understanding of knowledge creation, learning and innovation (...). Thus, a need to go beyond this simple dichotomy can be identified".

In the first papers (e.g. Asheim and Gertler, 2005; Asheim and Mariussen, 2003; Coenen et al., 2003; Hansen et al., 2005), the authors generally speak about a "knowledge base approach". The term "differentiated industrial knowledge base" is used only once in Coenen and Moodysson (2009) while the term "differentiated knowledge bases" has gained dominance in more recent work (see e.g. Asheim 2007; Asheim et al. 2011; Manniche 2012; Martin and Moodysson 2011a). The term "combinatorial knowledge base" appears for the first time in this special issue. Such a term implicitly claims that today's innovation processes no longer rely solely on cumulative, path dependent knowledge dynamics within specific sectors and regions but increasingly are realised through combinatorial knowledge dynamics developing in multi-location and cross-sector ways (Strambach and Klement, 2012). However, whether such a proclaimed shift from cumulative to combinatorial knowledge dynamics concerns the ways individuals and collectives learn and create knowledge per se or the ways that different types of knowledge is combined and used (by organizations) in the course of realising innovations, remains unclear. We argue in favour of the latter and suggest understanding 'combinatorial knowledge bases' mainly in terms of organizational activities of applying knowledge in innovations. This will be done as part of the below review of the use of the knowledge bases typology in the literature and of the resulting evidence regarding its scope and limitations.

The typology as applied in the literature

In particular the early contributions (e.g. Asheim and Mariussen, 2003; Asheim and Gertler 2005; Asheim et al. 2007) use the knowledge base typology to explain different geographies of cluster formations and knowledge network configurations at an aggregated industrial or regional level. These papers apply the typology for classifying and comparing regional innovation and production systems, industries and aggregates of firms more or less as an alternative to more established sector taxonomies (e.g. Asheim and Coenen, 2005; Coenen et al., 2006; Martin and Moodysson, 2011; Mattes 2012). Although the authors often introductorily mention that the knowledge bases are ideal-typical and that all three appear in all industries with different intensities, they basically conclude (e.g. Asheim and Mariussen, 2003; Martin and Moodysson, 2013) that emerging industries (such as life science) are characterized by analytical knowledge dynamics, traditional industries (such as food) are characterized by synthetic knowledge dynamics, and artistic industries (such as media) are characterized by symbolic knowledge (e.g. Martin et al., 2012). However, a few contributions (e.g. Asheim and Mariussen, 2003; Moodysson et al., 2008) also acknowledge that, within the same industry, it is possible to identify different innovation sub-systems, characterized by a different knowledge bases (for example in the predominantly synthetic innovation system of the food industry there is room for the analytical innovation sub-system of functional food (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008)).

In a similar vein of generalization, while the definition provided above states that synthetic knowledge is *predominantly* engineering based and analytical knowledge is *predominantly* scientific, often the terms have been used as if they were *exclusively* referring to engineering or scientific knowledge. Such shorts-cuts somehow violate the definition of the typology, crossing the formal borders of domains, sectors and occupations. Indeed it takes demanding qualitative research methods to exploit the analytical potentials of the typology but compromising on its definition bears the risk of eroding its possible value-added as compared to other concepts. Three man arguments for these concerns are highlighted.

Firstly, generalized classifications do not always reflect the true nature of the economic activity under study. Secondly, and partly an explanation to the inaccuracy of such generalized classifications, today's globalized knowledge economy are made of an increasing number of multi-product and multi-technology firms and the so called platform technologies have become more influential in a range of sectors. Thirdly, as introductory stated, recent studies have shown that modes of innovation differ substantially between firms within the same sector and that there are large categories of firms with similar modes of innovation across sectors (Leiponen and Dreijer, 2007; Shrolec and Verspagen, 2012).

Despite the oversimplification of the above referred analyses, they have provided important contributions in terms of identifying and describing the differentiated knowledge characteristics of specific regional and sectoral production and innovation systems and in terms of inputs to formulation of policies that abandon the one-size-fits-all traditions which too often are observed and criticized (see e.g. Asheim et al., 2011;

Halkier, 2012; Halkier et al., 2012). Several studies have suggested the knowledge base of firms and industries as the main point of departure for "fine-tuning" regional policy (e.g. Martin et al., 2012; Asheim et al., 2012).

More recently the knowledge base approach has been applied to unpacking learning processes within firms in specific innovation projects. In brief, in this group of papers the knowledge base typology is used for identifying and describing knowledge creation processes at the micro-level of individual actors or groups of actors, and is not applied for taxonomy-like classification of firms, sectors or systems. In some cases, only analytical and synthetic knowledge bases are taken into consideration (e.g. Moodysson, 2008; Moodysson et al., 2008; Coenen and Moodysson, 2009), while in others the role of symbolic knowledge is emphasized too (e.g. Hermelin et al., 2014; Manniche and Testa, 2010; Testa, 2014; Strambach, 2012; van Tuijl and Carvalho, 2014).

A main contribution to the empirical application of the knowledge base typology on innovation studies is provided by a stream of papers and books resulting from or related to the EU EURODITE project[1] (see e.g. Cooke et al. 2010; Crevoisier and Jeannerat 2009; Jeannerat and Crevoisier, 2011; Halkier et al., 2012; Hermelin et al., 2014; Manniche and Larsen, 2009, 2013; Strambach, 2012; Strambach and Klement, 2013). In the project, more than 50 case studies of wide-ranging knowledge dynamics and varying types of actors, networks and communities involved in and contributing to firm-level innovations were produced. As noted by Manniche (2012), the comparability of the empirical data collected through these case studies may be questioned due to differences among the many involved research teams regarding the precise interpretation of the CKB construct and other of the applied, complex concepts and methodologies. However, the empirical case studies seem to suggest that organizations, when engaged in the realization of innovations, rarely rely on interactions within one single knowledge base but rather coordinate their actions in and combine the cognitive output of several interrelated learning modes, communities and contexts. Moreover, , the EURODITE data indicates that innovations can be decomposed into distinct phases of micro-level knowledge creation targeted the development of specific 'bricks' of knowledge needed for realising the innovation and that the three ideal-typical knowledge bases, if interpreted in a broad and inclusive way rather than a narrow and rigorous manner, are applicable for describing and classifying such (cumulative) phases of knowledge creation. Hence, the case studies provide empirical evidence for suggesting that the principles of the three knowledge bases are employed with different intensity in different phases of innovation processes but individually rather than in combinations, and that the output of individual phases of analytical, synthetic or symbolic knowledge creation subsequently is combined with the results of other (analytical, synthetic or symbolic) knowledge creation phases (for

[1] The EURODITE project, Regional Trajectories to the Knowledge Economy: A Dynamic Model, was supported by the EU Sixth Framework program, Priority 7: Citizens and Governance in a Knowledge Based Society, Proposal/Contract no.: 006187, Integrated Project (2005–2010).

illustrations of such combinatorial knowledge dynamics, see e.g. Strambach and Klement, 2012; Manniche, 2012). These findings suggests that innovating organizations indeed combine outputs of activities based on several knowledge bases, but they do not necessarily imply that the knowledge creation processes within the individual knowledge bases, for instance the (analytical) molecular research of chemical scientists, are combinatorial and no longer cumulative in nature. This proposes an understanding of the term 'combinatorial knowledge bases' in which the *combinatorial* element is ascribed to the organizational level of knowledge coordination and exploitation rather than to the micro-level of learning and knowledge creation of individual actors and communities.

The value added of a CKB typology

As mentioned above, a main theoretical value-added of the knowledge base typology is connected with the possibilities of transcending the traditional dichotomy between codified and tacit knowledge as well as the common distinction in innovation research between 'high tech' and 'low tech' activities and sectors (Asheim et al., 2011). Compared to other typologies and concepts for categorizing and analysing knowledge, the CKB approach is inclusive regarding the involved types of knowledge, modes of learning, actors and social contexts, suggested important for innovations. In particular, the inclusion of symbolic knowledge as an in principle equally important knowledge category alongside the analytical and synthetic types of knowledge that traditionally are considered in innovation studies, opens opportunities for studying the knowledge dimensions of important ongoing trends in markets and economies such as the 'culturization of economies' (Allen, 2004; Power and Scott, 2004), i.e. how the creation of scientific and technological knowledge is influenced by socio-cultural dynamics and values and how consumers and consumption resources such as product knowledge increasingly are engaged in the innovations and value-creating activities of private enterprises (Crevoisier and Jeannerat, 2009; Pine and Gilmore, 1999). In this empirical context, the conceptualization of the specific (symbolic) type of knowledge and mode of learning that in particular seems accentuated by these changes, gives the knowledge bases typology an extra valuable dimension.

It is important to stress here, though, that the symbolic knowledge type should not be restricted to cover the artistic and aesthetic activities and competences of creative designers and artists, but also is suitable for describing more mundane and widespread forms of knowledge activities connected with, for instance, communication and customer services (see e.g. Manniche and Larsen, 2009). In general, as said before, the potentials of the typology are best exploited if the ideal-typical categories are interpreted in a broad and inclusive way rather than a narrow and rigorous manner. This allows a break with the strong empirical bias within innovation studies on very distinct forms of advanced science and high-tech activities within specific

(urban) clusters and professional communities and a more open perspective for also considering the role of less formally sophisticated types of knowledge and innovations for instance in traditional manufacturing or services sectors.

Furthermore, the typology does not suggest any predetermined, logical, linear phases of knowledge development but proposes instead three generalized principles of questioning and reasoning and criteria for validating knowledge. Hence, in a conceptually simple structure of three ideal-typical categories the typology captures and connects a wide spectrum of differing types of knowledge, learning and actors that industrial innovation may be sourced from but that usually are not considered as part of one coherent analytical framework, ranging from abstract scientific theory building, over technological problem solving and practical learning-by-doing, and to interpersonal communication and customer observation via social medias. Applying the typology as a coherent conceptual tool (rather than the categories individually) provides a useful lens for identifying the roles and interconnectedness of differing micro-level knowledge creation processes in innovations and thereby for further studying of the intra- and inter-organizational actor constellations and further contextual conditions (including time and space) of these knowledge processes.

Yet, despite its above mentioned advantages, the CKB typology certainly also has limitations. The CKB construct suggests that all three knowledge bases are important and are combined in innovations but does not specify why, how and when 'combinatorial' knowledge dynamics take place. In other words, it fails to specify the organizational aspects of knowledge coordination and management. This limitation and its methodological implications are dealt with in the following section.

3. A broadened interpretation of the CKB-approach

Despite the evident strengths of the CKB approach, which have been highlighted in the previous section and which have been testified over time by the many publications applying the CKB approach, a few weaknesses ought to be mentioned.

Firstly, while the knowledge creation dimension is at the core of most innovation processes, it is arguably not the only and maybe in some cases not even the most important part of the innovation process (e.g. Smith et al., 2005). Equally important as the creation of knowledge, and the overcoming of technological challenges, are, for example, the acquisition, re-interpretation, application, and diffusion of knowledge (Holzner and Marx, 1979; Alavi and Leidner, 2001; Swan and Scarbrough, 2001). These dimensions may be contingent on, or even determined by, the nature of knowledge, as specified in the CKB typology, but it may be equally contingent on other characteristics. Such characteristics, not directly related to knowledge

creation per se, may be strongly decisive for the actual organisation of innovation processes. Examples of such are different types of organisational factors such as firm size, age, and country of origin; key individuals' personal networks and professional experiences, and a range of other institutional constrains and incentives which may influence the organisation of the process in one way or another (see e.g. Daft, 2007; Rothaermel and Hess, 2007). While the CKB approach in a convincing way addresses the knowledge creation dimension of innovation, it does not pay much attention to the other dimensions mentioned above. Therefore it remains an incomplete model for depicting how innovation processes are organized in practice.

Secondly, while the CKB proponents suggest that innovations draw on combinations of the three knowledge bases, they do not conceptualize or indicate why, how and when innovating organizations coordinate and combine the varying cognitive practices associated with the different knowledge bases. Through assessing the dominant or crucial knowledge base at the time of analysis the knowledge base approach can for instance convincingly claim that activities heavily dependent on analytical knowledge would be less hampered by spatial distance with respect to knowledge transferability between learning counterparts than activities heavily based on synthetic knowledge, but such identification of distance decay or barriers is not sufficient for explaining empirical observations revealing that some innovation processes actually are organized in global networks while some take place on a local scale. This is because there might be other, equally or more important factors than the transferability of knowledge or modes of knowledge creation explaining this outcome, and there might be a time-lag involved in defining the spatial distribution of knowledge networks implying that barriers of transferability and accessibility of knowledge at one point in time may influence the outcome of network formation at another point in time when the transferability and accessibility barriers are no longer present. This second concern is thus strongly related to the first.

The two weaknesses identified above call for a broadened and more inclusive interpretation of CKB. Such interpretation proposes paying closer attention to other dimensions than knowledge creation and transferability of knowledge. Not least the managerial-organizational dimensions of innovation must be included in the conceptual model, since these have a strong impact on knowledge diffusion and application within and between organisations and since they may also imply organisational routines and incentives which are equally strong or even stronger than the knowledge creation and transferability preconditions. In this paper's view, innovation processes are based on three interrelated dynamic processes:

1. the intra- and inter-organizational individual processes of creating and validating new knowledge,

2. the managerial-organizational processes through which the innovating organization coordinates, combines and exploits the outcomes of such knowledge dynamics,

3. the contextual (spatial, institutional, sectorial, technological, social etc.) processes framing and affecting the above processes.

These three processes receive various attentions by different strands of literature within innovation studies and attempts of integrating all three levels represent an exception although several authors (see e.g. Baldridge and Burnham 1975) have underlined the importance of doing so. The process of creating and validating new knowledge is the main focus of literatures within the fields of organizational and workplace learning, based on social, collective, practice-related and community-centred understandings of knowledge (e.g. Amin and Cohendet, 2004; Lave and Wenger, 1991; Cook and Brown, 1999; Gherardi, 2009; Knorr-Cetina, 1999, 2001; Nerland, 2011). The processes of knowledge coordination is a central topic within organizational management research, based on understandings of knowledge creation as a basically cognitive (as opposed to social) activity and conceptualizations such as ambidexterity, i.e. the need of balancing knowledge exploration and knowledge exploitation (e.g. March, 1991; Gupta et al., 2006; Lavie et al., 2011; Tushman and O'Reilly, 1996). The spatial and institutional context for knowledge creation is a traditional focus of economic geography research, e.g. within the varying 'Territorial Innovation Models' (Moulaert and Sekia, 2003) such as 'regional innovation systems' (Cooke, 1992), and 'learning regions' (Morgan, 1997) which commonly emphasize the role of localized, institutionalised and path-dependent forms of interactive learning and knowledge development.

Even though the knowledge base approach originates from and draws upon combinations of these different strands of literature it lends more heavily towards the first and third, while the second has been largely overlooked. Yet, integrating these three perspectives into a reinterpreted CKB approach strengthens the abilities to provide more sensitive explanations as to how firms organize their innovation processes and why and how such organisation varies over time and across space. While the cognitive dimension may be entirely decisive for intra- and inter-organizational processes of creating and validating new knowledge at certain stages of the innovation process (which is evident in previous studies of "analytical industries" such as life science and parts of ICT), managerial-organisational concerns and other contextual influences may be critical in others. This may explain why the findings for "synthetic" and "symbolic" industries have been somewhat less clear cut than for "analytical" industries in previous studies (e.g. Martin and Moodysson, 2011a). It is indeed possible that knowledge networks in industries like pharmaceuticals and ICT, which in previous studies have been described as largely globally oriented (e.g. Coenen et al., 2004; Gertler and Levitte, 2005), would display different geographical characteristics if a time dimension was added to the analysis (see e.g. Moodysson et al., 2008). Likewise it is possible that industries like media, advertisement and design, which according to previous studies displays more spatially concentrated network patterns, would be more geographically dispersed when attention is paid to application rather than creation and validation of knowledge (Martin and Moodysson, 2011a).

A broadened interpretation would thus add sensitivity to the analysis, but also complexity. It is therefore important to note that such an interpretation also by definition would dismiss previous classification of firms (or industries or economies) into fixed categories like those referred to above (e.g. analytical, synthetic and symbolic) since the knowledge base dominance would vary over time. As an analytical tool the conceptual model would still work, but classification into knowledge base categories would be limited to sub-parts of innovation processes within or across organisations. The remainder of this paper outlines how this can be done in empirical research and how the CKB could be an integral part of an analytical framework for innovation studies.

4. A method for applying the CKB approach to innovation studies

Understanding innovation processes from a CKB point of view, including gaining insights into how various knowledge is combined at various stages of the innovation process and how this affects the outcome of the combinatorial processes, indeed raises high demands on sensitive research methods allowing for rich data collection and detailed analysis focusing on sub-firm as well as organizational and institutional levels of analysis. To cater for this we suggest to apply a biographical approach (see e.g. Wengraf et al., 2002) which embraces the entire life-span of an innovation process from the initial idea formation to the final phases of commercialization, rather than only paying attention to those sub-parts that often *ex post* or without further assessment are perceived as crucial for the realization of the innovation (e.g. scientific activities upon which a new technology is based, development and application of platform technologies etc). Instead we suggest paying careful attention to the time-dimension and the sequential interconnectedness of activities and events contributing to the realization of innovations. This is not to suggest a linear view on innovation processes but, on the contrary, to allow for analyses of their complexity and reliance on diverse forms of feedback loops and combinatorial mechanisms (Kline and Rosenberg, 1986).

A biographical approach to the study of innovation allows for tracing and mapping the knowledge dynamics (i.e. the creation, distribution, adaptation, and use of knowledge) involved in and contributing to innovations, including their time dimension and the multiple territorial scales involved, the modes of and rationale for knowledge creation and development, the shifting constellations of participating actors (both intra and extra organizational), and the contextual frameworks within which activities take place (e.g. institutions). Such an approach thus transcends the focus on transferability and accessibility of knowledge which has been widespread among economic geography scholars aiming to explain the spatial configuration of knowledge networks (e.g. Maskell and Malmberg, 1999).

Below follows an elaboration of such a biographical method referred to as knowledge biography, which was initially developed within the EU FP6 project *EURODITE* (see Butzin et al., 2010; Crevoisier et al. 2008) and

with which the approach suggested in this paper share basic similarities. The aim with the knowledge biography method of *EURODITE* was to collect data on firm-level innovations in order to reveal their 'Territorial Knowledge Dynamics' (Crevoisier and Jeannerat, 2009), acknowledging the relevance of diversified, cross-sector and multi-scalar knowledge exchange in innovation processes. *EURODITE* researchers have further developed and applied the method in later work (see e.g. Butzin and Widmayer, 2012; Strambach, 2012; Strambach and Klement, 2013; Manniche 2012; Hermelin et al., 2014). It is worth noting that while the first contributions use the term "knowledge biography", later papers (e.g. Butzin and Widmaier, 2012) use the term "innovation biography". While Butzin and Widmaier (2012) present the two terms as synonymous, in our view, such a change represents a rather strong shift in the perspective. While in the former case, it is knowledge dynamics underpinning innovation processes at the core of the investigation, in the latter case it is the innovation outcome, therefore implying the need of taking into greater consideration the management action, necessary to drive and coordinate knowledge dynamics into an innovation valuable to the company. In line with the arguments above, this paper draws on and further elaborates on the latter perspective, hence using the term innovation biographies.

The basic idea of such a biographical approach is to draw on a rich set of data to disentangle and reconstruct specific innovation processes in order to reveal crucial mechanisms for knowledge generation, application and diffusion at various stages of the development process. More concretely, the method systematically decomposes the process into distinct phases of knowledge dynamics which represents 'knowledge bricks' by which the innovation is built. As regards data collection, innovation biographies are largely based on semi-structured interviews focusing in innovating actors' perception of their own role in the process, the activities they carry out, the challenges they face, and the context in which they operate. These interviews are combined with egocentric network analysis focusing on the actor network in which the innovation process takes place (see Butzin and Widmaier, 2012). As regards data analysis, the first step is to identify the knowledge bricks mentioned above i.e. the sub-sequences of micro-level knowledge dynamics through which the innovation process as a whole develops. Each knowledge brick is decomposed into the diverse time-space bibliographic information on its activities and the participating actors, the applied approach to idea-generation, problem solving and development and the institutional and territorial context of the knowledge dynamics are investigated and identified. Thus, the analytical lens moves between the micro level of learning individuals and/communities, the meso level of innovating organizations, and the macro level of territorial, institutional and sectorial framework conditions.

Although the CKB typology, as introduced in the previous section, seems to be applicable for defining individual sub-parts of the innovation processes under investigation (Manniche, 2012; Strambach and Klement, 2012), the lack of a clear conceptual basis on which to divide the innovation process caused major practical obstacles in previous studies applying the innovation biography method. Furthermore, previous

studies have been less careful in conceptually explaining and analytically distinguishing the 'community' level of knowledge dynamics and the organizational level of coordinating and exploiting these knowledge dynamics for the purpose of innovation. Such contributions lack a conceptualization of the organizational/management dimension as a part of the analytical framework and seem to interpret innovation processes as purely cognitive. This causes a risk of overemphasizing the role of cognitive processes at sub-firm and community levels, thereby overlooking important coordination and management functions which, according to our conceptualization, might be equally decisive for the actual development and outcome of the innovation process. Hence, for the purposes of improving the method in terms of theoretical clarity and practical use, there is a need to elaborate on how to conceptualize and define the distinct phases of the knowledge dynamics involved in innovation processes.

In order to reach this goal, this paper draws further on conceptual work from the management studies literature. A long-standing tradition in management studies conceptualizes processes in terms of sequences of phases (Bales and Strodtbeck, 1951; Barley, 1986; Fisher, 1970; Langley and Truax, 1994). The so called p*hasic analysis* attempts to identify the coherent periods of activity through which a process unfolds. Poole et al. (2000) discuss several methods, both qualitative and quantitative, used for the identification of these phases. They find that most methods adopt a *transactional* view of time by focusing on the temporal occurrence of significant events. This view regards time as "divisible, but differentiated, with certain points serving as 'critical values' (McGrath and Kelly, 1986, p. 33). Specifying *events* are the natural way to simplify social processes (Abbott, 1990); thus events are the most valid representation of what occurs in development and change processes (van de Ven and Poole, 1990).

It is worth noting that, when applying the transactional view (e.g. van de Ven and Poole, 1990; van de Ven, 2006) a distinction between an incident (a raw datum) and an event (a theoretical construct) is made (Abott, 1984). The incident concept was introduced and diffused by Glaser and Strauss (1967) and Strauss and Corbin (1990), the originators of grounded-theory building. They suggest beginning with small units of data (incidents) and gradually constructing a system of categories or concepts that describe the phenomena being observed. Whereas an incident is an empirical observation, an event is not directly observed; it is a conceptual construct in a model that explains incidents. The stream of incidents, a directly observable first-order set of activities, is translated into a sequence of events, a more abstract second-order construction.

Identification of events can be conducted after the outcomes are already known (by means of a retrospective approach) or when the process unfolds, by means of real-time observations (van de Ven, 2006). The former approach provides the advantage of knowing the "big picture", how things developed and the outcomes that ensued. This *post hoc* knowledge is helpful for interpreting events that unfolded, and for constructing a narrative of the process. On the contrary, the latter approach does not provide the

advantage of afterthought, and researchers may miss occurrences or events which later can be viewed as critical. However, prior knowledge of the outcome of an organizational change also may bias a study. In fact, the observer is critical in determining these key points in terms of type/specificity. Significant events are determined by what the observer notices or believes is significant. A researcher adopting the transactional view of time would observe it by identifying events critical or significant to subjects under investigation (in our case the knowledge dynamics). In some cases this is done "from the outside" by the researcher who defines the critical events, which may be major turning points (e.g. an organizational crisis or a performance evaluation) or more commonplace events (e.g. each interaction the employee has with her manager or each statement made by a group member during a decision making discussion). In other cases, this is done "from the inside" by having process participants indicate which events are significant to them as for example in van de Ven et al. (1999).

To sum up, we suggest that the break-down of the innovation process in smaller phases of knowledge creation used as units of data collection should be made not by considering only the involved cognitive processes but by also paying attention to the managerial processes and to key moments or 'events' where the innovating organization intervenes in and tries to coordinate, affect and exploit the knowledge processes. These could be, for instance, recognition of a demand for new knowledge, organization of search for new knowledge, formation or termination of project teams, and decisions to build alliances to external knowledge sources. Each of these 'management intervention events' is suggested to be incited by the management's evaluation of a need for a specific type of knowledge and knowledge creation that in most cases can be described by the principles of one of the three ideal-typical CKB categories.

'Events' may be a core concept allowing for analytical integration of the micro/cognitive, meso/organizational, and macro/spatial dynamics through which innovations are accomplished. Events might result from either internal micro level incidents of individuals/communities or by external macro level incidents such as the introduction of new technologies, regulation schemes, and change of customer demands. Both internally or externally incited events are considered when decomposing and reconstructing the realization of specific innovation processes, however they are analytically separated and the implications for events of knowledge processing type naturally attract main attention from a knowledge base point of view. More general events are treated as contextual factors which may influence the knowledge processing events to varying degree and in various ways.

Besides this analytical advantage of using events for breaking down the innovation process, a more practical advantage is that management interventions are more easily observable (summits of meetings, plans, budgets, team organization, etc.) than cognitive processes of diverse actors.

5. Conclusions

This paper has made three main contributions. Firstly, it provided a critical review of previous conceptualizations of the knowledge base approach in the research fields of innovation studies and economic geography, highlighting strengths as well as limitations. Secondly, it proposed a broadened interpretation of the knowledge base approach which allows for considering combinatorial knowledge bases within and across industries, regions and time periods. The reason behind this proposal was an observed limitation of the previous interpretations of the conceptual approach when it comes to explaining the organisation of innovation and its spatial implications. Thirdly, it provided a suggestion for how to apply such a broadened interpretation of the knowledge base approach in empirical innovation studies, regardless of industrial, geographical or temporal context. The paper thereby dismissed the wide-spread taxonomical application of knowledge base conceptualizations in innovation studies and economic geography for classification of firms, industries and economies into fixed categories based on their "dominant" or "crucial" knowledge base characteristics. Instead it is argued (1) that the knowledge base characteristics vary not only between firms and industries but also over time and through innovation trajectories within firms and industries, and (2) that the knowledge base characteristics are defined not only by the modes and rationale for knowledge creation and application but also by managerial-organisational aspects with regard to coordination and exploitation of such knowledge dynamics.

Thus, in addition to highlighting limitations of the knowledge base approach as it has been applied in the literature hitherto, the paper targets investigation of unexploited potentials of the knowledge base construct and provides suggestions for future research. Not least with regard to methodological implications the paper calls for new perspectives. By dismissing the taxonomical approach of classifying aggregates of activities (e.g. firms, industries, economies) into fixed categories, the paper calls for adding complexity to the research design and analysis. The method proposed to deal with such complexity is referred to as "innovation biographies". By disentangling and analytically recomposing innovation trajectories, based on historical data collected through various qualitative research techniques, the proposed method makes it possible to assess the knowledge characteristics, management practices and contextual factors which represent critical incidents and events in an innovation process. The 'phases' of micro-level knowledge development, which in this interpretation are the units of analysis to which the knowledge base typology is applied, and the management intervention 'events' by which such phases are initiated, terminated and combined, are thus conceptual constructs which are used to explain the realization of innovations . Through such analysis it is possible to specify at what points in time the various knowledge bases are crucial, and thereby also provide better advices to innovation policy on what priorities are needed to shape effective measures.

Important to note though is that both the CKB typology as applied in previous studies and the broadened interpretation and application through the proposed innovation biography method of this paper are highly resource demanding in terms of providing the required level of detail in the empirical data and analysis. Lacking resources for the research might explain a part of the regular "automatic" labeling of distinct activities as analytical, synthetic or symbolic only on the basis of the occupation or the departmental domain of the involved persons. Similarly, to exploit the biography method and fully cover entire knowledge processes of innovations, takes almost unrealistic amounts of resources. Furthermore, also when sufficient quality data are collected and a detailed analysis of incidents and events are carried out, the possibilities for aggregating findings into generalized results (e.g. classifications) are limited. A critical decision for future studies applying this method is at what level of detail researchers should settle. Also issues of how to compare long and short biographies and how to set up consistent guidelines for the use need to be dealt with.

References

Abbott, A., 1984. Event sequence and event duration: Colligation and measurement. *Historical Methods*, 17: 192-204.

Abbott, A., 1990. Conceptions of time and events in social science methods: causal and narrative approaches. *Historical Methods* 23, 140–150.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.

Allen, John (2002). Symbolic economies: The 'culturization' of economic knowledge. In: du Gay, Paul (ed.). *Cultural Economy: Cultural Analysis and Commercial Life*. SAGE Publications, UK, pp. 38-56. Boggs j and Rantisi n the relational turn in economic geography . *journal of economic geography* 3, 109-116

Amin, A., Cohendet, P., 2004. Architectures of Knowledge: Firms Capabilities and Communities. *Oxford University Press*, Oxford.

Asheim, B. (2007) Differentiated knowledge bases and varieties of regional innovation systems, Innovation—The European Journal of Social Science Research, 20(3), pp. 223 – 241.

Asheim, Bjorn (2012). The Changing Role of Learning Regions in the Globalizing Knowledge Economy: A Theoretical Re-examination. REGIONAL STUDIES , Vol 46(8), pp. 993-1004.

Asheim, Bjorn T. (2012). Innovating: creativity, innovation and the role of cities in the globalizing knowledge economy. In Yigitcanlar, T; Metaxiotis, K; Carrillo, FJ (eds.) BUILDING PROSPEROUS KNOWLEDGE CITIES: POLICIES, PLANS AND METRICS, pp. 3-23.

Asheim, Bjorn T.; Boschma, Ron; Cooke, Philip (2011). Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases, *REGIONAL STUDIES* , 45(7), pp. 893-904.

Asheim, B. and Coenen, L. (2005) Knowledge bases and regional innovation systems: comparing Nordic clusters, *Research Policy*, 34(8), pp. 1173 – 1190.

Asheim, B. and Coenen, L. (2006) Contextualizing regional innovation systems in a globalizing learning economy: on knowledge bases and institutional frameworks, *Journal of Technology Transfer*, 31, pp. 163 – 173.

Asheim, B.; Coenen, L.; Moodysson, J.; and Vang, J. 2007. Constructing knowledge-based regional advantage: Implications for regional innovation policy. *International Journal of Entrepreneurship and Innovation Management* 7:140–55.

Asheim, B., Coenen, L., Moodysson, J., & Vang, J. (2005). Regional innovation system policy: A knowledge-based approach. *CIRCLE (Centre for Innovation, Research and Competence in the Learning Economy) Working Paper*, *13*.

Asheim, B., Coenen, L. and Vang-Lauridsen, J. (2007b) Face-to-face, buzz and knowledge bases: socio-spatial implications for learning, innovation and innovation policy, *Environment and Planning C*, 25(5), pp. 655 – 670.

Asheim, B.; Ebersberger, B; Herstad, S. (2012). MNCs between the local and the global: knowledge bases, proximity and distributed knowledge networks. In Heidenreich, M (ed.*) INNOVATION AND INSTITUTIONAL EMBEDDEDNESS OF MULTINATIONAL COMPANIES*, Book Series: New Horizons in International Business, pp. 77-104.

Asheim, B. and Hansen, H. (2009) Knowledge bases, talents, and contexts: on the usefulness of the creative class approach in Sweden, *Economic Geography*, 85(4), pp. 425 – 442.

Asheim, B. and Gertler, M. (2005). The geography of innovation: regional innovation systems, in: J. Fagerberg, D. Mowery & R. Nelson (Eds), *The Oxford Handbook of Innovation*, pp. 291 – 317 (Oxford: Oxford University Press).

Asheim, B. and Mariussen A. (Eds.) (2003) *Innovations, Regions and Projects: Studies in New Forms of Knowledge Governance.* Stockholm: Nordregio.

Asheim, B; Lawton Smith, H; Oughton, C (2011). Regional Innovation Systems: Theory, Empirics and Policy. *REGIONAL STUDIES*, 45(7), pp. 875-891.

Baldridge, J. V., & Burnham, R. A. (1975). Organizational innovation: Individual, organizational, and environmental impacts. *Administrative Science Quarterly*, 165-176.

Bales, R. F., & Strodtbeck, F. L. (1951). Phases in group problem-solving. *The Journal of Abnormal and Social Psychology*, *46*(4), 485.

Barley, S. R. (1986). Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments. *Administrative science quarterly*, 78-108.

Bathelt, H.; Malmberg, A.; and Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, Vol. 28, 1, pp. 31-56.

Butzin A, Larsson A, Widmayer B (Eds.) (2010). *EURODITE Work Package 6 Final Report*. Gelsenkirchen: Institute for Work and Technology, https://dl.dropbox.com/u/7725404/WP6_final_report.pdf.

Butzin, Anna and Brigitta Widmaier (2012). *The Study of Time-Space Dynamics of Knowledge with Innovation Biographies*. Marburg Geography 07.12, Philipps-Universität Marburg.

CHAMBERLAYNE, P., BORNAT, J. and WENGRAF, T. (2000) *The Turn to Biographical Methods in Social Sciences*, Taylor and Francis, Routledge, London.

Coenen, L., Moodysson, J., Asheim, B. and Jonsson, O. (2003). *The role of proximities for knowledge dynamics in a cross-border region: biotechnology in Oresund*. Paper presented at the DRUID (Danish Research Unit on Industrial Dynamics) Summer Conference, Copenhagen, Denmark, 12 – 14 June.

Coenen, L., Moodysson, J., & Asheim, B. T. (2004). Nodes, networks and proximities: on the knowledge dynamics of the Medicon Valley biotech cluster. *European Planning Studies*, *12*(7), 1003-1018.

Coenen, L., Moodysson, J., Ryan, C., Asheim, B. and Phillips, P. (2006) Comparing a pharmaceutical and an agro food bioregion: on the importance of knowledge bases for socio-spatial patterns of innovation, *Industry and Innovation*, 13(4), pp. 393 – 414.

Cook, S.D.N. and Brown, J.S. (1999). Bridging Epistemologies: The Generative Dance Between Organizational Knowledge and Organizational Knowing. *Organization Science*, Vol. 10, No. 4, August 1999, pp. 381-400.

Cooke, P. (1992) Regional innovation systems: Competitive regulation in the new Europe, *Geoforum*, 23(3), pp. 365–382.

Cooke, P.; de Laurentis, C.; MacNeill, S; Collinge, C. (eds.) (2010) *Platforms of Innovation. Dynamics of New Industrial Knowledge Flows.* Cheltenham, Edward Elgar.

Crevoisier, Oliver and Jeannerat, Hugues (2009). Territorial Knowledge Dynamics: From the Proximity Paradigm to Multi-location Milieus. *European Planning Studies* Vol. 17, No. 8, August 2009, pp. 1223-1241.

Crevoisier O, Helmstädter E, Larsson A, Widmaier B, Vale M, Burfitt A (2008) *The Guidelines for the empirical research of the Work Packages 5 and 6*. EURODITE Report.

Daft, R. L. (2007). Understanding the Theory and Design of Organizations.

Dahlström, Margareta and Sigrid Hedin (editors) (2010). *Regional trajectories to the knowledge economy: Nordic-European Comparisons*. Nordic Innovation Centre & Nordregio, August 2010, http://www.nordregio.se/en/Publications/Publications-2010/Regional-trajectories-to-the-knowledge-economy---Nordic-European-comparisons/

Dahlström, Margareta; James, Laura (2012): Regional Policies for Knowledge Anchoring in European Regions. *European Planning Studies*, Vol. 20 (11), 2012.

Fisher, B. A. (1970). Decision emergence: Phases in group decision-making. *Communications Monographs*, *37*(1), 53-66.

Gertler, M. S., & Levitte, Y. M. (2005). Local nodes in global networks: the geography of knowledge flows in biotechnology innovation. *Industry and Innovation*, *12*(4), 487-507.

Gertler, M. 2008. Buzz without being there? Communities of practice in context. In *Community, economic creativity and organization*, ed. A. Amin and J. Roberts, 203–26. Oxford, U.K.: Oxford University Press.

Gherardi, S. (2009). Community of Practice or Practices of a Community? In S. J. Armstrong & C. V. Fukami (Eds.), *The SAGE Handbook of Management Learning, Education and Development* (pp. 514-530). London: Sage.

Glaser, B., & Strauss, A. (1967). The discovery of grounded theory. 1967. *Weidenfield & Nicolson, London*.

Gupta, A., Smith, K., and Shalley, C. (2006) The interplay between exploration and exploitation, *Academy of Management Journal*, 49, (4), 693–706.

Halkier, Henrik; James, Laura; Dahlström, Margareta; Manniche, Jesper (2012): Knowledge Dynamics, Regions and Public Policy, *European Planning Studies*. Vol. 20 No 11, pp. 1759-1766, DOI: 10.1080/09654313.2012.723419.

Hansen, H. K.; Vang, J.; and Asheim, B. T. 2005. *The creative class and regional growth: Towards a knowledge based approach*. Paper presented at Regional Studies Annual European Conference, Aalborg, Denmark, May.

Hermelin, B; Dahlström, M; Smas, L. (2014). Geographies of Knowledge and Learning: The Example of Medical Technology. *Growth and Change*, Vol. 45 No.3, pages 450–470, September 2014. DOI: 10.1111/grow.12054.

Holzner, B., & Marx, J. H. (1979). *Knowledge application: The knowledge system in society*. Boston: Allyn and Bacon.

Jeannerat H and Crevoisier O (2011) Non-technological innovation and multi-local territorial knowledge dynamics in the Swiss watch industry. *International Journal of Innovation and Regional Development*. 3: 26–44.

Jensen, M. B., Johnson, B., Lorenz, E. and Lundvall, B. Å. (2007) Forms of knowledge and modes of innovation. *Research Policy*, 36, pp. 680-693.

Kebir, L. & Crevoisier, O. (2007) Cultural resources and regional development: The case of the cultural legacy of watchmaking, in: P. Cooke & L. Lazzeretti (Eds) *Creative Cities, Cultural Cluster and Local Economic Development*, pp. 48-69 (Cheltenham: Edward Elgar).

Kline, S. J., & Rosenberg, N. (1986). An overview of innovation. *The positive sum strategy: Harnessing technology for economic growth*, *275*, 305.

Knorr-Cetina, K. (1999). *Epistemic cultures: how the sciences make knowledge*. Cambridge, MA: Harvard University Press.

Knorr-Cetina, K. (2001). Objectual practice. *The practice turn in contemporary theory,* (eds.) T. Schatzki, K. Knorr Cetina, and E. von Savigny, 175–88. London: Routledge.

Langley, A., & Truax, J. (1994). A PROCESS STUDY OF NEW TECHNOLOGY ADOPTION IN SMALLER MANUFACTURING FIRMS*. *Journal of Management Studies*, *31*(5), 619-652.

Lave, Jean; Wenger, Etienne (1991). *Situated Learning. Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Lavie, Dovev; Stettner, Uriel; Tushman, Michael L. (2010). Exploration and exploitation within and across organizations. *The Academy of Management Annals,* Vol. 4, No.1, pp.109-155.

Liu, Ju; Chaminade, Cristina; Asheim, Bjorn (2013). The Geography and Structure of Global Innovation Networks: A Knowledge Base Perspective. *EUROPEAN PLANNING STUDIES,* Vol. 21(9), pp.1456-1473.

Manniche, Jesper (2012). Combinatorial Knowledge Dynamics: On the Usefulness of the Differentiated Knowledge Bases Model, *European Planning Studies*. Vol. 20 No 11, pp. 1824-1841, DOI: 10.1080/09654313.2012.723423.

Manniche J, Larsen KT (2009) *Firm-level knowledge dynamics of creating Bornholm food. EURODITE WP6 FKD Report*. Centre for Regional and Tourism Research, Bornholm, June 2009.

Manniche J, Larsen KT (2013). Experience staging and symbolic knowledge: The case of Bornholm culinary products. *European Urban and Regional Studies*, Vol. 20(4), October 2013, pp. 401—416, DOI: 10.1177/0969776412453146.

Manniche, J.; Testa, S. (2010). Knowledge bases in worlds of production: The case of the food industry. *Industry and Innovation.* Vol. 17 No 3, pp. 263-284.

March, James G (1991). Exploration and Exploitation in Organizational Learning. *Organization Science*, Vol. 2 No. 1, pp.71-87.

Martin, Roman and Moodysson, Jerker (2011a). Comparing knowledge bases: on the geography and organization of knowledge sourcing in the regional innovation system of Scania, Sweden. European Urban and Regional Studies, DOI: 10.1177/0969776411427326.

Martin, Roman and Moodysson, Jerker (2011b). Innovation in symbolic industries: the geography and organisation of knowledge sourcing. *European Planning Studies*, Vol. 19, issue 7, pp.1183-1203.

Maskell, P., and Malmberg, A (1999) The Competitiveness of Firms and Regions 'Ubiquitification'and the Importance of Localized Learning. *European Urban and Regional Studies,* 6(1), 9-25.

McGrath, J. M., and J. R. Kelly 1986 *Time and human interaction: Toward a social psychology of time*. New York: Guilford.

Moodysson, J.; Coenen, L.; and Asheim, B. (2008). Explaining spatial patterns of innovation: Analytical and synthetic modes of knowledge creation in the Medicon Valley life science cluster. *Environment and Planning A,* 40:1040–56.

Moodysson, Jerker; Coenen, Lars; Asheim, Bjorn T. (2009). Two sides of the same coin? Local and global knowledge flows in Medicon Valley. In Belussi, F; Sammarra, A (eds.) BUSINESS NETWORKS IN CLUSTERS AND INDUSTRIAL DISTRICTS: THE GOVERNANCE OF THE GLOBAL VALUE CHAIN. Book Series: Regions and Cities, Vol 38, pp. 356-376..

Moulaert, F. & Sekia, F. (2003). Territorial innovation models: A critical survey. *Regional Studies*, 37(3), pp. 289–302.

Morgan, K. (1997). The learning region: Institutions, innovation and regional renewal. *Regional Studies*, 31(5), pp. 491–504.

Nerland, Monika and Jensen, Karen (2012): Epistemic practices and object relations in professional work, *Journal of Education and Work*, 25:1, pp. 101-120.

Pentland, B. T. 1999. Building process theory with narrative: From description to explanation. *Academy of Management Review*, 24, 4: 711-724.

Pine II JB, Gilmore JH (1999) *The Experience Economy: Work is Theatre and Every Business a Stage.* Boston: Harvard Business School.

Poole, M. S., & Roth, J. 1989. Decision development in small groups V: Test of a contingency model. *Human Communication Research*, 15, 4: 549-589.

Poole, M. S., Van de Ven, A. H., Dooley, K., & Holmes, M. 2000. *Organizational change and innovation processes: Theory and methods for research*. New York: Oxford University Press.

Poole, M. S. 1983. Decision development in small groups, III: A multiple sequence model of group decision development. *Communication Monographs*, 50: 321-341.

Poole, M. S., Folger, J. P., & Hewes, D. E. 1987. Analyzing interpersonal interaction. In M. E. Roloff & G. R. Miller (Eds.), *Interpersonal processes*. Beverly Hills: Sage.

Poole, M. S., & Holmes, M. E. 1995. Decision development in computer-assisted group decision making. *Human Communication Research*, 22: 90-127.

Poole, M.S., A.H. van de Ven, K. Dooley, M.E. Holmes (2000). Organizational Change and Innovation Processes, Theories and Methods for Research, O.U. Press, 2000.

Rothaermel, F. T., & Hess, A. M. (2007). Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. *Organization Science*, *18*(6), 898-921.

Shearmur, R. (2011). Innovation, regions and proximity: from neo-regionalism to spatial analysis. *Regional Studies*, 45(9), 1225-1243.

Smith, K. G., Collins, C. J., & Clark, K. D. (2005). Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. *Academy of Management Journal*, *48*(2), 346-357.

Strambach, Simone (2012). Knowledge Dynamics and Knowledge Commodification of KIBS in Time and Space. In: *Exploring Knowledge-Intensive Business Services. Knowledge Management Strategies* (Eds.) Di Maria, Eleonora; Grandinetti, Roberto; Di Bernardo, Barbara, Palgrave Macmillan, UK, pp. 56-78.

Strambach, S. and Klement, B. (2012) Cumulative and combinatorial micro-dynamics of knowledge – the role of space and place in knowledge integration. *European Planning Studies*, Vol. 20, No 11, pp. 1843-66.

Strambach Simone; Klement, Benjamin (2013). Exploring plasticity in the development path of the automotive industry in Baden-Württemberg: the role of combinatorial knowledge dynamics. In *Zeitschrift für Wirtschaftsgeographie*, University of Marburg, 57(1-2), pp. 67–82.

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications, Inc.

Swan, J., & Scarbrough, H. (2001). Knowledge management: Concepts and controversies. *Journal of Management Studies*, *38*(7), 913-921.

Tushman, Michael L. & O'Reilly, Charles A. (1996). Ambidextrous Organizations: Managing evolutionary and revolutionary change. *California Management Review*, Vol. 38, No 4.

van de Ven, A. H. 1992. Suggestions for Studying Strategy Process: A Research Note. *Strategic Management Journal*, 13 (Summer): 169-188.

van de Ven, A. H. (2013). Process studies of change in organization and management: Unveiling temporality, activity, and flow. *Academy of Management journal* 2013, Vol. 56, No. 1, 1-13.

van de Ven, A. H., Angle, H. L., & Poole, M. S. (Eds.) 2000. *Research on the management of innovation*: *The Minnesota studies*. New York: Reprinted by Oxford Univ. Press (originally published in 1989).

van de Ven, A. H., and Ferry, D. L. 1980. *Measuring and assessing organizations*. New York: Wiley.

van de Ven, Andrew H. and Grazman, David N. (1999). 'Evolution in a nested hierarchy: A genealogy of Twin Cities health care organizations, 1853-1995'. In *Variations in organizational science: In honor of Donald T. Campbell*. J. A. C. Baum and B. McKelvey (eds), 185-212. Thousand Oaks, CA: Sage.

van de Ven, A. H., and Polley, D. E. 1992. Learning while innovation. *Organization Science* 3: 92-116.

van de Ven, A.H., Polley, D.E., Garud, R., & Venkataraman, S. (1999). *The innovation journey*. New York: Oxford Univ. Press.

van de Ven, A. H., and Poole, M.S. (1995). Explaining development and change in organizations. *Academy of Management Review*, 20: 510-540.

van de Ven, A. H. and Poole, Marshall Scott (1990). Methods for Studying Innovation Development in the Minnesota Innovation Research Program. *Organization Science*, Vol. 1, No. 3, Special Issue: Longitudinal Field Research Methods for Studying Processes of Organizational Change (1990), pp. 313-335

van Tuijl, E and Carvalho, L (2014). Knowledge sourcing, knowledge bases, and the spatial organisation of car design, *Environment and Planning A* 2014, volume 46, pages 1966 – 1982, doi:10.1068/a46282.

Wengraf, T., Chamberlayne, P., Bornat, J. (2002). A biographical turn in the social sciences? A British-European view. In: *Cultural Studies – Critical Methodologies*, (2)2, 245–269.