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# The Study of Time-Space Dynamics of Knowledge with Innovation Biographies

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## **Abstract:**

The paper presents the methodology of Innovation Biographies that has been designed to study the time-space dynamics of knowledge and ways of knowledge combination in innovation processes. Innovation Biographies allow capturing relationships, contextual settings and different kinds of knowledge and enable insights into the evolvment and development of innovations. By following the process of creation with specific interviewing methods and triangulation, the biography of an innovation is reconstructed including the evolution of related knowledge. Data collection is able to transcend sectoral as well as local, regional or national categories and sheds light on cross-sectoral knowledge combinations and its multi-scalar reach.

**Keywords:** Innovation Biographies, knowledge dynamics, knowledge combinations, time-space paths, multi-level view.

**JEL Classifications:** D83, O12, O31, R11

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## ***Introduction***

This paper takes some new perspectives of economic geography research about the dynamics of innovation as its starting point. They refer to the growing influence of the various knowledge facets on innovation processes and imply disentanglement from the confinement on technological progress and the regional level as two prominent objects of study. In particular, three lines of argumentation are basis for the new thinking: Firstly, the re-organisation of economic activities is heavily influencing the nature of innovations. Examples are the growth of services taking over R&D functions or the commercialization of products (STRAMBACH, 2008) and the influences of customers on innovation processes having strong implications for related knowledge flows (GRABHER et al., 2008). Secondly, apart from techno-scientific knowledge in innovation, socio-cultural forms of knowledge are ascribed to be of equal importance (CREVOISIER and JEANNERAT, 2009; LORENTZEN, 2008). They more and more complement the still dominant analytic (science-based) and synthetic (engineering-based) knowledge bases by symbolic (art-based) knowledge focussing on design, advertisement and the image of a product through which customers find it easier to identify with products or services (ASHEIM et al., 2011; MARTIN and MOODYSSON, 2011). Thirdly, the growing mobility and multi-locality of knowledge increases the pressure for regions and firms to integrate knowledge from distant locations and from different sectors in order to stay competitive (CREVOISIER and JEANNERAT, 2009).

One consequence to be drawn is that the methods to retrieve empirical evidence have to be adapted to the changing economic landscape. Approaches have tended to focus on one particular geographical level to explain innovative activities and the role of knowledge. This has been dominated by the macro-level with the concept of national systems of innovation and indicators measuring R&D expenditures or patents (LUNDVALL, 1992; NELSON, 1993) and the regional level with qualitative methods playing a bigger role (STORPER, 1993; COOKE, 1992, 1998). When taking into account the above mentioned observations, further evidence is needed addressing the questions of how knowledge in innovation processes is generated and applied across different geographical levels, where it comes from and who has contributed to an innovation project.

Against this background, the aim of this paper is to present a qualitative methodological approach named Innovation or Knowledge Biographies developed and applied in a large five year European research project of the 6<sup>th</sup> Framework Programme called EURODITE that was of central importance for the project's empirical work. Innovation Biographies have been designed to take account of the above mentioned three lines of argumentation and aim at analysing the evolvement of knowledge flows in innovation over time and space. They allow capturing relationships and contextual settings within and between firms and on different spatial levels and thereby make possible to follow knowledge flows when they unfold. The basic principle is to examine the procedural, interactive and dynamic nature of knowledge applied during the entire life-span of an innovation by re-constructing the development process from its first idea until its implementation as a product, service or organisational change. In this sense, rather than discussing in depth the broader theoretical implications of the above changes, this paper integrates them from a conceptual perspective in order to focus on

explaining the methodological building blocks and the concrete research procedure of Innovation Biographies.

Accordingly, the paper is structured into three parts. The first part shortly discusses the background against which Innovation Biographies have been developed in order to argue why new approaches might be helpful in furthering our current understanding of economic activities. This is done with reference to economic geography research about the relationship of knowledge, innovation and space. The second part elaborates on the contextual pillars of Innovation Biographies, such as the intention to grasp knowledge flows, a multi-level view and a time-space perspective, that have strongly influenced the concrete methodological set-up. It then presents the research procedure and interviewing techniques in detail, including advantages and drawbacks that need to be considered in the conduction of Innovation Biographies. In the third part, two Innovation Biographies are illustrated to show the nature of obtained results and how the research procedure works in practice.

### ***Background***

Within economic geography, for quite some time a central topic in exploring the sources for regional economic development has been to study the relationship of innovation and space (SIMMIE, 2005, LORENTZEN, 2008). The underlying assumption was that the diffusion of knowledge and the mechanisms which lead to innovative developments in firms can be achieved best in cooperation with neighbouring firms or organizations (COOKE and MORGAN, 1998). In particular, it was plausibly assumed that the transfer of essential tacit knowledge from person to person requires them to have a common socio-cultural, institutional and cognitive background and thus, depends on geographical proximity in the innovation process (ASHEIM and GERTLER, 2005; LORENTZEN, 2008). This was backed by success stories of Silicon Valley, Baden-Württemberg and the Third Italy who are the most prominent examples for economic success on the sub-national level.

Taking geographical proximity as a starting point, the favoured object of study is the regional level and the question how regional actors of all kinds (public, private and intermediary) interact, apply and share knowledge in the process that brings about innovations. Some well-known attempts of conceptualizing this issue are territorial innovation models (MOULAERT and SEKIA, 2003) such as regional innovation systems (COOKE, 1992, 1998) and innovative milieux (CAMAGNI, 1991; CREVOISIER, 2004) which basically follow the idea that the sharing of – in particular tacit – knowledge across larger distances is a difficult, if not impossible task. Explanations for the effects of territorial innovation models on innovative behaviour include factors of industrial and social organisation, the regional infrastructure and in particular the role of local institutions, social interaction processes and networks. The most appreciated finding is best summarised as a – now broadly accepted – understanding of innovation as a spatial and knowledge-intensive learning process generated through the interaction of different actors.

In more recent debates, the view on innovation has been complemented and broadened (TORRE 2008; GERTLER and LEVITTE, 2003; BATHELT et al., 2004). There is agreement that geographical proximity needs to be actively organised (TORRE and RALLET, 2005) or supported in some way. Among others, equally social as well as cognitive dimensions of proximity (BOSCHMA, 2005) are assumed to be a necessary prerequisite to make learning and innovation successful. For TORRE (2008) this can

also be a matter of 'temporal geographical proximity' obtained on short or medium turn visits which often provide sufficient background for actors to exchange knowledge. Along the same lines, MASKELL et al. (2006) see elements of temporality in knowledge generation on fairs which they term 'temporary clusters'. Fairs can – for a certain period of time – function as a substitute of a permanent cluster insofar, as they bring together actors working in the same industry, provide stimuli and enable knowledge exchange. These advancements of the proximity discussion imply that innovation development and knowledge exchange have broader sources that are not necessarily bound to a regional environment.

Related to qualifying proximity as a multi-faceted phenomenon, another strand of research explicitly argues to study innovation processes from a multi-level view that is not limited to a certain pre-defined space. The reasoning is that innovation is supposed to have a multi-scalar character and is developed by actors coming from various locations all over the world (cp. DICKEN and MALMBERG, 2001; BUNNELL and COE, 2001 for early considerations on this topic and STRAMBACH 2012 for a recent one). Along the same lines of argumentation OINAS and MALECKI (2002) developed the concept of spatial systems of innovation (SIS) as a concept complementary to the body of research that assumes geographical proximity to be the most stimulating form for innovative activity. In contrast to view places as a manifest system, they suggest that "innovation systems [...] exhibit different spatial configurations" and that "technological evolution occurs through the interplay between elements of national, subnational, and transnational innovation systems that produce flows of innovation [...]" (p.103). Although not explicitly focusing on the generation of novelty, the concept of global production networks too, includes the quest for a multi-level view on the analysis of economic activity (HENDERSON et al., 2002). The intention is to have an integrated territorial emphasis of the production and distribution of goods and services including regional, national and global links and as such a dynamic view on regional development without over-emphasizing a region's endogenous economic forces (COE et al., 2004).

It is important to notice that indeed the existence of extra-local links and their role in innovative activity is not unconcerned in the body of literature on territorial innovation models, especially as regards innovative milieux: "The attraction of external synergies and know-how is exactly the objective we assign to innovation networks: through formalized and selective linkages with the external world (or, very often, with other external and specialized 'milieux') local firms may attract the complementary assets they need to proceed in the economic and technological race" (CAMAGNI, 1991: 4). However, as a consequence of the proximity assumption and the ascribed "stickiness" of local knowledge and other socio-cultural factors, extra-local links have not been at the conceptual or empirical centre of research (OINAS and MALECKI, 2002).

This is why BUNNELL and COE (2001) as proponents of the global production network framework argue for innovation to be studied by "exploring the linkages and interrelationships between and across various spatial levels or scales, from the 'regional/local' through to the 'global'" (577). The key argument is that sources of knowledge can be found all around the globe, and that firms operate in a radius, not limited to a certain territory when they are in search of specific problem solutions. Behind this multi-level view lies the notion that the environment of innovations is characterised by a contin-

uous and dynamic flux of knowledge and technological change that permanently transcends regional-administrative and sectoral boundaries.

Therefore, by conceptually and empirically building upon the earlier approaches summarized under the heading of territorial innovation models, there is renewed interest in finding out where knowledge comes from and how actors from various levels cooperate with each other to bring about innovative developments. The recent approach of territorial knowledge dynamics (TKDs), discussed in the majority of contributions in this issue, takes this notion as a starting point. TKDs are understood as a dense knowledge-space bringing about novelty through the combination of knowledge from different places and from different domains. In a world of endless possibilities of knowledge generation and combination, and knowledge sources placed around the globe, their key characteristic is the ability to mobilise well-suited knowledge independently from its sectoral or geographical origin and to anchor it within the regional context. The underlying intention of the TKD concept is setting apart from the paradigm of cumulative knowledge generation in which innovation was determined by building upon the existing stock of knowledge within a firm or a region (and as such being defined by geographical proximity) with the consequence of strong (or even over-) specialisation. Instead, combinatorial knowledge dynamics as a new paradigm describing modes of production and innovation development, as will be discussed below, imply diversification, cross-sectoral knowledge exchange and a global search radius. In this context, Innovation Biographies<sup>1</sup> have played the role of a 'magnifier' shedding light on the inner dynamics of TKDs by focussing on concrete innovations, their knowledge composure and global reach.

### ***Contextual Pillars of Innovation Biographies***

#### *Knowledge flows, dynamics and combinations*

Innovation Biographies aim at analysing knowledge flows in innovation processes across time and space and therefore, knowledge generated in innovation is the central object of study. Knowledge flows and related dynamics are understood as evolving in a perpetual but unsteady flow of distinct innovative actions that cause movement, transformation and creation of knowledge (STRAMBACH, 2008). Though knowledge dynamics are strongly connected to individuals as their carriers and main stimulants, their emergence can also be caused by newly set up political regulations or other occurrences through which the pressure increases to change the status-quo. Projects, firms and organisations understood as micro-level agents of economic activity (in contrast to aggregated regional, national, international levels) play a distinct role for knowledge dynamics, as they usually capture a critical density of people who interact with each other and, in the process of innovation, make knowledge dynamics arise. This is intensively discussed in the literature on firm-centred competence and (dynamic) capability based approaches (e.g. TEECE et al., 1997; ZAHRA et al., 2006) with the idea that a precondition of knowledge generation is knowledge sharing and the combination of diverse knowledge. Furthermore, by following knowledge flows and individuals through certain interviewing techniques and by leaving aside administrative borders, it is possible to apply multi-level research. In this sense, the micro level and related innovations are only regarded as the entry point to the world of knowledge dynamics. By starting here, it is possible to grasp knowledge dynamics at their origin



and then follow them when they unfold and move through the economic system and across spatial scales.

Having the starting point at the micro-level implies a shift in focus which has not been done quite often in economic geography, since it does not “end at the factory gate” as MASKELL (2001: 330) once critically described the majority of research. And, although research on the micro-level, e.g. about the formation of knowledge within firms (AMIN and COHENDET, 2005) or on relational distances in innovation projects (IBERT 2010) has meanwhile been undertaken, there still remain some open questions regarding the interplay and complementary assets of internal and external sources of knowledge. Therefore, Innovation Biographies step inside the ‘factory gate’ to understand how internal knowledge is related to the various sources of external knowledge coming from multiple levels and how this evolves over time.

Decisive boosters of knowledge dynamics are cross-sectoral knowledge combinations observed in current economic activities (STRAMBACH 2012). The reason is that the process of combining knowledge from different sectoral origins in innovation processes calls for creativity reaching beyond traditional modes of innovation, simply because it was developed in a totally different context (in contrast to knowledge accumulation taking place within regional or sectoral boundaries). One of the most plausible examples for combinatorial knowledge is the integration of customers into innovation processes with the aim to catch the taste of consumers at a stage as early as possible (GRABHER et al., 2008). The view of analytical, synthetic and symbolic knowledge-bases becoming more and more equal parts of innovation and production processes (ASHEIM et al., 2011) too, is a matter of knowledge combinations. Examples are the creative industries (based on symbolic knowledge) that increasingly fulfil the function of being a ‘refiner’ of industrially or technically made products. The case study of an Innovation Biography in the third part of this paper will give further implications on the combinatorial aspects of knowledge generation.

#### *A Time-Space Perspective*

The nature of knowledge dynamics suggests incorporating a time-related view in their analysis to follow the process of learning and development. The sequencing puts focus on the *evolution* of knowledge dynamics and on the question how they interrelate, build upon each other and constitute the *biography* of innovations. This is done by help of interviewing techniques and desk-research as will be illustrated further down. Results provide insights on how knowledge is generated, used and combined and how it is incorporated into existing knowledge structures.

By studying the knowledge dynamics of an innovation process and combining them with the geographical dimension their time-space path and micro geography becomes visible (an example is provided in one of the case studies illustrated in this paper). The time-space path is basically defined and constructed by intersecting the territorial spread of involved actors and their actions over time with data on the actor’s geographical locations. But its single parts can have different characteristics shaped by the modes of communication between the actors involved. The construction of time-space paths is an element of time geography (HÄGERSTRAND, 1967, 1987; LENNTROP, 1976) where it is utilized both as a general point of departure how to look at time and space together, but also as a practical tool to measure and visualise movement in time-space. Time geography in combination

with the Innovation Biographies provides a framework to better understand the social construction and tempo-spatial reach of knowledge dynamics. To use time-geography in current economic geography research on the spatiality of knowledge production is also suggested by IBERT and THIEL (2009) and MATTSON (2009). They ascribe time geography new conceptual input as an approach well-suited to the temporal, project-based and dynamic nature of current economy.

A time-related view has also been applied in other research contexts with the aim to acquire greater knowledge on the constitution of development processes. It is of course the fundament of human-centred research where the biography of individuals is at centre of attention. Biographical research and life-history approaches are a field of social sciences having gained increased attention with the orientation from the social to the individual level (RUSTIN, 2000). Some proponents even speak of a biographical turn (RUSTIN, 2000, CHAMBERLAYNE et al., 2000). Its fundamental idea is to get insights into individual lives in order to understand broader societal structures and cultural meaning (FISCHER-ROSENTHAL and ROSENTHAL, 1997; ROBERTS, 2002; FUCHS-HEINRITZ, 2005; CHAMBERLAYNE et al., 2000). But biographical research has also found its entrance in geography. Already in the early 1990s, MILES and CRUSH (1993) suggested using narratives and life history approaches for recovering 'lost geographies' of marginalized groups. More economically oriented, VINODRAI (2006) followed career paths of designers based in Toronto to show high circulation of talent and related knowledge flows in the local design sector. Another example is TÖRNQVIST (2004), who has illustrated biographies of Nobel laureates with time-geography diagrams to examine the importance of innovative places for the careers of individuals.

Time-spatial questions are equally applied in studying the evolvement of products. Food geographers for instance, have studied the globalisation processes of local foods (e.g. tortillas, sushi) (BESTOR, 2005; GABE and BOLLER, 2003) and, in this context, explicitly drawn the connection of biography and geography (COOK et al., 1998) as done in Innovation Biographies. Van de Ven et al. as proponents of science and technology studies have undertaken 'Innovation Journeys', and followed innovation processes over time to develop a process theory of innovation processes from concept to implementation (VAN DE VEN et al., 1999: ix). In a similar manner, this was also explored by RAMMERT (2000), who actually termed his approach 'innovation bigographies'. More generally addressing the evolution of technologies, KASH and AUGER (2005) examined the generation process of the Bosch diesel fuel injection systems from 1922 onwards, or BRUNS et al. (2009) the evolution of the German wind energy sector.

What is new in the Innovation Biographies presented in this paper is the layering of time, geographical data about the location of involved actors and information about knowledge flows and dynamics. Together these components constitute a multi-level research approach able to grasp mechanisms of knowledge generation and application in innovation processes.

#### *A Qualitative Approach*

What the above mentioned time-related approaches have in common is a broad application of qualitative methods that allow grasping the fine-grained relationship of social structures and product development. Innovation Biographies too, are composed of qualitative research methods that in addition allow a pronounced emphasis on knowledge dynamics.

KRUGMAN's well-known citation says "knowledge flows ... are invisible, they leave no paper trail by which they may be measured and tracked" (1991: 53). This is certainly a true observation when looking for hints of knowledge flows on paper with the idea of a clear quantitative measurement. However, it is argued that knowledge in fact must leave a trail even if not (fully) documented on paper. This trail takes shape in the biographies of innovations – and it can be replicated verbally by the people who have been involved in it. A quantitative research emphasis on the sequence of single measurable points in time would provide a rather patchy picture of the process. By searching for ways to get information beyond mere input and output of innovative activities the focus lies on describing and interpreting instead of measuring. Therefore, empirical analysis needs to address three questions: What knowledge is used to create a new product, service or organisational feature? What are the social processes and related interactions through which the knowledge is generated, shared, combined and used? What conditions (e.g. institutional, social, economic, political, spatial) shape these social processes and related interactions? These questions can only be addressed by methodologies allowing in-depth longitudinal qualitative analyses, as also emphasized by CRANG (2002). Accordingly, qualitative approaches in economic geography "[...] have enabled the study of, and emphasized the importance of, seeing economic activity as a set of lived practices assumptions and codes of behaviour" (CRANG, 2002: 648) and consequently been applied in research on the embeddedness of economic activities, the culture of firms, or tacit and local knowledge in global contexts (CRANG, 2002: 648). In case of Innovation Biographies, applied methods need to perform a bridging process from human to non-human biographies, which partially has been undertaken in research on the geography of food, where "the organizing principle for research could be specific foods and ingredients, simple or complex". Therefore, food geographers "get inside [their] networks, go with the flows and look to connect" (COOK, 2006: 657, with reference to CRANG, 2005: 49). In case of Innovation Biographies the organizing principle is the innovation itself. Going with the flow and getting insights into the networks will be primarily achieved by interviewing the actors who have advanced an innovation project. How this is done in practice will be discussed in the following section.

### **Research Procedure**

Accordingly, a mix of methods transforms the above ideas into a manageable research procedure. Three dimensions of an innovation process have been guiding the selection of instruments: the time-dimension to grasp the evolvement of knowledge dynamics, their multi-level and combinatorial character, and the social interactions and the network of actors.

These three dimensions are mirrored in the methods applied: Insights into the time-space dimension are obtained through tools of *biographical research* (ROBERTS, 2002). This is done by following the life-story of an innovation through a major narrative and interviews with the main actors of the innovation process. *Egocentric network analysis* was chosen to make visible the actors, their location and content of interaction. *Triangulation* and mapping of the *time-space path* is a means to combine the data as only their ensemble as a whole eventually constitutes the Innovation Biography.

### **Preparation and narrative interview**

There are two ways of starting the research process. Either an innovation is known from the beginning as being a promising candidate for an innovation biography or a certain firm or organisation is chosen which is assumed to have carried out an interesting innovation. Selecting the case as well as the definition of what is considered innovative is essentially connected to the research context in which it is carried out. Experience of field work within EURODITE has shown that Innovation Biographies are equally applicable on organisational, process, product, social or service innovations and – not unimportantly – also in the case of failed innovation processes.

Intensive desk research about the firm, its main products and markets, shareholdings, history, number of employees, etc. should be part of the preparation for the narrative and for the interviews following the narrative. This will provide relevant background information of the context of innovation and facilitate the communication with the interviewees. Moreover, the innovative products of the firms might be advertised on the homepage or in press articles and could be pre-selected if not known beforehand. Another way of pre-selecting innovations for Innovation Biographies is to let sectoral experts (e.g. from industry associations, banks or chambers of commerce) recommend current innovative undertakings. In case this procedure is not feasible, the innovation can be agreed upon during a first interview with firm representatives.

The backbone of an Innovation Biography is a narrative interview with the major responsible person of the innovation process. The overall aim is to get in-depth insights into the entire innovation process from its beginning until its implementation and to have a first version of the innovation's biography. To start the narrative, the interview partner is motivated by an initial question that stimulates a free reflection of experiences in a continuous flow of words. To achieve this, the question needs to contain a clear starting point, e.g. the situation in which the first idea of the innovation arose; a straightforward 'narration corridor', e.g. what the actors, time-line, milestones and barriers were; and an end, e.g. means of implementation or market introduction (FISCHER-ROSENTHAL and ROSENTHAL, 1997). Detailed questions at the end of the narrative should aim at concretizing important aspects, for instance actors involved or the time-line of the biography, that have not been described clear enough by the interviewee.

It should not be unnoticed that quality and quantity of narrative information heavily depend on the narrator's ability and willingness to speak about the innovation process. In some cases the responsible persons simply do not want or cannot talk about the innovation process because they have to protect intellectual property or the R&D partners of the firm. Furthermore, even a well-expressed detailed story may leave aside problematic periods, put certain actions in an inadequately positive light or vice versa, or may not mention major failure during the process (cp. MILES and CRUSH, 1993 for a discussion of advantages and drawbacks of narratives). Partly, this can be balanced out by subsequent interviews carried out with other actors of the process as they might see things from a different perspective. However, a residual risk of getting inexact information will remain. Another problem lies in the nature of disclosure agreements or other contractual obligations that prohibit speaking about certain parts of an innovation project. In this case the research team has to decide whether the obtained information is authentic enough to continue the research procedure.

Provided that the narrative was successful in terms of getting sufficient information about the innovation process, a first version of a biographical text is developed that includes the time-line or sequence of events, involved actors, their geographical locations and the development progress.

#### *Egocentric network analysis and further interviews*

Based on this information, subsequent desk research aims at identifying the actor network around the innovation. Generally speaking, in egocentric network analysis which is applied here, a network is described via one node (ego), usually an organisation or a person and its relationship to other persons or organisations. Egocentric network analysis only asks for the relations of one ego to different alters, but does not analyse the entire network (JANSEN, 1999). In Innovation Biographies, the node is neither a person nor an organisation but the innovation itself.

In the first instance, the egocentric network analysis shall shed light on the actors that have taken part in the development. Concretely, this means analysing modes and frequency of the interaction among the main responsible and externals, the type of exchanged knowledge, the sectoral affiliation etc. To better understand the evolvement of knowledge dynamics, it is of significance to know at what point in time a particular actor has got involved in the process, where he/she is located or when other aspects have set knowledge dynamics in motion. This enables to analyse the impulses affecting them, how they build upon each other, cause feedback loops or might even require a radical change in the direction of development.

Egocentric network analysis is always selective (i.e. it is seen from the perspective of the “story teller”) and covers only a particular part of a more complex and multiple network (GERICH and LEHNER, 2003). But its advantage is a straightforward access to the composition of actors, information on a considerably detailed level, and a direct evaluation of the influence actors have on the innovation process. The ego-network is combined with geographical data (cp. figure 2). In so doing, every link of the innovation biography has a territorial dimension and the spatial origin of the knowledge applied in the innovation can be visualized.

The ego-network is also crucial for finding the next interview partners. This should be another person who had decisive functions in the innovation process from inside the firm or from other externally involved actors. In a narrative, semi-structured or structured way – depending on the quality of information obtained in the first interview – the first aim is to enrich the biographical picture developed through the information of the first interview and implicitly have verified the information gathered. The second aim is to be led to next interview partners (snowball sampling) and again these can come from the same organisation or from other involved actors. The selection criterion is based on their role in the innovation process. The same interviewing procedure is then applied in the following interviews so that the body of biographical material extends with the number of interviews. It is surely not possible or necessary to speak with every actor involved in the innovation process. What is important is to get a full picture of the major actors, what they have contributed, when they entered the development process and where they are located.

### *Triangulation: Building the biography and analysis*

To make the biography accessible for analysis, the concluding step is to triangulate data of the various interviews, the egocentric and geographical analysis and of desk research into a coherent story. Their ensemble eventually constitutes the Innovation Biography. The term triangulation rests from geodesy and means determining the exact position of an object from different points of reference (FLICK, 2011: 11, 12). Translated to social sciences, triangulation means applying different empirical methods to one object of study, such as an innovation process. Different methods may bring about different perspectives and complementary data and by combining the data-sets, information on the study object is likely to be enriched and verified. To achieve maximum output, an optimal procedure is acquiring data on different levels (cp. FIELDING and FIELDING, 1986; FLICK, 2011). In this case, data on the *structural level* of knowledge dynamics, i.e. the involved actors, modes, frequency and geographical spread of interaction, was obtained with the egocentric network analysis. The various interviews reflect an *individual level* by asking the interviewees for their view on the process of knowledge generation and combination. Document analysis as a third component has the function to enrich the biography by publicly made official information but primarily to provide information of the knowledge dynamic's *contextual level*.

Basing upon data triangulation, writing down an Innovation Biography is a process of telling a real and detailed story covering all aspects that have been of relevance for the development of the innovation process and its related knowledge flows. These are an explanation of the contextual settings and the impulses through which the innovative idea arose for the first time; the development and change of the actor constellation over time and the channels through which they have got in contact with the main responsible firm; strongly related to the actors is the geographical spread of actions that can be textually replicated, but also through mapping the time-space path of action (cp. figure 2); the content-related boosters and barriers, drawbacks and opportunities, internal and external impulses that have affected the nature and flow of knowledge dynamics; and not at least a reflection of the mechanisms that facilitated the implementation of the innovation.

This coherent and multi-faceted case-study is a result by itself and a meaningful exemplification of the complexity of innovation processes and their multi-level reach (cp. e.g. VISSERS and DANKBAAR *forthcoming*). An alternative are comparative analyses of particular aspects as conducted in case of the EURODITE project, where special attention was e.g. paid on the combinatorial characteristics of knowledge generation in approx. 60 Innovation Biographies. In other perspectives, selected aspects can be sharpened and elaborated upon in separated textual analyses, as the examples of this paper's following part will shortly illustrate. Here, one innovation biography is presented with a focus on the mechanisms of combining knowledge from different sectoral sources and the other on the multi-level reach of the innovation process's knowledge flows.

### ***Innovation Biography I: ceramic wallpaper***

The first example case is about the development of a flexible ceramic wallpaper carried out in a research-based company in the field of nanotechnology. With the development of a product for the end consumer market, the company entered completely new grounds since before its products were suited to intermediate markets in chemistry. The innovation biography is based on five interviews

with major actors of the innovation process. The first interview was given by the head of company and had the two functions of agreeing upon an innovation project which subsequently was introduced shortly, but especially of getting easy access to other actors of the innovation process (through his high position others interview appointments were easily organized). The second interview was dedicated to the narrative (duration approx. two hours). It was held with the project manager as he was involved in all central development phases and had detailed knowledge about the entire innovation process. Egocentric analysis, as well as the project manager's recommendation (snowball sampling) led to further interviews. These had a twofold structure in which the interviewees narrated the innovation story from their perspective (in order to get new information and to check existing one) and afterwards were asked to answer some structured questions.

The Innovation Biography is characterized by three decisive phases of cross-sectoral knowledge combinations. The science based nanotechnology related knowledge needed to be combined with knowledge from the film industry, from painters and from creative industries in order to find solutions for serious technical problems as well as to enhancing the wallpaper's application and design attributes. Altogether they represent an illustrative example of how analytic, synthetic and symbolic knowledge components are combined in innovation (cp. figure 1). In terms of different geographical levels, the innovation process broadens its scope parallel to the development process. It starts on company-internal base where the idea and the prototype were developed and then stretches out on national level. Distribution channels were established on a Europe-wide basis.

The innovation's starting point has three origins of very different nature. Firstly, knowledge existed on how to produce flexible ceramics in the context of lithium ion batteries and the company wanted to benefit from greater returns of the knowledge. Secondly, the disproportion of the price of ceramic wall tiles and the price for its professional application noticed by an employee who moved into a new home by that time. And thirdly, a general search of the company for new markets to place their products. The idea arose to develop a flexible ceramic wallpaper that would combine the advantages of tiles (waterproof, fireproof, dirt-repellent) and conventional wallpaper (quick application, broad range of designs).

A prototype was developed and presented on a fair very early in the project. This was a means to test market reaction that was of considerable importance for the company, since until now development was kept strictly internal for reasons of nondisclosure. Positive feedback from the fair's professional participants laid ground for the construction of a larger production plant in the technical school of the company.

#### *Knowledge combination I: nano and film industry*

When the plant was ready for production it turned out that first test series had uneven margins. This was a serious problem, because unlike ordinary wallpaper ceramic wallpaper is inflexible and cannot be pushed to butt at the edges. Additionally, the water-resistance could no longer be maintained. After an unsuccessful period of searching for an internal solution, pressure increased the need of spreading the problem throughout external (regional) networks. An intensive search process began that reached far beyond sectoral borders. The solution was found in the film industry since in former production processes of film rolls too, existed need for accuracy to ensure that films did roll up

smoothly from their spool. (Surely the digitalization has changed production processes today.) Therefore a film company was involved in the innovation process from now on. This is the first case of combinatorial knowledge dynamics in the Innovation Biography. It is not only about combining science based (analytic) and engineering based (synthetic) knowledge of the two actors but also about the combination of knowledge that has totally different sectoral origins. Combination was only possible because the geographical scope of the innovation process was enlarged from internal activities through to regional networks towards the national scale where the film company was finally found.

#### *Knowledge combination II: nano and painters*

Modified production was a milestone in the innovation process and disclosed further properties regarding the wallpaper's application that needed improvement. Through cooperation with painters a practitioner's perspective was integrated into the innovation process. It was expected that this measurement would effectively complement the scientific approach of the actors being involved so far. A painter was hired in order to apply the wallpaper and test its functional properties within the company building and immediate feedback and interaction between scientific and practice oriented knowledge was enabled. Other painters as actors being on the market on daily basis were invited to a series of workshops in order to experience and evaluate the product and through this indirect consultation contribute to the further modification of the wallpaper.

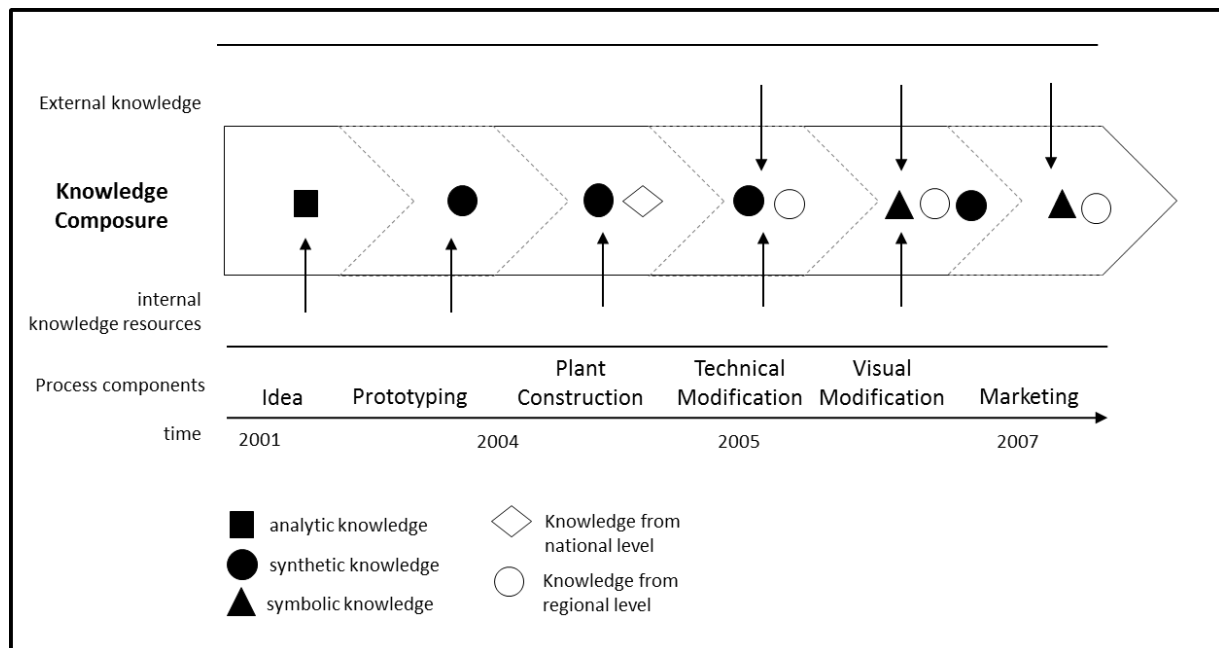
#### *Knowledge combination III: nano and creative industries*

One result of the consultation process was that the visual appearance of the wallpaper was in need of improvement. To increase the variety of colours, surface structures and collections, a freelance interior designer was assigned who worked for a certain period of time together with the technicians. With this employment the so far technically and functionally oriented innovation process reached a stage in which symbolic knowledge attributes, i.e. the development of design, appearance and emotional features became more central. This, on the other hand, implied that the competences and reach of internal knowledge of the nanotechnology firm rather quickly reached its limits and that other actors needed to finalize the innovation process. Therefore, the entire commercialization and marketization process too, was externalized and conducted by an agency specialized in bringing high-technology innovations on end-consumer markets through image production and branding.

The time-line of the Innovation Biography, its knowledge combinations and geographical reach are illustrated in the following figure.



Figure 1: Knowledge composure of ceramic wallpaper



Source: own illustration, after Strambach et al. (2009)

### ***Innovation Biography II: A new hotel concept<sup>2</sup>***

The second example is taken from the tourism sector in Antalya, Turkey. It is a biography of the development of a new hotel concept combining elements of all-inclusive mass tourism with the advantages of small highly luxury privately owned hotels. The reason for the selection of this case is its spatial extension connected to major knowledge dynamics demonstrating the multi-locality of innovation. It is possible to show when and how knowledge from different spatial levels was combined in order to establish and develop a business model addressing the particular target group of wealthy Russian tourists (cp. figure 2). The innovation process is narrowly tied to the development of a company and the career of a Turkish business man. It is based on 10 interviews.

#### ***Antalya and Moscow***

The beginning of the case can be devised by the foundation of two small hotels and a real estate agency in Antalya and an opening of a jewellery shop in Moscow by a Turkish business man. For the development of the hotel concept, for which the first idea arose by that time, this is of double significance: Antalya region is the place where all the later activities are carried out, and strong formal and informal networks have played the role of a facilitator in a variety of aspects. Russia is the country where most of the potential customers for the boutique hotel were supposed to come from and by running a business in Moscow and providing services for Russian customers (real-estate) insights into upper-class requirements could be acquired. In fact, already in the initial stage both the regional and the international scale are of great importance for current and later developments.

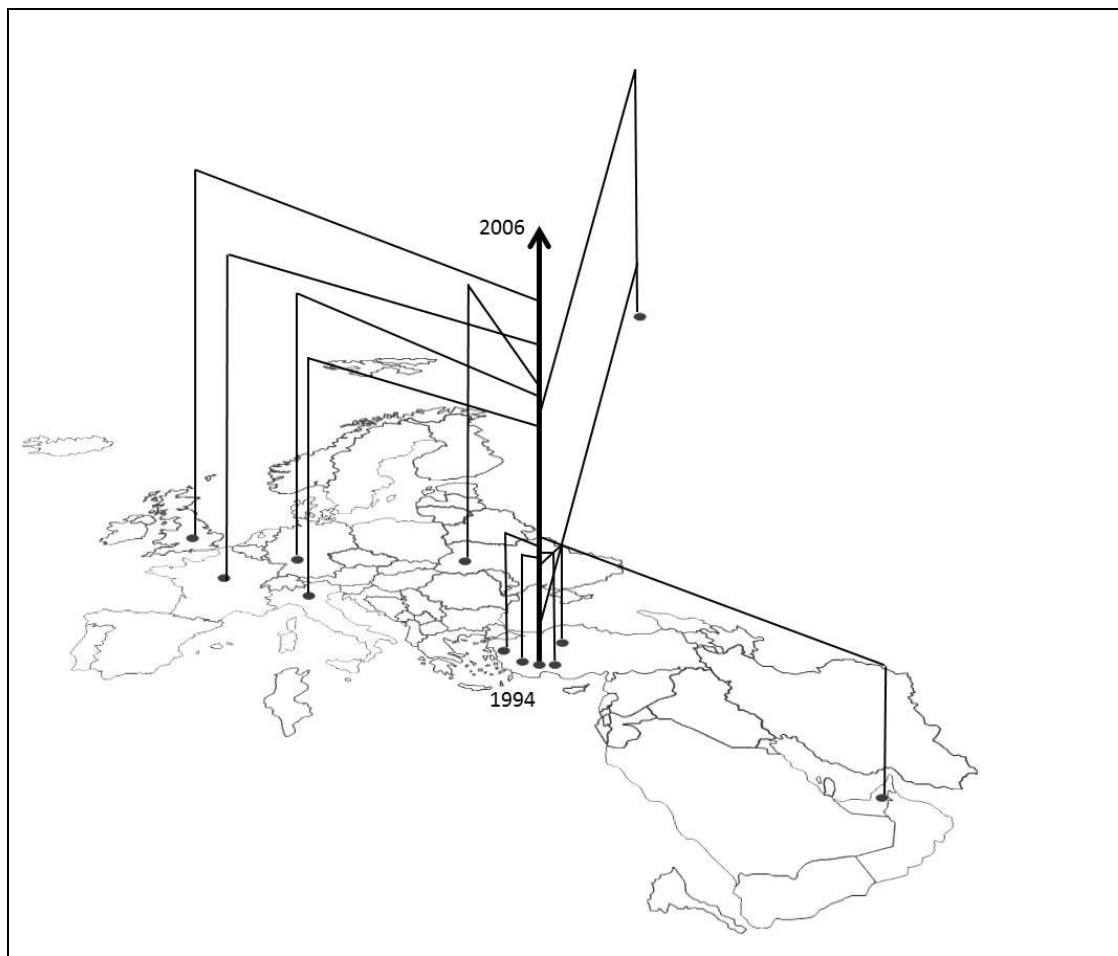
#### ***Dubai***

Business contacts to the Dubai-based hotel sector, established during an official delegation of the Turkish prime minister to Dubai, enabled to successfully apply for the management of a local upscale hotel. This was evaluated as an intensive learning period as the manager, now being part of the world-leading luxury hotel industry in Dubai, got insights into market trends, the expectations of highly demanding hotel guests, and not the least into the practical management of a five-star hotel.

#### *Antalya and Europe*

Furthermore, contacts to European companies providing luxury goods or services for hotels were established to develop a highly comprehensive wellness concept. These are e.g. contacts to a butler school in London, to companies providing spa equipment in Paris and Milan, close interaction to a yogi in the Far East, to a Russian security company, and contacts to Trutskavets (Ukraine) to hire Russian speaking pedagogues for child care and animation. Figure 2 gives an impression of the branching out of the knowledge process over time and space.

Figure 2: Time-space extension of the innovation process



Source: own illustration

The central arrow illustrates the time-line of developing the new hotel concept (from 1994-2006) and the other connections represent external actors, their date of entering the development process for the first time and their geographical location. It is of course possible to further qualify the links, e.g. through differently dotted lines or colours and in so doing attach knowledge attributes or ways of cooperation (formal/informal) to the link. But for reasons of providing a basic and simple illustration of a time-space path it has been left out in this paper.

What becomes clear in addition to the various local, national and global relationships that evolved around the case is the place-specific distinctiveness of innovations, implying that a consideration of what innovation actually means, is context-dependent. Whereas the hotel-concept would, due to the pronounced history of luxury hotels, not be considered as something novel and innovative in Dubai, it was a success-story in Antalya as the first hotel of its kind.

### ***Conclusions***

Earlier parts of the paper stated that there is a new conceptual thinking concerning multi-level and combinatorial characteristics of knowledge and innovation. It was claimed that Innovation Biographies are an approach to gain empirical evidence to this, as the methodological set-up has been guided by the observation that knowledge generation, use and sharing does not follow space and time bound regularities. The following key arguments have been developed throughout the paper: It was argued that Innovation Biographies are suited to overcome the separate view of different spatial levels. They grasp knowledge dynamics and then follow them through time and space and thereby shed light on the micro-dynamics and a broader understanding of TKDs as an approach aiming at further developing territorial innovation models. The time dimension was seen as a means to get new insights into the nature of knowledge dynamics and innovation processes as it implies an in-depth analysis on the evolution of knowledge. Combining knowledge evolution with a territorial dimension makes visible the time-space path and micro geography of innovation.

Though illustrated in a summarized manner, the two example cases have shown the reach of Innovation Biographies and provided a snapshot of the kind of information and results that can be achieved.

However, extracting results from single case studies is only one way of achieving new insights from Innovation Biographies. It is a challenging task of future research to analyse in a comparative manner several Innovation Biographies, as every innovation process has unique characteristics. Such analysis will always imply a balancing act between the provision of case specific information and generalizing aspects that allow comparability. Potential ways of systematizing the results of a variety of Innovation Biographies are e.g. the construction of an empirically grounded typology (KLUGE, 2000; WENGRAF, 2000), comparative analyses of innovations in different sectors, or different kinds of innovations (e.g. organizational, service, product, university-based, innovations in multi-national companies, social innovations, etc.).

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<sup>1</sup> The term Innovation Biography was also mentioned by German industrial sociologists some years ago (**RAMMERT, 2000; LENZEN et al., 2005**). However, it was used in the context of studying *Technikgenese*, the evolution of new industries, e.g. wind energy or renewable energies (**BRUNS et al., 2009**), instead of single innovation processes, their knowledge dynamics and time-space paths. Due to its focus it contained a different methodological approach (constellation analysis) and did not include the mix of instruments and the thematic focus of knowledge and territory as suggested in this paper.

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