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University of Helsinki
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COMPLEXITY AND COLLABORATION IN CREATIVE GROUP WORK

Petro Poutanen

ACADEMIC DISSERTATION

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Abstract

In concert with the emergence of cross-disciplinary collaborative working practices, the demands of creativity and innovation in working life have increased. The problems of the 21st Century are inherently complex and require the creative contributions of multiple stakeholders to solve them. Furthermore, working life settings are often ad hoc and diverse in their nature, making collaboration challenging in terms of creative synergy. However, creativity has been predominantly studied from the individual perspective, meaning the research tradition is out of step with changes in working practices as it does not provide guidance for complex creative and interactional processes. Therefore, new approaches that account for the complexity of human interaction and collaboration need to be developed to better understand what creativity is and how it can emerge from synergy between people who are very different from each other. This is the focus of the dissertation.

This dissertation argues that creative collaboration can be approached through the lens of the theories about complex systems. These theories conceptualize creative collaboration as an interactive and emergent phenomenon, in which creativity emerges continuously and unpredictably from the interactions of the actors and elements of the system. This argument is investigated in this study by developing a research framework based on the theories of complex systems and examining creative collaboration through empirical case studies that were conducted in the context of innovation camps. The proposed research framework emphasises three important points of attention when studying creative collaboration: temporal patterns, social mechanisms, and meanings and communication.

The findings of the explorative research suggest several interesting research avenues. Firstly, the creative process seems to follow unanticipated temporal orders, including points of sudden discontinuities. This suggests that a creative process requires patience for an efficient working mode to emerge. Secondly, the mechanism of emergence describes how a system of contributors includes both individual and collective level knowledge, skills and memory. This suggests that the emergence of shared practices in a group setting requires a certain level of autonomy and self-direction. Thirdly, human creativity is a process of symbolic exchange and meaning-making. The acknowledgement of the constructive communicative nature of the creative process helps individuals involved in a creative collaborative process understand how different interpretative frames can contribute to a creative process, which stands in contrast to the information transmission-based understanding of communication and knowledge building.

This dissertation incorporates two conceptual and three empirical articles that are further developed in the concluding article.

Tiivistelmä

Luovuuden ja innovatiivisuuden vaatimukset ovat lisääntyneet työelämässä, kun työnteke samanaikaisesti muuttuu yhä monialaisemmaksi ja yhteistyötä painottavaksi. Tämän ajan ongelmat ovat monimutkaisia ja niiden ratkaiseminen edellyttää useiden sidosryhmien luovaa panosta. Työnteosta on tullut myös tilannekohtaisiin ja nopeasti syttyviin tarpeisiin reagoimista, mikä tekee luovasta yhteistyöstä haasteellista. Tästä huolimatta luovuuden tutkimus on lähes yksinomaan painottanut luovaa yksilöä, mistä johtuen tutkimusperinne on jäänyt jälkeen työelämän muutoksista, eikä kykene tarjoamaan ymmärrystä nyt vaadittavan monitahoisen ja vuorovaikutteisen yhdessä luomisen tueksi. Yhteisöjen erilaisuudesta kumpuavan luovuuden ymmärtämiseksi ja tukemiseksi tarvitaan uutta näkökulmaa, joka huomio inhimillisen vuorovaikutuksen ja yhteistoiminnan ulottuvuudet. Tämä väitöskirjatutkimus keskittyy tähän aihepiiriin.

Väitöskirjassa esitetään, että luovaa yhteistoimintaa voidaan ymmärtää kompleksisten systeemien teorioiden kautta. Tämän näkökulman avulla luova yhteistoiminta voidaan käsittää vuorovaikutteiseksi ja emergentiksi ilmiöksi, jossa luovuus ilmaantuu ennustamattomalla tavalla osallistujien vuorovaikutusprosesseista ja systeemin muista osista. Tätä väitettä tutkitaan kehittämällä kompleksisten systeemien teorioihin perustuva tutkimuksellinen viitekehys, jota sovelletaan innovaatioleireillä toteutettujen empiiristen tapaustutkimusten erittelyyn. Kolme keskeistä näkökulmaa ohjaavat viitekehysten käyttöä: keskittyminen ajassa eteneviin vuorovaikutusprosesseihin, toimintaa tuottavien sosiaalisten mekanismien tunnistaminen ja viestinnän ymmärtäminen vuorovaikutteisena merkitysten rakentamisena.

Tutkimus on luonteeltaan eksploraatiivinen, ja sen löydökset viittaavat useisiin kiinnostaviin luovan prosessin piirteisiin. Ensinnäkin luova työprosessi vaikuttaisi noudattavan osin ennustamatonta ajallista dynamiikkaa sisältäen yhtäkkisiä epäjatkuvuuskohtia. Siksi luova työprosessi edellyttää kärsivällisyyttä tehokkaan työtavan löytymiseksi ja ylläpitämiseksi. Toiseksi luova yhteistoiminta on emergenttiä, mikä tarkoittaa sitä että sekä yksilö- että yhteisötasot ovat läsnä tiedon ja taitojen tuotannossa ja säilömisessä. Tämän perusteella voidaan päätellä, että ryhmän yhteisten työtapojen ilmaantuminen edellyttää jonkinasteista itseohjautuvuutta ja itsenäisyyttä päätöksenteossa. Kolmanneksi inhimillinen luova prosessi perustuu symboliseen merkitysten rakentamiseen. Konstruktivisuuden tunnistaminen avaa luovaan yhteistoimintaan näkökulman, joka huomioi myös yksilöllisten tulkinnallisten kehysten arvon luovalle prosessille.

Väitöskirja sisältää kaksi käsitteellistä ja kolme empiiristä tieteellistä artikkelia, joiden löydöksiä kootaan yhteen ja kehitetään edelleen väitöskirjan yhteenvetoluvussa.

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List of original articles

This thesis is based on the following publications:

- I. Poutanen, P. (2013). Creativity as seen through the complex systems perspective. *Interdisciplinary Studies Journal. Learning by Developing – New Ways to Learn. Proceedings of the 2012 Conference on Creativity in Higher Education*. An unrefereed special issue, 2(3), 207–221
- II. Poutanen, P., Soliman, W., & Ståhle, P. (Accepted for publication). The complexity of innovation: An assessment and review of the complexity perspective. *European Journal of Innovation Management*.
- III. Poutanen, P. & Nisula, A-M. (In review). The mutual facilitation of creativity in temporary problem-solving groups.
- IV. Poutanen, P.K. & Ståhle, P. (2014). Creativity in short-term self-directed groups: An analysis using a complexity-based framework. *International Journal of Complexity in Leadership and Management*, issue Vol.2, no.4, 259–277.
- V. Poutanen, P. K., Kianto, A., & Ståhle, P. (2012). Developing dynamic intellectual capital through creative group dynamics: The ACSI innovation platform. In J. Surakka (Ed.), *Proceedings of the 4th European Conference on Intellectual Capital* (pp. 377-385). Reading: Academic Publishing International Limited.

The publications are referred to in the text by their roman numerals.

1 Introduction

Creativity and innovation as concepts have become almost meaningless in their ubiquity in the everyday language of politics and businesses. At the same time, they are needed more than ever. The problems of the 21st Century are intractable and complex and need solutions that are beyond those of individual players. Such problems require and affect multiple stakeholders, whose interests and contributions are necessary for solving them (Koschmann, Lewis, & Isbell, 2011). Hence, a question arises: How does creativity and knowledge creation take place in diverse, collaborative settings?

For too long, creativity has been conceptualised as “idea generation”, assuming that ideas are entities that can be evaluated as good or bad from the outset and that the process follows some set phases from generation to implementation (Carlsen & Välikangas, 2016). In reality, ideas exist only within the context of their creation as different acts of communication. Furthermore, the process of creation is iterative rather than sequential in its nature (ibid.). In the context of this dissertation creativity is understood as an ability to think differently about the prevailing “truths” and come up with novel and surprising perspectives and approaches. This approach emphasises that creativity is a process of discovery, a way of thinking and acting in order to create novelty.

In the study of creativity the individual has almost exclusively been the focal point, in fact, even in studies that take group creativity as their research focus, the group is often seen as a context for individual creation (Shalley, Zhou, & Oldham, 2004) This context is usually seen as harmful with such group effects as production blocking, social inhibition, social loafing, and groupthink (Sawyer, 2007, p. 64–66). Moreover, very rarely do the studies that focus on collaborative creation take place in real organisational contexts (George, 2007). The ideas derived from individually-centred creativity research are less useful in providing guidance for collective creativity. More research is needed on what actually takes place in groups and group processes (George, 2007). In the context of this dissertation *collective creativity* refers to a collaborative situation in which many people come together to solve difficult problems or create novel ideas, and in which their diversity and interaction is beneficial to their creative efforts. Creative collaboration is more about *combinations of people* rather than individual talents coming together.

Therefore, new approaches that account for the inherent complexity of human interaction and collaboration need to be developed in order to better understand what creativity is and how it emerges from synergy between people. Indeed, it has been argued that psychologically oriented studies do not adequately consider the social level, which is the most important level for collective creativity (Sonnenburg, 2004). Nevertheless, a new social approach

has started to emerge (e.g. Csikszentmihalyi, 1988; Sonnenburg, 2004; Hargadon, 2006; Miettinen, 2006).

While collaboration is certainly the more rigid part of modern organisational practices, a new set of problems has arisen from the imminent complexity and interconnectedness brought about by collaboration. In reality, collaborative settings can be *ad hoc*, diverse and ephemeral in nature, making collaboration challenging in terms of creative synergy because people come from different backgrounds and have varying organisational and cultural values, and differentiating needs and goals. Researchers are now considering asking how, exactly, people from diverse backgrounds can engage in problem solving and innovation processes, and do so in such a manner that the collaboration benefits from the wisdom of many (e.g. John-Steiner, 2000; Sawyer, 2007; Harvey, 2014)?

A newly born field called *complexity science*¹ states that many social and natural systems are characteristics of complexity, interdependency, interactivity, unpredictability, emergent order and structures, and self-organising behaviour (Cilliers, 2011). Theories of complex systems have spread into different fields of the social sciences and include, but are not limited to, the study of such complex *social* systems as societies, globalisation, organisations, policy making, groups and teams, leadership, and scientific disciplines (e.g. Byrne & Callaghan, 2014; Castellani & Hafferty, 2009, Urry 2003). The central tenet of researchers working under the rubric of complexity sciences is that a complex system cannot be understood by simply breaking it into its components (“entities”) and studying these components in isolation; instead, a complex system needs to be approached holistically and in relation to the evolving interactions between the components and the interaction of the whole within its environment (Cilliers, 1998).

The purpose of this research is to answer the following question: *How can the application of complexity sciences improve our understanding of collective creativity?* Creativity research has a long history of studying individuals while the social side of creativity is less studied. Therefore, it is important for creativity research to pursue questions concerning the collective and creativity, while also bringing a novel interdisciplinary perspective to the field. With respect to this, the situation has begun to change, and there are nowadays several novel perspectives that try to capture the phenomenon of collective creativity. However, these perspectives are based on the assumptions of traditional individual-centric creativity research, making it difficult to reconcile them with social scientific and interactional perspectives. Therefore, a new research framework would help to organise the phenomenon of collective creativity from a novel perspective and combine the most appropriate research perspectives. In addition, there are many important

¹ Also: the “science of complex systems” and “complexity theory”. In this dissertation they are also referred to as “theories of complex systems”, since there are multiple theories and perspectives rather than one theory of (all kinds of) complex systems.

questions that remain unanswered because they have been difficult to fit into the existing research frameworks, such as the role of time, the interaction of multiple elements, the non-linearity of the creative process, etc. On the other hand, complexity science is a developing research perspective, which has made its way into a variety of disciplines – from psychology to sociology – that study human behaviour. The applications of complexity vary from highly mathematical modelling and computational simulations to qualitative and narrative soft-approaches. However, their overarching message is the same: phenomena that involve many complex dynamics and interactions may be better understood as complex systems than through traditional methods. Therefore, the discipline of complexity science gains from studies like this dissertation, which attempts to develop and apply research methods and theory outside of the disciplinary boundary they were created for.

There is also another research question in this dissertation that addresses the practical side of creativity: *What are the most important factors for fostering creative collaboration from the perspective of complexity theories?*

The dissertation comprises this article and five research articles (I–V). Two of the articles included in this dissertation are conceptual in nature. The first, Article I, discusses complex systems theory and creativity research. The second, Article II, deals with complex systems theory and innovation research. Articles III–V are empirical and report the findings of empirical case studies conducted on creative problem solving groups working within an innovation camp, namely *Aalto Camp for Societal Innovation (ACSI)*, which took place in 2010 and 2011. Seven problem-solving groups were studied and observed during the empirical studies, providing a unique and rich basis for studying creativity and collaboration empirically. The groups dealt with real-life societal challenges, worked intensively, and were formed on an *ad-hoc* basis and worked in a self-directed manner (without a formal leader, set hierarchies or a working plan). Due to these conditions, there was strong support for the argument that these groups – as collaborative systems – would exhibit high complexity and emergent patterns of interactions.

The author's theoretical and empirical understanding of the subject has gradually grown as the process has developed over the years. This concluding article draws together the individual studies and constructs a complexity-based research framework, based on the applied theories, which serves as a theoretical lens for summarising the research results.

The structure of the thesis is as follows. First, chapters 2 and 3 consist of the theoretical background of the dissertation. In chapter 2 the study of creativity and creative collaboration is introduced, putting an emphasis on the developments and perspectives that have led to the emergence of a “collaborative turn” in creativity research. In chapter 3, the complexity perspective is presented, with a focus on its key concepts and philosophical ideas derived from complex systems sciences and applied in the study of social systems.

Chapter 4 defines the research aims of this study in more depth, and presents the research design, including the research strategy, its approach, the underlying philosophical assumptions, and a description of the data, the research process, and the methods used in the articles. This chapter also includes a summary of the articles.

Chapter 5 presents the results of this dissertation, which are summarised from the research articles, and are presented in light of the framework developed in this concluding article. At the end of the chapter 5, the most important results are translated into proposals for practice.

Chapter 6 comprises the discussion and conclusion, with a brief summary of the research results in the context of the research aims of the dissertation. The limitations of the study, as well as avenues for future research are discussed in this chapter.

Figure 1 below summarises the relationships between the presented articles and the concluding article, also illustrating the research process of the dissertation.

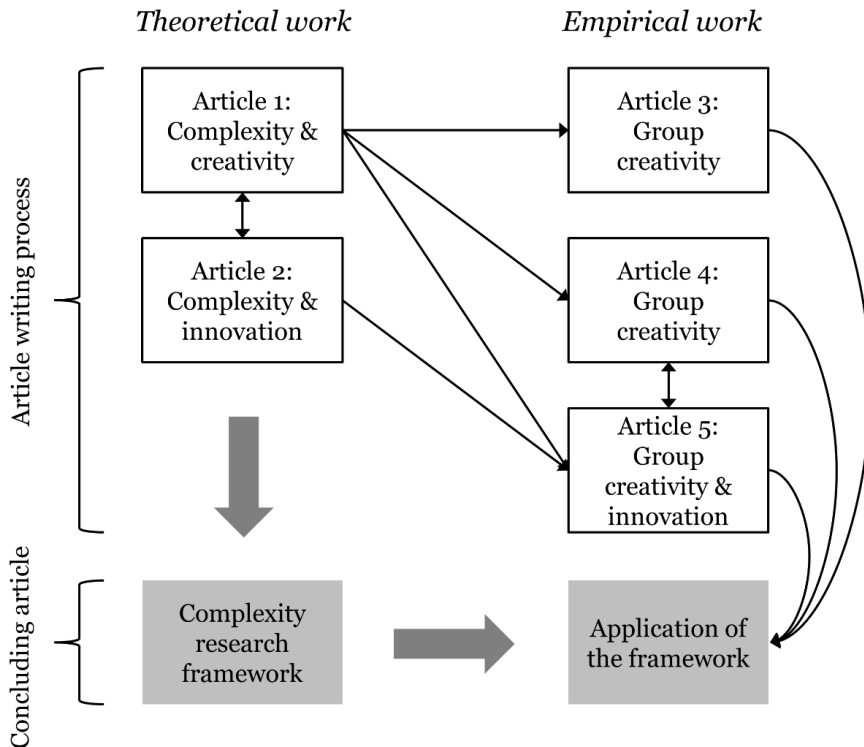


Figure 1. *The research process and the relationships between the articles and the concluding article.*

2 Creativity in groups

Creativity is central to organisations, as it is the antecedent of innovation and survival (Shalley, Zhou, & Oldham, 2004). Creativity is needed to reformulate old habitual modes of acting and working, when the conditions and the environment surrounding us change (Miettinen, 2006). Creativity research studies moments of creation as well as the processes of idea-generation, which are imperative factors when formulating solutions to small and large problems. Creativity is also associated with innovation, which stands for the process of creating inventions and putting them into use through the process of implementation. In order to prosper in a highly competitive environment, companies must innovate (West & Sacramento, 2012). All in all, creativity is vitally important for organisational growth and effectiveness (Amabile, 1996).

This chapter sets out to introduce the concept of creativity as it has been discussed in academic research and reviews some of the relevant approaches to it (2.1). It then discusses the meaning of creativity in collective settings and reviews the most central approaches to the collective creative process (2.2). This chapter concludes with an identification of the research gap and a rationalisation of why a novel research perspective is needed (2.3).

2.1 Creativity as a research object

We are living in the age of instantly visible creativity and innovation. New concepts are present everywhere. It is widely believed that creativity is what is needed for societal wellbeing and economic growth, in the face of difficult societal and environmental problems. Most of the studies share the idea that creativity is a driving force of civilisation, and these views are almost entirely positive. But this is not, of course, the whole truth: creativity can be also dangerous, if used for unethical purposes, such as criminal activity (see e.g. Cropley, Cropley, Kaufman & Runco, 2010). Similarly, what is considered as an ingenious innovation for some stakeholders may turn out to be a catastrophe for a millions of other people, such as the subprime lending instruments of brokers, bankers and investment banks that led to the 2008 global financial crisis (Shiller, 2012).

Indeed, a historical analysis of the concept of creativity shows that the present overtly positive interpretation is exceptional. The word creative derive from the Latin word “creare”, make or produce, and the word was first mainly used in the context of the divine creation (Williams, 1983). In the Middle Ages in Europe to see someone as creative would have been blasphemous, because only God created; people merely made things (Weiner, 2000; cited in Hanchett Hanson, 2015). From the 18th Century onwards the term was

generally associated with the creation of art, and in the 20th Century it developed its current meaning (Williams, 1983).

Academically, creativity is hard to define precisely, resulting in multiple suggestions (see e.g. Barron & Harrington, 1981). Usually, however, it is accepted that creativity involves the creation of a novel product, whether material or conceptual, and its socially evaluated appropriation in a given context. However, this is the point from which creativity research develops in many different directions.

One of the problems arises from the fact that it is very hard indeed to talk about creativity in non-trivial ways. The original meaning of the word as something genuinely original, emphasising the making of human beings and innovation, has faded away and the term has become amorphous. Williams write:

The difficulty arises when a word once intended, and often still intended, to embody a high and serious claim, becomes so conventional, as a description of certain general kinds of activity, that it is applied to practices for which, in the absence of the convention, nobody would think of making such claims (Williams, 1983, p 84).

Williams refers to the convention of using “creative” as sufficient prefix in some fields, such as in “creative arts” and perhaps today in the “creative industries”, when it is clear that the work of art, advertising, music, culture, etc. is largely based on reproduction and copying. On the other hand, there are areas and professions which we do not refer to as “creative”, such as the work of crime detectives, but which certainly need creativity in order to be successful.

Nowadays, many people from quite different fields (not necessarily related to “the arts” in any reasonable manner) would refer their work as “creative” and politicians talk about “creative industries”, “creative cities”, and “creative clusters” (see Hesmondhalg, 2008). However, back in the 1960s few would have used the term creative as a word to describe their work, when to be counted as “skilled” was the ambition of the day (Heartfield, 2008). It may indeed be that our present understanding of creativity is too heavily coloured by florid business writing (ibid.) and the creativity discourse used by politicians and marketing. Therefore, we need a more theoretical and critical reflection on what creativity is and how it can be scientifically studied.

In scientific research, creativity has been a topic of interest since the American Psychological Association (APA) presidential address by J.P. Guilford – one of the founders of creativity research in psychology. In his speech, Guilford (1950) stressed the importance of creative talent for education, science, industry and the arts. Since then creativity has been an important area of psychological research, until recently it has grown ever more important and become a distinctively multi-disciplinary area of academic interest.

2.1.1 The scientific study of creativity

In creativity literature the concept of creativity is usually split into two parts and creativity is talked in terms of “everyday creativity and “historical creativity” (often referred to also as creativity with lower-case “c” and creativity with capital “C”) (see e.g. Boden, 2004). The former term refers to personal creativity, something that is novel, surprising and appropriate for an individual creator him- or herself, whereas the latter comes close to the concept of innovation, standing for a socially recognised invention, a socially appropriated output of a creative process.

The nature of novelty has not been the only difficulty, when trying to define creativity. For instance, the question remains, whether the characteristics of creativity correspond across different domains of inquiry. It may well be that some creativity-relevant characteristics may be relevant in one context but irrelevant in others. For example, dissimilar skills types are needed when generating novel solutions to technical problems and writing a novel. The best answer to the problem of domain-specificity vs. domain-generality is that some creativity-related factors are more general and others more specific (Baer, 2010, p. 321). Therefore, it may be that creativity should be approached as an ultimately context-dependent phenomenon.

In psychological studies on creativity, a common way to approach it has been to break the concept into the so-called “four Ps” of creativity: person, product, process, and press (environment). This model, suggested by Mel Rhodes in 1961, has helped researchers to focus on certain aspects of creativity, such as creator’s personality or favourable and harmful aspects in the creator’s environment. For example, Guilford (1967) suggested that a creative *person* is fluent in what he called “divergent thinking”, i.e. producing a lot of different types of solutions to problems within a short period of time. On the other hand, researchers studying organisational creativity have often approached creativity as a *product* that considers the diversity or the sheer volume of ideas produced, i.e. creativity can be seen as easily evaluated and measurable “end products” derived from a creative process (Borghini, 2005). The *process*-perspective has dominated in studies with a focus on “problem-solving”. For example, Wallas (1926) suggested a stage-model of the creative process, consisting of the sequential stages of preparation, incubation, illumination, and verification. Osborn (1953) applied the lessons of creativity research in the context of brainstorming and problem-solving groups and suggested a process model for groups to work with. This tradition has spurred a significant research tradition within group creativity research (see Paulus & Brown, 2003). Amabile (1983, 1997) has produced ground-breaking research on the motivational and *environmental* aspects of creativity. She has proposed, for instance, that creativity is influenced heavily by a person’s intrinsic motivation, which, in turn, is dependent on environmental support and limits. However, the model of the four Ps is, in many ways, obsolete. For example, it does not provide any way to explain the relationships between the different Ps (Watson, 2007, p. 425) and it does not take into account the social side of

creativity. Of the perspectives provided by this model, the process view nowadays serves as a theoretical starting point for most creativity studies (Sawyer, 2003, p. 21), and it is also assumed (in this dissertation) to be a starting point for studying creativity from the process perspective.

Overall, psychologists, as well as other scholars, have studied the creative process for several decades and most agree that its four basic elements are: (1) the initial phase, during which data and information is gathered; (2) the delay, during which the material is internally elaborated on; and (3) followed by the subjective experience of having the idea (“the eureka moment”); and (4) finally evaluating the appropriateness and value of the idea and elaborating that into its final form (Sawyer, 2006, p. 58–59). However, more and more scholars have recently started contesting the traditional definitions and approaches of creativity and pointed out several problems in simple stage models, such as the apparent complexity and non-linearity of the creative process, as well as the finding that creativity does not occur as a sudden insight but includes rather many small insights that are developed and combined over time (p. 70). The scope of creativity research further expanded when the social and contextual models gained ground in the 1980s (e.g. Amabile, 1983; Csikszentmihalyi, 1988).

In summary, creativity is no longer merely seen as an externalised piece of knowledge, an idea owned by one creator, which suddenly burst into the mind, but rather as a process embedded in dynamic interactional relationships between people and their cultural and material realities. These themes will be further developed in the following sections, after a brief section introducing the concept of innovation.

2.1.2 Creativity and innovation: similar but different

Innovation is considered fundamental to organisational survival and sustainability (March, 1991). Innovation and creativity research are partly overlapping areas of research, but they derive from different traditions and have mostly been studied in exclusion from each other. In addition, some scholars consider them as synonymous, whereas others see creativity as merely representing the idea-generation activity that is relevant in the early phase of an (usually linear) innovation process.

In general, innovation is a knowledge-intensive process of renewal and renovation, of putting something novel into practical use, or simply something that is being used or applied for the first time (Utterback, 1974). In this context, creativity is often defined as the generation of novel and useful ideas, whereas innovation is about putting those ideas into use. In other words, creativity involves exploring new ideas, whereas innovation is about exploiting and implementing the ideas (Paulus, Dzindolet, & Kohn, 2012, p. 328). Sometimes innovation refers to the whole process, implying that innovation is superior to creativity, and that creativity has the role of a brutal idea-generating machine.

However, in reality it is likely that actions calling for creative thinking and novel ideas do not immediately end after a certain phase of an innovation process; instead, the whole innovation process is creative, although creativity is used for different purposes (Rickards, 1996). For example, in the early phase of an innovation process creative thinking is probably needed for creating novel solution prototypes for a given problem, whereas later on creativity is used for making appropriate improvements to an invention, or solving other newly emergent problems. This suggests that an innovation process is most probably highly complex, systemic and interactional, involving different feedback loops to ensure improvement and learning.

This line of thinking is certainly not new among innovation researchers. Indeed, already by the 1960s, innovation scholars had shown that in most industries, “most of the ideas successfully developed and implemented by any firm came from outside that firm” (Utterback, 1974, p.621). According to the so called “open innovation paradigm” organisations should expose themselves to and respond to external events by opening up their boundaries to external sources of knowledge and innovation. Recently, even more open and complex approaches to innovation haven begun to emerge, such as crowdsourcing, i.e. outsourcing an organisation’s problems to “its customers or audience” in order to broaden its solution landscape (Afuah & Tucci, 2012).

For better or worse, once the value of creativity for innovations is acknowledged, the question of the social and cultural value of creativity becomes more pressing. When creativity is taken into the context of innovation, it becomes a goal-oriented activity with criteria that are socially and contextually determined. Therefore, an approach taking into account the individual creators, interaction between them and other stakeholders, as well as the larger social and cultural context, is required.

2.2 Creativity in collective settings

Interaction with others makes it possible to communicate ideas and discover novel perspectives and knowledge that originate from others, as well as receive emotional and social support and the evaluation of the ideas involved according to the standards of the given social context (e.g. Ohly, Kase, & Skerlavaj, 2010). Scholars have started highlighting “collective creativity”, the idea that a group’s members stimulate each other’s creative thinking, resulting in output that none of the individuals could have created alone (Kurtzberg & Amabile, 2000).

Most earlier studies on creativity have focused on the antecedents of individual creativity rather than groups or teams. There is a large body of research on idea generation and brainstorming groups (e.g. Paulus & Brown, 2003), but this research avenue focuses mostly on the antecedents and mechanisms that contribute to or inhibit idea generation rather than the creative process itself (e.g. Sonnenburg, 2004). Fewer studies have focused on

the impact of group and team processes on creativity (Shalley et al, 2004). On the other hand, researchers suggested long ago that relationships and interactions in a group foster creativity (e.g. Woodman, Sawyer, & Griffin, 1993), but exactly how that happens is not understood.

The early understanding of group creativity was coloured by results pointing out the negative effects of group processes on creative performance (e.g. Diehl & Stroebe, 1987). Despite results such as those, research examining the social side of creativity has steadily grown in the last 20 years, and theoretical perspectives have expanded beyond those of social and personal psychology, and today the variables of interest include a wide range of social influences and processes (Hennessey & Amabile, 2010).

Next, I survey some of the studies on group creativity in order to review the most important findings, i.e. what do we know about group creativity, as well as identify the shortcomings and research gaps, i.e. what do we need to know more about.

2.2.1 What do we know about collective creativity?

If we adhere to the idea that creativity is best understood as a process (e.g. Sawyer, 2003) – in alignment with social and systemic views on creativity – we need to ask: what kind of process? To answer this question, we can extract four different perspectives on the creative process in social settings from the research literature: the cognitive, the social-psychological, the systemic, and the collaborative perspectives.

The cognitive perspective. Studies taking the cognitive perspective focus on idea generation and selection processes and how cognitive mental processes transform representational structures, leading to novel solutions or a great amount of raw ideas, from amongst which the best solutions can be subsequently selected (e.g. Simonton, 1988). In the context of groups, these studies usually focus on brainstorming or idea-generation groups. It is assumed that in teams and groups the thoughts and ideas of individuals are implicitly and explicitly influenced by others via communication and information exchange (Mueller & Cronin, 2009). While individuals can employ only a simplified mental representation to frame the problem and guide the selection process, a group can hold multiple evaluation schemes simultaneously (p. 296). A review of team creativity processes revealed that among the most important cognitive processes (that have received attention from creativity researchers) are idea generation, brainstorming, problem identification, idea evaluation and selection, and information gathering processes (Reiter-Palmon, Wigert, & de Vreede, 2012). These studies have found that nominal groups outperform idea generation groups because of the production loss caused by social and cognitive factors related to group situations, such as production blocking, social evaluation apprehension, social loafing, and groupthink (Latane, Williams, & Harkins, 1979; Diehl & Stroebe, 1987, Janis, 1973). These processes negatively influence the efficiency of the

group both in terms of taking up time during idea-generation and making it socially harder for group members to express their ideas. One of the resolutions suggested for overcoming these deficiencies has been anonymous electronic brainstorming applications (Cooper, Gallupe, Pollard, & Cadsby, 1998).

Many of the studies focusing on idea generation have equated the process with the creativity itself, measuring the creative output as the number of ideas produced, i.e. the fluency of producing many ideas. However, it would be more accurate to state that idea generation is just one of the processes contributing to creativity (Reiter-Palmon et al., 2012, p. 312). The underlying assumption of the creative production is the model of “random variation”, which assumes that many minds produce more ideas – making it is more probable that a creative solution will be found (Harvey, 2014).

The social-psychological perspective. For a group to benefit from the diverse knowledge and cognitive skills of each other, they need to deal with social processes. Therefore, social-psychological studies of creativity have suggested how many social processes, from communication and interaction to different relational behavioural acts (e.g. Taggar, 2002), can contribute to a group’s creative process. For example, Taggar (2002) defines three social processes relevant to team-creativity: inspiring others, effective communication and feedback, and recognising others' ideas and asking for them. In his study he found that groups that contained creative individuals and had these social processes were the most creative. However, according to his study, if there was less creativity at the individual level, this tended to stifle the benefits of the team-level processes.

Other types of social processes studied within this cluster are studies of group communication processes. This research has demonstrated how a moderate amount of communication and a low level of centralisation are beneficial for group creativity, since they allow group members to equally share their ideas and discuss them in a constructive manner because no one or only a few members can dominate the process (Leenders, van Engelen, & Kratzer, 2003). This suggests that too much communication makes the interaction too time-consuming, and perhaps such groups fail to integrate and evaluate ideas properly. On the other hand, less centralised groups benefit from their members more effectively, since such groups have access to all of the members’ inputs. In addition, the tone of communication matters, since communication is beneficial when contributing to collaborative behaviour, while contentious communication can be detrimental (Lovelace, Shapiro, and Weingart, 2001). Collaboration and open communication are necessary conditions for group members to share their knowledge and benefit and integrate diverse perspectives, however as a review by Reiter-Palmon et al (2012) revealed, social processes are interrelated in many ways, and their effect may also be influenced by time, which would necessitate longitudinal perspectives. This makes the understanding of them a complex (empirical) task.

In comparison, Mueller and Cronin (2009) take a relational perspective and suggest a model that identifies "relational processes" which encourage creative teams to excel. The authors identify several factors – derived from previous studies on group creativity, brainstorming and idea generation – that can make it difficult for team members to benefit from other teammates' ideas and the different evaluation schemes for assessing them. Among those factors are a tendency to focus on commonly shared rather than unique information, time pressure, evaluation apprehension, poor comprehension, and the added effort and conflict experienced when trying to convince others. They suggest that relational processes of exchange of help, information, advice, and emotional concern can help a team's creative processes. They argue that relational support emerges from intense interaction and the exchange of resources over time in a team, and is necessary for creativity that is a cognitively and emotionally difficult process. In their focus on "relational" rather than "social" processes, the authors want to emphasise that teams and groups are "relational contexts" – characteristic of commitments and obligation to the other person (p. 292).

Social-psychological studies in general have made great progress in studying creativity from a non-individualistic perspective. This suggests that accounting for all complex interactions of the multiple variables influencing creativity is anything but an easy task. This perspective, however, handles the social as external to creativity in the sense that individuals are still often seen as the idea generators and problem-solvers, while the group is a specific type of environment for them to operate in (Shalley, et al., 2004; George 2007; Glăveanu , 2011). Another type of holistic approach can be provided by the systemic model of creativity.

The systemic perspective. The systemic models of creativity see the creative process embedded in the interaction of different elements, i.e. as a systemic phenomenon. The most well-known of such models is Csikszentmihalyi's (1988) systems model of creativity, which suggests an evolutionary process-based perspective on creativity, whereby the creativity emerges from a combination of symbolic (culture), social (judges), and creational (the inventor) processes. This suggests the value of novelty stems from the culturally determined valuation of the change it can introduce into a system. Csikszentmihalyi's "gatekeeper model" focuses on the production of cultural artefacts within a certain field, as creativity emerges from the interactions of an individual inventor, field experts, and the symbolic resources provided by the domain. Csikszentmihalyi (1999) further developed the model by describing the dynamics of creativity through an evolutionary analogy, whereby the dynamics of creativity are analogous to evolutionary variation and selection. In these terms, individuals produce variations, which are either rejected or selected by the environment and, in the latter case, transmitted to the next generation. In this model the variation corresponds to individual contributions, the selection to the gatekeeper role, and transmits the contribution of the idea to the domain (1999, p. 316).

The systems view has helped to shift the focus from individual talents and geniuses and products to the recognition of creativity as a socio-cultural phenomenon. It has helped to explain the interactions between the creator and the social context over time, and served as a model rich enough to correspond to the complexity of organisations (Ford & Gioia, 2000). Thus, the systems view has probably contributed to the adoption of creativity as a research topic outside of the psychological domain, and opened the doors, for example, to the study of organisational creativity.

However, the gatekeeper model also has its shortcomings. Perhaps its biggest limitation is that it pays little attention to the question of how creators assist each other in the creative process. In addition, the model overemphasises the role of gatekeepers, seeing creativity almost solely as a function of its social acceptance. The early systems views on creativity have contributed to the emergence of interactional and collaborative perspectives on creativity, which are discussed next.

The collaborative perspective. The advocates of so called collaborative creativity have suggested that creativity is emergent (Sawyer, 2010), participatory (Hanchett Hanson, 2015), socio-cultural (Glăveanu, 2010), and pragmatic-reflective (Miettinen, 2006), etc. That raises the question: What are the conclusions of studies focusing on the other types of processes involved in creative group work? Even though this cluster is most incoherent in its nature, some conclusions can be drawn. Firstly, the collaborative perspective relies on the core insights of the socio-cultural view and the systems models, recognising that creativity is defined through the process of social judgment and fed by existing cultural systems, into which products could later be integrated (Glăveanu, 2010, p. 50). This view also brings forth the interaction of those who are involved in the creative process, without neglecting the role of individuals in the process of creation. Rather, it sees creativity as emerging from the individuals and their situational interactions (e.g. Sawyer, 2010). Thus, the results of such processes cannot be reduced to the individual cognition. Creativity is not anymore embedded in the mind, the social side is seen as intrinsic to creativity and creativity as embedded in interaction (Glăveanu, 2011). Such a model might be better understood through the “dialectical model” of creation, i.e. the integration of different perspectives through the process of dialogue (Harvey, 2014).

Researchers have taken various perspectives on studying collaborative creativity. For example, in their study conducted in real organisational contexts, Hargadon and Bechky (2006) found four interactional processes that led to “moments of collective creativity” (p. 494). They studied interactions that lead individuals to combine their different areas of knowledge in a creative way and suggest four behavioural patterns: a) help seeking, b) help giving, c) reflective framing, and d) reinforcing. Help seeking encompass all occurrences of seeking the assistance of another person to solve a problem, while help giving is spontaneously putting time and effort into helping others. Reflective framing refers to behaviour in which all participants mindfully build upon

others work, i.e. a dialogic way of communicating ideas. Reinforcing, on the other hand, stands for all kinds of activities that encourage people to act in accordance with the aforementioned behaviours, such as promoting values that encourage people to help each other and ask help.

Drawing from the work of Lev Vygotsky's process- and relationship-oriented cultural-historical psychology, Moran and John-Steiner (2003) define creativity as a "capability" of individuals, which "transforms both the creator through the personal experience of the process, and transforms other people via the creation of the knowledge and innovative artefacts propagated through the culture to be appropriated by others" (p. 5). This view is based on an assumption that "all mental functions are first experienced socially, learned in interaction with others, then internalized..." and it is through "transforming" that a person comes to know about the world rather than "absorbing" (p. 4). In the context of collaboration, Moran and John-Steiner (2004) have focused on the effects of identity and motivation on creativity. In this study they define creative collaboration as a process in which "a shared vision of something new and useful" is created (p. 11). According to this view, a group or any other collaborative ensemble forms an inter-subjectively constructed "meaning-making system", consisting of collaborators, relationships, and communication and the interaction between them (p. 14–15). They list three important elements that characterise such creative collaboration: 1) the complementarity of the members in terms of their backgrounds, expertise, perspectives, 2) tensions that nurture fruitful novelty, and 3) the emergence of outcomes, meaning that collaboration can be more than the sum of its elements (p. 12).

The Vygotskian interpretation of creativity also comes close to how pragmatists see creativity as an inherently adaptive process (Moran and John-Steiner, 2003, p. 22). For example, drawing from socio-technical systems and innovation research, Miettinen (2006) suggests that creativity stems from the recognition of the systemic failures or a crisis within a practice, which necessitates change and novelty. According to Miettinen (2006), this view is in line with Dewey's pragmatism, which holds that a changing world causes habits to lead to failure and calls for conscious reflection on the conditions of a needed activity as well as new working hypotheses for reconstructing situations (p. 175). This view contends that an innovation or invention develops in reaction to a conflict or imbalance in a system of practices (Miettinen, 2006, p. 176), and helps to extend the study and understanding of creative action to the socio-material environment of the actor(s).

These are just but a few examples of how creativity research is breaking out of the disciplinary boundaries of traditional psychology and abandoning the individual-centric approach to creativity. The collaborative turn is not a group with a unifying perspective, but rather a research agenda focusing on collaboration and interaction in the creative activities of groups, teams, work-mates, organisations or networks of people embedded in their material and cultural environments. Collaborative approaches value both individual agency

and social structure, but abandon the idea of individual ownership of ideas (Hanchett Hanson, 2015).

The four different stands on the process-based studies of creativity in collective settings are compiled in Table 1 below. In reality many of the studies on creativity are likely to reside somewhere on the borders of different boxes, or they may occupy several of them. Thus the typology is more of a model than empirical fact. On the horizontal axis of the table are the approaches focusing either on the ideation production, i.e. how ideas come to be, or on the social action, i.e. social processes relevant to creativity. On the vertical axis are the atomistic views, focusing on different variables and parts of the process, and holistic views focusing on the interactive and systemic ensemble involved in the creation. These four clusters all adopt a process-orientation on understanding creativity, however, their takes on the key questions about the phenomenon of creativity reflect different underlying assumptions guiding their research. For example, all of the perspectives have a different view on what the core process of creation is like: cognitive perspectives tend to see it as an additive process, where ideas are generated and put together. A social-psychological perspective may see it similarly, but acknowledge that each participants' cognitions are fed by others and their mental representations can be shared and expanded. A systems view adopts an evolutionary perspective and sees the ideation process as variation and selection between different agents. The collaborative perspective sees the creative process as embedded in and emerging from the amalgamation of interactional socio-cultural reality.

	Atomistic	Holistic
Idea production	<p style="text-align: center;"><i>Cognitive perspective</i></p> <ol style="list-style-type: none"> 1) Cognitive and mental processes 2) Inside individuals 3) Additive 	<p style="text-align: center;"><i>Systems perspective</i></p> <ol style="list-style-type: none"> 1) Social and symbolic cultural processes 2) Within the social and cultural systems 3) Evolutionary
Creative action	<p style="text-align: center;"><i>Social-psychological perspective</i></p> <ol style="list-style-type: none"> 1) Social and cognitive / mental processes 2) Inside and between individuals 3) Additive/ synergistic 	<p style="text-align: center;"><i>Collaborative perspective</i></p> <ol style="list-style-type: none"> 1) Socio-cultural and situational processes 2) In the situated interactions 3) Emergent / dialogic

Table 1. Four possible answers to the three questions about the underlying assumptions of the research: (1) "What are the key processes to consider?", (2) "Where is creativity?", and (3) "What is the creative process like"?

2.3 Conclusion: Why do we need a novel perspective?

The analysis and review of the dominant perspectives on studying collective creative processes points towards a few shortcomings in the existing literature. Research examining creativity and innovation in teams is still in its early stages, compared to the study of creativity and innovation on the individual level. More research on all the elements involved in collective creativity is needed, including group composition, social processes, and cognition (Reiter-Palmon et al., 2012).

Collective creativity research has advanced in many areas, but also stumbled upon the fact that it is very hard to capture the important elements of the creative process. Firstly, many studies suggest complex interrelationships between the social and cognitive processes in predicting creativity (Reiter-Palmon et., 2012), while few can demonstrate them. There are also a number of limiting conditions for many of the factors that have been found beneficial for group creativity, and which require more research (Paulus et al., 2012). Thus, we need studies that aim to capture the complex causal

relationships between the different multiple variables, instead of focusing on single determinants.

Secondly, it was evident according to the review conducted by Reiter-Palmon et al. (2012) that the interactions that occur between variables over a long time period have been neglected, and that the research community lacks longitudinal research settings in general. Thus, studies that use a longitudinal research design and attempt to figure out how creative processes evolve over time, what social processes are relevant in different phases and how they themselves evolve according to the creative process would be of great importance as well as challenging.

Thirdly, regarding attempts to incorporate an interpersonal approach to creativity research, some conceptual problems have occurred. For example, the literature describing the relationship between interpersonal relationships and creativity holds mixed results because the literature operationalises interpersonal relationships in many different ways (Mueller & Cronin, 2009). In a similar vein, researchers have confused the concepts of collaboration and communication (Reiter-Palmon, et al. 2012), leading to research gaps about the exact conditions in which (internal) communication is beneficial for groups.

Fourthly, besides those studies that are based in laboratory-like conditions, studies focusing on the real world applications of creative groups are required. At the moment we have very few empirical studies on collective creativity. Indeed, some scholars have claimed that there are no studies that have clearly demonstrated synergy in real world work teams (Paulus et al., 2012). Those studies focusing on real-world creativity also need to pay close attention to the context of creation, i.e. what is the context in which the group functions (George, 2007). For example, Hargadon and Becky (2006) studied collective creativity in professional service firms, but can collective creativity be encouraged by similar behaviour in other kinds of organisations, such as bureaucratic organisations or in organisations facing time pressures? (George, 2007). Thus, we need studies that focus on creativity in real-world social settings, as well as the proper contextualisation of the observed phenomena and findings.

Thus, irrespective of the perspective on creativity in groups and social settings, we need more information about the possible boundaries of collective creativity and the quality and quantity of the many possible interactive elements involved in the creative process of a group. In essence, a perspective accounting for the complex-contextual interrelationships between different variables, including the time and the evolution of the process and the research design, and which operates from a clearly defined conceptual basis and within defined empirical contexts is required. As it turns out, such a research perspective can be provided by complexity science. In the next chapter a novel research perspective is built around ideas derived from the study of complex systems.

3 A complexity research framework

The study of complex systems has exploded in the last two decades. Researchers from various disciplines, from the natural to the social sciences and humanities have developed an interest in the meaning, influence, and significance of complexity to their domain of research and more broadly to our understanding of the world.

The term complexity derives from Latin word “plectere”, meaning interwoven and intertwined. Complexity does not mean complicated or chaotic. Jumbo jets are complicated systems, and chaotic systems are abstract mathematical constructs. Complex systems, in contrast, are hard to describe and their behaviour hard to predict, because their actions and processes are constantly changing through adaptation, parts of the system are interdependent and their behaviours are patterned in a non-proportional manner. The behaviour of the whole system emerges from the behaviours of the lower-level components and sub-systems, and therefore the system may exhibit qualitatively novel macro-level characteristics, which cannot be reduced back to the characteristics of “lower-level” components. Examples vary from ant colonies, and flocks of birds to the economic system, human brains, and organisations, teams, and collectives. The main point is that such systems behave in novel ways as collectives and complexity makes the prediction of their behaviour difficult by means of analytical tools, that is, breaking the whole into parts and analysing them in isolation from each other and the whole. Therefore, the complexity perspective invites researchers to adapt a complexity worldview to better understand the behaviour of such systems.

This chapter takes the lessons derived from the theories of complex systems and merges them into a *complexity research framework*. The focus is on the critical review and evaluation of complexity concepts and ideas, the assumptions related to them, and their applicability and value for the understanding and study of collective creativity. Section 3.1 introduces the basic concepts of complexity theories. Section 3.2 then reviews the applications and interpretations of the complexity perspective in the realm of social inquiry. Finally, section 3.3 suggests a research framework for creative collaboration that is based on the ideas derived the study of complex systems.

3.1 Complex systems science

The question of complexity has intrigued researchers since the emergence of sociological research in the mid-1800s. However, the enthusiasm for complexity did not gather pace in the social and cultural sciences until the 1990s, when applications of chaos theory emerged in these fields (Eve, Horsfall, & Lee, 1997; Kiel & Elliott, 1996). Today, studies in the fields of the

organisational and social sciences increasingly utilise complexity-informed approaches (see e.g. Poutanen, Siira, & Aula, 2016).

The study of complex systems has its origins in the natural sciences, especially in mathematics, mathematical biology, computational sciences, and physics. However, from the 1980s onwards, complex systems sciences have gradually grown to be a widespread movement within the social sciences and humanism. Some researchers have even promulgated the sharp contrast between complex systems sciences and the reductionist Newtonian sciences, heralding a shift in the scientific world-view (Heylighen, Cilliers, & Gershenson, 2007). Until now, complex systems science has had a wide reach and influenced the research areas of politics, organisations, society, globalisation, urban development, innovation, and communication (e.g. Byrne & Callaghan, 2014; Castellani & Hafferty, 2009; Urry 2003).

Scholars have suggested that complexity science provides new theoretical perspectives, methodological approaches, and novel concepts, deriving mostly from the fields of mathematics and biology (Reilly & Linds, 2010). In reality, there is no single “complexity theory”, nor “science”. What can be found is a set of different perspectives, theories, models, and ideas that researchers study under the rubric of complexity science. Thus, it must be stressed that the complexity perspective is not a single, unified body of theory but an emerging approach (Walby, 2007). Nor is it a methodology or toolbox, instead it provides “a conceptual framework, a way of thinking, and a way of seeing the world” (Mitleton-Kelly, 2003, p. 26; original emphasis removed).

Then, what is complexity science about? Some of the more or less general characteristics of complex systems are listed in Table 2 below. Complex systems are systems that comprise “a large number of entities that display a high level of nonlinear interactivity” (Richardson & Cilliers, 2001, p. 8). Complexity describes the deeply connected and interdependent nature of some systems. It is a state somewhere between order and disorder (Heylighen, 2008).

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- (1) Complex systems consist of a large number of elements
 - (2) The elements interact in a dynamic manner, e.g. transfer information
 - (3) The interactions are rich; elements are interdependent, and any element can influence any other
 - (4) Interactions are non-linear; small causes can have large results, and vice versa
 - (5) Interactions are usually short-range, and modulated along the way
 - (6) There are positive and negative interactions loops
 - (7) They are usually open systems, i.e. interact with their environment: borders are determined by "framing"
 - (8) They operate in conditions far from equilibrium, i.e. they exchange constantly information/energy with their environment
 - (9) They have histories, partly determining their present behaviour
 - (10) Elements are typically ignorant of the behaviour of system as a whole; complexity results from the patterns of interactions between the elements
-

Table 2. *Characteristics of complex systems (From: Cilliers 1998, p. 3–5).*

Complexity scholars are interested in the change and evolution of a system over time, rather than its stable structures or states of equilibrium. Since complex systems are considered to be open systems, they coevolve with their environment and other systems. Hence, complex systems can generate change in their environment as well as adapt to changes in that environment. Furthermore, complex systems have the capacity to self-organise, meaning that they are able to respond to external perturbations by reorganising internal structures through feedback loops (Gregson & Guastello, 2011).

At the heart of complexity is the idea that the research subject can be understood as a complex system, a web of (many kinds of) agents interacting in nonlinear ways and exhibiting collectively emergent patterns of behaviour, in other words, it is qualitatively different behaviour that is non-reducible to the individual level (Cilliers, 1998). This property of complex systems that generates unpredictable macro-level structures is called emergence. But the agents of a complex system not only generate macro-level structures. they are also influenced by them (Maguire, 2011, p. 82). This view breaks away from the duality of agent and structure and sets the complexity perspective in

contrast to strict methodological individualism or collectivism (see, e.g., Hodgson, 2007), which is akin to the agency–structure debate in sociology (Giddens, 1984; Sawyer, 2005). The next section discusses complexity more in the context of the social sciences.

3.2 Complexity in the context of the social sciences

This section brings complexity and social theory together in an attempt to contextualise the use of complexity theories in the domain of the social sciences. Gilpin and Murphy (2009, p. 33–34) have suggested three approaches to complexity, each equipped with different ideas about what complexity means, how it can be applied, and the most appropriate methods for studying complexity. Behind these differences are paradigmatic assumptions related to ontology, epistemology, and methodology. The schools of complexity, as Gilpin and Murphy call them, are “reductionist complexity science”, “soft complexity science”, and “complexity-based thinking”. The scholars working under the assumptions of the first school aim at describing phenomena in terms of universal laws, in the tradition of classical positivist science. In contrast, the scholars ascribing to the second school have approached complexity as a metaphor for reality, and used the concepts of complexity science as conceptual tools to understand the aspects of social reality. The third school differs radically from the other two, because its scholars use the doctrines of complexity as tools for reconstructing existing theories and the assumptions behind them. In doing so, they present complexity as a “radical epistemology” challenging the status of knowledge and introducing contingency and the boundaries of scientific inquiry and generated knowledge.

In the following section, ideas are presented that mostly derive from the “complexity-based thinking” school, which takes its most important objective to be the formulating of a complexity-based or complexity-informed approach to conducting social research and it also reconstructs some of the assumptions of the existing models in their application area.

3.2.1 Complexity and social theory

Social theory and theories of complex systems deal with similar issues and share the language of systems, structures, contexts, mechanisms, process transformations, regularities, conflicts, and continuities (Byrne & Callaghan, 2014, p. 79). Different authors have suggested different links between complexity theories and social theories, i.e. they have reformulated the understanding of social reality in complexity-informed ways and applied this understanding to the study of complex social phenomena. Next, some of the most important readings of complexity theories in the context of social theory

are presented. These examples are selected on the basis of their influence on the research conducted in this dissertation.

Byrne and Callaghan (2014) suggest that complexity theories can be linked with the development of system theoretical and evolutionary explanations of society as well as debates on agency and structure in social theory. These focuses illuminate the important sides of theorising about complexity: how systems evolve and change over time, how order can be seen in patterns of change over longer time, and how non-linearity emerges from the interaction of agents and structures (p. 79).

Byrne and Callaghan review the works of eminent social systems theorists, Spencer, Parsons, and Luhmann, and show how these theories discuss the questions of reproduction and system stability, and provide differing views on a system–environment relationship. These theories are inherently functionalist and thus depart from the complexity perspective, which comes with a more exploratory focus (p. 105). Byrne and Callaghan see evolutionary theory, as a systems theoretical explanation, similar to complexity theories. They highlight the role of retroductive explanations of systems change in terms of mechanisms as effective causes, which develop over time and consist of multiple sources of contingencies related to individual and collective agencies, actions, consequences, and their interactions across history (p. 106). In their subsequent discussion, Byrne and Callaghan, relying on Bourdieu and Archer, hold irreducibility between structure and agency, emphasising reflexivity, identity, and strategies in individual actions of reproduction and change (p. 124). In their reading, emergence becomes the expression of structure–agency interactions in systems, in a specific time–space context (p. 147).

Sociologists Castellani and Hafferty (2009) have applied complexity theories to sociology and suggested an “interactional” approach, presuming that neither individual nor organisational/institutional structures can be taken as the ontological basis for social reality. In their reading of complexity Castellani and Hafferty rely on the works of sociologists, such as Bourdieu, Giddens, and Foucault, and refer to their strategy of conceptualising social reality as a group “social practices”, which are created in the coupling of agency and structure encompassing social reality (Castellani & Hafferty, 2009, p. 37).

The concept of “social practice” thus becomes a basis for the investigation of complex social systems. Castellani & Hafferty (2009) suggest five components that social practices are comprised of: interaction, social agents, communication, social knowing and coupling. They remark how these components move beyond structure/agency dualism, but also point out that that social agents and interactions can be subsumed under “social agency”, whereas communication and social knowing go under “symbolic interaction”, in which case the “coupling” of social practices becomes a term describing the intersection between the symbolic interaction and agency (p. 38–39).

Sawyer (2005) has developed a complexity-based theory of “social emergence” based on the interaction and structure paradigms of social research. He traces back the roots of the “emergence paradigm” in

structuration theories and socio-cultural and interpretive theories of human action. According to him, the emergence paradigm suggests, in addition to the structural macro-level (social) and the interactional micro-level (individual), three new levels of inquiry: “stable emergent” consisting of group subcultures, slang, routines, shared social practices, and collective memory; “ephemeral emergent” consisting of topics, contexts, interaction frame, participant structure, roles and statuses; and “interaction” consisting of discourse patterns, symbolic interaction, collaboration, and negotiation (p. 211). These levels form a basis for interaction analysis, when collaboration emerges across different levels of social reality.

Salem (2009) has referred to multiple social theorists in his development of a dynamic theory of human communication, and this is based on analogies with theories of complexity. A review of philosophical and social theories in relation to the important characteristics of complex systems is summarised as “paradigmatic principles” in Salem’s book (p. 48–53). Salem points out, in the spirit of Bergson, Lewin, Campbell, and Chomsky, how human communication is an emergent process occurring and gaining its meaning over time; how sequences of communication are producing novelty and creativity, while also retaining their nature in the reproduction; and how this is related to the nature of agents and social systems (p. 49–50). He also suggests, following Campbell, that the emergence of communication patterns serves to improve competitive advantage, making the search for selection processes and criteria an interesting research problem (p. 50). The system of communication consists of a collection of rules with certain selection parameters, the structure that produces the behaviours of the system (p. 50–1). Finally, Salem suggests that emergent communication phenomena take place on multiple mutually causal levels. This relates to the social theorist discussion of human interaction as multi-layered. Salem explains how differing agents may exhibit individual level rules, whereas the repetition of certain interactions indicates mutuality and the existence of collective level rules (p. 51). One level may act both as a building block for another and as a passive constraint of behaviours (ibid.).

These readings of complexity theory point in an important direction regarding the study of social systems and interaction. First, Byrne and Callaghan and also Salem suggest that social systems need to be studied over time, as a web of interactive and evolving processes. Secondly, Sawyer and Salem both point to the layered nature of human interaction, consisting of individuals and socially defined levels, which are in causal interaction together. Thirdly, Sawyer highlights the role of emergence in social systems, which can be located in the interactions of individual agency and social structures in social systems. At this dynamic intersection of structures and agency are social practices, as suggested by Castellani and Hafferty. These practices are manifested in symbolic interactions, such as communication, the actions of agents and all other systemic interactions.

3.2.2 Critical remarks

Studies based on the premises of the complex systems sciences have faced much criticism. A large part of the critique is likely attributable to the relative infancy of the field and its position at the cross-section of the natural and social sciences – where the old discord between objectivist and subjectivist explanations remains. The most relevant parts of that critique are discussed next.

First, the extensive use of metaphors and analogies is characteristic of complexity literature outside the natural sciences. In general, analogies play an important role in the creative formulation of new models and perspectives (see e.g. Uden et al., 2001). However, some scholars see the practice of casually importing models, theories and concepts from the physical sciences to the study of social phenomena as problematic. For example, Rosenhead (1998) states that scholars have been employing the concepts of complexity despite the questioning of their validity in the field of natural sciences, leading to superficial references to “scientific authority” without real scientific evidence. Others have pointed out that researchers applying complexity concepts have not paid enough attention to the hard scientific origin of the concepts, and have used them in non-specific and sometimes even confusing ways (Maguire & McKelvey, 1999; Rosenhead, 1998).

Second, much of the complexity literature in social sciences is conceptual or theoretical in nature, leading to a lack of empirical evidence in the field of application. This is not surprising, given that complexity approaches are rather new to the social sciences. On the other hand, some scholars in the social sciences may be “ill equipped” (Corman et al. 2002, p. 158) to study complex phenomena by use of existing research methods. Thus, speculative writing and also theoretical modelling are often based on illustrative examples, anecdotal empirical cases, and analogies and metaphors, even though they do not amount to empirical evidence (Contractor, 1999, p. 156; Corman et al., 2002; Scott, 2002).

The lack of empirical evidence is probably not, however, a pivotal hindrance to the advancement of research on complex social phenomena. Many methods are needed, including non-empirical approaches from a metaphorical stance (e.g. Guastello, 2009; Poole, 2014). In essence, there is no need to refrain from using certain concepts as tools for theorising, providing they illuminate the studied phenomenon in some important way. The value of theorising is, however, further valued in debates discussing the social sciences and empirical evidence, not in the authenticity of the use of an original idea (cf. Cohen, 1994; Stewart, 2001).²

² There has never been just a one-way street from the physical to the social sciences, as critics may imply. For example, in the 19th century, physicist James Clerk Maxwell was inspired by Henry Thomas Buckle’s works on social statistics and law-like regularities governing seemingly random human behaviour and went on to use them as an analogy for gas particles in a physical system (Ball, 2004, p.

This study takes the perspective that complexity science serves best as a general systemic understanding of the complex research object, i.e. creative collaboration, and as an epistemological guideline. Thus, it provides important ideas about the general characteristics of a complex system and thus helps to orient the focus of a researcher towards certain important characteristics and dynamics, as well as setting the limits for the knowledge that can be generated (the oxymoron of a “perfect model”).

3.3 A complexity research framework

When we look at [...] any group of humans, we find that their total behaviour is the result of an intricate web of influences and effects that links all of the many different scales of processes and organization. Behaviour and processes sit within each other, and their effects penetrate to the parts within them, as well as to their surroundings and connections in both directions. It is this linking across the spatial and temporal scales that is really why the understanding of human systems requires a ‘complex systems’ approach. (Allen, 1997, p. 232; cited in Byrne & Callaghan, 2014, p. 164).

A research framework, using scientific theories, is needed for a study to be a scientific. A research framework guides a researcher to observe phenomena from a certain viewpoint. This viewpoint or “lens” can be called a research framework (or a theoretical framework). According to Anfara and Mertz (2006, xxvii), a research framework is a theory on those social and psychological processes that can be applied to understand the phenomenon being studied. Thus, it is not equal to a method or a research paradigm, but the theory is a lens through which the phenomenon is scrutinised (ibid.).

In this study the research framework refers to a collection of those principles and ideas that derive from the complex systems science developed so far in this chapter. This section begins with a brief discussion on “calibrating” the research framework. Then two perspectives are presented, in an attempt to summarise the research framework here and put it in the context of this study. These perspectives are: 1) the general principles of a complex system, described by Cilliers (1998) and as applied in the context of groups and the systems examined in this study; and 2) an analytical framework of process theories suggested by Langley and Tsoukas (2010), which serves as an “organiser” of the research results pointing out the important research findings and enabling their identification and summary from the complexity point of view. The results of the included research articles are organised around this framework in chapter 5.

67–68; see also Cohen, 1994, for the historical account on the exchange of ideas between the natural and social sciences).

3.3.1 Towards a complexity approach on social action

Cilliers (1998) reminds us that when approaching a complex system, one must first frame the system adequately. For instance, when standing far away from the system, one could examine it as a whole and see how its elements are connected with elements in its environment, such as an organisation connected with other organisations and stakeholders, consisting of its operational environment. When standing very close to the system, the important aspects that should become clear would be each communicative act, each word and gesture, every raise of the eyebrows of the organisational members and actors. At halfway, the level of detail will be focused on the patterned interactions of the entities, such as the organisational groups and departments.

In social systems actors, interactions, communication, individual and collective practices, rules, skills, strategies, and the coupling of agency and structures in the process of emergence can be found among the elements. Thus, it is possible to ask: How does collective behaviour emerge from the patterned interactions in a self-organising manner?

A focus on communication patterns, symbolic exchange between human actors, can inform a researcher of the social structures of the systems and, for example, describe who is likely to interact.³ These structures are part of the system's culture, the collection of social rules, norms, values and beliefs, which manifest themselves in communication patterns, the cultural artefacts of the environment and the ways these artefacts are used and modified. Communication is human interaction on a level of information exchange, but it is also an interpretative process ("a process of symbolic exchange") of constructing individual and (contextually) shared frames of references.

Human actors differ from unconscious and rule-governed "simple agents" that are often described as the agents of a complex system, in the realm of reductionist complexity science (see Gilpin & Murphy, 2009). However, human actors have strategies and they are goal-oriented and they respond to their surroundings in certain ways (Axelrod & Cohen, 2000). These strategies can be deliberate or not, they can be more or less conscious for their holders, and they are subject to change, of which one source is an actor's personal experiences of what works and what does not (*ibid.*, p. 4). In other words, human actors learn through their experience and reasoning. Once actors pursue different types of outcomes, they apply strategies and try them out within their world. Actors' needs, desires, interests and wants drive strategies. In this way, strategies are like the mental descriptions of (social) practices.

Interactions and communication processes and especially their patterned forms are important because they illustrate individual and social strategies

³ Although communication and interaction are here sometimes used interchangeably, communication is not considered equal to interaction, which is a broader category, including all kinds of movements, behaviours, processes, and relationships between many kinds of elements of the system, such as cultures, discourses, objects (Castellani & Hafferty, 2009, p. 39).

and the ways they are manifested in social practices. Through learning and various selection processes some forms of social practices become more prominent than others and continue to exist, while also beneficially serving certain purposes. This necessitates learning from others, the development of skills, and collective level knowledge and a system's "memory" of the social organisation. This is the type of understanding of social reality that is harnessed in this study and developed throughout the work.

3.3.2 Groups and complex systems

Collaborative units can be used effectively for accomplishing everyday tasks, as well as those going beyond routines. Collaboration can take place in clearly defined work units and large groups, such as departments, teams, task force groups, or committees, or it can be more fluid in its nature, such as in the context of crowds, informal networks, ad hoc groups, or emergent communities. Groups have different types of purposes: they may serve as organisational goals, such as marketing, human relations, or sales, or their purpose can be designated in terms of more clearly bounded goals, such as problem-solving and solution delivering.

There is a long tradition of using systems theories in the research of small group communication (see e.g. Mabry, 1999). Some of the earlier works on using complexity in studying groups are from the 1970s and 1980s. For example, Fisher, Glover, and Ellis (1977) examined the complexity of communication systems in small groups from an information theory standpoint. Fisher (1985) has also adopted the concept of the "law of requisite variety" and "entropy" from cybernetics to describe group leadership as an information-processing activity. Similarly, Contractor and Seibold (1993) have applied adaptive structuration theory and self-organising systems theory for studying group decision support systems. Contractor and Seibold also provide a mathematical simulation example that demonstrates the approach.

These early developments are important and they clearly point towards the applicability of the systemic lens for studying collaboration and group work. However, studies in the tradition of communication research have focused less on the creativity of the individuals and groups and more on the decision-making processes of groups. The work of Salazar (2002) is an exception to that trend and it will be briefly overviewed next.

Salazar (2002) has applied the concepts of self-organisation, chaos, and complexity for understanding group creativity. In his conceptual work Salazar examines the relationships between group communication and creativity and defines creativity as "communicatively constituted and emergent process through which a group produces novel and relevant ideas, responses, processes, or products" (p. 181). He then goes on to describe and examine a large body of concepts of self-organisation and complexity and examines their applicability in the context of understanding group creativity. Salazar suggests that in order for a group to engage in a truly creative activity it needs to have

established a new order through emergence, i.e. developed new mental models, and be in a complex state between stability and instability, i.e. be able to adapt. Salazar suggests that for a scholar interested in studying creativity the identification of those “generative mechanisms” that promote complexity are key (p. 188). Salazar takes the view that communication is the key mechanism through which conditions for emergence and self-organisations are built. Among the most important communicative mechanisms is “ambiguity”, i.e. communicative acts that create “perturbations” to the states of the different structural system of the group, including relational, technical, and information systems (p. 193). The second mechanism that he proposes is leadership. According to him, leadership plays a crucial role in groups in the way that it can influence the group context and thus shape the emergence of complexity, such as help the group to focus on important perturbations (p. 194). The third mechanism is metaphor, by which Salazar means storytelling activities and fantasy sharing in an attempt to extend the perturbations. Salazar’s study represents an important conceptual attempt to extend the understanding of creative group dynamics in terms of communication and complexity.

Though Salazar uses slightly different concepts and conceptualisations of complexity than this dissertation, his study presents important research avenues, such as the role of perturbations, ambiguity, and leadership in creating favourable conditions for creativity, and metaphors as a communicative strategy for amplifying perturbations. Similar themes will be discussed later in this dissertation.

Next, the characteristics of a complex system, as suggested by Cilliers (1998), (see Table 1 in Section 3.1) are presented in terms of the complex system studied in this dissertation. This study focuses on creative groups that are attempting to solve problems and action that necessitates creative input from the group members. The elements of such a system, interpreted as a complex system, are as follows:

- (1) The elements of a human group consist of conscious individual human actors, as well as all the material elements (such as paper sheets, whiteboards, pens, laptops, etc.) in their environment. Also the environmental actors that intervene in the work of a group are elements of the system (such as facilitators or someone giving feedback, including a researcher observing the group while it is working).
- (2) Actors interact together in various ways and uses elements of their environment for different purposes.
- (3) Actors communicate in various ways (verbally, by gestures, through actions, in written forms, by visual means, etc.) and communication is a symbolic meaning-making process, sometimes provoking conflicting interpretations. Actors are dependent on each other in that each actor’s identity and roles are formed in social interaction.

- (4) Interactions are non-linear, i.e. small acts may generate large events. One word or gesture can lead to a breakthrough in problem solving – or a vicious cycle of devastating social conflict.
- (5) Actors are more likely to interact with those who are close to them, but not necessarily in a spatial sense. In general, communication is easier between close friends with a long history and between those who share similar cultural backgrounds – due to the shared interpretative frames of reference.
- (6) Actors encourage and discourage each other's actions by providing feedback (or no feedback at all). A group can also receive feedback based on the environment created by its success and failures, which can lead either increase or decrease certain behaviours. Through feedback, actors learn to behave in certain ways; interactions are patterned and begin to form the interaction structure of the system. In this way the group becomes self-organising, and the patterned behaviours become collective level emergent features of the group, representing the collective memory of the system. Examples of such features can be certain group practices, such as "rule-governed" ways of conducting idea-generation discussions. Therefore, groups are not systems operating at a single level, but rather nested social systems, with different layers of emergent structures.
- (7) A group of human actors is an open system. People interact with other people in their environment. Teams working in an organisational environment are influenced by management, resources, organisational culture and politics. A group consists of the on-going interactions of its elements, both within and between the group and the environment. Therefore, a group is also subject to both internal and external sources of change.
- (8) When in a group, people, more or less, constantly interact. New understandings are created and problem solutions are tested against different scenarios. Without constant interaction, the exchange of information and the processing of meaning, actors would be isolated from each other, and thus not comprise an operating group.
- (9) Groups develop over time. Actors learn to get along better, learn to know each other in person, and develop shared skills and knowledge. In addition, each member brings his or her own history with experiences and memories that influence the ways a group's roles, tasks, and responsibilities are understood and carried out. However, due to the reflexive and iterative nature of the interactions, all of these actions are subject to constant change.
- (10) Actors are not fully conscious of the knowledge of whole group. Actions and decisions are based on their individual evaluations of situations, and not all information can be taken into account all of the time by each actor.

This far it has been found that complex systems experience constant change, they are emergent (non-reducible) and self-organizing, they are agent-based and interdependent, and their events are non-proportional (non-linear). Complexity arises from the fact that such systems consist of a larger number of connections and interactions, and such systems' behaviours are dependent on a large number of different types of variables. Thus, the study of such systems depends on the analytical framework and methods adopted. Next, a framework for the study of systems is presented. Its main focus in this study is to help focus on the important elements of the systems being studied and to serve as an organiser of the research results. The methodological choices are discussed in Chapter 4.

3.3.3 An analytical framework for studying complex systems

The complexity perspective is *de facto* a process perspective. Process perspectives focus on how things take place in their messy and complex real-world settings, how changes are implemented in practice, and how their influence spreads across organisations and interacts with the organisational context (Langley & Tsoukas, 2010, p. 10–11). Langley and Tsoukas (2010) specify three different conceptual products that can be developed in process studies to describe the “process knowledge” that is generated. They are “patterns”, “mechanisms” and “meanings”. Next, each element and their relationship to this study are presented.

Patterns are observed repetitive temporal events and activities, a specific kind of sequence or cycle of phases or points of divergences (Langley & Tsoukas, 2010, p. 14). For example, in creativity research a temporal pattern can be chains of certain creativity fostering acts in group communication situations as identified in Articles IV and V. Similarly well-known are temporal descriptions in creativity and innovation research, including several stage- and cycle-like processes (see Article II). From the perspective of complexity sciences, patterns may embrace such complexity dynamics as “tipping points”, patterns leading to self-organisation and emergence, and nonlinearities. In this study tracing back the patterns of interactions and group development are important strategies. Specific methodological choices related to pattern tracking are presented in Section 4.3.2.

The second conceptual element, a mechanism, gives an explanation of the observed progression and phases. Mechanisms are generative underlying “motors” that make things happen in the way they do, i.e. they suggest an explanation for a change. They are the reasons behind the observed behaviours of entities. The idea of generative mechanisms derives from realist ontology that assumes mechanisms are real, although unobservable, underlying causal forces to be uncovered in scientific studies by empirical evidence (Langley & Tsoukas, 2010, p. 16). They are the constellations of entities and activities that are linked to one another, and which regularly bring about certain outcomes due to their organisation (Hedström & Ylikoski, 2011, p. 389). By identifying

certain regularly occurring processes, such as the patterns of social interaction making a system work as it does, complexity theorists can explain social phenomena (Marion, 2012; Uhl-Bien, Marion, & McKelvey, 2007; Sawyer, 2010; Pickel 2011).

Among such mechanisms can be some of the characteristics of complex systems, such as emergence, self-organisation, coevolution, and adaptation (see Article II). In essence, the focus on mechanisms suggests a more inductive-based and *abductive* research approach, where analytic strategies serve as heuristics (Langely & Tsoukas, 2010, p. 16–17). In this respect, complexity sciences serve as “sensitizing devices” (p. 16). From this perspective it follows that the concepts of the complexity sciences do not necessarily need to describe in a predictive sense the behaviours of social actors. Rather, they help to point towards certain kind of dynamics and structures and thereby help researchers embrace the complexity of real-life phenomena in their considerations and modelling.

Meaning, the third element, can refer to subjective interpretations of individuals that are studied, as well as to the competing and conflicting narratives that have been suggested (Langely & Tsoukas, 2010, p. 17–18). Complexity perspective’s stance on “meanings” is two-fold: on the one hand, some complexity theorists have taken a traditional logico-scientific position to complexity and considered it a theory to be tested objectively against empirical evidence (“reductionist complexity science”). In this line of research, complexity researchers have developed mathematical models and simulation strategies to eliminate human subjectivity, i.e. a variety of meanings, and formulated testable “laws” of complex phenomena. Some researchers refer to “restricting” or “simplifying” research strategy in relation to these kinds of complexity-based studies (Boisot & Child, 1999; Maguire et al., 2006; Morin, 2007; see also Article I in this dissertation).

On the other hand, other complexity theorists argue that complexity is driven by human inability to explain the world, i.e. contradictory and rich observations that generate a complex view of reality through complex constructions or subjective accounts (e.g. Tsoukas & Hatch, 2001). By allowing complex constructions and admitting the inability of explaining and predict everything perfectly, a researcher accounts for the complexity generated in the interaction between the research object and the researcher. This strand of complexity-based research has sometimes been referred to as a generalising or absorptive view of complexity (Boisot & Child, 1999; Maguire et al., 2006; Morin, 2007), leading to interpretive research strategies and the consideration of the concepts of complexity first and foremost as the metaphors and heuristics of social life.

In this study the interpretative nature of human actors, as well as the subjectivity that it introduces to the processing of meaning and the interpretation of different events and situation, is taken seriously. Therefore, the interpretations of individual actors are also seen as important factors behind how and why actors behave as they do, which factors constrain their

interactions and decision-making, and how they experience emotionally different events.

For example, in article IV the author studied three different creative problem-solving groups by interviewing the members of the groups and studying their experiences and interpretations of the groups' identity, communication, exchange of information, process and time awareness, etc. In doing so the research was able to identify several factors that drive or inhibit creativity. On the basis of the interviews and observational accounts three different narratives were constructed regarding the evolution of the group over the period of their collaboration.

These lessons from complexity science can serve as a “guiding theory” towards the understanding of creative collaboration as it occurs through and within the characteristics and dynamics of a complex system.

4 A research problem and the summaries of the articles

4.1 Research problem

Complex systems science may serve as an important source of novel approaches for conceptualising and reconstructing the understanding of creativity in collaborative settings. In this dissertation it is argued that it provides an applicable framework for studying collaboration as a complex system of interacting actors. In addition, it is argued that the complexity framework helps to reconstruct the idea of creativity in the following ways: it helps to see group creativity as a phenomenon embedded in the interaction of individual actors in their specific contexts, rather than a group as an idea-generation machine. Such an understanding is essential, since modern working patterns increasingly occur within a distributed net of different actors and stakeholders.

Previous research has recognised the need to reconceptualise creativity in the context of collaboration (Section 2). Models resting on systems theory, interactional and participatory approaches, cultural theory, as well as on complex systems sciences, have been introduced. However, many authors have referred to “interaction” in a casual and/or undetailed manner, without properly addressing what it is exactly that takes place in the creative interaction, how it is patterned, and what factors can be important in fostering self-organising and emergent patterns of behaviour in a group. In this dissertation it is argued that such an understanding of collective creativity is missing and that the complex systems approach provides a promising alternative in this respect.

This dissertation investigates two questions:

- 1. How can the application of complexity sciences improve our understanding of collective creativity?**
- 2. What are the most important factors for fostering creative collaboration from the perspective of complexity theories?**

The purpose of the dissertation is to find out how complexity sciences can help us to understand and study collective creativity, as well as enrich the practical understanding of creative collaboration.

Section 4.2 presents the research aims posed in this dissertation. Section 4.3 presents the research design of this dissertation. It includes section 4.3.1 on selected research strategy, section 4.3.2 on philosophical premises and assumptions, and section 4.3.3 and 4.3.4 on the methods used in each article. Section 4.4 presents summaries of each article.

4.2 Research aims

The objective of this study is to develop a research framework for collective creativity that is informed by complex systems science and put it into use to discover the most important elements of such systems and how the framework can improve our understanding and working and support a well-functioning research frame. This goal is decomposed into four broad research aims:

- (1) The first research aim is to develop a research framework for studying collective creativity that is informed by complex systems science (Chapter 3). This research framework helps to conceptualise creative collaboration as a complex interaction system which has certain assumptions and elements that research can focus on (see Section 3.3).
- (2) The second research aim is to put the framework into use and test its applicability and usefulness for studying creative collaboration. This aim has been reached partly in the articles and partly in this concluding article.
- (3) The third research aim is to identify the most important elements of creative collaboration, as informed by the research framework, and in the light of the empirical case studies presented in this dissertation (Chapter 5). The presentation is organised around the three different conceptual products, i.e. patterns, mechanisms and meanings (section 3.3.3).
- (4) The fourth research aim is to provide insights and important information for the practice of creative collaboration. For example, it raises the question: what interpersonal strategies, social rules, or communication strategies can be used for fostering creative collaboration in different contexts? (Chapter 5.2).

These aims are addressed both in the research articles, included in this dissertation, and this concluding article. All the articles take a unique perspective on the issue, and they all approach the issue from slightly different perspectives. These perspectives are: (1) the development of a systemic framework for creativity research; (2) mapping the complex innovation practices; (3) an interaction perspective on creative collaboration; (4) interpersonal strategies in self-organising creative groups; and (5) conditions and practices for bottom-up innovation strategies.

Each of the research aims are addressed in the Section 6.1, whereas Chapter 5 covers the results of the articles, summarising them from the viewpoint of the complexity research framework, and answers the research question asked in section 4.1.

4.3 Research strategy

This dissertation studies collective creativity and develops a research framework based on complex systems sciences for understanding collaboration and creativity and applies it in the context of few empirical case studies. The results are compiled together in this concluding article. The empirical materials were collected from the *Aalto Camp for Societal Innovation* organised in 2010 and 2011 in Espoo, Finland.⁴ The focus of the data gathering was on qualitative data such as interviews and non-participant observations, but also video materials and documents were collected. The approach to the analysis of the materials is qualitative and explorative and was conducted by collecting materials with a complexity-informed theoretical framework that was developed during the development of this dissertation and which is summarised in this article. This section provides an overview of the data and methods used in the articles, as well as the philosophical assumptions underlying the research process.

4.3.1 Philosophical assumptions

This dissertation provides an exploratory focus on the phenomena of interest. The aspects of creativity were studied in the context of collaboration, and this investigation was conducted with a focus on the observed behaviours and accounts of the participants.

The ontological perspective adopted in this study represents Critical realism. Critical realism focuses on reality and assumes that reality corresponds more or less accurately to our perceptions of it. However, it also acknowledges the interpretative nature of knowledge production, which frames and constrains our conceptions and understanding of reality. This concerns both the actors being studied, i.e. human beings, as well as the researcher who is conducting the study. However, in contrast to subjective interpretative studies, the aim of realistically oriented inquiry is to explore the complex and contingent causalities in complex systems (Byrne, 2011).

The nature of the reality is seen in this study as emergent, which means that it is in constant flux and in the process of emergence. Researchers occupying this type of position are less interested in the structural characteristics of phenomena, and focus on how social phenomena emerge in the sequence of individual and collective events, actions and activities (Pettigrew, 1997; cited in Cunliffe 2011). Such a research approach is generally interested in processes, change, and the relationships between entities and objects. Furthermore, they see reality as a network of elements and a process of becoming (Cunliffe, 2011).

Although a number of systems theorists and institutional theorists take an essentialist position, assuming that systems have fixed and durable properties

⁴ See: https://www.youtube.com/watch?v=cpK_2GhtK7w

that can be identified, this study comes closer to a non-essentialist perspective, which sees objects and events gaining meanings in relation to each other (cf. Cunliffe, 2011, p. 655). However, the critical realist position adopted in this study assumes the relationships to be real, even though constructions of them are “certainly made rather than found” (Byrne & Callaghan, 2014, p. 69–70). This means that reality has a “voice”, it speaks in our accounts of it, rendered by us (ibid). Events, entities, relations, etc. are thus real, but their function and meaning emerge from their relational positions in the network. In addition, our accounts of them are constructed from certain positions. In terms of the research process, this means that the researcher needs to *purposefully* select a certain position from which the research object is studied. But the boundary of such a system is neither a function of our description, nor purely natural (Cilliers, 2001).

In the domain of complex systems sciences, ontological and epistemological questions have been given serious attention, and for many complexity scholars the main point in adapting a complexity lens is deeply philosophical in nature (see. e.g. Byrne, 2011; Cilliers, 2011; Richardson, 2011). Cilliers (2000, 2006) has pointed out that the boundaries of a complex system are not clearly defined, meaning that from the point of view of a researcher, the scope of such a system is usually determined by the purpose of the description. This means that such descriptions are influenced by the observer and are thus best understood through the process of “framing” (2006, p. 2). Cilliers also points out that in order to generate understanding, researchers need to model complex systems but the models are always flawed and reductions of complex reality (p. 3). The claim is based on the fact that since complex systems are non-linear, it is, in practice, impossible to keep track of the all the causal relationships between the components and the system is, in essence, incompressible (p. 3). Thus, a researcher cannot precisely know which important parts should be included in a model and which should be left out – for the purposes of the modelling. Consequently, the framing of the phenomenon will always introduce some distortion (p. 3).

Therefore, a complex systems perspective provides a general set of guidelines and heuristics for a researcher dealing with complexity. However, a researcher cannot make accurate predictions of the behaviour of complex systems (Cilliers, 2000, p. 27). All models, whether formal, mathematical, descriptive or qualitative, are limited, and these limitations are determined in the particular frame of investigation selected and the results cannot be interpreted independently of that frame (p. 30).

Byrne and Callaghan (2014) adopt a “complex realist” epistemology, and approach complex systems as “cases” – as complex configurations of events (the state of a system) and structures, which a researcher deals with through the construction of narratives (p. 154–5). In the process of describing such cases, a discussion should take place both in terms of the complex and interacting components (taxonomy, classification) as well as their relationships (networks) (p. 156). Thirdly, the research should pay attention

to “trending”, which is described as the trajectories of complex systems, i.e. constructing narratives – whether they take textual, numerical, or visual forms. For instance, “a description of mechanisms depends on a clear account of how something has come to be what it is”, i.e. a historical narrative (p. 171–2). In constructing clear narrative accounts, Byrne and Callaghan (2014) suggest that the research process should be “retroductive”, i.e. when constructing narratives, for example, through simulation, it is necessary to compare the results with what has actually happened in establishing past trajectories, i.e. to “calibrate” the model with real data (p. 164). Byrne and Callaghan summarise their discussion on investigating causalities in complex social systems as follows (p. 190):

- What is caused is a state of the systems, a character at a point in the system’s trajectory.
- Cause operates in any and all directions (micro, macro, parts, wholes, between of intersected systems, etc.).
- Causes are seldom and almost never single or additive; interactions and emergence matter.
- For two similar systems, the same systems states can be produced in different ways.
- Time (sequence and duration) is important to consider when exploring complex systems.
- A retroductive explanation of a system, from its history to the present state of the system, is the first step, whereas what informs future actions is of great interest.

In the reading of Byrne and Callaghan, as well as of Cilliers, the complexity perspective grows into a radical epistemological approach that takes a critical and reflective stance and helps one to “complexify” one’s theories and thinking about what is social. For such researchers, a complexity perspective is not “only” a novel way to understand social transformation, but is also an instrument of reconstruction of the social theory (see Byrne 2005, p. 98). Methodologically, this perspective leads, for example, to the notion that there are many kinds of appropriate methods for studying complex systems, of which the most appropriate ones are determined by nature of the system and the problem at hand, in fact, the recognition of the limits of our knowledge is more important than the exactness of a given description (see Richardson & Cilliers, 2001).

This type of application of complex systems sciences has a dual influence on social scientific study: first, it challenges existing theories and models and provides novel language and ideas for modelling complex social systems. Secondly, it provides an ontological and epistemological worldview, which a researcher can use to reassess their ontological and epistemological position in order to account for the complexity of the studied entities properly and

consistently. These influences intertwine together in the process of the inquiry.⁵

Next, the data gathering and techniques of analysis used in the articles are presented and discussed.

4.3.2 Data and methods

As discussed earlier, complex systems evolve over time, and can thus be fully understood only by focusing on interactions between elements over time. There can be different temporal orders, including periods of stability as well as periods of flux, which need to be included in the description of a system. The descriptions are constructed in relation to specific environmental conditions and other contextual elements, from which the observed phenomena derive their meaning and function. Consequently, understanding complex systems requires many types of sources of data and many kinds of techniques if one is to develop a detailed picture of the evolution of a system and the factors that played important roles in its evolution.

Two research approaches are suitable for the purposes of generating descriptions that develop over time: an iterative grounded theory approach suggested by Orton (1997) and a narrative approach suggested by Byrne and Callaghan (2014).⁶

The iterative grounded theory is an approach, “in which researchers cycle back and forth between process theory and process data to produce process knowledge” (Orton, 1997, p. 419). These approaches entail many different types of methods that are suitable for generating process knowledge about a system’s behaviour. Methods are understood here as concrete strategies for investigation that can help describe, explore and model social mechanisms and causalities in their varying contexts.

According to Byrne and Callaghan (2014), the difference between the qualitative and quantitative is broken down and all methods are primarily tools for exploration (p. 196). Others have also suggested “methodological pluralism”, which allows many kinds of methods, both mathematical and

⁵ If this stance is considered against the backdrop of postmodernism, or the interpretative perspective in general, it is perhaps not so radical. After all, the complexity perspective presented is realistic in that it assumes reality – even though acknowledging that it is both complex (hard to predict) and our perceptions of it are only possible through the process of modelling. In this way, adopting a social constructionist stance, for example, would require a similar type of attention to both ontological (social reality is constructed) and epistemological (our knowledge of reality is also constructed) questions in order to be internally coherent.

⁶ The narrative approach presented here should not be confused with such (inter-)subjective narrative approaches that see, for example, talk and text as narratives. Rather, it concerns a retroductive strategy of providing historical narratives of selected cases (see e.g. Cunliffe, 2011)

narrative, since one can be more appropriate than the other under certain circumstances (Richardson & Cilliers, 2001, p. 12).⁷

This study applies qualitative methodology to the study of the selected complex social systems. In accordance with the preceding discussion on ontological and epistemological position of this study, a wide range of qualitative research methods can be used, such as ethnography, observations, interviews, grounded theory, and case studies (cf. Cunliffe, 2011, p. 660).

The empirical studies presented here are retrospective in their nature, meaning that the understanding of the studied cases was constructed afterwards by looking for multiple different data sources. Such a research approach comes close to what can be labelled a case study approach, the purpose of which is in general “to provide an analysis of the context and processes which illuminate the theoretical issues being studied” (Hartley, 2004, p. 323).

Because human actors are interpretative and strategic actors, capable of learning and changing their strategies in accordance with their experiences and reasoning, it is important to understand what their representations of the events and actions they conduct and witness are, and the system(s) they belong to. Therefore, the actors themselves are also important objects of study, and their interpretations can be best achieved by means of qualitative research methods, such as interviews. This type of knowledge would help to understand the motives and reasons for different types of actions, as well as provide rich information about the context and the occurrences within that context in general. Therefore, semi-structured interviews were conducted in the empirical cases included in this study. The benefit of the adopted “responsive interviewing model” is that it enables depth and detailed answers and rich and thematic materials (Rubin & Rubin, 2005, 129–151).

The articles included in this dissertation include interviews (semi-structured and spontaneous – conducted on the spot), observational accounts and memos, videos, and documentary materials. In the selection of the data sources, sources that would provide different types of accounts of the studied phenomena were sought, e.g. more and less successful groups, in order to attain a wide overview of the studied phenomena, and thus enable a comparison of the cases. Similarly, a range of people, representing different backgrounds, positions, and nationalities, were selected for the semi-structured interviews. On the other hand, many types of data sources, i.e. data triangulation, helped to deal with the issue of subjectivity and to identify the strongest candidates for meaningful and effective causes in the evolution of the systems.

⁷ Cilliers (2011) has argued that the selection of a restrictive or generalising strategy depends, for the most part, on what kind of phenomenon one is concerned with: if one is concerned with understanding and modelling a specific and a rather clearly bounded phenomenon, then a restricted strategy may work well, but not if one is concerned with “complex (social) phenomena which are volatile, self-reflexive, adaptive, and where boundaries are ill-defined” (p. 143).

An iterative analysis procedure, including an iterative cycle between the data and theories, proved to fit best with the author's conception of how new knowledge can be critically and carefully generated. Iterative grounded theory can be posited between deductive and inductive knowledge generation strategies (sometimes referred to as *abductive*). Glaser and Strauss introduced the first inductive grounded theory approach in 1967 as an alternative to the deductive-hypothetical approach. They described a grounded theory approach as theory generating, in contrast to the deductive approach, which is theory testing. This view has, however, faded away, and organisation science scholars have developed approaches that fall between these two opposites (Orton, 1997).

According to Orton (1997), this kind of modification of grounded theory is consistent with the ideas of process theorising. The idea is that, since research in practice is often a function of both deductive and inductive approaches, simultaneously, there is no need to refrain from using *a priori* introduced theoretical ideas when starting to collect and analyse data, and generate new theoretical knowledge. Research committed to iterations is likely to utilise several research techniques as a response to emerging questions throughout a study, instead of one research methodology (p. 432).

In article III the focus was on the mutual interaction patterns between participants in creative group collaboration. In article III this collaboration was examined through the lens of a "collaborative emergence", suggesting that group creativity arises from the complex interaction of individual agents (e.g. Sawyer, 2010; Sawyer & DeZutter, 2009). In the article this approach was taken as an onset and further developed so that the unit of analysis was defined as "patterns of interactions" that were observed on the level of chains of mutual interactive episodes between participating individuals. These chains of mutual acts were extracted from various materials sources (e.g. video, observations) and analysed by applying the principles of inductive qualitative content analysis (Hsieh and Shannon, 2005). However, this process did not stem from nothing, but was informed by the concepts and theoretical understanding of theories of complex systems and such concepts as "emergence". Therefore, the final categorisation system (or a "theory") was formulated in an attempt to describe the phenomenon under study as informed by the concepts of complex systems.

In accordance with the presentation of research methods by Byrne and Callaghan (2004), two types of methods are suitable for constructing historical narratives: text-based narratives (based on textual materials) and on-going narratives (based on observations). These narratives are constructed on the basis of carefully constructed histories of the cases, constructed either retrospectively, looking back over the processes and interactions, or through observation prospectively as the system develops and changes (Byrne & Callaghan, 2014, p. 199). This stresses the idea of a longitudinal element in the research, making a detailed description of emergent and non-linear processes possible. One example of the "complexity-informed process tracing" that

Byrne and Callaghan refer to comes from a study by Gerrits (2008), who uses a “double presentation” strategy: first, the evolution of the studied systems is described in a conventional chronological manner, and then they are revised in terms of co-evolution and complexity, engaging with the narrative in order to explore complex causalities (p. 200).

This approach comes close to what has been done in this research and applied specifically in empirical articles IV and V. In the studies reported in these articles the research process started on an exploratory basis, based on discovery and reflection. In the beginning of the research process, the author immersed himself in the materials (interviews, observational accounts, documents) concerning the creative collaboration and innovation initiatives. The next step was to break the whole research area into cases that could be then investigated in more detail. Different problem-solving groups were labelled as cases and their distinctive trajectories were reported as narratives.

Only when a research process was developed did the author introduce the complexity framework and begin to identify some of the important factors, as suggested by complexity framework. This process of analysis was conducted by using the qualitative content analysis technique (Hsieh & Shannon, 2005; Graneheim & Lundman, 2004). For example, in Article IV a fixed set of complexity categories were developed and introduced for constructing the categorisation of the complexity elements in the developed narratives. In article V the key concepts of complexity science, such as self-organisation, were taken and conceptually applied to the creative process. Then this complexity-informed theoretical understanding was used to illustrate certain events from the collected narratives. In both articles, a narrative approach was applied as the research process included 1) a construction of a detailed historical narrative over time for each case; and 2) the identification of critical points in the development of the narratives.

The non-empirical articles (I and II) as well as this concluding article are theoretical and conceptual in their nature. The research process in them has roughly followed the logic of an integrative literature review (see: Torraco, 2005), in which a certain perspective is chosen in order to review a given set of literature and provide a critique of existing models and literature and follow that with a synthesis that provides a new framework, propositions and agendas for further research.

4.4 Summaries of the articles

4.4.1 Article I: The development of a systemic framework for creativity research

This article explores the possibilities of complex systems sciences and systems modelling in providing new insights for creativity research. It starts from the idea that creativity research is rich and versatile but that it also invokes

unsolved paradoxes, which are partly caused by insufficient assumptions and theories on creativity. The article highlights the need for more integrative frameworks for studying and supporting creativity in varying contexts.

The study then proceeds by suggesting how a systems view can be one possible candidate for the purpose of developing a more integrative theoretical understanding of creativity. In the late 1980s, systems models responded to the challenges of creativity research, especially those brought about by the notion of the social context. However, those models have become somewhat obsolete and impractical. The article makes the claim that it that might be partly caused by the fact that the link between the now well-known systems models of creativity and recent developments in the systems sciences, such as in the area of complex systems theories, are not well established.

With this in mind, the article then aims at clarifying these links and makes the argument that a complexity perspective may provide a useful framework for reframing many of the well-known “facts” about creativity. Hence, the study presents a review of some of the applications of complex systems sciences in the field of creativity research and presents a synthesis of the findings.

4.4.2 Article II: Mapping the complex innovation practices

This article takes innovation research as its focus when examining the applications of complexity theories. The study consists of a literature review that has a special focus on studies applying a complexity perspective in the context of innovation and open innovation. It takes a somewhat critical stance and aims at assessing the added value that such applications provide for our knowledge on innovation practices. Thus, it contributes both to the areas of innovation and creativity literature and to the development of complexity-based frameworks.

In the analysis of the literature, the study focuses on the key concepts used, their alleged value for the practice of innovation, the possible links the referred complexity concepts have with the existing literature on innovation, and the methodological and philosophical positions the examined literature takes.

The article identifies the key concepts of "edge of chaos", "phase shift", "emergence and self-organisation", "(co)evolution", and "complexity regulation" from innovation literature and clarifies the ways these concepts are used in these studies from the ontological and epistemological perspectives. In addition, the study suggests key areas of development for future research, including forging a stronger link with existing innovation theory and giving greater weight to empirical evidence. In addition, the study applies the findings of the literature review and presents a complexity framework for practitioners so that they can benefit from the advantages of a complexity theoretical lens.

4.4.3 Article III: Interaction perspective on creative collaboration

This article presents an empirical case study of creative collaboration based on the data gathered from ACSI (Aalto Camp of Societal Innovation) held in Espoo, Finland in 2011. It focuses on the interactions of the participants and aims at finding out how people mutually facilitate each other's work by focusing on the interactional patterns of the participants.

Empirically, this study is grounded on the data of groups, which work in a self-directed manner, free of hierarchies and working scripts, with cases that necessitate a great amount of creative input from the groups. It is the aim of this study to examine the interactions in such groups when they are truly in a "self-organising state" – a working mode suggested as beneficial for creative collaboration, according to complexity scholars. As the empirical case makes this possible, the data provides a unique view on creative collaboration.

From the practical point of view, it is the focus of this study to find out how self-managed groups, which have creativity as the primary foci of their work, can benefit from the synergy of diverse others. This observational study conducted in an eight day-long innovation camp sheds light on this issue by identifying several interactive patterns facilitating the creative process of the groups. The findings point toward certain strategies that can be beneficial for the facilitation of creative collaboration.

4.4.4 Article IV: interpersonal strategies in self-organizing creative groups

This article presents an empirical case study of creative problem-solving based on the data gathered from ACSI (Aalto Camp of Societal Innovation) held in Espoo 2010. As with article III, this study focuses on creative problem solving in self-organised groups. However, it is a case study of a different camp and groups and was conducted post-hoc.

This paper uses a complexity-based framework from the outset, meaning that it takes certain categories a priori, as suggested by the complexity science-based framework, and applies them to narratives that were constructed based on the empirical data, which were collected through interviews and written observational accounts. This analysis yields a group of factors that supported and inhibited creative problem-solving in these groups. The study thus uses complexity theories as a theoretical device to point at certain elements in the data.

The results reveal group differences in creative capacity as well as difficulties in achieving a working mode that enables the production of creative output within a short space of time. The study discusses some of the problematic issues in creativity research literature and aims at providing novel answers to them from the point of view of its findings.

4.4.5 Article V: Conditions and practices for bottom-up innovation strategies

The third empirical article presents a longitudinal case study of an innovation initiative, focusing on the interaction between a city as a client and a group of experts as collaborators and creative problem solvers. The case study is based on data gathered from two consecutive ACSIs (Aalto Camp of Societal Innovation) held in Espoo 2010 and 2011.

This paper takes a different perspective on creative collaboration to the two other empirical articles (III and IV) because it focuses on only one innovation case in a longitudinal setting and pays attention to stakeholder relationships and the enabling environmental conditions and their interactions with group dynamics. Thus, it operates on multiple different levels of analysis.

The case study examines how the urban planning challenge of a city area has been worked on in two consecutive ACSI camps. Based on the analysis, the article suggests heterogeneous, self-organising groups are key structures for generating innovations. The study demonstrates the process of generating change and reveals how the role of "solutions" in an innovation process is complex and how initial goals and solutions transform along with the process and across a web of different stakeholders.

5 Results

In the following sections the main findings of the study are reviewed. Each article contributes to the dissertation from its own, individual angle, and they are also partly based on different research contexts and methodologies. The following section compiles the most important findings of the articles. The presentation of the articles is organised around the analytical framework, as presented in the section 3.3. Then each finding is reflected on from the practical point of view, namely, how collective creativity can be fostered in an organisational context. Section 4.1 answers the first research question: How can the application of complexity science improve our understanding of collective creativity? Section 4.2 answers the second research question: What are the most important factors for fostering creative collaboration from the perspective of complexity theories? Table 3 below compiles the key contributions of the articles and presents their data, contexts and records.

5.1 Elements of creative collaboration

Creative collaboration might be best understood as a systemic phenomenon. This is argued to be indeed the case because the entity-based approach to creativity, the one that focuses on the individual attributes and performances in isolation from others or the group merely as a context for individuals, is insufficient in terms of explaining how collective creativity emerges, i.e. how people mutually facilitate each other's work and influence each other in order to achieve a synergistic creative output (e.g. Marion, 2012; Hargadon & Bechky, 2006). An entity-based approach violates the complexity-based approach, according to which interactivity, processes and the holistic perspective are central.

Article I argues that a systems view containing recent developments in complex systems science provides a useful lens. The complex systems perspective goes beyond entity-based explanations of creativity and focuses on the processes, flows of information, the dynamics of interactions and how they can help to foster creativity (Marion, 2012). Complexity scholars aim at focusing on particular key processes or social mechanisms (e.g. Hedström & Ylikoski, 2011) that make the system work, instead of the static elements of the systems (Marion, 2012; Sawyer, 2010; Pickel, 2011).

The complexity research framework (see Chapter 3, and especially Section 3.3), suggests that a group of people collaborating together in order to generate novel solutions and benefit from the synergy of others can be best understood as a complex system. The following characteristics are important to focus on when generating knowledge about such systems: patterns, mechanisms and meanings. Next, the key results of the articles are reviewed by organising them around these key elements. At the end of each perspective, a brief summary of the key findings is presented.

5.1.1 Temporal patterns in the processes of creative groups

Patterns are observed repetitive temporal events and activities, specific kinds of sequences, cycles of phases, and points of divergence (Langley & Tsoukas, 2010, p. 14). In the context of this study, patterns refer to the temporal dynamics of a group's interactional processes and the evolution of a group as a complex system. Articles IV and V approach creative collaboration from a temporal perspective by constructing historical narratives of how the creative collaboration emerged in the interaction of the participants over time and discovering what the most important elements in the development of the groups on a collective level were. These levels can be separated only for analytical purposes, because the interactions and collective behaviours are entangled in the process of emergence.

Article	Research question(s)	Data	Context
I	Why does a systems approach provide a fruitful starting point for creativity research? What does it mean to conduct a study from a systems perspective?	Literatur, journal articles	Creativity research, systems theory
II	How has complexity theory been applied to explain the dynamic and networked characteristics of an innovation process, and what added value does it bring from an open innovation perspective?	Sampled journal articles	Innovation research, complex systems science
III	How is creative collaboration constructed and enabled in short-term self-organising groups from the interactional perspective, i.e. how do people mutually facilitate each other and the group?	Observations, memos, video-material	Collective creativity
IV	In terms of the antecedent conditions of self-renewal, which factors supported the groups' capacity to attain creativity?	Interviews and observations	Collective creativity, self-renewal systems
V	What were the main enabling conditions of the ACSI working model for self-organisation and creativity to emerge in group projects?	Interviews, observations, documents	Creativity, innovation research

Table 3. *The relationship between the articles and the research questions and data and methodological contexts of the articles.*

Publication date and forum	Significance in this study
Proceedings of the Conference on Creativity in Higher Education (2013)	Introducing the complex systems perspective and systems perspectives in creativity research. Reviewing complexity-informed inquiries on creativity.
European Journal of Innovation Management (2016)	Introducing the concept of innovation. Reviewing applications of complexity-based research on innovation.
Submitted for review (2016)	Providing an empirical example to applying a complexity perspective on group creativity.
International Journal of Complexity in Leadership and Management (2014)	Providing an empirical example of applying a complexity perspective to group creativity.
Proceedings of the 4th European Conference on Intellectual Capital (2012)	Providing an empirical example of applying a complexity perspective to innovation collaboration.

Table 3 continues.

Article IV uses a narrative technique to find out how members of a group see the evolution of their work and how important points in the evolution of the group influenced the effectiveness of their collaboration and creative output. What follows next is a “generalised” description of a group evolution in creative collaboration, based on the empirical evidence of the included studies.

In the case site, all the groups were first in disagreement about the working methods, goals, and the ways in which the solutions should be sought. This was apparent in the conflicts that the groups had in the early phase of their projects. The study reported in article IV found out that a group needed to develop a clear purpose, a vision and an identity as well as mutual trust and commitment for it be successful in its task. The first critical point for the groups were to establish a certain type of working order, certain rules and structures that helped group members navigate their activities. This structure could be provided by a structured plan or by a shared vision that could anchor the activities of the group’s members.

It was found to be important that a group agreed on a working order. In creative collaboration there are multiple variables that a group needs to ensure are taken care of, such as idea and knowledge exchange, dialogue and how it is fostered, the (ad hoc) leadership of different emerging issues, the archiving and documentation of the process, the prototyping and implementation of suggested ideas – to name but a few of the important tasks. Therefore, group members need to be in agreement on the general working methods before they can start achieving other goals.

In the studies reported in articles IV and V, after establishing an initial operating working mode followed a stable period, all the groups experienced a kind of “mid-term conflict” caused by the breakdown of their existing working methods and practices (the time-span of the working period was 8 days, and the conflict took place in the middle of that time-span). This conflict was initiated by external feedback and often served to facilitate discussion and feedback.

The last critical points in time that were identified in the studies were the speeding up of the process that took place at the end of the working process, when there was pressure to meet deadlines. At this point a new “inner hierarchy” was usually established, which was evident, for example, in the ways work was purposefully divided and reallocated to the participants so as to integrate the generated ideas into a coherent solution prototype.

Even though each group had different triggers for their critical points and they used different strategies for solving them, the groups all followed a similar temporal pattern: from early brainstorming to an operational working mode, a mid-term crisis that was caused by feedback and solved by the search for novel working models. Lastly, there was a nonlinear “jump” to a new level of operation in which a group finally achieved an effective “implementation mode” with which to integrate the generated information into more coherent set of ideas and knowledge. The process is illustrated in Figure 2 below.

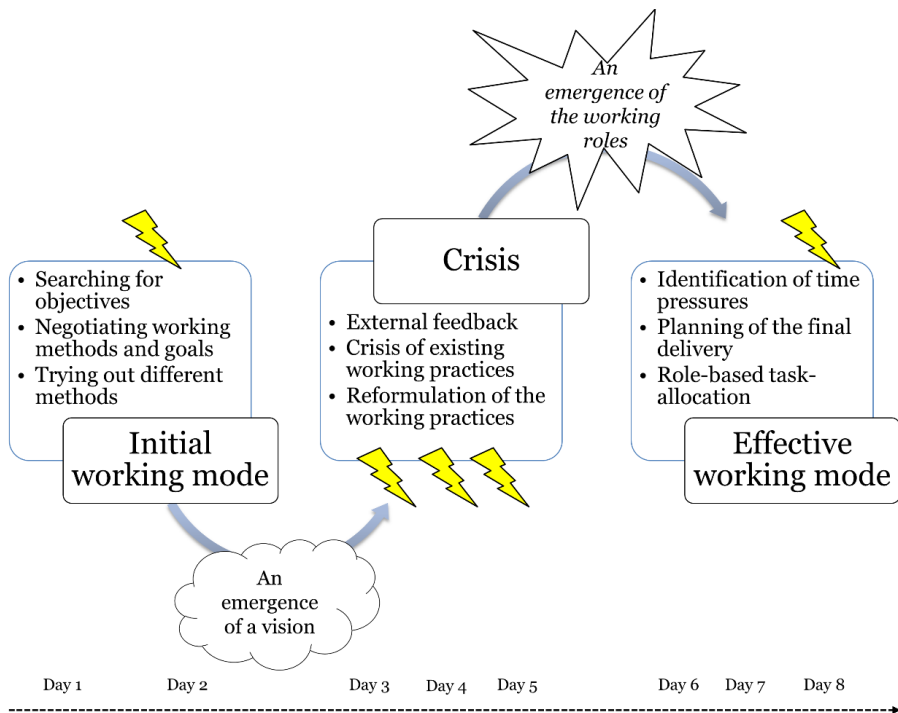


Figure 2. A generalised process of group evolution. The flashes symbolise the level of conflict and pressure.

The observations resemble the findings of Gersick (1988; see also the earlier works of Fisher, 1970), who formulated, based on her empirical observations, the punctuated equilibrium model of group development. The punctuated equilibrium model departs from traditional linear models, such as Tuckman's (1965) stage model, which incorporates the sequential phases of forming, storming, norming, performing and adjourning. Gersick's (1988) model includes sudden jumps and the revisions of a group's performance frameworks. Most importantly, the model includes a similar midpoint to that which was observed in the studies reported in articles IV and V, in which a group experiences a sudden transition that provides a window of opportunity for seeking an improved operational working mode.

Article II identified the temporal descriptions of an innovation process, at a different level of abstraction, namely that of an organisation or industry, rather than the context of group creativity. The macro-level consideration of literature on innovation revealed that temporal asynchronies are a recognisable part of innovating companies as well, according to the literature. Hence, complex systems can evolve in a stable manner for a long period of time, but nonetheless can face unanticipated qualitative changes. These kinds

of “phase shifts” or “phase transitions” are often cited elements in complex systems literature.

From the complex systems theory perspective few observations can be made concerning the observed evolution of creative groups. The first important point is that complex systems are thought to be driven into an unstable state *far from equilibrium* by powerful feedback loops and/or external pressures, which makes the transition possible, i.e. a condition in which a system can “choose” between different attracting points. Here, an analogy can be drawn with a crisis that might befall a practice in a group setting when the use of certain habitual ways of working and novel unsolvable problems arising from interaction with an environment (external feedback), cause internal instability and a need to generate novel ways of working, or “adaptation”.

The second point related to the temporal asynchronies is that at any point in time no one actually knows precisely what solution or what knowledge would prove to be important in the later part of the process. This notion introduces a paradox, since not all knowledge can be stored, and usually both knowledge and the frames of reference for interpreting it change and develop over time. Thus, knowledge does not represent a fixed entity. For this reason, several “dead ends” in the creative process may be encountered, and only at the point at which a final solution can be anticipated, can a direction finally be selected and all the resources devoted to that selected path.

- *Summary:* Through a narrative analysis of the evolution of a group’s overall working processes over time and the identification of the most crucial elements a general type of model – for the development of a creative group – is suggested. The model should roughly follow the following steps: from early exploration to an initial operational working mode, from a sudden mid-term crisis regarding a practice to a novel working model, and to a new level of operation and implementation. The suggested temporal model resembles the one presented by Gersick (1988). Complex systems science suggests that external feedback may launch internal pressures to change the prevailing working practices, causing a crisis in a practice. This internal instability forces systems to change and find a new internal balance. Complexity science also introduces a paradox related to knowledge production in the sense that the creative process can never be fully “focused” but always comprises a waste of resources in terms of knowledge production, since resources cannot be effectively steered before the final direction reveals itself.

5.1.2 Complex mechanisms and emergence

Mechanisms are generative underlying “motors” that make things happen, and they give an explanation for observed progressions and dynamics; they

regularly appear in processes that make the system work. In the context of complex systems, mechanisms are represented by some of the regular behaviours of different types of complex systems, such as the emergence of macro-level structures from the interactions of the lower-level elements and self-organising behaviour.

Complexity science may partly provide an answer as to why the creative process ultimately seems to follow such a temporal path with a “sudden jump” in the practice of creative efforts. Many scholars identify a dual mechanism in operation behind the creative process, namely exploration and exploitation (March, 1991) as well as divergent and convergent thinking (Guilford, 1967), in other words, variation and selection (Csikszentmihalyi, 1999). In the realm of complexity science, Mitchell (2006) has discussed the ability of complex biological systems to explore and exploit the environment in an optimally balanced manner (see Article I). According to Mitchell, complex systems in biology are able to fluidly adapt their exploration and exploitation processes by adjusting the resources given to a certain strategy. As a system gathers more information, it learns to give more weight to successful strategies. According to Mitchell, this evolution leads to a shift in the optimal balance over time: early explorations are based on only a small amount of information and they are largely random and unfocused, bottom-up searches. When information is obtained and acted on, the search becomes more focused and top-down in alignment with the system’s feedback mechanisms (see also Hofstadter & Mitchell, 1994; Holland, 1992). Mitchell (2006) refers, for example, to the immune system as an example of an “intelligent” biological system. The search for pathogens is conducted by “lymphocytes” (a type of white blood cell) of which the most successful ones are given more weight in subsequent offspring. At the same time, less promising searchers are not completely replaced. In this way, the system utilizes randomness. And in this way, the creative process seems to become more and more focused over time, because the information gathered and generated is acted on and applied to the problem at hand. At one point, the most promising model(s) are selected and the best solution or candidate is proposed. This dynamic of the exploration and exploitation processes is illustrated in Figure 3 below.

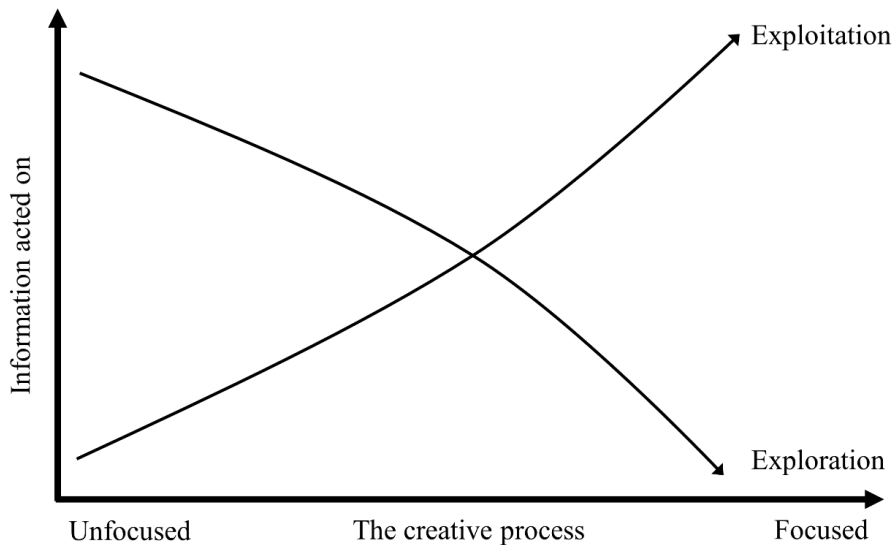


Figure 3. *The average tendency between the exploration and exploitation strategies shifts over the creative process.*

Article III which focused on the individual acts that mutually facilitate the creativity of others (“facilitative interactions”) uses the concept of “emergence” by referring to a mechanism which combines micro-level interactions and acts with macro-level collective capabilities. The interaction of the levels is manifested in the patterned interactions and coherent collaborative processes of the groups. In this study, creativity facilitating acts were observed. They were understood as arising from micro-level interactional patterns, and were observed in the study at the level of behavioural “rituals”, such as direct and indirect contributions to knowledge creation activities, the maintenance of the information flow, the promotion of the culture of creativity, etc. First, many of the interactions were observed as “tentative rituals”, the groups were still trying out which way of working would best suit them. However, over time, some of the rituals became continuously used group practices, i.e. part of the collective level capabilities of the groups. In this reading of complex systems perspective, emergence was the central concept for theoretically understanding the collaborative process. In this regard, the concept of emergence is an important construct for creativity research (e.g. Sawyer, 2010; Marion, 2012)

The analysis of the groups in article III – through the lens of emergence – revealed how the members of the groups learnt to work together and developed different types of behavioural patterns. An example of these creativity facilitating patterns are the different ways of maintaining a constructive and critical dialogue between the participants in group

discussions, which are described in article III. These types of behaviours help a group to organise their work and produce novel ideas – the task of a problem-solving group. Such behavioural patterns, when occurring regularly, become part of the collective capabilities of a group, when group members learnt to use them fluently. In this way the macro-level functioning and social structures of the group actually emerge from the micro-level interactive and behavioural patterns of the group members over time, and the emergence explains their coupling.

- *Summary:* Complex systems science suggests there are two important mechanisms – exploration and exploitation – behind the creative process. The balance between them shifts as the amount of information increases: early explorations are based on only small amounts of information and they are largely random and unfocused bottom-up searches. However, as information is obtained and acted on, the search becomes more focused and top-down in alignment with the system's feedback mechanisms. In addition, the concept of emergence provides a useful way to conceptualise and understand how agency and structures are coupled together in the development of new social processes and practices, and thus it provides an analytically sound concept with which to study group creativity.

5.1.3 Meanings and communication

Meanings are subjective interpretations of individuals. Even under monolithic cultural circumstances people tend to have conflicting views on different topics, which results in competing narratives explaining and describing events and happenings around them. The notion of a meaning is important in two ways. First, when acknowledging a worldview according to which individuals make subjective interpretations and learn about their social environment, it follows that all discussions and behaviours derive from a combination of cultural and subjective knowledge. This has clear consequences for the adopted research strategy, in the sense that individual interpretations become an important research object.

Secondly, meanings are important to take into account when trying to understand creativity and co-creation. Creativity is actually a form of interpretation or sense-making in itself (e.g. Drazin, et al. 1999). For example, Runco (2007) has suggested an interpretative view of creativity, in which he defines creativity as the ability to construct original interpretations of experiences, that is, to create new knowledge in the construction of an understanding. When the interpretations are both original and effective, i.e. they have a personal or social impact, the construction process is a creative one, according to Runco (p. 91–2).

Weick (1979) has described how humans enact their surroundings, which means that they react and construct meanings from their environment while

in interaction with others. The process of sense-making in which people make sense of the different situations and events they encounter is in effect retrospective and iterative (Weick, 1979). According to Weick, (1995), the process of sense-making is actually not about finding the right explanation in terms of its objective accuracy as much as it is about finding a good and plausible narrative to hold the elements of the story together in order to guide action and engage others to contribute to sense-making (Weick, 1995, p. 58). Following the notion of sense-making, it is the process of constructing novel frames of reference and developing and testing them in practice that yields novelty in the sense of creativity. In this way, creativity can be seen as an interpretative process of trying to make sense of different situations and coming up with novel ways to reframe a situation (without the need to see a situation in a new light, there would be no need for creativity, and the old, habitual ways of behaving would work).

In this dissertation, meaning making processes are considered to happen in the process of symbolic exchange, i.e. in communication between actors and (within actors). Communication patterns, as well as the meaning making that takes place in that process and is entangled within it, are emergent (cf. Salem, 2009). Since ideas cannot be sent as such (only messages into which ideas are encoded can be sent), the process in itself is highly complex and subject to multiple different factors influencing the interpretation of the ideas, such as the prior knowledge of the receiver, world views, the frames of reference, contextual factors, historical relationships between the communicators, interests, etc. (Leeuwis & Aarts, 2011). According to this view on communication, meanings are actively constructed between people in complex and contextual settings, thus communication may lead to increasing comprehension but also conflicts and contradictions (ibid., p. 25). Facilitating the communicative processes between people can therefore be important in creative collaboration.

Articles III and IV identify several communicative processes important for creative collaboration. According to them, communication can be understood as playing several roles in the creative process.

First of all, both empirical articles (III and IV) highlight the importance of dialogue, which means that a discussion between participants is most productive when it has the characteristics of reflexivity and criticality; when there is no need to refrain from criticality, as is commonly thought, probably due to widespread ideation guidelines, such as brainstorming. The point here is that ideas are in conflict, not people, and from the conflicts of ideas emerge new ones. Therefore, communication that fosters the criticality and reflexivity of both their own and other's ideas was found to be important.

Secondly, it was observed that the knowledge people shared had a dual role: on the one hand, it was the information and expertise that people could bring to the situation that allowed them to contribute to the common pool of knowledge through their experiences and background knowledge. On the other hand, it was the ability to build knowledge, i.e. to integrate and build

novel constructions of what has been said that was of importance. This finding suggests two important but different group roles and ways of communicating: informants or content-experts who communicate their ideas as clearly as possible and, secondly, creativity experts, who have possibly no content-related information but who are skilful in connecting different pieces of information together to form new ideas and suggest novel frames of references for the reinterpretation of existing knowledge. For the latter group the ability to unambiguously communicate one's idea is perhaps not as important as the ability to ask questions and make critical remarks and use nonverbal techniques. Of course, there is no reason why the same person cannot occupy both roles in a group.

Thirdly, it was found that communication was related to the negotiation of power structures. This was evident when the participants slipped away from content-related argumentation and knowledge building activities and instead focused on using persuasive or even coercive language for arguing on the behalf of their ideas. Even though power relations were not the focus of the studies reported here, it was an important finding and it should not be dismissed that communication is not only about communicating ideas or constructing understanding, but that it also entails a persuasive level, suggesting different power relations that may be at play, for example, by preferring certain ways of thinking and talking about matters.

The fourth notion related to the role of communication is that of a mediator or diplomat. It was found that certain persons could play an important role as mediators between others, and especially so in conflicting situations. It was evident that such persons helped group members to understand each other. They filled the gap caused by the differences in the world views, background knowledge, or in other matters that could not have been resolved by those involved alone. This finding leads to the notion of the importance of diplomatic communication skills that help to avoid conflicts between people. This is especially important because there a risk that people fear bringing dissenting voices into the conversation ("ideas in conflict"), when on the contrary that is exactly what they should do.⁸

- *Summary:* creativity was defined first from an interpretive perspective as the (interpretative) process of trying to make sense of different situations and come up with novel ways to reframe a situation. When this definition is placed in a social context, it is about communication and the novel frames that make a discussion creative. In this way, a creative social situation becomes a negotiation of novelty, how things can be seen in novel, surprising, and appropriate ways together – to use the classical defining attributes of creativity. Communication itself has the potential to

⁸ In relation with the importance of studying "group roles" in creative collaboration, see Hanchett Hanson (2015).

lead to both consensus and conflicts. Both are perhaps needed in a creative process, but the facilitation of the communication proved to be essential, since some communication processes are more fruitful than others in certain situations. Furthermore, important group roles regarding communication were found, such as the usefulness of having a substance expert, an integrator and a diplomat in a group.

5.2 Towards a view on the enabling infrastructures of creative collaboration

In this chapter examples of the results from Articles I–V were presented and the lens of complexity was applied to the study of creative collaboration. The findings presented above draw a picture what has been learnt by using such a framework and how the understanding of creative collaboration can be improved. Next, this section summarises some of the central findings from the practical perspective and answers the second research question of “What are the most important factors for fostering creative collaboration?” Seven such factors are proposed.

- (1) ***Building a proper “working together” culture.*** The culture discussed here is understood to be that of a working climate and the set of shared knowledge of the team of people that are collaborating. Culture that fosters creativity includes building commitment to the task by asking “Why we are working?” and “What is this good for?”. It also includes constructing an appealing vision by asking “What could be the consequences or impact of the solution at its best?”. It also includes a “working mode” which determines the motivational aspects (resources to be used for the task at hand), a description of the ways the group works (working methods), how it is set up in order to achieve its goals (working plan), how it would organise its processes (leadership), and how it would generate new knowledge (creativity practices). In addition, it includes knowledge about the current situations, capabilities and capacities of the group, which are gained by asking “What do we have? and “What do we need to get?
- (2) ***Knowing the process.*** The creative process follows a partly unanticipated path, but there are certain regularities and by knowing them, it is easier to evaluate the progress of a group. The creative group process starts with confusion, when members are faced with an unknown task and unknown others. From this outset an initial working mode and methods are adopted and idea generation and solution seeking activities can start. In the middle of the working period, the practices that the group members have been using so far may fall into

crisis, because members have learnt to work together and they are able to evaluate more precisely the status of their progress and clarify the goals. In a good case scenario, this leads to an improved working mode and methods. Finally, the group attains an implementation phase, when the selected solution prototypes need to be decided and implemented. At this time a complete updating of the working order emerges.

- (3) ***Embracing variation and context.*** Even though there are some general regularities, or rather the phenomena and characteristics of complex systems, which may help an observer to understand the behaviour of a system, probably the most important lesson is that the behaviour of such systems is contextual, i.e. it may vary from one context to another. For example, in creative group work, even though there are similarities between the groups and even though the evolutions of their operations could be understood as originating from similar starting points, they will differ and each of them will have their own ways of achieving goals. Therefore, complexity scientists often tend to talk about such concepts as “self-organisation”, “emergence”, and “enabling conditions” rather than stage-gate process models or control variables. In the human context at least, it is important to leave room for people to find their own ways of doing things. This bottom-up approach does not mean accepting everything suggested, but emphasises the fact that human systems are hardly controllable and probably not effective, even when everything is micro-managed or forced into a certain structured way of working.
- (4) ***Encouraging emerging practices.*** The observed groups tended to develop their own peculiar working practices. Some of them may not have been the most optimal ones, but they were developed and adopted by the groups themselves. Thereafter, they were also adjusted and tested as suitable for the current situation. According to the pragmatist understanding of human action, people try out different ways of behaving and acting in the world, and develop practices that work well and adequately enough – until a crisis in the practice forces the reconceptualisation of the situation at hand (Miettinen, 2006). This means that at least in the context of ad hoc groups whose members need to learn new skills and knowledge, such as those enabling them to work together, novel (working) practices need to be developed. Often those practices emerge by testing and trying and learning and they are combinations of old and new habits. For example, let us imagine a group of people who had learnt that the best way for them to generate novel ideas is to go out and walk in small groups of two people and then gather together, share the ideas and vote for the best two options. Once they become used to harnessing this practice and find it useful time

after time, it becomes part of their social structure. Everybody knows that when new ideas are needed, it is better to go out and split into pairs. Sometimes, maybe due to some environmental condition, such as a sudden need to speed up the project, the practice proves to be less useful and falls into crisis. There is no time to go out and walk because the group needs to integrate the knowledge at a much faster pace than previously. Therefore, a new way of generating ideas needs to be developed, and in this way novel practices emerge from the interaction of the people and their environment.

- (5) **Identifying the levels of creativity.** An important yet confusing part of creativity research is that the focus on creativity is often badly defined. Namely, it is important to distinguish whether the studied creativity refers only to the creative output of the group (“the ideation process”), or to the creative capability of the group in order for them to operate successfully (“creativity-relevant social processes”), or to both (see Section 2.2.1). When talking about the creativity of a group in a vague sense it is often hard to distinguish between the two types. In practice, they are inseparable. This is because when the focus is on the group as an emergent entity in its own right, it becomes impossible to talk about the output of a group in isolation from its social processes relevant to creativity, the ones that will lead to a well operating system. Secondly, as discussed earlier (see Section 2), measuring the creativity of the output is hard, because the value of the output should always be set in context, and thus it becomes a relative attribute and partly a function of the subjective evaluations. Therefore, the holistic systems approach sees the output and the factors that contribute to it as parts of the dynamic whole.
- (6) **Appreciate subjectivity.** When approaching creativity from the perspective of sense making, i.e. as a retrospective and iterative process of generating plausible and practical narratives of reality, the subjective variation of peoples’ frames of references enters the picture. This is indeed a good thing from the perspective of creativity. After all, the point of coming together to solve problems is that each of the participants possesses different knowledge, perspectives, and interpretations of the situations at hand, in other words – the diversity. Diversity is perhaps generally understood from the perspective of diverse backgrounds, implying that each member has a different area of expertise or a different socio-cultural background enabling different frames of references. However, the subjectivity of each participant’s interpretation of the situation can be a driver of creativity; through dialogue people challenge each other to imagine the points of view of others, and, through this process, generate yet more interpretations of

the situation at hand in an iterative manner. This interactive cycle of interpretations boosts creativity.

- (7) ***Nurturing the communication landscape.*** Communication is a neglected aspect of research in the field of creativity, and similarly, creativity has very rarely been studied in the field of communication. However, a communication perspective on groups can provide a fruitful perspective on creativity in collaborative settings. Among the important aspects of communication found in this study were dialogue, understood as a reflexive critical discussion; two functions of communication (expertise information and knowledge building); the related roles of a content expert and a creativity facilitator; the persuasive level influencing the power structures and hierarchies, which leads to the evaluation and appreciation of different ideas; and the conflicts caused by communication breakdowns and how “mediators” can bridge such gaps.

6 Discussion and conclusion

6.1 Summary of the main findings

Distributed collaboration and non-formal ad hoc working groups are usual in today's working life and diverse experience is needed for many complex problems (Paulus et al. 2012, p. 327; Kozlowski & Bell 2008, p. 15). Tightly controlled groups and teams might work well for the performance of routine tasks, but non-routine tasks, which demand creativity, require that group members have the freedom to develop their own ways of doing things (Montuori, 2011). However, it can be challenging for people with no or little shared working histories and different social, cultural, and professional backgrounds to develop a firm basis for successful collaboration. This dissertation provides several insights into this problem area, which are summarised in this chapter.

The first research aim was to develop a complexity science informed research framework for studying collective creativity (Chapter 3) and the second research aim was to put the framework into use and test its applicability and usefulness for studying creative collaboration (Chapter 5). Indeed, the purpose of this concluding article is to summarise the theoretical and practical understanding behind constructing and using complexity-informed research framework and use it here as an instrument for reflecting on and presenting the most important research results of the articles. The framework is the result of a gradually growing understanding, deriving from both the extensive reading of the theoretical principles of complex systems science as well as the practical application of those ideas when studying cases of creative collaboration.

The complexity framework challenges many of the traditional ideas of understanding social dynamics. Among them are the following aspects: the collapse of the difference between qualitative and quantitative methods and the embrace of narrative trajectories; the denial of simple causal laws in the realm of social reality and the appreciation of contextuality; a focus on interactions, dynamics, and processes instead of the attributes of static entities; a focus on the general characteristics of complex systems, such as emergence, self-organisation, adaptation, coevolution, and non-linearity; the importance of bottom-up and top-down (causal) emergence instead of variables for explaining the dynamics of complex systems; the coupling of micro-level social interactions and macro-level social structures in the process of emergence.

The complexity framework provides a novel kind of description of the world and a philosophy or a worldview that guides thinking about that world. As a meta-theory of the social world, it points toward certain characteristics of complex social systems, and challenges researchers to further investigate how

delving into the dynamics of real-life complex systems, through empirical observations, may help in the understanding of those systems. However, it is by no means a magic bullet, which will explain all kinds of social dynamics. On the contrary, it provides a context for the reconstruction of existing social theories and an empirical lens that helps to point towards certain elements of reality, helping to see them as complex systems.

Therefore, among the most important findings in relation to the first two research aims was the recognition of how a complexity framework can challenge many of the conventional ideas of “how things work”. As such it works well as a research framework, the purpose of which is to guide and help researchers see what underlying mechanisms are in operation, what kind of patterns of interaction to look for, or what other elements there are in social systems. However, at the same time, in its focus on the complexities and contextual variation, it has proved to be less useful in terms of providing ready-made methods for conducting research. A complexity framework’s value is in its ability to change opinions about “how things work” and make one’s perception of reality match its actual complexity.

The third research aim was to identify the most important elements of creative collaboration, as informed by the research framework. This aim was pursued through the use of the empirical case studies reported in the research articles. The presentation was organised around three different concepts: patterns, mechanisms and meanings.

First of all, it was shown that the creative group process can be understood through a general type of developmental model that accounts for the complexities and non-linearity involved in the creative process. That stands in contrast to the traditional linear stage models of group development. Secondly, it was found that of the mechanisms of complex systems, the concept of emergence was perhaps the most useful in that it describes how novelty emerges from the interaction of micro-level interactions and processes and is illustrated in changes in macro-level behaviours, while group members are both developing novel ideas and novel practices to create them. Thirdly, a meaning and communication-based definition of creativity was developed on the basis of the findings of the articles and several communication processes were identified as important to be taken care of by means of internal or external facilitation (roles related to the communication functions).

The fourth research aim was to provide insights and important information for the practice of creative collaboration. For example, what interpersonal strategies, social rules, or communication strategies can be used for fostering creative collaboration in different contexts? From a practical point of view, seven factors important for fostering collective creativity were presented (Section 5.2) and form the basis for the building of a culture of working together, knowing the process, embracing variation and context, encouraging emergent practices, identifying levels of creativity, appreciating subjectivity, and nurturing the communication landscape. These practical guidelines are believed to help build an environment that fosters creative collaboration.

6.2 Contributions of the study

There are two significant contributions provided by this study. The first category consists of the source disciplines of the used theories and approaches, which are creativity research (collective creativity), complex systems sciences (social complexity), and theories on communication and sense-making. The second category includes: theoretical, empirical and practical viewpoints. These categories form a matrix that can be used to evaluate the contributions of this research (Table 4). In accordance, with the matrix, nine contributions are presented.

Discipline	Theory	Empirical results	Practice
Collective creativity	A novel approach for studying collaborative creativity	A description of the creative process	Guidelines for fostering problem-solving in groups
Social complexity	Philosophically and methodologically grounded research framework	Emergence as an important concept and its various applications	Complexity-oriented mindset or a worldview
Communication and sense-making	Complexity-informed framework can be useful	Communication-based definition of creativity	Different communication practices for collaboration

Table 4. *A matrix of the contributions of the study*

The contributions of the study to collective creativity. First, this study suggests a novel kind of approach to thinking about creativity. This approach is based on the premises of complex systems science, but it also draws from the field of social sciences, and especially those fields where the focus is on interaction, interpretation and communication. As such, it challenges the prevailing individual-based assumptions underlying much theoretical work on creativity, and the applications of group creativity research based on those assumptions. Secondly, this study contributes to the empirical findings of creativity research by suggesting a complexity-based developmental model for creative groups, which complements the knowledge of the creative process in groups. Related to that, the study suggests the key mechanisms of exploration

and exploitation that guide the creative search. Thirdly, this study provides guidelines for creative problem-solving groups that can be applied, for example, by creativity facilitators.

Contributions to the study of social complexity and complex social systems. Complexity science has grown rapidly over the last two decades and became more mature and an accepted theoretical approach for social inquiry. At the same time as it is maturing, the provocativeness of its propositions have lost their sharpness. Particularly in the context of the social sciences, there is nothing new in saying that social phenomena are complex or that systems formed by people are dynamic and interactive and consist of multiple interactive variables. However, the research framework presented here is specifically tuned to aid with social inquiries comprising the elements of interaction and communication, and it also accounts for both the micro- and macro-levels, and is grounded on the principles of complexity. Therefore, it can be a useful starting point for complexity-informed social researchers. Secondly, the concept of emergence plays a central role in the understanding of the micro-macro link and is thus useful for many applications of the concepts of complexity in social research, which deal with the relationship of micro-level interactions and macro-level collective behaviours. Thirdly, delving deeply into complexity thinking may help a researcher develop a complexity-informed mind-set or a world view that can guide a researcher to better take into account aspects of social reality that have been neglected by previous research.

Contributions to the study of communication. Organisations are a form of collaborative entities; complex social systems, consisting of people who communicate together and coordinate their actions in order to achieve certain goals. Creativity and innovation are needed in organisations, since organisations need to adapt to their changing environment and reinvent their internal operations occasionally. The study of organisational communication practices can benefit from the results and the presented framework of this study in three ways. First, the complexity-informed framework can itself be beneficial for the purposes of research on communication in organisations. It can open up novel research avenues and perspectives. Secondly, the communication-based definition of creativity (presented in section 5.1.3) can help communication scholars study the topics of creativity and take creativity and innovation studies to the realm of their future research. Thirdly, the practical communication practices, processes and roles that have been presented, can be useful in terms of the coaching or facilitating of communication skills in organisations in order to promote creativity in organisations.

6.3 Limitations of the study

In the evaluation of the trustworthiness of this study, three criteria presented by Graneheim and Lundman (2004) will be covered: credibility, dependability and transferability. The consideration of these three aspects is expected to help to identify the limitations of this study.

According to Graneheim and Lundman (2004), *credibility* deals with how well the used data and the process of analysis correspond with the focus of the study, including such questions such as, Who were the participants? What was the context? How were the data gathered. What was analysed in the materials? How credible was the analysis process? *Dependability* deals with the changes that occurred in the research process during its different stages, and how consistent the different procedures have been. Finally, *transferability* deals with the question of how transferable the research results are across different contexts.

Concerning this study, the question of credibility can be best approached by first contextualising the selected research approach. This study is a compilation of theoretical and empirical work. The study has not followed the traditional path of a scientific inquiry, according to which more or less well established theoretical premises will be formulated into testable hypotheses and thereafter investigated against empirical data. Rather, this study is based on the premises of complex systems science suggesting both novel theoretical as well as methodological understanding and the frames of references that follow from them and guide and determine the trajectories of this research. It is through this lens that the shortcomings of the study can be assessed – regarding how credible and logical the study is as a whole.

First of all, the data used in this study comprises literature (text and concepts) and qualitative empirical material (text, observations). In the empirical part of the study, the materials were gathered from an innovation camp context, which needs to be taken into account. Firstly, the composition of the participants is likely to be naturally skewed, since the camps consisted of certain types of individuals who were invited to participate, most of them are used to working in creative processes. In a real-life organisational context, the results would probably be different. Secondly, the context of the research site, an innovation camp, already set certain constraints on the interpretation of the results, because people could not be thought to behave in an innovation camp as they would in the natural context of their work places. However, in the research articles this context was accepted and embraced in the sense that the empirical studies became more or less studies covering creative collaboration under these specific circumstances – an important aim on its own. The data gathering methods included interviews (conducted by the author), observational reports (made by external observers), observations and memos (made by the author), and video data (recorded by the author).

With this notion, the *dependability* of the research process comes into focus. This research process did not follow a traditional hypothetic-deductive

model of science, neither was it a completely inductive process of the traditional grounded theory, but it included cycles of both of those processes. Firstly, interesting questions were formulated based on the research interest (how creative collaboration can be understood). Next, novel theoretical concepts were considered (complex systems science). Thirdly, data were collected and analysed, and through this process, the theoretical focus was sharpened (useful concepts were identified), and the data analysis part was conducted several times. Lastly, the most convincing parts of the analysis were presented as results. Of course, in reality the whole research process intertwined with the apparent learning process of the researcher, putting the data, theories, findings, and everything else almost constantly into new perspectives, while, simultaneously, the understanding of the research object gradually grew.

Lastly, in terms of the *transferability* of the results (their generalisability across different contexts of applications), the empirical part of the study can perhaps be placed closer to the latter end of the nomothetic–idiographic continuum. Extending beyond singular cases is a problem for studies based on individual cases that have only a few other cases available for comparison. For example, the results of this study can be helpful when planning to implement work environments supporting collaboration and creativity, but they should not be considered universal in the sense that the findings would stack up across different contexts. This is the price that comes with deep and detailed focus, triangulation with several data sources and methods, and the gradual increase of the researcher’s understanding of the research objects.

6.4 A proposal for future research

In the introduction it was argued that collaboration of a cross-disciplinary nature that occurs in the context of increasingly networked working lives has changed the ways creative activities are conducted. It was argued that it is not enough to persuade creative geniuses to join an organisation or establish R&D departments responsible for the "creative" side of the work. Creativity lies at the interaction of old and new knowledge and experiences, at the intersection of differing worldviews, and thus results in ideas and their applicability transforming across different practical contexts. Moreover, organisations are increasingly formed by complex and ephemeral webs of interactions between different stakeholders, and their functions and identities are reproduced in these relations. In essence, they are collaborative entities.

Some scholars have argued that the whole image of today’s organisations has changed in accordance with these changes. For example, McPhee and Iverson (2009, p. 51) point out that the acceleration of social creativity in institutional and organisational arenas that is accompanied by the rapid cycle of organisational creation and dissolution and the strategic exploitation of innovations, has led to a new image for today’s organisations.

What could this image be like? This question is examined in the form of proposals for future research, and it is made with organisational scholars in mind, since creativity and innovation are topics of growing popularity and increasingly important in practice.

The image of an organisation McPhee and Iverson draw is one that encompasses a continuous embracing of challenges and opportunities for creating novel products, solutions, services, processes, approaches, working practices, structures, etc. It is an organisation experiencing constant change, through the processes of exploration – in terms of novel opportunities and exploitation regarding the execution of existing opportunities. However, many essentially critical questions arise when standing in front of the image of such an organisation. The majority of the innovation and creativity literature is of a positive nature. Indeed, there is a serious positivity bias in academic knowledge about these important issues. Therefore, the following proposals for future research are devoted to a critical approach to creativity and innovation, suggesting a slightly unconventional but beneficial agenda for organisational creativity and innovation research.

First, of all, more research needs to be conducted on the harmful effects of creativity and innovation. For example, the factors that differentiate good innovations from harmful ones are unknown. We lack clear ethical criteria (see: Moran, Cropley, Kaufman, 2014) for what constitutes good output from a creative process, i.e. an innovation implemented. Very often, the only evaluation criteria are the notion of “social value”, i.e. a value proposed by the community that makes use of the output of the creative process. However, on the basis of the incapability of predicting complex systems, a creative process may have unintended consequences (cf. Cilliers, 2011). It is practically impossible to see what these consequences are, say, a newly launched product. A computer algorithm-based innovation may unintentionally turn into a discriminating practice. A financial innovation can have unintended consequences leading to an economic crisis. Creativity and innovation clearly have their “dark side” – irrespective of the intentions (Cropley et al., 2010). This is partly a question of framing (what is valued), partly a question of non-linearity. For example, the framework of sustainable innovation should take benefits for the environment into account, whereas the framework of social innovation would focus on the benefits for community and social relations. A policy innovation aimed at fostering and developing business start-ups for immigrants would benefit those who are in a disadvantaged position. This implies that the social value of creativity is an ethical question, embedded in the cultural and practical realities of a community, and that a much wider array of evaluation frameworks needs to exist and be under constant negotiation than short- or long-term economic growth, for example. In addition, the benefit of one entity in a system can be harmful to other entities, which evokes the subsequent question of what are the boundaries of the frames of references that are used for assessing the value of current innovation and creativity activities and how they should be defined.

Secondly, a constantly innovating company can also be dysfunctional. Too many creative activities and innovations can make organisational life stressful, unbalanced, and generally aimless. If a company focuses too much on the production and development of novel solutions, at the expense of the exploitation of prevailing ones, it may ultimately fail to maintain its operations. Organisational culture emphasising innovativeness may also be “biased” in the sense that people working in such companies do not value balanced work routines, and want to constantly reinvent the wheel in the organisation. This can increase stress, conflicts, and competition within the company, leading to poorer performance.

From a different point of view, an organisational innovation can also be harmful to some parts of the organisation. For example, a new intelligent business system can make some members of the organisation dispensable and thus it is irrational to keep them on the payroll. Again, the value of such an innovation is dependent on the value framework adopted. The fact that innovation can mean job losses for some parts of the organisation has also caused fear and suspicion, leading to resistance to change in many organisations. This has not contributed to the adoption of such innovations that could actually be beneficial to all members. However, instead of “managing change” in order to silence critics, organisational members who voice criticism can also be learnt from. It can be suggested that those are the members with real commitment to the organisation, people who have points of views that have not been heard and thus not critically evaluated. On the other hand, the organisational members judging the innovation strategies of a company as “all spin and no delivery” may actually be also beneficial in protecting the organisation from over innovating. However, at the same time, they are reproducing and perhaps strengthening an anti-innovation/anti-creativity culture, which may impede organisational development.

A third and final proposal for a future research agenda is that of communication and power. As was suggested in the results of this study, communication has been a neglected aspect of research in the field of creativity, and similarly, creativity has only rarely been studied in the field of communication. This has probably contributed to the fact, that the role of communication as a coercive and persuasive means by which power relations are negotiated in organisations, has not become a popular topic within creativity research. However, creativity is influenced in many ways by power relations and power negotiations, which take place in communication between organisational members. For example, biased power relations and steep hierarchies in teams may be dysfunctional disrupters of creativity. For example, when the participants of a creative process slip away from content-related argumentation and knowledge building activities and focus on using persuasive and coercive language for arguing on behalf of their ideas, the ideas are not developed further and the group actually negotiate over its internal power structures instead. In this way, communication is never “just”

communication, but it always favours certain ways of thinking and talking about some matters instead of others.

These “critical” perspectives on the topic of creativity research and organisational creativity should not be thought of as presenting creativity as a “dark” phenomenon. These research topics are suggested in order to make organisations more effective and better places to work. Creativity is mostly neutral, sometimes funny, sometimes frustrating. It is always vital when providing continuity for any kind of complex living system.

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