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**Creative Knowledge Environments
in the Innovation System**

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Creative knowledge environments in the innovation system

Studies of work teams in knowledge organisations

A research proposal granted by the Swedish Agency for Innovation Systems
(VINNOVA)

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Background

This paper summarises a grant proposal to the Swedish Agency for Innovation Systems (VINNOVA).

The aim of this research project is to increase our understanding for factors that are crucial for creative working processes and innovative results in knowledge organisations. Its objective is to make a contribution to the construction of a model, which describes how to increase creativity with work teams in knowledge organisations. The reason to pursue this project is first that knowledge workers are key-persons in the innovation system, and second that we know surprisingly little about what is important for knowledge workers to develop creative processes.

This research is based on two assumptions. One is that innovations are based on creative processes. Another is that social scientists argue that we now have a society, which can be seen as a knowledge and network society.

Research about innovations deal to a great extent with conditions and mechanisms conducive to innovations. In this research we include the question of how to organise and manage innovative activities. A related problem is how creative research and knowledge environments should be organised and managed. These two problem areas are linked in several ways. First, R&D and knowledge are needed for innovations, since universities, research institutes and industry labs belong to the innovation system. Second, a commercial environment, entrepreneurs and companies are needed for knowledge to be transformed into and contribute to innovations. Third, we are now in a state where knowledge production and use of knowledge is increasing, but where knowledge about leadership, organising, management and work processes in 'the new knowledge production' is scarce.

In the recent and highly debated literature about the new knowledge production (Gibbons et al., 1994; Etzkowitz & Leydesdorff, 1997), it is argued that we now face a changed and contextualised knowledge production, where various producers join into new coalitions, networks and organisations between universities, industry and government. Mode 2 and Triple Helix are the concepts used for this new phase in the changed institutionalisation of knowledge development. In research and technology policy literature a new contract between the academy and society is discussed (Martin et al., 1996; Bragesjö, 2001). The previous contract meant that society left researchers free to do research in line with their own ideas and objectives. This was regarded by politicians to lead to progress, development and prosperity for citizens and society as a whole. The new re-negotiated contract means that society and its actors (e.g, companies, public organisations and NGO: s) participate in knowledge production in a more active, direct and leading capacity. In the private sector changes in knowledge production towards 'learning organisations' are taking place. But also in the mediating fields between societies' public and private spheres an increasing development of knowledge production and knowledge use in networks is taking place. And the development of regions described in the literature is typical for what we call a 'network society' (Sörlin & Törnqvist, 2000). Studies on new knowledge producers are so far few and empirical studies of knowledge workers and their working environments are even scarcer.

Hemlin and collaborators have ¹studied the new knowledge production from an organisational perspective (Hemlin, in press; Hemlin & Widenberg, 2001; Thorpenberg, 2000). In this research we tried to map and understand new knowledge organisations from seven basic aspects of organising (organisational form, leadership, ownership, production forms, communication, decision-making and reward system). In an interview study of leaders of such organisations, we selected organisations that fulfilled two criteria, namely contextualised knowledge production and multi-disciplinarity, which were taken from the literature. This study comprised ten mainly scientifically based environments in a mode2/triple helix context. Results showed that organisational forms varied from concentrated and traditional to dispersed and flexible structures. Leadership was in all cases traditional bureaucracies, consisting of boards, chief managers and project leaders (knowledge workers). Ownership was private and public, but forms varied from foundations, authorities to business companies. A similarity between organisations was financing (missions, research councils, foundations, business). Production forms could be described as project based in all organisations. The variation concerned mostly project length and size. It was more difficult to trace differences between research projects and other kinds of project work, which is consistent with the mode 2 model of knowledge production. The communication aspect of organising was typically a most crucial one, which is in line with the production forms of projects and networking. Personal meetings and IT communications were intensive and extensive. Decision-making was described as following the leadership structure, highly decentralised, although there was a variation. According to the literature the reward system is changing in the new knowledge production. However, we didn't find any new or changed rewards. In two case studies of the two organisations showing the most typical characteristics of mediating environments (mode 2/triple helix) we found, in one case based on interviews observations and documents, that organisational borders were fluid. This led to a certain degree of insecurity for organisational members of objectives and function of the organisation. The second case showed that ownership of knowledge products was not always clear, which indicated problems with 'intellectual property rights'. It was common to both organisations with crossing of institutional borders and the creation of organisational change. Analytically we made a difference between trans-institutional organisations of this kind and more traditional organisational structures, which we called mono-institutional. The former category of organisations worked interactively between different actors in a triple helix. In short, the picture from the empirical studies gave some support to the two models of the new knowledge production (mode2/triple helix). However, the models are not particularly detailed and demand empirical studies and analytical development. One way to proceed is to study working groups and production forms in the new knowledge production.

There is a demand of knowledge about how organisations can be creative and innovative (Kanter, 1999; Paulus & Yang, 2000; Shelley & Perry-Smoth, 2000; Sternberg, 1999; Williams & Young, 1999). It is argued by some authors that it is the organising of the company and the relations between companies, which is crucial to innovative work (see Johnson, 1997). Against this background we want to study, try to find and describe the most important organisational and leadership factors with the new knowledge producers and especially the most successful ones in different institutional settings focusing on work group levels.

A Swedish example on the importance of organisational aspects of innovations can be taken from the food sector. Some years ago an international conference was organised by the Swedish agricultural university, Lund university and the IDEON Agro Food Foundation (IDAF). The main

¹ This research was supported by the Swedish Working Life Fund (RALF) and the Swedish Agency for Innovation Systems (VINNOVA).

question was phrased: How can universities, companies and society organise to promote innovations (SLU, 1999). In this research project we have chosen to let IDAF participate as a research partner. The knowledge broker IDAF is taking part in the project to serve as mediator to business companies and projects aiming at innovations.

We have chosen to select study objects in the fast growing bio-technology and surrounding sectors as well as the ICT-sectors. It is in these areas we clearly can see 'the new knowledge producers'. Our previous studies showed that research, development and commercial organisations were connected in networks and changed their organisational forms. Therefore it is crucial to study creative environments in these organisations and in the mediating fields of organising.

In order to study creative processes we need also knowledge from research on creativity. It is a psychological research area dominated by two directions. One has had the individual as its main interest, while the other one focused creativity in groups and organisations. It is mostly the latter direction, which is also the expanding one that we use here. The research project is focusing on the environmental factors conducive to creativity in a knowledge organisation. This does not mean that we put back the individual's creative ability, but see it as part of the group's creativity or as a part of a system (see Sternberg, 1999 for a recent overview of creativity research). The main applicant of this research proposal have also as part of his research on research quality been dealing with research environments (Hemlin, 1991). We also draw on knowledge in the area of about innovative work teams in the organisation area and organising foremost with Kanter (1996; 1999).

Purpose

The research suggested here studies creative and innovative organisational environments with knowledge producers in different institutional contexts at the micro-level, that is in work teams in the natural sciences knowledge fields. The purpose is to increase the understanding for what factors that are crucial to creative work processes and innovative results in knowledge organisations. We pursue this by describing empirically and analysing knowledge workers work processes and environments. The objective of the research project is to give a substantial contribution to the construction of a model describing how to increase creativity with work groups in knowledge organisations within the fields investigated.

Research questions

The innovation process in the new knowledge production is taking place in different phases of collaborations between university, industry and government, but also in different ways and in different forms (Etzkowitz & Leydesdorff, 1997). In this research project we focus on the successful environments, i.e., those that show a high degree of creativity and innovativeness. The research project aims at answering the following questions: Which are the factors of leadership and organising of the new knowledge production on the level of individuals and teams that are connected to creative processes and innovations. Which are the most crucial factors in these respects? How can these factors be described and conceptualised? Which are the relations between these factors? How are work teams lead and collaborating in the successful organisation? Which contextual factors are important for work group creativity?

Study object

We study knowledge organisations at the level of work teams including the individual knowledge workers. Traditionally a distinction is made between two institutional environments for knowledge organisations, namely the academic (universities) and the private (business companies). We study both and do not exclude intermediaries (consorts, network organisations) and temporary groups that are created.

Theoretical grounds and previous empirical research

We have found, although with some effort, that it is possible to divide the relevant literature about creativity aspects of knowledge organisations and their workers into four partly overlapping fields: organisation research, research about creativity and innovation enhancing factors, research environment studies and science, technology and innovation studies. The research is therefore collecting contributions from several disciplines and is multi-and cross-disciplinary.

Organisation research. We use the cross-disciplinary organisation research in our studies (see for instance the review in the handbook by Clegg, Hardy & Nord, 1996; Pfeffer, 1997; Pfeffer, 1998). The research is directed towards the work team, but also towards the individual in his/her specific role as a member of a group and an organisation.

In Sweden Alvesson (1992) and Sveiby (1997) studied and described characteristics in leadership and organisation of knowledge producing private companies. The latter described the knowledge company from the 1980's with Mintzberg's terminology as an 'adhocratic' organisation, rapidly growing, successful, and in a specific knowledge sector (in Alvesson's case ICT). But he also found several deviations from these features. The organisational structure was viewed as flat and small scale according to the employees. However, Alvesson found 2-3 management levels. Sveiby (1997) characterized the creative or innovative companies as quality improvers rather than growing in the number of employees or in turnover.

In the same manner as knowledge has become a value in companies the organising of knowledge in companies has become even more important (knowledge management). Nonaka et al. (2000) emphasised 'knowledge-creating' in organisations. This is in line with our interest since knowledge-creating processes should be creative.

The organisation researcher, Rosabeth Kanter, outlined a model in four steps to describe how innovations are created, that is which creative phases one can distinguish. The first one she called idea generation, the second coalition building (i.e., where colleagues are persuaded to support ideas), the third realisation of ideas and the fourth transfer or dissemination. During these separate phases different structural and social factors come into play. Kanter preferred organic models for organising, because they more easily adapt to rapid changes in the environment and new technologies. In these models workers have a more important role in steering the organisation than structures and rules. In this way, Kanter argued, creative idea generation is favoured. Other innovation promoting changes are changes in power and resources, cross communications and increased and spread information flow (Kanter, 1997; Kanter, 1999; Williams & Young, 1999). Kanter also described the ideals of innovation promoting leadership styles. Leaders should be convincing rather than ordering, build teams, have several meetings and disseminate information, seek for information with users and collaborators, accept peer reviews, acknowledge other peoples'

efforts, show political sensitivity and generously share acknowledgements and rewards to co-workers.

We are aiming at using Kanter's phase model of innovations to structure organisation and social factors in the creativity process with work teams in knowledge organisations.

Creativity enhancing factors. Much of the creativity research being done has not very surprisingly studied creative individuals and mental processes. This research has often ended in a description of personal characteristics with the creative person such as openness to new experiences, less conventional and conscientious, more self confident, self-accepting, ambitious, dominant, hostile and impulsive (Feist, 1999), while the importance of the very high intelligence is still disputed as the most important characteristic with the creative person (Sternberg & O'Hara, 1999). Other researchers has emphasised motivational factors as the driving force behind creativity. Amabile and co-workers (Amabile, 1999; Collins & Amabile, 1999) argued that the person who loves his/her tasks also become creative if s/he possesses knowledge and skills in the domain and a certain degree of openness in thinking. Researchers who criticized the individually directed creativity research start from the thought that creativity should be judged according to the results, e.g. an innovation. It is of course possible to argue that individuals, groups and organisations are creative in their working processes, without ending up in a result that others can judge. However, the epistemological ground for research creativity is meaningless according to such a view, because we finish up in a judgement of creativity solely possible to judge by the creator. By this reasoning from Csikszentmihalyi (1999) we choose to study creativity processes and contributing factors if they result in innovations. We focus on the creativity of the work team and decide if they are creative according to their results. To find out what factors lie behind these creative processes we use the model proposed by Amabile.

A great deal of the work by work teams is knowledge work. It concerns getting access to and sharing knowledge, apply knowledge and information and to create new knowledge (cf. Nonaka et al., 2000). Paulus and Young (2000) described in an empirical study how the flow of information can be improved in work teams. By letting group members generate ideas individually before group interactions, creativity with groups was improved in comparison with a condition when group members generated ideas together. In an empirical study of how expectations of result control and role models steered creativity activities in work teams Shelley and Perry-Smoth (2000) found that informative and relevant information about results (in comparison to standardised control routines) and showing good role models (in comparison to no models) gave the best results.

There is also some research about the creativity of organisations that can contribute to the research project suggested. This research made use of both individual and systems focused creativity research by Amabile and others. Williams and Young (1999) reviewed research about creativity enhancing factors in organisations. One conclusion from their overview was that social factors in organisations are important. An innovation process is about getting acceptance for your ideas from your colleagues. Another factor concerns skills like thinking in new ways, which is important for both individuals and groups. Creativity enhancing factors have been described as education and training of co-workers in creative skills, changes in organisation structures to create an environment for creativity (e.g., from hierarchical to more flat structures that are increasing communication between co-workers).

The creativity and innovation research we have described above steers the research project towards a system perspective of creativity following Amabile and Csikszentmihalyi.

Research environment studies. A research area partly overlapping with creativity research have considered how research environments and research groups are best organised to be successful. The classical studies in this area, related to productivity and quality in research were done in the 1960's and 1970's by Pelz and Andrews (1966) and Andrews (1979). Also in Sweden researchers have been quite active in this research area, e.g., Stankiewicz (1980), Hemlin (1991; 1993) and Widenberg (1995). In a review of the significance of the research environment for research productivity and quality, Premfors (1986) identified four factors found in the literature: a) steering and organisation, b) size of groups, c) resources and incentives, d) creativity. All of these factors bears a striking resemblance with the factors important for innovations in the former section on creativity research. In an epistemological review of research environments Elzinga (1986) described the following four factors to be considered in research environment studies: a) richness of ideas (bold hypotheses in critical review), b) stability (faithfulness to traditions), c) mediation of research traditions which have problem solving capacity, and d) paradigm supporting environments (paradigm awareness). The common factor in both reviews is creativity in research. A more recent review of the literature from the 1960's to 1990 described twelve characteristics in the research environment for research groups in the natural sciences (Bland & Ruffin, 1992), which is the most comprehensive review found so far. First, there is a need for clear objectives functioning in a co-ordinating way for researchers. Secondly, the research environment must be focused on solely research. Thirdly, there must be a genuine research culture built up during a longer time period. Fourthly, a positive group climate is necessary. Fifthly, it is important that group members are participating in the leadership of the group's research. Sixthly, flat and decentralised organisational structures are most favourable. Seventhly, internal and external communications should be lively and supporting. Eighthly, staff, time, research financing, research equipment and library resources are needed. Ninthly, size, age and differentiating in increasing degrees favourable to productivity. Tenthly, rewards such as money and awards have a favourable effect on productivity. Eleventhly, selection of staff to the research group is important. Twelfthly, it is argued that leadership of the research group is crucial (cf. Stankiewicz, 1980).

Studies referred to above have in general focused on traditional disciplines and departments at universities, but also included some industrial laboratories. A few more recent studies on research environments have been found. The first one, although ten years old, was done by Ben Martin and Jim Skea at SPRU (Martin & Skea, 1992). It largely confirmed the important factors described above, but also came up with a number of important contextual factors such as hiring policy and prestige as important for productivity of research groups. In a recent doctoral thesis in Norway Magnus Gulbrandsen (2000) emphasised that organisational dynamics and tensions are basic to the creative potential in research environments. In other words the peaceful environment in harmony is not the creative one. However, the most recent study we found speaks another language. It was done Bo Jacobsen (2001), who studied research environments by means of a questionnaire to 250 Danish researchers. They were instructed to write down in their own words what they regarded as a good research environment as well as judging on rating scales a number of pre-chosen factors conducive to good research environments. In addition, they rated their own environment. In sum, Jacobsen found that collaboration, locally and internationally, was of utmost importance for the best research environment with the selected group of researchers. It is particularly interesting that there was a strong relationship between the good research environment and a high research productivity, although the relation could not be determined (one could as well interpret this relationship in the way that a high productivity leads to a good environment). Jacobsen draw the conclusion that there were three factors which were important, namely atmosphere, social forms and leadership.

In sum, the research environment studies present a broad and partly inconsistent picture of crucial conditions and mechanisms for achieving creative research. However, it is seldom that we find creativity, research environment and innovation studies from different research traditions summarised and used together as we do. We argue that there is a need for new studies of research and innovative work in the new production of knowledge, in which also private companies and mediating institutions take part.

Macro studies of science, technology and innovations. Macro research on innovations is generally using a system approach on national or regional levels and focusing on industrial sectors (Carlsson, 1997; Edqvist, 1997; see also Sörlin and Törnqvist, 2000). Innovation researchers study interactions between institutional actors (which they call rules) and organisation (which they call players). We who want to study the micro level of innovation do not dismiss such frames, but try to have them in control.

Research about networks between innovative private companies is presently having a great deal of attention (see Meyer-Krahmer, 1997), but more seldom we see studies of the single actors, that is the innovating firm. However, it is evident that they are important. For instance, Ehrnberg and Jacobsson (1997) stressed that organisational routines in private companies must change when technologies change. However, their own study does not much concern the structure of the single organisation and even less how work groups are lead and organised. This is the purpose of this research project.

In a system analysis of innovations Dougherty (1996) concluded that four dichotomies are important to balance for the organisation's innovative process. The first dichotomy deals with the demand of the external world and the functioning of the organisation, which is balanced by the market and technology. The second one is about new production and established structures, in which the balance is achieved by creating an organisation suited for creative problem solving. The third one concerns objectives and new, creative ideas, which are balanced by evaluation and monitoring of production. Finally, the fourth dichotomy is the one between employees' freedom and responsibility. It should be balanced by commitment to innovations, which is argued to be the most difficult by Dougherty. The best way to solve this problem is to select the "best individuals" and create an innovation culture in the organisation. In line with the research environment studies, we see that individuals, goal-steering, innovation culture, evaluation and organisational tensions are emphasised, which imply that research and innovation environments have something in common.

Mode 2 is the phase of research, which it is expected to reach when scientific knowledge is developing into a more contextual endeavour, while Triple helix is the concept denoting institutional changes and effects of the knowledge production (Etzkowitz, 1996; Etzkowitz & Leydesdorff, 1997). In addition, Leydesdorff (1997) has elaborated on the networks and communications aspects of the Triple helix. According to Etzkowitz (1996) the Triple helix encompasses four dimensions. The first one concerns internal transformations that are happening in each helix, e.g. strategic alliances between private companies. The second dimension is signifying the influence that one helix exerts on another, e.g. new laws such as the Bayh-Dole act in the U.S., which changed possibilities of owning scientific knowledge produced by state financed research. The third dimension consists of tri-lateral networks through interaction between the three spirals such as high-tech development in Silicon Valley projects. The fourth dimension entails recursive effects of the new organisations on the original helices and society as a whole. For example science

and knowledge production in general can be changed by the new constellations. And this is the development that Gibbons et al. (1994) foresee concerning a great deal of the university based knowledge production. The relations between the models of the new knowledge production in an epistemological and institutional perspective by Gibbons et al. and Etzkowitz and co-authors is rather strong since Mode2 knowledge production presupposes an increasing integration of political, economical and scientific directions in research practice (Leydesdorff, 1997). There are examples of organisational changes such as offices for technology transfer, incubators and research centres including industrial participants and new established companies, which are spin-offs from the integration between the three sectors (university-industry-government) (Etzkowitz & Leydesdorff, 1997; Klofsten et al., 1999). In Sweden, the research village called IDEON at Lund, where our partner in this project is situated, is an example of an environment for this development.

In sum, we have found that the following factors in the literature influence creative efforts and innovations: individual competencies and characteristics, gender, hiring policies, leadership (in groups, in organisations), quality control, research and work ethics, organisation culture (atmosphere, tensions), formal organising, work group composition (variation in interests, size, ages, experience), motivation and rewards (joy, salary, promotion, career), tasks (united and different goals), communication (internal, external, media), financing and economical support, time (in relation to other tasks such as administration, teaching), equipment, premises (offices, labs, meeting places), institutional base, prestige (group, department, university, company).

Method

Our approach is descriptive and comprises four studies. Three different data types will be collected, namely interview data, rating data and data from case-studies, in order to get a more trustworthy picture of work group creativity factors than by only one type of data. This will also make it possible to compare extracted creativity factors. We will select the most successful, innovative organisations to find out about the crucial creativity factors. This will also demand a selection of controls, that is organisations that are less successful. The selection of organisations will be done on the basis of a number of objective criteria such as patents, citations, publications in prestigious journals, growth and also through peer judgements. In the selection process we will besides contacts via our research partner IDAF also use different registers and indices.

Study 1. Interviews

We will carry out semi-structured interviews about creativity and innovation enhancing social, cognitive and organisational factors during different phases of the innovation process in knowledge intensive sectors (bio-tech and ICT-sectors mainly) in two institutional settings: a) university departments, university centres and consorts (that is public and intermediary environments), b) knowledge companies (private environments). In each category we will select 10-15 work places, 4-5 male and female knowledge workers including the leader at each unit of successful and less successful work places. The interview guide will be thematically constructed according to previous interview and questionnaire studies on good research environments and innovations. However, the main purpose is to get the respondents to generate their own conceptions of creativity factors. After this phase, when respondents more or less have exhausted their own views, we will ask about reactions to specific factors on creativity.

Study 2. Questionnaire with rating scales

Respondents in study 1 will directly after the interview get a questionnaire with proposals of creativity enhancing factors (on Likert scales) to rate their importance for innovation at their workplace. The proposals will be constructed on the basis of previous interview and questionnaire studies about research environments and innovativeness. Statistical analyses (factor analysis, multiple regression) will be carried out to group data, make group comparisons and find out about the predictive power of the factors.

Study 3 and 4. Case studies in bio-tech and ICT- sectors. A successful organisation in each sector will be chosen for deeper analysis. The case studies aim at testing the conclusions drawn in studies 1 and 2, and to deepen, nuance and exemplify the creativity factors, which can lead to innovation. The data collections will be done as field studies of work groups in the organisations (interviews, observations).

Participants

This research project will be carried out by the author of this paper and a doctoral student. We will also have the knowledge broker IDAF as our partner, especially in the data collection phase. A network of researchers at SPRU, University of Sussex, UK, MPP, CBS, Copenhagen, Science Studies Unit at Tampere university, Business School in Göteborg and Stockholm and others.

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