Knowledge worker performance in a cross-industrial perspective

Rainer Erne
Leeds Metropolitan University, UK

ABSTRACT

Knowledge workers in specific professional domains form the fastest increasing workforce in OECD countries. Since this fact has been realised by management researchers, they have focussed on the question of how to measure and enhance the productivity of said workforce.
According to the author's cross-industrial research undertaken in five different knowledge-intensive organisations, it is, however, not productivity in the traditional meaning of the term which is to be regarded as the crucial performance indicator in knowledge work. There rather exist multiple performance indicators, each of which is, moreover, differently graded as to its importance by different stakeholders. These findings, firstly, indicate the need for an alternative definition of productivity when the term is applied to knowledge work. Secondly, they indicate the need for alternative definitions of the specific challenges that might be involved in making knowledge workers productive. Thirdly, they imply different consequences for the management of knowledge workers.
This chapter closes abovementioned research gaps by summarising the indicators employed in five knowledge-intensive organisations from different business sectors for the assessment of knowledge workers' performance, by subsequently deducing the specific challenges involved in the management of knowledge workers and by further delineating consequences for the management of knowledge workers – consequences affecting various 'knowledge-intensive' industries.

1 THE CHALLENGE OF KNOWLEDGE WORKER'S PRODUCTIVITY

One of Peter F. Drucker's great achievements is said to have been his ability to anticipate key management challenges decades in advance (Byrne & Gerdes, 2005). In 1969, he defined one such challenge as follows: "To make knowledge work productive will be the great management task of this century, just as to make manual work productive was the great management task of the last century" (Drucker, 1969, p.290).

In one respect, Drucker was unquestionably right: Nearly all surveys of past decades point to a fundamental structural change in the labour markets of the OECD countries:

- There has been, from 1985 onwards, a 10 percentage-points increase in so-called 'derivative services', e.g. consulting, coaching, teaching, researching, development and management work (Weidig et al., 1999; Dostal & Reinberg, 1999; Dostal, 2001; Reinberg & Hummel, 2002).

- The number of occupations of the categories 'manager', 'professional occupation' as well as 'associate professional' and 'technical occupation' has increased by 10 percentage-points over the last two decades (UK National Statistics, 2000; Baldwin & Beckstead, 2003; Beckstead & Gellatly, 2004; UK National Statistics, 2006; Davenport, 2005; US Department of Labor, 2006; Brinkley, 2006).

- The demand for employees with an academic education has increased by 190 percentage-points between 1975 and 2004, whereas the demand for employees with a lower educational background is continually decreasing (Weidig et al., 1999; Kleinert et al., 2000; Dostal, 2001; Reinberg & Hummel, 2002; Reinberg & Hummel, 2005; OECD, 2006a; OECD, 2006b).

- Levy & Murnane (2006) noted a disproportional increase in the demand for two skill requirements within the US labour force between 1979 and 1999: 'expert thinking' and 'complex communication'. In contrast to this development, they observed that the demand for manual and routine cognitive skills has been continually decreasing within the same time frame (Figure 1).

Figure 1: Economy-Wide Measures of Routine and Non-Routine Task 1969 -1998
(Levy & Murnane, 2006, p.15)

In regard to Drucker's other thesis, i.e. that the productivity of knowledge workers will be the crucial challenge for 21st century management, it can be stated that he initiated an abundance of research in the description, measurement and enhancement of knowledge workers' productivity (Ray & Sahu, 1989; Sumanth, Omachonu & Beruvides, 1990; Drucker, 1991; Sveiby, 1998; Drucker, 1999; Horibe, 1999; Pfiffner & Stadelmann, 1999; Amar, 2002; Davenport et al., 2002; Hauber, 2002; Newell et al., 2002; Paradi et al., 2002; Ahn & Chang, 2004; Balazova, 2004; Herman, 2004; Ramirez & Nembhard, 2004; Davenport, 2005; Hube, 2005; Suff & Reilly, 2005; Malik, 2006; Stam, 2007; North & Gueldenberg, 2008; Dörhöfer, 2010) – a stream of research that does not seem to come to an end, neither in the near nor in the remote future.

This chapter aims at corroborating three theses:

1. Up to now, there is no such thing as a concept of what knowledge workers' productivity implicates, relating to the business practices of knowledge-intensive companies. Different concepts of knowledge worker productivity have been rather developed from certain academic viewpoints than with a view to daily business practices.

2. Consequently, the challenges involved in making knowledge workers productive have not been stated with a view to the business needs of knowledge-intensive companies. Therefore, a revised and more specific problem definition is required with a view to the ‘management challenges of the 21st century’.

3. Both theses root in a lack of empirical research on this matter in general and on a lack of cross-industrial empirical research into knowledge-intensive businesses in particular. The chapter here presented undertakes to close said research gap.

In order to corroborate these three theses, the chapter starts with a brief review of general concepts of knowledge worker productivity (chapter 2). Those concepts are being reviewed and, as a consequence, an alternative research design is being proposed (chapter 3). Chapter 4 exhibits the major outcomes of the research with respect to concepts of knowledge worker productivity from a cross-industrial point of view on the one hand and involved challenges on the other hand (chapter 4). Finally, practical management conclusions for rendering knowledge workers productive will be deduced (chapter 5).

2 CONCEPTS OF KNOWLEDGE WORKER PRODUCTIVITY

It is evident that ‘productivity’ in the traditional meaning of ‘relation between quantity of output in relation to amount of input’ (Gutenberg, 1958; Pedell, 1985) cannot be applied to knowledge work. When summarising the different approaches to knowledge worker productivity, one can distinguish three different concepts which will subsequently be labelled as ‘performance concepts’ (chapter 2.1), ‘authoritative concepts’ (chapter 2.2) and ‘contribution concepts’ (chapter 2.3). These three concepts can be traced back to different academic disciplines: The ‘performance concepts’ originate in research of cognitive psychology into expert performance, the ‘authoritative concepts’ have derived from research into the sociology of professions and the ‘contribution concepts’ stem from approaches to knowledge management (Figure 2).

Figure 2: Classification of knowledge worker productivity concepts

2.1 Performance concepts

The first attempt at grasping knowledge worker productivity is based on the fact that in every domain, there are individuals who are able to continually and repeatably accomplish outstanding results, as compared to average performers. Taking this viewpoint, cognitive psychology has tried to describe and explain this phenomenon, investigating experts and their performance in domains such as jurisdiction, physics, engineering, mathematics, education, finance and consulting (Larkin et al., 1980; Chi et al., 1981; Sweller et al., 1983; Posner, 1988; Krems, 1990; Patel & Groen, 1991; Boshuizen & Schmidt, 1992; Gruber & Ziegler, 1996; Sonnentag, 1996; Hron, 2000; Bredl, 2005; Chi 2006; Feltovich et al., 2006). It was found that experts distinguish themselves from average performers by the way in which

they represent domain-specific problems as well as in the strategies which they apply in solving such problems: They solve domain-specific problems more efficiently, more effectively and more accurately. This cannot be attributed to general intelligence, but to the way in which they group, store and retrieve domain-specific information. This skill is regarded to be a result of 'deliberate practice' in the respective domain over an extended period of time. Since their performance is measured by the amount of time spent on solving a given domain-specific problem and by the quality of the results (in comparison to novices), the two performance measures here applied can be labelled as measures of 'performance' in the traditional meaning.

Both measures have been assimilated and specified in productivity measurement models such as IBM's 'Function Point Analysis' for software development, which tries to measure development productivity by the amount of business functionality that an information system provides to a user (Garmus & Herron, 2000), Ray & Sahu's (1989) 'Operations-Based Productivity Model', which tries to grasp knowledge worker productivity by indices assigned to categories of job characteristica and work places, or Paradis et al.'s (2002) 'Data Envelopment Analysis', which measures knowledge worker productivity according to 'Decision Making Units' (DMUs).

2.2 Authoritative concepts

However, since the efficiency and effectiveness of work are frequently difficult to assess, especially when embedded in a social context, there exists an alternative approach to determining whether knowledge work has been successful. It is a simple indicator at work in the daily operations of an organisation: This indicator becomes explicit when an individual has gained more or less exclusive authority over a certain domain, be it hierarchical or a knowledge domain. For authority over a hierarchical domain, i.e. over a group of people on a broader scale, sociology-of-occupations representatives have coined the term 'professions' (Parsons, 1939; Millerson, 1964, Larson, 1977; Abbott, 1988; Hitzler, 1998; Hesse, 1998; Huber, 1999; Mieg, 2001; Pfadenhauer, 2003a; Pfadenhauer, 2003b). Even though the views of sociologists differ widely with respect to the indicators applied in categorising an occupation as a profession as well as with respect to the reasons offered for the emergence and evolvement of such expert occupations, the tasks ascribed to professionals are viewed as being basically similar by adherents of the psychological perspective: Professional tasks have been defined as 'applying abstract knowledge to particular cases'. The sociological point of view, nevertheless, differs from the psychological one in regard to the features determined which make an expert a professional: not primarily outstanding performance, which would be difficult to observe and measure, but exclusive authority over a particular domain of expertise such as the domain of curing diseases or the domain of jurisdiction. In other words, professionalism can be described as socially institutionalized expertise. In order to maintain this authority on an individual level, the respective professional has to demonstrate expertise (Abbott, 1988; Mieg, 2001; Pfadenhauer, 2003a; Pfadenhauer 2003b).
Therefore, a knowledge worker can also be regarded as being 'productive' if he or she has achieved exclusive authority over a certain domain.

This point of view has been adopted mainly by sociologically inclined management researchers such as Wallace (1995), Blackler (1995), Keuken (1996), Pfadenhauer (2003a, 2003b) and Alvesson (2004), the latter emphasising, above all, the importance of rhetoric management, image and social processes in knowledge-intensive companies.

2.3 Contribution concepts

A third approach to determining knowledge worker productivity focuses less on individual performance, as cognitive psychologists maintain or on the performance of some occupational groups, as propagated by

occupational sociologists, but rather on the contributions an individual or a group make to a certain business.
Since the contribution of knowledge workers does not consist in physical changes resulting from manual work, but in the identification, acquisition, generation, dissemination, application, in the retention and the assessment of knowledge, researchers in knowledge management are looking for approaches in order to identify, acquire, generate, disseminate, apply, detain and assess knowledge in organisations (Nonaka & Takeuchi 1995; North 1999; Willke 2001; Davenport 2005; Hasler Roumois 2007; Probst, Raub & Romhardt 2010).
From this perspective, a knowledge worker's productivity cannot solely be defined by outstanding individual performance or by his attaining an exclusive status. The core of this productivity concept rather lies in the contribution an employee makes to a certain business. This contribution may consist in the acquisition, generation, dissemination, application, retention and / or assessment of knowledge. It is the contribution to an organisation's business that counts, and not the achievements of a single person or a group of persons.

This approach has been adopted by scholars like Sumanth, Omachonu & Beruvides (1990) who proposed a model which adds the 'contribution criterion' to the 'efficiency' and 'effectiveness criteria' of 'white collar worker productivity'. Peter Drucker (1991; 1999) emphasised the importance of regarding knowledge workers as assets, thus enhancing the contribution to an organisation, and Tom Davenport (2005) as well as Pfiffner & Stadelmann (1999) and Francis Horibe (1999) try to distinguish management interventions according to the type of activity a knowledge worker performs, i.e. creating, distributing or applying knowledge.

3 RESEARCH GAPS AND RESEARCH DESIGN

How have above-mentioned concepts been created? In order to answer this question, three types of methodological approaches can be distinguished:

Firstly, purely theoretical approaches, stating general characteristics of 'experts', 'professionals' respectively 'knowledge workers' and corresponding management guidelines on the basis of literature reviewed and of personal experience, however, omitting any systematical empirical foundation (e.g. Horibe, 1999; Pfiffner & Stadelmann, 1999; Davenport, 2005).
Secondly, deductive approaches, testing particular hypotheses in regard of performance, motivation, identification or commitment of engineers, researchers, consultants, physicians or academics in a narrow business segment by usage of quantitative statistical methods and generalising the outcome as attributes of 'experts', 'professionals' resp. 'knowledge workers' on the whole (e.g. Wallace, 1995; Hron, 2000; Baldry et al., 2005).
Thirdly, inductive approaches, generating a theoretical framework for the management of engineers, researchers, consultants, physicians or academics in a narrow business segment by usage of qualitative methods and generalising the outcome as attributes of 'experts', 'professionals' resp. 'knowledge workers' (e.g. Alvesson, 1995; Keuken, 1996; Blackler, 1995).
The first type of studies can be regarded as insufficient in empirical foundation, the last two kinds as too narrow in scope for a generalisation for the management of experts, professionals respectively knowledge workers.
Furthermore, the different disciplines dealing with the same subject matter from different points of view, i.e. cognitive psychology, occupational sociology and knowledge management research, seem not to take much notice of one another (Mieg, 2000).

Hence, despite above-mentioned research results, we still lack certain knowledge on the meaning of knowledge workers' productivity in different industries and on the specific challenges involved in the management of knowledge workers' productivity.

These findings call for a cross-industrial empirical research, aiming at answering two questions:
1. What does ‘performance’ mean with respect to the notion of the knowledge worker?
2. Which challenges are involved in the management of knowledge workers’ performance?

This chapter presents answers to these two questions, based on a cross-industrial empirical research carried out in five different organisations commonly regarded as ‘expert’, ‘professional’ or ‘knowledge-intensive’ organisations in previous treatises (Grossmann, Pellert & Gotwald, 1997; Alvesson, 2004; Davenport, 2005; Brinkley, 2006): a software development company, a hardware development company, a consulting company, a hospital and a university. In these organisations, 42 semi-structured episodic face-to-face interviews (Bortz & Döring, 2003; Lamnek, 2005; Yin, 2009) with experts and their managers from three hierarchical levels were conducted by the author. The data gathered by means of interviews were subsequently coded and interpreted with the aid of Atlas.ti, Version 5.5.4 (Figure 3).

Figure 3: A cross-industrial research design on the productivity of knowledge workers

In order to keep the results comparable, the focus of the study was not on the knowledge worker in general, but on that proportion of knowledge workers termed ‘experts’. Davenport (2005) provides a useful classification for a differentiation between a specific class of experts and knowledge workers in general (Figure 4).

Figure 4: A classification structure for knowledge workers (Davenport, 2005, p.27)

Following his approach, different types of knowledge workers differ in the way in which they transform knowledge into business value: by carrying out routine or complex tasks, by performing individual or collaborative work etc. (Davenport, 2005). The specific contribution of experts to business value consists in their capability of professional discernment, i.e. in applying a comprehensive body of knowledge to individual and rather complex cases. This is the core feature in the work of engineers and consultants as well as of researchers, teachers and physicians.

Owing to confidentiality agreements with all participating organisations the results here presented have been described in an aggregated and abstracted manner. Hence, the original data cannot be disclosed, only referenced.

4 KNOWLEDGE WORKER PRODUCTIVITY REVISED

4.1 Concepts for knowledge worker productivity

Since productivity in its traditional meaning of ‘relation between quantity of output in relation to amount of input’ (Gutenberg, 1958; Pedell, 1985), as other scholars have already noted, does not reflect any possible indicators for an expert’s performance, the question raised by the study and posed to experts as well as to their line managers was: “What is performance in your respective type of expert work?” In this study, only those performance factors are referred to, which have been named by experts and their managers independently. Therefore, it can be concluded that these indicators are shared collectively within the respective organisation, that they may be regarded as collectively motivationally directive and, hence, part of the organisational culture (Sackmann, 1991; Sackmann, 2002).

For the software development company (Erne, 2009a), the predominant performance indicators were:
1.‘Good software’, further specified by terms like ‘correctness’, ‘stability’, ‘maintainability’, ‘expandability’ as well as ‘clarity and transparency of the coding’
2. ‘Planning compliance’, indicated by ‘achievement of milestones’ and ‘correctness of resource estimation’.
3. ‘Quality of interaction’, perceived in the ‘communication and cooperation behaviour’ of the software developers, in an ‘appropriate broaching of topics towards different stakeholders’ as well as in the ‘proactive communication of relevant topics to management representatives’.
4. ‘Innovation behaviour’ with respect to the products and processes of the organisation, measured by ‘patent filings’, ‘integration of existing solutions’, measures ‘to reduce lead times’ and to ‘detect software bugs earlier in the development process’.

5. ‘Personal skill development’, which was basically regarded by management representatives to be the ‘ability to move on to other topics according to business demand’ and ‘development of comprehension for the entire software system’ beyond single functions was a crucial factor for the experts.
6. ‘Compliance with organisational standards’, which includes development processes deployed by the head office - despite criticism from experts as well as line managers - and project-specific agreements.

For the hardware development company (Erne, 2009b) we found a very similar picture:
1. ‘Good hardware quality’, which can be measured by static and dynamic hardware tests, by ‘parts per million (PPM) failure rates in the operational area’ and, moreover, by ‘conformance to specifications’.
2. ‘Planning compliance’, which is represented by the indicators ‘conformance to specifications’, ‘achievement of milestones’, ‘compliance with the planned development budget as well as the product target costs’ and the ‘correctness of resource estimation’ for a development project.
3. ‘Acquisition rate’: Since hardware developers have direct contact to their customers, the increase of hardware projects is viewed as another success factor of an hardware developer’s work.
4. ‘Quality of interaction with the relevant stakeholders’, which refers to ‘communication and cooperation behaviour with all internal interfaces as well as with different customers’, a ‘low escalation rate within the organisation’ and the ‘appropriate broaching of topics towards different stakeholders’.
5. ‘Innovation behaviour’, which is indicated by the development of ‘competitive solutions for the future’ in regard to critical topics, such as ‘power dissipation concepts’ and ‘electromagnetic compatibility’.
6. ‘Personal skill development’, which refers to an ‘enhancement in the appreciation of the whole circuit system’ beyond the particular task as well as to the ‘development of know-how as to specific topics’.
7. ‘Compliance with organisational standards’, which refers to the observance of development processes which control the cooperation of the different specialists in hardware development.

The experts and managers in the consulting company (Erne, 2009c) mentioned:
1. ‘Accepted solutions and working solutions’, which means, above all, ‘functioning systems’ on the customer’s side, secondly, ‘re-usable solutions’ and, thirdly, the number of critical situations’.
2. ‘Number of requests for a certain consultant’, which is indicated, to describe it quite vividly, by “how often the phone rings” when a client tries to reach a certain consultant.
3. ‘Acquisition rate’ in customer projects, which can be measured in turnover achieved by the end of the business year.
4. ‘Quality of interaction with relevant stakeholders’, which is represented by the ‘quality in which a consultant broaches topics within and outside of the organisation’, by ‘one’s visibility within the business sector’, by the ‘creation of an image of being a trusted advisor for the customers’, by the ‘visibility within the organisation and the professional community’ as well as by ‘cooperation and communication with customers and other stakeholders’ in general.
5. ‘Innovation behaviour’, which refers to the ability of the consultants to take up new topics on a yearly basis, like ‘Green IT’ or ‘Service-Oriented Architecture (SOA)’ which, in turn, can be used for public relations activities, customer projects, development projects and acquisition projects.
6. ‘Number of parallel activities’: Any consultant has to handle several activities in parallel, thereby reacting to requirements from within her/his organisation on the one hand and to market demands on the other hand.
7. ‘Personal skill development’ with respect to the acquisition of knowledge required for actual projects at hand as well as to the acquisition of knowledge which is marketable to customers, colleagues and the expert community.
8. ‘Compliance with organisational standards’, which refers to an observance of conformity with common documentation standards, with defined methods as well as with general organisational administrative rules.

The doctors and chief physicians in the hospital (Erne, 2009d) stated the following performance factors:

1. ‘Medical outcome’, which can be measured by clinical indicators, like blood loss, mortality rates, post-operative complication rates on the one hand and by more subjective indicators, like patient condition and patient satisfaction, on the other hand.
2. ‘Compliance with professional and organisational standards’, which affects transparency and tidiness when performing a surgery on the one hand as well as compliance with diagnostic and therapeutic methods proven in use.
3. ‘Quality of interaction’, which relates, again, to the proactive communication of newsworthy issues to the chief physician, and to the target-group related broaching of topics, e.g. the condition of a patient in ward meetings or the description of treatment and its outcomes in discharge letters.
4. ‘Medical skill development’ is regarded as one of the crucial indicators for an individual’s performance and is being ensured by various measures, such as regular trainings and conferences, individual discussion before and after surgery, personal feedback, joint ward rounds and the controlled delegation of responsibilities.
5. ‘Innovation behaviour’, which relates to the institutionalisation of interdisciplinary core areas within the hospital, such as the collaboration between surgeons and internists on certain kinds of cancer treatments, and to the establishment and financing of research activities.

The professors and deans of a university (Erne, 2009e) mentioned the following performance indicators:
1. ‘Quality of research and lectures’, which can be assessed by indicators like ‘internationality and topicality of research projects and lectures’, ‘academic success of students’, the ‘organization of conferences’ as well as the ‘number and rating of papers published’.
2. ‘Acquisition of resources rate’, such as third-party funds or internal budgets for research projects, the number of research positions and, especially, professorships in a faculty or team and the attractiveness of an academic activity for scholars.
3. ‘Quality of interaction with relevant stakeholders’, in this case, the representation of a faculty or research team to other stakeholders, the ability to bring forth convincing arguments for the acquisition of resources as well as the ability to build up supporting networks within the university.
4. ‘Innovation behaviour’, which refers to all activities listed above in order to establish a focal centre of research on a certain topic.

In short: It is neither productivity in the traditional meaning of the term nor one of the different productivity concepts presented in chapter 2 which is regarded to be the key performance factor in the work of experts. Rather, five discrete key factors can be regarded to be the predominant performance indicators for expert work across all investigated business segments. Some of these performance indicators have already been mentioned in previous concepts (e.g. Ray & Sahu, 1989; Drucker, 1999), but never been brought forward as a coherent system based on cross-industrial empirical research.

With respect to the current projects or cases, these performance indicators are (marked in dark grey in Figure 5):
- Quantity and/or quality of daily work results, which differ widely between the different business segments.
- Quality of interaction, which relates to cooperation and communication with different stakeholders, to the quality of representation of specific topics within the respective organisation as well as to varying target groups and the way in which competence and professionalism towards different stakeholder groups are being displayed.
- Compliance with work standards, which can - depending on the individual organisation - be either of a professional kind (and, then, relating to professional methods) or of an organisational nature (and, then, relating to administrative standards).

With regard to future developments, the named indicators are (marked in light grey in Figure 4):

- Innovation behaviour with respect to business or professional improvements, which is of varying importance to different individuals and in differing business segments, but has always been named as an important indicator together with the quality of day-to-day work.
- Skill development with respect to either the depths of skills, to the ability to arrive at an overview over a particular topic or to the adaptation of skills to new market demands.

Figure 5: Performance indicators for experts in different business segments

4.2 Challenges in rendering knowledge workers productive

While performance indicators for experts are widely shared across different business segments - apart from a few exceptions not treated here in depth –, differences with respect to the specific challenges faced when attempting to enhance performance in experts within and between organisations can be observed.

The differences observed can be roughly clustered into two strategy categories labelled as 'black box management', on the one hand, and 'white box management', on the other.

The 'black box management' strategy has been followed in all organisations studied. This strategy is best described by the original words of above-mentioned managers themselves:
In the software development company, between software developers and their department heads, *'You have to take care that you do not enter the space of these techies'* (Erne, 2009a, 115). *'Don't interfere'* (Erne, 2009a, 103).
At least partly in the hardware development organisation, between hardware developers and their line managers, *'As a manager I am not the best expert. I think, once, in the past, in this company, there existed the approach that the manager has to be the best hardware developer. Today, this is fortunately no longer required. Moreover, it would no longer be achievable'* (Erne, 2009b, 69).
In the consulting company, between consultants and their line managers, *'What we have here, in this organisation, are nothing but prima donnae. Don't tell them'* (Erne, 2009c, 93).
In the hospital, between the administrative director and the physicians, *'As an administration manager I have a decisional authority. .. But this is a theoretical authority. .. Since, if I issued a directive here, .. every department would demonstrate to me that it does not work this way'* (Erne, 2009d, 90).
In the university, between the deans and the professors in their department, *'A dean can govern a faculty* […] *with respect to budget topics. He is less able to take influence in issues of research or contents of research'* (Erne, 2009d, 55).

To sum up, in this system, there exists a sphere of professional work, on the one hand, and a sphere of business work, on the other hand, with some overlaps in the area of the definition and prioritisation of topics (not objectives) and in the sphere of performance appraisal. A system a consultant called 'governance' in contrast to 'management' (Erne, 2009c, 63).

The 'white box management' strategy was also identified in all organisations studied:
In the software development company, between software developers and their team leaders, *'The technical team leaders are responsible for controlling the code. .. A few people are reviewing the code, are reviewing the code together. Then, the code is checked with respect to maintainability'* (Erne, 2009a, 101).
In the hardware development organisation, between hardware developers and their group and team managers, *'That is what we expect from a manager, that when he is in a technical business that he does not simply act on an abstract level, but that he has a bit more comprehension of it. Otherwise, he is unable to assess if .. he has been told the truth or if things are going out of track since he cannot assess these things by himself. And that would be bad'* (Erne, 2009b, 93).
In the consulting company, between first-level certified consultants and their second-level certified colleagues as well as their stakeholders in the project, *'[…] Yes, as I worked together with a second-level certified colleague, this colleagues has just defined what meetings we are going to schedule together with the customer and what we want to achieve in each meeting. .. By structuring it this way, it turns out: Okay, what do we have to do in between in order to be well prepared for the next meeting.' (Erne, 2009c, 71) '[…] Important is also the feedback I get from, from the associates working in the same project, i.e. not from the consultant himself, but from the others /ehm/ .. colleagues from sales, in the first place'* (Erne, 2009c, 37).
In the hospital, between chief physicians and the doctors as well as the scientific community, *'I always tell my physicians: .. If I observe that one of you becomes sleazy, for example, in stitching up or anything else, .. I will tell them: Please take care that you do it properly. .. Since, if we do not do it properly, then our trainees do not see any necessity to do it properly either'* (Erne, 2009d, 93). *'Since, today, the tumor treatment is no longer unilateral, that means not only a matter of surgery or radiation therapy or internists, but rather an interplay of these three disciplines* […], *we regularly hold an interdisciplinary meeting on every case. In this meeting, the therapeutical path is being defined by consensus. Certainly, there are different opinions from time to time. Therefore, you have to take care to define it by consensus'* (Erne, 2009d, 77).
In the university, between professors and research assistants as well as the scientific community, *'I told my employee, the first I had hired, I told him: Okay, we are going to do a journal paper together. I have here the preliminary version which I have done. /Eh/ Make something of it.* […] *Then, we tried, in joint discussions, to make a journal paper. We were lucky that the first one was accepted. /Eh/ For him, this meant a great success. /Eh/ In the first place, for my employee, since he learned what you have to do here: How do I quote properly? How can I define a problem accurately? What are the objectives of my paper?'* (Erne, 2009e, 25). *'I want to experience the success. I think, when I do work in the field of differential equations, when I go to a conference, then I want, when I go to this conference, I want to deliver a great presentation for which I get the feedback: That is great what this guy has done. You see, that is, we want to play in the first league and be competitive on a global scale'* (Erne, 2009e, 33).

Dependent on the strategy employed in order to manage experts, the 'black box management' strategy as well as the 'white box management' strategy are confronted with some challenges which they have in common while two challenges are specific to the 'black box management' strategy. The common challenges are depicted in dark grey boxes in Figure 5 while the challenges which have been named independently of the management strategy are displayed in the light grey boxes (Figure 6).

Figure 6: Challenges in rendering experts productive

a. Assessment of expert performance

The first challenge which is typical for the 'black box management' strategy is the difficulty to assess expert performance: In contrast to manual work in which a physical result can be 'touched', compared and measured, it seems difficult to pin down the performance of experts for associates who do not belong to the professional sphere. In this respect, the statement of a business unit head from the software development organisation can be viewed as being paradigmatic for all other statements, *'We try to make the performance of our associates measurable.* […] *But we are not in a timbering, we are in a high-technology business segment.* […] *Therefore, we have to use auxiliary indicators'* (Erne, 2009c, 53). These auxiliary indicators are, *'positive feedback by two customers, 'peer recognition, .. which refers to the level of recognition a developer obtains from his team colleagues .., managers, team members'* (Erne, 2009a, 49-53). In other words: For the qualitative part, the scope of performance indicators assessed by the supervisors comprises: quality of interaction, especially a convincing and visible representation of competence and performance to important stakeholders (Pfadenhauer, 2003a; 2003b), visible activities in the field of product and process innovations, and compliance with organisational standards. This observation clarifies why especially these performance indicators are applied by managers of the 'black box management' system, i.e. the line managers of the software and consulting company, the administrative director of the hospital as well as the deans of the university faculties. The following reasons for the challenge of assessing experts' performance have been named: the number of possible indicators, as presented in the previous chapter, the number of independent variables which influence the result of a surgery, of a development result, of a conference or a customer decision, the long time frame during which feedback is available on the results of an expert's action in development or medical work, and the physical and/or intellectual distance a 'black box manager' has to the professional sphere.

b. Autonomy of experts

Strongly linked with the difficulty of assessing the performance of experts adequately is the challenge of governing highly autonomous experts. This autonomy can equally be observed in the 'black box management' system where the software developers, consultants, hardware developers, physicians and professors form a kind of an enclosed group in a professional sphere which is clearly distinct from the sphere of administration. This has been clearly stated by a faculty dean, a statement which can be viewed as being exemplary for all other cases, 'In a nutshell, our lecturers are pure 'sole member companies'. ..

They perceive me as an administrator. That means, if they need anything, they prefer to come to me, but apart from this case, they want to be left alone. In this perspective, they are a pure *'sole member company' without liability, certainly. A small company, but without liabiliy'* (Erne, 2009e, 59). This mainly applies to the case when administrative tasks are to be performed by experts, as reported by the administrative director of the hospital (Erne, 2009d), the managers of the software company (Erne, 2009a) and the consultants in the consultancy company (Erne, 2009c). As reasons for this challenge, a lack of incentive measures in some organisations (such as the university), the dependency of 'black box managers' on the commitment, cooperation and communication of their experts in order to achieve results and the role behaviour of experts as experts in knowledge-intensive businesses were mentioned.

c. Skill development in experts

The skill development of experts has been perceived as a third challenge imposed on the management of experts. This challenge has been broached in three different directions: From the strategic point of view of the department heads, the main challenge is the direction in which the skills of their experts should be developed according to business strategy. The central challenge in the management of experts is, as the department head of the consulting company stated, *'that we recognise in time where the train is heading to and /eh/ that we, consequently, take the right measures in order to guide the associates to the right direction with respect to /eh/ behaviour and mindset as well as skills and technologies. That is /eh/ the biggest challenge'* (Erne, 2009c, 133). Another perspective is being taken by the department heads following the ‚black box management' strategy: Here, the focus is clearly on the development of 'soft skills' such as self-presentation and communication, especially for engineers showing a certain degree of 'autism', as was stated by Guenther Dueck (2007) and referred to by some software managers and engineers (Erne, 2009a). A third way in which the skill development of experts has been approached is the formation of professional skills, especially true for 'white box management' systems. In these systems, quality assurance of professional work as well as enhancement of productivity seems to be dependent on one variable: the professional skill of the expert. Hence, everything is focussed on the formation of these skills. In hospital work, for example, this is done by direct instructions, ward rounds, conferences, case studies, coaching, feedback and regular on the job training (Erne, 2009d). Therefore, the challenge of skill development is being viewed differently, but in every perspective as being a crucial one.

d. Motivation of experts

As a fourth challenge, the interviewees in the different business segments have named the motivation of experts. Similar to skill development, the challenge to motivate experts is elicited by different reasons. A first reason is to retain 'valuable assets' into which extensive endeavours in education have been invested, as especially the software managers, hardware managers and physicians stated (Erne 2009a; Erne 2009b; Erne 2009d), *'I have recently lost my three best surgeons, .. they have been trained to the highest standard, all of them have done more than five thousand surgeries, .. they went to a private clinic. .. Three surgeons. For twelve years, they have been trained here. .. And endowed with five thousand surgeries, and many, many congresses, .. they simply left'* (Erne, 2009d, 267). A second perspective on the motivation topic is the motivation for the accomplishment of specific tasks such as the acquisition of another consultancy project by the end of a year, *'Here we have alternative .. governance measures with respect to remuneration. We are on an, .. on an incentive plan. That means, seventy percentage of our, our .. income is fixed, the rest is variable. In this variable segment, I can identify, selectively, .. small challenges. That are challenges .. I say: Man, .. give it all. If we get that opportunity in the third quarter, then that will make .. a thousand Euros extra for you' (Erne, 2009c, 061)*. In contrast to the thesis that payment does not motivate knowledge workers (North & Gueldenberg, 2008), payment for specific tasks is being regarded as being a very effective instrument in motivating experts to undertake specific efforts (Erne, 2009c). A lack of incentives is also being viewed by the deans and professors of the university as one reason why it is so difficult in this organisation to motivate highly autonomous lecturers (Erne, 2009e). Another important factor in keeping experts motivated is the job content, the opportunity of skill

development and a sound balance between regulations and autonomy – a balance, however, which could not really be specified in detail by anybody.

e. Time management for experts

The fifth specific challenge for rendering experts productive has been named completely independently of the management strategy and the business segment: the aligning of the tasks which an expert has to accomplish with the time disposable. This challenge had been already found by Peter Drucker who emphasised the necessity to organize one's own job, in contrast to the Tayloristic system in which the job organises the employee (Drucker, 1999). The findings of the study, however, do not bring to light many improvements on the individual, team or organisational level. Therefore, one of the main challenges the software engineers perceived was, that, when *'different tasks have to be done at the same time .. /ehm/ .. generating the right ideas on what has to be done in the first place'* (Erne, 2009a, 071). For the hardware developers the biggest challenges are *'the moving targets. Not only internal targets, but the targets which come from outside and punch through everything'* (Erne, 2009b, 047). Similarly, consultants *'permanently work in several streams in parallel. It is not the case that they are faced with one task which they accomplish and, then, they get the next task. But this company, unfortunately, works in the way that unbelievably many work streams are scattered over the day, the week or the month'* (Erne, 2009c, 059). The same is stated by the physicians, *'What imposes the greatest stress on me .. is the acute day ward, since it is permanently crowded. When I want to go and make the ward round, .. you do not get away from it. Yet, I have my plan. When I am on duty, I want to start the ward round at 3 p.m. or 3:30 p.m., in this timeframe, .. that means to look after the in-patients. But this heteronomously directed work, it, it .. annoys me'* (Erne, 2009d, 095). And, finally, the university professors, *'I believe, .. the challenge is to organise one's week in a way not to be diverted by all the different topics'* (Erne, 2009e, 105). Hence, the term 'time management' comprises a couple of different, yet strongly linked challenges: the workload in general and the administrative workload in particular, the parallelity of many topics, multiple stakeholders, task switching and the amount and correctness of input information. With respect to these topics, the perception of the interviewees is that these issues have to be solved on an individual level, not on a team or organisational level.

With the outline of the performance indicators and the challenges named by managers and experts in different business segments and presented in this chapter a scope definition can be outlined of how to enhance productiveness in knowledge workers which goes beyond the scope definition proposed to this day.

5 IMPLICATIONS FOR MANAGING EXPERT PERFORMANCE

The main topics which require further research on the question of how to render experts productive are, according to the study in different business segments here presented, the following:

a. Define clear performance indicators for expert work

The study showed clearly that performance indicators for expert work as well as for the stakeholders who are assessing these indicators are multiple and ambiguous. Management systems such as management by objectives, which are in place in all organisations studied, do not solve the problem, but rather exacerbate it. Therefore, the first strategy for rendering experts productive is to establish few, clear, business-specific performance indicators which do not necessarily have to be measured, but which can be assessed according to defined indicators. This practice was followed in the 'white box management' systems, especially in hospital work, *'[With respect to the performance indicators] there is no doubt for me: .. There are two indicators: the first is the medical assessment of the output. This can be measured by objective parameters.* […] *The second one is, of course,* […] *the subjective appraisal by the patient if he is content with the performance'* (Erne, 2009d, 47-51).

b. Establish knowledge symmetry

In the black box management systems, it became very clear that a stakeholder like a line manager only can gain influence on the performance of experts if he or she is able to compensate for the knowledge asymmetry on a professional level. As the department head of the consulatants stated, *‚I have one advantage over the consultants: I work /ehm/ .. /ehm/ on a higher level and know, know some specific details in different, .. different knowledge areas, which they do not know. Yet, they would like to know these details very much, especially if they are related to political discussions. And they use this'* (Erne, 2009c, 121). In this way or in other ways, a line manager has to provide value-adding knowledge or service to the experts, which makes the relationship between the two interdependent and symmetrical. Otherwise, it is nearly impossible to gain influence on an expert's work.

c. Develop strategies and measures for skill development

The importance which has been assigned to strategic and operative skill development in nearly all organisations studied is in contrast to actual strategies and measures in place. Most interviewees named personal preferences for a skill development, but did so rather randomly and focussed on professional skills in the 'white box management' system. Since the quality and performance of expert work are strongly linked to individual skills – much more so than in manual work -, there have to be additional and new ideas of how to integrate skill development into day-to-day work. In the technical spheres of hardware development, one can find good examples for corresponding measures, *'For this reason I have .. agreed in my team meetings, that we, /ehm/ .. that they, the associates who have all their specific knowledge domain, .. report regularly what they do at the moment, which technical approaches they follow,* […] *so that they arrive at an understanding of the whole system and not only on that of their own [module]'* (Erne, 2009b, 037). The examples in hospital work have already been depicted in the previous chapter.

d. Find appropriate measures for the motivation of experts

As the results of the study have shown, the topic of motivation as well as the measures to produce and enhance motivation have to be assessed differently: There is a general task of retaining experts, as Drucker (2009, p.142) stated, as 'assets'. This is being viewed by experts and managers as an issue of payment, balance of regulations and autonomy, work content and the opportunity to learn. In other words: It is a topic of remuneration and job design, and in contrast to the statements in a broad corpus of literature which only focuses on the last two parameters. A second topic is the motivation for certain tasks by incentives. Here the incentives have not been defined apart from financial ones. In university work professors and deans heavily focussed on another incentive, *'the possibility to gain reputation'* (Erne, 2009d, 61). The different kinds of incentives and their effectivity on different kinds of experts have not been fully explored.

e. Keep experts focussed

As stated by all interviewees in all business segments, the most common challenge for rendering experts productive is an appropriate handling of the workload in general and the administrative workload in particular as well as multitasking, task switching and, equally, a proper information handling. Since the effects of these working modes have been well explored, it can be viewed as one of the great risks to the productivity of experts, approximately accounting for a 20% to 40% loss in productivity (Rubinstein, Meyer & Evans 2001; Monsell 2003; Spira & Feintuch 2005). Furthermore, it may not be solely solved on an individual level by finding an appropriate personal working mode, as the interviewees have perceived. Since it is a common feature across all business segments, which results, according to the interviewees, in a bulk of uncontrolled tasks building up, one of the management challenges will be to find ways to reduce these 'task cascades', to design jobs and to assign tasks in a way in which all challenges can be addressed: focussing expert work, motivating it, making skill development in the workplace possible, creating a balance between regulations and autonomy and, thus, making expert

performance assessable. According to our study, these are the tasks for rendering experts productive. Tasks which have to be accomplished yet.

REFERENCES

Abbott, A. (1988). *The system of professions: an essay on the division of expert labor*. Chicago, IL: University of Chicago Press.

Ahn, J.H., & Chang, S.G. (2004). Assessing the contribution of knowledge to business performance: the KP3 methodology. *Decision Support System*s, 36 (4), 403-416.

Alvesson, M. (1995). *Management of knowledge intensive companies*. Berlin: De Gruyter.

Alvesson, M. (2004). *Knowledge work and knowledge-intensive firms*. Oxford: University Press.

Amar, A.D. (2002). *Managing knowledge workers: unleashing innovation and productivity*. Westport, WA: Quorum.

Balazova, M. (2004). *Methode zur Leistungsbewertung und Leistungssteigerung in der Mechatronikentwicklung*. Unveröffentlichte Dissertation, Universität Paderborn.

Baldry, C. et al. (2005). *Knowledge workers, commitment and occupational community*. Paper presented at the International Labour Process Conference 2005, Glasgow.

Baldwin, J.R., & Beckstead, D. (2003). *Knowledge workers in Canada's economy, 1971-2001*. Statistics Canada Analytical Paper. Ottawa: Statistics Canada.

Beckstead, D., & Gellatly, G. (2004). *Are Knowledge Workers found only in high-technology industries?* Statistics Canada Analytical Paper. Ottawa: Statistics Canada.

Blackler, F. (1995). Knowledge, knowledge work and organizations: an overview and interpretation. *Organisation Studies, 16* (6), 1021-1046.

Bortz, J, & Döring, N. (2003). *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler*. 3. überarb. Aufl. Berlin: Springer.

Boshuizen, H.P.A., & Schmidt, H.G. (1992). On the role of biomedical knowledge in clinical reasoning by experts, intermediates and novices. *Cognitive Science, 16*, 153-184.

Bredl, K. (2005). *Kompetenz von Beratern: Analyse des Kompetenzerwerbs bei Unternehmensberatern im Kontext der Expertiseforschung*. Unveröffentlichte Dissertation, Universität Regensburg.

Brinkley, I. (2006). *Defining the knowledge economy: knowledge economy programme report*. Research Paper. London: The Work Foundation.

Byrne, J.A., & Gerdes, L. (2005). The man who invented management: why Peter Drucker's ideas still matter. *Businessweek* [Internet], November 28, 2005. Retrieved 13 October, 2009, from http://www.businessweek.com/magazine/content/05_48/b3961001.htm.

Chi, M.T.H (2006). Two approaches to the study of experts' characteristics. In K.A. Ericsson, et al. (eds.), *The Cambridge handbook of expertise and expert performance* (pp. 24-27). Cambridge, MA: University Press.

Chi, M.T.H., et al. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121-152.

Davenport, T.H. (2005). *Thinking for a living: how to get better performance and results from knowledge workers*. Boston, MA: Harvard Business School Press.

Davenport, T.H., Thomas, R.J., & Cantrell, S. (2002). The mysterious art and science of knowledge-worker performance. *Sloan Management Review, 44* (1), 23-30.

Dörhöfer, S. (2010). *Management und Organisation von Wissensarbeit: Strategie, Arbeitssystem und organisationale Praktiken in wissensbasierten Unternehmen*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Dostal, W. (2001). *Neue Herausforderungen an Qualifikation und Weiterbildung im Zeitalter der Globalisierung*. Berlin: Deutscher Bundestag.

Dostal, W., & Reinberg, A. (1999). *Arbeitslandschaft 2010. Teil 2: Ungebrochener Trend in die Wissensgesellschaft*. IAB-Kurzbericht, Nr.10. Nürnberg: Institut für Arbeitsmarkt- und Berufsforschung.

Drucker, P.F. (1969). *The age of discontinuity: guidelines to our changing society*. New York, NY: Harper & Row.

Drucker, P.F. (1991). The new productivity challenge. *Harvard Business Review, 69* (6), 69-79.

Drucker, P.F. (1999). *Management challenges for the 21st century*. New York, NY: Harper.

Dueck, G. (2007). *Dueck's Panopticon: Gesammelte Kultkolumnen*. Berlin, Springer.

Erne, R. (2009a). *Interview Transcripts F&E_SW: Data Analysis in Atlas.ti V.5.6.3*. Unpublished Manuscript, Stuttgart.

Erne, R. (2009b). *Interview Transcripts F&E_PE: Data Analysis in Atlas.ti V.5.6.3.* Unpublished Manuscript, Stuttgart.

Erne, R. (2009c). *Interview Transcripts Consulting. Data Analysis in Atlas.ti V.5.6.3.* Unpublished Manuscript. Stuttgart.

Erne, R. (2009d). *Interview Transcripts Medizinische Versorgung KH: Data Analysis in Atlas.ti V.5.6.3.* Unpublished Manuscript, Stuttgart.

Erne, R. (2009e). *Interview Transcripts Forschung & Lehre Univ.: Data Analysis in Atlas.ti V.5.6.3.* Unpublished Manuscript, Stuttgart.

Feltovich, P.J., et al. (2006). Studies of expertise from psychological perspectives. In K.A. Ericsson, et al. (eds.), *The Cambridge handbook of expertise and expert performance* (pp. 41-67). Cambridge, MA: University Press.

Garmus, D., & Herron, D. (2000). *Function Point Analysis: measurement practices for successful software projects*. Upper Saddle River, NJ: Addison-Weslay.

Grossmann, R., Pellert, A., & Gotwald, V. (1997). Krankenhaus, Schule, Universität: Charakteristika und Optimierungspotentiale. In R. Grossmann, R. (Hrsg.), *Besser Billiger Mehr: Zur Reform der Expertenorganisation Krankenhaus, Schule, Universität* (S.24-35). Wien: Springer.

Gruber, H., & Ziegler, A. (1996). Expertise als Domäne psychologischer Forschung. In H. Gruber & A. Ziegler (Hrsg.), *Expertiseforschung: Theoretische und methodische Grundlagen* (S. 7-16). Opladen: Westdeutscher Verlag.

Gutenberg, E. (1958). *Einführung in die Betriebswirtschaftslehre*. Wiesbaden: Gabler.

Hasler Roumois, U. (2007). *Studienbuch Wissensmanagement: Grundlagen der Wissensarbeit in Wirtschafts-, Non- Profit- und Public- Organisationen*. Zürich: Orell-Füssli.

Hauber, R. (2002). *Performance Measurement in der Forschung und Entwicklung: Konzeption und Methodik*. Wiesbaden: Deutscher Universitäts Verlag.

Herman, S. (2004). Produktive Wissensarbeit: Eine Herausforderung. In S. Hermann (Hrsg.) *Ressourcen strategisch nutzen: Wissen als Basis für den Dienstleistungserfolg* (S.207-228). Stuttgart: Fraunhofer IRB-Verlag.

Hesse, H.-A. (1998). *Experte, Laie, Dilettant : Über Nutzen und Grenzen von Fachwissen*. Opladen: Westdeutscher Verlag.

Hitzler, R. (1998). Reflexive Kompetenz: Zur Genese und Bedeutung von Expertenwissen jenseits des Professionalismus. In W.K. Schulz (Hrsg.), *Expertenwissen: Soziologische, psychologische und pädagogische Perspektiven* (S. 33-47). Opladen: Leske + Budrich.

Horibe, F. (1999). *Managing knowledge workers: new skills and attitudes to unlock the intellectual capital in your organization*. Toronto: John Wiley.

Hron, J. (2000). *Motivationale Aspekte von beruflicher Expertise: Welche Ziele und Motive spornen Experten im Rahmen ihrer Arbeit an?* München: Utz.

Hube, G. (2005). *Beitrag zur Beschreibung und Analyse von Wissensarbeit*. Unveröffentlichte Dissertation, Universität Stuttgart.

Huber, B. (1999). *Experts in organizations: the power of expertise*. In Academy of Business & Administrative Sciences (ed.), Globalization and Emerging Economies: International Conference Proceedings. July 12-14, 1999, Barcelona, Spain. Retrieved December 12, 2009, from http://www.sba.muohio.edu/abas/1999/huberbe.pdf.

Keuken, F. W. (1996). *Management von Akademikerorganisationen*. Hamburg: Kovac.

Kleinert, J. et al. (2000). *Globalisierung, Strukturwandel und Beschäftigung*. Tübingen: Mohr Siebeck.

Krems, J. (1990). *Zur Psychologie der Expertenschaft*. Unveröffentlichte Habilitation, Universität Regensburg.

Lamnek, S. (2005). *Qualitative Sozialforschung: Lehrbuch*. 4. vollst. überarb. Aufl. Weinheim: Beltz.

Larkin, J.H. et al. (1980). Expert and novice performance in solving physics problems. *Science, 208*, 1335-1342.

Larson, M.S. (1977). *The rise of professionalism: a sociological analysis*. Berkeley, CA: University of California Press.

Levy, F., & Murnane, R.J. (2006). How computerized work and globalization shape human skill demands. *MIT IPC Working Paper, 05-006*. Retrieved January 09, 2007, from http://web.mit.edu/ipc/publications/ pdf/05-006.pdf.

Malik, F. (2006). *Führen, leisten, leben: Wirksames Management für eine neue Zeit*. Komplett überarb. Neuaufl. Frankfurt: Campus.

Mieg, H.A. (2000). Vom ziemlichen Unvermögen der Psychologie, das Tun der Experten zu begreifen: Ein Plädoyer für Professionalisierung als psychologische Kategorie und einen interaktionsorientierten Expertenbegriff. In: R.K. Silbereisen, & M. Reitzlem (Hrsg.), *Bericht über den 42. Kongress der Deutschen Gesellschaft für Psychologie 2000* (S. 635-648). Lengerich: Pabst.

Mieg, H.A. (2001). *The social psychology of expertise: case studies in research, professional domains, and expert roles*. Mahwah, NJ: Lawrence Erlbaum.

Millerson, G. (1964). *The qualifying associations: a study in professionalization*. London: Routledge & Kegan Paul.

Monsell, S. (2003). Task Switching. *Trends in Cognitive Sciences, 7* (3), 134-140.

Newell, S. et al. (2002). *Managing knowledge work*. Houndmills: Palgrave Macmillan.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company: how Japanese companies create the dynamics of innovation*. New York, NY: Oxford University Press.

North, K. (1999). *Wissensorientierte Unternehmensführung: Wertschöpfung durch Wissen*. 2. Aufl. Wiesbaden: Gabler.

North, K., & Gueldenberg, S. (2008). *Produktive Wissensarbeit(er): Antworten auf die Management-Herausforderung des 21. Jahrhunderts*. Wiesbaden: Gabler.

OECD (2006a). *OECD employment outlook. 2006 edition: boosting jobs and incomes*. Paris: Organisation for Economic Co-operation and Development.

OECD (2006b). *Education at a glance. OECD indicators 2006. Indicator A8: labour force participation by level of educational attainment*. Paris, Organisation for Economic Co-operation and Development. Retrieved January 07, 2007, from http://www.oecd.org/document/6/ 0,2340,en_2649_34515_37344774_1_1_1_1,00.

Paradi, J.C., Smith, S., & Schaffnit-Chatterjee, C. (2002). Knowledge worker performance analysis using DEA: an application to engineering design teams at Bell Canada. *IEEE Transactions on Engineering Management, 49* (2), 161.

Parsons, T. (1939). The professions and social structure. *Social Forces, 17* (4), 457-467.

Patel, V.L., & Groen, G.J. (1991). The general and specific nature of medical expertise: a critical look. In: K.A. Ericsson, & J. Smith (eds.), *Towards a general theory of expertise: prospects and limits* (pp. 93-125). Cambridge, MA: University Press.

Pedell, K.L. (1985). Analyse und Planung von Produktivitätsveränderungen. *Zeitschrift für betriebswirtschaftliche Forschung, 37* (12), 1078-1097.

Pfadenhauer, M. (2003a). *Professionalität: Eine wissenssoziologische Rekonstruktion institutionalisierter Kompetenzdarstellungskompetenz*. Opladen: Leske & Budrich.

Pfadenhauer, M. (2003b). Macht – Funktion – Leistung: Zur Korrespondenz von Eliten und Professionstheorien. In H.A. Mieg & M. Pfadenhauer (Hrsg.), *Professionelle Leistung – Professional Performance: Positionen der Professionssoziologie* (S. 71-87). Konstanz: UVK.

Pfiffner, M., & Stadelmann, P. (1999). *Wissen wirksam machen: Wie Kopfarbeiter produktiv werden*. 2. unveränd. Aufl. Bern: Haupt.

Posner, M.I. (1988). Introduction: What is it to be an expert? In M.T.H. Chi, R. Glaser, & M.J. Rees (eds.) *The nature of expertise* (pp. XXIX-XXXVI). Hillsdale, NJ: Erlbaum.

Probst, G., Raub, S., & Romhardt, K. (2010). *Wissen managen: Wie Unternehmen ihre wertvollste Ressource optimal nutzen*. 6. überarb. u. erw. Aufl. Wiesbaden: Gabler.

Ramirez, Y.W., & Nembhard, D.A. (2004). Measuring knowledge worker productivity: a taxonomy. *Journal of Intellectual Capital, 5* (4), 602-628.

Ray, P.K., & Sahu, S. (1989). The measurement and evaluation of white-collar productivity. *International Journal of Operation & Production Management, 9* (4), 28-48.

Reinberg, A., & Hummel, M. (2002). Zur langfristigen Entwicklung des qualifikationsspezifischen Arbeitskräfteangebots und –bedarfs in Deutschland: Empirische Befunde und aktuelle Projektionsergebnisse. *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung, 35* (4), 580-600.

Reinberg, A., & Hummel, M. (2005). *Höhere Bildung schützt auch in der Krise vor Arbeitslosigkeit*. IAB-Kurzbericht Nr.9. Nürnberg: Institut für Arbeitsmarkt- und Berufsforschung.

Rubinstein, J.S., Meyer, D.E., & Evans, J.E. (2001). Executive Control of Cognitive Processes in Task Switching. *Journal of Experimental Psychology, Human Perception and Performance, 27* (4), 763-797.

Sackmann, S.A. (1991). *Cultural knowledge in organizations: exploring the collective mind*. Newsbury Park, CA: Sage.

Sackmann, S.A. (2002). *Unternehmenskultur: Erkennen – Entwickeln – Verändern*. Neuwied: Luchterhand.

Sonnentag S. (1996). *Experten in der Software-Entwicklung: Untersuchung hervorragender Leistungen im Kontext intellektueller Teamarbeit*. Unveröffentliche Habilitation, Universität Gießen.

Spira, J.B., & Feintuch, J.B. (2005). *The cost of not paying attention: how interruption impacts knowledge worker productivity*. New York, NY: Basex.

Stam, C. (2007). *Knowledge productivity: designing and testing a method to diagnose knowledge productivity and plan for enhancement*. Unpublished Ph.D. thesis, Universiteit Twente.

Suff, P., & Reilly, P. (2005). *In the know: reward and performance management of knowledge workers*. HR Network Paper, MP47. Brighton, Institute for Employment Studies.

Sumanth, D.J., Omachonu, V.K., & Beruvides, M. G. (1990). A review of the state-of-the-art research on white collar / knowledge-worker productivity. *International Journal of Technology Management, 5* (3), 337-355.

Sveiby, K.E. (1998). *Wissenskapital – das unentdeckte Vermögen: Immaterielle Unternehmenswerte aufspüren, messen und steigern*. Landsberg: Moderne Industrie.

Sweller, J., et al. (1983). Development of expertise in mathematical problem solving. *Journal of Experimental Psychology, General 112*, 639-661.

UK National Statistics (2000). *Standard occupational classification 2000 (SOC 2000): Summary of Structure*. London, UK National Statistics. Retrieved January 09, 2007, from www.statistics.gov.uk/methods_quality/ns_sec/downloads/ SOC2000.doc.

UK National Statistics (2006). *All in employment by socio-economic classification (NS-SEC) (Not seasonally adjusted*. London, UK National Statistics. Retrieved August 20, 2008, from http://www.statistics.gov.uk/STATBASE/ ssdataset.asp?vlnk=7919.

US Department of Labor (2006). *Occupational outlook handbook*. Washington, Bureau of Labor. Retrieved January 09, 2007, from http://www.bls.gov/ oco/home.htm.

Wallace, J.E. (1995). Organizational and professional commitment in professional and nonprofessional organizations. *Administrative Science Quarterly, 40* (2), 228 - 255.

Weidig, I. et al. (1999). *Arbeitslandschaft 2010 nach Tätigkeiten und Tätigkeitsniveau*. Beiträge zur Arbeitsmarkt- und Berufsforschung, Nr. 227. Nürnberg: Institut für Arbeitsmarkt- und Berufsforschung.

Willke, H. (2001). *Systemisches Wissensmanagement*. 2. neu bearb. Aufl. Stuttgart: UTB.

Yin, R.K. (2009). *Case study research: design and methods*. 4th ed. Thousand Oakes, CA: Sage.

ADDITIONAL READING SECTION

Antikainen, R., & Lönnqvist, A. (2005). *Knowledge worker productivity assessment*. White Paper. Tampere, Tampere University of Technology. Retrieved March 19, 2010, from http://butler.cc.tut.fi/~mettanen/KWPA-Antikainen-Lonnqvist.pdf.

Argyris, C. (1957). *Personality and organization: the conflict between system and the individual*. New York, NY: Harper Collins.

Ashton, R.H., & Ashton, A.H (1995). Perspectives on judgement and decision making research in accounting and auditing. In R.H. Ashton, R.H. & A.H. Ashton (eds.) *Judgment and Decision-Making Research in Accounting and Auditing* (pp. 3-28). Cambridge, MA: Cambridge University Press.

Bailyn, L. (1988). Autonomy in the industrial R&D lab. In R. Katz, R. (ed.) *Managing professionals in innovative organizations: a collection of readings* (pp.223-236). New York, NY: Ballinger.

Barfield, W. (1997). Skilled performance on software as a function of domain-expertise and program organization. *Perceptual and Motor Skills, 85* (3), 1471-1480.

Benson, J., & Brown M. (2007). Knowledge workers: what keeps them committed; what turns them away. *Work Employment Society, 21* (1), 121-141.

Bosch-Sijtsema, P.M., Ruohomäki, V., & Vartiainen, M. (2009). Knowledge work productivity in distributed teams. *Journal of Knowledge Management, 13* (6), 533-546.

Bucher, R., & Stelling, J. (1969). Characteristics of professional organizations. *Journal of Health and Social Behaviour, 10* (1), 3-15.

Chang, L., & Birkett, B. (2004). Managing intellectual capital in a Professional Service Firm: exploring the creativity-productivity paradox. *Management Accounting Research, 15* (1), 7-31.

Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research, 2* (6), 429-444.

Charnes, A., Cooper, W., Lewin, A., & Seiford, L. (1994). *Data Envelopment Analysis: theory, methodology and application*. Boston, Massachusetts: Kluwer Academic Publishers.

Clark, T. (1995). *Managing Consultants: consultancy as the management of impressions*. Milton Keynes: Open University Press.

Coad, A. F. (1999). Some survey evidence on the learning and performance orientations of management accountants. *Management Accounting Research, 10* (2), 109-135.

Coates, J. (1986). Three models for white collar productivity improvement. *Industrial Management, 28* (2), 7-14.

Cortada, J.W. (1998). Where did the knowledge workers come from? In J.W. Cortada (ed.), *Rise of the knowledge worker: resources for the Knowledge-Based Economy* (pp. 3-21). Boston, MA: Butterworth-Heinemann.

Christopher, W.F. (1984) How to measure and improve the productivity in professional, administrative, and service organizations. In Institute of Industrial Engineers (ed.) *Issues in white collar productivity: proceedings of the Institute of Industrial Engineers Annual Conference 1984* (pp. 29-37). Norcross, GA: Industrial Engineering and Management Press.

Davenport, T.H. (2002). Making knowledge work productive and effective. *Knowledge Management, 6* (3), 20-23.

Davis, T. (1991). Information technology and white-collar productivity. *Academy of Management Executive, 5* (1), 55-68.

De Marco, T., & Lister, T. (1999). *Peopleware: productive projects and teams*. 2nd ed. New York, NY: Dorset.

Ericsson, K.A., & Charness, N. (1994). Expert performance: it's structure and acquisition. *American Psychologist, 49* (8), 725-747.

Eschenbach, S., Riedl, D., & Schauer B. (2006). Knowledge work productivity: where to start. In U. Reimer & D. Karagiannis (eds.) *Practical aspects of knowledge management: lecture notes in computer science. Vol. 4333/2006* (pp. 49-60). Berlin: Springer.

Eschenbach, S., & Schauer, B. (2008). More productive knowledge work: a report on a systems theory based approach to identify options for higher knowledge work productivity and its applications in Business and Public Management. In: K. Tochtermann et al. (eds.) *I-Know '08 and I-Media '08: International conferences on knowledge management and new media technology. Conference proceedings* (pp. 68-75). Graz: Verlag der Technischen Universität.

Geoff, N. et al (2006). Expertise in medicine and surgery. In K.A. Ericsson, N. Charness, P.J. Feltovich, & R.R. Hoffmann (eds.), *The Cambridge handbook of expertise and expert performance* (pp. 339-353). Cambridge, MA: University Press.

Greenwood, R., Li, S.X., Prakash, R., & Deephouse, D.L. (2005) Reputation, diversification, and organizational explanations of performance in Professional Service Firms. *Organization Science, 16* (6), 661-673.

Groysberg, B., & Ashish, N. (2008). Can they take it with them?: The portability of star knowledge workers' performance. *Management Science, 54* (7), 1213-1230.

Jauch, L.R., Glueck, W.F., & Osborn, R.N. (1978). Organizational loyalty, professional commitment, and academic research productivity. *Academy of Management Journal, 21* (1), 84-92.

Jones, E.C., & Chang, C.A. (2006). A methodology for measuring engineering knowledge worker productivity. *Engineering Management Review IEEE, 34* (3), 71-72.

Joseph, R. (2005). The knowledge worker: a metaphor in search of a meaning? In D. Rooney, G. Hearn, & A. Ninan (eds.), *Handbook on the knowledge economy* (pp. 245-254). Cheltenham, PA: Edward Elgar Publishing.

Klassen, K.J., Russell, R.M., & Chrisman, J.J. (1998). Efficiency and productivity measures for high contact services. *Service Industries Journal, 18* (4), 1-19.

Nomikos, G.E. (1989). Managing knowledge workers for productivity. *National Productivity Review, 8* (2), 165-174.

Picard, R.G. (1998). Measuring and interpreting productivity of journalists. *Newspaper Research Journal, 19* (4), 71-80.

Quinn, R.W. (2005). Flow in knowledge work: high performance experience in the design of national security technology. *Administrative Science Quarterly, 50,* 610-641.

Ray, P.K., & Sahu, S. (1989). The measurement and evaluation of white-collar productivity. *International Journal of Operation & Production Management, 9* (4), 28-48.

Schroeder, R., Anderson, J., & Scudder, G. (1985). Measurement of white collar productivity. *International Journal of Operations & Production Management, 5* (2), 25-33.

Shapero, A. (1989). *Managing professional people: understanding creative performance*. New York, NY: Free Press.

Smith, C. (1984). Awareness, analysis and improvement are keys to white collar productivity. *Industrial Engineering, 16* (1), 82-86.

Thomas, B.E., & Baron, J.P. (1994). *Evaluating knowledge worker productivity: literature review*. Interim Report, FF-94/27, USACERL. Retrieved August 15, 2009, from www.cecer.army.mil/kws/tho_lit.htm#abs.

Walker, D.L. (2000). Physician compensation: rewarding productivity of the knowledge worker. *Journal of Ambulatory Care Management, 23* (4), 48-59.

Yellowlees, R.A. (1986). White collar productivity: the technology challenge. *Industrial Management, 28* (2), 14-17.

Zigon, J. (1998) *How to measure white collar employee productivity*. ZPG Measurement Resources To Help You Improve Employee Performance. Retrieved April 04, 2009, from http://www.zigonperf.com/store/articles.html.

KEY TERMS & DEFINITIONS

Black box management: A management approach which defines and controls goals and resources while leaving the definition and controlling of professional work completely to the experts.

Experts: In cognitive psychology somebody who performs constantly and continuably superior in a specific domain when compared to average performers (novices). In sociology an associate who has the role to define and solve ill-defined or complex domain-specific problems.

Management: The task to bring about results by defining and controlling goals and tasks, methods and tools and/or resources.

Performance: In business management the result of a goal-oriented effort in order to produce an added-value to one or more stakeholders.

Productivity: In the classical production-oriented meaning the quantity of production output in relation to the quantity of production input.

Professional: In occupational sociology a member of a certain occupational group who deals with significant values (like justice or health), who needs a high degree of domain-specific knowledge and who enjoys a high degree of autonomy in carrying out his or her work.

Knowledge Worker: An employee whose main tasks consists in identifying, creating and/or disseminating knowledge.

White box management: A management approach which, besides defining and controlling goals and resources, also defines and controls the methods and tools of how to achieve the goals and use the resources.