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Jani Ursin

Characteristics of Finnish Medical and Engineering Research Group Work

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UNIVERSITY OF JYVÄSKYLÄ

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ABSTRACT

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The study examined research group work characteristics from the perspective of the work design approach. The purpose was, first, to describe research group work characteristics and, second, to explore the relationships between different work characteristics and form a model with which to analyse research group work. Third, attention was also paid to the advantages and disadvantages of research group work and the allocation of working time. The respondents were drawn from medicine (n = 110) and engineering (n = 121). The data was collected through semi-structured questionnaires and analysed using descriptive, comparative and explanatory statistical methods.

The findings suggested that the respondents highly valued research group work: they had a high team orientation, task and outcome interdependence, team self-management and team spirit. The respondents were also supportive, and they reported good opportunities to participate in decision making and clear cooperative group norms. The only dissimilarity within-groups was in group members' goals. Furthermore, the respondents rarely experienced conflicts and, if so, these were usually task-related. The respondents also trusted each other. The different research group work characteristics found were incorporated into the model of research group work design which showed a close relationship between trust and different forms of conflict. In the model trust and conflict explained process characteristics not vice versa although there was one important exception: team-oriented behaviour, which was an important determinant in creating a conflict-avoiding social climate. Structural characteristics, like group size, only modestly explained other group work characteristics. The main advantages of research group work were opportunities for scientific discussions and co-operation, whereas the main disadvantage of group work was always having to take others into consideration. Rank-and-filer members spent more time on research than group leaders, who performed more administrative and group management tasks.

The general conclusions suggest (1) that the medical and engineering research groups were internally harmonious, (2) that research group work was not academic in nature and, (3) that the role of discipline in medical and engineering research group work was modest. Thus, in future research attention especially needs to be paid to determining the cultural aspects of research group work, the relationships between group outcomes and work characteristics, and dyadic relationships between group members, especially between the group leader and rank-and-file members.

Keywords: group work, organisation of research, research group, research work, work characteristics, work design

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PREFACE

Now, as I sit in my living room trying feverishly to figure out how to start this preface, I start recalling how it was that I ended up doing my dissertation on this particular subject. And the use of reflection – a must for every learner nowadays – seems to lead to a result. Actually, the history of this thesis is quite a lengthy one. As I entered the university as an undergraduate in 1994 I gained familiarity not only with the research done in higher education but also with the field of science and technology studies as well as, to some degree, with the philosophy and sociology of science. After reading a couple of influential books on higher education and doing my Master's thesis on academic knowledge production I was already so deep in the subject that I was beyond the point of no return; my doctoral studies had already been given their final impetus – although I did not know it that back then.

The process of doing a PhD is often regarded as a lonely battle towards full membership of the academic world. I do not know about full membership but loneliness definitely does not apply in my case as I have always been surrounded by the most eminent and encouraging people to whom I am grateful for being academically where I am today. In Department of Education, Professor Tapio Aittola has been a patient, critical and constructive supervisor from the early phases of my thesis to its final version and has always been available when I needed support of any kind. Whenever we have met to discuss my work-in-progress, he has shown extreme dedication. Professor Jussi Välimaa from the Institute for Educational Research, who became my supervisor in 2002 when I entered the Finnish Network for Higher Education Research and Training (FINHERT) graduate school, has been encouraging and inspiring in his comments and has also taught me a lot about national and international higher education systems and policies. I am also grateful to the heads of the Department of Education under whom I have been working since 1999. I especially owe a great debt of gratitude to Professor (Emerita) Sirkka Hirsjärvi for creating such ideal working conditions in which to conduct a doctoral research in its critical phases, of which, as everybody who tackles a dissertation knows, there are many. Dr Elinor Edvarsson Stiwne from University of Linköping has followed my work in progress at annual ECER conferences and also acted as a reviewer of my thesis. She also gave me feedback on my manuscript in its final phase together with Dr Michael Rosander. I am very much obliged to you both. Professor Annikki Järvinen from the University of Tampere also gave me valuable comments while reviewing my thesis.

I am also grateful to Michael Freeman, from the Department of Languages for carefully and patiently correcting and commenting on my English and to Antero Malin from the Institute for Educational Research for his sharp and knowledgeable comments regarding the statistical analyses. And of course, I

owe a big vote of thanks to all of those informants who participated in the study and made it possible in the first place.

For financial support I wish to thank the University of Jyväskylä, the Faculty and Department of Education of the University of Jyväskylä and FINHERT graduate school.

I have also been a member of two communities both of which have offered unforgettable and unique working environments. In the Department of Education I have found a relaxed, encouraging and supportive social atmosphere – both at and outside work. This is down to my past and present colleagues. I am also grateful for having had an opportunity to deepen my knowledge in higher education as a member of FINHERT graduate school. In our research seminars we have had both many stimulating discussions and fun-filled activities indeed, sometimes 24 hours did not seem to be enough. I especially wish to thank our group here in Jyväskylä for the enjoyable moments and conversations we have had in both formal and informal settings.

Finally, I am thankful to my friends, and especially to the people closest to me: my sisters with their families and my brother for supporting me and sharing my ups and downs over the years.

Jyväskylä, June 2004

Jani Ursin

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1 INTRODUCTION

Issues surrounding the production of scientific knowledge, especially the changing role of university as a central actor in knowledge generation, have been topics of national and international debate recently. Some (e.g. Gibbons, Limoges, Nowotny, Schwartzman, Scott & Trow 1994) agree that the university's role is fundamentally being eroded while others (e.g. Delanty 2001) see that the university has maintained its centrality in knowledge production although its role has changed. Nonetheless, knowledge production is facing challenges both externally and internally which ultimately affect how university research is conducted and organised. Externally, changes in the structures of the knowledge society and the capitalisation of knowledge, that is, the reassessment of the relationship between higher education, government and industry, are reformulating scientific knowledge production. Internally, the democratisation of knowledge, the fact that the actors involved in knowledge production are drawn not only from universities but also from private enterprise, government bodies and consultancy agencies combined with the fragmentation of disciplines, that is, the emergence of new disciplines and the increase in multidisciplinarity, are eroding traditional views of science and the nature of academic work. These external and internal transformations, which are described in chapter 2, create the current dynamic environment in which academics as individuals and as groups operate.

The transformations taking place in scientific knowledge production also determine the nature of academic work. Thus, the changing nature of scientific knowledge production has consequences for the organisation of research practices as well. The current transition has been characterised as a shift from Mode 1 to Mode 2 knowledge production (Gibbons et al. 1994) or as a second academic revolution (Etzkowitz & Leydesdorff 1997). Nonetheless, as a result of this change collaborative research and collaboration among different scientific communities have increased (e.g. Etzkowitz & Webster 1995), multidisciplinary and cross-professional research has became more common (e.g. Hakala, Kaukonen, Nieminen & Ylijoki 2003), and knowledge production has to some extent become dislocated and detached from its disciplinary foundations. Such

changes have lead to the emergence not only new research cultures, but also of novel modes of knowledge production so that nowadays scientific knowledge is being generated more often in a loosely institutionalised research group, especially in the hard sciences.

Relatively little, however, is known about research group work. The majority of previous studies have been based either on the constructionist (e.g. Latour 1987; Knorr Cetina 1999), cultural-historical activity theoretical (e.g. Miettinen 1999; Saari 2003) or work design (e.g. Lacy & Sheehan 1997; Winter & Sarros 2002) approaches. Each of these approaches has contributed to the study of research group work and are discussed in chapter 3. The present study has its origin in the work design approach, where the focus is on the work characteristics typical of research groups. Thus, work characteristics, and especially the relationships between them, form the central components of the work design approach. In chapter 4, attention is paid to the work characteristics that define research group work: to structural characteristics, process characteristics (individual and group level), intragroup conflict and interpersonal trust among group members. Structural characteristics primarily refer to the social composition of the group, as group members differ in numerous attributes, such as gender, status in group and the discipline they represent. Process characteristics are those means by which members work interdependently to utilise various resources, such as expertise, and to yield meaningful outcomes. Interdependence, social support and preference for teamwork are examples of process characteristics in this study. In chapter 4, a theoretical model of research group work design, constructed from the characteristics typical of research group work is presented.

The respondents were purposefully selected from medicine (n = 110) and engineering (n = 121) both of which are hard-applied sciences (see Becher & Trowler 2001). The data were collected through semi-structured questionnaires and analysed using descriptive, comparative and explanatory statistical methods. The aims of this study are presented in detail in chapter 5, but in general the purposes are, first, to describe research group work characteristics and second, to explore the relationships between different work characteristics so as to construct a model which can be used to analyse research group work. Third, attention is also paid to the advantages and disadvantages of research group work and to the allocation of working time. Furthermore, a classification of research group members is made in order to illustrate that scholars not only differ in terms of structural characteristics, such as discipline or experience as a researcher, but also in terms of how they perceive and comprehend their job. This classification is also used as an analytical instrument to describe work characteristics. More generally, *the purpose of the study is to gain knowledge of how research group members perceive their jobs and what research group work characteristics are perceived as the most important ones*. Overall, the study provides information about the kind of social climate which characterises medical and engineering research groups. This knowledge helps towards a better understanding of what is needed in order to create optimal conditions for the

production of new knowledge. The study also in part reveals the nature of group work when the spotlight is on highly innovative and creative tasks.

In chapter 6 methodological aspects of the study are addressed. There are three reasons for this. First, by becoming aware of the epistemological and ontological issues of the study, one can better comprehend the pros and cons of the study process. Second, by analysing the scientific reasoning or regulative principles behind the study, the epistemological and ontological assumptions become more evident. Third, a detailed focus on methodology can also be justified by in the fact that recent quantitative studies, at least in the field of education, have paid relatively little attention to methodological issues. This study is intended as a kind of counter-balance to this tendency.

Trying to locate the present study within the academic field is not a simple task as it can be placed at the intersection of Higher Education (HE) research, Science and Technology Studies (STS) as well as group work studies. In chapter 2, the HE and STS theories and studies are both utilised in order to draw a picture of the environment, the *Zeitdiagnose*, in which a research group operates. Typically, the demarcation between HE researchers and STS scholars has been justified given that they rather complement than oppose each other (Wittrock 1985). In the present study both strands are drawn upon in describing current developments in knowledge production. Group work studies, especially those based on the work design approach, constitute the mainstay of the empirical part of the study describing the different characteristics of research group work. The present study is composed of two, equally important, parts. The first, and most obvious of these is the empirical part which is concerned with analysing the concepts used to define research group work characteristics (chapter 4), describing and explaining the relationships between work characteristics in Finnish medical and engineering research group work (chapter 7) and relating the findings to those of previous studies (chapter 8). The second part is the *Zeitdiagnose* of higher education and science policy which defines the contexts in which research group operate. Although this part of the study is not empirically relevant, in terms of understanding the phenomenon under investigation and in creating an interpretative foundation it offers a basis on which to further comprehend research group work and also offers a justification for studying it in the first place. The importance of the *Zeitdiagnose* becomes clear in relation to the general conclusions about research group work drawn in section 9.1 as this would not have been possible without close familiarity with the literature in higher education and science and technology studies.

Altogether, higher education research, STS and group work studies form the framework through which research group work is analysed and discussed. Thus, this study offers both internalist and externalist perspectives on research group work and the organisation of knowledge production. The study can be seen not only as an effort to describe and explore research group work but also as an effort to incorporate different disciplinary traditions.

2 TRANSFORMATIONS IN KNOWLEDGE PRODUCTION AND ACADEMIC WORK

Given the breadth and diversity of the recent transformations in higher education and knowledge production, trying to fit them within a single explanatory rubric is demanding and even unnecessary. Nevertheless, it is essential to describe and analyse these transformations in order to illustrate what kinds of developmental processes knowledge production is undergoing and how these transformations affect the organisation of research practices and research group work. Knowledge and knowledge production can be seen to include at least two components of change: those which come from society and those which originate in knowledge itself. Thus, in the following sections the transformations that have taken place in knowledge production are described from two perspectives: from the point of view of *the external transformations of knowledge production* in society, that is, what the recent changes in Western societies have meant for the production of scientific knowledge and for the organisation of knowledge generation, and from the point of view of *the internal changes in knowledge production*, that is what impacts the transformations in the epistemological structures of scientific knowledge are having on knowledge production and academic work. Overall, the purpose of this chapter is to outline the conditions and circumstances under which academics as individuals and as groups operate, laying emphasis upon the fact that these conditions and circumstances are dynamic in nature, and to highlight why it is important to study research group work.

2.1 The external transformations of knowledge production

Since scientific knowledge production is always in a dynamic state (e.g. Ziman 2002), it is rather vague to argue that knowledge production and more broadly higher education is in transition. Nevertheless, the recent transitions in knowledge production have been rapid and the relationship between university

and society has grown more complex (Gibbons et al. 1994, 73; Nowotny, Scott & Gibbons 2001) for at least three reasons. Firstly, the rise of the knowledge society (Stehr 1994; Castells 1997) has implications for the university-society relationship (Etzkowitz & Leydesdorff 1995; Etzkowitz 1998). Secondly, the capitalisation of knowledge production has its impact on academic work and academic life as well (Jacob & Hellström 2000). Thirdly, as a consequence of first two reasons, collaboration and communication among different scientific communities[1] and other sites in society have increased (Ziman 1994; Baldwin & Austin 1995; Etzkowitz & Webster 1995; Powell & Owen-Smith 1998; Chompalov & Shrum 1999; Kaukonen & Nieminen 2001). This increased collaboration between different disciplines and sites of knowledge production suggests that not only new research cultures, but also new modes of collaborative research work are emerging in all fields of study and especially in the hard and applied disciplines like medicine and engineering (Nowotny et al. 2001; Hakala et al. 2003), thereby challenging the traditional nature of academic work.

2.1.1 The changing structures of the knowledge society

Bell (1973) described post-industrialised society as an *informational society* because of the fact that the innovations were more often based on theoretical knowledge and knowledge formed the foundation of Western societies. Stehr (1994, 6–7), who calls current societies *knowledge societies*, adds that the appearance of knowledge societies was not a sudden occurrence but rather a gradual process which can be traced to the phase where knowledge challenged labour and property as the constitutive mechanisms of modern societies. Similarly, Suarez-Villa (2001, 4–5) labels contemporary societies as technocapitalism-oriented since knowledge and creativity are the most valuable resources of societies. Accordingly, a knowledge society is a society "based on the penetration of all its spheres of life by scientific knowledge" (Stehr 1994, 9).

Nevertheless, knowledge societies are more than just societies based on scientific knowledge, as Castells (1997, 469–478; see also Thorlindsson & Vilhjalmsson 2003) has implied. Castells adds the idea of globalisation as a key element in the informationalisation of Western societies in addition to the relatively increased amount of informational occupation. Therefore, he argues, the material foundation of contemporary societies is based on the space of flows and timeless time, which are (re)produced, (re)formulated and (re)directed in "the nodes of the networks, that is the location of strategically important functions that build a series of locality-based activities and organizations around a key function in the network" (Castells 1997, 413). Thus, Castells calls contemporary societies *networked societies,* meaning that they are characterised by set of interconnected nodes, a node being the point at which a curve intersects itself. Despite of the different terminology used to describe

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[1] Scientific community can be defined as a representation of a "distinctive mode of collective production which is characterised by decentralised action coordination via local interpretations of the shared subject matter of work" (Gläser 2003, 41).

contemporary (Western) societies, they all agree that, owing to scientisation, knowledge and science have became immediately productive forces in the market, where a new sector of production has emerged, that is, the production of new knowledge (Stehr 1994).

One way to analyse the rise of the knowledge society is to examine changes in the numbers of informational occupations.[2] These have increased in all Western societies (Castells 1997; Reich 1992). In Finland, the information sector[3] accounted for 6.5 per cent of all jobs in 1999. The increase in informational occupations, however, has been most rapid during the last decade (Figure 1). The proportion of all information sector jobs increased from 23 per cent in 1993 to over 30 per cent by the year 1995, and since 1996 there have been no major shifts in these proportions. (On the road to the Finnish information society III 2001, 140–141.)

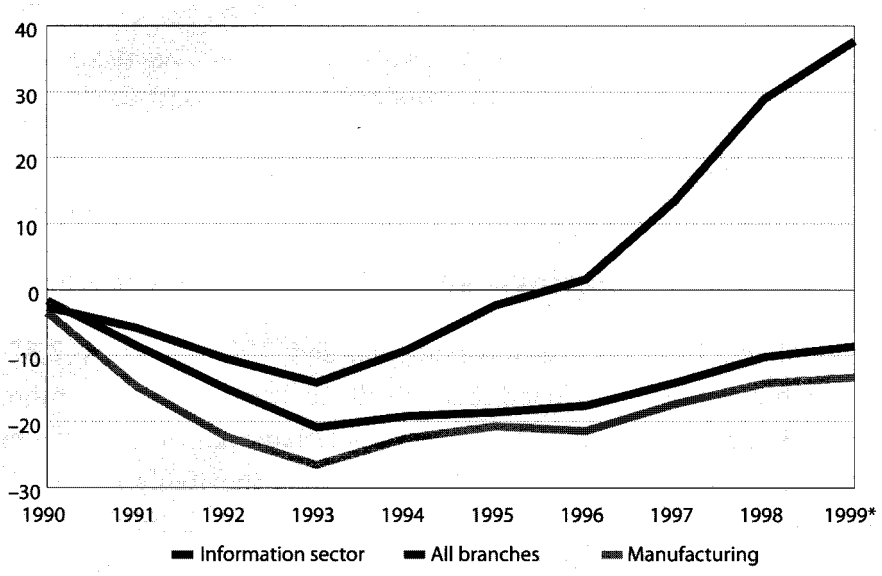

FIGURE 1 Annual change in employment in the information sector (top line), in all branches (middle line) and in manufacturing industry (bottom line) in 1989–1999 (1989 = 100) in Finland (On the road to the… 2001, 140).

The rise of the knowledge society has its implications for science as well. According to Scott (1997, 8–9), the scientisation of society has changed the status of knowledge at least in three more or less interrelated ways. *The disturbance of intellectual culture* has accelerated the emergence of sceptical science in which the risks and reflexivity of knowledge societies are (re)interpreted. The rejection of naïve positivistic accounts of a progressive

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2 The indicators that are presented here to illustrate the rise of the knowledge society are not inclusive. They are selected for the purposes of this study, i.e. to describe the changes that affect scientific knowledge production and academic working environments (see also Gibbons et al. 1994, 76–80).

3 The information sector is understood here as the production of information-related goods and services.

science has led to the *epistemological wobble*, the increasing difficulty in distinguishing truth from un-truth. Further, the *massification of higher education* has its implications for the university especially in the forms of the intensified academic and social pluralism of the modern university. The university's role as a societal agent has changed so that it still is one of the most important producers of knowledge, but it is not the main user of that knowledge (Delanty 2001, 152; Gumport & Snydman 2002, 376).

Thus, a number of important societal developments have occurred in higher education and in knowledge production over the past two to three decades of which three are emphasized by Jacob and Hellström (2000, 1): the shift from internationalist/national science systems to internationalist/global science networks, the capitalisation of knowledge, and the integration of academic labour into the industrial economy, also known as a triple helix, that is, linkages between universities and users of knowledge in industry and public institutions (Etzkowitz & Leydesdorff 1995). These linkages are said to be a logical outcome of structural developments, such as a shift towards more knowledge-intensive technology in promoting economic growth (Jacob 2000, 13–14). Further, Adler, Hellström, Jacob and Norrgren (2000, 125) stress that knowledge societies can be characterized as transdisciplinary, based on collaborative partnerships which involve researchers and practitioners. In addition, knowledge societies can be characterized as a heterogeneous market of knowledge-producing organisations which recruit knowledge producers who can transform academic knowledge into applications for resolving practitioners' problems. This has also meant a greater role for practitioners in determining the research problems (cf. Gibbons et al. 1994, 4). The knowledge society has thus changed the institutional status of the university such that "the university as an institution shifts from being an ideological apparatus of the nation state to being a relatively independent bureaucratic system" (Readings 1996, 14).

Massification of higher education

The massification of higher education seems to be one of the key elements in analysing the transformations in knowledge production caused by the rise of the (networked) knowledge society. Gibbons et al. (1994, 76–81; also Scott 1995; Altbach 1999) see that the massification of higher education has several consequences of which the most important are: the diversification of university functions, alteration of the social profile of student populations, education for the professions, increase in problem-oriented research and decline in primary knowledge production, multiple sources of funding for higher education, and increased efficiency demands which have made universities organisational rather than intellectual institutions. The consequences of massification in higher education are thus diverse: massification has its effects on higher education systems as well as on research, teaching and ultimately on the nature of academic work.

Välimaa (2001b, 44–45) distinguishes three different trends in the massification of higher education in Finland: democratisation of Finnish higher education, equalisation of the gender distribution of students and diversity of the university students' regional background. Välimaa, however, concentrates only on a systemic review of the massification of higher education in Finland and does not extend the description to knowledge production, e.g. to the impact of the massification of the Finnish higher education system on knowledge production. This approach is offered by Gibbons (1998, 73–75) who notes that there is expansion on both the supply and demand sides in knowledge production due the massification of higher education. On the supply side, the numbers of potential knowledge producers is increasing, as universities are "producing" more and more researchers who are capable and qualified knowledge generators. On the demand side, there is an expansion of the demand for specialist knowledge of all kinds. This is what Stehr (1994, 177) has referred to as the expansion of experts in knowledge societies, that is, the need for occupations capable of handling specialised knowledge.

In Finland there is a similar trend towards expansion both on the supply and demand sides in knowledge production. As noted earlier (Figure 1) the increase in informational occupations reflects the expansion on the demand side. On the supply side, the numbers of new doctorates have also increased (Kivinen, Lehti & Metsä-Tokila 1997, 34–50). As Määttä (2001, 139–144) has observed, the number of new doctorates at the end of the 1990s was almost three times as high as it was at the end of the 1980s. However, there are differences between fields of study with regard to the number of new doctorates. The increase in the number of new doctorates has been most rapid in certain small fields such as the arts and the sport sciences, but large increases have also occurred in some of the biggest fields like engineering and the social sciences. On the other hand, medicine and the natural sciences are below the average rate of growth, although they produce high number of new doctorates.

Besides considering the (im)balance between supply and demand, there are two indicators which illustrate the impact of massification in knowledge production. The first indicator is the change in the number of highly educated (Master's degree and higher) persons. The second indicator is the variation in the proportion of employees working in the R&D sector[4] since as Slaughter and Leslie (1997, 25) point out that post-industrial societies depend on higher education for training as well as research and development to a greater degree than do industrial societies. During the 1990s in Finland, the number of highly educated persons has increased on an average three per cent per year and the number of doctorates has increased seven per cent per year. In 1998, 11 000 employees had doctorates. There were almost twice as many new doctors in year 1998 as in 1991. (Tiede & teknologia 2000, 17–18.)

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4 Research and development is understood as systematic action taken to increase new knowledge and its applications and includes R&D activities in private enterprise, organisations in the public sector, universities, university central hospitals and polytechnics (Tutkimus- ja kehittämistoiminta 2001, 21).

Since the recession in Finland at the beginning of the 1990s, the numbers of employees working in R&D have increased, especially in private enterprise, but also in the university sector (Figure 2). Employees with a university degree accounted for more than fifty per cent of person-years of research work in the year 2001. In addition, when comparing the years 1995 and 2001, there is a notable increase regarding R&D expenditure: in 1995 expenditure was 2.2 billion euros and in 2001 more than 4.6 billion euros. (Tutkimus- ja kehittämistoiminta 2001, 5–6.)

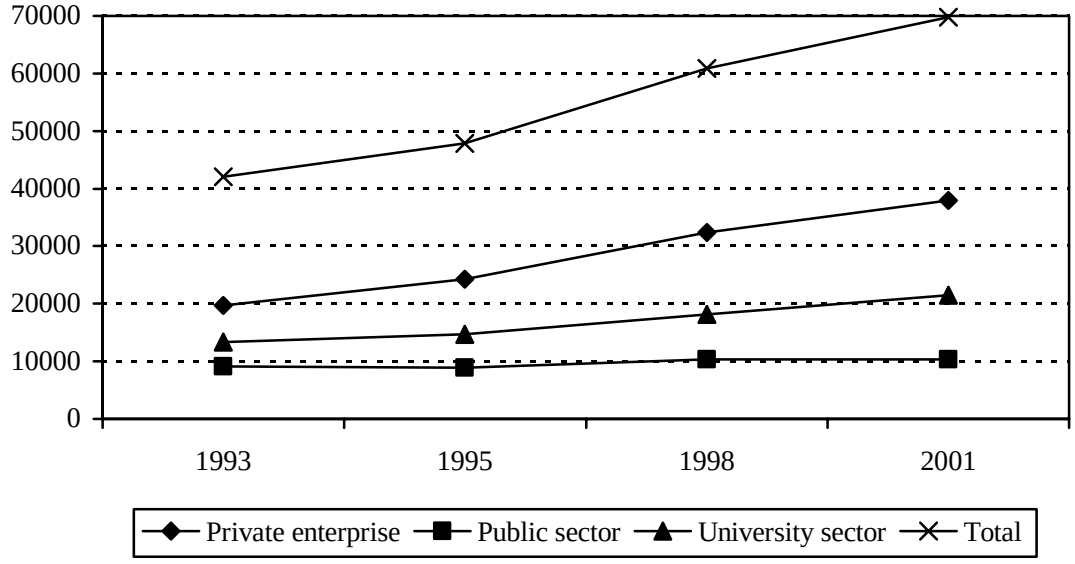

FIGURE 2 R&D personnel by sectors in 1993–2001

The transformations in the research setting: from Mode-1 to Mode-2 science

The transformations in Finnish society have increased and strengthened the status of knowledge as a constitutive mechanism of society. The increase in informational occupations, in the numbers of doctorates and in R&D expenditures are, however, only quantitative indicators of the informationalisation of Finnish society. It is equally important to examine qualitative changes in knowledge production, e.g. the transformations in research settings.

Since knowledge is a constitutive mechanism of knowledge societies, the status of science is also experiencing change and new challenges. Therefore, Nowotny et al. (2001, 1) state that the growth of the contextualised and socialised knowledge is a critical feature of "modern science", that is Mode-2 science. Thus, one way of viewing the changes in knowledge production is to examine the changes in the settings in which knowledge is produced.

Gibbons et al. (1994; see also Scott 1995, 140–167; Nowotny et al. 2001) make a division between Mode 1 and Mode 2 scientific knowledge production (Table 1). In Mode 1, the research context is defined in relation to the cognitive and social norms that govern academic science. In Mode 2, by contrast, knowledge is produced in the context of application. Instead of producing

knowledge within the discipline, research in Mode 2 is transdisciplinary and heterogeneous. New forms of organisation have emerged to accommodate the changing nature of the problems addressed by Mode 2. This also expands social accountability and reflexivity as well as creates new forms of quality control. In sum, Mode-2 science reflects the closer interaction of science and society and the emergence of a new kind of science: context-sensitive science, which is an outcome of the contextualisation of knowledge in a new public space, the development of conditions for the production of socially robust knowledge and the emergence of socially distributed knowledge. Therefore, "science itself now consists of a set of complex practices deeply – – integrated and implicated with society" (Nowotny et al. 2001, 230).

TABLE 1 Sites of opposition between Mode 1 and Mode 2 (Godin 1998, 466)

Mode 1	Mode 2
Academic interests	Context of application
Disciplinary context	Transdisciplinary context
Homogeneity of sites and practitioners	Heterogeneity of sites and practitioners
– Hierarchical and institutionalised organisation	– Egalitarian and transient organisation
Relative autonomy	Social responsibility
– Technicity	– Reflexivity
Peer review	Various considerations

Although the visions and ideas which Gibbons et al. (1994) have presented can be questioned (e.g. Godin 1998; Shinn 2002; Raman 2000; Rip 2000)[5] and alternative rhetoric for this change offered such as the *second academic revolution* of Etzkowitz and Leydesdorff (1997) as well as the *academic capitalism* of Slaughter and Leslie (1997), they have managed to describe the situation referred to by Scott (1997, 8–9) as a state of "epistemological wobble" in which the social meaning and function of science is undergoing change and becoming obscured (Nieminen & Kaukonen 2001, 15), and in which the boundaries between innovation activities and academic as well as industrial research are becoming increasingly difficult to delimit (Tuomi 1999b, 36). Nevertheless, the changes in the settings of knowledge production – described as Mode-2 science – have their implications for the organisation of knowledge production and working environments as well. As Nowotny et al. (2001 102–104, 106) have stated, Mode-2 science opens up new co-operative relationships not only with other scientists but also with actors from other sectors of society. That is especially the case in medicine and engineering where knowledge is often produced for commercial purposes and out of academic interest. Thus, there

5 The criticisms can be summarised as (1) the lack of empirical evidence of Mode 2 features (Calvert 2000; Jansen 2002), (2) the change – the appearance of Mode-2 science – is more moderate in the wider historical perspective (e.g. Godin 1998; Martin & Etzkowitz 2000; Rip 2000; Bleiklie & Byrkjeflot 2002; see also Toulmin 1992) (3) the distinction between Mode 1 and Mode 2 is problematic and inert (Huff 2000) and only a heuristic tool, and (4) the lack of theoretical reference (Shinn 2002).

seems to be both the pressure and the possibility to increase collaborative research.

Mode-2 science forces the university to pay attention to its contexts, especially its close-range environment. In Finland in the mid 1990s, after the recession, universities began paying more attention to their role in regional development. Accordingly, present regional innovative systems are based on cooperation between universities and other educational and R&D institutions. The university has thus come to play an important role in regional development.[6] (Korkeakoulujen alueellisen työryhmän muistio 2001, 66; also Mansfield & Lee 1996.) This kind of development brings the university closer to its close range environment and thus towards more contextualised and socialised knowledge (cf. Nowotny et al. 2001). In other words, Finnish universities are not only cooperating with other regional (and national) institutions but this cooperation is becoming a standard procedure (e.g. Etzkowitz, Schuler & Gulbrandsen 2000; Nieminen & Kaukonen 2001; Etzkowitz, Asplund & Nordman 2003). Accordingly, regional development constitutes a new mission for Finnish universities in addition to research and teaching (Virtanen 2002), and thus poses new challenges to the organisation of academic work.

2.1.2 The capitalisation of knowledge

The capitalisation of knowledge refers to the university's changing role in society. Initially the university was seen as producing primary commodities (e.g. scientific knowledge) which are later transformed by industry into capital such as goods and services (Jacob & Hällström 2000, 1). Currently this division has become unclear since "the university is being asked to perform as a partner who participates in the transformation of the primary commodities it produced into manufactured commodities" (ibid., 1). The capitalisation of knowledge affects knowledge production in many ways, and thus the key question is what kinds of impact the capitalisation of knowledge has on knowledge production and on the organisation of knowledge generation.

One key element in the capitalisation of knowledge has been the reassessment of the relationship between higher education, government and industry. This has led to the present situation in which an ideological consonance between higher education, government and industry has been created in order to further enhance and encourage the collaboration between these three. (Neave 1986, 16.) This in turn has led to a situation where the influence of government and industry on higher education has increased and is continuing to increase (Neave & van Vught 1996, 253; Scott 1997). This is what Etzkowitz and Laydersdorff (1997) call the second academic revolution, that is, the institutionalisation of the economic function of the university. Although the

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6 Kolehmainen, Kautonen and Koski (2003, 110–112) distinguish two different visions of innovation policy: technopolis and the learning economy. Technopolis characterises innovative systems which involve universities and hi-tech enterprises whereas the learning economy takes a wider perspective on innovation.

relationship between higher education, government and industry is complicated and this division can be transcended (e.g. Nowotny et al. 2001), Salter and Martin (2001, 520–526; also Narin, Hamilton & Olivastro 1997) have distinguished several different types of contribution that publicly funded research makes to economic growth. A traditional justification is the increase in the stock of useful knowledge. The primary economic benefit is the flow of skilled graduates, termed symbolic analysts by Reich (1992, 177–180), from universities onto the labour market as well as the creation of new scientific instrumentation and methodologies. In addition, public funding may support and generate new forms of interaction among the actors in the innovation system[7] and increase the capacity for scientific and technological problem solving. Thus, the reassessment of the relationship between higher education, government and industry has changed the organisation of knowledge production and academic work such that cooperative working methods have also become more frequent in academic settings (e.g. Nowotny et al. 2001; Hakala et al. 2003), especially in those fields of study, like medicine and engineering, which operate in the domain of the triple helix.

As Etzkowitz et al. (2000, 41, 56–57; also Subotzky 1999; Clark 1998) note, academic science has become increasingly entrepreneurial. This entrepreneurship is not only manifested by connections with private enterprise but the inner dynamic of science has also changed. Thus, academic entrepreneurship has a dual focus on the advancement and commercialisation of research. Furthermore, formerly the institutional spheres of academia, industry and government had separate institutional identities, missions and purposes, but now these are overlapping. This common and border-crossing institutional sphere creates a novel foundation for knowledge production and academic work (see also chapter 2.2.1).

Slaughter and Leslie (1997, 209) argue that the academic work is changing, especially due the academic capitalism, i.e. in response to the emergence of global markets. Kerr (1994) continues that in this new academic culture emphasis is placed more on individual and group concerns and less on the overall welfare of the university. Therefore, the means of financing the academy, the conception of scientific knowledge and the profile of the researcher have also changed, which has meant that academic work has been faced by challenges in terms of increased uncertainty (e.g. Kogan, Moses & El-Khawas 1994; Enders & Teichler 1997; Enders 2001; Puhakka & Rautopuro 2001; Ylijoki 2003) and increased administrative work (e.g. Vidovich & Currie 1998; McInnis 2000). In addition, funding agencies have become more diversified and tied funding has increased (Jacob 2001, 83–84) with the result that scholars working on research projects with short contracts of employment have become more frequent (Välimaa 2001a, 83; Hakala et al. 2003, 42–47, 77). This has meant new demands on knowledge production, which in turn has led to the opening up hitherto tightly-knit scientific communities. Gibbons et al. (1994) refer to this process as the contextualisation of knowledge production. For research work

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7 For more about the Finnish innovation system, see Miettinen (2002).

this has meant that as no individual researcher is able to meet all the scientific and especially bureaucratic demands involved in it, research groups are formed that can meet all these demands (Baldwin & Austin 1995, 46–47). In fact, in the 1990s national science and technology policy promoted scientific collaboration and cooperation in Finland (Nieminen & Kaukonen 2001, 30–38; see also Benner 2003, 136–137), which in turn both promoted working in research groups and increased the size of the latter in all fields of study (Hakala et al. 2003, 77–81).

2.1.3 Collaboration among scholars and practitioners

Collaboration[8] is a growing phenomenon in higher education and knowledge production as in other (economic) sectors in contemporary societies (e.g. Hull 1990; Etzkowitz & Kemelgor 1998; Hemlin 2000; Hakala et al. 2003; Scott 2003). As Chompalov and Shrum (1999, 338–339) point out, the growth of science is not simply an increase in the scale of research but also an increase in collaboration across a variety of different scientific institutions and communities. This increased collaboration can partly be seen as a result of the capitalisation of academic life. Knowledge is generated in projects with external funding and which have dynamics different from those of "traditional" disciplinary-based and individual-oriented research. It seems that hard sciences like medicine and engineering are disciplines where group working is the most common mode of knowledge production (Hakala et al. 2003, 76). Accordingly, collaboration can contribute to the transformation of the whole field of study or, as Knorr Cetina (1995a, 121) puts it, to the genealogical change in the field of study, while allowing new (disciplinary) subcultures to develop. Thus, collaboration among the different sites inhabited by knowledge producers changes the whole landscape of scientific knowledge production and academic work.

Over (1982, 996) found that collaborative research among scientists has increased significantly since the Second World War, in particular owing to the fact that "the resources and techniques that are needed to address research issues in some disciplines have increasingly fallen outside the command of individuals."[9] According to Baldwin and Austin (1995, 46) as well as Becher and Trowler (2001, 122–126) there are, however, differences between disciplines with regard to collaboration. Collaboration is more common in the hard

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8 Wildavsky (1986, 237; see also Häkkinen & Arvaja 1999, 207–211) distinguished between cooperation and collaboration in his work on collaboration in academic research. He defines cooperation as necessary to get the job done, but different from collaboration because the purpose of collaboration is for "participants to make use of each other's talents to do what they either could not have done at all or as well done." In sum, collaboration refers to the formation of joint understanding so that it facilitates the evolution of group synergy. Furthermore, intragroup collaboration can be defined as collaboration between individuals in the same research group (Katz & Martin 1997, 10).

9 Similarly, research collaboration has increased significantly in the industrial sector (Hicks, Isard & Martin 1996).

sciences with their well-established conceptual paradigms. Collaboration also tends to occur with greater frequency in fields for which external financial support is available and in those fields of study requiring sophisticated facilities and instrumentation. Though collaboration is more frequent in hard disciplines (e.g. physics and medicine) than soft disciplines (e.g. history and literature), multi-authored publications in both fields increased between 1949 and 1979 (Over 1982, 997–999), although the increase was more rapid in the hard than soft sciences (Thagard 1997, 243–245).

Many of the previous studies (e.g. Bayer, Smart & McLaughlin 1990) on cooperative research are based on the analysis of author co-citations. These studies do not, however, reveal anything about the nature of research group work. And yet, according to Baldwin and Austin (1995, 46–47) as well as Katz and Martin (1997, 4; see also Ziman 2002, 69–71) the reasons for increased collaboration among academics are diverse. The growing specialisation of fields of study and the greater sophistication of research equipment, especially, require researchers to work together. Also the desire of researchers to increase their scientific popularity, visibility and recognition has meant an increase in collaborative research. Additionally, increased demands for productivity and accountability derived from the changed relationship between higher education, government and industry have promoted (interdisciplinary) collaboration, thereby changing academic work so that "the traditional individualistic image of an ivory tower researcher" (Ylijoki 2003, 322) no longer applies and individualism has been replaced by an individual public identity (Henkel 2000, 199–200). Hakala et al. (2003, 81–83) note that cooperative research is a key feature in science and technology policy in Finland and that this has promoted research group work. Wray (2002), on the other hand, gives a more critical explanation – what he calls a "functional explanation for the persistence of collaborative research in science" – and claims that "in certain fields, those in which scientists must compete for access to resources in order to engage in research effectively, collaborative research has become the norm, playing an important causal role in enabling scientific communities to realise their epistemic goals" (Wray 2002, 166).

In the university, naturally, cooperative research has always existed and it has had different modes due to the different academic cultures inherent in its institutional space. As Treid and Traweek (2000, 6–10) note, the spaces in the academic world are more diversified than stated by Snow (1959), who differentiated two academic cultures: literary intellectuals and scientists. Therefore, one way to illustrate different forms of academic collaboration is to distinguish between different modes of (inter)disciplinary cooperation or, as Moore (2003) puts it, between cross-boundary collaboration.

According to Huber (1992, 195) various modes of (inter)disciplinary cooperation can be distinguished three of which are discussed here (Figure 3).[10]

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10 Thagard (1997, 245–246) has offered a different classification of the forms of collaboration among academics.

The first, most traditional one, is disciplinary-based collaboration within a given discipline. This kind of collaborative research is conducted within disciplinary boundaries so that research is based on established practices in the discipline in question and no overlaps exist.[11] Second, multidisciplinary collaboration is based on co-ordinated activity between different disciplines. This kind of collaboration does not, however, lead to the integration of disciplines as disciplinary elements retain their disciplinary identity (see also Gilbert 1998, 6). The integration of disciplines occurs in transdisciplinary collaboration in which "disciplinary divisions are overcome through joint aims and – – the streamlining of axioms and epistemology" (Huber 1992, 195). Thus, transdisciplinarity creates a new research sphere which has its own identity. However one labels the collaboration between different disciplines, it is unquestionable that multidisciplinary research is becoming increasingly rule in Finland (Hakala et al. 2003, 58–59).

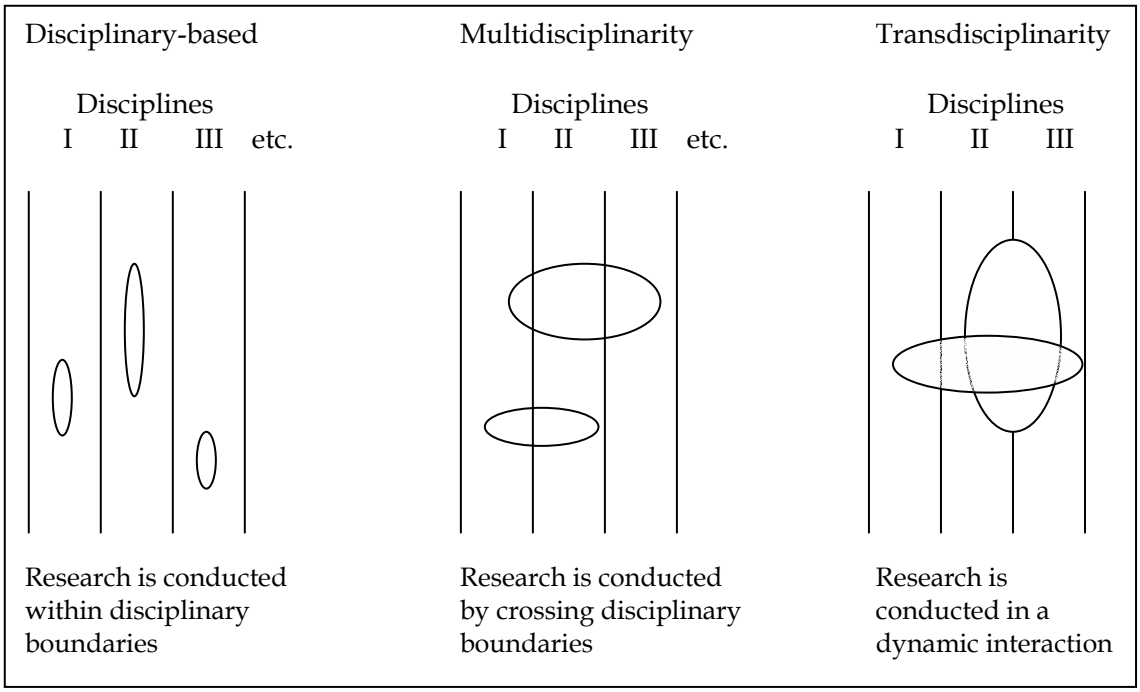

FIGURE 3 Disciplinary-based, multidisciplinary and transdisciplinary research (Aittola & Pirttilä 1998, 12, applied; see also Ursin 1999, 27)

All of the above-described modes of collaboration are based on disciplinary cooperation. Owing especially to the contextualisation of knowledge production cooperation with non-academic partners has increased. This kind of collaboration, however, has different features than that between academics. Collaboration which involves actors from universities and the public and/or private sector, that is, practitioners, is known as cross-profession collaboration

11 There is no straightforward definition of disciplinary boundaries. According to Squires (1990, 112) disciplines are rather loosely connected and more or less closely related specialisms than firmly united entities.

(Amabile, Patterson, Mueller, Wojcik, Odomirok, Marsh & Kramer 2001, 419) or as hybrid groups (Nieminen & Kaukonen 2001, 53). Academic-practitioner collaboration involves people from different professions and the collaborators are not all members of the same organisation (Amabile et al. 2001, 419). Additionally, cross-profession collaboration can be characterised as a joint effort in which both researchers and practitioners seek solutions to specific problems. As noted earlier (see Gibbons et al. 1994; Adler et al. 2000), practitioners are playing an increasing role in determining and solving research problems. This kind of cross-professional collaboration is partly due the contextualisation of knowledge production which requires the joint efforts of both producers and users (Nowotny et al. 2001).

2.1.4 Towards novel research cultures and working environments?

Delanty (2001, 150) states that market forces have obliged universities to acknowledge instrumentalist purposes. Therefore, the term "McUniversity" (Parker & Jarry 1995) is in a way appropriate to describe the change in the treatment of academics, whom Rhoades (1998) calls managed-professionals. Accordingly, the external changes in knowledge production are forcing scholars to reinterpret their working conditions on the institutional, organisational and personal levels. Becher and Kogan (1992, 67–129) call these levels institutional, basic unit and individual. At the institutional level scholars are facing a university with diversified functions and a university which has had to reassess its relationship to government and industry. At the organisational level the basic units of the university are changing in order to meet the demands facing the entrepreneurial university, especially those of enhanced competition and cooperation. At the individual level scholars have to accommodate themselves to the changes that have taken place in the nature of academic work and to different forms of knowledge production, of which one is cooperative research conducted in groups. (Välimaa 1999, 34–36.)

The external transformations of knowledge production can be summarised as follows: knowledge has become a constitutive mechanism of modern societies (Stehr 1994). In knowledge societies universities play an important role. However, the role of the university as an institution and as an organisation has been characterised as undergoing an epistemological wobble (Scott 1997, 7–8) which, in turn, has blurred the role of the university as a societal actor. Accordingly, the massification of higher education has its effects on knowledge production as well: the number of potential knowledge producers is increasing while the demand for specialist knowledge is also expanding (Gibbons et al. 1994; Määttä 2001). Owing to these changes, the research setting is in a state of transition which has been characterised as a transition from Mode 1 to Mode 2 knowledge production (Gibbons et al. 1994). Although this transition has meant greater opportunities for scholars to cooperate, it has also increased bureaucratic demands (e.g. Slaughter & Leslie 1997; Etzkowitz et al. 2000). Thus, academic capitalism has forced tightly-knit scientific communities to open up in order to meet economic and bureaucratic

demands. Collaboration among scholars has also increased not only in scale but also in nature, involving a greater variety of different scientific communities (Chompalov & Shrum 1999). Accordingly, collaboration can contribute to the transformation of the whole field of study (e.g. Knorr Cetina 1995a) and to the nature of academic work, especially now when transdisciplinary cooperation has became more frequent.

These external changes have contributed to the increase in the scale of research group work. Although there are differences between fields of study with regard to the prevalence of group work, research group work is increasing throughout the academic community for three reasons. First, since the numbers of informational occupations in the knowledge society and the number of doctorates capable of producing new knowledge are increasing and knowledge production is being harmonised internationally (e.g. EU-funded research programs), it is inevitable that the cooperative research will become more frequent, especially in the hard sciences. Second, owing to the capitalisation of knowledge production, an individual researcher is no longer able to meet all the attendant scientific and bureaucratic demands. Third, and most important, the contextualisation of scientific knowledge production is changing the relationship between knowledge producers and users which, in turn, is promoting collaboration among academics and practitioners. All of these above-mentioned factors are also affecting the nature of academic work by creating new working environments.

2.2 The internal changes in knowledge production

As noted in section 2.1, certain societal developments are affecting knowledge production and organisation of research practices. On the one hand, knowledge production is facing challenges based on the transformation of the epistemological structure of scientific knowledge. Thus, knowledge is a two-sided entity: although knowledge is self-producing it always exits in a social and cultural context (Delanty 2001, 18; also Barnes, Bloor & Henry 1996). The research group can be regarded as one such context.[12]

This dual nature of scientific knowledge – self-production as well as a social and cultural existence – means, according to Gumport and Snydman (2002, 375–376), first, that universities both reflect and reconstitute classifications of knowledge and thus establish categories of expertise. According to Hirst (1998, 260) these classifications and categories are based on structured and rational human experience, that is, the traditions upon which disciplines are founded. Second, organisational contexts play a role in what comes to count as knowledge. In other words, the university and its basic units reflect our understanding of what is counted as knowledge. In sum, the

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12 Fuller (2003, 24) notes that the internal scope of knowledge production is elided, for example, in the Mode 1 and Mode 2 distinction.

academic basic unit, whether a faculty, department or even research group, faces challenges both externally and internally. Between these two sources of change there is interdependence (e.g. Gumport & Snydman 2002), and it is this interdependence that defines the nature of academic work.

As there seems to be a close relationship between the epistemological structure of science, i.e. what counts as knowledge and the social and cultural contexts in which these structures are produced and maintained, the question is ultimately reduced to how external and internal sources of change interact. This leads to the contention that modern science is in a state of epistemological wobble (Scott 1997, 8–9), which means that contemporary science is ontologically and methodologically fragmented (Galison & Stump 1996) and thus the relationship between external and internal sources of change is also blurred. Knorr Cetina (1999, 4) has described this fragmentation as follows:

> The enterprise [the science], however, has a geography of its own. In fact, it is not one enterprise but many, a whole landscape – or market – of independent epistemic monopolies producing vastly different products.

This fragmentation of science into *epistemic monopolies* has its effects on knowledge production and on the organisation of knowledge production. Two different internal sources of change can be distinguished. First, the democratisation of knowledge, that is, the participation of more and more actors in the social construction of reality (Delanty 2001, 6) has changed the epistemological meanings of knowledge production. Second, new disciplines such as gender studies have emerged and some "traditional" disciplines have been divided into specialisms and subspecialisms (e.g. Traweek 1988) or into knowledge areas (van Vught 1989, 258), as their fields of study have become more sophisticated (see also Becher & Trowler 2001, 14–15), even to the extent of questioning the concept of a scientific discipline altogether (Knorr Cetina 1982, 117–119; 1999, 2–3). Taken in tandem, these two premises suggest that what is counted as scientific knowledge is changing, thereby obscuring the internal dynamics of science and affecting the nature of academic work.

2.2.1 The democratisation of knowledge

The contextualisation of knowledge production has changed not only the external conditions of knowledge generation and the nature of academic work but also the epistemological terms of knowledge construction, i.e. what is counted as scientific knowledge. As Delanty (2001, 6) has pointed out, the university still plays an important role in determining what is knowledge, but this demands reconstitution of the university as an institution.

The involvement of more actors in and outside the university in knowledge production is clearly changing the status and epistemological structure of knowledge. The effects of the contextualisation of knowledge production on the epistemological structure of knowledge are, however, controversial. Gumport and Snydman (2002, 376–377; also Delanty 2001, 17–22) claim that the changes in the understanding of what is counted as knowledge

are reflected in the bureaucratic structures of universities. Thus, the production and ritualisation of knowledge categories occurs through the creation and maintenance of the formal organisation of knowledge, that is, through academic departments and degree programs etc. On the other hand, not only do formal academic organisations of knowledge affect knowledge production and ritualisation, but formal non-academic organisations of knowledge, such as private enterprises, also affect how scientific knowledge is understood in academia (e.g. Clark 1998). This means that knowledge production is in turmoil both externally and internally, since the external changes described in chapter 2.1 are changing the concept of scientific knowledge and thereby the formal organisation of knowledge in the university.

Accordingly, with the democratisation of knowledge, what is regarded as science or scientific knowledge is no longer self-evident. As Gibbons et al. (1994, 4, 7) have noted, Mode-2 knowledge is an outcome of continuous negotiations by different interest groups, and thus knowledge production becomes diffused throughout society. Mode-2 science does not, however, imply that the scientific objectives of knowledge production are weakening. Instead, purposes additional to the scientific are being included in knowledge production. Since knowledge generation involves actors from different sectors of society (e.g. industry), the research aims come from different sources with the result, as Etzkowitz et al. (2000, 56–57) state, that knowledge is produced in a common and *border-crossing institutional sphere* where the domains of academia, industry and government are overlapping. In this sphere, the evaluation of what is counted as scientific knowledge is continuously being reassessed and reformulated and thus, boundary-work, i.e. how scholars define science and scientific knowledge by "attributing characteristics that spatially segregate it from other territories in the culturescape" (Gieryn 1995, 440) becomes important. Additionally, the epistemic structure of scientific knowledge has changed in the way that knowledge itself has become an ever changing and negotiated entity. This is what Gibbons et al. (1994, 7–8) refer to as social responsibility and reflexivity. Furthermore, the border-crossing institutional sphere of knowledge production has changed the role and status of disciplines (see section 2.2.2).

How has the democratisation of knowledge changed the organisation of knowledge production and the nature of academic work? As Nowotny et al. (2001) have stated, in Mode-2 science knowledge production is conducted in heterogeneous research settings which include practitioners from universities, the public sector and industry. This has opened knowledge production to both the producers and users of knowledge. Thus, researchers are, to a degree, forced to cooperate with practitioners and this in turn has increased the demand and possibilities for research group work. Although, as Fuller (2000, 137) notes, it is not self-evident that scholars are willing to negotiate about research standards and strategies, the question is less about actual cooperation and more to do with how the border-crossing institutional sphere of knowledge production modifies the conditions of knowledge generation in universities in general. According to Gibbons et al. (1994, 7–8) social responsibility ultimately

transforms and reformulates academic knowledge production in all fields of study but especially in those, like medicine and engineering, which operate in the heart of the border-crossing institutional sphere of knowledge production. Nevertheless, the democratisation of knowledge production has created spaces, of which the research group can be regarded as one, in which knowledge production and ultimately academic work is the outcome of negotiations between different, academic and non-academic, interest groups. This entails collaboration among academics as well as collaboration between scholars and practitioners such that networks and personal contacts can be seen as tradable currencies (Shove 2000, 65).

2.2.2 Fragmentation of disciplines

Disciplines are traditionally regarded as the foundation of all academic life and the basis of scientific knowledge production (Clark 1983, 28; Becher & Trowler 2001). Current developments in knowledge production, multidisciplinary research and the emergence of new disciplines, the contextualisation of knowledge production and the democratisation of knowledge are challenging disciplinary foundations of research practices and academic work. Thus, the idea of disciplines as a central feature of academic life has been questioned (Knorr Cetina 1999, 2–3).

Clark (1983, 28–34; 1996, 419–423) stresses the growth of knowledge as well as the growth and fragmentation of disciplines as constituting the basic structure of higher education. For example, new disciplines such as gender studies have emerged and some "traditional" disciplines have been divided into specialisms and subspecialisms (e.g. Clark 1983, 35–36; Traweek 1988). At the same time, disciplines seem to grow and disperse in order to cover more ground (Becher & Trowler 2001, 14). However, the idea of disciplines as the constitutive mechanism of higher education and knowledge production has been questioned.[13] Knorr Cetina (1982; 1999, 246) suggests that new scientific knowledge often emerges not within disciplinary communities but in interactions between different types of actors. Furthermore, actor network theory pays attention to the fact that a network is composed of heterogeneous elements and actors, the latter including not only human actors but also organisations such as laboratories (Miettinen 1993, 7). Knorr Cetina (1982, 1999) introduces the notions *transepistemic arenas of research* and *epistemic culture* both of which challenge the idea of the discipline as the territory where knowledge is produced. Transepistemic arenas of research are characterised by "negotiated symbolic or resource relationships" which scholars turn to or depend on (Jacobs 1987, 274). Similarly, epistemic culture refers to the different practices of creating and justifying knowledge in different domains. Knorr Cetina (1999, 2) rejects the specific term discipline since it has "proved less felicitous in capturing the strategies and policies of knowing that are not codified in

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13 The academic discipline is also problematic as an empirical entity. This is discussed more detailed in section 5.2.1 in terms of medicine and engineering.

textbooks but do inform expert practice." Knorr Cetina (1995b, 151–152) stresses that the key feature in the transepistemic research arenas is that almost everything from the elements, the outcomes and the procedures are negotiable in the making of scientific knowledge.

Moreover, Knorr Cetina (1999, 11–12, 166–171) shifts the focus from knowledge production to epistemic machineries in which individuals are replaced by the epistemic subjects. These epistemic machineries are the frameworks such as the laboratory or research group in which the scientists, epistemic subjects, operate. Thus, epistemic subjects are actors in knowledge-generating machineries that are organised and thought about but not governed by any single actor. There are, however, disciplinary differences with regard to the notion of epistemic subjects. Knorr Cetina (1999) studied laboratory life in the field of molecular biology and particle physics, both pure sciences (Becher 1989). Additionally, what is discussed in Knorr Cetina's study can be seen as applying more to the pure and technological sciences since they are at the centre of the border-crossing institutional sphere of knowledge production, that is, the pure and technological sciences meet the expectations held by industry, university and government. However, Knorr Cetina's epistemic subjects are actors in collective forms of knowledge production rather than actors in individual research practices.

Although the terminology which Knorr Cetina uses may seem abstruse, she has managed to describe the epistemological changes in the structures of disciplines. The epistemological core of a discipline is not unambiguous, since – as Knorr Cetina (1999, 3) has pointed out – contemporary science is fragmented for example via varying empirical approaches and different social machineries. Thus, replacing the idea of disciplines by that of transepistemic arenas of research in which an epistemic culture is evolved better captures the ever changing nature of science in the production of new knowledge.

The key implication that the fragmentation of disciplines as an arena for knowledge production and academic work have for research group work is, first, as Knorr Cetina (1999) has pointed out, that different empirical approaches and social machines are affecting collective research work, leading to a weakening of disciplinary boundaries. This means that the social, and especially cultural, contexts (cf. Barnes et al. 1996; see also Taylor, Barr & Steele 2002, 129–143) of research group work are determined in relation to different negotiable entities, such as the procedures used in knowledge production (Knorr Cetina 1995b, 152). Thus, research groups can be seen as transepistemic arenas of research where epistemic subjects interact and collaborate. This is particularly evident in medicine and engineering where research is often conducted in laboratory settings. Second, the foundation on which universities reflect and reconstitute classifications of knowledge and establish categories of expertise (Gumport & Snydman 2002) has been undermined with the questioning of the main building component, the discipline.

2.2.3 Towards negotiated research spheres?

As in external transformation, the changes in knowledge production internally are forcing scholars to reinterpret their conditions of work on the institutional, organisational and individual levels. At the institutional level the contextualisation of knowledge production is changing the institutional aspect of what is counted as knowledge. At the organisational level the basic units are changing since not only disciplines but also transepistemic arenas of research are defining research settings and the nature of academic work. At the individual level, scholars need to adjust themselves to diversified settings where scientific knowledge is not pre-determined but rather a constantly negotiated entity.

The internal transformations of knowledge production can be summarised as follows: due the contextualisation of knowledge generation knowledge producers and users are collaborating more often (Gibbons et al. 1994). This has changed the epistemological structure of knowledge. Thus, knowledge is produced in a common and border-crossing institutional sphere in which the domains of academia, industry and government are overlapping (Etzkowitz, 2000). In this sphere, the evaluation of what is counted as scientific knowledge is continuously being reassessed, negotiated and reformulated. Additionally, the concept of discipline as arena for producing new knowledge has been challenged by such notions as *transepistemic arenas of research* and *epistemic culture,* both of which stress that new scientific knowledge often emerges not within disciplinary communities but in interactions between different types of actors and domains (Knorr Cetina 1982, 1999).

Internal changes in knowledge production affect research group work, in particular through contextualised and democratised knowledge which is changing the concept of scientific knowledge and the idea of what is counted as scientific knowledge. Accordingly, research group work is an example of a situation where rather than disciplinary communities, cultural frameworks are defined by transepistemic arenas of research, which in turn are open to negotiations.

2.3 The societal and epistemological basis of research group work

Becher and Kogan (1992, 6–21) offer a model for higher education where they distinguish different structural components of higher education systems. In short, the model sees various structural components (individual, basic unit, institution and central authority) as facing external norms and pressures which have their effects on the internal norms and operations of each component. In Figure 4, the structural components in Becher's and Kogan's model are applied to the external and internal transformations in knowledge production presented in chapter 2.

	External pressures		Internal pressures	
Structural component	Changing structures of the knowledge society	Capitalisation of knowledge	Democratisation of knowledge	Fragmentation of disciplines

⇩ ⇩

Institution	Scholars are facing a university with diversified functions and a university which has had to reassess its relationship to government and industry.	Contextualisation of knowledge production changes the institutional aspect of what is counted as knowledge.
Basic unit	Basic units are changing in order to meet the demands facing the entrepreneurial university.	Basic units are changing since research settings, especially, are being defined not only by disciplines but also by transepistemic arenas of research.
Individual	Individual scholars have to accommodate themselves to the changing forms of knowledge production, changing nature of academic work and to diversified research settings where scientific knowledge is not pre-determined but rather a constantly negotiated entity.	

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SOCIETAL AND EPISTEMOLOGICAL BASIS OF RESEARCH GROUP WORK

FIGURE 4 Internal and external pressures toward change in knowledge production

External pressures toward change in knowledge production affect how institutions, basic units and individuals comprehend societal transformations. The institution has to accommodate to the diversification of functions, basic units have to face the demands of the entrepreneurial university and individual scholars have to adjust to changing research environments and the changing nature of academic work. Similarly, internal pressures toward change challenge what is counted as scientific knowledge, produce new research environments and subject scientific knowledge to negotiation. Since individual scholars form research groups, external and internal transformations in knowledge production come into being through individuals who operate in the same research group.

The external and internal pressures towards change in knowledge production create a tense environment in which different institutions, basic units, research groups and individuals operate. The different structural components are interdependent (Becher & Kogan 1992, 50–66) and, through this interaction between them, internal and external pressures toward change in knowledge production also come into being. Thus, this interaction between the internal and external constitutes the societal and epistemological basis of research group work and, as Ziman (2002, 67) observes, science's "social norms are inseparable from its epistemic norms" (ibid., 56). This means that the epistemology of science operates at the level of research practices and academic

work. What needs to be stressed here is that the societal and epistemological foundation of research group work is precisely that: it only creates the circumstances which enable the research group to function (for the role of societal and epistemological aspects of research group work in the whole research process see Figure 14 on page 87). The internal dynamics of research group work originates in the group itself through the relationship between different work characteristics (see chapter 4).

3 THREE APPROACHES IN STUDYING RESEARCH GROUP WORK

Before examining more closely the work characteristics of research groups, a short introduction to the different approaches which have been employed to study groups in research settings will be presented. Three different approaches can be distinguished: the constructionist approach (e.g. Latour & Woolgar 1986; Latour 1987; Knorr Cetina 1999), the cultural-historical activity theoretical approach (e.g. Miettinen 1999; Miettinen, Lehenkari, Hasu & Hyvönen 1999; Saari 2003), and the work design approach (e.g. Hackman 1988; Lacy & Sheehan 1997; Winter, Taylor & Sarros 2000; Parker, Wall & Cordery 2001; Winter & Sarros 2002).[14] The first two approaches, especially, have concentrated on analysing innovative group work, but the work design approach has also made a contribution to the study of research group work. In the following sections each of the approaches will be presented so that their epistemological premises, contribution to group work studies and critics they have met are illustrated.

3.1 Constructionist approach

The core idea of constructionism[15] – or more accurately social constructionism – is that knowledge is not a given social fact and hence scientific knowledge is constructed through social interaction. Thus, meanings are constructed and mediated through communication. Constructionists comprehend knowledge as "any and every set of ideas and acts accepted by one or another social group or

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14 Miettinen et al. (1999, 8) point out that there is great diversity with regard to approaches to the study of innovations. This classification, therefore, is not absolute. For example, philosophical-conceptual and historical approaches are ignored. Additionally, different categorisations have been offered (Miettinen et al. 1999, 8–15).

15 In general, this approach can be labelled the constructionist strand of the sociology of science.

society of people – ideas and acts pertaining to what they accept as real for them and for others" (McCarthy 1996, 23). Similarly, constructionist group work, and especially laboratory life studies, recognises that "the material world offers resistances; that facts are not made by pronouncing them to be facts but by being intricately constructed against the resistances of the natural (and social!) order" (Knorr Cetina 1995b, 148). Accordingly, science is ultimately a product of negotiation and renegotiation.

Most of the constructionist studies have focussed on analysing the construction of scientific facts in laboratories (e.g. Latour & Woolgar 1986; Knorr Cetina 1995a). Attention is paid for instance to the construction and fashioning of social arrangements within science (Knorr Cetina 1999), to the interactions between scientists in the pursuit of their goals and how internal standards and experimental evidence fail to provide for scholars' beliefs (e.g. Pickering 1984). What is common to constructionist studies is that they all address the importance of interaction in the construction of scientific facts instead of "cognitive processes" and "logical reasoning" both of which refer to the individual creation process.

In addition to the fact that knowledge production is viewed as a constructive process, the constructionist approach has questioned the traditional research frameworks by creating new concepts such as *transepistemic arenas of research* (Knorr Cetina 1982) or *epistemic cultures* (Knorr Cetina 1999) which replace the rather inert concepts *discipline* and *research community* (see also section 2.2.2). Furthermore, the constructionist approach has widened the methodological framework of studying research group work by introducing the ethnographical methodology (Knorr Cetina 1995b, 141).

The constructionist approach can be criticized for its overemphasis on the importance of social interaction. Ultimately, cognitive processes are excluded since knowledge production always includes social interaction.[16] In laboratory life studies this criticism is most pertinent with regard to the status of material objects in research work, that is, how a physical entity comes into existence. Second criticism can be levelled at the fact that constructionist laboratory studies have focussed on a single laboratory, whereas processes of consensus formation often involve more than one laboratory or even the whole scientific field. Third, the problem of applying a constructionist approach to laboratory studies in general is that it ignores the societal context and political aspects of science. Knowledge is seen as constructed in intramural laboratory lifeworlds, although the affect of external bodies, such as funding agencies, on the negotiation process is acknowledged. (Knorr Cetina 1995b, 152, 161–162.)

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16 Constructionism should not be confused with constructivism. In general, constructionism refers to social constructionism (Berger & Luckmann 1979), which stresses that reality is socially constructed. Constructivism includes a number of approaches, but all of them recognise the role of cognitive processes in the construction of reality. The existence of cognitive processes is ignored in constructionism. (e.g. Tynjälä 1999, 38–39.)

3.2 Cultural-historical activity theoretical approach

The cultural-historical activity theoretical approach is based on the Vygotskyan idea that the relationship between the human agent and objects in the environment is mediated by cultural means, tools and signs. Therefore, consciousness is not "situated inside the head of individual but in the interaction – realized through material activity – between the individual and the objective forms of culture created by the labour of mankind" (Miettinen 1999, 173). This symbolic mediatedness is central to the understanding of human consciousness, and thus consciousness and meaning are formed in collective activity (Miettinen 1993, 12; Miettinen 1999, 174). The essential unit of analysis is the *activity system,* which refers to a community of actors who have a common object of activity. Additionally, there is constant construction and renegotiation within the activity system. Thus, as a unit of analysis, an activity system unifies psychological, cultural and institutional perspectives (Miettinen 1999, 174; Miettinen 2000, 8). The cultural-historical activity theoretical approach stresses that the research object is always both historically and locally constructed (Saari 1999, 22) and that research activity is based on the orientedness of the object (Saari & Miettinen 2001, 304). Accordingly, activity is a collective, systemic formation that has a complex mediational structure (Engeström 1987, 78–79).

Activity-theoretical studies have concentrated on describing and investigating innovative processes either empirically (Miettinen 1999; Miettinen et al. 1999; Saari 1999) or theoretically (Tuomi 1999a). Studies have focussed, for example, on following the developmental cycle of a technical artefact from idea to material reality (Miettinen et al. 1999; Saari 2003), collaboration in constructing the research object (Saari 1999; Saari & Miettinen 2001) and the transition of innovations from developers to users (Hasu 2001). The results stress, among other things, the negotiability of scientific knowledge in research communities (Saari & Miettinen 2001) and understanding the development and creation of innovations as problem-solving processes (Miettinen et al. 1999).

The strengths and weaknesses of the cultural-historical activity theoretical approach is that it contains a number of theoretical positions, such as actor-network theory (Miettinen 1999) and sociotechnical system -thinking (Miettinen 2000). Additionally, Garrison (2001) levels three different criticisms at the activity-theoretical approach. First, contrary to its claims, activity theory does not transcend the dualism between the external and the internal. Second, it does not always take context into account because it fails to distinguish existence from essence. Third, the activity-theoretical approach over-intellectualises the activities it analyses. Additionally, activity-theoretical approach can be criticised over the fact that the central unit of analysis, that is, the activity system, is problematic when investigating research group work or the creation of innovations. Engeström (1987, 280) defines an activity system as a community of actors who have a common object of activity. When studying

research group work or innovation processes, however, this definition is problematic in that it is not self-evident that every actor is committed to the common goal of the activity. Thereby, it is doubtful whether consciousness and meaning are formed collectively, which is one of the key assumptions in the cultural-history theory of activity.

3.3 Work design approach

The work design approach consists of a heterogeneous group of social psychology-oriented group work studies. Therefore, this approach does not concentrate solely on studying research group work but rather group work in general. The work design approach pays attention to how a group is organised, for example, to process information, solve problems, or make decisions (Langfred & Shanley 2001, 86). It also enables analysis of the work characteristics typical of a certain job, thereby incorporating both the technical and the mental elements of that job (Eskildsen & Dahlgaard 2000, 1083). In sum, the work design approach pays attention how work is organised in groups and to how certain work characteristics interrelate. Current developments in the approach also stress the importance of contextualising work design as it enables "a greater integration with cognate area of research" (Parker et al. 2001, 433) and because these contextual factors have an impact on the internal composition of a group. Therefore, the relevant contextual factors are described in the present study (see Figure 9 on page 64). Altogether, the work design approach can be regarded as useful in analysing research group work, especially when the research purpose is describing and analysing group work *per se*.[17]

The work design approach is characterised by the fact that it models the phenomenon being investigated. Two different models or systems seem to dominate the recent literature (e.g. Farias & Varma 2000; Parker et al. 2001): Job Characteristics Model (JCM) and SocioTechnical Systems (STS) thinking.[18] They have affected how work design has been studied and they still are the most common approaches to work design research today although different extensions and challenges have been offered (Parker et al. 2001, 416). The JCM developed by Hackman and Oldham (1980; see also McGrath 1964) identifies five core job characteristics: skill variety, task identity, task significance, autonomy and feedback. The model assumes that these job characteristics or psychological states affect for example work satisfaction and internal work

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17 Work design should not, however, be confused with job design. Work design includes all the aspects related to a certain domain of work whereas job design only pays attention to the arrangement of the features of a specific job.

18 Also Herzberg's Two-factor theory (Parker et al. 2001, 415), Reengineering (Farias & Varma 2000) and Lean production (e.g. Niepce & Molleman 1998) have been identified as belonging to the work design approach.

motivation (Parker et al. 2001, 415) and thereby predict group effectiveness (Langfred & Shanley 2001, 87). As Ganster and Dwyer (1995) have pointed out, the JCM does not predict group performance well and therefore group level models based on the JCM also have been offered, such as input-process-output model which assumes that certain input states affect group outputs via the interaction that takes place among members, or a normative model of group effectiveness in which attention is paid on identifying the factors that enhance or depress the task effectiveness of a group (Hackman 1988, 316–318, 322–326).

STS concentrates more on group than individual work design and stresses the idea of autonomous or self-managing teams (Parker et al. 2001, 415) and takes into account the interdependence between the design features of the organisation and between the organisation and its environment (Farias & Varma 2000, 13). Thereby, compared to the JCM, STS widens the perspective from intragroup processes to cover organisational and even societal conditions (Hummels & de Leede 2000, 76). Additionally, these sociotechnical systems, which stress that different systems require a social system to integrate the activities of the people who operates, are guided by certain principles, such as a design's compatibility with its objective (Cherns 1976).

Previous studies on academics in the framework of the work design approach have paid attention to job satisfaction (Lacy & Sheehan 1997), academic work motivation (Winter & Sarros 2002), the quality of academic working life (Winter et al. 2000) and developing a model of academic research teams (Nason & Pillutla 1998). In general, the work design approach can be criticised for its tendency to oversimplify the reality it investigates, that is, group work (Hackman 1988). Furthermore, the work design approach pays little attention to the cultural conditions of group work, given that these conditions create the environment in which a group operates (Taber & Taylor 1990). The work design approach does not include learning as a key feature in group work, although recent studies (e.g. Senge 1990; Kasl & Marsick 1997) stress groups as the smallest unit of organisational learning and that the group, not only the individual, is able to learn. Therefore, extensions to work design theory have been made in order to overcome existing limitations (e.g. Parker et al. 2001; see also section 4.6).

3.4 Methodological aspects of the approaches

All of the approaches, constructionism, cultural-historical activity theory and work design, make their own contribution to the study of group work. They are suitable in investigating research group work, but their use depends on the purpose of the study. Therefore, there are differences between approaches with regard to their epistemological orientations, research focus, methods and research purposes (Table 2). The constructionist and cultural-historical activity theoretical approaches rely on subjectivism, that is, the research object is seen socially, and especially in activity-theoretical approach, situationally

constructed. On the contrary, the work design approach is mainly based on objectivism, where the research object is comprehended as a "realistic entity". The most important difference between the approaches is in their research focus: the work design approach stresses the different individual-, group- and environmental-level factors which affect group's effectiveness, the constructionist approach pays attention to negotiation and interaction between the group members and the activity-theoretical approach concentrates on the construction of the research object. The epistemological orientation in turn determines the purpose of the study and the methods used in the approach. Constructionism and cultural-historical activity theory thus seek to understand the phenomena under investigation whereas the work design approach describes and explains the relationships between the variables being measured.

TABLE 2 A comparison between the work design, constructionist and cultural-historical activity theoretical approaches

	Work design	Constructionism	Cultural-historical activity theoretical
Epistemology	objectivism	subjectivism	subjectivism, holism
Research focus	factors affecting group's work on the individual, group, and environmental levels	interaction and negotiation	construction of research object
Research purpose(s)	describing, differentiating, explaining	understanding; taking into account cultural aspects of research group work	understanding; taking into account psychological, cultural and institutional aspects of research group work
Methods (primary)	questionnaires	observation	multimethods, especially interviews and observation

As a whole, the different approaches should be seen as complementary rather than in opposition to each other. For example, the work design approach stresses how a group is organised, for instance, to solve problems, but it pays little attention to interaction between group members which, in turn, is the central unit of analysis in constructionism and in some respect also in the activity-theoretical approach. In this study, research group work is investigated in the framework of the work design approach since the purpose is, first, to describe and explain the relationships between different work characteristics and then to examine the results in relation to the elaborated model of work design, that is, in relation to the research group work design (for the methodological aspects of this study see chapters 5 and 6). Thus, the preferred approach will depend on the aim of the study.

4 CHARACTERISTICS OF RESEARCH GROUP WORK

As noted in the previous chapter, this study is based on the work design approach. In order to study research group work design, the work characteristics of research groups, that is, the role of the process characteristics at the group and individual levels, intragroup conflict and interpersonal trust are clarified and a theoretical model, which is loosely grounded in the elaborated work design model (cf. Parker et al. 2001), is constructed.

4.1 Process characteristics in group work[19]

Process characteristics refer to group interaction processes which can be defined as those things that go on in the group (Campion, Medsker & Higgs 1993, 829; Stewart & Barrick 2000, 136) or as "means by which members work independently to utilise various resources, such as expertise – – and to yield

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19 In common parlance the distinction between *team* and *group* is often ignored (Cohen & Bailey 1997, 241–243). As Katzenbach and Smith (1993, 214) have stated, teams can be distinguished from other collectives, such as groups, by the characteristic of shared interdependent work. On the contrary, the group is usually more broadly constituted to include work collectives whose members may have common goals but looser task connections (Offermann & Spiros 2001, 377). In the present study, however, no difference between group or team is made (both concepts are used equally) and research groups are defined on the basis of the following definition (see Langfred & Shanley 2001, 83): "a work group (or team) is a collection of individuals who see themselves and are seen by others as a social entity and who are embedded in one or more larger social systems." Furthermore, because the work done by groups affects people who do not belong to the group, the need to manage relationships with such people means their groups operate to some extent interdependently (Langfred & Shanley 2001, 83; also Katzenbach & Smith 1993, 45). Applying this definition to research group work, the larger social systems can be basic units, institutions or discipline and "people external to the group" are important reference groups such as funding bodies or collaborators.

meaningful outcomes" (Marks, Mathieu & Zaccaro 2001, 357). In this study process characteristics are divided into individual and group characteristics depending on whether the locus is on individual attributes or group outcomes. The selection of the process characteristics is based primarily on their frequency in the research literature, the work by Campion et al. (1993; 1996) having special importance here. *Individual process characteristics* refer primarily to group members' personal attributes, like team-oriented behaviour, or to those interaction processes which are personal rather than group entities. For example, task interdependence is primarily a personal attribute, although it can also be seen as a group process characteristic because the task each group member performs depends on how tasks are allocated within the group. However, it is ultimately each group member's personal decision how he or she will carry out that task. The individual process characteristics selected for this study are preference for teamwork, task and outcome interdependence, participation in decision making, workload sharing, social support and goal similarity. *Group process characteristics* are primarily outcomes of individual outputs for the sake of the group; typically these are shared expectations about the nature of group work. In this study three group process characteristics are considered: team spirit (group potency), group self-leadership and cooperative group norms. This categorisation into individual and group process characteristics is not, however, clear-cut as it is difficult at times to say whether the focus of a process characteristic is on individual attributes or group outcome. Therefore, the taxonomy used in this study is a heuristic tool rather than an absolute classification.

4.1.1 Individual process characteristics

Preference for teamwork

A central feature defining groups is the group's preference for team work, that is, the level and nature of interaction among group members. Watson, Johnson and Merritt (1998, 164) have stated that it is not always reasonable to make a clear distinction between group and self because members of groups operate within the context of both group and self and at times groups must turn their attention away from team integration and focus on individuals' expectations. Nevertheless, it is essential to recognise the group's preference for team work e.g. whether the team is self-oriented or team-oriented (Watson et al. 1998; Watson & Michaelson 1988). According to Schein (1999, 173–176), self-oriented behaviour refers to the definition and redefinition of individuals' roles in a group. Watson et al. (1998, 162) add that a team orientation can evolve when team members interact effectively. Furthermore, Campion et al. (1993, 828) stress that individuals who prefer to work in groups may be more satisfied and effective in teams than when working alone.

Preference for group work can be seen from the level of either the individual or the group. On the individual level, group member can act as if he or she is working either for the group or for him- or herself in order to

accomplish given tasks. On the group level, collectivistic group members interact firmly and frequently while in an individualistic group the interaction is weak and occasional. However, distinguishing between collectivistic and individualistic or self and group is heuristic in that in order to accomplish certain tasks, one has to behave in both self-oriented and team-oriented ways so the orientations are not exclusive but rather at opposite ends of the same continuum. Previous studies have found mixed results with regard to the effect of a preference for group work. Some studies (e.g. Battenhausen 1991) indicate that a team orientation usually will have positive effects on group performance, whereas self-orientation can both promote (Gersick 1988) and prevent (Watson et al. 1998) group behaviour. Watson and Michaelsen (1988, 496–497) in reviewing previous studies found that where individuals in a group do not freely pool crucial information the performance of the group will be poor whereas in other cases the sum of the individual inputs may yield a "synergy that greatly surpasses the best member" (ibid., 497). Schmitt and Klimoski (1991, 216–219; also Bonner, Baumann & Dalal 2002) specify that the likelihood of the group performing better than the best individual increases when the problem has multiple parts, no one member has all the information necessary, the problem is at least moderately complex, interdependence is necessary, and there is enough time for members to process information. Thus, it seems that groups are likely to be more productive than individuals in certain tasks. Additionally, the distinction between individualistic and collectivistic cultural values influences group work (Earley & Gibson 1998; Gibson 1999), although it is unclear whether collectivistic cultures promote team work (e.g. Sosik & Jung 2002). Furthermore, Wittenbaum and Stasser (1996) have suggested that group familiarity, that is, group members' familiarity with one anothers' expertise and perspectives, displays open communication and interaction among group members and thus promote group interaction. In sum, group interaction behaviour can both promote and prevent group work depending on the task in hand; similarly cultural values also have an influence on the individualistic and collectivistic orientation of the group.

Schmitt's and Klimoski's (1991) idea of group performance seems to be justified in research group work. In fact, many (transdisciplinary) research groups are formed in order to solve diverse problems and bring together scholars with different expertise (Chompalov & Shrum 1999, 339–341; Hakala et al. 2003, 48) because some scientific problems are impossible of solution by a single scholar. Additionally, individualistic and collectivistic (disciplinary) cultural values also play a role in research group work as Becher and Trowler (2001) have observed. Differences could also be found between disciplines in terms of commitment to and preference for group work. Collaboration and group work are more common in the hard sciences, whose well-established conceptual paradigms exist (e.g. Baldwin & Austin 1995, 46; Becher & Trowler 2001, 122–126), such as medicine and engineering. Therefore, a preference for group work would seem to be a significant determinant of the success of research group work, especially in hard disciplines such as those selected for this study (engineering and medicine).

Interdependence among group members

Interdependence[20] is a defining characteristic of all groups (Wall, Kemp, Jackson & Clegg 1986; Schmitt & Klimoski 1991, 216–218). Stewart and Barrick define (2000, 137; also Campion et al. 1993, 826–827) interdependence "as the extent to which team members cooperate and work interactively to complete tasks. High interdependence occurs when team members interact cooperatively and depend on each other for information, materials, and reciprocal inputs." Stewart and Barrick in turn focus on teams as whole and define (task) interdependence according to the division of labour within the group (see also Saavedra, Earley, & Van Dyne 1993). Thus it is essential for group work that the group's members understand and are able to manage their interdependence (Watson et al. 1998).

Group members can experience interdependence in terms of goals, tasks and outcomes (Figure 5). *Goal interdependence* (Campion et al. 1993, 827; Campion, Papper & Medsker 1996) refers to the closeness of each member's individual goals to the group's goals. These joint group goals reflect the purpose and mission of the whole group. According to van der Vegt, Emans and van de Vliert (2001, 63–66) there is a relationship between task interdependence and goal interdependence so that task interdependence can be either beneficial or detrimental to the affective responses of group members, depending on the degree of goal interdependence, and vice versa. Members who experience relatively high levels of task interdependence seem to be more satisfied with their job and the group, and the reverse pattern holds for members of groups characterized by low goal interdependence. *Task interdependence* can be defined as "the connectedness between jobs such that performance of one depends on the successful performance of the other" (Kiggundu 1983, 146; also Wageman 1995, 146–147; Langfred & Shanley 1997; van der Vegt, Emans & van de Vliert 1998, 127–128).[21] Thus, task interdependence is a structural feature of the instrumental relations that exist between team members (van der Vegt et al. 2001, 52) and exposes the degree to which group members must rely on one another to complete their work. Furthermore, Kiggundu (1983, 146–147) differentiates between initiated task interdependence and received task interdependence. Initiated task interdependence can be determined "as the extent to which work flows from one particular job to one or more other jobs such that the successful performance of the latter depends on the initiating job" (ibid., 147). Received task interdependence, on the other hand, is the extent to which a person in a

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20 Interdependence is conceptually close to preference for group work in that they both refer to group interaction processes.

21 Additionally, *resource interdependence* relates to task interdependence. Resource interdependence refers to interdependence where "each member can complete his or her part of the whole, but resources such as information are distributed among members and the whole task is not complete until each member has completed his or her part " (Wageman 1995, 146).

particular job is affected by the workflow from one or more other jobs (Kiggundu 1983, 147). Consequently, initiated task interdependence affects how other group members accomplish, that is, receive their tasks. *Outcome interdependence* is the individual's feedback and reward, where this is linked to the group's performance in order to motivate group-oriented behaviour (Guzzo & Shea 1992), e.g. team members believe that their personal benefits and costs depend on successful goal attainment by other team member (Van der Vegt et al. 1998, 130; see also Wageman 1995, 147). According to Van der Vegt et al. (1998, 130) outcome interdependence can be either positive or negative. In the case of positive outcome interdependence, group members believe that other members' goal attainment facilitates movement toward their own goals. Group members feel positively outcome interdependent to the extent that they all benefit from the excellent performance of fellow group members. In the case of negative outcome interdependence, team members believe that other group members' successful goal attainment makes them less likely to achieve their goals. Members of a research group may experience negative outcome interdependence when, for example, each of them wants to be seen as the most innovative group member by the immediate supervisor. Previous studies (e.g. Tjosvold, Andrews & Struthers 1991) indicate that group members working under circumstances of positive, as opposed to negative, outcome interdependence are more open-minded regarding others' arguments and desires, more concerned about each others' outcomes, and more inclined to search for solutions and compromises.

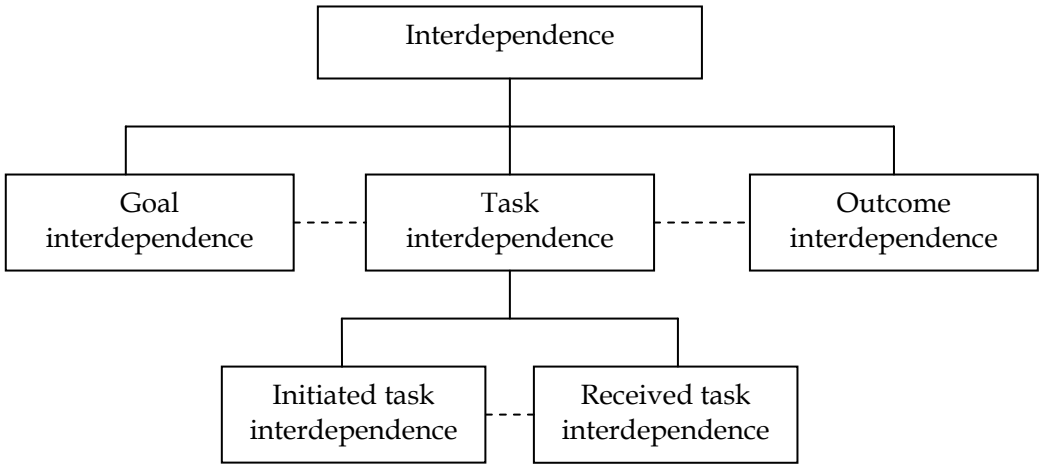

FIGURE 5 The elements of interdependence

Interdependence plays a central role in defining group work and especially group processes. Stewart and Barrick (2000, 144) have demonstrated a curvilinear association between interdependence and group processes and especially group efficiency. When interdependence is very high, intra-team processes are expected to be synergistic. In this case, the relationship between interdependence and intra-team processes is facilitated by group work principles. According to Hackman (1988, 329), the intense interaction created by

high interdependence results in a crystallisation of group norms. These intense groups tend to experience few process difficulties such as conflicts because the team members' behaviour is guided by shared expectations rather than by individual desires. Interaction also develops a cohesive group identity that motivates team members by encouraging them to subjugate personal interest to the interest of the team as a whole (Murnighan & Conlon 1991, 183–184). When interdependence is very low, group members operate as individuals, which means that the potential for process difficulties is low because group members are pursuing their personal interests. In such a case group work can function well, although the synergistic benefits of group work are elusive. In contrast to groups with high and low interdependence, groups with moderate interdependence experience process difficulties because of a need for intermittent dialogue between group members; however, the crucial point is that group member interactions are not consistent and intense enough to lead to the creation of open communication channels. Consequently, conflicts and other process difficulties between group members in moderately interdependent teams are more common than in high or low interdependent teams. (Stewart & Barrick 2000, 138.)

Wageman (1995) states that both interdependence and independence is required in group work and that the degree of interdependence needed is dependent on the tasks perform by the group. Wageman (1995, 151–152) also distinguishes a hybrid design that combines elements of interdependent and independent work. The research group can be regarded as a typical example of this hybrid group because usually each member has his or her own independent research which in turn is part of a larger project. As Clark (1983, 34–36, 41–49) has pointed out, academic work has traditionally been rather independent and fragmented, and universities themselves do not generally show strong interdependence, although the degree of interdependence among different types of universities with regard to their commitment to research or teaching varies considerably. Although interdependence between different academic institutions and organisations as well as individual researchers and research groups seems to be on increase (e.g. Chompalov & Shrum 1999), the lack of organisational interdependence can be seen as a major obstacle to interdependence and co-operation among individual scholars. Additionally, goal setting is an important part of interdependence. There are, naturally, differences between fields of study in terms of interdependence. Scholars in hard sciences, like medicine and engineering, tend to depend on each other more than scholars in soft sciences, like the humanities, because, for example, of their need for more sophisticated research instruments which in turn demand different kinds of expertise, thereby "forcing" scholars to cooperate (e.g. Baldwin & Austin 1995, 46). Patterson (2001, 161–163) has, however, observed a considerable diversity and complexity in university goals stemming from the effects on university operations of various interest groups, such as academic staff, administrators and funding bodies. Although there are no previous studies to show this, the increasing complexity of a university's goals must have an influence on the amount of interdependence among research group

members, since, for example, the research group leader has to take into account more different interest groups' goals than does the rank-and-file member.

Social support among members

Previous studies (e.g. Campion et al. 1993; 1996; Henkin & Wanat 1994) indicate that social support or team support is an important antecedent of group effectiveness. Most of the previous studies (e.g. Gladstein 1984; Campion et al. 1993) see social support as uni-dimensional, with primary emphasis on the emotional aspect of social support. However, according to West (1994, 66–71), team support is a multidimensional concept with four aspects: emotional, informational, instrumental and appraisal support. Team emotional support is the kind of social support that is most readily identified because it refers to the sympathetic understanding of another's emotional pain. For example, a research group will be more emotionally supportive if the scholars show mutual concern for each other's emotional well-being. Team informational support describes the extent to which team members exchange information necessary for their functioning, for instance, research group members help each other in order to solve a theoretical or empirical problem. Team instrumental support describes the practical support that group members offer each other; for example, a research group member helps a fellow-scholar if he or she has computing problems. Appraisal support refers to the help individual group members can provide one another in making sense of a particular problem situation. Dealing with problem situations is not mainly to do with offering solutions but rather about examining a range of alternatives. For example, research group members can consult each other on professional problems and exchange perspectives. These four facets of social support are conceptually distinct but in practice, naturally, intersecting.

Without social support group members may not be able to cope with their everyday tasks, and this will ultimately have a debilitating effect on group performance and cohesion (Porter, Lawler & Hackman 1979). On the other hand, the group's "effectiveness may be enhanced when members help each other and have positive social interactions" (Campion et al. 1993, 830) and thereby enhance feelings of fraternity and supportiveness. Axtell, Holman, Unsworth, Wall, Waterson and Harrington (2000, 276–277) found that team support and other organisational characteristics influence the implementation of ideas. Thus, regardless of whether social support is seen as uni- or multi-dimensional it can, depending on its degree and quality, either promote or hinder the group's effectiveness and the development of a good working atmosphere.

Participation in decision making, workload sharing and goal similarity

Groups can differ in terms of the degree to which all members are allowed to participate in decisions. Participation increases members' sense of responsibility and ownership of the work (Campion et al. 1993, 826), job satisfaction (Miller &

Monge 1986) as well as their cohesiveness (Keyton 1999). Furthermore, Wheelan, Murphy, Tsumura and Kline (1998) found out that little participation in decision making was negatively correlated with group productivity. In their study of academics in Australian universities, Winter and Sarros (2002, 253) observed that in general participation in decision making was moderately low, but professors participated more than lecturers. Currie and Vidovich (1998, 160–170) point out that decision making in universities is complex, involving different power groups in the policy process. Although different decision making styles are apparent, the power is concentrated in the senior academics.

Workload sharing is an important process characteristic in the sense that it prevents social-loafing and thereby enhances group effectiveness. Additionally, "workload sharing reflects the extent to which members of a team do a fair share of the team's work" (Erez, Lepine & Elms 2002, 930) and not depend on others to do the work for them. In order for group to share workload, "group members should believe their individual performance can be distinguished from the group's, and that there is a link between their performance and outcomes" (Campion et al. 1993, 830). Furthermore, there is a relationship between workload sharing and productivity as, according to Campion et al. (1993, 841; 1996, 448), workload sharing is very predictive in terms of group's productivity.

In group work, goal similarity is important because when individuals have goals that are not only "their own" but also contribute to the overall success or failure of the group goal, both individual and group performance are more successful. Because individual goals are closer to a person, that individual will strive more diligently to achieve them. As the individuals start to see success, then, in turn, the group eventually experiences more success. Over time, this often leads to individuals feeling more committed to the group (Sweeney & Lee 1999) and can lead to the eliminating of individual goals. (Schroeder 1996.)

4.1.2 Group process characteristics

Group potency, cooperative group norms and team self-management

Group potency refers to a belief or strong sense of confidence that group can be effective. In other words, group members develop a strong can-do attitude, the belief that the group can perform effectively, when they perceive that their personal resources are in accordance with the task at hand and, by developing this collective belief structure that is shared among its members, the group begins to develop a sense of coherence. Therefore potency, also known as team spirit, helps groups adapt to adversity and meet unexpected challenges, and it also contributes to how disagreements are handled. (Guzzo, Yost, Campbell & Shea 1993, 87, 89.) Campion et al. (1993, 839; 1996, 443–444) found that the potency beliefs of group members predicted group satisfaction and productivity. Additionally, both internal resources, such as group goals and size, as well as external resources, affect how potency is perceived in group

(Guzzo et al. 1993, 99–101). Thus, a group's sense of potency is a product both of assessments of resources within the group and the organisational conditions in which groups perform. Sivasubramaniam, Murry, Avolio and Jung (2002, 74) conclude from the previous studies that "groups that quickly develop shared beliefs of openness, participation, empowerment, trust, and challenging each other's beliefs – – develop a strong can-do attitude – – that translates to superior performance." Furthermore, there is a clear relationship between leadership styles and group potency (e.g. Shamir, House & Arthur 1993; Sivasubramaniam et al. 2002) and task performance (Lindsley, Brass & Thomas 1995).

Cooperation between group members is a key issue for the working and performing of groups because it refers to the quality of interaction among the members of a group. Ideally, cooperation is concretised in cooperative group norms which reflect "the degree of importance people place on their personal interests and shared pursuits, – – shared objectives, mutual interests, and commonalties among group members" (Chatman & Flynn 2001, 956). Cooperation or more precisely cooperative group norms within the group have been shown to be related to the group's effectiveness and productivity. Cooperation and member satisfaction are also positively related, although the relationship seem to be stronger in groups that do complex knowledge work than in groups that do other types of work (Campion et al. 1993; 1996).

Preference for group work on the group level relates closely to the group's self-leadership or self-management, which is defined as "the extent to which teams have the freedom and authority to lead themselves independent of external supervision. Teams with high self-leadership decide how tasks should be carried out, as well as what should be done and why." (Stewart & Barrick 2000, 139.) According to Langfred and Shanley (2001; also Dunphy & Bryant 1996), in self-leading groups members are expected to make independent decisions and be proactive in their work behaviours. This, in turn, encourages participating in decision making and increases members' sense of responsibility (Campion et al. 1993, 826).

4.2 The dual role of intragroup conflict

The paradox of conflict, the fact that conflicts in groups can both promote (e.g. Brown 1983; Amason 1996; Jehn, Chadwick & Thatcher 1997; Simons, Pelled & Smith 1999) and hinder (van de Vliert & de Dreu 1994) team processes, plays an important role in group work. In general terms conflict can be defined as a "process in which one party perceives that its interests are being opposed or negatively affected by another party" (Wall & Callister 1995, 517). On to this definition conflicts can occur between individuals, groups, and organisations. Consequently, in analysing group work the focus will be on the relationships between group members. Thus, intragroup conflict is a conflict occurring among group members within a group (DeChurch & Marks 2001, 5). There are, however, different sources of conflict in group work. According to Jehn and

Mannix (2001, 238–239; also Pinkley 1990; Priem & Price 1991; Jehn 1995, 1997; Pelled, Eisenhard & Xin 1999), task, relationship and process types of conflict can be distinguished (Figure 6). *Task conflicts*[22] indicate situations in which disagreements exist among group members about the contents of the task being performed, including differences in viewpoints. The impact of task conflict on group performance is less clear (e.g. DeChurch & Marks 2001, 5, 17), although moderate levels of task conflict have been shown to be beneficial as it promotes more open discussion and consideration of alternatives, especially when dealing with a complex cognitive task (e.g. Eisenhardt & Schoonhoven 1990; Jehn 1995); however, task conflict can also be harmful (Lovelace, Shapiro & Wiengart 2001). *Relationship conflict*[23] refers to interpersonal incompatibilities arising from differences in personality – such as tension and animosity – among group members (Jehn 1995, 258). Previous studies indicate that relationship conflict has negative impacts on group outcomes and effectiveness (Jehn 1995; Jehn & Mannix 2001). *Process conflict* is defined "as an awareness of controversies about aspects of *how* task accomplishment will proceed" (Jehn & Mannix 2001, 239) and thus attention is paid especially to the issues of duty and resource delegation. Process conflict seems to be detrimental to group work if group members continually disagree about task assignments (Jehn 1997, 547–548; Jehn, Northcraft & Neale 1999). In sum, a moderate level of task conflict seems to be beneficial to group work, whereas both relationship conflict and process conflict seem to be detrimental. No theory or studies exist which pay attention to the interplay between different types of conflict so that, although it is possible that one type of conflict may transform into another type, empirical evidence for this is lacking (Jehn 1997, 532).

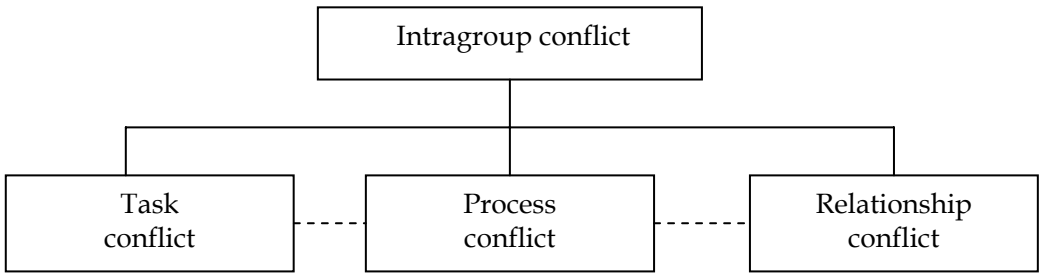

FIGURE 6 The elements of intragroup conflict

As conflicts are part and parcel of group work their actual implications only become apparent in the course of trying to resolve them. As DeChurch and Marks (2001, 17–18) suggest, conflict management plays an important role dealing with conflict situations so that even "groups with a great deal of disagreement can still be satisfied with their working experience if the conflict is managed in an agreeable manner." Jehn (1997, 533) points out that while on

22 Also known as cognitive or functional conflict.

23 Also known as affective or emotional conflict.

the other hand negative forms of conflict (i.e. relationship conflicts) need to be resolved, other more productive forms of conflict (i.e. moderate task conflict) can be beneficial. In other words, constructive conflict resolution increases the positive effects of conflicts (Jehn 1997, 551) and not all conflicts even need to be resolved. *Conflict norms* also play an important role in dealing with conflicts. Conflict norms refer to the standards that regulate behaviour among group members (Bettenhausen & Murningham 1985, 350), that is, how group members perceive and understand conflicts. An atmosphere which favours open discussions encourages members to express their opinions while also increasing tolerance of differing viewpoints. Accordingly, conflict norms can moderate the negative effects of conflicts and increase the positive effects of conflicts. However, conflict norms can also be harmful if they foster the avoidance of conflicts and see conflicts only as something that detracts from group work (Jehn 1995, 262–263; Brett 1991.)

Conflict in research group work has been little examined and sometimes even neglected altogether in collaboration studies (Baldwin & Austin 1995, 56–68). Younglove-Webb, Gray, Abdalla and Thurow (1999, 434–435) identified three tensions affecting group dynamics in (multidisciplinary) research teams: misunderstanding, mistrust and different degrees of focus that were needed in the group. Misunderstandings could either relate to the conceptual framework of the study or to questions of application. However, misunderstanding could also have positive effects where it forces group members to have ground-clearing discussions (cf. task conflict). Additionally, trust among group members was seen as important in order to have influence on other group members. The third source of tension refers to the fact that some group members are more outcome-oriented than others. Shrum, Chompalov and Genuth (2001, 689–702) note that in scientific collaborations conflicts occurred between groups, between researchers and the project management as well as between group members. They also add that disagreements are often interpreted by scholars as a challenge rather than a conflict. Furthermore, interpersonal difficulties in academic collaboration do not necessarily affect the venture as whole but rather remain at the interpersonal level. Shrum et al. (2001, 690), however, note the relative absence of interpersonal difficulties, such as idiosyncratic work styles, in academic collaborations.

4.3 Trust among group members

Trust is an important component of many social relationships, determining both the nature of the interaction and people's expectations of it (Fukuyama 1996). Clegg, Unsworth, Epitropaki and Parker (2002) have shown that trust plays an important role in innovative work and, according to Jones and George (1998; also Huff, Cooper & Jones 2002), trust is a key element in team work. Thus, trust facilitates informal cooperation and is therefore invaluable in work which demands cooperation. However, trust is a rather complicated concept

since it occurs among individuals as well as within groups, organisations, and even societies, and therefore trust can be viewed either as an individual characteristic, as a characteristic interpersonal transaction or as an institutional phenomenon (Bigley & Pearce 1998). Cummings and Promiley (1996, 303) define trust, in general, as "an individual's belief or a common belief among a group of individuals that another individual or group – – makes good-faith efforts to behave in accordance with any commitments both explicit or implicit, – – is honest in whatever negotiations preceded such commitments, and – – does not take excessive advantage of another even when the opportunity is available."

Lewicki, McAllister and Bies (1998, 439) specify trust as confident positive expectations concerning the other parties' conduct and distrust, in turn, as confident negative expectations concerning the other parties' conduct.[24] According to Huff et al. (2002, 25), the different definitions of trust have three elements in common. First, trust involves confident expectations regarding the intentions and behaviour of another party. Second, uncertainty plays an important role in trust because trust becomes salient in an environment of risk and uncertainty. Third, trust involves elements of dependence on the other party. Whitener, Brodt, Korsgaard and Werner (1998, 513) note "that trust involves some level of dependency on the other party so that the outcomes of one individual are influenced by the actions of another." Therefore, according to Yeatts and Hyten (1998), where trust is high, group members work more effectively and pay attention to things which are important for group work to succeed. Whitener et al. (1998, 513) also stress that trust always embodies the risk that the other party may not act as one has expected. Furthermore, trust develops through the individual's experiential process of learning about the trustworthiness of others by interacting with them over time (Lewicki & Bunker 1996), and therefore time is an important factor in the development of trust among group members. According to Sztompka (1999, 27–28) trust also involves at least three kinds of commitment. First, anticipatory trust, which is defined as action taken toward others "because I believe that the actions which they carry out anyway will be favourable to my interest, needs, and expectations" (ibid., 27). Second, responsive trust is the expected response of others to our placing of trust. The third form of commitment is when we trust intentionally to evoke trust. These different kinds of commitment reflect the fact that trust is socially embedded but subjectively experienced (see also Lewis & Weigert 1985).

In examining group work, special attention is paid to interpersonal trust. There are two components of interpersonal trust: trust as an affective state and as cognition (e.g. Lewis & Weigert 1985, 972–974; McAllister 1995, 25–26; Costigan, Ilter & Berman 1998, 306). Affect-based trust involves emotional investment in a relationship, and it therefore refers to the emotional bonds between individuals (Lewis & Weigart 1985, 971; McAllister 1995, 26). Trust is

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[24] This is very close to Luhmann's (1995) idea of the double contingency of trust/distrust.

cognitive-based in that we "choose whom we will trust in which respects and under which circumstances and, we base the choice on what we take to be 'good reasons' constituting evidence of trustworthiness" (Lewis & Weigert 1985, 970). Thus, the cognitive element in trust refers to the fact that ultimately trust rests on a "cognitive leap" (Lewis & Weigert 1985, 970), which indicates that trust is not only based on prior experience with the object of trust but that it has a collective foundation in that each individual trusts on the assumption that others trust. Previous studies indicate that there is a close relationship between affect- and cognition-based trust (McAllister 1995, 30), although cognition-based trust is seen as more superficial and less special than emotional trustworthiness. Additionally, Cummings and Bromiley (1996, 305; also Lewis & Weigert 1985, 970) distinguish a third component of trust, namely trust as an intended behaviour, that is, trust is not only an emotional state but it also effects how people plan to act. This behavioural content of trust is reciprocally related to its cognitive and emotional aspects (Figure 7). In reality these dimensions of trust, cognitive, emotional and behavioural, are overlapping and interpenetrating so that they form a "unitary experience and social imperative that we simply call 'trust'" (Lewis & Weigert 1985, 972).[25]

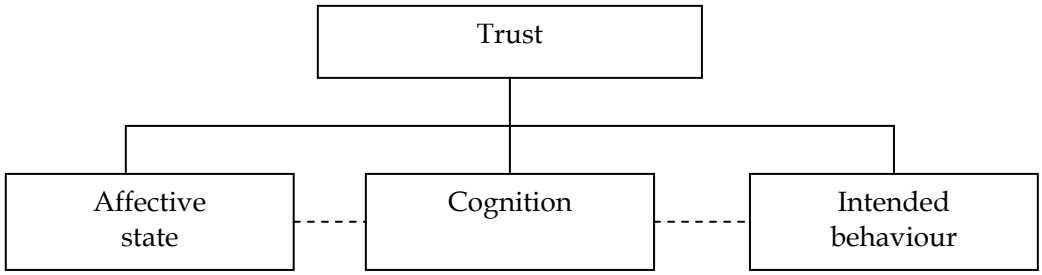

FIGURE 7 The components of interpersonal trust

Although trust has been found to be an important part of innovative work (Clegg et al. 2002) it has received little attention in research group work. Shrum et al. (2001, 716–717) found that higher trust does not increase a research group's productivity. When studying multi-institutional collaborations, Chompalov and Shrum (1999, 357–358) observed only an average level of trust between group members. Furthermore, Shrum et al. (2001, 686, 716–717) noted that collaborations with prior ties contained no greater overall trust than those without such relations, that is, groups that made use of extant social ties did not have higher levels of trust than groups brought together by mediators such as funding agencies. Shrum et al. (2001, 691, 716–717) also suggest a close relationship between trust and conflict whereby lower trust is associated with higher conflict. On the other hand, as Newell and Swan (2000, 1315) point out, an overly conflict-avoiding climate in research group work may cause a diminution of trust. Shrum et al. (2001, 687) also observed that in the academic

[25] Trust can also be classified differently; see for example Newell and Swan (2000, 1295–1297).

world where transient organisations are common the question is not so much about the level of interpersonal trust between research group members but rather between research groups. On the contrary, Newell and Swan (2000, 1323) argue that the nature of university environments is person-centred and therefore collaboration tends to be personal rather than organisational. Newell and Swan (2000, 1322–1324) also claim that the failure to develop trust is a consequence of the mechanistic pooling of knowledge where joint knowledge production is ignored. However, since the question concerns how group members trust each other, there are some elements of interpersonal trust that are important regardless of the type of group. Interdependence (Whitener et al. 1998), feedback and communication (Sapienza & Korsgaard 1996) and social similarity (McAllister 1995) are crucial antecedents of interpersonal trust but other organisational factors, such as leadership, and individual factors like thinking style also contribute to how trust is perceived (e.g. Clegg et al. 2002; Huff et al. 2002). To summarise, in research group work trust is important in that to attain individual and group goals it demands reliance on another group members, which, in turn, presumes interpersonal trust.

4.4 Structural characteristics of research group work

Group composition, especially group heterogeneity (Drach-Zahavy & Somech 2002) and group size (Bantel & Jackson 1989) have been shown to be important in explaining the success of a group. Group composition is mostly regarded as moderator (Parker et al. 2001), that is, group composition affects how work characteristics are experienced and it rarely affects *as such* research group work. Nevertheless, in this study group composition is named as a structural characteristic of research group work.

Group heterogeneity refers to the social composition of the group so that group members can differ in numerous attributes, such as gender, group tenure, personality traits and organisational role. There is, however, a distinction between task-related and relations-oriented attributes of heterogeneity. Task-related attributes are all the specific skills and abilities needed to perform the task at hand. In research work, task-related heterogeneity attributes might be, for example, tenure, educational level or skill at using a specific computer programme or special competence in relation to a specific research instrument. Relations-oriented attributes are personal characteristics that are *per se* irrelevant to the performance of the work. Gender and age are typical examples of relations-oriented attributes. (Drach-Zahavy & Somech 2002, 45). Additionally, functional heterogeneity, which refers to the diversity of organisational roles embodied in the group (Cox, Lobel & McLeod 1991, 841–842) has been distinguished. Functional heterogeneity is normally high in multidisciplinary and cross-professional teams. Previous studies (Pelled et al. 1999; Drach-Zahavy & Somech 2002) indicate a close relationship between group effectiveness and group heterogeneity. Pelled et al. (1999; also Ancona &

Caldwell 1992) found that functional heterogeneity drove task conflict. According to Drach-Zahavy and Somech (2002, 57–58) as well as Olson, Walker and Ruekert (1995), functional heterogeneity was positively related to the diversity of professional roles embodied in the group. On the contrary, a greater mix of educational backgrounds or educational levels did not contribute to the group's effectiveness. Similarly, the role of relations-oriented heterogeneity is less clear: some studies (Jackson 1992) indicate that it is detrimental to group work while some studies (Drach-Zahavy & Somech 2002) stress that it is advantageous to the group. Williams and O'Reilly (1998) conclude that diverse groups are more likely to be less integrated, have less communication and have more conflict.

The relationship between *group size* and group's effectiveness is not a simple one, although Shaw (1981, 168) concludes that group size directly influences group characteristics. Group size has been found to affect group effectiveness through its effects on team structures and on team processes (Bantel & Jackson 1989), but there is no group size which is optimal for effective performance since group size relates to, for example, task types. Nevertheless, Fay, Garrod and Carletta (2000, 481) found that group size relates to in-group communication so that communication in a 5-person group is more likely to be dialogue-based, whereas in 10-person groups communication tends to be based on serial monologue. Furthermore, Wagner (1995, 163–164), who studied participatory behaviours in an assigned group project, showed that as the group got smaller, more of the group's members participated in project preparation behaviours. Additionally, class-room studies have shown that as school class size increased, student achievement decreased (e.g. Mullen 1987). To conclude, previous studies indicate that large group size has a negative impact on group dynamics. In research group work, the size of the group depends, for example, on the variety and nature of the research problems addressed (what kinds of expertises is needed in order to solve the problems) and, especially, on the research funds allocated to employ research group members.

4.5 A summary of research group work characteristics

As noted in above sections, different, more or less interrelated, work characteristics are involved in research group work. In the summary chart of research group work characteristics presented in Figure 8 interpersonal trust, process characteristics and intragroup conflict form clusters of their own. The list of research group work characteristics is by no means complete, but the characteristics presented in Figure 8 form the basis for group work.

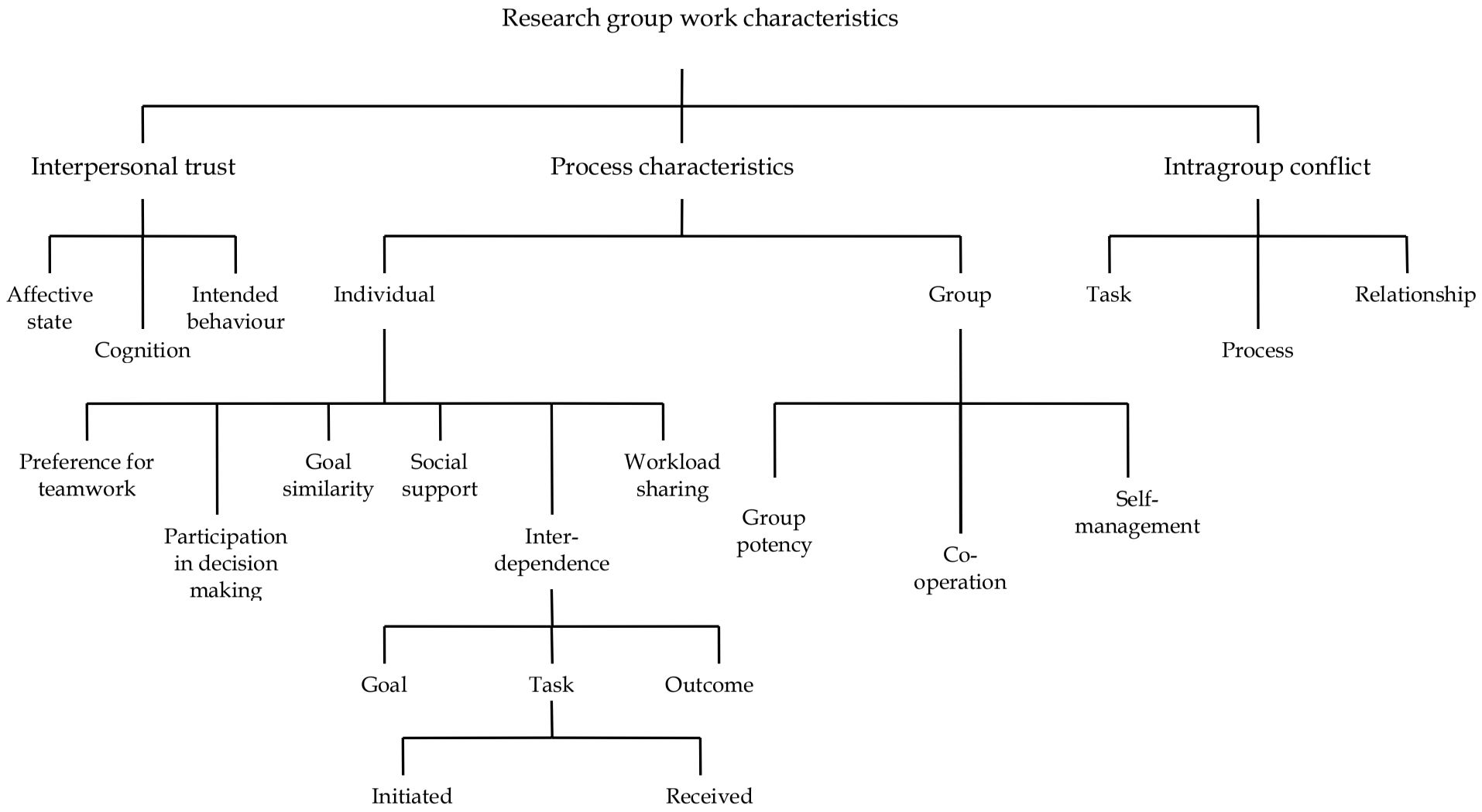

FIGURE 8 The key characteristics of research group work

4.6 A theoretical model of research group work design

The work design approach literature proposes different models for the analysis of group work. These are, for example, the input-process-output model (Hackman 1988), the team-level model of group processes (Hackman 1988) and the elaborated model of work design (Parker et al. 2001). What these models share is that they all focus both on how the group is *organised*, for instance, to process information, solve problems or make decisions (Langfred & Shanley 2001, 86) and on analysing the relationships between different work characteristics. In terms of research group work, at least one model based on the work design approach has been constructed. Nason and Pillutla (1998), for example, have developed a propositional model relating to international research teams in order to better understand the complexity of research group work. In the present study, a design for research group work is presented. The design is loosely based on the elaborated model of work design (cf. Parker et al. 2001), which comprises features from the JCM and STS (see also chapter 3.3) and on the model presented by Nason and Pillutla (1998).

The core idea of the design is that the research group does not exist in a vacuum but rather it always exists in cultural, organisational and societal contexts (Nason & Pillutla 1998, 158–159). Parker et al. (2001, 419) term these contexts antecedents and divide them into internal context, such as the nature of the tasks to be performed and culture, and into external contexts such as the uncertainty of the environment, social and cultural norms, and organisational factors, in order to illustrate the determinants that influence the choice of work design. The important contribution made by the inclusion of contextual antecedents is that it enables a better understanding of how the wider changes currently taking place influence work design and how work design could be regarded as a link between various contextual factors as well as organisational practices and outcomes (Nason & Pillutla 1998, 157–158; Parker et al. 2001, 419–421, 433). Therefore, the contextual factors are included in the theoretical model presented in this study to show that research group does not exist in a vacuum but in dynamic social and cultural contexts (see Figure 9).

To consider these contextual antecedents to research group work further, external antecedents can be described as developments that affect the group externally and irrespective of the actions taking place in it. In Figure 9 these antecedents are termed *epistemological and societal circumstances,* whereas in chapter 2 they were called internal and external transformations in knowledge production.[26] The most fundamental internal transformations were regarded as the democratisation of knowledge and the fragmentation of disciplines.

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[26] In case of knowledge production, the division between internal and external is such that internal changes are the changes in the epistemological structures of scientific knowledge and external transformations are the societal changes that affect knowledge production.

External transformations were regarded as the changing structures of the knowledge society and the capitalisation of knowledge production. The internal antecedents of research group work can be divided into two components: those which originate in the research group's culture and those which are based on the organisation of research group work. Cultural antecedents refer to the cultural conditions within which the group members interact (cf. cultural-historical activity theory). Organisational antecedents are based on the organisational design, for example how work is allocated among the research group members, which in turn impinges on how interaction takes place. These cultural and organisational antecedents are not, as such, investigated in this study although, for example, the allocation of working time by different tasks, which in some ways reflects the research group's organisation, was studied. *Work characteristics* refer to the characteristics that are typical of a specific job on both the individual and group levels. Therefore, work designs will differ (Parker et al. 2001, 422–424). For instance, work characteristics in research group work are different from the characteristics found in factory production lines. As noted in chapters 4.1–4.4, the key work characteristics of research groups are intragroup conflict and interpersonal trust as well as individual and group process characteristics (see also Figure 8). This list is by no means complete, but it contains the key work characteristics involved in research group work.

The elaborated model of work design also pays attention to the outcomes of group work, but since the present purpose is to focus on research group work characteristics and to the relationship between them, the close analysis of research group work outcomes must be left for future studies. In general, important individual outcomes in research group work are, in particular, job satisfaction, productivity and creativity. The two latter are also group outcomes. The clearest and most typical indicator of research group work effectiveness is publications. Altogether, research group work outcomes are diverse: they range from personally experienced job satisfaction or creativity to in-group reports or articles. Additionally, a variety of organisational, group and individual contingencies will affect work design. For example, the history of change in the organisation affects how work design leads to predicted outcomes. On the team level, group composition influences work characteristics and on the individual level, the individual's desire for learning, for example, can promote group effectiveness. In this study these contingencies – or structural characteristics as they are termed – are divided into two categories: those which originate in the group and those that are related to the individual. These structural characteristics are important as they can influence how research group members mould their work characteristics to fit their individual abilities.

Altogether internal antecedent, i.e. the research group's cultural and organisational principles as well as group outcomes are left outside the scope of this study and therefore they are not present in the theoretical model of work design (Figure 9). The structural and work characteristics of the research group and its epistemological and societal circumstances (external antecedents) are included in the theoretical work design model and form its substance.

As noted earlier, the design stresses the importance of noting the contexts in which the research group operates. These contexts were termed epistemological and societal circumstances, and they create, through institutions and basic units, a space and framework within which the research group can operate (cf. Nason & Pillutla 1998). In other words, these external circumstances function as *Zeitdiagnose,* not as empirical tools (see also Figure 14 on page 87), in the design. Research group work characteristics, which form the empirical component in the design, are divided into four categories: structural characteristics, process characteristics, interpersonal trust and intragroup conflict. The key question, however, is how research group work characteristics are interrelated and, especially, how structural and process characteristics affect interpersonal trust and intragroup conflict. It seems that process characteristics, which are the key elements in the division of labour within the group, determine how trust and conflict are perceived. For example how interdependence is perceived affects the degree of interpersonal trust and conflict among the group members. Furthermore, process characteristics seem to be interrelated; for instance, team orientation promotes cooperative group norms (Wittenbaum & Stasser 1996). Previous studies (Shrum et al. 2001; Clegg et al. 2002) indicate that interpersonal trust plays an important role in group work and that there is a close relationship between trust and conflict. Thus, it seems that if the group members trust each other highly, they experience fewer conflict situations, and if conflict is constructively solved, it increases interpersonal trust.

The role of structural characteristics is less clear since they are both antecedents and moderators of research group work, that is, structural characteristics can both cause and moderate certain work characteristics. The composition of the group (Bantel & Jackson 1989; Jackson 1992; Williams & O'Reilly 1998; Drach-Zahavy & Somech 2002) seems to generate contingencies and preconditions for research group work and thereby affect the relationships between different work characteristics. On the other hand, previous studies (e.g. Wagner 1995) have indicated a clear relationship, for example, between group size and intrateam processes, large group size being detrimental to group work.

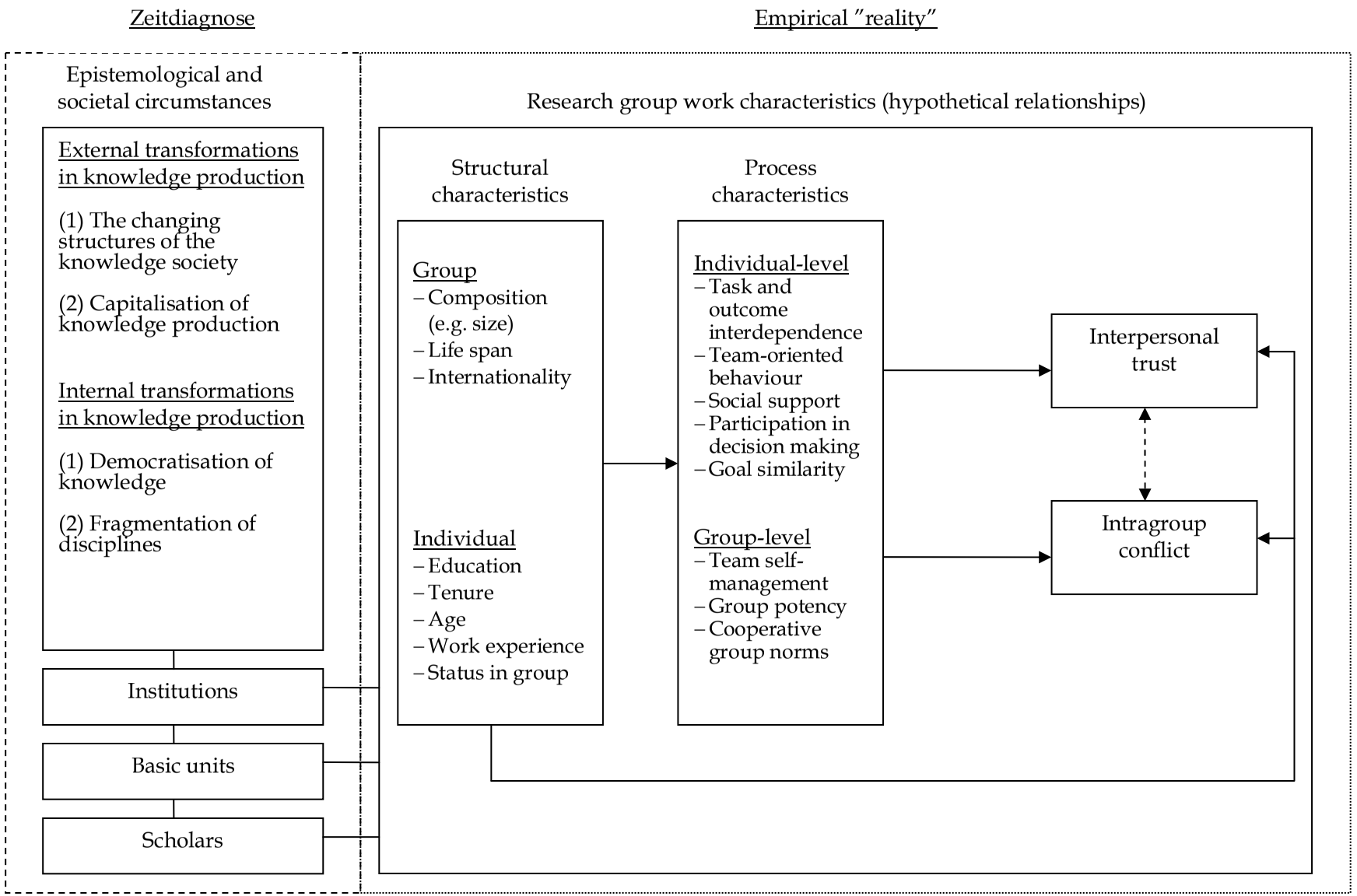

FIGURE 9 A theoretical model of research group work design

5 PURPOSES AND IMPLEMENTATION OF THE STUDY

5.1 Aims and problems of the study

How research questions are phrased depends on the purposes of the study. Typically, five different types of research purposes are distinguished: description, exploration, prediction, improvement and explanation (Marshall & Rossman 1995, 40–44; Gall, Gall & Borg 2003, 3–9). Many studies involve a *description* of specific social phenomena, i.e. what the typical features of a given social phenomenon are. In *explorative* studies, the researcher is interested in finding new perspectives on the phenomenon being investigated. In *prediction* studies the researcher predicts "a phenomenon that will occur at time Y from information available at an earlier time X" (Gall et al. 2003, 6). Thus, prediction is commonly used in longitudinal studies in which knowledge about factors that predict various outcomes that have social importance is generated. *Improvement* is a purpose in intervention studies where it is important to identify the effectiveness of interventions. *Explanation* is the most important study purpose since it subsumes the previous four. Ideally, explanations are framed as theories about the phenomenon being investigated.

The purpose of this study is to describe research group work characteristics and explain the relationships between them within the framework of the research group work design. Thus, the purposes of this study – describing and explaining – determine what kind of research questions need to be set. When the purpose of the study is to describe a given phenomenon, the questions posed are *how?* or *what kind of*? When the purpose is to explain, the focus is on *why* something is the way it is or *what results* the phenomenon being investigated has, i.e. attention is on the causal relationships. (Hirsjärvi, Remes & Sajavaara 2004, 128–130.) As noted earlier, however, explanation includes description – also at the level of research questions.

Research questions of the study

The research questions pay attention to how respondents *assess* work characteristics in their everyday working situations. Although the first main research question and its sub-questions are primarily descriptive, (probabilistic) explanation is also included (see also Table 5 on page 80–81). The study addresses the following questions:

1. How do members of research groups perceive work characteristics in medicine and in engineering?

   Work characteristics are central components of the work design approach. In research group work three different work characteristics are studied: process characteristics (individual and group level), intragroup conflict, and interpersonal trust among group members. For each of these work characteristics a description of how they were perceived by the respondents and an explanation of the relationships between them are given.

   1.1 What is the role of process characteristics in research group work?

   Previous studies (e.g. Campion et al. 1993; 1996) have indicated that the role of process characteristics is not clear-cut, although they seem more to have positive effects on how group work is perceived. The following sub-questions are posed about process characteristics in order to determine their role in research group work:

   1.1.1 What is the role of individual process characteristics (preference for team work, task and outcome interdependence, social support, goal similarity and participation in decision making) in research group work?

   1.1.2 What is the role of group process characteristics (group potency, cooperative group norms and team self-management) in research group work?

   1.2 What is the role of interpersonal trust in research group work?

   Previous studies (Clegg et al. 2002; Huff et al. 2002) indicate that interpersonal trust is a key component of work characteristics. Shrum et al. (2001) have also argued for a close relationship between trust and conflict whereby the higher the level of trust, the fewer the conflicts experienced. Thus, the purpose of this research question is to analyse the role of trust among research group members.

   1.3 What is the role of intragroup conflict in research group work?

   Conflict can both promote (Eisenhardt & Schoonhoven 1990) and prevent (Jehn 1995) a group's effectiveness. This dual role of conflict is unique in

work characteristics and attention is, therefore, paid to the occurrence of relationship, process and task conflict as well as to the resolution of conflict situations and to conflict norms, that is, to understanding how to behave in conflict situations.

2. How do research team members perceive their group work?

   2.1 What are the advantages and disadvantages of research group work?

   Previous studies (Younglove-Webb et al. 1999; Shrum et al. 2001) have pointed out that the advantages and disadvantages of academic group work have their origins in the work context as well as in different personalities. The purpose of this research question is to identify the typical pros and cons of research group work.

   2.2 How is working time allocated in research group work?

   Previous studies (e.g. McInnis 2000) have indicated that administrative tasks have increased, especially from the point of view of the most experienced researchers. The purpose of this research question is to determine how much time research group members spend on conducting research, writing publications, teaching, administration, managing the group and solving conflicts.

3. What is the design of research group work like?

   This study also seeks to formulate a design for research group work. A theoretical design was presented in section 4.6. This design will be supplemented and reshaped on the basis of the empirical findings. Thus, the design functions as an empirical and theoretical framework enabling the most important work characteristics to be identified and research group work placed into a wider social context.

Comparisons made in the study

In first two main research questions, comparisons are made between

- disciplines (medicine/engineering)
- genders
- status in group (leader/rank-and-file member)
- work experience as researcher (<3/3–9/>9 years)
- work experience in the group (<12/12–36/>36 months)
- degree of multidisciplinarity (discipline-based/multidisciplinary)
- group size (3–5/6–10/>10 members)

Furthermore, a classification of different types of research group members was constructed in order to differentiate respondents not only on the basis of their structural characteristics, e.g. discipline, but also according to their individual attributes (see section 7.1.1). Some of the variables studied measure group-level phenomena and some individual-level phenomena on the basis of the in-built assumption in the research group work design (see Figure 9).

5.2 Selection of target group

The selection of the target group has its theoretical and practical grounds. Theoretically, the selection was based on the Becher's (1989; also Becher & Trowler 2001) classification of disciplinary cultures. In practice, the target groups were selected from disciplines that have a long tradition in producing new knowledge in groups. Purposeful selection was used in order to recruit the research groups which participated in the study.

5.2.1 Practical and theoretical grounds for the target group selection

The target population in this study comprised members of research groups.[27] Research groups were drawn from two disciplines: medicine (n = 20) and engineering (n = 31). There were both practical and theoretical reasons for selecting these particular disciplines. Collaboration is standard practice in some fields of study and almost unheard in others; for example, research groups are more common in the natural sciences than in some soft fields of study (Baldwin & Austin 1995, 65; Hakala et al. 2003, 80). For practical reasons, therefore, medicine and engineering, which can be regarded as hard and applied as well as urban and convergent disciplines (see Figures 10 & 11), were selected. In addition, it was easier to find research groups in medicine and engineering than, for instance, in the social sciences.[28]

Theoretically, the selection was based on the Becher's (1989) classification of disciplines. In order to classify disciplines, Becher distinguishes two basic dimensions, cognitive and social. In the cognitive realm, there are two sets of properties: hard/soft and pure/applied. Hard disciplines have a clear

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27 The target population of the study is difficult to estimate as it consisted of all the members of research groups in medicine and engineering in Finland in 2001. Altogether 185 research groups in medicine and 296 in engineering were found. Multiplying the number of research groups by their mean size would yield target population of roughly 2600 in medicine and 2000 in engineering. The overall number of research group members in medicine and engineering in Finland would thus be around 4600.

28 The purpose was, originally, to include groups representing the social sciences in the study. However, there were too few groups (n = 3) willing to participate in the research and therefore groups from the social sciences were excluded. Additionally, the problems of using convenience as a ground for selecting target groups are recognised (e.g. Patton 2002, 241–242).

theoretical structure and they focus on causal propositions, generalisable findings and universal laws. Thus, the available methods tend to determine the choice of problems. Soft disciplines are characterised by the problems that are broad in scope and loose in definition as well as a relatively nonspecific theoretical structure. In soft fields, the problems determine the methods. The pure sciences are self-regulating while the applied sciences tend to be more open to external influences. On the social side as well, there are two sets of properties: convergent/divergent and urban/rural. Convergence relates to the maintenance of reasonable uniform standards and procedures and the existence of intellectual control. Divergence, in contrast, refers to the tolerance of a great measure of intellectual deviance. The urban–rural dimension of the social aspect of a disciplinary culture concerns the people-to-problem ratio. Urban scientists occupy a narrow area of intellectual territory and concentrate on a limited number of discrete topics. Rural researchers, however, occupy a broader area and it takes considerably longer to solve broadly determined research problems. (Becher 1989, 150–154.)

In this Becherian framework, knowledge fields and cognitive communities can be grouped according to Table 3.

TABLE 3 Knowledge and culture by disciplinary grouping (Becher 1994, 154)

Disciplinary grouping	Nature of knowledge	Nature of disciplinary culture
Pure sciences (e.g. physics): "hard-pure"	Cumulative; atomistic; concerned with universals, quantities, simplification; resulting in discovery/explanation.	Competitive, gregarious; politically well-organised; high publication rate; task-oriented.
Humanities (e.g. history) and pure social sciences (e.g. anthropology): "soft-pure"	Reiterative; holistic; concerned with particulars, qualities, complication; resulting in understanding or interpretation.	Individualistic, pluralistic; loosely structured; low publication rate; person-oriented.
Technologies (e.g. mechanical engineering): "hard-applied"	Purposive; pragmatic; concerned with mastery of physical environment; resulting in products/techniques.	Entrepreneurial, cosmopolitan; dominated by professional values; patents substitutable for publications; role-oriented.
Applied social sciences (e.g. education): "soft-applied"	Functional; utilitarian; concerned with enhancement of (semi-) professional practise; resulting in protocols/procedures.	Outward-looking; uncertain in status; dominated by intellectual fashions; publication rates reduced by consultancies; power-oriented.

When applying medicine and engineering to Becher's characterisation of disciplinary cultures, engineering seems clearly to be a "hard-applied"

discipline on the cognitive side.[29] In general, medicine is "hard-applied" science, but this categorisation is not unproblematic. The nature of the disciplinary culture in medicine is competitive and it has a high publication rate (Atkinson, Batchelor & Parsons 1998); thus, medicine has features of the "hard-pure" sciences. On the one hand, medical knowledge is cumulative and concerned with universals, but on the other hand, it is pragmatic and results in products or techniques. Thus, medical knowledge has features of the "hard-applied" sciences as well (Figure 10).

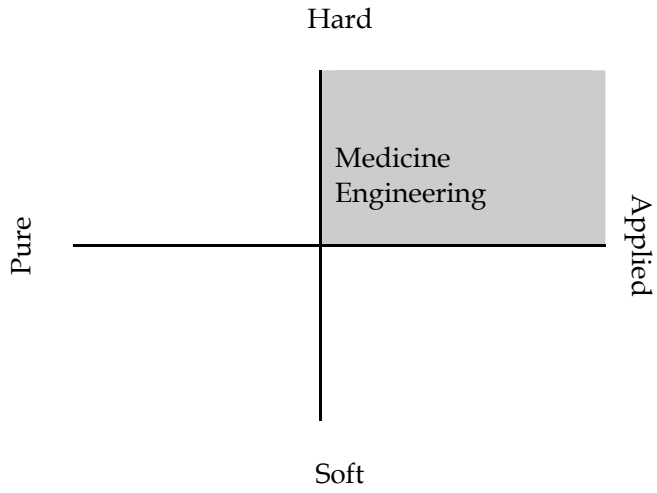

FIGURE 10 Medicine and engineering in the cognitive realm

On the social side, both medicine and engineering are categorised as convergent-urban disciplines. Medicine and engineering have and maintain reasonably uniform standards and procedures, although this is not an unproblematic characterisation. There may also be different "schools" researching the same topic using different approaches and procedures, but this is not as common as it is in more divergent disciplines like the social sciences. Both medicine and engineering are urban sciences, since they occupy a narrow area of intellectual territory and concentrate on a limited number of discrete topics (Figure 11).

[29] There are other ways to classify disciplines as well. Fields of science can be grouped as natural sciences (e.g. physics), applied sciences (e.g. engineering), life sciences (e.g. medical and health sciences) and interdisciplinary sciences (see e.g. Bourke & Butler 1998, 713).

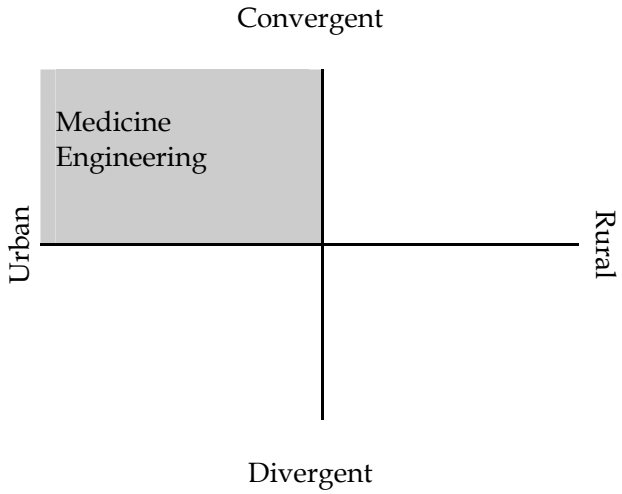

FIGURE 11 Medicine and engineering in the social realm

However, some remarks need to be made in connection with the discussion of disciplines. Atkinson et al. (1998, 261) have stated that "groups of scientists are unlikely to be static entities. They are characterized by movement and changing boundaries that are defined – – to incorporate researchers from other research networks or specialities or to take advantage of new opportunities." Thus, the term "discipline" is problematic in terms of its relation to specialisms and subspecialisms (Becher 1989, 42–45). The question which arises is how far different specialisms and subspecialisms can differ from each other and still belong to the same discipline. In the present study, there were 10 specialisms in medicine and 32 in engineering.[30] Therefore, it is important to consider whether these specialisms can be regarded as coming under a single discipline, "medicine" or "engineering". If they are, some of the crucial features of these specialisms is inevitable lost. Nevertheless, as Squires (1990, 112) has noted, disciplines are rather loosely connected and more or less closely related specialisms than firmly united entities.

However, there are some limitations in Becher's taxonomy (see also Ursin 1999, 41). Firstly, since academic knowledge production is currently in a state of epistemological wobble (Scott 1997, 8–9), the significance of disciplines is also being questioned (Squires 1990, 112). Therefore the cognitive basis of Becher's typology is problematic. Secondly, Becher's typology can be said to be old-fashioned (Knorr Cetina 1999, 2–3) and ideal type in the Weberian sense[31] (Välimaa 1998, 124). Thus, taxonomies are a problematic tool in empirical

30 In addition, there were specialisms (e.g. sociology, chemistry, economics) which could not be classified under either medicine or engineering. These specialisms existed owing to the formation of multidisciplinary groups.

31 An ideal type is an analytical construct that serves as a measuring rod for social observers to determine the extent to which concrete social institutions are similar and how they differ from some defined measure. The ideal type never corresponds to concrete reality but is a description against to which we can compare reality. (e.g. Aron 1970, 244–247.)

analysis. Thirdly, while stressing the epistemological features of disciplines, Becher detaches the cultures of disciplines from their social contexts (Huber 1990, 242). Despite these limitations, Becher's typology is a theoretical and heuristic tool of value in analysing disciplines, since the dimensions draw attention to the range and variety of academic activity and provide "logical attributes of subjects and segments and the sociological properties of disciplinary communities and networks" (Becher 1989, 154). Therefore, the dimensions describe both a discipline's epistemological conditions and the social features of academic communities (Kekäle 1997, 117).

5.2.2 Data collection and selection procedure

Since there is no single register or index for research groups in Finland and as it was not possible to create a complete list of research groups, purposeful selection was used. More accurately, the selection was based on criterion sampling, in which all cases that meet criteria prepared beforehand, are picked out (Patton 2002, 238). There were two criteria for selecting research groups:

1) The minimum number of group members should be three.
2) The study, which the group was carrying out, should be in progress or have recently, within a month, expired.

These criteria were partly based on the criteria used by Stolte-Heiskanen and Alestalo (1978, 73). The information of the groups was received through electronic databases as well as departments' and faculties' homepages.[32] After all the possible research groups which fulfilled the criteria were gathered from various sources, thus creating a sampling frame (see Gall et al. 2003, 168), simple random sampling was used to select the groups (n = 50 per discipline), whose leaders were then contacted (see also Appendix 1). If the group declined to participate in the study, a compensatory group was selected.

The data were collected using semi-structured and self-administered questionnaires (Appendix 2) which were sent to each group member. The data was gathered in two phase. During the first phase, in the summer and autumn 2001, the questionnaire was pre-tested.[33] In this phase, 11 groups from medicine and 25 groups from engineering participated in the study (see Table 4). In addition, one follow-up letter was sent. Since the intention was to have at least thirty groups from both disciplines in order to obtain a representative sample with regard to the reliability of the measures and the requirements for the

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32 The databases used were: TUHTI (University of Helsinki) and TKKtutkii (Helsinki University of Technology). In other universities, information was gained through departments' homepages.

33 Since the first test should include a sample of respondents from the target population (Gall et al. 2003, 230) and since it was relatively difficult to get research groups, especially, in medicine to participate in the study, the first phase was used to pre-test the questionnaire. Additionally, the respondents from the first phase were included to the study.

research methods used, the sample was completed in the second phase with nine groups in medicine and six groups in engineering. In the second phase of the data collection, two follow-up letters were sent.

In engineering, it was relatively easy to find thirty research groups willing to participate in the study. In medicine, however, it was difficult to recruit research groups despite the large number of groups in existence. Thus, the overall number of medical research groups was only twenty. There may be several reasons for this. During the first phase, in summer 2001, physicians went on strike for a relatively long period in Finland. Since some of the group leaders were also physicians on call, they might have been unreachable during the first phase. Some of the group leaders who were not willing to participate in the study reported that they already had enough questionnaires to fill in as part of their everyday work and were reluctant to accept any additional burdens. Furthermore, although some of the group leaders were willing to participate in the study, they were doubtful about the readiness of the rank-and-file members of the group to participate and therefore declined to join the study. The fact that only twenty medical research groups were recruited was not ultimately a problem as the total number of respondents in medicine was only slightly below that in engineering.

TABLE 4 Research groups participating and response rates

Phase of the study	Number of research groups	Number of research group members participating in the study	Response rate (posted/returned)
First*			
Medicine	11	57	58.2 (98/57)
Engineering	25	92	71.9 (128/92)
Total	36	149	65.9 (226/149)
Second**			
Medicine	9	53	62.4 (85/53)
Engineering	6	29	63.0 (46/29)
Total	15	82	62.6 (131/82)
Total			
Medicine	20	110	60.1 (183/110)
Engineering	31	121	69.5 (174/121)
Total	51	231	64.7 (357/231)

* Nine questionnaires were returned because of unknown addresses.
** Four questionnaires were returned: two of them did not reach the respondents and two respondents were no longer working in the group.

The overall response rate was 65 and the response rates were similar in the first and second phases of the study. The overall response rate can be regarded as good since it was above fifty per cent (Babbie 1992, 267; Newell 1993, 96) and therefore statistically adequate. Additionally, the response rate also indicates that the questionnaire content was of relevance to the respondents (see Gall et al. 2003, 225). However, certain aspects need to be emphasised. As noted earlier, the selection of the respondents was based on contacting them before sending a

questionnaire. In general, precontacting has been found to increase the response rate since such contacts identify the investigator to the respondent and request cooperation (Gall et al. 2003, 231). However, in this study only group leaders were precontacted and informed about the study. Accordingly, rank-and-file members of the group were aware of the study only if the group leader had informed them about it. Thus, precontacting respondents might have increased the response rate, but not as much as if all the group members had been contacted beforehand.[34] There were, however, differences between disciplines with regard to the rate of return in the first phase of the study. In medicine, the response rate was considerably lower than the rate in engineering. One reason for this could be the same as that which affected the selection of research groups: the physicians' strike of summer 2001.

5.3 The development of the questionnaire

The questionnaire was developed by utilising existing measurements (see also Appendix 3). The questionnaire included common questions for all, as well as separate questions, which applied only to the leader of each group. The overall number of items was 138 in the first version and 109 in the final questionnaire.[35] Some of the questions were modified and the following constraints were applied in developing and modifying the questions:

- Items were to be kept as simple as possible.
- Items were phrased both at the group level ("We think that we…") and at the individual level ("I think that I…") depending on whether the focus was on group-level phenomena or on individual opinions.
- Items were thematically arranged and each item was randomised under its theme.

All of the items, except few items developed by the author, were translated from English into Finnish. The questionnaire was pre-tested before the first phase. It was given to three persons representing different disciplines and who had worked or were working in a research group. Each of these respondents gave face-to-face feedback to the author on the questionnaire and some minor modifications, such as the wording of an item, were made accordingly.

After the first phase (n = 149), some items were removed (see Appendix 4). The reasons for removing these items were primarily either content-based or

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34 When leaders' (84.3 %) and rank-and-file members' (60.8) response rates are compared, there is a noticeable difference in that leaders seem to be more committed to the study than rank-and-file members. This confirms partly the hypothesis that personal precontacting increases the response rate (Gall et al. 2003, 231).

35 The first version of the questionnaire was a 138-item for rank-and-file members of the group and a 144-item for group leaders. The final questionnaire was a 109-item for rank-and-file members and a 118-item for group leaders (see Appendixes 2 & 5).

method-based. Content-based reasons are completely controlled by the researcher. In other words, the aggregated variables formed are adequate, but the researcher, nonetheless, has reasons relating to content for not including the variable in the study. For example, there was no point in measuring the same entity, team-oriented behaviour, with two different aggregated variables of which one was reverse scored. Method-based reasons for excluding items or variables are not wholly controlled by the researcher. In statistical terms, that is, the aggregated variable formed is not reliable because of inconsistence of responses by an individual test-taker. In this study, Cronbach's Alpha Coefficient (α) was used to measure item reliability as it is suited to multiple-choice tests and tests that include items that have several possible answers (Gall et al. 2003, 198).[36] There could be at least two reasons for low reliability (Cronbach's α-coefficient < .60) in this study. First, modifications – e.g. some items were excluded because they did not apply to the target group studied – made to the original measurements were not successful. Second, as noted earlier, Cronbach's Alpha Coefficient depends on the sample and target group from which it is derived and therefore, the internal consistency might have been significantly lower than in the original measure.

In addition, one item and two questions were added to the questionnaire after the first phase. In the first phase, when asked about the type of tasks respondents performed, they reported spending quite a lot of time teaching. In the original questionnaire, there was no option for teaching. Therefore, teaching was added as an option to question number 97. For the group leader the background information section of the questionnaire was modified after the first phase. First, the question asking about the research group's department or unit was removed. During the first phase this question was difficult to answer since the respondents gave different interpretations, for example, for the term "department". Second, one question, which concerned the number of disciplines represented by the group members, was added. In the first phase this question was excluded as this information could be obtained by observing group members' educational background. However, since not everybody returned the questionnaire, the information about whether the group was multidisciplinary or not had to be obtained from other sources, such as websites. Adding this question to the final questionnaire it was a more economical and reliable way of getting the information needed (Figure 12).

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[36] Reliability coefficients do not, however, isolate different sources of systematic measurement error (Gall et al. 2003, 199; see also section 9.2).

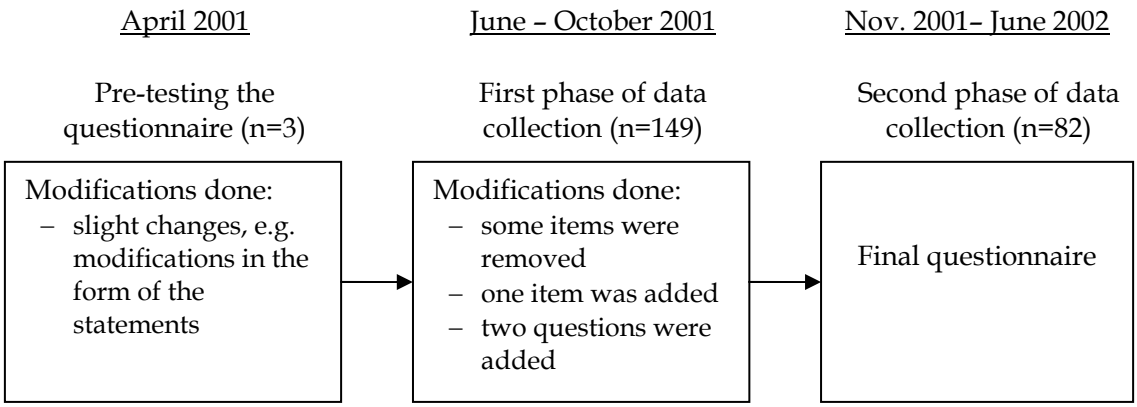

FIGURE 12 The development of the questionnaire

Since most of the items used in the questionnaire were translated from English into Finnish, the effects of this translation process need to be further examined. Cultural and linguistic differences present challenges to the construction of a questionnaire. If the structure of the languages is similar, it is easier to make "correct" translations; but if the structure is dissimilar, translation becomes more difficult. Furthermore, in order to be sure that the translation is as close to the original version as possible, different translation techniques need to be combined. (Brislin, Lonner & Thorndike 1973, 42–43, 44–50; Behling & Law 2000 16–49.) In this study, however, no translation technique was used. The questionnaire was translated by the researcher himself and thus some linguistic inaccuracies might have remained. Furthermore, English and Finnish have a very different linguistic structure which makes it difficult to capture all the nuances and meanings present in English. Altogether, inaccuracies caused by translation may have some effect on the reliability of a study; however, more important indicators of reliability are: (1) understanding of the questions, and (2) internal consistency of the items. Both of these indicators showed a good reliability in the present study (for internal consistency see Appendix 5).

5.4 Measures and data analysis

The study variables were distributed into two groups as follows (Figure 13; for the first phase see Appendix 3):

1. structural characteristics of research group
   - 1.1 demographics (e.g. age, gender, occupational status)
   - 1.2 composition of the research group (e.g. size, degree of multidisciplinarity)
2. research group work characteristics
   - 2.1 process characteristics
     - 2.1.1 individual-level (e.g. interdependence)
     - 2.1.2 group-level (e.g. group potency)

2.2 intragroup conflict
2.3 interpersonal trust

Structural characteristics

The individual demographic data sought were gender, age, tenure of membership, status in group, permanence of membership, educational level, discipline, time spent (span) in the group and place of work (items 100–109). The group demographics that were asked were life-span of the group, grounds for forming the group, number of permanent members, number of disciplines present in the group, international cooperation, in which university or research institute the group is located and the percentage estimates of how much basic, applied and development research is done by the group (items 110–118).[37] In the final analysis the following structural characteristics were included: gender, status in group, discipline, work experience as a researcher, work experience in the group, degree of multidisciplinarity and group size. Tasks performed by group members were investigated using the task classification (item 97) developed by Stewart and Barrick (2000).

Research group work characteristics

Preference for team work (team-oriented behaviour) was assessed by adopting Watson's et al. (1993; 1998) Group Style Instrument (GSI), which is a 26-item survey describing critical group member process activities that affect team productivity. In this study, however, the GSI was reduced to a 14-item survey. The self-management measure comprised two items (18, 20) drawn from the work of Campion et al. (1993) and two items (21–22) developed by the author. Two different kinds of interdependence were measured. The (initiated) task interdependence instrument was developed by Kiggundu (1983). Outcome interdependence was assessed using the six-item measure of van der Vegt et al. (1998). Group potency and cooperative group norms were assessed by means of the instrument developed by Campion et al. (1993). Social support was comprehended as one-dimensional (cf. West 1994), and the instrument of Campion et al. (1993), which comprises elements from informational and instrumental support, was used. The measurement of group members' participation in decision making (items 16–17) was also derived from the work of Campion et al. (1993), with the addition of one item (19) by the author. Furthermore, goal similarity (items 53, 55, 57) was measured using Jehn's (1995) scale (Figure 13).

Relationship, task, and process conflict measures comprised nine items, which were drawn from the work of Jehn and Mannix (2001) and conflict norms

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37 Although the different types of research are not conceptually clear-cut (Calvert 2000), in general basic research describes research done to advance scientific knowledge. When basic research is used in practical applications it is known as applied research. Development research in turn refers to practices where both new knowledge and applications are produced at the same time. (Hakala et al. 2003, 51.)

(items 23–25, 28, 35–37) were measured by adopting the scale of Jehn (1995). In addition, three items (30, 32–33) measured conflict resolution in order to examine coping with conflict situations. Interpersonal trust was measured (items 70–74, 76–78) using the short version of Organizational Trust Inventory (OTI) which is based on the work by Cummings and Promiley (1996). OTI can be applied to the study of interpersonal trust among group members, although initially the inventory was constructed to measure trust between units in organisations or between organisations.

As can be seen in Figure 13, not all the research group work characteristics presented in Figure 8 were tested, although work characteristics were included in the first phase of the study. After the first phase, however, some modifications were made and as a result some items were removed for either content- or method-based reasons (see section 5.3).

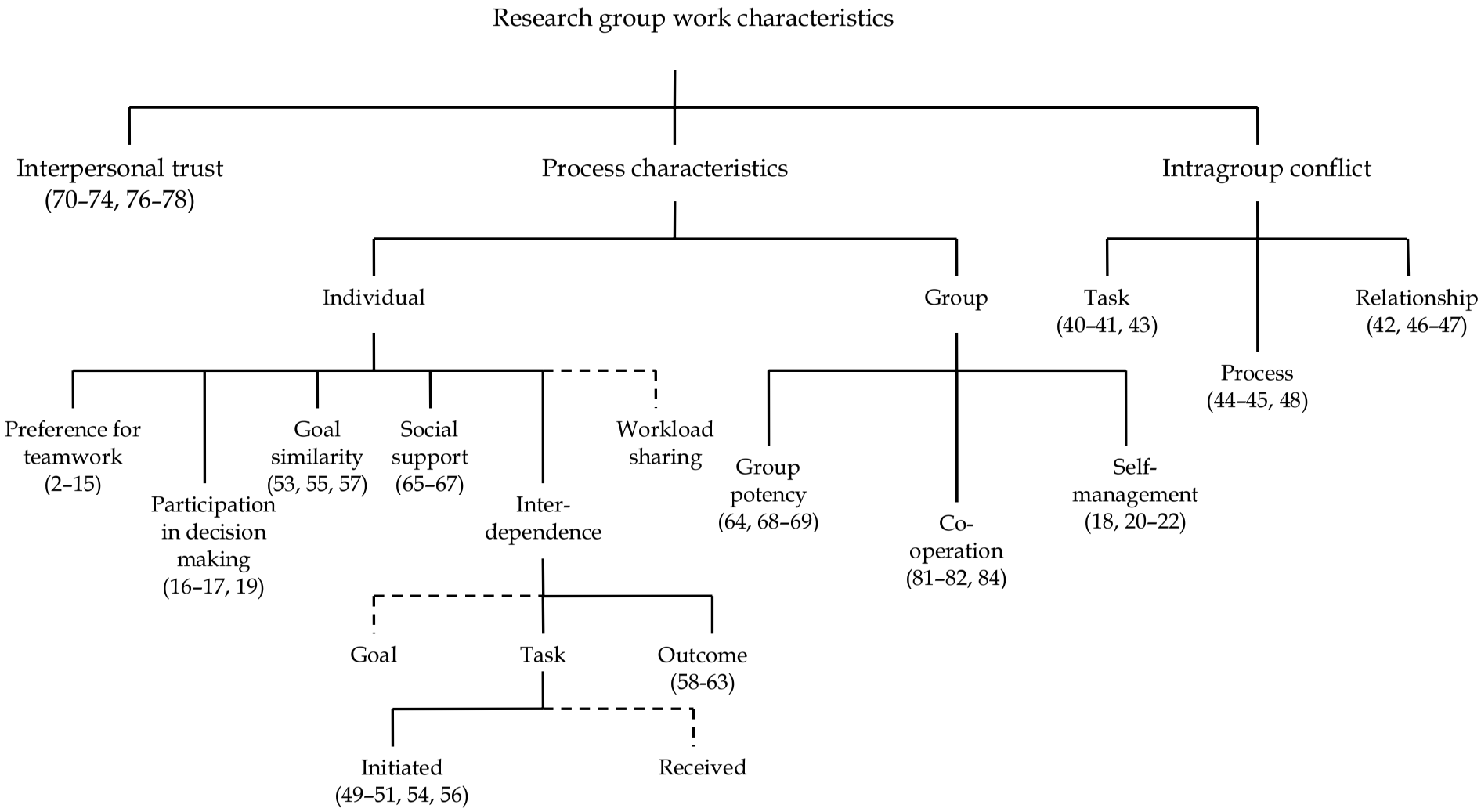

FIGURE 13 An empirical model for the key characteristics of research group work
Note: Empirically tested relationships are shown in bold and the numbers in brackets refer to the items in the questionnaires.

Data analysis

As the purpose of the study was to describe, compare and explain, it imposed certain demands on the methods. For the purpose of *description,* frequency distributions and cross tabulations were used. For *comparisons*, t-test for independent samples (where two sub-groups were compared) and ANOVA (where more than two sub-groups were compared) were employed. In post hoc multiple comparisons, the Bonferroni test at the .05 level of significance was used. Because no previous information existed on the direction of the hypotheses, the two-tailed t-test for independent samples was applied (see Nummenmaa, Konttinen, Kuusinen & Leskinen 1997, 77). The chi-square test and, for 2x2 tables, Fisher's exact test were used to find out whether there was an association between the measured variables. For the purpose of *explanation*, a stepwise multiple regression analysis, which comprises elements from forward selection and backward elimination (Nummenmaa et al. 1997, 310) and two-way analysis of variance were used. The reason for using multiple regression analysis was to identify statistically significant predictors and to better understand the relationships between different work characteristics (ibid., 308). Stepwise multiple regression analysis produces successive models of which the last suggested was accepted in order to identify statistically significant predictors. Two-way analysis of variance allows possible interaction effects to be detected and, since one-way ANOVA and t-test for independent samples already indicate if there are differences between the sub-groups measured, there is no need to look for main effects. For open-ended questions, categories coherent in content were formed and numerical indicators given. Thereafter they were put on the datamatrix. A more detailed exposition of the methods used is given in Table 5.

TABLE 5 Data analysis by research problems

Research problem	Method	Purpose
1. How do members of research group perceive work characteristics in medicine and in engineering?		To describe and explain the relationships between work characteristics
What is the role of process characteristics in research group work?	t-test for independent samples, ANOVA, discriminant analysis, multiple regression analysis, Fisher's exact test	
What is the role of interpersonal trust in research group work?	t-test for independent samples, ANOVA, multiple regression analysis, chi-square test	

(continues)

TABLE 5 (continues)

What is the role of intragroup conflict in research group work?	t-test for independent samples, ANOVA, multiple regression analysis, chi-square test	
2. How do research team members perceive their group work?		To describe typical pros and cons of research group work as well as working time allocation
What are the advantages and disadvantages of research group work?	Content analysis, frequency distribution, chi-square test	
How is working time allocated in research group work?	t-test for independent samples, ANOVA	
3. What is the design of research group work like?	Primarily multiple regression analysis	To summarise the findings of the study => model of research group work design

5.5 Characteristics of the respondents

As can be seen from Table 6, the respondents of the medical research groups were mainly female and the respondents of the engineering research groups mainly male. When compared to the national distribution by gender of the number of Master's degrees or higher[38] the engineering research group members were representative: most engineering graduates in Finland are male. In medicine and the health sciences, however, the overall distribution among graduates is not as female-dominated as it was among the respondents in this study: little more than half of all graduates are female. (Tiede ja teknologia 2000, 38.) In medicine half of the respondents had finished either doctoral or licentiate studies, and 20 percent had only done their Master's. This is as expected, since in medicine licentiate studies are done automatically. In engineering, a little over a third of the respondents had a doctoral or licentiate degree, but almost half of the respondents had finished their Master's. Respondents who did not have a higher degree were usually laboratory personnel. Work experience, when divided into three categories, was the same in both disciplines: there were fewer, moderate and well experienced researchers in the groups. In work experience in the groups, almost half of the respondents in the medical research groups had worked for at least three years in the same group. In engineering, only 29 percent of the respondents had a long work history in the same group. In both disciplines most of the respondents had permanent posts and only 14 percent had temporary contracts.

38 This includes Master's, Licentiate and Doctoral degrees.

TABLE 6 Characteristics of respondents. Percentage distributions (numbers of respondents)

	Discipline		
	Medicine	Engineering	Total
Gender			
Female	67.3 (74)	24.0 (29)	44.6 (103)
Male	32.7 (36)	76.0 (92)	55.4 (128)
Status in group			
Leader	15.2 (16)	24.5 (27)	20.0 (43)
Rank-and- file member	84.8 (89)	75.5 (83)	80.0 (172)
Age			
20–28 years	34.0 (36)	35.0 (42)	34.5 (78)
29–38 years	32.1 (34)	32.5 (39)	32.3 (73)
≥ 39 years	34.0 (36)	32.5 (39)	33.2 (75)
Highest degree held			
PhD or licentiate	50.5 (54)	38.7 (46)	44.2 (100)
Master's	19.6 (21)	46.2 (55)	33.6 (76)
Bachelor's*	18.7 (20)	0.0 (0)	8.8 (20)
Non-academic education	11.2 (12)	15.1 (18)	13.3 (30)
Work experience as a researcher			
< 3 years	28.7 (29)	30.3 (36)	29.5 (65)
3–9 years	34.7.(35)	37.0 (44)	35.9 (79)
> 9 years	36.6 (37)	32.8 (39)	34.5 (76)
Work experience in the group			
< 12 months	11.5 (12)	20.9 (23)	16.4 (35)
12–36 months	33.7 (35)	52.7 (58)	43.5 (93)
> 36 months	54.8 (57)	26.4 (29)	40.2 (86)
Group membership			
Permanent	89.5 (94)	82.8 (96)	86.0 (190)
Temporary	10.5 (11)	17.2 (20)	14.0 (31)
Total	47.6 (110)	52.4 (121)	100 (231)

Note. The overall number of respondents may not reach 231 in every category owing to missing cases.
* Includes degrees awarded by polytechnics

There were some differences in group characteristics between medicine and engineering. When the number of permanent group members was divided into three categories, half of the medical groups had at least eight members. In engineering, however, quarter of the groups had at least eight group members and 35 percent three or fewer members. In addition, the medical research groups seemed to be multidisciplinary more often than the engineering groups,

of which seventy percent was discipline-based.[39] Six out of ten medical research groups were involved in an international research project. In engineering, only 31 percent were participating in an international project. In both fields only a few groups were located in a specific research institute (Table 7).

TABLE 7 The characteristics of the groups. Percentage distribution (number of groups)

	Discipline		
	Medicine	Engineering	Total
Number of *permanent* members			
3–4 members	12.5 (2)	34.6 (9)	26.2 (11)
5–7 members	25.0 (4)	38.5 (10)	33.3 (14)
≥ 8 members	62.5 (10)	26.9 (7)	40.5 (17)
Number of disciplines group members represented by			
1 (discipline-based)	33.3 (5)	70.4 (19)	57.1 (24)
≥ 2 (multi-disciplinary)	66.7 (10)	29.6 (8)	42.9 (18)
Is group part of an international research project?			
Yes	60.0 (9)	30.8 (8)	41.5 (17)
No	40.0 (6)	69.2 (18)	58.5 (24)
Is group located in a specific research institute?			
Yes	14.3 (2)	16.7 (4)	15.8 (6)
No	85.7 (12)	83.3 (20)	84.2 (32)
Total	39.2 (20)	60.8 (31)	100 (51)

Note. The overall number of research groups may not reach 51 in every category owing to missing cases.

[39] The research groups whose members represented at least two different disciplines were termed multi-disciplinary. A more refined categorisation (cf. Figure 3 on page 29) was not possible because of the research methods used.

6 METHODOLOGICAL CONSIDERATIONS OF THE STUDY

6.1 Epistemological and ontological issues

Reflection on the methodological basis of the study provides an analytical apparatus to further understand and interpret the research process as a whole and, especially, its limitations (Luostarinen & Väliverronen 1991, 197). In order to characterise the methodological basis of the study, three questions need to be answered (Guba 1991, 18):

1) Ontological: what is the nature of "reality"?
2) Epistemological: what is the nature of the relationship between the knower and the known?
3) Methodological: how should the inquirer go about seeking knowledge?

Positivism is a tradition usually related to quantitative research. However, positivism is often taken for granted as a methodological compass throughout the research process and careful methodological reflection ignored (Raunio 1999, 19).[40] Many of our stereotypes about science come from a period where science was dominated by positivism. Nowadays, it is suggested that science, and especially quantitative research, has moved on in its thinking into an era of postpositivism where many of those stereotypes no longer hold up (Raunio 1999, 117–120; Gall et al. 2003, 14–16; Töttö 2000).[41] Nevertheless, positivism and its successors, especially postpositivism, share certain ontological and

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40 This had lead to the situation where positivism has been criticised to be superficial and that it lacks theoretical orientation (Raunio 1999, 19; also Töttö 2000).

41 Additionally, there are other paradigms in science. Lincoln (1991, 67–78) distinguishes constructivist paradigm in which reality is comprehend as relativist and its epistemology is subjectivist and interactive. Thus, constructivist paradigm describes qualitative research.

epistemological assumptions that, in the case of the present study, can help to clarify its methodological basis. The focus in the following sections is on postpositivism since it can be seen as a modified version of positivism[42] in which some of the basic assumptions of the latter are modified in order to enable it to be applied more accurately to the needs of the social sciences (Guba 1991, 20).

How, then, is the nature of reality perceived in postpositivism? The idea of reality is grounded in critical realism where the concept of a real world driven by real natural causes is acknowledged. However, it is not possible for humans truly to perceive the real world with their imperfect sensory and intellective mechanisms. These notions of reality impose some limitations on how the phenomenon being investigated can be studied, but realism remains a central perspective guiding the research process. (Guba 1991, 20–21.) Additionally, one of the imbalances which is deeply rooted in positivism is seeing reality as consistent across time and settings and thus, in order to investigate reality, it is quantified (e.g. in terms of interval scales). Postpositivism tries to take cognizance of and avoid this imbalance. (Gall et al. 2003, 20–21.) Epistemologically, in postpositivism objectivity is seen to be achieved "reasonably closely", but not entirely (Guba 1991, 21). Objectivity can be reached by becoming aware of one's own predispositions and "by relying on 'critical tradition', that is, requiring the reports of any inquiry to be consistent with the existing scholarly tradition of the field" (ibid., 21). Methodologically, emphasis is placed on critical multiplism which can be seen as a form of triangulation in which inquiry is based on as many sources as possible. Furthermore, postpositivism recognises that there are many imbalances, such as the imbalance between discovery and verification, while trying to achieve realistic, objective inquiry. (Ibid., 21–23.)

Guba (1991, 23) has summarised postpositivism as follows with regard to the status of methodological questions:

Ontology:	Critical realist – reality exists but can never be fully apprehended. It is driven by natural laws that can be only imperfectly understood.
Epistemology:	Modified objectivist – objectivity remains a regulatory ideal, but it can only be approximated, with special emphasis placed on external guardians such as the critical tradition and the critical community.
Methodology:	Modified experimental/manipulative – emphasizes critical multiplism. Redresses imbalances by conducting inquiry in more natural settings, using more qualitative methods, depending more on grounded theory, and reintroducing discovery into the inquiry process.

42 Positivism is based on a realist ontology, objectivist epistemology and empirical experimentalism. This means, in short, that the reality which is being investigated exists "out there" and the researcher need to adopt a distant stance in order to investigate the phenomenon empirically. (Guba 1991, 19–20.)

In this study, the ontological assumptions of postpositivism are visible in the model of research group work design (see Figure 9 on page 64) since it assumes certain, more or less causal, relationships between research group work characteristics. Thus, in the model reality is comprehended in some respect as driven by natural laws. It should be kept in mind that the model only concentrates on certain characteristics of research group work. Accordingly, by using the model, the purpose is not fully to comprehend the reality being investigated but rather focus on some aspects of the reality in which group operates. Epistemologically, there are two issues that need to be addressed. First, preconceptions and other issues that are related to the neutrality of the researcher and to the accuracy of research process are reported and thus the reader can draw his/her own conclusions about the objectivity of the study.[43] Second, the study is a typical quantitative inquiry in the sense that the data was gathered using questionnaires and thus, the researcher has a certain objectivity with regard to his relationship with the respondents. Methodologically, the study was conducted in "natural setting" in that the respondents were asked to evaluate their *everyday life* in a research group. On the other hand, no method-based triangulation was used in order to enhance the credibility of methodological choices (see also Table 9 on page 95).

6.2 Scientific reasoning in the research process

During the research process it is essential to become aware of how scientific reasoning affects different phases of the study. There are three different forms of scientific reasoning: induction, abduction and deduction. Inductive reasoning moves from specific observations to broader generalisations and theories. On the contrary, deductive reasoning begins with a theory about the topic of interest which then is reduced to research hypotheses or research questions. The research hypotheses or questions are empirically tested with specific data and ultimately, the theory is either confirmed or not. (Alvesson & Sköldberg 1994, 41–47; Niiniluoto 1983, 19–32.) Abductive reasoning is often based on the individual case which is a starting point for further analysis. Theory formation is possible only if there is a guiding principle which guides the investigator through the empirical and theoretical realities. Thus, abduction has elements from both induction and abduction. (Alvesson & Sköldberg 1994, 41–47; Hookway 1992, 43–44.)[44]

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43 In the constructivist paradigm, the idea of the "objectivity" or "neutrality" of the researcher and the research process has been criticised (e.g. Lincoln 1991).

44 Abduction is especially common in studies where both quantitative and qualitative methods are used and in studies where the investigator uses reflection based on his/her own experiences about the research object being studied (e.g. Aittola 1992) or in case-studies (Alvesson & Sködberg 1994).

This study is primarily based on deductive reasoning, although the boundaries between the different reasoning methods are not clear-cut. The study has a strong theory-ladenness (Hanson 1971): the "theory", or rather the model used in this study, that is, model of research group work design, has been derived from previous studies. The model has been formulated as research questions which, in turn, have been tested in order to see how the model applies to the investigation of research group work (Figure 14). Using deduction as an approach to the research object, which in this case is research group work, has ultimately meant that the researcher himself has made the decision about which aspect of group processes to investigate. This means that some, even important aspects of group work, might have been ignored and that some phenomena which are typical of research groups might remain undetected due to the researcher's conceptualisations. Therefore, the use of deductive reasoning imposes some limitations on how the research object is understood and constructed and ultimately what kind of results it is possible to obtain.

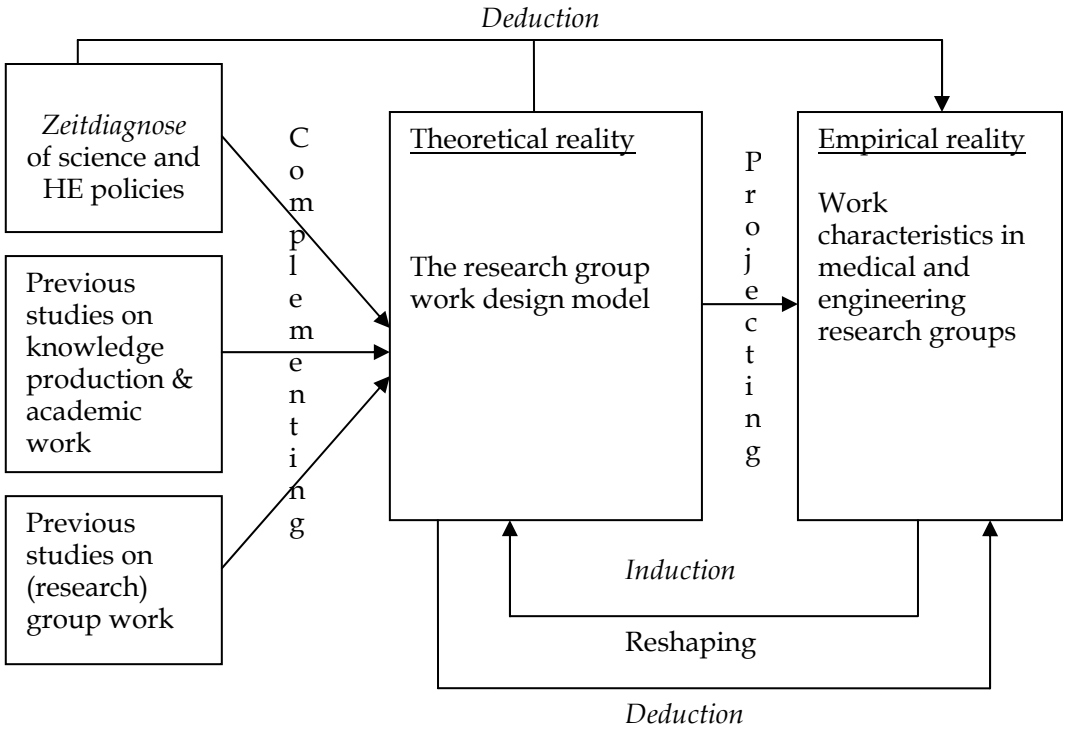

FIGURE 14 The logic of reasoning in different phases of the study

The model used in this study (see Figure 9) is loosely drawn from the work of Parker et al. (2001) and Nason and Pillutla (1998). Thus, the model is not solely derived or generated by the author, but it is complemented and applied in order to meet the purposes of the study, that is, in order to analyse research group work characteristics. Three phases can be distinguished in the research process in which reasoning plays an important role: (1) complementation or reflection on the research group work design model, (2) projection and (3)

reshaping of the model on the basis of the empirical findings (Routila 1986, 36–37). The model is complemented by analysing the contemporary theorising of our time (*Zeitdiagnose*) in order to recreate the societal context in which the research group operates. Additionally, previous studies on knowledge production and group work characteristics were analysed in order to obtain a picture of the implications that knowledge generation has for research group work. On the basis of these analyses, the model was complemented (Routila 1986, 38). Model reshaping was done according to the empirical findings and the final model formed (see section 7.4).

The logic of reasoning during the research process was mainly based on deduction since the research questions were formulated in order to reshape the model empirically. However, both induction and deduction was used in considering the relationship between "theory and practice", that is, between theoretical and empirical realities. As noted earlier, the purpose of the study is to describe research group work characteristics, to explore and explain the relationships between different work characteristics and to form a model of research group work design. Thus, description is inductive, i.e. research group work characteristics are described on the basis of empirical observations. In order to explain, however, pure observations are not enough; the "theory" needs to be included in the process of explaining the results, which means that deduction comes to play a major role (Figure 14).

Deduction has effects on how explanation takes place. Broadly, two different modes of explanation, which have their origin in positivism, can be distinguished: deductive-nomology and probabilistic explanation (Raunio 1999, 156–164). *Deductive-nomological explanation* pays attention to the causal relationships between the variables being measured. There are certain preconditions that must be satisfied for causality to be verified (e.g. Bryman & Cramer 1990, 31–32) and, even when these are satisfied, causality remains fundamentally impossible to determine. It is argued that for this reason it is unnecessary to verify causality in the social sciences (Raunio 1999, 171). Additionally, in the social and human sciences causality cannot be seen as a deterministic but rather as stochastic phenomenon, where incidental factors are taken into account (Valkonen 1971, 84). The *probabilistic explanation* assumes that there are several causes for the existence of a given phenomenon, but some reasons are more important than others, and thus empirical research is concerned with the latter. Unlike deductive-nomological explanation, probabilistic explanation does not focus primarily on the causality between the variables being measured. (Raunio 1999, 160.) In this study, it is argued that there are several factors which could explain research group work (see Figure 13), but only some of these are empirically tested.

In probabilistic explanation it is important to pay attention to elaboration. By means of elaboration one can verify and give more credibility to the research findings and, in addition to that, by elaborating a moderator variable(s) it is possible to discover what happens to the association between two variables (Valkonen 1971, 90–96; Alkula, Pöntinen & Ylöstalo 1995, 200–215). In this study, therefore, elaboration is used in order to determine the probable

relationship between the variables of interest. For example, two-way analysis of variance was used to observe whether interaction effects between two variables exist or not. The simplest form of elaboration is to present the results for selected variables, for example, the results of the analysis of variance and regression analysis in chapter 7 are presented by discipline. (Alkula et al. 1995, 200–215.)

6.3 Methodical issues of the study

There are various questions that need to be taken into account in order to evaluate the methodical quality of the study. The first of these concerns reliability and validity, that is, the overall credibility of the measures, and the second, those concerning the generalisability, neutrality and utility of the findings.

6.3.1 Reliability and validity

The central quality issues in quantitative research are reliability and validity. In general, reliability concerns the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials. Validity, on the other hand, is the extent to which any measuring instrument measures what it is intended to measure. (Carmines & Zeller 1990, 11–15; Nummenmaa et al. 1997, 202–203). Thus, reliability and validity estimate the overall credibility of the measurement (Alkula et al. 1995, 89).

Reliability

Since repeated measurements never exactly equal one another, unreliability is always present. Thus, the measurement of any phenomenon always contains a certain amount of chance error, that is, random error. Therefore, the focus in estimating the reliability of a measurement is on the tendency toward consistency found in repeated measurements of the same phenomenon. Furthermore, the question is not about whether the measurement contains random error, but to what extent it contains random error. Random error can be caused by e.g. errors due to coding or due to the written instructions in the questionnaire. (Carmines & Zeller 1990, 11–15.)

Different methods have been developed to assess the reliability of measurements. Three of these are discussed here: the retest method, the split-halves method and the internal consistency method. In the *retest method* the same test is given to the same respondent again after a period of time and the correlation between scores of the two administrations of the test is calculated. Unlike in the retest method, the split-halves method and internal consistency method can be conducted on a single occasion. In the *split-halves method* "the total set of items is divided into halves and the scores on the halves are

correlated to obtain an estimate of reliability" (Carmines & Zeller 1990, 41). The *internal consistency* method does not, however, require the splitting of items but only a single test administration. In contrast to the other forms of assessing reliability, internal consistency methods, and especially Cronbach's alpha, depend on the average intercorrelation among all of the items. (Ibid., 37–51.) On the other hand, as Nummenmaa et al. (1997, 203) state, reliability can also be regarded nowadays as an alternative interpretation of the results in addition to evaluating quality of measurement.

Validity

The focus in validity is on the interpretation of data arising from a specific procedure, that is, "one validates not the measuring instrument itself but the measuring instrument in relation to the purpose for which it is being used" (Carmines & Zeller 1990, 17). Thus, validity relates closely to the operationalisation of the study and to the planning of the instrument of measurement (Alkula et al. 1995, 89–90), and, therefore, validity is not a quality of the instrument but a way of describing the accuracy of the conclusions drawn after using the instrument (Nummenmaa et al. 1997, 203). There are different types of validity (Carmines & Zeller 1990, 17–27), or different ways of gaining information and evidence of validity (Nummenmaa et al. 1997, 203), of which three are discussed next.

Criterion-related validity refers to a situation where the purpose is to use an instrument to assess some form of behaviour that is external to the measuring instrument itself. The degree of criterion-related validity depends on the extent of the correspondence between the test and the criterion. The problem is that, in many situations, there are no criteria against which the measure can be reasonable evaluated. Moreover, the content of the measure has to be sensible and argumentative with regard to the concept or phenomenon being investigated. This is called *content validity*. There are, however, no predetermined criteria or procedures for determining content validity. Basically, this means that the more abstract the research problem is, the more difficult it is to define its content validity. Nevertheless, content validity involves careful reflection on the whole process of operationalisation. *Construct validity* "is concerned with the extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses concerning the concepts (or constructs) that are being measured" (Carmines & Zeller 1990, 23). Thus, in order to determine the construct validity of the study, theoretical and empirical relationship between the concepts or constructs and their measures must be specified and the empirical evidence must be interpreted. Therefore, the process of construct validity is theory-laden. (Tschudi 1989, 110–111; Carmines & Zeller 1990, 23.)

6.3.2 Generalisability, objectivity and applicability of the findings

Reliability and validity concern the assessment of the measure used. It is necessary, however, to evaluate other aspects of the research process as well. Generalisability, objectivity and applicability of the research findings, especially, need to be discussed.

Generalisability

The key question in quantitative research is how the findings can be generalised[45] across settings and from a sample to a population, which is also known as population validity or one aspect of external validity. In order to achieve good population validity, the sample should be selected randomly from the population to which the results are to be generalised (Gall et al. 2003, 164). Thus, the selection of the target group plays an important role in determining the generalisability of the findings.

In section 5.2 the selection of target group is presented in detail. However, some issues need to be addressed here. According to Gall et al. (2003, 169) generalisation requires two "inferential leaps". First, the results must be generalised from the sample to the accessible population from which the sample was selected and, second, the findings must be generalised from the accessible population to the target population. In this study, the *accessible population* was formed from all of the research group members representing medicine and engineering in the Finnish universities. The *target population* is not, however, that simple to determine. Actually, there are two different interpretations for the target population in this study. First, all research group members in the Finnish universities can be regarded as the target population. Then, however, disciplinary differences are ignored as a source of differences in research group work. The second interpretation for the target population would be that it includes all the Finnish university research group members representing medicine and engineering. The problem with this interpretation is that, basically, the accessible and target populations would be identical. Despite that limitation, the target (and naturally accessible) population in this study is composed of the members of Finnish university-based medical and engineering research groups.

The assessment of generalisability from the sample to the accessible population and ultimately to the target population is rather difficult since purposeful sampling was used. In general, if the sample was not randomly formed, the sample should be compared with the accessible population in terms of certain critical characteristics (in this study such characteristics are size of the group, group heterogeneity, etc.). However, no systematic information about the accessible population or target population was available and so it was not

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45 Lincoln and Guba (1985, 110–122) criticise the whole idea of generalisability as dependent on the assumption of determinism, of inductive logic and of freedom from time and context.

possible to compare the latter with the sample and accessible population. Nevertheless, other indicators should be used. The selection of the target groups was based on the sampling frame formed from the information drawn up from several sources. While forming the sampling frame, all the possible sources of information needed about medical and engineering research groups were systematically looked over. This gave an overall picture about the extent of research groups in the selected disciplines, but no indicators about the characteristics of the groups and their members. On the other hand, the size of the accessible population was limited because of the criteria used in the selection of research groups (see section 5.2.2). Therefore, the findings can be generalised to research groups which fulfil the set criteria.

The other issue that needs to be discussed is that how the findings can be generalised across different settings. The main theoretical framework, i.e. research group work design, has its origin in analysing group work in general. In this study, however, the focus is on group work where innovativeness plays a major role. Therefore, the model can be used in analysing research group work, but the findings cannot be generalised to all kinds of group work. Innovativeness and creativity in the production of new knowledge play an important role in the group work which is investigated in this study. Thus, the findings can be generalised to some extent to any group work which involves creativeness and innovativeness no matter whether the group operates in a university or in the private sector. There are limitations if the findings are generalised to other settings, that is, to settings where group work has other goals than the generation of new (scientific) knowledge.

Objectivity

The objectivity or neutrality of a study is closely related to the epistemological assumptions of the research process. In general, objectivity refers to the fact that the conclusions depend on the people being investigated, not on the researcher. Additionally, objectivity refers to the value-free process of knowledge production, that is, knowledge generation is free from various interests such as the political. This view, however, has been criticised by relativists since ultimately "facts are not given but constructed by the questions we ask" (Lather 1990, 317) and thus, objectivity – or confirmability – means being aware of how one's own beliefs and values affect the research process. Postpositivism, however, provides a frame through which objectivity is understood in this study. As mentioned in section 6.1, in postpositivism it is assumed that objectivity can almost be attained through awareness of one's own predispositions and of the tradition the study is based on.

What are these predispositions on which the researcher is consciously or unconsciously relying? Or what kind of predispositions does the researcher have with regard to the research object he/she is constructing on the basis of a given theoretical orientation or approach? These questions reveal the researcher's "theoretical sensitivity" that is, his/her understanding of other ways of studying the object being investigated. This is important in order to

analyse the role of objectivity – or the extent of the objectivity which can be gained – in the research process.

As noted in chapter 3, there are three different approaches to studying research group work: the constructionist, cultural-historical activity theoretical and work design approaches. All of these approaches comprehend research group work differently and give different theoretical interpretations for group work. Additionally, the role of objectivity is understood differently in these approaches, but all of them increases knowledge about the role of objectivity in the research process.

This study is based on the work design approach in investigating research group work. The approach pays attention especially to research group work characteristics and to the relationships between them. However, one could argue that the work design approach is rather mechanical. Therefore, by committing to this approach, some important factors could have been excluded which the other approaches would have included and vice versa. On the other hand, the work design approach is in accordance with the methodological basis, postpositivism, of the study. Thus, objectivity relates to postpositivistic notions about how ”reality” is understood. Additionally, the extent which objectivity can be reached will be in relation to the purposes of the study. In this study, the main purpose is to describe research group work characteristics and explain the relationships between them. Both of these purposes focus on top-down examination rather than bottom-up, that is, understanding the phenomenon being investigated (cf. relativism).

In sum, in this study objectivity is seen as something that cannot be completely attained, but by taking into account the researcher's predispositions, the tradition in which the study is based on and the purpose(s) of the study, the role of objectivity in the research process can be made more visible.

Applicability

In the assessment of the research process, the question of pragmatic validity (Kvale 1989, 86–88) cannot be avoided. Discussion of the application of the research findings not only gives a practical dimension to the research process, but it also reflects study's relation to previous studies on the same topic. By relating the research findings to previous studies, a more comprehensive picture can be drawn, and thus some practical implications can be suggested or challenges made. The question of applicability also relates closely to the domains of knowledge of the study (Habermas 1971; Raunio 1999, 362–373). As seen from Table 8, the relationship between “theory and practice” is somewhat different with regard to the methodological tradition in which the study is based. However, the borders between different methodological traditions are fluctuating so that any categorisation will not be mutually exclusive. Thus, the matter of the applicability of research findings is more complex than Table 8 suggests. As noted previously, this study has its methodological foundation in postpositivism which has its root in positivism, but yet is different from it

(Lincoln & Cuba 1985, 33), and therefore the practical dimension of this study is something more than just "technocratic problem-solving".

TABLE 8 Scientific knowledge and its practical importance (applied Raunio 1999, 364)

Methodological tradition	Kind of knowledge	Practical significance
Positivism	Instrumental (explanation)	Technocratic problem-solving
Interpretive research	Practical (understanding)	Support decision-making
Critical tradition	Emancipation (reflection)	Empowerment of citizens

The aim of the study is to produce new knowledge what it is to work in a research group. Additionally, some practical challenges can be posed on the basis of the findings. The purpose, however, is not to attempt to supply ready-made answers, but rather to raise some questions about the practical challenges confronting group work in the academic contexts (see section 9.3). Therefore, the practical objectives of this study are two-fold: first, to produce new knowledge for the use of individuals interested in research group work, and, second, to highlight challenges for research group work practitioners.

6.3.3 The framework for evaluating the study

The methodical issues presented in this chapter constitute a framework through which the credibility of the study can be analysed. The framework presented in Table 9 is by no means a complete interpretation of the methodical issues. Instead, the framework has been made in order to analyse and evaluate the quality issues which are critical in this study, in other words, the framework has been constructed for the purposes of this investigation. The adaptation of the framework to this study will be shown more detail in section 9.2.

TABLE 9 Matrix for evaluating the methodical issues of the study

	Methodical issue						
	Reliability	Validity			Generalisability	Objectivity	Applicability
		Criterion-related validity	Content validity	Construct validity			
Definition	The assessment of the extent of random error in the measurement.	Estimation of a phenomenon that is external to the measuring instrument itself.	The extent to which empirical measurement reflects a specific domain of content.	The extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses.	The extent to which the findings can be generalised across settings and from a sample to a population (population validity).	The extent to which the research process is value free.	The extent to which practical challenges can be presented on the basis of the research findings (pragmatic validity).
Indicator(s)	Different methods: retest method, split-halves method, internal consistency method (e.g. Cronbach's alpha).	Correlations between test and criterion.	The specification of the full domain of content that is relevant to the measurement situation, number of adequate items used in the measure and the form of statement used in the measure.	A careful specification of the theoretical relationship between the concepts used and assessing the relationship between empirical results and theoretical assumptions.	A careful analysis of how the sample was selected and what conclusion can be drawn from that selection with regard to the generalisability of the findings.	Becoming aware of: (1) researchers´ predispositions, (2) the tradition in which study is based, (3) the purpose(s) of the study.	Linking the research findings to previous studies and to the purposes of the study.

7 WORK CHARACTERISTICS OF FINNISH MEDICAL AND ENGINEERING RESEARCH GROUPS

7.1 The role of process characteristics in academic group work

Process characteristics play an important role in group work although the results of previous studies (Campion et al. 1993; 1996) have been contradictory. As described in section 4.1, process characteristics can be divided into group and individual characteristics. Group-level process characteristics are team self-management, group potency and cooperative group norms, whereas individual-level process characteristics are preference for teamwork, task and outcome interdependence, social support, participation in decision making and goal similarity. In the following sections these process characteristics are described in medical and engineering research group work.

7.1.1 Individual process characteristics in research group work

Interdependence and preference for team work as the key process characteristics

Interdependence defines how group members interact and cooperate in order to accomplish tasks and outcomes, whereas preference for team work indicates the extent and level of team-oriented behaviour among group members. As shown in Table 10, the respondents reported depending on each other highly in outcomes, but less in tasks. In other words, the respondents did not experience as strong a sense of connectedness in performing their tasks as they did in their outcomes. The respondents were also relatively team-oriented, that is, they interacted reasonably often in order to establish a breeding ground for group synergy to evolve. There were, however, differences in these process characteristics in terms of discipline, gender, status in group, size of the group and work experience as a researcher. Respondents in engineering were more task-interdependent than those in medicine. There also seemed to be gender

differences with regard to the interdependences: men were more task- and outcome-interdependent than women. Additionally, group leaders reported being more task- and outcome-interdependent as well as more team-oriented than rank-and-file members. The most experienced researchers (research experience > 9 years) were more task-interdependent than the less experienced researchers (< 9 years). Furthermore, respondents in large research groups (more than 10 members) reported being less team-oriented and task-interdependent than those in small research groups (number of members 3–5). Multidisciplinary research groups did not differ from disciplinary-based groups in terms of team orientation, outcome or task interdependence. Neither did work experience in the group to make any difference in terms of team-oriented behaviour, outcome or task interdependence.

TABLE 10 Team orientation, outcome and task interdependence (means) by discipline, gender, status in group, degree of multidisciplinarity, group size and work experience (t-test for independent samples & ANOVA)

	Team-oriented behaviour	Outcome interdependence	Task interdependence
Discipline			
Medicine (n=107–110)	3.39	4.17	3.21
Engineering (n=121)	3.46	4.16	3.53
Total (n=229–231)	3.42	4.17	3.38
	$t_{(229)} = -.978$	$t_{(226)} = .208$	$t_{(209.7)} = -2.903^{*}$
Gender			
Female (n=101–103)	3.34	4.08	3.16
Male (n=127–128)	3.49	4.24	3.56
Total (n=229–231)	3.42	4.17	3.38
	$t_{(229)} = -1.996^{*}$	$t_{(226)} = -2.149^{*}$	$t_{(228)} = -3.739^{***}$
Status in group			
Leader (n=43)	3.67	4.40	3.95
Rank-and-filer (n=169–172)	3.37	4.10	3.23
Total (n=213–215)	3.43	4.16	3.38
	$t_{(213)} = 3.119^{**}$	$t_{(210)} = 3.188^{**}$	$t_{(212)} = 5.325^{***}$
Degree of multidisciplinary			
Disciplinary-based (n=86)	3.48	4.23	3.50
Multidisciplinary (n=116–119)	3.34	4.15	3.31
Total (n=203–205)	3.40	4.18	3.39
	$t_{(203)} = 1.675$	$t_{(200)} = 1.038$	$t_{(202)} = 1.687$
Experience as a researcher			
< 3 years (n=64–65)	3.48	4.06	3.17
3–9 years (n=79)	3.34	4.18	3.28
> 9 years (n=74–76)	3.53	4.29	3.68
Total (n=218–220)	3.45	4.18	3.39
	$F_{(2, 217)} = 2.152$	$F_{(2, 215)} = 3.017$	$F_{(2, 216)} = 8.365^{***}$

(continues)

TABLE 10 (continues)

Experience in the group			
< 12 months (n=34–35)	3.49	4.02	3.18
12–36 months (n=91–93)	3.43	4.14	3.31
> 36 months (n=85–86)	3.38	4.25	3.50
Total (n=211–214)	3.42	4.16	3.37
	$F_{(2, 211)} = .506$	$F_{(2, 208)} = 2.368$	$F_{(2, 210)} = 2.257$
Size of group			
3–5 (n=65)	3.59	4.21	3.56
6–10 (n=84–85)	3.46	4.19	3.42
> 10 (n=79–81)	3.24	4.10	3.19
Total (n=228–231)	3.42	4.16	3.38
	$F_{(2, 228)} = 6.874$**	$F_{(2, 225)} = .844$	$F_{(2, 227)} = 3.965$*

* p<.05; **p<.01; ***p<.001.

Note. The variation in the number of respondents is due to lacunae in the data. The scale format in TOB and task interdependence was a five-point Likert-type format in which 1 = strongly disagree … 5 = strongly agree. The scale format in outcome interdependence was a five-point Osgood-type format.

Two-way analysis on variance was used in order to see whether an interaction effect existed between the independent variables which most differentiated the dependent variable in given sub-categories. The effect of group status and group size on team-oriented behaviour was tested, but no interaction effect was found (F = .578; df = 2, 209; p = .562). For outcome interdependence the effect of gender and group status was tested. There was no interaction effect (F = .643; df = 1, 208; p = .424). Regarding task interdependence the effect of gender, discipline, group status and work experience as a researcher were tested, but no interaction effect was found.[46]

In order to emphasise the differences in levels of team orientation, TOB was grouped into low orientation and high orientation. Initiated task interdependence was also dichotomised as low-high.[47] Ten per cent of the respondents were highly task-dependent, but low in team-orientation (Figure 15; see also Appendix 6). Almost twenty-five per cent of the respondents had a high team orientation but low task interdependence. One in ten of the respondents had both a low team orientation and low task interdependence. Fisher's exact test showed a significant relationship between team orientation and task interdependence (p = .004), team orientation showing a close association with task interdependence.

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46 *Group status x gender*, F(1, 210) = .045; p = .832; *Group status x work experience as researcher*, F(1, 204) = .022; p = .883; *Gender x work experience as researcher*, F(2, 213) = .210; p = .811; *Gender x discipline*, F(1, 226) = .024; p = .876.

47 Initially, both task and outcome interdependence were included in the discriminant analysis to see which one is a better predictor, and task interdependence was ultimately chosen in forming a classification for further analysis (see also footnote 48). Initiated task interdependence and outcome interdependence significantly discriminated between levels of team-oriented behaviour (Wilk's lambda = .90; df = 2; p = .000). Outcome interdependence (Z = .85) was a better predictor of team-oriented behaviour than task interdependence (Z = .76). The averaged scores were predictive of high versus low team-oriented respondents to within 67 % accuracy.

In order to illustrate the differences in terms of team orientation and task interdependence, the research group members were classified into four types (Figure 15).[48] This classification will be used later to illustrate how individual and group process characteristics, conflict and trust are perceived by different types of research group members. The respondents who had low team orientation and low task interdependence were labelled *independent performers of separate tasks*. These members of a group work as individuals and do not have clear task continuity. In the case of this synergistic dimension of group work is not present. If team orientation was high and task interdependence was low, the group members can be seen as *joint constructors of separate tasks*. These scholars have their own individual research projects and duties, but they also have something in common, for example a shared supervisor or research object. Respondents who had low team orientation but high task interdependence were classified as *independent performers of consistent tasks*, which means that the member of the group has task continuity but tasks are performed independently. Respondents reporting both high team orientation and high task interdependence were *joint constructors of consistent tasks*. More than half of the respondents believed that group tasks were jointly constructed, and therefore these research groups seemed to have a social atmosphere which allowed for the evolution of synergy.

		TEAM ORIENTATION	
		Low	High
TASK INTER-DEPENDENCE	Low	Independent performers of separate tasks, 12 %	Joint constructors of separate tasks, 25%
	High	Independent performers of consistent tasks, 10%	Joint constructors of consistent tasks, 54 %

FIGURE 15 Task interdependence by team orientation (percentage distribution of respondents)

48 As defined in section 4.1.1, outcome interdependence refers to an individual's feedback as this is linked to the group's performance in order to motivate group-oriented behaviour, whereas task interdependence is defined as functional workflow between different tasks. In academic work, therefore, the crucial point is how to link different tasks into a meaningful whole. This was also verified by the respondents of this study (see Table 10). Furthermore, the present results indicated that team orientation and task interdependence have a statistically significant association (Appendix 6), which was not the case for outcome interdependence and team orientation (Fisher's exact test, p = .096). For these reasons task interdependence was chosen instead of outcome interdependence as the counterpart to team-oriented behaviour in order to classify the respondents.

The other question, however, is: what were the most important predictors of task and outcome interdependence as well as preference for team work? A step-wise multiple regression analysis was conducted to test the effect of the background variables (gender, group size, discipline, degree of multidisciplinarity, status in group, work experience in the group and work experience as a researcher) and work characteristics[49] on team-oriented behaviour and task and outcome interdependence. With regard to the preference for teamwork, group potency, cooperative group norms and participation in decision making were the key antecedents (Table 11). Thus, a strong can-do attitude, i.e. confidence that the group can perform effectively, good interaction among group members and a heightened sense of responsibility for one's work promoted team-oriented behaviour. However, the role of group potency as a predictor of preference of teamwork can only be regarded as tentative because of the presence of multicollinearity (see Appendix 14). The fact that task conflict seemed to depress team-oriented behaviour was a somewhat unexpected finding as task conflict has been seen to promote group work (Eisenhardt & Schoonhoven 1990; Jehn 1995) while other forms of conflict, relationship and process conflict, have been seen to be more detrimental (Jehn 1995; 1997). Additionally, status in the group (leader/rank-and-filer) affected how team-oriented a research group member was, with the result that leaders were more often team-oriented than rank-and-file members (Table 11). This difference was clearly shown by the t-test for independent samples analysis (Table 10).

In terms of task interdependence the effect of status in the group was statistically significant but negative. The effect of cooperative group norms, outcome interdependence and gender had a positively significant association with task interdependence. Thus, good quality of interaction among group members as well as high interdependence on outcomes enhanced the sense of continuity between different tasks whereas rank-and-file membership seemed to be detrimental to task interdependence. With respect to gender males were more likely to be task-interdependent than females (see also Table 10). The key antecedents of outcome interdependence were work experience in the group, social support, goal similarity, interpersonal trust and task interdependence. The result was expected because in order to develop dependency regarding outcomes, research group members have to have a relatively long working history together (see also Table 10). Additionally, in order to produce a joint outcome, like a scientific article, group members need to have similar goals and support as well as trust each other and depend on tasks as well. Overall, task and outcome interdependence in research group work had different predictors. The coefficient of determination (R-square) was notably higher for preference for team work than it was for task and outcome interdependence. Thus, for task

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[49] The work characteristics included were: group potency, cooperative group norms, participation in decision making, social support, self management of the group, goal similarity, task conflict, process conflict, relationship conflict, conflict norms, conflict resolution, and interpersonal trust, task and outcome interdependence as well as team-oriented behaviour.

and outcome interdependence other variables may exist that are better predictors than those selected in the study.

TABLE 11 Results of the multiple regression analysis (stepwise method) for preference for teamwork, task interdependence and outcome interdependence (all data)

	Preference for teamwork (n = 162)	Task interdependence (n = 162)	Outcome interdependence (n = 162)
Independent variables	Beta (t-value)	Beta (t-value)	Beta (t-value)
Background variables			
Status in group	-.094 (-2.290)*	-.270 (-3.782)***	ns.
Gender	ns.	.153 (2.174)*	ns.
Work experience in the group	ns.	ns.	.249 (3.734)***
Process characteristics			
Group potency	.360 (6.195)***	ns.	ns.
Cooperative group norms	.305 (5.647)***	.173 (2.364)*	ns.
Participation in decision making	.232 (5.132)***	ns.	ns.
Social support	ns.	ns.	.170 (2.094)*
Goal similarity	ns.	ns.	.177 (2.516)*
Outcome interdep.	ns.	.222 (2.983)**	-
Task interdep.	ns.	-	.215 (3.068)**
Conflicts			
Task conflict	-.183 (3.879)***	ns.	ns.
Trust	ns.	ns.	.201 (2.458)*
	$F_{(5, 156)}$ = 95.062; p = .000; R^2 = .753	$F_{(4, 157)}$ = 15.357; p = .000; R^2 = .281	$F_{(5, 156)}$ = 15.691; p = .000; R^2 = .335

* p<.05; **p<.01; ***p<.001.

The results of the multiple regression analyses were compared in medicine and engineering in order to see whether there were any similarities or differences (Appendix 7). In preference for team work there were minor differences between respondents from the two disciplines. Interestingly, process conflict seemed to predict team-orientation in engineering, whereas in medicine relationship conflict was an important antecedent, but both forms of conflicts were nonetheless detrimental to team-oriented behaviour. Furthermore, it also seemed that in engineering research group leaders were more often team-oriented than rank-and file members. In medicine, team-orientation was better predicted by disciplinary-based research group work than interdisciplinary. The coefficients of determination (R-squares) in both disciplines were high in preference for teamwork. In both disciplines, group status was an important predictor of task interdependence and in medicine group potency and in engineering conflict norms also predicted task interdependence. However, the

coefficient of determination was low in both disciplines. For outcome interdependence work experience in the group was a good predictor both in medicine and in engineering. The most important predictor in medicine was interpersonal trust, whereas in engineering outcome interdependence was best predicted by task interdependence. It was noteworthy that the coefficient of determination was considerably higher in engineering than in medicine in terms of outcome interdependence. In fact, the model poorly explained outcome interdependence in medical research groups.

Social support, goal similarity and participation in decision making

Other individual process characteristics were also reported to be on a fairly high level (Appendix 8). Social support, especially, was found to be high among the respondents, as was participation in decision making. It was only group members' goals that were seen as dissimilar rather than similar. Altogether, respondents expressed feelings of fraternity and supportiveness. There were, however, differences with regard to participation in decision making: respondents working in large groups (more than 10 members) found it more difficult to participate in decision making than those working in small groups, and leaders were also evaluated as having better possibilities to participate in decision making than rank-and-file members. Furthermore, respondents in disciplinary-based research groups reported having better opportunities to participate in decision making than those in multidisciplinary research groups. In engineering it was easier to participate in decision making than in medicine.[50] Additionally, males and heads of the group seemed to receive more support from other group members than females and rank-and-file members.[51] There were, however, no differences in social support, goal similarity and participation in decision making in terms of work experience as a researcher or work experience in the group.

As can be seen in Figure 16, independent performers of separate tasks (n = 27) differed especially from those respondents who had high team orientation and task interdependence, that is, from joint constructors of consistent tasks (n = 122–124), but also from the others, as they reported receiving less support from other group members, having dissimilar group goals and participating less in decision making. Interestingly, independent performers of consistent tasks (n = 22) reported the least possibilities to participate in decision making.

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50 Two-way analysis of variance was conducted in order to see if there were interaction effects between independent variables in terms of participation in decision making. Regarding *group status x group size*, F = .091; df = 2, 209; p = .913 no interaction effect was found. *Group status x degree of multidisciplinarity*, F = .249; df = 1, 185; p = .619, did not have interaction effect. However, there was an interaction effect in terms of discipline and size of the group (F = 3.112; df = 2, 225; p = .046).

51 Two-way analysis of variance was used to test the possible interaction effect between gender and group status. However, no interaction effect was found (F = .001; df = 1, 209; p = .970).

Those respondents who were classified as joint constructers of separate tasks (n = 56–57) reported receiving support from other group members and having enough opportunities to participate in decision making. Thus high level of team orientation seemed to facilitate social support, goal similarity and participation in decision making, which indicates that team-oriented behaviour played a more important role in research group work than task interdependence.

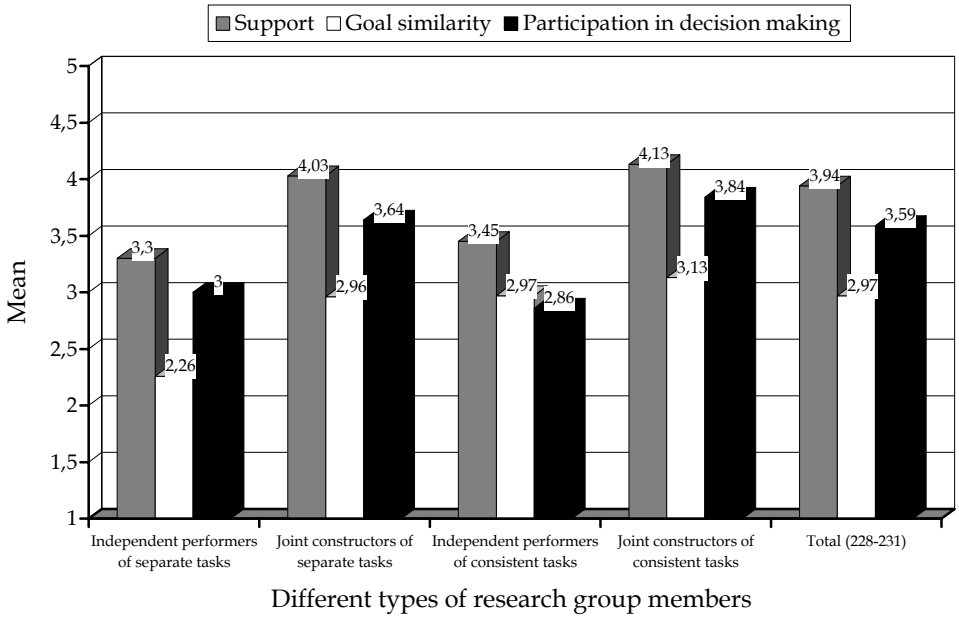

FIGURE 16 Social support, goal similarity and participation in decision making by different types of research group members

A stepwise multiple regression analysis was conducted to test the effect of the independent variables on participation in decision making, social support and goal similarity (Table 12).[52] The process characteristics seemed to predict each other[53] well and preference for team work, especially, was a significant predictor. For participation in decision making group size and discipline were important predictors, thus favouring small groups and engineering. The most important predictors, however, were preference for team work and team self-management, but also process conflict and conflict resolution predicted participation in decision making. Thus, high level of team orientation and team self-management as well as conflict resolution promotes participation in decision making. However, one has to regard the important role of team-oriented behaviour with some scepticism as the problem of multicollinearity is an obvious one (see Appendix 14). The role of process conflict is interesting as it had a negative relationship to participation in decision making. Thus, process conflict seemed to be detrimental to participation in decision making. Social

52 The independent variables were the same as in those used to test the effects of TOB, task and outcome interdependence.

53 Because the process characteristics correlate with each other (Appendix 10), the risk of multicollinearity is present (for detail, see section 9.2).

support was predicted by group potency, cooperative group norms and participation in decision making. Therefore, a strong can-do attitude, a social climate which encourages cooperation and equal opportunities to participate in decision making promoted the evolution of social supportiveness. For goal similarity preference for teamwork, outcome interdependence and conflict resolution were statistically significant predictors. Thus, properly solved conflicts, high level of team orientation and dependence on group outcomes seemed to increase similarities in goals among respondents.

TABLE 12 Results of the multiple regression analysis (stepwise method) for individual process characteristics (all data)

	Individual process characteristics		
	Participation in decision making (n = 162)	Social support (n = 162)	Goal similarity (n = 162)
Independent variables	Beta (t-value)	Beta (t-value)	Beta (t-value)
Background variables			
Group size	-.135 (-2.085)*	ns.	ns.
Discipline	.148 (2.356)*	ns.	ns.
Process characteristics			
TOB	.405 (5.209)***	ns.	.186 (2.031)*
Outcome interdep.	ns.	ns.	.198 (2.601)*
Group potency	ns.	.397 (5.820)***	ns.
Cooperative group norms	ns.	.376 (5.680)***	ns.
Participation in decision making	-	.154 (2.808)**	ns.
Social support	ns. predictor	-	ns.
Team self-management	.391 (6.914)***	ns.	ns.
Conflicts			
Process conflict	.153 (2.321)*	ns.	ns.
Conflict resolution	.193 (2.776)**	ns.	.192 (2.117)*
	$F_{(6, 155)}$ = 31.329; p = .000; R^2 = .548	$F_{(3, 158)}$ = 83.908; p = .000; R^2 = .614	$F_{(3, 158)}$ = 13.364; p = .000; R^2 = .202

* p<.05; **p<.01; ***p<.001.

7.1.2 Group process characteristics in research group work

In terms of group process characteristics, cooperative group norms, especially, were on a high level, but team spirit and team self-management were also found to be high (Appendix 8). Thus, the respondents valued the group's shared pursuits, had faith in the competency of the group and believed that the group was self-managed. There were hardly any differences in the independent variables, but medium-sized groups (6–10 members) were more self-manageable than large groups, and, interestingly, the smallest groups (3–5 members) did not differ from the large ones. Thus, compared to individual

process characteristics, there were not that many differences in structural characteristics.

The pattern found in group process characteristics was rather similar to that in individual process characteristics when different types of research group members were compared (Figure 17). It is notable that those respondents who could be classified as independent performers of separate tasks (n = 27) gave lower assessments of group potency and cooperative group norms than the others. Group potency, especially, was regarded as very low by independent performers, that is, by those who had low team orientation. On the other hand, joint constructors of consistent tasks (n = 123–124) evaluated all the group process characteristics above the average. Interestingly, those respondents who were classified as independent performers of consistent tasks (n = 22) rated team spirit as low and group self-manageability as limited, but reported relatively clear cooperative group norms. Altogether, high team-orientation seemed to enhance group process characteristics as respondents who were classified as joint constructors of separate or consistent tasks reported above-average group potency, cooperative group norms and team self-management.

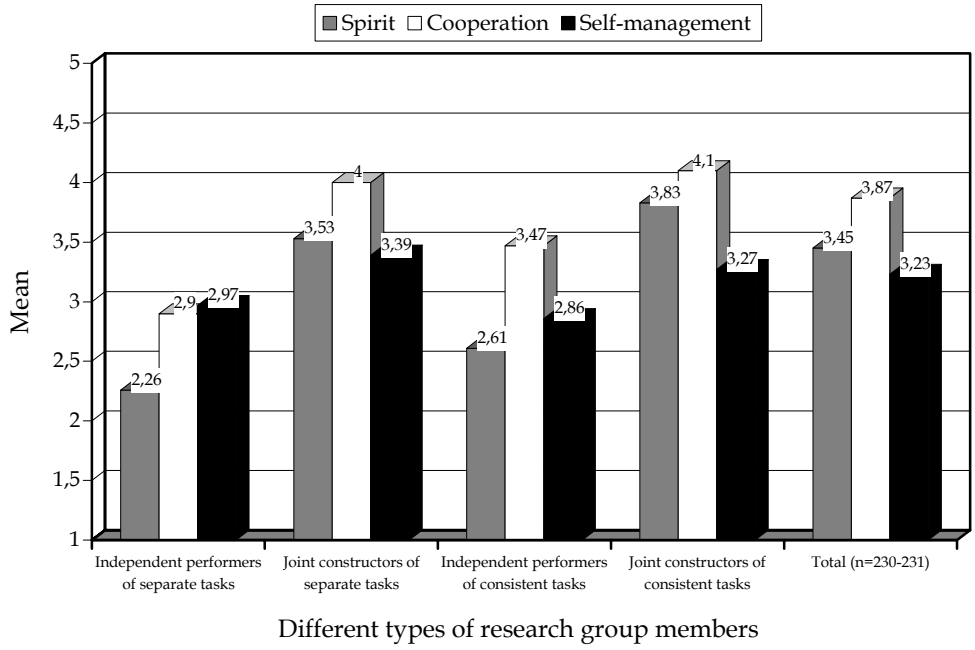

FIGURE 17 Team spirit, cooperative group norms and team self-management by different types of research group members

When the effect of background variables and work characteristics were tested on group process characteristics, discipline and participation in decision making predicted team self-management in that the opportunity to participate in decision making increased team self-management (Table 13). Additionally, research groups in medicine were more likely to be self-managed than those in engineering. Preference for team work, social support and interpersonal trust were the key predictors of cooperative group norms so that team orientation as well as a supportive and trustful social climate enhanced the evolvement of

cooperative group norms. The key antecedents for group potency were preference for teamwork, social support, team self-management and conflict resolution. Thus, team spirit depended on how team-oriented and supportive the respondents were and how they manage to solve conflicts. Again, however, the role of team-orientation and social support as key antecedents of both cooperative group norms and group potency must be viewed sceptically as the problem of multicollinearity is present. It was unexpected that team self-management would show a significant but negative relationship with group potency. Thus, the more self-managed the group was, the less their team spirit. It was notable that none of the background variables was a significant predictor in the case of either cooperative group norms or group potency. Furthermore, the coefficients of determination were relatively high in all the other group process characteristics except team self-management.

TABLE 13 Results of the multiple regression analysis (stepwise method) for group process characteristics (all data)

	Group process characteristics		
	Cooperative group norms (n = 162)	Group potency (n = 162)	Team self-management (n = 162)
Independent variables	Beta (t-value)	Beta (t-value)	Beta (t-value)
Background variables			
Discipline	ns.	ns.	-.206 (-3.028)**
Process characteristics			
TOB	.369 (5.034)***	.428 (6.211)***	ns.
Participation in decision making	ns.	ns.	.539 (7.915)***
Social support	.358 (5.162)***	.346 (5.479)***	ns.
Team self-management	ns.	-.102 (-2.226)*	-
Interpersonal trust	.177 (2.784)**	ns.	ns.
Conflicts			
Conflict resolution	ns.	.194 (3.349)***	ns.
	$F_{(3, 156)} = 88.298$; $p = .000$; $R^2 = .629$	$F_{(4, 156)} = 86.632$; $p = .000$; $R^2 = .690$	$F_{(2, 159)} = 32.523$; $p = .000$; $R^2 = .290$

* p<.05; **p<.01; ***p<.001.

Summary and examination of the findings

The majority of the respondents had a high team orientation and thus optimal conditions for effective performance in their work (see Campion et al. 1993, 828). The important role of team orientation was also observed when different types of research group members were compared in terms of process characteristics. It seemed that those who had a high team orientation, i.e. joint

constructors, were more supportive and cooperative and they participated actively in decision making. The findings of this study also suggested that the respondents cooperated quite frequently and that cooperative group norms were important predictors of team orientation (see Watson et al. 1998). Furthermore, the findings were in accordance with those of previous studies (Campion 1993; 1996; Watson et al. 1998) which have pointed to the importance of team orientation in promoting group work as team orientation prevented task and process conflicts, raised team spirit, made team members more conscious of cooperative group norms and conflict norms and increased the probability of conflict resolution.

Task and outcome interdependence were high, although the respondents found a clearer connection between outcomes than between tasks. Furthermore, cooperation was a good predictor of task interdependence, which confirms previous findings (Campion et al. 1993; Stewart & Barrick 2000) indicating that cooperative interaction leads to high interdependence. Altogether, task interdependence and team orientation showed a close relationship, a high value in one being closely associated with a high value in the other.

The fact that group leaders were more task- and outcome-interdependent and team-oriented than rank-and-filers was expected, as group leaders have to be aware of the different tasks and outcomes in their groups as well act as the driving force of the group. What was surprising was that males were more team-oriented, outcome- and task-interdependent than females. This is difficult to interpret as there were no interaction effects, for example between gender and discipline, in task interdependence. Thus, it seems that gender was an important factor in both team orientation and outcome and task interdependence. Additionally, the most experienced researchers were more task-interdependent than the others, but the same difference was not found for outcome interdependence. One reason for this could be that the most experienced researchers can easily trace a clear line of continuity across successive tasks, unlike less experienced researchers, who are still adjusting themselves to academic work.

In addition to team-oriented behaviour and interdependence, other process characteristics were, generally, on a high level. The respondents supported each other, cooperated frequently and had relatively good opportunities to participate in decision making. Groups also had a good team spirit and they were to some degree self-manageable. More dissimilarity than similarity was reported only in group goals. Many respondents and especially group leaders assessed social support as being on a very high level, which made room for the implementation of ideas (see Axtell et al. 2000). Given that academic work is a typical example of knowledge work where the nature of the individual's everyday tasks tends to be rather diverse and personal resources are stretched to the extreme (Winter & Sarros 2002), the relatively high level of group potency reported by the respondents was somewhat unexpected as in order to develop a can-do attitude, members need to feel that their personal resources match the task at hand (Guzzo et al. 1993).

Although there were some differences, respondents reported to having relatively good opportunities to participate in decision making. This, as found in previous studies (Campion et al. 1993; Keyton 1999), increases members' sense of responsibility, ownership of the work and cohesiveness. Interestingly, in engineering it was easier to participate in decision making in small and large research groups than in medicine. The case was the reverse in medium-sized research groups. This interaction effect between group size and discipline was unexpected as it indicates the existence of a curvilinear association between discipline and group size in participation in decision making. However, these findings are in accordance with the observation by Winter and Sarros (2002, 253; also Currie & Vidovich 1998) that the most experienced researchers (especially professors) participated more in decision making. Furthermore, the results suggest that in multidisciplinary research groups members do not have as many opportunities to participate in decision making as their counterparts in disciplinary-based groups. The finding was expected as multidisciplinary research groups are diverse in the potential range of opinions they contain regarding tasks being performed and therefore individual members may feel that their voices count for little (cf. Younglove-Webb et al. 1999). Many respondents also reported their group to be rather self-manageable which, according to Langfred and Shanley (2001; also Dunphy & Bryant 1996), encourages group members to make independent decisions and to be proactive in their work.

The fact that cooperative group norms were at a relatively high level among the respondents was partly expected as Campion et al. (1993; 1996) have noted that the relationship between cooperative group norms and member satisfaction is stronger in groups that do complex knowledge work. Shared goals has been regarded as a key element in commitment to group work (Sweeney & Lee 1999), but the present respondents reported more goal dissimilarity than similarity. On the one hand, this might indicate low commitment to group work, but as other indicators, such as preference for team work, were at a high level, goal dissimilarity rather reveals the nature of academic work which, according to Clark (1987), is characterised by great internal variety.

7.2 Conflict and trust in research group work

In general, trust among the respondents was high and no differences were found in terms of gender, discipline, status in the group, degree of multidisciplinarity or work experiences (Table 14). Additionally, conflicts were quite rarely experienced and usually concerned the tasks group members performed. Also, if conflicts occurred, they usually were solved ($\overline{X} = 3.47$)[54] and

[54] There were no differences in discipline ($t_{(221)} = -.117$), gender ($t_{(221)} = -.694$), group status ($t_{(207)} = 1.421$), multidisciplinarity ($t_{(195)} = .423$), work experience as researcher

conflict norms, i.e. the reaction to conflicts, had generally been established. Although respondents working in a disciplinary-based research group reported more trusting the other members than did those in multidisciplinary groups and also experienced fewer conflicts, the difference was not statistically significant. Furthermore, although the F-value indicated that some differences in trust were related to group size, the Bonferroni test revealed that the largest research groups did not differ from the smaller ones (p = .072). Although relationship conflict was least experienced there were differences according to discipline, gender and work experience and group size. It seemed that medical research group members, females, and members with moderate work experience as a researcher (3–9 years) and with long work experience (>36 months) in the group underwent more relationship conflicts than others. Furthermore, respondents from large research groups reported facing more relationship conflicts than those from the smallest groups (p = .006). The case was the same for process conflict as respondents from the smallest research groups experienced less process conflict than those in the largest groups. Given that conflicts were quite rarely experienced, the atmosphere in dealing with conflicts, i.e. conflict norms, showed some differences. It seemed that medical research group members perceived conflicts more negatively than those in engineering. Also females experienced disagreements more negatively than males and rank-and-file members more negatively than group leaders. Furthermore, in the largest group (> 10 members) it was found more difficult to comprehend groups' conflict norms (p = .001) than in the smallest one (3–5 members).

TABLE 14 Interpersonal trust, conflicts and conflict norms (means) by discipline, gender, status in group, degree of multidisciplinarity, size of the group and work experience (t-test for independent samples & ANOVA)

Independent variables	Trust	Conflict			Conflict norms
		Relation-ship	Task	Process	
Discipline					
Medicine (n=105–110)	4.02	2.10	2.51	2.06	2.95
Engineering (n=121)	4.11	1.74	2.47	1.98	3.18
Total (n=226–231)	4.07	1.91	2.49	2.02	3.07
	$t_{(229)} = -1.022$	$t_{(225)} = 3.486^{**}$	$t_{(225)} = .391$	$t_{(224)} = .826$	$t_{(229)} = -3.209^{**}$
Gender					
Female (n=99–103)	4.03	2.05	2.53	2.02	2.96
Male (n=127–128)	4.10	1.80	2.46	2.01	3.16
Total (n=226–231)	4.07	1.91	2.49	2.02	3.07
	$t_{(229)} = -.788$	$t_{(225)} = 2.354^{*}$	$t_{(225)} = .758$	$t_{(224)} = .086$	$t_{(229)} = -2.761^{**}$

(continues)

($F_{(2, 209)} = 1.572$), work experience in the group ($F_{(2, 204)} = .836$) or group's size ($F_{(2, 220)} = 1.261$) with regard to conflict resolution.

TABLE 14 (continues)

Status in group					
Leader (n=43)	4.14	1.76	2.40	1.88	3.29
Rank-and-filer (n=167–172)	4.06	1.92	2.50	2.04	3.03
Total (n=216–220)	4.08	1.88	2.49	2.00	3.08
	$t_{(213)}$ = .671	$t_{(209)}$ = -1.186	$t_{(209)}$ = -.748	$t_{(208)}$ = -1.235	$t_{(213)}$ = 2.869**
Degree of multidisciplinary					
Disciplinary-based (n=84–86)	4.14	1.84	2.40	1.92	3.12
Multidisciplinary (n=116–119)	4.02	1.97	2.55	2.08	3.01
Total (n=226–231)	4.07	1.90	2.49	2.02	3.05
	$t_{(203)}$ = 1.213	$t_{(199)}$ = -1.094	$t_{(199)}$ = -1.522	$t_{(198)}$ = -1.458	$t_{(203)}$ = 1.451
Work experience as a researcher					
< 3 years (n=62–65)	4.19	1.64	2.34	1.85	3.08
3–9 years (n=78–79)	4.00	2.10	2.55	2.13	3.03
> 9 years (n=76)	4.07	1.86	2.50	1.98	3.20
Total (n=216–220)	4.08	1.88	2.48	2.00	3.10
	$F_{(2, 217)}$ = 1.365	$F_{(2, 214)}$ = 6.039*	$F_{(2, 214)}$ = .918	$F_{(2, 213)}$ = 2.402	$F_{(2, 211)}$ = 2.025
Work experience in the group					
< 12 months (n=33–35)	4.21	1.60	2.34	1.88	3.16
12–36 months (n=90–93)	4.12	1.82	2.50	1.95	3.11
> 36 months (n=86)	3.96	2.12	2.51	2.12	3.00
Total (n=209–214)	4.07	1.90	2.48	2.01	3.07
	$F_{(2, 211)}$ = 2.107	$F_{(2, 207)}$ = 6.073*	$F_{(2, 207)}$ = .728	$F_{(2, 206)}$ = 1.553	$F_{(2, 217)}$ = 1.266
Size of the group					
3–5 (n=65)	4.17	1.70	2.34	1.81	3.26
6–10 (n=83–85)	4.15	1.88	2.48	2.02	3.07
> 10 (n=78–81)	3.91	2.11	2.62	2.18	2.92
Total (n=226–231)	4.07	1.91	2.49	2.02	3.07
	$F_{(2, 228)}$ = 3.500*	$F_{(2, 224)}$ = 4.991**	$F_{(2, 24)}$ = 2.732	$F_{(2, 223)}$ = 4.350*	$F_{(2, 228)}$ = 6.867***

* p<.05; **p<.01; ***p<.001.

Note. The variation in the number of respondents is due to lacunae in the data. The scale format in trust and conflict norms was a five-point Likert-type format in which 1 = strongly disagree … 5 = strongly agree. The scale format in relationship, task and process conflict was 1 = none … 5 = a lot.

Two-way analysis of variance was used in order to see whether an interaction effect existed between those independent variables which differentiated the dependent variable most in given sub-categories. In relationship conflict two-way analysis of variance was used to test for the effect of discipline and gender as well as the effect of discipline and size of the group. The result showed no interaction effect for discipline and gender (F = 2.202; df = 1, 223; p = .139). The

case was similar when the possible interaction effect of discipline and group size was tested: there was no interaction effect (F = 2.270; df = 2, 221; p = .106). In conflict norms, two-way analysis of variance was used to test for the possible interaction effect of discipline and group size as well as discipline and status in group. The results indicated that discipline and group size did not have an interaction effect on conflict norms (F = .616; df = 2, 225; p = .541). Similarly, when the interaction effect of discipline and group status was tested for, no interaction effect was found (F = .120; df = 1, 211; p = .729).

Trust among research group members and lack of conflict seemed to be highly dependent on each other: the higher the trust among respondents reported, the less often they experienced conflicts (Table 15; see also Appendix 10). Six out of ten respondents reported to have a high level of trust with few conflicts in their group and only one per cent of the respondents experienced lots of conflicts and a low level of interpersonal trust.

TABLE 15 Level of experienced conflict (percentage distributions) by interpersonal trust (number of respondents)

Level of experienced conflict*	Level of interpersonal trust			Total
	Low	Moderate	High	
Low	0 (0)	5.3 (11)	59.9 (124)	65.2 (135)
Moderate	0 (0)	15.5 (32)	17.9 (37)	33.3 (69)
High	1.0 (2)	0.5 (1)	0 (0)	1.4 (3)
Total	1.0 (2)	21.3 (44)	77.8 (161)	100 (207)

χ^2= 178.6; df = 4; p = .000. Because of the small number of observations, 5 cells (55.6 %) have the expected count of less than 5.

* An aggregated variable "conflict" was formed from variables which measured relationship, task and process conflict.

When, according to their reported task interdependence and team orientation, research group members were compared in trust as well as task, process and relationship conflict, some differences were observed (Figure 18). Those respondents who were highly team-oriented, i.e. joint constructers of separate (= 54–57) or consistent (n = 124) tasks, had a high level of trust and low level of conflict compared to those whose team-orientation was low, that is, independent performers of separate (n = 27) or consistent (n = 21–22) tasks. Thus, it seemed that preference for teamwork plays an important role in research group work. This observation was strengthened by the multiple regression analysis (see Table 16).

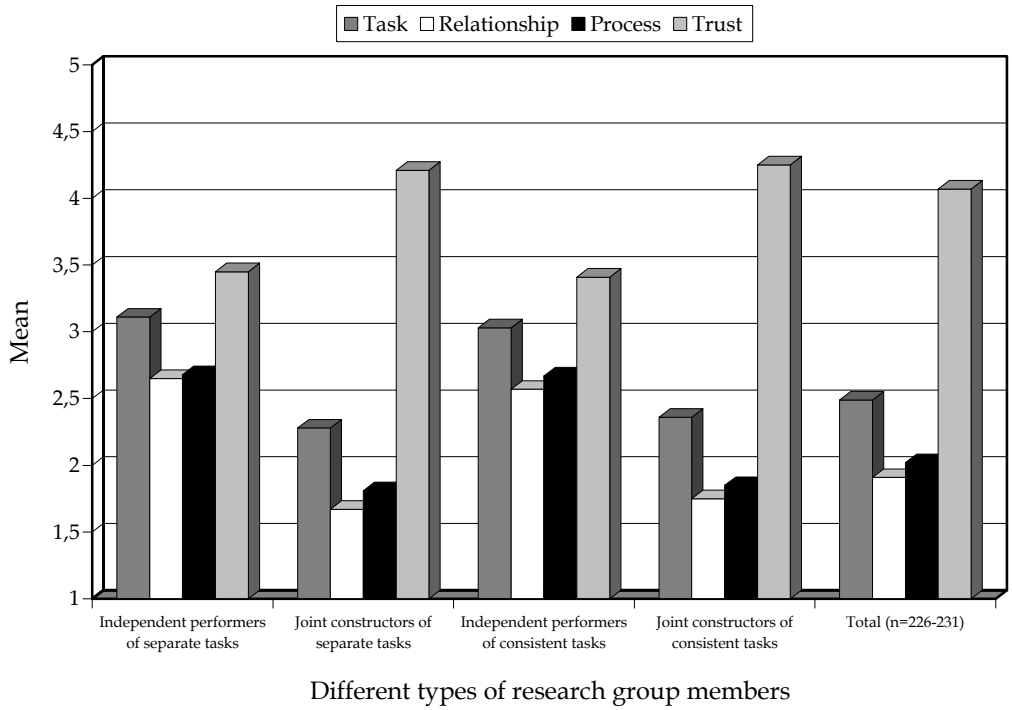

FIGURE 18 Experienced conflicts and trust by different types of research group members

A stepwise multiple regression analysis was conducted to determine the most important predictors of trust and different forms of conflict (Table 16). Task and process conflict had negative associations with interpersonal trust whereas the other significant predictors had positive associations. Thus, the more process and task conflict respondents experienced, the less trustful was the climate surrounding group work (see also Table 15). For this observation, however, the problem of multicollinearity needs to be acknowledged (Appendix 14). If conflicts were properly solved and group had clear conflict and cooperative group norms interpersonal trust was enhanced. In total, the above-mentioned predictors explained 66 per cent of the variance in interpersonal trust. In terms of relationship conflict, task conflict had a significant and positive effect whereas the other predictors had a negative effect. Thus, findings indicate that task conflict increased relationship conflict whereas trust and cooperative group norms diminished relationship conflict. The role of trust needs to be observed with reservation as the problem of multicollinearity is obvious (Appendix 14). The role of discipline was as expected, as t-test for independent samples had already indicated in Table 14 that in medicine relationship conflicts occurred more often than in engineering. Task conflict was best predicted by preference for team work, process and relationship conflict, conflict norms as well as interpersonal trust. Preference for teamwork and interpersonal trust seemed to diminish task conflicts whereas process and relationship conflicts promoted the development of task conflict. The role of conflict norms was unexpected: the result indicated that the more aware respondents were of conflict norms, the more likely they were to engage in task conflict. This observation in addition to

the role of team-oriented behaviour and process conflict needs to be viewed with caution because of the possible multicollinearity (Appendix 14).

TABLE 16 Results of the multiple regression analysis (stepwise method) for trust and other factors in relation to forms of conflict (all data)

	Form of conflict		
	Relationship (n = 162)	Task (n = 162)	Process (n = 162)
Independent variables	Beta (t-value)	Beta (t-value)	Beta (t-value)
Background variables			
Discipline	-.166 (-3.098)**	ns.	ns.
Gender	ns.	ns.	.112 (2.273)*
Process characteristics			
Cooperative group norms	-.172 (-2.547)*	ns.	ns.
Preference for teamwork	ns.	-.164 (-2.487)*	-.136 (-2.087)*
Conflicts			
Process conflict	ns.	.425 (6.481)***	-
Task conflict	.412 (5.807)***	-	.506 (7.534)***
Relationship conf.	-	.265 (4.172)***	ns.
Conflict norms	ns.	.176 (2.961)**	ns.
Trust	-.243 (-3.014)**	-.203 (-2.818)**	-256 (-3.624)***
	$F_{(4, 157)}$ = 48.898; p = .000; R^2 = .555	$F_{(5, 155)}$ = 66.574; p = .000; R^2 = .660	$F_{(4, 157)}$ = 65.985; p = .000; R^2 = .627
Independent variables	Conflict norms (n = 162)	Conflict resolution (n = 162)	Trust (n = 162)
Background variables			
Discipline	.166 (2.870)**	ns.	ns.
Size of the group	ns.	.165 (2.800)**	ns.
Process characteristics			
Cooperative group norms	ns.	ns.	.183 (2.936)**
Preference for teamwork	.292 (3.909)***	.245 (3.007)**	ns.
Outcome interdependence	.157 (2.547)*	ns.	ns.
Participation in decision making	ns.	.163 (2.334)*	ns.
Conflicts			
Process conflict	ns.	ns.	-.215 (-2.917)**
Task conflict	ns.	ns.	-.298 (-4.171)***
Conflict norms	-	.248 (3.500)**	.168 (.2.833)**
Conflict resolution	.373 (5.084)***	-	.195 (3.096)**
Trust	ns.	.275 (3.731)***	-
	$F_{(4, 156)}$ = 36.334, p = .000, R^2 = .482	$F_{(5, 156)}$ = 33.909, p = .000, R^2 = .521	$F_{(5, 156)}$ = 59.218, p = .000, R^2 = .655

* p<.05; **p<.01; ***p<.001.

With regard to process conflict, gender and task conflict had a statistically significant and positive association whereas trust and preference for teamwork had significant but negative associations. Therefore, interpersonal trust and preference for teamwork prevented process conflict, although the role of trust needs to be viewed with caution (Appendix 14). Task conflict, on the contrary, promoted process conflict. Additionally, it seemed that males were more likely to encounter process conflict than females. Statistically significant predictors of conflict norms were discipline, preference for team work, outcome interdependence and conflict resolution. They all had a positive association with conflict norms with a high level of team orientation, high interdependence among outcomes and properly solved conflict facilitating a better understanding of conflict norms. Furthermore, in engineering, respondents seemed to be more aware of the norms that regulate conflicts than in medicine (see also Table 14). The effect of preference for teamwork (Appendix 14), trust, conflict norms, group size and participation in decision making had statistically significant and positive associations with conflict resolution. The positive effect of group size was unexpected as it indicates that with increasing group size, conflict resolution becomes easier. The other predictors were as expected, high trust, a clear understanding of how to behave in conflict situations, the opportunity to participate in decision making and teamwork-oriented behaviour all increasing the probability of felicitous conflict resolution.

The results of the multiple regression analysis were compared in medicine and engineering (Appendix 9). For trust, medicine and engineering had different predictors. Task conflict was the only statistically significant predictor in both disciplines. In addition to task conflict in medicine interpersonal trust was predicted by process conflict, conflict resolution and cooperative group norms whereas in engineering conflict norms and social support were additional predictors. The coefficient of determination (R-square) was markedly higher in medicine ($R^2 = .743$) than in engineering ($R^2 = .586$). The case was quite similar with regard to the predictors of relationship conflict. Task conflict was a significant predictor in both disciplines whereas all the other predictors were different. There were two interesting predictors in medicine: work experience as a researcher and goal similarity. They both had positive associations with relationship conflict. Thus, the longer the respondent's history as a researcher, more likely he/she was to experience relationship conflict; similarly, kindred goals also seemed to increase the probability of relationship conflict. For relationship conflict the coefficient of determination was higher in medicine ($R^2 = .652$) than in engineering ($R^2 = .452$). In terms of task conflict, the significant predictors were almost the same in both disciplines. Medicine and engineering were predicted by process and relationship conflict, which both had a positive effect. In medicine trust also had a significant but negative relationship with task conflict. The R-square was equal in both disciplines. Task conflict was a significant predictor in both disciplines for process conflict. Additionally, conflict norms had significant but negative effect in medicine, and in engineering interpersonal trust had a significant and negative relationship. Thus, in medicine a clear understanding of conflict norms prevented task

conflict, and in engineering trust diminished the probability of task conflict emerging. The coefficients of determination were the same in both disciplines.

Summary and examination of the findings

The respondents trusted each other and rather rarely experienced conflict. Furthermore, trust and lack of conflict seemed to be highly dependent on each other: the higher the trust among the respondents was, the less conflict they experienced. This finding is in accordance with that of previous studies (Shrum et al. 2001), which have indicated that lower trust is associated with higher conflict. Accordingly, the respondents reported solving problems as they emerged, which might in part have increased interpersonal trust. This study also indicated that conflict seemed to have a negative impact on trust – no matter whether it was task, process or relationship conflict. Thus, the findings suggested that trust was best promoted in the absence of conflict. Therefore, the findings of this study support those of the previous studies (Jehn & Mannix 2001; Lovelace et al. 2001), which indicate that all kinds of conflict are detrimental to group work.

The fact that some respondents, especially those from medicine and the largest groups, females and rank-and-filers, were not fully aware of their groups' conflict norms may actually have heightened the negative impacts of conflicts (see Bettenhausen & Murningham 1985). Previous studies (e.g. Shrum et al. 2001) also indicate that highly interdependent collaborations increase the likelihood of conflicts. This was not supported in this study due to the ambivalent role of interdependence. As such, interdependence did not play an important role, but when team orientation was also taken into account it seemed that those members who had a high team orientation and low or high task interdependence experienced fewer conflicts than those with low team orientation and low or high task interdependence.

7.3 The advantages and disadvantages of working in a research group and allocation of working time

In general, the respondents liked doing research in a group: 97 per cent expressed a preference for group work over individual work. Nevertheless, respondents were asked, in open-ended questions, to report the advantages and disadvantages of research group work. Four advantages and six disadvantages emerged. The most important advantage was the opportunity to engage in scientific debate with other group members (Table 17). A rank-and-file member from an engineering research group wrote that discussions with other group members *increase points of view and perspectives in research [16]* and a rank-and-filer from medicine added that group has *more ideas and information [171]* than

an individual.[55] In addition, respondents stressed co-operation and sociability as important benefits of group work. For example, a group leader from engineering reported that *with others one can generate something noteworthy [34]* and a rank-and-file member from a medical research group described that it is *more fun and more of a social experience [178]* to work in a group. Thus, the research group was not only a place for co-operation but also a space in which meaningful social relationships can evolve. In all kinds of problematic situations, the group was the first place to look for support and help, as a rank-and-filer from engineering put it: *one can ask for help in whatever problems arise and try to find a solution together [94]*. On the other hand, working in a research group "forces" the individual to work efficiently because, one way or the other, research group members depend on and are accountable to each other. Hence, *group work enables results to be obtained within a reasonable time [76]* as a head of the medical research group noted.

TABLE 17 The advantages of research group work by discipline. Percentage distributions (numbers of respondents)

Advantages of research group work	Discipline		Total
	Medicine	Engineering	
Discussion	26.6 (21)	36.8 (39)	32.4 (60)
Co-operation	25.3 (20)	32.1 (34)	29.2 (54)
Support	29.1 (23)	18.9 (20)	23.2 (43)
Efficiency	17.7 (14)	10.4 (11)	13.5 (25)
Other	1.3 (1)	1.9 (2)	1.6 (3)
Total	100 (79)	100 (106)	100 (185)

There were no differences according to discipline, degree of multidisciplinarity, gender, group size and status in the group with regard to the advantages gained from research group work. It seemed, however, that the least experienced researchers found support from other group members to be of great value whereas the most experienced researchers valued co-operation (X^2 = 13.595; df = 6; p = .035).

The disadvantages of research group work were more diverse than the advantages (Table 18). The most central disadvantage was the fact that in working in a group one always has to consider the other members and therefore *the tasks performed in the group are interdependent [79],* as the head of an engineering research group stated. Thus, on the one hand co-operation was valued, but on the other hand it was seen as a major disadvantage. Time management was also seen as a disadvantage. A head of an engineering research group reported that *group work takes time and this time comes off actual research work [102]*. It would seem that as scientific knowledge is a result of negotiations where mutual understanding of the research object is established, working in a group was time consuming. Another more practical problem with time management was that it was difficult to arrange group meetings due the

[55] The number after the quote in italics refers to the respondent's code.

members' different schedules. Respondents also reported experiencing two different kinds of conflicts in group work: disagreements about work-related matters and conflicts between group members. Disagreements about work-related matters were situations where discussions ended up in a blind alley, as a member of an engineering research group noted: *disagreements about scientific matters – – may significantly hinder work [82]*. Conflicts between group members concerned the mismatch of chemistries between different persons. A respondent from an engineering research group described this kind of situation as follows: *one group member with the support from another if they are the boss's most trusted individuals, can make it too difficult a small group to function [17]*. Thirteen per cent of the respondents reported bureaucracy to be a significant disadvantage in group work. The group leader, especially, seemed to do additional administrative tasks, as the head of a medical group stated: group work includes *more bureaucracy and formalities etc., an unnecessary waste of time and energy [110]*. Eight per cent of the respondents found inequality in workload sharing, situations where at least one member of the group does not do his or her allotted tasks, to be the biggest disadvantage of group work. A respondent in an engineering research group wrote that *not all group members work efficiently enough [120]*. In addition, other problems in group dynamics, such as poor team spirit and inflexibility, were reported.[56]

TABLE 18 The disadvantages of the research group work by discipline. Percentage distributions (numbers of respondents)

Disadvantages of research group work	Discipline		
	Medicine	Engineering	Total
Considering other group members	34.4 (22)	27.5 (25)	30.3 (47)
Time management	15.6 (10)	18.7 (17)	17.4 (27)
Conflicts			
Work-related	9.4 (6)	12.1 (11)	11.0 (17)
Interpersonal	1.6 (1)	4.4 (4)	3.2 (5)
Bureaucracy	7.8 (5)	16.5 (15)	12.9 (20)
Other problems in group dynamics	14.1 (9)	6.6 (6)	9.7 (15)
Inequality workload sharing	9.4 (6)	6.6 (6)	7.7 (12)
Other	7.8 (5)	7.7 (7)	7.7 (12)
Total	100 (64)	100 (91)	100 (155)

The respondents were asked to evaluate how they allocate their time during a normal working day (Table 19). Most of their time was spent working on the project at hand. There were, however, some differences. Females, rank-and-filers and those who had worked for the shortest time in the group and had short work experience as researcher spent more time doing research than males, group leaders, those who had long work history in the group and had a longer

56 Because there were seven different variables in the disadvantages of research group work, it was not possible to test the differences in terms of discipline etc. as the number of observations would have been too small. Neither were there content-based reasons for regrouping the variables.

work experience as researcher. The respondents also reported spending a little over 20 per cent of their time writing scientific publications. Although in general relatively little time was reported to be spent on administrative and management tasks, there were some differences: it was obvious that leaders and the most experienced researchers had administrative and group management duties. However, it also seemed that respondents in engineering, disciplinary-based groups and in the smallest research groups had more administrative and management duties than those in medicine, multidisciplinary and the largest groups. Additionally, males did more administrative and management tasks than females. This was as expected, as the majority of group leaders were males.[57] Respondents spent a little time resolving conflicts and they also spent approximately ten per cent of their total working time on other duties, especially teaching but also, for example, applying for grants.

TABLE 19 Time allocation (means) by discipline, gender, status in group, degree of multidisciplinary, group size and work experience (t-test for independent samples & ANOVA)

	Conduct-ing study	Writing reports	Admin. tasks	Manag-ing the group	Solving conflicts	Other duties
Discipline						
Medicine (n=105)	53.3	22.7	6.2	4.3	2.0	9.2
Engineering (n=119)	45.8	21.8	9.6	7.9	1.9	11.4
Total (n=224)	49.3	22.2	8.0	6.2	2.0	10.3
	$t_{(204)}$ = 2.114*	$t_{(200.7)}$ = .424	$t_{(222)}$ = -2.398*	$t_{(214)}$ = -2.785**	$t_{(222)}$ = .169	$t_{(222)}$ = -.930
Gender						
Female (n=97)	54.4	22.6	5.2	3.0	1.6	12.2
Male (n=127)	45.4	22.0	10.2	8.7	2.2	9.0
Total (n=224)	49.3	22.2	8.0	6.2	2.0	10.3
	$t_{(222)}$ = 2.616*	$t_{(222)}$ = .305	$t_{(220)}$ = -3.602***	$t_{(211)}$ = -4.663***	$t_{(222)}$ = -1.175	$t_{(222)}$ = 1.368
Status in group						
Leader (n=43)	25.0	19.5	15.1	19.0	2.9	14.1
Rank-and-filer (n=166)	54.9	23.2	6.1	3.0	1.6	9.6
Total (n=209)	48.7	22.4	7.9	6.3	1.9	10.5
	$t_{(97)}$ = -9.671***	$t_{(71)}$ = -1.548	$t_{(59)}$ = 4.734***	$t_{(47)}$ = 8.334***	$t_{(47)}$ = 1.363	$t_{(207)}$ = 1.529
Degree of multidisciplinary						
Disciplinary-based (n=86)	44.8	22.2	10.7	7.7	2.0	11.3
Multidisciplinary (n=114)	51.7	22.3	6.6	5.5	1.9	10.2
Total (n=200)	48.8	22.2	8.4	6.4	1.9	10.7
	$t_{(198)}$ = -1.867	$t_{(198)}$ = -.065	$t_{(150)}$ = 2.475*	$t_{(198)}$ = 1.511	$t_{(198)}$ = .160	$t_{(198)}$ = .420

(continues)

57 Seventy-nine per cent (n = 34) of the leaders were male and twenty-one per cent (n = 9) were females.

TABLE 19 (continues)

Work experience as a researcher						
< 3 years (n=63)	62.7	22.6	2.9	1.2	1.5	7.8
3–9 years (n=77)	53.4	23.9	6.8	4.0	2.2	8.7
> 9 years (n=75)	30.9	21.2	14.5	13.5	2.4	14.1
Total (n=215)	48.3	22.6	8.3	6.5	2.0	10.3
	$F_{(2,212)}$ = 40.500***	$F_{(2,212)}$ = .616	$F_{(2,212)}$ = 25.401***	$F_{(2,212)}$ = 38.218***	$F_{(2,212)}$ = .897	$F_{(2,212)}$ = 2.913
Work experience in the group						
< 12 months (n=35)	65.9	18.9	2.9	1.1	1.2	9.6
12–36 months (n=89)	49.4	23.2	8.5	7.1	2.1	7.8
> 36 months (n=85)	41.7	23.1	9.4	7.5	2.2	13.5
Total (n=209)	49.0	22.5	7.7	6.3	2.0	10.4
	$F_{(2,206)}$ = 12.195***	$F_{(2,206)}$ = 1.171	$F_{(2,206)}$ = 4.802**	$F_{(2,206)}$ = 6.008**	$F_{(2,206)}$ = .771	$F_{(2,206)}$ = 2.331
Size of the group						
3–5 (n=64)	45.0	22.6	10.5	8.2	1.5	10.0
6–10 (n=84)	46.6	24.0	8.4	6.8	2.1	10.5
> 10 (n=76)	55.9	19.9	5.5	3.9	2.2	10.5
Total (n=224)	49.3	22.2	8.0	6.2	2.0	10.3
	$F_{(2,221)}$ = 3.852*	$F_{(2,221)}$ = 1.535	$F_{(2,221)}$ = 3.916*	$F_{(2,221)}$ = 3.437*	$F_{(2,221)}$ = .484	$F_{(2,221)}$ = .017

* p<.05 **p<.01 ***p<.001.
Note. Scale format in time allocation was 0–100 per cent.

Summary and examination of the findings

The main advantages of research group work were the opportunity for scientific discussions and co-operation whereas the most important disadvantage of group work was always having to take other group members into account. Altogether, the advantages and disadvantages of research group work primarily concerned interpersonal relationships and had little to do with academic content. The advantages and disadvantages reported were similar to previous findings on research group work (Younglove-Webb et al. 1999) and to findings in other fields (Toseland, Palmer-Ganele & Chapman 1986). Contrary to Shrum et al. (2001, 690), who found that interpersonal difficulties were rare, the present respondents reported a number of such problems, especially disagreements over work-related matters, personal conflicts between group members and inequality in workloads. In terms of the allocation of working time administrative tasks fell more heavily on group leaders and most experienced researchers. Most of the actual research seemed to be done by the rank-and-filers and junior researchers.

TABLE 20 Summary of the essential research findings by the main research questions

Main research questions		
1. How do members of research groups perceive work characteristics in medicine and in engineering?	2. How do research team members perceive their group work?	3. What is the design of research group work like?
(a) The role of process characteristics	(a) The advantages and disadvantages of research group work	
The respondents were team-oriented, task- and outcome-interdependent and they believed their group to have potency. Respondents also reported supportiveness, good opportunities to participate in decision making and clear cooperative group norms. The group was also regarded as self-managed. Only group members' goals were seen to be dissimilar rather than similar. Altogether, although there were some differences between the independent variables, e.g. discipline, the findings indicated that in research group work a high team orientation played an important role as it seemed to relate to an increase in interpersonal trust, social support, participation in decision making, visibility of cooperative group norms, team spirit and to a diminution in the amount of conflict.	The main advantages of research group work were the opportunity for scientific discussions and cooperation with other group members. Support from fellow group members and increased efficiency were also regarded as advantages. The fact that one always has to take into account other group members and difficulties in time management, additional bureaucracy and conflicts were seen as drawback in group work.	The design stressed three aspects of research group work (see section 7.4). First, the existence of a close parallel relationship between trust and conflict so that high level of trust prevented conflicts and vice versa. Second, the fact that team-oriented behaviour was an important determinant in creating a conflict-avoiding climate, although in general trust and conflict explained process characteristics rather than vice versa. Third, structural characteristics relatively modestly explained research group work characteristics despite the expectation, for example, that discipline would emerge as an important single predictor of group work characteristics. Altogether, the success of research group work seems to rely on trust among group members, on a low level of conflict and a high level of team-oriented behaviour.
(b) The role of trust and conflict	(b) Working time allocation	
Respondents reported working in conflict-avoiding and conflict-resolving groups in a social climate of trust. If conflict occurred, it most likely concerned tasks. Conflict and trust were also highly interdependent: the higher the trust, the less the conflict. Altogether, trust and conflict played an important role in research group work	Respondents spent most of their time on research. Rank-and-filers spent more time on research than group leaders who performed more administrative and group management tasks.	

Note: The findings of regression analysis are not summarised in this table as they are presented in Figure 19.

7.4 An empirical model of research group work design

A hypothetical model of research group work, which was termed a research group work design, was presented in section 4.6. In this section, the model is revised and complemented on the basis of the empirical observations (see summary in Table 20). Hence the results of the multiple regression analysis are entered into the model, the arrows in the figure showing that certain factors are statistically significant predictors (Figure 19). Because only the statistically significant relationships which emerged from the regression analysis are included in the model, it is unavoidably a simplification. Nevertheless, the model gives an overall picture of the most important factors affecting research group work. The epistemological and societal conditions for research group work are excluded from the empirical model as the empirical findings are discussed along with the relevant contextual factors in chapter 9.1.

First, the most evident relationship is between conflict and trust: interpersonal trust prevented conflict whereas conflict had a debilitating effect on trust among research group members (Figure 19). This finding is in accordance with previous studies (Lovelace et al. 2001; Shrum et al. 2001): thus, avoiding conflict and trusting the social climate are key elements of research group work. However, this observation needs to be taken with some scepticism as the problem of multicollinearity is obvious (for more see appendix 14). Second, conflict had a controversial effect on individual process characteristics. On the one hand, conflict seemed to have a negative effect, as task conflict was detrimental to team-oriented behaviour. On the other hand, process conflict seemed to have a positive effect on participation in decision making in the group in so far as the more respondents participated in decision making, the more they experienced process conflict. This can be explained by the fact that those who actively take part in decision making need to experience process conflicts, as decision making is matter of reconciling different ways of thinking. Altogether, however, it can be argued that conflict, no matter whether it is task-, process- or relationship-related is more likely to have negative than positive impact on work characteristics (Jehn & Mannix 2001; Lovelace et al. 2001). Third, cooperative group norms enhanced interpersonal trust, i.e. a better understanding of how to cooperate in the group increasing trust. Trust, on the other hand, enhanced both individual and group process characteristics, trust having a positive effect on outcome interdependence and cooperative group norms (cf. Newell & Swan 2000). Team-oriented behaviour was also an important process characteristic as it seemed to diminish the occurrence of task and process conflicts. Fourth, structural characteristics had an impact on research group work characteristics, although in this case there was no justification for estimating how positive or negative the impact was in terms of specific factors, such as discipline or gender. However, on the group-level, group size had a negative effect on participation in decision making with large groups experiencing more difficulty in taking part in decision making. One-

way analysis of variance also supported the negative impact of group size, as was expected on the basis of previous studies (Shaw 1981; Mullen 1987; Wagner 1995; Williams & O'Reilly 1998). Work experience in the group had a positive effect on outcome interdependence with long work experience in the group enhancing outcome interdependence. In addition discipline, gender and group status affected certain work characteristics; multiple regression analysis indicated that discipline (medicine/engineering) affected participation in decision making, team self-management and process conflicts, whereas gender had an influence on task interdependence and process conflict. Group status predicted team orientation and task interdependence. However, for discipline, gender and group status the direction of causality is not as important as the effect itself.[58] What needs to be stressed here is that relatively few structural characteristics explained process characteristics, trust or conflict. For example, the degree of multidisciplinarity was not a statistically significant predictor of any of the research group work characteristics. In part this was expected, as structural characteristics can also be regarded as moderators (see Parker et al. 2001). The moderating effect of structural variables was not tested in this study.

When this empirical research group work design is compared to the hypothetical model (Figure 9 on page 64), the relationship between trust and conflict is as expected. However, in the hypothetical model it was not possible to posit any clear hypotheses about the different work characteristics since these can be comprehended as both independent and dependent variables. In this respect the empirical design clarified the relationships between the different research group work characteristics. In the hypothetical model process characteristics were seen to have an effect on how trust and conflict are perceived. However, the findings showed that the direction of causality was rather the opposite, although team-oriented behaviour was an important determinant of conflicts. Interpersonal trust and conflict, especially task and process conflict, explained how the process characteristics of outcome interdependence, team-oriented behaviour, participation in decision making and cooperative group norms, particularly, were perceived. In relation to structural characteristics it was unexpected that they did not affect either trust or conflict – the only exception was gender, which predicted process conflict.

To conclude, the design shows three distinct observations: a close relationship between trust and different forms of conflict, the fact that team-oriented behaviour was an important determinant in creating a conflict-avoiding climate, although in general trust and conflict explained process characteristics rather than vice versa, and the relatively modest role of structural characteristics in explaining research group work characteristics. The relationship between trust and conflict was very unambiguous and hence the results support those of previous studies (Jehn & Mannix 2001; Lovelace et al.

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58 This is because in the multiple analysis of regression the variables included should be expressed on, at least, an interval scale, which gender and discipline obviously cannot be. However, in educational research, variables which are expressed on a nominal scale, and especially so called dummy-variables, are also used in conducting regression analysis.

2001; Shrum et al. 2001) which have pointed out that trust and conflict are interdependent. The fact that team-oriented behaviour had an important role in preventing conflicts was expected (see Watson et al. 1998; Campion 1993; 1996). Furthermore, structural characteristics explained process characteristics (cf. Williams & O'Reilly 1998), trust and different forms of conflict rather little. Only group size and work experience in the group showed clear relationships with some of the process characteristics.

The research group work design model has, however, two empirical limitations. First, the model was not tested although, in principal, this would have been possible. Path analysis, especially, or multilevel models (Malin 1997) are methods that take into account both exogenious and endogenious variables, that is, direct and indirect relationships between different variables. There were two reasons for neglecting the empirical modelling of the research group work design. First and foremost, developing causal closure was difficult as causal relationships between variables are not unequivocal (cf. Parker et al. 2001). Second, even if the problem of causality could have been solved, it would have been rather difficult to interpret the model as it contained several variables and hence several direct and indirect relationships. The second empirical limitation of the design was that it can be criticised for oversimplifying, as it only takes into account the statistically significant relationships which were revealed by multiple regression analysis, thereby casting doubt on how to interpret the outcome (see also section 9.2).

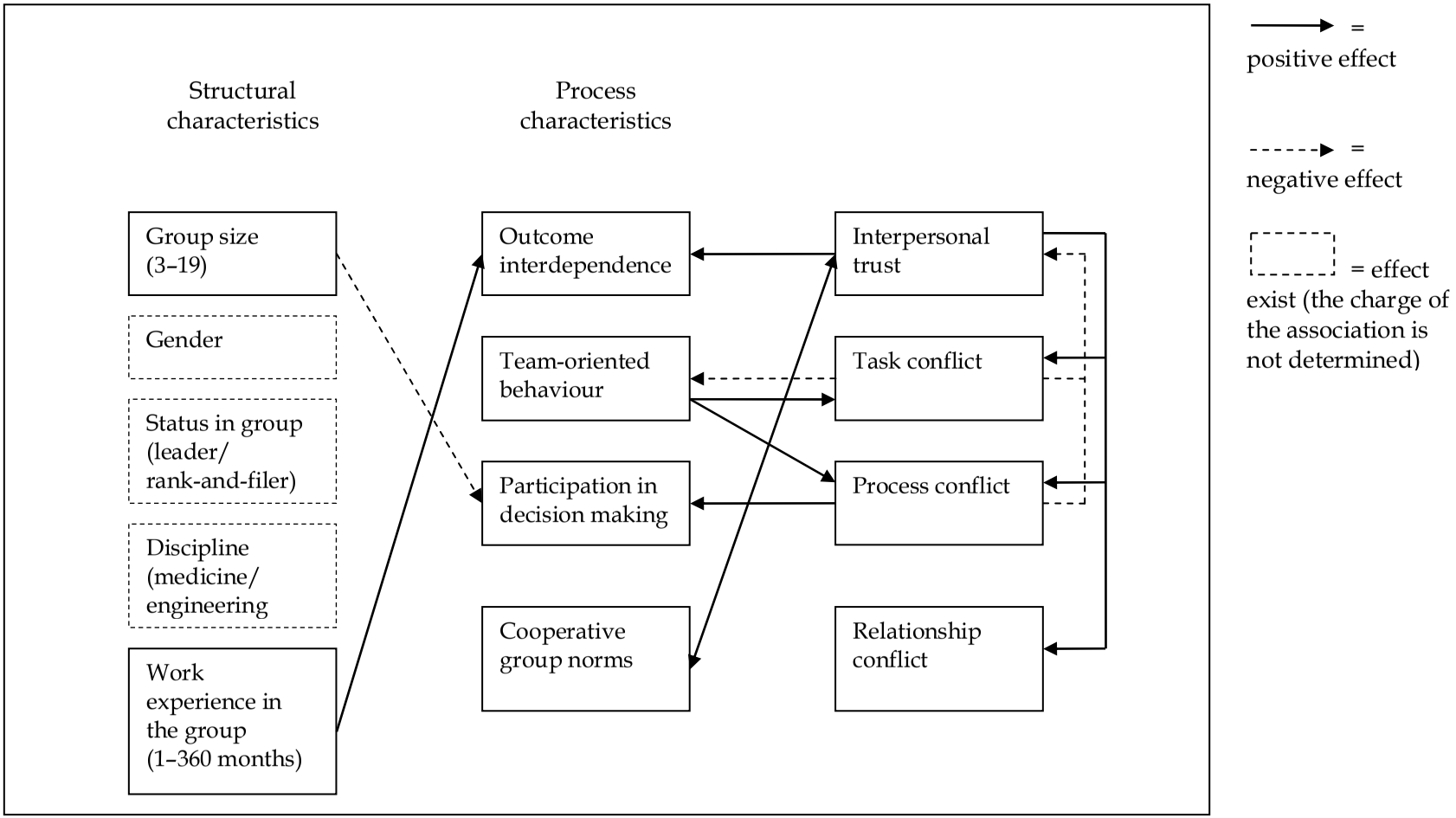

Figure 19 Research group work characteristics and their relationships after empirical testing

8 GROUP WORK IN MEDICAL AND ENGINEERING RESEARCH SETTINGS

Process characteristics in medical and engineering research group work

What do the results tell us about process characteristics in medicine and engineering? What conclusions can be drawn? Campion et al. (1993, 828) noted that those who had a high team orientation were more satisfied and effective in groups than when working alone. Thus, as the majority of the respondents reported a high team orientation they had optimal conditions for effective work performance. The important role of team orientation was also observed when different types of research group members were compared in terms of process characteristics, trust and different types of conflict. It seemed that those who had a high team orientation, that is, joint constructors, experienced fewer conflicts and placed high trust in their fellow group members. They were also more supportive and cooperative and they participated actively in decision making. Watson et al. (1998, 162) argue that a high team orientation evolves when team members interact effectively. The findings of this study suggested that the respondents cooperated quite frequently, and cooperative group norms were also important predictors of a high team orientation. Thus, in this respect the findings support the observation by Watson et al. (1998) about the development of a high team orientation. Although team orientation was relatively high among the respondents, previous studies (Gersick 1988; Watson & Michaelsen 1988; Battenhousen 1991) have found that high team orientation can both promote and hinder a group's effectiveness. Further, Schmitt and Klimoski (1991) claim that the group performs better than the best individual when the problem is sophisticated. In general, research group work is based on solving diverse and complex problems, and from this perspective the findings of the present study support the view that a high level of team orientation will increase a group's effectiveness. Furthermore, the findings of this study were in accordance with those of previous studies (Campion 1993; 1996; Watson et al. 1998) regarding the importance of a high team orientation in promoting group work as such an orientation prevented task and process conflicts, promoted a

team spirit, raised awareness of cooperative group norms and conflict norms, and increased the probability of conflict resolution.

Task and outcome interdependence were high, although the respondents found a clearer connection between outcomes than between tasks. This finding throws some light on the nature of academic work: at the level of tasks research group members can work as individuals, but when it comes to outcomes a joint effort is needed in order to realise and attain group goals (Wray 2002, 166). At the same time, current science policy is outcome-oriented (Hakala et al. 2003, 48–56) which leads scholars produce, for example, joint articles just to increase the number of their publications despite a low level of task sharing. Furthermore, Steward and Barrick (2000) found that when interdependence was high, the synergistic benefits of group work were best obtained in those groups primarily engaged in conceptual tasks. Tackling conceptual tasks is a typical feature of research group work. Thus, as the majority of the respondents reported high relations of interdependence, the synergistic aspects of research group work could be utilised. One can also conclude that the respondents seemed to experience positive outcome interdependence and believe that other members' goal attainment facilitated progress toward their own goals. This notion is in harmony with the results of van der Vegt et al. (1998). Positive outcome interdependence also increases open-mindedness regarding others' reasoning and concern about each others' outcomes (Tjosvold et al. 1991). Furthermore, cooperation was a good predictor of task interdependence, which confirms previous findings (Campion et al. 1993; Stewart & Barrick 2000) indicating that cooperative interaction results in high interdependence. Additionally, Hackman (1988) argues that the intense interaction created by high interdependence leads to a crystallisation of group norms which, in turn, diminishes process difficulties such as conflicts. The findings of this study in part supported this claim as those respondents who had high (task) interdependence seemed to experience few conflicts but *only* if they also were highly team-oriented. This was also the case for those respondents who had low (task) interdependence: if they had a high team orientation they experienced few conflicts (cf. Steward & Barrick 2000). Thus, there was a close parallel relationship between task interdependence and team orientation. On the other hand, outcome interdependence was an important predictor only in terms of goal similarity and conflict norms, whereas task interdependence was not a statistically important predictor at all, suggesting that interdependence *per se* was not so important a factor in determining the quality of research group work.

On the one hand, the high level of interdependence was not a surprise as in the hard sciences, which medicine and engineering represent, scholars usually are more interdependent than in the soft sciences. The reasons for this are, for example, more sophisticated and costly research instruments (Baldwin & Austin 1995; Chompalov & Shrum 1999) and the fact that scholars are more often adapted to group work (Hakala et al. 2003, 80) and hence used to interdependence in doing research. On the other hand, the fact that more than one third of the respondents had low task interdependence does not necessarily

indicate task imbalance but rather points to the fact that both interdependence and independence is required in research group work (Wageman 1995). The fact that group leaders were more task- and outcome-interdependent and more team-oriented than rank-and-filers was expected as group leaders have to be aware of all the different tasks being carried out in their group, and the outcomes, as well as being the driving force of the group. What was surprising was that males were more team-oriented, outcome- and task-interdependent than females. This is difficult to interpret as there were no interaction effects, for example between gender and discipline. Thus, it seems that gender was an important factor regarding team orientation, outcome and task interdependence. Additionally, the most experienced researchers were more task-interdependent than the others, but this difference was not found in outcome interdependence. One reason for this could be that more experienced researchers can more easily see a clear line of continuity between the tasks they are called upon to do; this is less easy for less experienced researchers who are adapting themselves to academic work.

In addition to team-oriented behaviour and interdependence, the other process characteristics were, generally, on a high level. The respondents supported each other, cooperated frequently and had relatively good opportunities to participate in decision making. Research groups also had a good team spirit and they were to some degree self-manageable. Group goals, however, showed more dissimilarity than similarity. Previous studies (Campion et al. 1993; 1996; Lindsley et al. 1995) indicate that if process characteristics are positively perceived they increase a group's productivity and performance. Thus, in the medical and engineering research groups process characteristics seemed to alleviate mundane tasks and thereby promote group effectiveness.

When Axtell et al. (2000) examined the different process characteristics more closely, they found that social support was a key element in implementing ideas, which, in turn, is an inseparable aspect of research group work. The present respondents, and especially group leaders, reported a very high level of social support, which allowed for the implementation of ideas. Group potency (team spirit) helps group members to meet sudden setbacks and it helps determine how conflicts are dealt with (Guzzo et al. 1993). Thus, a high team spirit, the confidence that the group can be effective, was found to enhance the functioning of the medical and engineering research groups. The findings of this study did not, however, support the claims by Guzzo et al. (1993) that group potency contributes to how conflicts are dealt with, as social support was not an important predictor of conflict resolution. Group potency was not a central determinant of group satisfaction either, if satisfaction is understood as high level of trust and low level of conflict. Thus the findings are contrary to those of Campion et al. (1993; 1996). Given that academic work is a typical example of knowledge work where the nature of mundane tasks is varied and (personal) resources are extended to the extreme (Winter & Sarros 2002), the relatively high level of group potency among the present respondents was somewhat unexpected, as in order to develop a can-do attitude, members

should feel that their personal resources are adequate for the task at hand (Guzzo et al. 1993). The findings of this study are also contrary to the finding of Guzzo et al. (1993) that group size affects group potency as there was no relationship between group size and potency.

Although there were some differences, the respondents reported that they had relatively good opportunities to take part in decision making, which, according to previous studies (Campion et al. 1993; Keyton 1999), increases members' sense of responsibility, ownership of the work and group cohesiveness. Interestingly, in the small and large engineering research groups it was easier to participate in decision making than in those in medicine. The case was the opposite in the medium-sized research groups. This interaction effect between group size and discipline was unexpected as it indicates a curvilinear association between discipline and group size in relation to decision making. However, the findings of this study are in accordance with the observation by Winter and Sarros (2002, 253; also Currie & Newson 1998) that the most experienced researchers (especially professors) participated more in decision making, although the proposition that in general academics take a relatively low part in decision making was not supported. This difference can be explained by the fact that Winter and Sarros (2002) looked at academics in general, not those working in research groups where participation in decision making is on a wholly different scale compared to the situation in academic departments. Furthermore, the results suggest that members of multidisciplinary research groups do not have as many opportunities to participate in decision making as members of disciplinary-based groups. The finding was expected due to the greater diversity of multidisciplinary research groups in terms of members' opinions about the tasks in hand, which may lead members to feel that they have little influence on decision making (cf. Younglove-Webb et al. 1999). Furthermore, a multidisciplinary group may be dispersed over many institutions thus rendering collective policy difficult. On the other hand, the respondents also reported their groups to be rather self-manageable, a feature, which according to Langfred and Shanley (2001; also Dunphy & Bryant 1996), encourages group members to make independent decisions and be proactive in their work. Self-management may also indicate that groups had the freedom and authority to lead themselves independently of external supervision (Stewart and Barrick 2000, 139), by bodies such as funding agencies.

The fact that cooperative group norms were relatively high among the respondents was partly expected, as Campion et al. (1993; 1996) have also noted a strong relationship between cooperative group norms and member satisfaction in groups that do complex knowledge work. Shared goals have been regarded as a key element of commitment to group work (Sweeney & Lee 1999), but many of the present respondents reported their goals to be more dissimilar than similar to those of their fellow group members. Alternatively, this might indicate low commitment to group work, but as other indicators, such as preference for team work, were at a high level, the existence of goal

dissimilarity is rather evidence of the nature of academic work, which, according to Clark (1987), is a profession characterised by great internal variety.

Trust and conflict in medical and engineering research group work

In general, the respondents in both the medical and engineering research groups trusted each other and rarely experienced conflicts. The finding is a little surprising as the level of trust shown towards other group members was higher than that found by Chompalov and Shrum (1999, 357–358) in their study of multi-institutional collaboration. Trust among respondents and lack of conflicts seemed to be highly dependent on each other: the higher the trust among the respondents, the less they experienced interpersonal collisions. This finding is in accordance with previous studies (e.g. Shrum et al. 2001) which have indicated that lower trust is associated with higher conflict. Thus, the finding does not support Newell and Swan's (2000) view that a conflict-avoiding climate in research group work diminishes trust. Various reasons can be offered for the high trust and low disharmony found in the medical and engineering research groups. First, the respondents reported solving problems as they arose, and this might in part have increased the level of interpersonal trust, as conflicts, if they are constructively solved, can promote group work (e.g. Eisenhardt & Schoonhoven 1990; Jehn 1995; Amason 1996; Chadwick & Thatcher 1997; DeChurch & Marks 2001). Second, relationship and process conflicts can be detrimental to group work (Jehn 1995; Jehn 1997; Jehn et al. 1999; Jehn & Mannix 2001), whereas task conflict can promote a group's functioning (Eisenhardt & Schoonhoven 1990). According to the respondents, relationship and process conflicts were experienced less often, whereas task conflicts were more frequent. This study, however, indicated that conflicts seemed to have a negative impact on trust – no matter whether it was task, process or relationship conflict. Thus, the findings suggested that trust was best maintained in the absence of conflicts. In this respect, the findings of this study support previous studies (Jehn & Mannix 2001; Lovelace et al. 2001) indicating that conflict of any kind is detrimental to group work. On the other hand, the fact that disagreements were reported to be short-lived may indicate that the respondents had not been in situations where they would have encountered the kind of uncertainty which makes trust salient (see Huff et al. 2002, 25). Third, as the medical and engineering research groups seemed to have high interdependence and team-orientation, they also had a good basis for joint knowledge production, which, according to Newell and Swan (2000), increases interpersonal trust. A limitation of this study, however, was that the effects of conflicts on group work were not studied. In other words, how conflicts ultimately affected group was not studied as the focus was primarily on how *often* conflicts occur in group work not on the role of conflicts, such as "clearing the air". Fourth, one reason for the low number of disagreements might have been that respondents shared the same ideas about how the actual (research) work should be carried out (cf. Younglove-Webb et al. 1999).

The fact that the respondents, especially those from medicine and the largest groups, females and rank-and-filers, were not fully aware of the conflict norms may, on the other hand, heighten the negative impacts of conflicts (Bettenhausen & Murningham 1985; Jehn 1995). Previous studies (Shrum et al. 2001, 699–700) also indicate that highly interdependent collaborations increase the emergence of disagreements. This argument was not supported in this study, as interdependence was found to play a contradictory role. Although the role of interdependence was not an important one, when team orientation was also taken into account it seemed that those members who had a high team orientation and low or high task interdependence experienced fewer conflicts than those with a low team orientation and low or high task interdependence. Altogether, team orientation seemed to be more important in determining the occurrence of contradictions than interdependence, and in this respect the findings suggest that rather than paying attention to the relationship between interdependence and conflicts it would be more fruitful to study the relationship between team orientation and conflicts (cf. Shrum et al. 2001).

Advantages and disadvantages of research group work and working time allocation

The most important advantages of research group work were the opportunity for scientific debate and co-operation, whereas the most important disadvantage of group work was always having to take in consideration other group members. Altogether, the advantages and disadvantages of research group work primarily concerned interpersonal relationships and little was said about the content of academic work. The pros and cons reported were similar to those of the previous findings on research group work (Younglove-Webb et al. 1999) and findings in other fields (e.g. Toseland et al. 1986). Support was also reported to be an important advantage of group work, and was mainly seen as either practical support or appraisal support (see West 1994, 66–71). Contrary to Shrum et al. (2001, 690), the respondents reported experiencing various interpersonal difficulties, especially disagreements about work-related matters, personal conflicts between group members and inequality in workload sharing. An interesting finding was that no advantages or disadvantages were reported that could have been characterised as a typical feature of academic work. The respondents did not stress, for example, the uncertainty of academic work, which has been found to be an important feature of academic (project) work (Kogan et al. 1994; Enders & Teichler 1997; Enders 2001; Puhakka & Rautopuro 2001) and a source of tension between individuals (Ylijoki 2003, 329). Additionally, the respondents did not stress, for example, disciplinary cultures as either a benefit or impediment in research group work. This was the case even in the multidisciplinary groups. On the one hand this might have been caused by the open-form of the question, which did not encourage consideration of the cultural aspects of group work. On the other hand, research groups can be seen as "administrative units" with one main function, to produce new knowledge (Ylijoki 2003). Therefore, the role of disciplinary

cultures is ignored and attention is rather paid to intragroup processes, like interpersonal relationships.

The allocation of working time in the research groups was as expected: group leaders and the most experienced researchers did more administrative tasks whereas rank-and-filers and junior researchers had more time to conduct research. This finding is in accordance with Ylijoki's (2003, 328–329) notion that senior researchers create an operational environment for young researchers to carry out the actual research. For senior researchers and group leaders administrative tasks take up quite a lot of time, which supports the suggestion by McInnis (2000, 58) that academics spend more time on demotivating administrative work. Respondents also differed from each other in terms of group status. It seemed that in general group leaders evaluated the group's internal processes more positively than rank-and-filers (cf. Stolte-Heiskanen & Alestalo 1978, 154). For example, group leaders were more task-interdependent and supportive than rank-and-filers. This can partly be explained by their different organisational position in the group, and in that respect some functional heterogeneity existed (see Cox et al. 1991, 841–842).

The effect of group size and discipline in medical and engineering research group work

The role of multidisciplinarity was interesting as only a few differences, e.g. respondents from discipline-based research groups participated more in decision making, emerged between the discipline-based and multidisciplinary research groups, whereas previous studies (Younglove-Webb et al. 1999; Amabile et al. 2001) have indicated more substantial differences. Especially the fact that there were no differences in terms of the experience of conflict was contrary to the indications of previous studies (e.g. Amabile et al. 2001). One reason could be that the present research groups were more multidisciplinary than transdisciplinary and therefore cooperation was based on each member's own disciplinary premisses, not on the integration of any single new intellectually coherent entity (see Huber 1992; Gilbert 1998), and thus knowledge production was not a result of constant negotiations regarding disciplinary differences.

Altogether, differences between the disciplines themselves seemed more important than whether the research groups were discipline-based or multidisciplinary. Accordingly, respondents from the engineering research groups were more task-interdependent, more aware of conflict norms and experienced fewer relationship conflicts than those from the medical research groups. Furthermore, although there were no other statistically significant differences, the engineering respondents attributed slightly higher importance to work characteristics than did their medical counterparts. Moreover, when the results of the multiple regression analyses were compared by discipline, quite different predictors were observed. Altogether, engineering research group work seemed to entail fewer problems among the group members than medical group work. Although this finding is only indicative, it reveals the differences in the nature of different disciplinary cultures in research group work. In

section 5.2.1 medicine and engineering were presented in a Becherian framework which showed that their social-epistemological structures were very similar. Despite this resemblance, what is understood as "medicine" and as "engineering" is of consequence as both disciplines are formed from different (sub)specialisms. In this study there were 10 specialisms in medicine and 32 in engineering (see section 5.2.1). Thus, the medical research groups incorporated fewer specialisms than the engineering research groups. This indicates that a high number of specialisms is not necessarily detrimental to research group work. However, the medical research groups were more heterogeneous than the engineering groups. Such heterogeneity has been thought to require more systems maintenance, that is, negotiation about goals and procedures. (Baldwin & Austin 1995; Williams & O'Reilly 1998). As noted in section 5.5, the research groups in medicine were larger, more often multidisciplinary and part of an international research project than those in engineering. In the terminology of Drach-Zahavy and Somech (2002, 45), the medical research groups had higher task-related heterogeneity. Thus, especially due the fact that the medical research groups were larger, the slightly more negative assessment of work characteristics in those groups is understandable.

Research group size was the most important single structural factor that impacted on work characteristics. The respondents from the smallest research groups (3–5 members) were more team-oriented, task-interdependent, participated more in decision making, were more aware of conflict norms and had higher trust in other group members than those from the largest ones (more than 10 members). Furthermore, the respondents from the smallest groups experienced fewer relationship and process conflicts than those from the largest. The smallest teams were also more self-manageable. Thus, in general, respondents from the largest research groups gave more negative assessments of work characteristics than respondents from the smallest ones. These findings are in accordance with those of previous studies (Shaw 1981; Mullen 1987; Wagner 1995; Williams & O'Reilly 1998) which indicate that large size has a negative impact on group work. However, one cannot argue for an optimal size of research group as the production of new knowledge is more than just group work characterised by different administrative tasks and research practices. It is, despite increased notions about academic capitalism (Slaughter & Leslie 1997), a matter of individual creativity which can only be enhanced or prevented by the group but not generated by the group (Becher & Kogan 1992, 182; Nieminen 2002).

In addition to structural characteristics, like discipline and group status, attention was paid to various individual attributes, which were partly reflected in the task-related heterogeneity of the group (see Drach-Zahavy & Somech 2002, 45). Hence research group members were classified according to how team-oriented and task-interdependent they were. The findings indicated clearly that in research group work a high team orientation played an important role as it seemed to relate to an increase in interpersonal trust, social support, participation in decision making, visibility of cooperative group norms, team spirit and to a diminution in the amount of conflict. Therefore, the results

suggest that preference for team work is crucial in order to enhance group processes (cf. Battenhausen 1991). Furthermore, the classification revealed differences between group members which are easily neglected in the course of group work; hence it can be argued that task-related heterogeneity was relatively high among the respondents.

Model of research group work design in medicine and engineering

As noted in section 7.4, the research group work design shows three distinct observations: a close relationship between trust and different forms of conflict, the fact that trust and conflict explained process characteristics not vice versa (with one exception as TOB was an important antecedent in producing a conflict avoiding social climate) and the relatively modest role of structural characteristics in explaining research group work characteristics. The relationship between trust and conflict was very unambiguous; hence the results support those of previous studies (Jehn & Mannix 2001; Lovelace et al. 2001; Shrum et al. 2001), which have pointed to the interdependence of trust and conflict. The result that trust and conflict more likely explained process characteristics was unexpected, as the hypothetical model implies the opposite. Thus, trust and conflict not only promote interaction between group members but also enhance it. Finally, structural characteristics partly explained process characteristics (cf. Williams & O'Reilly 1998), trust and different forms of conflict. Only group size and work experience in the group showed clear relationships with certain process characteristics.

What can be concluded about research group work in medicine and in engineering in the framework of the work design approach? As noted in section 4.6, the hypothetical model of research group work design assumes that certain contextual antecedents affect the actions taking place in a research group. These antecedents were epistemological and societal circumstances, which included the changing structures of the knowledge society, the capitalisation and democratisation of knowledge production and the fragmentation of disciplines. What, then, might the empirical findings reveal about the effects of these contextual factors on research group work characteristics? The role attributable to contextual antecedents can only be theoretical as only work characteristics were empirically studied. These contextual factors cannot therefore be regarded as *empirically* relevant, but this does not mean that they have no relevance. The role of contextual factors takes on meaning when the results of the study are interpreted (see also section 9.1). For example, high interdependence among the respondents was expected, as in the hard sciences, which medicine and engineering represent, group members have to cooperate more frequently because the research instruments in these disciplines are more sophisticated (Baldwin & Austin 1995). Furthermore, the dissimilarity found in goals is revealing about the nature of academic work, which has lots of internal variety (see Clark 1987). Thus, this epistemological fact about the nature of disciplines and of academic work increases the interpretive scope of the research findings. Altogether, the design suggests that epistemological and societal circumstances

create a setting in which academic institutions, basic units and ultimately individual group members operate. Thus a framework is established within which research group work characteristics are interpreted and experienced.

9 DISCUSSION

9.1 Research group as a working environment

What general inferences, then, can be drawn on the basis of the views of the respondents? What does the data suggest about the research group as a working environment? The general conclusions can be summarised as follows:

1) the medical and engineering research groups showed internal harmony;
2) research group work in medicine and engineering was "non-academic" in nature; and
3) discipline played a modest role in medical and engineering research group work

These general conclusions are not separate but rather interdependent. In the following sections each of these conclusions are viewed from two perspectives, methodological and content-based, each of which receive different emphasis in relation to the above-mentioned general conclusions.

9.1.1 Internal harmonious research groups in medicine and engineering

The respondents evaluated research group work characteristics in a very positive way. Inevitably this leads to the question, is it a general fact that research groups in medicine and engineering are internally highly harmonious? And if this is so, what might be the reasons behind that? In part this internal harmony can be explained by reference to two methodological aspects: because of the method of selection of the respondents and the fact that the respondents evaluated their relation to the group in general rather than any dyadic relationship, such as between group leader and rank-and-filer. Thus, a respondent might have had, for example, a problematic relationship with another group member, but in general he/she was satisfied with his/her colleagues in the group. This was highlighted by a few respondents in the last

open-form question in the questionnaire. Furthermore, because of purposeful selection groups with internal problems might have been excluded from the study, yielding thereby results that are overly optimistic and positive (see also section 5.2.2).

If the focus is shifted from methodological to content-based issues, the role of conflict and trust needs to be discussed. As trust and conflict were highly interdependent, a trusting social climate in a research group has inevitable implications for how group members perceive their relation to other group members. This is especially because trust and (lack of) conflict seemed to be important determinants of process characteristics (see also section 7.2). Thus, if a respondent found that he/she generally trusted the other group members, he/she was more likely to evaluate the overall social climate, i.e. other work characteristics, as very positive. When different types of research group members were compared, however, it can be argued that the picture of research group work was not quite so harmonious as it seemed that those respondents who had a low team orientation experienced conflicts more often and had low level of trust compared to those who had a high team orientation. This observation partly emphasises the importance of person-to-person relationships within the group as in group work the differences between personalities tend to be balanced.

Nevertheless, the existence of internal harmony may also reflect the organisation of a group, i.e. all the group members had responsibilities, obligations and opportunities that match their position and expertise. Differences in participation in decision making, for example, may indicate that groups have a rather hierarchical organisation, which is a typical feature of Mode 1 knowledge production (Gibbons et al. 1994). A positive outcome of a hierarchical organisation is that it can reduce the internal disharmony of the group. The results indicated that the respondents had a relatively clear picture of their individual role in the group, for example, task allocation was generally clear. Internal harmony may also be caused similarities of opinions and views held by group members about the work the group is carrying out. Using the concept proposed by Knorr Cetina (1982) it seems that group members occupy the same *transepistemic arena of research*, which is understandable as it is crucial for a research group to survive that its members have similar scientific views about the object being studied. On the other hand, as Shrum et al. (2001, 716; also Atkinson et al. 1998) have pointed out, competition is greater between groups representing the same field of study than between members of the same group. Thus, group members need to pay more attention to how they manage competition with other groups, personal relationships with other group members taking a back seat. This partly reduces the likelihood of internal problems in the group as members' focus has to be on the overall success of the group rather than their within-group relationships.

Additionally, on the basis of the research findings, one can argue that although it has been noted that knowledge production is in a state of epistemological wobble in which the social meaning and function of science is becoming obscure (Scott 1997), this turbulent environment does not extend to

how group members actually interact with each other and how they perceive their work. Ultimately, this goes against the core idea of the work design approach as well as the idea that societal and epistemological circumstances affect how individual group members perceive their role in a group (cf. section 2.3). Thus, the environment in which a group operates can effect how its members *as individuals* perceive their job, whereas if they are asked how they see themselves *as a part of the group*, context takes on a less important role. For example, uncertainty about future of one's job may affect how one experiences and perceives that job, but it does not greatly affect ones' opinions about other group members. Groups can also help to meet all the demands made by the rapid changes in science and higher education policy compared to the lone researcher situation (see Baldwin & Austin 1995). In sum, one can conclude that how the researcher experiences and perceives his or her relationships toward other group members is, at least to some respect, independent of the contextual antecedents that define the success of the group.

9.1.2 Non-academic nature of medical and engineering research group work

It was difficult to find in the respondents answers anything that could be concerned typical of *research* group work, for example, advantages and disadvantages. Thus, research group work was seen like any other group work. Mostly, this can be explained by the research strategy used as it did not encourage highlighting the special characteristics of research group work, as can be done in open-form questions. In the case of structured questions (multiple-choice tests) respondents, naturally, cannot affect the content of a statement, since it is formulated by the researcher.

If the focus is shifted to content-based aspects of the research group work, the ultimate question is: is research work really no different from any other kind of group work? For example, the question of what is academic has been raised (e.g. Scott 1997). On the basis of previous studies of academic work, for example, disciplinary cultures (Becher & Trowler 2001) and the nature of academic work (Kogan et al. 1994; Enders 2001; Hakala et al. 2003) imbue research group with some special characteristics, although it has been argued that academic capitalism (Slaughter & Leslie 1997) dispels the boundaries between the academic, public and industrial. However, when considering the work characteristics of group work, it is indisputable that the same characteristics are present irrespective of the environment the group operates in or the nature of tasks individual group members perform. Thus, conflicts always exist, trust is an important determiner of interpersonal relationships and team spirit defines the overall climate of the group. The question is rather one of the extent to which these characteristics exist and how they interrelate. It is this that distinguishes the different contexts in which groups operate. When, for example, disciplines were compared, some differences between medicine and engineering emerged in the results of the regression analysis. For instance, medicine and engineering had different predictors in terms of trust. Thus, there were disciplinary differences how research group work characteristics were

interrelated. Hence a discipline can be regarded as an element of the context in which the group operates (see also section 9.1.3). The problem with the work design approach, however, is that although it takes contexts into account it only does so in a descriptive way. In other words, how context affects the relationship between group members can be better captured by other approaches, such as the constructionist approach (see chapter 3).

It was somewhat surprising that the effect of different interest groups, such as private enterprise, did not show up in the research findings, especially since medicine and engineering can be regarded as fields of study which operate at the heart of the border-crossing institutional sphere, where the spheres of academia, industry and government overlap (see Etzkowitz et al. 2000, 56–57) thereby justifying the notion of the democratisation of knowledge (Delanty 2001). One would have expected that although the focus was not on collaboration with different interest groups there would have been some indication of this, for example, in terms of the advantages and disadvantages of group work. The only indicator was that research groups seemed to be relatively self-managed, which suggests freedom from external supervision (see Stewart and Barrick 2000). Additionally, no effect of the basic unit and the institution where group is located was observed although the institution and basic unit create the physical and social environment where group operates. In this case, also, the methodological limitations apply, but overall the research groups seemed to be loosely institutionalised, that is, they were highly flexible in terms of their functioning, which is a typical feature of Mode-2 science (Gibbons et al. 1994) although, as noted above, there was hardly any hint regarding the contextualisation of knowledge production, the most evident feature of Mode-2 science. To conclude, although the results indicated that the present research group work lacked academic features, it cannot be argued that this is ultimately the case as this finding is bound up with the methodological approach used.

9.1.3 The modest role of discipline in medical and engineering research group work

In this study, discipline seemed to play a rather modest role in research group work, given the emphasis in previous studies (e.g. Clark 1983; Kuh & Whitt 1988; Becher & Trowler 2001) on the importance of disciplinary cultures in determining the nature of academic work. There were only few differences between medicine and engineering; for example, the respondents from the engineering research groups were more task-interdependent than those from medicine. Furthermore, discipline was not an important structural predictor of research group work characteristics. The modest role of discipline raises the question of whether research group work diminishes the effect of disciplinary cultures by creating an epistemological culture of its own.

When medicine and engineering were examined as disciplines in the Becherian framework, they showed relatively similar social and epistemological structures (see section 5.2.1). Thus, only a few differences were expected

between medicine and engineering. The situation might have been different if soft fields of study like the social sciences had been included in the study. Contrary to previous studies (e.g. Younglove-Webb et al. 1999), there were hardly any differences between multidisciplinary and disciplinary-based research groups. In collaborations which involve actors from different disciplines the importance of discipline is more easily acknowledged than in discipline-based groups, as actors need to negotiate their disciplinary premises. Therefore, this constant negotiation might have been expected to have ultimately affected research group work and the relationships between group members. On the other hand, a relatively high self-management of the research groups could indicate that groups were free not only from external supervision, but also from disciplinary insistences. Altogether, the results indicate that the research group, at least in hard-applied sciences, has its own culture which transcends the importance of individual disciplinary cultures in constructing the epistemological and especially social foundations of research work.

Again, there are methodological reasons for the modest role of discipline. The focus in this study was rather on the effect of discipline than disciplinary cultures *per se* and therefore it was not possible to determine the ultimate impact of disciplinary culture on research group work. However, discipline might have been expected on the basis of previous studies (e.g. Becher 1989), for example, to have predicted work characteristics better than it did. Group size was a better structural predictor than discipline, which partly supports the notion that discipline plays a relatively weak role in research group work. On the other hand, as noted in section 2.2.3, research group can be regarded as an example of a transepistemic arena of research where the focus is on negotiated symbolic relationships rather than on disciplinary cultures and, therefore, the work culture which develops in the group is more important than the culture generated by discipline. Thus, the minor role of discipline may indicate that the research group has its own social and epistemological premises which only partly relate to disciplinary culture. This may, as Knorr Cetina (1999) has stated, suggest that knowledge is not produced within disciplinary communities but rather in interactions between different actors, who develop their own cultural premises which allow better adjustment to the changes in academic life (see Wray 2002). Therefore, the research group is detached from premises external to its functions.

Altogether, the role of discipline as a *structural* factor was controversial as, contrary to previous studies, it did not have that crucial an impact on research group work in medicine and engineering. However, this is partly due to methodological reasons and, if the aim is to study importance of disciplinary *culture* in research group work, a different theoretical position needs to be adopted, for example the constructionist approach or the cultural-historical activity theoretical approach. However, one cannot argue that disciplinary culture has no impact, but rather the cultural effects of discipline are interwoven with everyday practices in research group work. Thus, the findings also suggest that it is important to focus on the in-group culture, which contains features drawn not only from the disciplines group members represent, but also

from the organisation the group is part of as well as from the other, scientific and societal, communities group members are cooperating with. Thus, the group's "own culture", or transepistemic arena of research, creates a foundation for research practices and research work.

9.2 Methodological reflection of the study

A framework for evaluating the study was presented in section 6.3.3. In this section, the framework is considered in more detail. Thus, in order to evaluate the quality of the study, reliability, validity, generalisability, objectivity and applicability are discussed. It is also important that attention be paid to the research methods used in analysing the data and to the epistemological and ontological underpinnings of the study.

Reliability and validity of the measurement

Although there are various methods for determining the *reliability* of a measuring instrument (section 6.3), only one method was used in this study, namely Cronbach's Alpha, which is an internal consistency method. The measures used in this study showed good internal consistency (Appendix 5) as in the first phase of the study all those measures which did not show reliability were removed (see section 5.3). Thus, aggregated variables could be formed. What needs to be remembered here, however, is that the Alpha Coefficients differed from those for the original measures. This is because the coefficient of internal consistency is dependent on the target group from which it is derived. In addition to determining the average intercorrelation for all of the items, reliability also refers to alternative interpretations of the results (Carmines & Zeller 1990; Nummenmaa et al. 1997), that is: how does the random error effect the results? There were several possible reasons for random error in this study: it might have been caused by the written instructions in the questionnaire, by the format of the individual questions in the questionnaire, as the items were translated from English into Finnish, by the difference in length of the questionnaire between the first and second phases of the study, and by changes in the response scales for some the measures from 7- to 5-point scales. The written instruction at the beginning of the questionnaire was as brief as possible in order to avoid complications. Given the relatively good overall response rate and the fact that the returned questionnaires were properly filled in, the instructions can be regarded as clear. The problem with the overall lay-out of the questionnaire was that majority of the questions were multiple-choice questions which added rather to the total numbers of the items thereby weakening the answers. On the other hand, the questions were thematically arranged, which may have made them easier to answer. The effect of translation on the reliability of the study is difficult to estimate. A possible indicator is how comprehensively the respondents filled in the questionnaire, that is, how many

items were left blank. It seemed that there were no difficulties in understanding the content of the statements as there were only a few items left blank altogether. Therefore, the statements can be regarded as having an appropriate level of semantic and conceptual equivalence (see Behling & Law 2000). The questionnaire was longer in the first phase of the study than it was in the second phase. This might have induced some random error, but as the total response rates were almost the same in both phases of the study, the differences in the length of the questionnaire can be considered to have had minimal effects on the reliability of the study. The fact that the Likert-type scale of some measures was reduced the original 7-point to a 5-point scale might have affected the internal consistency of the measuring instrument. The number of points, however, is context-dependent and study-dependent; scales in some settings may require more or fewer discrete points. In this respect, the effect of rescaling the measuring instrument may not have led to a significant deterioration in the measure.

Validity refers to the operationalisation of the study and to how the measuring instrument is planned; therefore, validity is a way of describing the accuracy of the conclusions drawn after using the instrument (Alkula et al. 1995; Nummenmaa et al. 1997). In section 6.3.1, different types of validity were presented, but only content validity can be applied to this study. Content validity means that the content of the measure has to be reasonable with regard to the phenomena being investigated (Carmines & Zeller 1990). Content validity was enhanced because of the use of ready-made measures which already had been tested and validated by other scholars. Accordingly, prior validation of the instrument minimises the risk that the measure has low content validity. Furthermore, some of the phenomena investigated, such as conflict, were comprehended as multi-dimensional and hence the empirical measurement reflected multifaceted aspects of those phenomenon. It was not possible to evaluate the other forms of validity, criterion-related and construct validity. For construct validity, the theoretical relationships between the measured variables (or constructs) were not clear enough to form an unambiguous picture of their interrelationships. Criterion-related validity was not feasible as it was not possible to determine any criterion variable with which the performance of the test could be correlated.

Generalisability, objectivity and applicability of the research findings

The assessment of *generalisability* from the sample to the accessible population and ultimately to the target population is rather difficult since purposeful sampling was used. In general, if a sample is not randomly formed, it should be compared with the accessible population in terms of certain critical characteristics (in this study such characteristics are, for example, size of the group). However, since no systematic information about the accessible population or target population was available, comparisons were not possible. Nevertheless, other indicators were used. The selection of the target group was based on the sampling frame formed from the data, which has been drawn

from several sources. When forming the sampling frame, all possible sources of information about medical and engineering research groups were systematically searched. This gave an overall picture of the extent of research groups in the selected disciplines, but no indicators about the characteristics of the groups or their members. On the other hand, the size of the accessible population was limited because of the criteria used to select the research groups (see section 5.2.2). Therefore, the findings can be generalised to research groups which fulfil these criteria. The overall size of the target population, that is, medical and engineering research group members in Finland, was roughly estimated at 4600 persons. Therefore, one can argue that the research findings can to some extent be generalised to the target population as about five per cent of that population participated in the study. Another question, however, concerns whether the respondents identified themselves as members of a group or saw themselves rather as individuals working together yet lacking the features of a group. This has also its limitations for the generalisability of the findings.

With regard to the generalisability of the research findings the number of non-respondents needs to be discussed as it is a major potential source of measurement error. Altogether 35 per cent of the target group did not return the questionnaire. The number of non-respondents was higher in medicine than in engineering and among rank-and-filers than among group leaders. There are several possible reasons for this: the length of the questionnaire, sensitivity of the issues being studied, and, especially with regard to medicine, the physicians' strike of summer 2001 and the fact that in medicine those working in research groups already have enough questionnaires to fulfil as part of their everyday work and could be reluctant to take on additional burdens. The fact that group leaders showed a higher response rate in part owes to pre-contacting them. Also important is the degree to which non-respondents are similar to respondents. A rough characterisation of non-respondents was possible as the head of the group had provided information on the number of group members, their names and whether he or she is group leader or a rank-and-filer. Altogether, it seemed that non-respondents did not differ substantially in any important single factor from the respondents. The only difference, as noted above, was that there were more rank-and-file members among non-respondents than group leaders. On the other hand this was expected as the overall number of rank-and-filers was considerably higher than the number of group leaders in the target group.

The other issue that needs to be discussed is how the findings can be generalised across different settings. The main theoretical framework, that is, research group work design, has its origin in analysing group work in general. In this study, however, the focus was on group work where innovativeness plays a major role. Therefore, the findings cannot be generalised to all kinds of group work without some reservations, although the findings of the study indicated that research group work did not greatly differ from any other kind of group work. The findings can be generalised primarily to any group work which involves creativeness, especially in university settings but also in the

private sector. There are limitations if the findings are generalised to other settings, that is, to settings where group work has other goals than the generation of new (scientific) knowledge.

Objectivity means that the conclusions depend on the people being investigated, not on the researcher and the value-free process of the study. Postpositivism provides the frame within which objectivity is understood in this study. In postpositivism it is assumed that objectivity can almost be attained through awareness of one's own predispositions and of the tradition the study is based on. The work design approach, which the study is founded on, pays special attention to research group work characteristics and to the relationships between them. It is possible that by committing to this approach, some important factors may have been excluded which other approaches, such as cultural-historical activity theory, would have included. Overall, the work design approach offered specific lenses through which the researcher could examine the phenomenon under investigation. The position of researcher himself also needs to be discussed in terms of objectivity since he is an actor in the academic world, even if he represents a discipline different from those selected for the study. The collection and analysis of the data are relatively free from the effects of the researcher. However, there are two crucial points in the research process where bias can be caused by the investigator: the operationalisation of what is comprehended as "research group work characteristics" and the conclusions drawn from the research findings. Although research group work characteristics were studied in the framework of the work design approach, which set certain requirements on it, the researcher might have unintentionally excluded some important aspects of research group work. For example, the role of team management was not included in the study, although the present study gave some indications of its importance in research group work. In terms of the interpretation of the results, especially, it is unavoidable that the researcher will compare the findings to the situation in his own academic setting; hence formulating the conclusions demanded special alertness so as to avoid coming to one-caution or one-stated conclusions.

Discussion of the *application* of the research findings not only gives a practical dimension to the research process, but it also reflects the relation of the study to previous studies on the same topic. Hence, the applicability of the research is two-fold: on the one hand it concerns the relationship between current and previous findings and on the other hand it concerns the practical implications. As the latter are discussed in more detail in section 9.3, the focus in this section is on the former aspect of applicability. Altogether, the research results suggest both similarities and dissimilarities with those of previous studies (see chapter 8), which allows more general conclusions to be drawn (see section 9.1). The practical significance of the study primarily comes from a better understanding of the basic mechanisms that define research group work, and thus one can be more aware of the crucial determinants of research group work, even if the focus of the study was more on the instrumental purposes of knowledge generation, i.e. on explaining research group work rather than understanding and reflecting on the phenomenon (see also section 6.3.2).

Fulfilment of basic assumptions of research method

In order to evaluate the quality of the study, attention also needs to be paid to how far the basic assumptions of the most frequently used methods (t-test for independent samples, ANOVA & multiple regression analysis) were met. By doing this one gains more information about the reliability of the research findings.

For the tests that were used to compare means between different sub-groups, i.e. t-test for independent samples and F-test (ANOVA), certain basic assumptions are set (Agresti & Finlay 1997, 221, 439) of which two are stressed here: all populations are approximately normally distributed (normality assumption) and all of the population variances are assumed to be equal (homogeneity of variances assumption). The normal distribution of a population can be ascertained by simple graphical means (see examples in Appendix 11). Overall, it can be argued that the populations were approximately normally distributed, although a few bipolar distributions were found. Equality of variances was tested using the Levene's test where the null hypothesis is that all variances are equal. As shown in Appendix 12, for ANOVA the population variances were equal with only a few exceptions. For t-test for independent samples, the Levene's test takes into account both possibilities; i.e. that population variances are equal or unequal, and therefore no separate indicators are needed. T-test for independent samples and ANOVA can be regarded as partially robust methods, which means that the method gives reliable results even if the basic assumptions are violated. When two-sided tests are used, which was the case in this study, even if the population is not normally distributed, the t-test still works quite well. For ANOVA a moderate departure from normality can be also tolerated. However, misleading results may occur in the F-tests if the populations are highly skewed (Agresti & Finlay 1997, 221, 473–474). Thus, for ANOVA and t-test for independent samples certain deficiencies and violations in the fulfilment of the assumptions are allowed. Altogether, the basic assumptions of t-test for independent samples and ANOVA were relatively well met in the study and hence the results based on these methods can be regard as reliable.

In the case of the regression analysis two important aspects need to be further discussed: the role of outliers and the problem of multicollinearity. An outlier is a research subject whose scores differ markedly from the general pattern established by other subjects in the sample. The problem with outliers is that they may distort the results of the regression analysis. Hence, it is important to decide whether the outliers need to be eliminated or not. However, whether to eliminate outliers from a study is a problematic decision. According to Gall et al. (2003, 152) outliers cannot be eliminated purely because they distort the results. In this study, therefore, comparisons were made between the model with outliers and the same model with the outliers eliminated. If there were substantial differences between the two models, the better model was accepted (see Appendix 13). In specifying the outliers the number of outliers per dependent variable and standardised residual need to be

taken into account. A casewise diagnostics test was used to determine the outliers as it indicates all those cases where the standardised residual has an absolute value more than 3. Appendix 13 shows that in total there were 20 outliers and that for six dependent variables there were at least two outliers. For each of these dependent variables a new analysis was conducted in which the outliers were removed and the results compared to those of the original analysis. However, as noted above, the elimination of outliers is not a simple matter. Therefore, if the results of the regression analysis changed considerably, the decision whether to change the model was carefully considered. In some cases, for example, the elimination of an outlier(s) increased the multicollinearity between variables and hence no changes were made (see Appendix 13). Altogether, the original model was changed due to outliers in four cases and seven models were retained because the elimination of outliers did not significantly improve the model.

Multicollinearity refers to a situation where the standard errors of coefficients are large, reflecting the imprecision of the Beta-coefficients. Thus, small changes in the data can cause substantial changes in the regression model. The impact of multicollinearity on the precision of the estimation can be evaluated by various measures; however, the variance-inflation factor (VIF) and tolerance index are most often used. The higher the VIF or lower the tolerance index, the higher the variance of the Beta-coefficients, which means that severe multicollinearity effects are present. The drawback of using the VIF and tolerance index, however, is that there is no theoretical way of knowing what the threshold value for a high VIF or a low tolerance should be. Therefore, no quick fix for multicollinearity is available, and the best response is to acknowledge that the results of the multiple regression analysis are subject for certain reservations. (Fox 1991, 10–21; Nummenmaa et al. 1997, 318–324.) In this study, the problem of multicollinearity was acknowledged if the VIF-value was 2 or higher and tolerance index was .50 or less. Using these criteria some multicollinearity was found (see Appendix 14). Most notable was the result regarding the close relationship found between different forms of conflict and trust, which needs to be viewed with caution.

Limitations imposed by the scientific reasoning and work design approach

How was scientific reasoning and explanation seen in the research process? As noted in Figure 14 (page 87), the study was primarily based on deduction, although induction was also present when the model of research group work design was reshaped on the basis of the empirical observations. The role of deduction and induction can easily be pointed out in the research process, but this is less easy for explanations. The present study was founded on probabilistic explanation only in the form of elaboration, that is, when the relationships between the variables under investigation were specified (see section 6.2). Thus, explanations were difficult to categorise as typical of either deductive-nomological or probabilistic reasoning. Instead they are better viewed as following the logic of reasoning presented in Figure 14 (on page 87)

the statistical methods used and as complying with the basic assumptions of work design approach. One can also argue that explanations were for the most part viable as it was possible to conduct a reshaping of the research group work design model on the basis of the empirical observations, thereby ensuring conformity with the ontological and epistemological assumptions of the study (see also section 6.1).

The work design approach, however, has some limitations. The main limitation is that although the elaboration of the approach (e.g. Parker et al. 2001), on which the model of research group work design was based, takes into account the various contexts of group work, it only does so descriptively. Hence, the ultimate effect of context is purely hypothetical. The second limitation is the mechanical understanding of group work, i.e. certain inputs like interdependence lead, through group processes, that is, through the relationships between process characteristics, to certain outputs, like job satisfaction. Therefore, the approach is inert, or as Knorr Cetina (1982, 115) has claimed, the empirical study of research group work should not be based primarily on externally imposed similarity classifications but rather on participants' contextual involvements in this work. The third limitation is that the work design approach can also be criticised for being old-fashioned such that, instead of focussing on attributes and the way they are distributed among the subjects, the focus could have been directed at structures and relations (e.g. Palonen 2003) allowing a more dynamic understanding of research group work to be gained.

9.3 Suggestions for future studies and practical challenges

The study gave a rather clear picture of the nature of research group work in terms of work characteristics. However, certain important aspects of research group work were outside the scope of this study. Hence the following suggestions for further studies:

1) the role of research group culture needs to be analysed;
2) multidisciplinary and cross-professional cooperation as well as cooperation in the soft fields of study merit close attention;
3) the relationship between group outcomes and work characteristics should be further examined; and
4) dyadic relationships between research group members, especially between group leader(s) and rank-and-filers, need to be analysed.

The present study did not pay attention to organisational and disciplinary *cultures*. However, previous studies (Kuh & Whitt 1988; Becher 1989) have pointed to their importance in determining the epistemological and social conditions underlying academic work. Thus, by including cultural aspects in studies it would be possible to obtain information about the influence of the

institution where group is physically located as well as the influence of disciplines on whose borders the group operates. This would enable a picture to be drawn of the culture generated by the group. The present conclusions suggest that this may be a central element in defining the epistemological premises and norms that regulate group behaviour. The research method, however, would need to be different that used in this study in order to capture the cultural aspects of research group work. A possible approach is through constructionism. By taking culture as the object of study, one can transcend one of the most essential limitations of the work design approach, that is, the heuristic comprehension of context. Furthermore, by including the cultural aspect one can also gain information about whether groups are internally as harmonious as the recent study would suggest.

In order to be sure that discipline indeed plays a modest role in research group work soft fields of study should also be included as well as attention paid to multidisciplinary and cross-professional collaborations. Contrary to previous studies (e.g. Younglove-Webb et al. 1999), the findings of this study found hardly any differences between multidisciplinary and disciplinary-based research; hence it would be important to further examine multidisciplinary and cross-professional collaborations. Such a study should be designed to compare multidisciplinary and/or cross-professional group work with discipline-based work and thereby obtain information on the interactions between group members from different disciplinary and professional backgrounds. Furthermore, although soft fields of study, like the social sciences, were not included in the present study, the role of research group work needs to be studied in the soft disciplines as, according to Hakala et al. (2003), group work seems to be increasing in the soft sciences as well. The meaning of "discipline" may also be different in the soft than hard sciences.

The purpose of this study was to describe the relationships between work characteristics. Therefore, attention was not paid to the group's outcomes, which may be either individual, such as job satisfaction, or organisational, such as the number of publications produced by the group. It would be interesting to study the latter, as one argument in favour of the research group has been that it can better confront the ever changing demands posed to academic work, of which one is high productivity. The problem, however, is that the groups selected for such a study need to have a similar life-span in order to compare, for example, the number of publications they produce. It is also difficult to evaluate the quality of publications. By studying individual outcomes one can gain information, for instance, about how satisfied group members are with research group work, finding out at the same time something about how research group work is experienced by its members. The present study paid solely attention to group work characteristics and, although research group work was seen to be harmonious, one cannot be sure whether group members were satisfied with it. Altogether, by studying the relationship between research group work characteristics and group outcomes one can identify those work characteristics that best promote the productivity of the group and thereby gain useful information about the effectiveness of research group work.

The study also gave some indication that the dyadic relationships between group members need to be studied. This is especially the case where the relationship between head of the group and rank-and-filers is concerned as it seems to be important in determining the overall social climate of the group. Originally, a closer examination of the leader–rank-and-file member relationship was excluded from this study as the purpose was to comprehend research group as a single entity not as an entity constructed from dyads within groups. Nonetheless, in the future it will be important to include this relationship as it also reveals how the group is managed. It is also essential to study the role of group management, as on the basis of the present findings, group leaders seem to spend one third of their working time on managing the group and on different administrative tasks. Thereby, it is important to know how the group is actually managed and how this is experienced by rank-and-filers and by the leader him- or herself.

From practical perspective the study gave a very positive and harmonious picture of research group as a *working environment*. However, one has to remember that a functional working environment does not necessarily mean that a group is effective and productive. On the basis of the findings of this study it is arguable that group work in the production of new knowledge enhances interactions between group members, thereby overcoming some of the disadvantages of working in an "ivory tower". Nonetheless, the study noted some practical challenges. First, it is important that a group has a trusting and conflict-avoiding social climate in order to create a functional working environment. How such a climate can be achieved is not easy to determine but according to a recent study a preference for team work, especially, plays an important role in creating a conflict-avoiding climate. Second, it is essential that group members have enough time and opportunities for scientific debates, thereby creating an open and supportive environment. This is a challenge which, in the current outcome-oriented research culture, is not easy to fulfil. Third, it is important to pay attention to group goals and make them as explicit as possible, thereby clarifying each group member's personal goals and interests regarding research work.

Altogether, the study raised several challenges for future research and raised some practical challenges for those who are working in research groups. It also seems that it is important to study research group work from both higher education and science and technology perspectives in order to obtain externalist and internalist views on research group work and thus essential knowledge on research groups as working environments and as cultural and epistemological entities. By including these two aspects one can better understand the role and function of research groups in Finnish academic contexts.

YHTEENVETO

Tutkimusryhmätyöskentelyn piirteet lääke- ja teknisissä tieteissä.

Johdanto

Viimeaikaista kehitystä tieteen harjoittamisessa on luonnehdittu toiseksi akateemiseksi vallankumoukseksi (Etzkowitz & Leydesdorff 1997) ja siirtymäksi perinteisestä tiedon tuotannosta sen uuteen muotoon (Gibbons ym. 1994). Yhteistä näille luonnehdinnoille on yhteistyön korostaminen tieteellisen tiedon tuotannossa. Tämä näkyy muun muassa monitieteisen ja -alaisen tutkimuksen lisääntymisenä (esim. Hakala ym. 2003) ja tiedon tuottamisen irtaantumisena akateemisesta tieteenalaperustasta (Jacob 2001). Muutokset tieteen harjoittamisessa vaikuttavat myös akateemiseen työhön ja erityisesti sen organisoitumiseen, sillä muutokset ovat haastaneet perinteiset tavat tuottaa tietoa. Tieteen harjoittamisen perusyksikköinä erityisesti kovissa tieteissä pidetäänkin ”löyhästi vakiintuneita” tutkimusryhmiä. Tutkimusryhmätyöskentelyä on kuitenkin tutkittu suhteellisen vähän huolimatta sen tärkeydestä tieteellisen tiedon tuottamisessa. Sellaiset kysymykset, kuten mikä merkitys ryhmän jäsenten keskinäisellä luottamuksella ja ristiriidoilla on ryhmätyöhön tai mitä etuja ja haittoja tutkimusryhmätyöskentelyssä on, ovat jääneet vähälle huomiolle. Tämä tutkimus pyrkiikin tuomaan lisäinformaatiota muun muassa näihin kysymyksiin tarkastelemalla tutkimusryhmiä työympäristöinä.

Tutkimuksen tausta

Tieteellisen tiedon tuottamisessa tapahtuvat muutokset heijastuvat akateemiseen työhön. Näitä muutoksia voidaan tarkastella kahdesta näkökulmasta tai reunaehdosta käsin. Ensinnäkin yhteiskunnallinen kehitys on muuttanut yliopiston institutionaalista asemaa. Tätä kehityssuuntaa voidaan kutsua tiedon tuottamisen ulkoiseksi reunaehdoksi. Toiseksi tiedon tuottamisen sisäisellä ehdolla tarkoitetaan tieteen voimakasta eriytymistä sitä, että tieteenala on kyseenalaistunut keskeisenä akateemisen elämän jäsentäjänä. Nämä tieteen harjoittamisen ulkoiset ja sisäiset (reuna)ehdot muodostavat dynaamisen ympäristön, jossa akateemiset toimivat yksilöinä ja ryhminä.

Tieteellisen tiedon tuottamisen ulkoisia reunaehtoja on muokannut tietoyhteiskunnan voimistuminen ja tämän seurauksena tiedon kapitalisoituminen. Tietotyöläisten määrä on merkittävästi kasvanut kaikissa länsimaissa (esim. Castells 1997). Suomessakin informaatiosektorin työllisyys kasvoi muita sektoreita voimakkaammin 1990-luvulla (On the road… 2001). Tietoyhteiskunnan kehittyminen on siten lisännyt tietotyöläisten tarvetta, mikä on ollut keskeistä korkeakoulutuksen massoittumisen syntymisessä (esim. Scott 1995). Gibbons (1998) korostaakin, että korkeakoulutuksen massoittumisen seurauksena kysyntä ja tarjonta tiedontuottajista ovat lisääntyneet. Kysynnän näkökulmasta tietoyhteiskunta tarvitsee tiedon käsittelijöitä ja tarjonnan näkökulmasta yli-

opistot tuottavat aikaisempaa enemmän henkilöitä, jotka ovat kykeneviä tuottamaan uutta ja käsittelemään olemassa olevaa tietoa. Suomessa tämä on näkynyt muun muassa tietotyöläisten ja tohtoreiden lisääntymisenä (Tiede & Teknologia 2000; Määttä 2001) sekä tutkimus- ja kehittämismenojen voimakkaana kasvuna (Tutkimus- ja kehittämistoiminta 2001).

Määrällisten muutosten lisäksi korkeakoulutuksen massoittuminen on aiheuttanut myös laadullisia muutoksia. Gibbonsin ym. (1994) mukaan tutkimusympäristöt ovat muuttuneet siten, että perinteisestä tiedontuotannosta, jota luonnehtii tieteenalasidonnaisuus, akateemisuus ja autonomisuus, ollaan siirtymässä sen uuteen muotoon. Tämän uuden muodon piirteitä ovat muun muassa poikkitieteellisyys, tiedon sovellettavuus ja yhteiskunnallisen refleksiivisyys. Nowothy ym. (2001) puhuvatkin kontekstisidonnaisesta tieteen harjoittamisesta korostaessaan tietoa tuottavien instanssien, erityisesti yliopiston, vahvistunutta roolia alueellisena toimijana ja kehittäjänä. Suomessa tämä on näkynyt yliopistojen kolmannen tehtävän, alueellisen vaikuttamisen, vakiintumisena tutkimuksen ja opetuksen rinnalle (esim. Virtanen 2002). Tiedon kapitalisoitumisella, jota voidaan pitää toisena tiedon tuottamisen ulkoisena reunaehtona, tarkoitetaan juuri yliopiston muuttuvaa yhteiskunnallista roolia ja asemaa suhteessa muihin keskeisiin sosiaalisiin instituutioihin ja toimijoihin. Tiedon kapitalisoituminen on merkinnyt korkeakoulutuksen, julkisen ja yksityisen sektorin välisten suhteiden uudelleen arviointia samalla lähentäen näitä sektoreita sisällöllisesti ja toiminnallisesti (Etzkowitz & Leydersdorff 1997). Osin tämä lähentyminen on näkynyt niin sanottuna akateemisena kapitalismina, uusliberalististen arvojen ja tavoitteiden korostumisena yliopistoissa (Slaughter & Leslie 1997). Tämä uusi akateeminen kulttuuri (ks. Kerr 1994) on vaikuttanut myös yliopistoissa tehtävän työn luonteeseen lisäämällä sen epävarmuutta (Enders 2001; Puhakka & Rautopuro 2001) ja byrokraattisuutta (Vidovich & Currie 1998; McInnis 2000). Tutkimustyön näkökulmasta tämä on tarkoittanut sitä, ettei yksittäinen tutkija pysty vastaamaan kaikkiin tämän uuden kulttuurin asettamiin tieteellisiin ja erityisesti hallinnollisiin haasteisiin ja vaatimuksiin. Tämä on osaltaan lisännyt tutkijoiden välistä yhteistyötä ja tutkimusryhmien perustamista (Hakala ym. 2003).

Tiedon tuottamisen sisäisinä ehtoina voidaan pitää tieteellisen tiedon demokratisoitumista ja tieteenalojen kyseenalaistumista keskeisinä akateemisen toiminnan jäsentäjinä. Tieteellisen tiedon demokratisoitumisella (Delanty 2001) viitataan siihen, että monitieteinen ja -alainen tutkimus altistaa tieteellisen tiedon epistemologiset perusteet neuvottelunalaisiksi ja viime kädessä tämä keskustelu heijastuu yliopiston rakenteisiin (Gumport & Snydman 2002) muuttuneina tiedekäsityksinä ja tieteenalamäärityksinä. Tieteellisen tiedon demokratisoituminen on osaltaan lisännyt eri (tieteen)aloilta tulevien tutkijoiden ja käytännön toimijoiden välistä yhteistyötä, mikä on luonut paineita ja mahdollisuuksia tutkimusryhmätyöskentelylle. Tieteenalan kyseenalaistuminen keskeisenä tiedon tuottamista ja akateemista työtä määrittävänä tekijänä perustuu näkemykseen, että nykyään tietoa tuotetaan lisääntyvässä määrin tiedekulttuurien ulkopuolella eri toimijoiden välisissä vuorovaikutustilanteissa, esimerkiksi laboratorioissa (Knorr Cetinan 1982; 1999). Knorr Cetina (1982; 1999) käyttääkin

sellaisia käsitteitä kuin *transepisteeminen tutkimustila* ja *episteeminen kulttuuri* korostamaan tieteellisen tiedon neuvoteltavuutta liikkumattoman tieteenala-käsitteen sijaan. Tällainen lähestymistapa kyseenalaistaa tieteenalojen välisiä ja sisäisiä rajoja ja altistaa ne keskustelunalaisiksi tuottaen samalla uusia ympäristöjä, joissa tutkijat ja tutkimusryhmät voivat toimia.

Aikaisemmat tutkimukset ovat tarkastelleet tutkimusryhmätyöskentelyä erityisesti kolmesta perspektiivistä: konstruktionistisesta (esim. Latour & Woolgar 1986; Knorr Cetina 1999), kulttuurihistoriallisesta toiminnan teorian (esim. Miettinen 1999) ja työn piirreteorian (esim. Winter & Sarros 2002) näkökulmasta. Konstruktionistiset tutkimukset painottavat tieteen ja tutkimustoiminnan neuvoteltavuutta ja eri toimijoiden välistä vuorovaikutusta (esim. Pickering 1984) sekä tieteellisen tiedon rakentumista muun muassa laboratoriossa (esim. Knorr Cetina 1995a). Kulttuurihistoriallisessa toiminnan teoriassa korostuu tutkimuskohteiden konstruointi erilaisissa toimintajärjestelmissä, kuten tutkimusryhmissä (esim. Saari 1999; Saari & Miettinen 2001). Työn piirreteorioihin kuuluva työn design -lähestymistapa (work design) tarkastelee tutkimusryhmää toimintaympäristönä ja erityisesti kiinnittää huomiota siihen, miten erilaiset ryhmätyötä määrittävät tekijät tai työn ominaispiirteet jäsentävät ryhmän ja yksilön toimintaa sekä työn ja yksilön välistä suhdetta. Tätä lähestymistapaa edustavat tutkimukset ovat kartoittaneet muun muassa akateemisten työmotivaatiota (Winter & Sarros 2002) ja työtyytyväisyyttä (Lacy & Sheehan 1997) sekä tuottaneet tutkimusryhmätyöskentelyä kuvaavan mallin (Nason & Pillutla 1998).

Tämä tutkimus tarkastelee tutkimusryhmätyöskentelyä työn design -näkökulmasta. Tutkimuksessa kiinnitetään huomiota tutkimusryhmätyöskentelyn ominaispiirteisiin, joita ovat ryhmän jäsenten vuorovaikutukseen tai ryhmäprosesseihin liittyvät tekijät (process characteristics), ristiriidat sekä jäsenten välinen luottamus. Vuorovaikutukseen liittyvät tekijät voidaan jakaa yksilö- ja ryhmäperustaisiin. Yksilöperustaisilla tarkoitetaan sellaisia vuorovaikutukseen liittyviä tekijöitä, jotka ensisijaisesti ymmärretään yksilöstä johtuviksi ja yksilöihin palautuviksi. Tällaisia tekijöitä tässä tutkimuksessa ovat ryhmätyöskentelyorientoituneisuus, ryhmän jäsenten keskinäinen riippuvuus, osallistuminen päätöksentekoon, sosiaalinen tuki sekä työhön liittyvien tavoitteiden samankaltaisuus. Ryhmäperustaiset tekijät sitä vastoin ovat yksilöiden tuottamia mutta ryhmässä jaettuja ja koettuja. Ryhmäperustaisia vuorovaikutukseen liittyviä tekijöitä tutkimuksessa on kolme: ryhmähenki, ryhmän mahdollisuus itsenäiseen päätöksentekoon ja ryhmän yhteistoimintaa määrittävä normisto. Aikaisemmat tutkimukset ovat osoittaneet, että ryhmätyöskentelysuuntautuneisuus, vahva ryhmän jäsenten keskinäinen riippuvuus, sosiaalinen tuki, yhtäläinen mahdollisuus osallistua ryhmän päätöksentekoon, työmäärän tasapuolinen jakautuminen, hyvä ryhmähenki, ryhmän mahdollisuus itsenäiseen päätöksentekoon sekä selkeät toimintaa määrittävät ryhmänormit edistävät ryhmän toimivuutta ja koheesiota sekä jäsenten työtyytyväisyyttä ja -motivaatiota (Gersick 1988; Battenhausen 1991; Campion ym. 1993; Guzzo ym. 1993; Wheelan ym. 1998; Stewart & Barrick 2000; Langfred & Shangley 2001; Erez ym. 2002).

Ryhmätyöskentelyssä esiintyvät ristiriidat voidaan jakaa tehtäviin, vuorovaikutukseen ja jäsenten välisiin suhteisiin liittyviksi (Jehn & Mannix 2001). Aikaisemmissa tutkimuksissa on havaittu (Eisenhardt & Schoonhoven 1990; Jehn 1997; Jehn ym. 1999), että kohtuullinen määrä tehtäviin liittyviä ristiriitoja edistää ryhmän toimintaa, mutta vuorovaikutukseen liittyvät ja henkilöiden väliset ristiriidat sitä vastoin ovat ryhmätyöskentelylle haitallisia. Tärkeää ryhmän toiminnan näkökulmasta myös on, miten mahdolliset ristiriidat onnistutaan ratkaisemaan sekä miten hyvin tiedostetaan konfliktitilanteita määrittävä normisto (Jehn 1997; DeChurch & Marks 2001). Shrum ym. (2001) havaitsivat tutkimusryhmiä tutkiessaan, että asioihin liittyvät erimielisyydet usein tulkitaan ennemminkin haasteiksi ja luonnolliseksi osaksi tutkimustyötä kuin aidoiksi ristiriidoiksi. Myös henkilöristiriidat olivat suhteellisen harvinaisia akateemisessa yhteistyössä. Ristiriitojen lisäksi luottamus on keskeinen yksilöiden välisiä suhteita määrittävä tekijä (esim. Fukuyama 1996). Luottamusta on pidetty myös keskeisenä tutkimusryhmätyöskentelyn määrittäjänä (Clegg ym. 2002). Newell ja Swan (2000) korostavatkin luottamuksen keskeisyyttä akateemisessa maailmassa, missä yhteistyötä edelleen luonnehtii yksilökeskeisyys. Shrum ym. (2001) kuitenkin huomasivat, että jäsenten välinen korkea luottamus ei lisännyt tutkimusryhmän tuottavuutta. Shrum ym. (2001) havaitsivat myös luottamuksen ja ristiriitojen välisen riippuvuuden: vähäinen luottamus oli yhteydessä lisääntyneisiin konflikteihin. Myös ryhmän rakenteellisilla tekijöillä, kuten jäsenten lukumäärällä, on vaikutusta ryhmän toimintaan. Tutkimukset (mm. Wagner 1995; O'Reilly 1998; Fay ym. 2000) ovat osoittaneet, että isoihin ryhmiin kehittyy heikosti toimivaa dynamiikkaa ja että koostumukseltaan hyvin heterogeeniset ryhmät ovat usein heikosti integroituneita ja alttiita ristiriidoille. Rakenteellisten tekijöiden vaikutusta tutkimusryhmätyöskentelyyn ei kuitenkaan juuri ole tutkittu.

Tutkimustehtävät, menetelmät ja aineisto

Tutkimuksen tarkoituksena on tarkastella tutkimusryhmätyöskentelyä lääketieteissä ja teknisissä tieteissä työn design -näkökulmasta. Tutkimustehtävät voidaan tiivistää kolmeen pääkysymykseen. Ensimmäiseksi tutkimuksessa kuvataan, mikä merkitys työn ominaispiirteillä on tutkimusryhmätyöskentelyyn. Näitä työn ominaispiirteitä ovat luottamus, konfliktit sekä aiemmin kuvatut ryhmäprosesseihin liittyvät yksilö- ja ryhmäperustaiset tekijät. Toiseksi tutkimuksessa kiinnitetään huomiota siihen, kuinka tutkimusryhmän jäsenet arvioivat omaa työtään. Tällöin tarkastellaan tutkimusryhmätyöskentelyn etuja ja haittoja sekä työajan jakautumista eri työtehtäviin. Kolmanneksi tuotetaan malli, johon kootaan keskeisimmät tutkimusryhmätyöskentelyä määrittävät tekijät ja niiden väliset suhteet. Tutkimuksessa on useita vertailuja, joista keskeisimpiä ovat lääketieteen ja teknisten tieteiden välinen, monitieteisten ja tieteenalasidonnaisten ryhmien välinen, erikokoisten ryhmien välinen vertailu sekä johtajien ja rivijäsenten näkemysten vertailu.

Tutkimusryhmien jäseniä valittiin lääketieteistä (n = 110) ja teknisistä tieteistä (n = 121). Lääketieteen ja teknisten tieteiden valintaa ohjasivat sekä teo-

reettiset että käytännölliset perusteet. Teoreettisesti valinta nojasi Becherin (1989) sosiaalis-kognitiiviseen tieteenalojen jaotteluun. Kognitiiviselta ulottuvuudeltaan lääketiede ja tekniset tieteet voidaan luokitella koviksi ja soveltaviksi tieteiksi, mikä tarkoittaa sitä, että kummallakin tieteenalalla tiedon tuottamista luonnehtii kilpailuhenkisyys, pyrkimys tiedon soveltamiseen ja nopeatempoiseen julkaisemiseen. Sosiaaliselta ulottuvuudeltaan lääketiede ja tekniset tieteet edustavat urbaaneja ja konvergentteja tieteitä. Toisin sanoen lääketieteissä ja teknisissä tieteissä ylläpidetään suhteellisen yhtenäisiä tutkimusta määrittäviä menettelytapoja ja tutkimus kohdistuu kapealle alalle jotain tiettyä tutkimusaluetta. Tieteenalojen valintaa ohjasivat myös käytännölliset perusteet. Tutkimusryhmätyöskentely on tietyillä, yleensä kovilla ja soveltavilla, tieteenaloilla yleisempää kuin pehmeillä aloilla, kuten yhteiskuntatieteissä. Koska lääketieteet ja tekniset tieteet ovat tyypillisiä esimerkkejä tällaisista ryhmätyöskentelyyn perustuvista tieteenaloista, sisällytettiin ne mukaan tutkimukseen. Tutkimukseen osallistuneet tutkimusryhmät valittiin harkinnanvaraisesti siten, että ryhmien oli täytettävä kaksi ehtoa: ryhmässä oli oltava vähintään kolme jäsentä sekä tutkimusryhmän oli oltava toiminnassa tai se sai olla lopettanut toimintansa korkeintaan kuukausi ennen tutkijan yhteydenottoa (vrt. Stolte-Heiskanen & Alestalo 1978). Nämä ehdot täyttävät tutkimusryhmät poimittiin eri lähteistä, kuten yliopistojen tutkimustietokannoista, esimerkiksi Teknillisen korkeakoulun TTKtutkii ja ainelaitosten www-sivuilta. Tämän jälkeen tutkimusryhmän johtajaan otettiin yhteyttä sähköpostitse ja varmistettiin etukäteistietojen paikkansapitävyys sekä pyydettiin tutkimuslupa.

Aineisto kerättiin kyselylomakkein, joissa kysymykset oli jaoteltu teemoittain (ks. liite 2). Lomake sisälsi ensisijaisesti strukturoituja, mutta myös avoimia kysymyksiä. Kysely lähettiin jokaiselle tutkimusryhmän jäsenelle. Tutkimusryhmien johtajilla oli täytettävänään laajempi ryhmien taustatekijöitä kartoittava lomake. Aineisto kerättiin kahdessa vaiheessa. Ensimmäisen vaiheen jälkeen lomaketta muokattiin, mutta ensimmäisen vaiheenkin lomakkeet sisällytettiin lopulliseen aineistoon. Kokonaisvastausprosentti (64.7) oli suhteellisen hyvä, vaikka lääketietiessä (60.1) palautusprosentti oli teknisiä tieteitä (69.5) pienempi. Kyselylomakkeen laadinnassa hyödynnettiin kansainvälisiä mittareita. Strukturoidut kysymykset olivat joko 5-portaisia Likert- tai Osgood-asteikollisia väittämiä. Lopullisessa lomakkeessa oli 109 kysymystä tai väittämää. Aineisto analysoitiin kuvailevin, vertailevien ja selittävin tilastollisin menetelmin.

Tulokset

Tarkasteltaessa ryhmätyön prosessipiirteitä havaittiin, että vastaajat riippuivat toisistaan erityisesti erilaisista ryhmätoiminnan tuloksista mutta myös päivittäisistä työtehtävistä. Tämä tarkoitti sitä, että vastaajat kokivat muiden ryhmäläisten kontribuution tärkeäksi erityisesti silloin, kun ryhmän yhteisiä tuloksia oli saatava aikaan. Kuitenkin ryhmien johtajat kokivat vahvemman yhteyden jokapäiväisten työtehtäviensä välillä kuin rivijäsenet. Lisäksi miesvastaajat arvioivat riippuvansa naisia enemmän ryhmän toisista jäsenistä niin tulosten kuin

tehtävienkin suhteen. Vastaajat kokivat myös ryhmätyöskentelyn mielekkääksi. Tämä näkyi siinä, että valtaosa vastaajista arvioi oman toimintansa olevan ennemminkin ryhmä- kuin yksilösuuntautunutta ja erityisesti ryhmien johtajat olivat rivijäseniä halukkaampia työskentelemään ryhmässä.

Koska ryhmätyöskentelysuuntautuneisuus ja tehtäväriippuvuus olivat tärkeitä ryhmän toimintaa määrittäviä tekijöitä, tyypiteltiin tutkimusryhmien jäsenet näiden kahden muuttujan avulla. Analyysin tuloksena saatiin neljä eri (ideaali)tyyppiä. Yli puolet (54 %) vastaajista oli luokiteltavissa *yhteisten työtehtävien tiimityöskentelijöiksi*, henkilöiksi, joilla oli sekä korkea tehtäväriippuvuus että ryhmätyöskentelysuuntautuneisuus. Tällaiset ryhmän jäsenet rakentavat yhteisesti kollektiivisen toiminnan perustan. *Omien työtehtävien tiimityöskentelijät* (25 % vastaajista) sitä vastoin olivat sellaisia jäseniä, joiden tehtäväriippuvuus oli vähäinen, mutta ryhmätyöskentelysuuntautuneisuus korkea. Tällaiset jäsenet työstävät esimerkiksi omaa tutkimustaan tiiviisti osana ryhmän toimintaa. *Omien työtehtäviensä itsenäiset suorittajat* (12 % vastaajista) olivat sellaisia ryhmän jäseniä, joiden tehtäväriippuvuus ja ryhmätyöskentelysuuntautuneisuus olivat vähäisiä. Toisin sanoen, tällaiset ryhmän jäsenet työskentelevät ryhmässä ”yksilöinä” ilman, että heidän työtehtävänsä suoranaisesti liittyivät muiden ryhmän jäsenten tehtäviin. *Yhteisten työtehtävien itsenäisillä suorittajilla* (10 % vastaajista) oli vahva tehtäväriippuvuus mutta heikko ryhmäsuuntautuneisuus. Tällaisia ryhmän jäseniä luonnehtii se, että heidän työtehtävänsä liittyvät kiinteästi ryhmän toimintaan, mutta he tekevät työnsä varsin itsenäisesti.

Ryhmätyöskentelysuuntautuneisuuden ja ryhmän jäsenten keskinäisen riippuvuuden lisäksi tutkimuksessa kartoitettiin sosiaalista tukea, tavoitteiden samankaltaisuutta ja osallistumista päätöksentekoon. Vastaajat arvioivat työskentelevänsä ryhmässä, jossa on tukea antava ilmapiiri ja tasavertaiset mahdollisuudet osallistua päätöksentekoon. Ainoastaan ryhmän tavoitteet koettiin epäselviksi ja ei-eksplisiittisiksi. Vastaajat suurista (yli 10 jäsentä) lääketieteellisistä tutkimusryhmistä arvioivat mahdollisuutensa osallistua päätöksentekoon heikommiksi kuin pienimpien (3–5 jäsentä) teknistieteellisten ryhmien vastaajat. Odotetusti ryhmien johtajat arvioivat päätöksentekomahdollisuutensa rivijäseniä paremmiksi. Tarkasteltaessa sosiaalista tukea, tavoitteiden samankaltaisuutta ja osallistumista päätöksentekoon eri tyypeittäin, havaittiin, että ne jäsenet, joilla oli vahva ryhmätyöskentelysuuntautuneisuus, siis tiimityöskentelijät, arvioivat erityisesti saaneensa sosiaalista tukea itsenäisiä suorittajia (heikko ryhmätyöskentelysuuntautuneisuus) enemmän. Samoin tiimityöskentelijät kokivat mahdollisuutensa osallistua päätöksentekoon itsenäisiä suorittajia paremmiksi.

Tutkimuksessa tarkasteltiin myös ryhmähenkeä, ryhmän mahdollisuutta itsenäiseen, muista tahoista riippumattomaan päätöksentekoon ja ryhmän yhteistoimintaa määrittävää normistoa. Vastanneet olivat hyvin tietoisia ryhmän yhteistoimintaa määrittävistä normeista ja he arvioivat ryhmällä olevan hyvän me-hengen. Lisäksi vastaajat uskoivat ryhmän olevan varsin riippumaton muista tahoista omaa toimintaansa määrittäessään. Jälleen verrattaessa ryhmän eri jäsentyyppejä keskenään havaittiin, että tiimityöskentelijät arvioivat ryhmä-

hengen itsenäisiä suorittajia paremmaksi. He olivat myös itsenäisiä suorittajia tietoisempia ryhmän yhteistoimintaa määrittävistä normeista.

Ryhmäprosesseihin liittyvien tekijöiden lisäksi tutkimuksessa tarkasteltiin luottamusta ja ristiriitojen esiintymistä. Vastaajat luottivat vahvasti ryhmänsä jäseniin ja konfliktit olivat harvinaisia. Mikäli ristiriitoja esiintyi, ne liittyivät yleisimmin työtehtäviin, harvemmin henkilösuhteisiin tai vuorovaikutustilanteisiin. Kuitenkin henkilösuhteisiin liittyviä ristiriitoja koettiin eri tavoin. Isojen ryhmien (yli 10 henkilöä) jäsenet kokivat pienempien ryhmien (alle 10 henkilöä) jäseniä useammin henkilösuhteisiin liittyviä konflikteja. Myös lääketieteellisten ryhmien jäsenet raportoivat henkilösuhteisia ristiriitoja teknistieteellisiä useammin. Vastaajat olivat myös melko hyvin tietoisia ristiriitatilanteita määrittävistä normeista, vaikka erityisesti vastaajat suurista ryhmistä pitivät konfliktinormeja pienten ryhmien vastaajia epäselvempinä. Luottamuksella ja ristiriidoilla oli vahva riippuvuus: mitä korkeampi luottamus, sitä harvemmin ristiriitoja koettiin. Verrattaessa tutkimusryhmän jäsentyyppejä toisiinsa havaittiin, että tiimityöskentelijät kokivat vähemmän ristiriitoja ja luottivat ryhmän muihin jäseniin itsenäisiä suorittajia enemmän.

Tutkimusryhmätyöskentelyn etuja kartoittavien avointen kysymysten vastauksia luokiteltaessa esiin nousivat tieteellinen keskustelu, tehokkuus, yhteistyö ja muiden jäsenten tuki. Näistä tärkeimpänä mainittiin mahdollisuus tieteellisesti hedelmälliseen keskusteluun muiden ryhmäläisten kanssa. Käytännössä tämä tarkoitti mahdollisuutta erilaisten näkökulmien ja mielipiteitten vaihtoon. Lisäksi vastanneet korostivat yhteistyön ja sosiaalisuuden merkitystä tutkimusryhmätyöskentelyssä: ryhmä tarjosi mahdollisuuden työskennellä yhdessä ja toimi samalla tärkeänä sosiaalisena foorumina. Vastanneet kokivat saavansa myös tukea muilta ryhmän jäseniltä erilaisissa ongelmatilanteissa. Toisaalta ryhmässä työskentely ”pakotti” toimimaan tehokkaasti, sillä ryhmän jäsenet ovat tavalla tai toisella toisistaan riippuvaisia. Niinpä jokaisen on hoidettava omat tehtävänsä sovitussa aikataulussa. Tutkimusryhmätyöskentelyssä koetut haitat olivat etuja moninaisempia. Muiden jäsenten huomioon ottaminen arvioitiin selvästi keskeisimmäksi ryhmätyöskentelyä vaikeuttavaksi tekijäksi. Myös ajanhallinta aiheutti ongelmia. Tämä näkyi toisaalta siinä, että ryhmässä työskentely vei aikaa, toisaalta siinä, että ryhmän jäsenten aikataulujen yhteensovittaminen arvioitiin työlääksi. Tutkimusryhmissä koettiin myös kahdenlaisia ristiriitoja: näkemyksellisiä ja henkilöiden välisiä. Näkemyksellisiä ristiriitoja voidaan luonnehtia tilanteina, joissa ryhmän jäsenet ovat niin erimielisiä jostakin asiasta, että keskustelu johtaa umpikujaan. Henkilöiden välisillä ristiriidoilla tarkoitetaan tilannetta, jossa ”henkilökemiat” eivät kohtaa. Vastaajat raportoivat myös muita ryhmädynaamisia epäkohtia, kuten huono ryhmähenki ja joustamattomuus. Lisäksi ryhmätyöskentelyä haittaavaksi tekijäksi mainittiin ylimääräiset työtehtävät ja byrokratia. Tällä tarkoitetaan hallinnoinnista erityisesti ryhmän johtajalle aiheutuvia ylimääräisiä tehtäviä. Osa vastanneista koki epätasaisen työpanoksen – sen, että osa ryhmän jäsenistä ei syystä tai toisesta tee muiden ryhmäläisten mielestä omaa osuuttaan – haittaavan ryhmätyöskentelyä. Tarkasteltaessa työajan jakautumista, valtaosa vastaajista ilmoitti käyttävänsä suurimman osan työajastaan tutkimuksen tekemiseen. Kuitenkin tutki-

musryhmän johtajilta viidennes työajasta kului ryhmän johtamiseen liittyvien asioiden hoitamiseen. Tiivistäen voidaankin todeta, että tutkimusryhmien johtajat ja varttuneemmat tutkijat tekivät valtaosan hallinnollisista tehtävistä rivijäsenten ja nuorempien tutkijoiden huolehtiessa tutkimuksen toteuttamisesta.

Tutkimuksessa tarkasteltiin myös askeltavan regressioanalyysin avulla, mitkä tekijät ovat keskeisiä tutkimusryhmätyöskentelyn määrittäjiä. Regressioanalyysi osoitti kolme keskeistä havaintoa. Ensinnäkin tutkimusryhmätyöskentelyssä luottamus ja ristiriidat ennustivat vahvasti toisiaan ja riippuivat toisistaan (ks. Jehn & Mannix 2001; Shrum ym. 2001). Tähän havaintoon on kuitenkin suhtauduttava varauksella multikollineaarisuuden vuoksi. Toiseksi ryhmätyöskentelysuuntautuneisuus ehkäisi ristiriitojen syntymistä (ks. myös Watson ym. 1998). Kolmanneksi ryhmän rakenteelliset tekijät ja jäsenten ominaisuudet selittivät odotettua vähemmän ryhmätyön ominaispiirteitä. Ainoastaan ryhmän koko oli yksiselitteisesti merkittävä tutkimusryhmätyöskentelyä selittävä tekijä siten, että ryhmän suuri koko näytti haittaavan työskentelyä ryhmässä. Näistä havainnoista koottiin tutkimusryhmätyöskentelyä kuvaava malli, joka on esitetty kuviossa 19 (ks. sivu 124).

Pohdinta

Tutkimustulosten pohjalta voidaan tehdä seuraavat yleiset johtopäätökset: lääke- ja teknistieteelliset tutkimusryhmät olivat sisäisesti harmonisia, ryhmien työskentelyä luonnehti ”ei-akateemisuus” ja tieteenalalla *rakenteellisena* tekijänä oli suhteellisen vähäinen rooli tutkimusryhmätyössä. Sisäinen harmonisuus viittaa siihen, että vastaajat arvioivat ryhmätyöskentelyn hyväksi ja toimivaksi tavaksi tehdä tutkimusta ja näin ryhmätyöskentelystä muodostui hyvin positiivinen kuva. Tähän voidaan löytää useita mahdollisia syitä. Osin sisäinen harmonisuus selittyy sillä, että vastaajia pyydettiin kyselylomakkeessa arvioimaan koko ryhmän toimintaa, ei yksittäisten jäsenten välisiä suhteita. Tällöin kuva ryhmätyöskentelystä väistämättä näyttäytyy todellista positiivisempana, vaikka tästä pyrittiin analyysissa pääsemään eroon tyypittelemällä tutkimusryhmän jäsenet. Tällöin havaittiinkin selvempiä eroja vastaajien välillä. Toisaalta ryhmän sisäinen harmonisuus voi heijastaa sen jäsenten selkeitä ja yhdenmukaisia käsityksiä siitä, mitä ryhmässä tutkitaan. Tällöin ryhmän jäsenet ovat vahvasti sitoutuneet samaan episteemiseen kulttuuriin (ks. Knorr Cetina 1999), mikä osaltaan harmonisoi ryhmän toimintaa. Tutkimusryhmätyöskentelyn ei-akateemisuudella viitataan siihen, että vastauksista puuttui tietty akateeminen ulottuvuus eli vastaukset kuvasivat ennemminkin ryhmätyöskentelyä yleensä kuin työskentelyä *tutkimus*ryhmässä. Tämä näkyi erityisesti avointen kysymysten, joilla kartoitettiin tutkimusryhmätyöskentelyn etuja ja haittoja, vastauksissa. Eduiksi ja haitoiksi ei raportoitu mitään sellaista, mikä olisi yksiselitteisesti liitettävissä tyypilliseksi yliopistomaailman piirteeksi. Esimerkiksi työsuhteiden epävarmuutta ei vastauksissa mainittu ryhmän toimintaa haittaavaksi, vaikka aikaisemmat tutkimukset (esim. Puhakka & Rautopuro 2001) ovat havainneet akateemisten työsuhteiden määräaikaisuuden ongelmalliseksi. Toisaalta ei-akateemisuuden korostaminen on selitettävissä menetelmällisillä va-

linnoilla, sillä strukturoidut kysymykset eivät mahdollistaneet tutkimusryhmätyöskentelyn tyypillisten piirteiden esiin tuomista. Ei-akateemisuus heijastui osin myös siinä, että tutkimusryhmätyöskentely näytti häivyttävän tieteenalan rakenteellista merkitystä työn jäsentäjänä. Tämä näkyi siinä, että tieteenala ei merkittävästi ennustanut tutkimukseen mukaan valittuja ryhmätyön eri piirteitä. Lisäksi tutkimukseen valittujen tieteenalojen, lääketieteen ja teknisten tieteiden, välillä oli vain vähäisiä eroja. Tämä olikin odotettua, sillä lääketiede ja tekniset tieteet ovat becheriläisittäin tarkasteltuna hyvin samankaltaisia tieteenaloja. Kuitenkin tieteenalan vähäinen merkitys korostui verrattaessa monitieteellisiä tutkimusryhmiä tieteenalasidonnaisiin. Erityisesti monitieteellisissä ryhmissä tiedekulttuureista johtuneiden erojen olisi olettanut aikaisempien tutkimuksen (esim. Younglove-Webb ym. 1999) mukaisesti näkyvän myös ryhmätyöskentelyssä esimerkiksi lisääntyneinä asiaristiriitoina. Aineistossa monitieteiset tutkimusryhmät eivät kuitenkaan juuri eronneet tieteenalasidonnaisista. Tämä havainto osaltaan vahvistaa Knorr Cetinan (1999) näkemystä siitä, että tieteellisen tiedon tuottamisen ja akateemisen työn kulttuuriset ehdot luodaan yksilöiden välisissä vuorovaikutustilanteissa, eikä niitä omaksuta valmiina tiedekulttuuriin vahvasti sidoksissa olevina premisseinä.

Tutkimus herätti useita jatkotutkimushaasteita. Koska tutkimus antoi viitteitä siitä, että tieteenalan vaikutus tutkimusryhmätyöhön on suhteellisen vähäistä, olisi tätä tärkeä tutkia tarkemmin sellaisella tutkimusotteella, joka ottaa paremmin ryhmätyön kulttuuriset aspektit huomioon, esimerkiksi konstruktionistisesta näkökulmasta. Lisäksi monitieteistä tiedon tuottamista olisi tärkeä kartoittaa tarkemmin ja tarkastella erityisesti sitä, miten tieteellisen tiedon tuottamisen sisäisiä ehtoja tällaisessa ryhmässä rakennetaan ja muokataan. Tässä tutkimuksessa huomiota kiinnitettiin erilaisiin tutkimusryhmätyöskentelyn ominaispiirteisiin. Tutkimuksen ulkopuolelle kuitenkin jätettiin erilaiset ryhmätoiminnan tulokset, kuten ryhmän jäsenten työtyytyväisyys tai ryhmän tuottamat julkaisut. Tulevaisuudessa olisikin tärkeää selvittää, millainen yhteys ryhmätyön ominaispiirteillä ja ryhmän tuloksilla on. Tässä tutkimuksessa vastaajia pyydettiin arvioimaan tutkimusryhmän toimintaa kokonaisuudessaan, mikä jätti dyadiset suhteet tutkimuksen ulkopuolelle. Kuitenkin useampi vastaaja korosti avoimessa kysymyksessä tutkimuksen johtajan merkitystä ryhmän toiminnan ja erityisesti ilmapiirin määrittäjänä. Niinpä jatkossa huomiota olisi kiinnitettävä tutkimusryhmän johtamiseen ja erityisesti ryhmän johtajan ja rivijäsenten välisiin suhteisiin.

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APPENDIXES

Appendix 1. The email sent to the group leader (translated)

Dear research group leader/responsible researcher

My dissertation ”Group dynamics in the production of new knowledge” concerns research group work. The study focuses on the different factors which affect group work: interdependence between group members, commitment to group work, group self-management, trust, conflict and the nature of the tasks performed in the group. The purpose of the study is to find out what role research group work has in the academic world, a world which traditionally has been viewed as individual-oriented.

The research group led by you (name of the group is the title of the email) has been selected for the study.

The research groups have been selected from two disciplines: engineering and medicine. Information of the groups was received through electronic databases and departments' and faculties' homepages. The data is to be collected by means of an 11-page semi-structured questionnaire, and it is estimated to take 20–25 minutes to fill in. The idea is that all members of the group answer the questionnaire. The questionnaire addressed to the research group leader is slightly longer as it includes seven additional items requesting background information about the group. The answers will be treated with strictest confidence and the results reported so that it will not be possible to identify either individual researchers or research groups.

Before sending the questionnaires I would like to know if you are willing to participate in the study and I hope that you will email answers to the following questions:

1) Is the group willing to participate in the study?
2) Is the information obtained from the databases correct, e.g. is the group still in existence or has it recently disbanded?
3) Are the persons whose names were listed in the database still involved in research?

If any members of the group are missing or additional have joined the group, could you kindly correct the information.

I hope that your research group will be willing to participate in the study.

Kind regards,

Jani Ursin

Appendix 2. The semi-structured questionnaire (group leader's version)

THE INNER DYNAMICS OF A RESEARCH GROUP: QUESTIONNAIRE

This questionnaire consists of statements about your team, and how your team functions as a group. Please indicate the extent to which each statement describes your team. Circle the number of the alternative, which best describes the function of your research group or write the answer in the space reserved. **For each item you may only choose one alternative**. Leave the item blank if you don't know or the statement is not applicable.

1. Name of research group:

Team-oriented behaviour

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
2. Everybody participates in discussions ……..…	1	2	3	4	5
3. We share high performance expectations ….……...	1	2	3	4	5
4. We have sort of a "cheerleader" who emphasises the positive things we do ……..….....	1	2	3	4	5
5. We listen to each individual's input	1	2	3	4	5
6. Someone makes sure that quieter members get chance to express their ideas ……..…….....	1	2	3	4	5
7. We delegate our group work ……...	1	2	3	4	5
8. We organise our time well ……...	1	2	3	4	5
9. We do not have total agreement, but we reach a kind of consensus that we all accept ……...….....	1	2	3	4	5
10. We show positive attitudes regarding group work …….....	1	2	3	4	5
11. Our individual styles seem compatible ……..	1	2	3	4	5
12. We identify the functions necessary for the successful completion of group projects …….....	1	2	3	4	5
13. A leader who is effective at organising tasks has emerged in our group ……..……..	1	2	3	4	5
14. We are willing to spend enough time to ensure that our group projects are done well ..…….....	1	2	3	4	5
15. A leader has emerged who is effective at getting us to work out interpersonal difference …..……..	1	2	3	4	5

Group self-management

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
16. Most members of my team get a chance to participate in decision making ..……..….	1	2	3	4	5
17. As a member of a team, I have a real say in how the team carries out its work ……..…..……...	1	2	3	4	5
18. Most work-related decisions are made by the members of my team rather than by manager ……	1	2	3	4	5
19. Chance to participate in decision making depends on my position in the group …..……....	1	2	3	4	5
20. My team rather than my manager decides who does what tasks within the team ….…….	1	2	3	4	5
21. Some external institutions, e.g. finance, determine group's working schedule ...…….....	1	2	3	4	5
22. Some external institutions, e.g. finance, determine group's research methods …...……....	1	2	3	4	5

Conflicts

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
23. Conflict is detrimental to getting the work done in our group…….....	1	2	3	4	5
24. Emotional displays (i.e. yelling) are accepted in our group ……..……..	1	2	3	4	5
25. Differences of opinions about job responsibilities are avoided in our group ……..	1	2	3	4	5
26. There is harmony within my group …...……...	1	2	3	4	5
27. There is "we" feeling among the members of my group ……..……...	1	2	3	4	5
28. Conflict is dealt with openly in our group ….....	1	2	3	4	5
29. There is dissension in my group	1	2	3	4	5
30. Emotional conflicts are usually resolved in the group ……...	1	2	3	4	5

		strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
31.	There is friendliness among the members of my group …….	1	2	3	4	5
32.	Disagreements about the specific work being done are usually resolved in the group ……..……..	1	2	3	4	5
33.	Disagreements about who should do what are usually resolved in the group …….…….....	1	2	3	4	5
34.	The member's of my group are supportive of each other's ideas.....	1	2	3	4	5
35.	People in our group try to avoid conflict at all costs …...……..….	1	2	3	4	5
36.	If conflict arises in our group, the people involved initiate steps to resolve the conflict immediately	1	2	3	4	5
37.	Disagreements are encouraged in our group ……...	1	2	3	4	5
38.	In our group, we have lots of bickering over who should do what job ……..…….……....	1	2	3	4	5
39.	There is difference of opinion among the members of my group……...…….....	1	2	3	4	5
		None		some(times)		A lot
40.	How much conflict of ideas is there in your group……...	1	2	3	4	5
41.	How frequently do you have disagreements within your group about the task of the project you are working on? ……..……..	1	2	3	4	5
42.	How much relationship tension is there in your group ….…….	1	2	3	4	5
43.	How often do people in your group have conflicting opinions about the project you are working on? …...……..…….	1	2	3	4	5
44.	How often are there disagreements about who should do what in your work group? …....	1	2	3	4	5
45.	How much conflict is there in your group about task responsibilities? .	1	2	3	4	5
46.	How often do people get angry while working in your group?…...	1	2	3	4	5
47.	How much emotional conflict is there in your working group? ...…	1	2	3	4	5
48.	How often do you disagree about resource allocation in your work group? ……...……	1	2	3	4	5

Interdependence

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
49. Unsatisfactory performance of my job would delay the work performance of other people …….....	1	2	3	4	5
50. I provide other people with the help or advice they need to do their work ..…….....	1	2	3	4	5
51. Other members' work depends directly on my job ……..	1	2	3	4	5
52. I provide support services which other people need to do their work	1	2	3	4	5
53. The main goals of the group are the same for all members in my group .	1	2	3	4	5
54. Unless my job gets done, other members cannot do their work	1	2	3	4	5
55. As a group, we have similar goals ..	1	2	3	4	5
56. I provide other people with information they need to do their work ……...……..	1	2	3	4	5
57. We (my group) all agree on what is important to our group ….....……..	1	2	3	4	5

Choose the alternative (1–5) which best describes the work done by the group (1 = left alternative, 5 = right alternative)

58. It benefits 1 2 3 4 5 hinders,
me when other members of the group attain their goals

59. The things my colleagues want to accomplish and the things I want to accomplish are
compatible 1 2 3 4 5 incompatible

60. When members of my team succeed in their jobs, it is at my
expense 1 2 3 4 5 benefit

61. My concerns and those of group members are
harmonious 1 2 3 4 5 clashing

62. It is advantageous 1 2 3 4 5 disadvantageous,
for me when my colleagues succeed in their jobs.

63. When my colleagues succeed in their jobs, it works out
positively 1 2 3 4 5 negatively

Team Spirit

	Strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
64. My team has a lot of team spirit …..	1	2	3	4	5
65. Members of my team help each other out at work when needed …..	1	2	3	4	5
66. My team increases my opportunities for positive social interaction …..……...…..…….....	1	2	3	4	5
67. Being in my team gives me the opportunity to work in a team and provide support to other team members …….	1	2	3	4	5
68. Members of my team have great confidence that the team can perform effectively …….……...	1	2	3	4	5
69. My team can take on nearly any task and complete it ……..	1	2	3	4	5

Trust

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
70. No one in our group does mislead us ……..	1	2	3	4	5
71. Members of our group negotiates with me honestly ……...	1	2	3	4	5
72. Not everybody in our group keep his/her promises ……...	1	2	3	4	5
73. Some member of our group takes advantage of people who are vulnerable …….……..	1	2	3	4	5
74. I can trust to the members of my team …….….....	1	2	3	4	5
75. I deliberately withhold some information when communicating with members of my group ….……	1	2	3	4	5
76. Some members of our group try to take advantage of our problems	1	2	3	4	5
77. Some members of our group try to get the upper hand ….……...……	1	2	3	4	5
78. Members of our group will keep their word …...……...	1	2	3	4	5

Tasks completed in the group

		strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
79.	The work our group performs has social value……...……..	1	2	3	4	5
80.	The work our group performs is scientifically valuable ……..	1	2	3	4	5
81.	Members of my work cooperate to get the work done……...……..	1	2	3	4	5
82.	Group enhances the communication among its members ……	1	2	3	4	5
83.	The work our group performs is valuable to our own discipline and disciplines close to our own …..….	1	2	3	4	5
84.	Members of my group are very willing to share information with other team members about our work ……..…….	1	2	3	4	5
		none		some(times)		a lot
85.	How much routine is there in your job? …….....	1	2	3	4	5
86.	How much variety is there in your job? ...……..	1	2	3	4	5
87.	To what degree does your job include being creative? ..…..……	1	2	3	4	5
88.	To what extend is your job tiresome? ..…….....	1	2	3	4	5
89.	How often is you work simple? ….	1	2	3	4	5
90.	How often does your work give you a sense of accomplishment?	1	2	3	4	5
91.	To what degree does your work include actually performing tasks (rather than planning)? ……	1	2	3	4	5
92.	To what extent do you feel like you are doing the same thing over and over again?…….……...	1	2	3	4	5
93.	To what extent is your job challenging?....……...……	1	2	3	4	5
94.	How often is your job boring?…….	1	2	3	4	5
95.	How often can you predict how long a task will take? …...……	1	2	3	4	5
96.	How much does your job include problem-solving? .....…...…….....…	1	2	3	4	5

97. Estimate in percentages (sum of items 1–7 = 100%) how much time you spend
    1 doing your research _____ %
    2 producing research-related documents _____ %
    3 on administrative functions _____ %
    4 managing the research group _____ %
    5 solving conflict situations between team members _____ %
    6 other _____ %, if so what? _____
    7 teaching ____ %

98. If you could choose, would you rather do research
    1 in teams
    2 by yourself

Why?

_____
_____
_____
_____
_____

99. Evaluate,
    a) What are the benefits of working as a team rather than by yourself

    _____
    _____
    _____
    _____

    b) What are the disadvantages of working as a team rather than by yourself

    _____
    _____
    _____
    _____
    _____

Background information

100. I am

    1 female
    2 male

101. I am _____ years old.

102. I have been working as a researcher (in a job where I have produced new knowledge) for _____ years

103. My position in the research group is

1	Professor	7	Researcher
2	Associate professor/docent	8	Doctoral student/graduate student
3	Lecturer	9	Research assistant
4	Senior assistant	10	Student (master degree or lower)
5	Assistant	11	Technician/laboratory assistant
6	Senior researcher	12	Other, state _____

104. I am
1 a permanent member of the research group
2 not a permanent member of the research group

105. My education (highest degree)

1 PhD or equivalent
2 Licentiate or equivalent
3 Master's degree or equivalent
4 Bachelor's degree or equivalent
5 Vocational education
6 Non-academic education
7 Other, state _____

106. Discipline (e.g. statistics), which you represent _____

107. Are you
1 leader of the research team
2 not leader of the research team
3 our research team doesn't have a leader per se

108. I have been working in this research group for _____ months

109. Where do you currently work (e.g. university, research institution)?
_____

Background information of the group (group leader/responsible researcher fills in)

110. The group is established in year _____ and it will continue to operate until year _____ .

111. Why is the group established?
_____
_____
_____
_____

112. Estimate in percentage (the sum of the items 1–3 is 100 %), how much your group practise
    1 basic research ____ %
    2 applied research ____ %
    3 development research ____ %

113. In which university is your group located?
    1 University of Helsinki
    2 University of Kuopio
    3 Lappeenranta University of Technology
    4 University of Oulu
    5 Tampere University of Technology
    6 University of Tampere
    7 Helsinki University of Technology
    8 University of Turku
    9 Other, state _____
    10 The research group does not operate under any university

114. The group has _____ permanent members.

115. How many disciplines are represented in your group? _____

116. Is your group part of an international research project?
    1 Yes, state _____
    2 No

117. Is your group located in a specific research institute?
    1 Yes, state _____
    2 No

118. Do you accept that the name of your group is published in the appendix of the report?
    1 Yes
    2 No

If you have any (other) comments concerning your research group or this study, please write them down.

THANK YOU!

Appendix 3. Items of the questionnaire. The first phase

TABLE 22 Items of the questionnaire in the first phase

Item(s)	Measure	Operationalised by
2–3, 5–6, 8, 10–12, 14–16, 18, 20, 22, 25	Team-oriented behaviour	Watson et al. 1998
4, 7, 9, 13, 17, 19, 21, 23–24, 26	Self-oriented behaviour	Watson et al. 1998
29, 31	Self-management	Campion et al., 1993
32–33	Self-management	Author
27–28	Participation	Campion et al., 1993
30	Participation	Author
34–36, 39, 46–48	Conflict norms	Jehn, 1995
37–38, 40, 42, 45, 49–50	Intrapersonal conflict	Rahim, 1983
41, 43–44	Conflict resolution	Jehn, 1995
53, 57–58	Relationship conflict	Jehn & Mannix, 2001
51–52, 54	Task conflict	Jehn & Mannix, 2001
55–56, 59	Process conflict	Jehn & Mannix, 2001
60, 69–70	Task interdependence	Campion et al., 1993
62, 72, 74	Goal interdependence	Campion et al., 1993
66, 68, 73	Goal similarity	Jehn, 1995
61, 63–65, 67, 71	Initiated task interdependence	Kiggundu, 1983
75–80	Outcome interdependence items	Van der Vegt et al., 1998
87–89	Flexibility	Campion et al., 1993
81, 85–86	Potency (spirit)	Campion et al., 1993
82–84	Social support	Campion et al., 1993
90, 94, 98, 100	Communication	Currall & Judge, 1995 (applied)
91–93, 95–96, 99, 101	Organisational trust	Cummings & Promiley, 1996
102, 109–110	Sharing the work	Campion et al., 1993
103–104, 107	Relevance of the work performed in group	Author
105–106, 108	Cooperation/Cooperative group norms	Campion et al., 1993 (applied)
111–122	Task type	Jehn, 1995
123	Task classification	Stewart & Barrick, 2000
124–134	Background information (demographics)	
135–143	Background information about the group (group leader fills in these items)	

Appendix 4. Measures removed after the first phase

TABLE 21 Measures removed

Removed Items (Coefficient of internal consistency, α)	Reason for removal
Self-oriented behaviour (α = .850) – Arguments carry on too long* – In discussions, we drift of the point* – Some members of the group take our group work too lightly* – Some members interrupt when another is speaking* – There is conflict and hostility among members* – One or two members dominate the discussion more than they should* – Sometimes people with good ideas do not seem to speak up enough* – Some members pretend to know what they are talking about when they really do not* – Some members of the group do not disagree for fear of what others might think* – Some members are unreasonable stubborn in their viewpoints*	*Content-based grounds*: Since the items measuring team-oriented behaviour were adequate for the purposes of this study, there was no need to employ two different aggregated variables that in principle measure the same thing.
Team-oriented behaviour – We exercise leadership skills as a group and do not really have a leader per se	By removing this item, the reliability of team-oriented behaviour increased. The correlation of this item with the aggregated variable was weaker than te correlations of the other items.
Task Interdependence (α = .412) – Other members of my team depend on me for information or materials needed to perform their tasks – Within my team, jobs performed by team members are related to one other – I cannot accomplish my tasks without information or materials from other members of my team	Method-based grounds: The α - coefficient < .60
Goal Interdependence (α = .463) – My work activities on any given day are determined by my team's goals for that day – I do very few activities on my job that are not related to the goals of my team – My work goals come directly from the goals of my team	Method-based grounds: The α - coefficient <.60

(continues)

TABLE 21 (continues)

Flexibility (α = .426) – Most members of my team know each other's jobs – My group is very flexible in terms of changes in membership – It is easy for the members of my team to fill in for one another	Method-based grounds: The α - coefficient < .60
Communication (α = .430) – I give the group all known and relevant information about important issues even if there is a possibility that it might jeopardise it – I think carefully before telling the group my opinions* – I minimise the information I give to the member of my group*	Method-based grounds: The α - coefficient < .60
Sharing the work (α = .061) – Nearly all the members of my team contribute equally to the work – Everyone on our group does their fair share of the work – No one in my team depends on the other group members to do the work for them*	Method-based grounds: The α - coefficient < .60

* = reverse scored

Appendix 5. Items of final questionnaire and coefficients of internal consistency

TABLE 23 Matrix of final questionnaire items

Items in the final questionnaire (Coefficient of internal consistency, α)
Team-oriented behaviour, n = 214 (α = .868)
2. Everybody participates in discussions
3. We share high performance expectations
4. We have sort of a "cheerleader" who emphasises the positive things we do
5. We listen to each individual's input
6. Someone makes sure that quieter members get chance to express their ideas
7. We delegate our group work
8. We organise our time well
9. We do not have total agreement, but we reach a kind of consensus that we all accept
10. We show positive attitudes regarding group work
11. Our individual styles seem compatible
12. We identify the functions necessary for the successful completion of group goals
13. A leader who is effective at organising tasks has emerged in our group
14. We are willing to spend enough time to ensure that our group projects are done well
15. A leader has emerged who is effective at getting us to work out interpersonal difference
Participation in decision making, n = 229 (α = .738)
16. Most members of my team get a chance to participate in decision making
17. As a members of a team, I have a real say in how the team carries out its work
19. Chance to participate in decision making depends on my position in the group*
Self-management, n = 218 (α = .588)
18. Most work-related decisions are made by the members of my team rather than by manager
20. My team rather than my manager decides who does what tasks within the team
21. Some external institutions, e.g. financier determine group's working schedule*
22. Some external institutions, e.g. financier determine group's research methods*
Conflict norms, n = 213 (α = .717)
23. Conflict is detrimental to getting the work done in our group*
24. Emotional displays (e.g. yelling) are accepted in our group
25. Differences of opinions about job responsibilities are avoided in our group*
28. Conflict is dealt with openly in our group
35. People in our group try to avoid conflict at all costs*
36. If conflict arises in our group, the people involved initiate steps to resolve the conflict immediately
37. Disagreements are encouraged in our group
Intragroup conflict n = 220 (α = .815)
26. There is harmony within my group
27. There is "we" feeling among the members of my group
29. There is dissension in my group*
31. There is friendliness among the members of my group
34. The member's of my group are supportive of each other's ideas
38. In our group, we have lots of bickering over who should do what job*
39. There is difference of opinion among the members of my group*

(continues)

TABLE 23 (continues)

Conflict resolution, n = 211 (α = .754)
30. Emotional conflicts are usually resolved in the group
32. Disagreements about the specific work being done are usually resolved in the group
33. Disagreements about who should do what are usually resolved in the group

Task conflict, n = 220 (α = .747)
40. How much conflict of ideas is there in your group?
41. How frequently do you have disagreements within your group about the task of the project you are working on?
43. How often do people in your group have conflicting opinions about the project you are working on?

Relationship conflict, n = 222 (α = .856)
42. How much relationship tension is there in your group?
46. How often do people get angry while working in your group?
47. How much emotional conflict is there in your working group?

Process conflict, n = 218 (α = .801)
44. How often are there disagreements about who should do what in your work group?
45. How much conflict is there in your group about task responsibilities
48. How often do you disagree about resource allocation in your work group?

Initiated task interdependence, n = 225 (α = .774)
49. Unsatisfactory performance of my job would delay the work performance of other people
50. I provide other people with the help or advice they need to do their work
51. Other members' work depends directly on my job
54. Unless my job gets done, other members cannot do their work
56. I provide other people with information they need to do their work

Goal similarity, n = 219 (α = .675)
53. The main goals of the group are the same for all members in my job
55. As a group, we have similar goals
57. We (my group) all agree on what is important to our group

Outcome interdependence, n = 223 (α = .786)
58. It benefits/hinders me when other members of the group attain their goals*
59. The things my colleagues want to accomplish and the things I want to accomplish are compatible/incompatible*
60. When members of my team succeed in their jobs, it is at my expense/benefit
61. My concerns ant those of group members are harmonious/clashing*
62. It is advantageous/disadvantageous for me when my colleagues succeed in their job*
63. When my colleagues succeed in their jobs, it works out positively/negatively*

Potency (spirit), n = 224 (α = .706)
64. My team has a lot of team spirit
68. Members of my team have great confidence that the team can perform effectively
69. My team can take on nearly any task and complete it

(continues)

TABLE 23 (continues)

Social support, n = 224 (α = .746)
65. Members of my team help each other out at work when needed
66. My team increases my opportunities for positive social interaction
67. Being in my team gives me the opportunity to work in a team and provide support to other team members
Organisational trust, n = 228 (α = .903)
70. No one in our group does mislead us
71. Members of our group negotiates with me honestly
72. Not everybody in our group keep his/her promises*
73. Some member of our group takes advantage of people who are vulnerable*
74. I can trust to the members of my team
76. Some members of our group try to take advantage of our problems*
77. Some members of our group try to get the upper hand*
78. Members of our group will keep their word
Relevance of the work performed in the group, n = 230 (α = .771)
79. The work our group performs is socially valuable
80. The work our group performs is scientifically valuable
83. The work our group performs is valuable to our own discipline and disciplines close to our own
Cooperation/Cooperative group norms, n = 230 (α = .771)
81. Members of my group cooperate to get the work done
82. Group enhances the communication among its members
84. Members of my group are very willing to share information with other team members about our work
Task type, n = 226 (α = .789)
85. How much routine is there in your job?*
86. How much variety is there in your job?
87. To what degree does your job include being creative?
88. To what extent is your job tiresome?*
89. How often is your work simple?
90. How often does your work give you a sense of accomplishment?
91. To what degree does your work include actually performing tasks (rather than planning)?*
92. To what extent do you feel like you are doing the same thing over and over again?*
93. To what extent is your job challenging?
94. How often is your job boring?*
95. How often can you predict how long a task will take?*
96. How much does your job include problem-solving?

* = reverse scored

Appendix 6. A cross-tabulation of task interdependence and team orientation

TABLE 24 Level of task interdependence by team orientation. Percentage distribution (number of respondents)

		Team orientation		
		Low	High	Total
Task interdependence	Low	11.7 (27)	24.8 (57)	36.5 (84)
	High	9.6 (22)	53.9 (124)	63.5 (146)
	Total	21.3 (49)	78.7 (181)	100 (230)

Appendix 7. Results of regression analysis by discipline

TABLE 25 Results of regression analysis (stepwise method) in terms of team-oriented behaviour and task- and outcome-interdependence by discipline

TOB (dependent variable)	Medicine (n = 77)	Engineering (n = 85)
	Beta (t-value)	Beta (t-value)
Background variables		
Status in group	ns.	-.143 (-2.483)*
Degree of multidisciplinarity	-.134 (-2.567)*	ns.
Conflict		
Process conflict	ns.	-.243 (-3.704)***
Relationship conflict	-.141 (-2.294)*	ns.
Conflict resolution	ns.	.187 (2.384)*
Process characteristics		
Group potency	.263 (3.438)***	.317 (3.606)***
Cooperative group norms	.468 (6.327)***	ns.
Participation in decision making	.261 (4.387)***	.180 (2.802)**
Social support	ns.	.160 (2.003)*
Preference for teamwork	-.113 (-2.174)*	ns.
	$F_{(6, 70)}$ = 56.324; p = .000; R^2= .828	$F_{(6, 78)}$ = 43.244; p = .000; R^2= .769

Task interdependence (dependent variable)	Medicine (n = 77)	Engineering (n = 85)
	Beta (t-value)	Beta (t-value)
Background variables		
Status in group	-.386 (-3.804)***	-.268 (-2.657)**
Conflict		
Conflict norms	ns.	.319 (3.164)**
Process characteristics		
Group potency	.275 (2.707)**	ns.
	$F_{(2, 74)}$ = 12.112; p = .000; R^2= .226	$F_{(2, 82)}$ = 11.119; p = .000; R^2= .213

Outcome interdependence (dependent variable)	Medicine (n = 77)	Engineering (n = 85)
	Beta (t-value)	Beta (t-value)
Background variables		
Work experience in the group	.250 (2.262)*	.208 (2.638)**
Interpersonal trust	.351 (3.182)**	ns.
Process characteristics		
Preference for teamwork	ns.	.291 (2.736)**
Task interdependence	ns.	.336 (4.066)***
Participation in decision making	ns.	.141 (.070), p = .047
Social support	ns.	.291 (.106), p = .007
	$F_{(2, 74)}$ = 6.296; p = .003; R^2= .145	$F_{(4, 80)}$ = 21.920; p = .000; R^2= .523

* p<.05; **p<.01; ***p<.001.

Appendix 8. Individual and group process characteristics by structural components

TABLE 26 Participation in decision making, goal similarity and social support (means) by certain independent variables (t-test for independent samples & ANOVA)

	Participation in decision making	Goal similarity	Social support
Discipline			
Medicine (n=109–110)	3.45	3.02	3.90
Engineering (n=120–121)	3.73	2.93	3.98
Total (n=228–231)	3.59	2.97	3.94
	$t_{(229)} = -2.674^{*}$	$t_{(226)} = .764$	$t_{(227)} = -1.098$
Gender			
Female (n=103)	3.51	2.99	3.86
Male (n=125–128)	3.66	2.96	4.01
Total (n=228–231)	3.59	2.97	3.94
	$t_{(229)} = -1.473$	$t_{(226)} = .268$	$t_{(227)} = -2.002^{*}$
Status in group			
Leader (n=43)	3.91	2.98	4.15
Rank-and-filer (n=169–172)	3.53	2.96	3.92
Total (n=212–215)	3.60	2.97	3.97
	$t_{(96.69)} = 3.747^{***}$	$t_{(210)} = .166$	$t_{(211)} = 2.464^{*}$
Degree of multidisciplinary			
Disciplinary-based (n=86)	3.78	3.07	3.96
Multidisciplinary (n=116–119)	3.39	2.89	3.90
Total (n=202–205)	3.55	2.97	3.92
	$t_{(203)} = 3.490^{**}$	$t_{(200)} = 1.537$	$t_{(201)} = .754$
Experience as a researcher			
< 3 years (n=63–65)	3.64	3.13	4.03
3–9 years (n=79)	3.59	2.81	3.91
> 9 years (n=75–76)	3.66	2.97	3.98
Total (n=217–220)	3.63	2.96	3.97
	$F_{(2, 217)} = .153$	$F_{(2, 214)} = 2.524$	$F_{(2, 215)} = .929$
Experience in the group			
< 12 months (n=33–35)	3.65	3.02	3.95
12–36 months (n=93)	3.64	3.01	3.98
> 36 months (n=85–86)	3.49	2.91	3.91
Total (n=211–214)	3.58	2.97	3.95
	$F_{(2, 211)} = .889$	$F_{(2, 208)} = .408$	$F_{(2, 209)} = .406$
Size of the group			
3–5 (n=65)	3.84	2.93	4.06
6–10 (n=84–85)	3.81	3.11	3.95
> 10 (n=79–81)	3.17	2.86	3.85
Total (n=228–231)	3.87	2.97	3.94
	$F_{(2, 228)} = 19.707^{***}$	$F_{(2, 225)} = 2.040$	$F_{(2, 226)} = 2.688$

* p<.05; **p<.01; ***p<.001.

Note. Process characteristics were evaluated on a five-point Likert-type format in which 1 = strongly disagree … 5 = strongly agree.

TABLE 27 Team self-management, potency and cooperative group norms (means) by discipline, gender, status in group, and work experience (t-test for independent samples & ANOVA)

	Team self-management	Group potency	Cooperative group norms
Discipline			
Medicine (n=109–110)	3.32	3.40	3.86
Engineering (n=120–121)	3.14	3.50	3.89
Total (n=229–231)	3.23	3.45	3.87
	$t_{(229)} = 1.860$	$t_{(228)} = -.841$	$t_{(229)} = -.350$
Gender			
Female (n=103)	3.25	3.34	3.81
Male (n=126–128)	3.21	3.54	3.93
Total (n=229–231)	3.23	3.45	3.87
	$t_{(229)} = .485$	$t_{(228)} = -1.860$	$t_{(229)} = -1.354$
Status in group			
Leader (n=43)	3.27	3.63	4.02
Rank-and-filer (n=170–172)	3.21	3.42	3.87
Total (n=213–215)	3.22	3.46	3.90
	$t_{(213)} = .483$	$t_{(212)} = 1.504$	$t_{(213)} = 1.369$
Degree of multidisciplinary			
Disciplinary-based (n=85–86)	3.31	3.48	3.88
Multidisciplinary (n=118–119)	3.12	3.42	3.85
Total (n=203–205)	3.20	3.44	3.86
	$t_{(155.5)} = 1.837$	$t_{(202)} = .560$	$t_{(203)} = .249$
Work experience as a researcher			
< 3 years (n=62–65)	3.32	3.55	3.98
3–9 years (n=78–79)	3.18	3.36	3.78
> 9 years (n=76)	3.26	3.50	3.95
Total (n=216–220)	3.25	3.47	3.89
	$F_{(2, 217)} = .683$	$F_{(2, 216)} = 1.028$	$F_{(2, 217)} = 2.036$
Work experience in the group			
< 12 months (n=35)	3.07	3.61	3.94
12–36 months (n=92–93)	3.32	3.46	3.91
> 36 months (n=85–86)	3.19	3.35	3.83
Total (n=212–214)	3.23	3.44	3.88
	$F_{(2, 211)} = 1.695$	$F_{(2, 210)} = 1.285$	$F_{(2, 211)} = .530$
Size of the group			
3–5 (n=64–65)	3.27	3.60	4.04
6–10 (n=84–85)	3.35	3.47	3.81
> 10 (n=81)	3.05	3.31	3.80
Total (n=229–231)	3.23	3.45	3.87
	$F_{(2, 228)} = 3.879$*	$F_{(2, 227)} = 2.223$	$F_{(2, 228)} = 2.884$

* p<.05 **p<.01 ***p<.001.

Appendix 9. Results of regression analysis by discipline

TABLE 28 Results of the regression analysis (stepwise method) by discipline for trust and task, process and relationship conflict

Trust (dependent variable)	Medicine (n = 77)	Engineering (n = 85)
	Beta (t-value)	Beta (t-value)
Conflict		
Process conflict	-.280 (-2.914)**	ns.
Task conflict	-.330 (-3.545)***	-.375 (-4.714)***
Conflict resolution	.311(4.486)***	ns.
Conflict norms	ns.	.402 (4.581)***
Process characteristics		
Cooperative group norms	.179 (2.337)*	ns.
Social support	ns.	.190 (2.068)*
	$F_{(4, 72)}$ = 52.153; p = .000; R^2 = .743	$F_{(3, 81)}$ = 38.246; p = .000; R^2 = .586
Relationship conflict		
Background variables		
Work experience as researcher	.149 (2.108)*	ns.
Conflict		
Task conflict	.377 (3.621)***	.471 (4.977)***
Process characteristics		
Group potency	ns.	-.298 (-3.143)**
Preference for teamwork	-.259 (-2.856)**	ns.
Goal similarity	.176 (2.258)*	ns.
Interpersonal trust	-.335 (-2.939)**	ns.
	$F_{(5, 71)}$ = 26.561; p = .000; R^2 = .652	$F_{(2, 82)}$ = 33.835; p = .000; R^2 = .452
Task conflict		
Background variables		ns.
Conflict		
Process conflict	.411 (4.136)***	.552 (6.279)***
Relationship conflict	.278 (2.880)**	.298 (3.388)***
Interpersonal trust	-.235 (-2.186)*	ns.
Process characteristics		ns.
	$F_{(3, 73)}$ = 51.979; p = .000; R^2 = .681	$F_{(2, 82)}$ = 57.898; p = .000; R^2 = .585
Process conflict (dependent variable)		
Background variables		ns.
Conflict		
Task conflict	.495 (4.855)***	.628 (8.564)***
Conflict norms	ns.	-.299 (-4.072)***
Interpersonal trust	-.363 (-3.560)***	ns.
Process characteristics		ns.
	$F_{(2, 74)}$ = 65.633; p = .000; R^2 = .639	$F_{(2, 82)}$ = 63.293; p = .000; R^2 = .607

* p<.05; **p<.01; ***p<.001.

Appendix 10. Correlation matrix

TABLE 29 Intercorrelations (Pearson) between work characteristics (n = 205–231)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TOB	-														
Decision making	.550***	-													
Team self-manag.	.305***	.491***	-												
Conflict norms	.595***	.433***	.212**	-											
Process conflict	-.524***	-.300***	-.161*	-.347***	-										
Task conflict	-.487***	-.200**	-.083	-.283***	.697***	-									
Relation. conflict	-.496***	-.294***	-.102	-.404***	.610***	.596***	-								
Conflict resolution	.667***	.508***	.269***	.618***	-.440***	-.380***	-.442***	-							
Trust	.558***	.393***	.232***	.458***	-.616***	-.565***	-.612***	.532***	-						
Task interdep.	.334***	.246***	-.006	.300***	-.121	-.085	-.136*	.300***	.165*	-					
Outcome interdep.	.383***	.231***	.238***	.321***	-.297***	-.209*	-.202**	.323***	.383***	.346***	-				
Group potency	**.767*****	.437***	.171*	.535***	-.461***	-.450***	-.493***	.610***	.539***	.341***	.353***	-			
Goal similarity	.342***	.213**	.150*	.245***	-.295***	-.276***	-.207**	.289***	.345***	.197***	.298***	.356***	-		
Social support	.669***	.452***	.261***	.467***	-.408***	-.375***	-.453***	.531***	.506***	.327***	.386***	**.707*****	.203**	-	
Cooperation	**.710*****	.378***	.178*	.503***	-.476***	-.405***	-.477***	.584***	.539***	.343***	.350***	.674***	.329***	**.710*****	-

* p<.05; **p<.01; ***p<.001, 2-tailed. Note: Strong correlations (r > .70) are shown in bold.

Appendix 11. Two examples of normal distributions in data

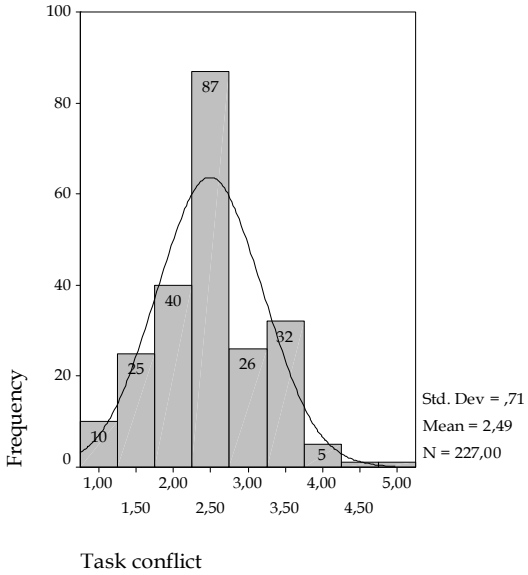

FIGURE 20 Example of a relatively normal distribution (task conflict)

The distribution presented in Figure 20 can be regarded as approximately normal. The data contained 9 cases which could be seen as clearly normally distributed. However, Figure 21 is a somewhat more problematic case as it shows a bimodal distribution. However, here, too, the distribution can be regarded as approximately normal (because the variable in question was an aggregated variable) as the bimodality is not that clear-cut and therefore no non-parametric tests were used. The data contained 6 cases which could be seen as having a partially bimodal distribution.

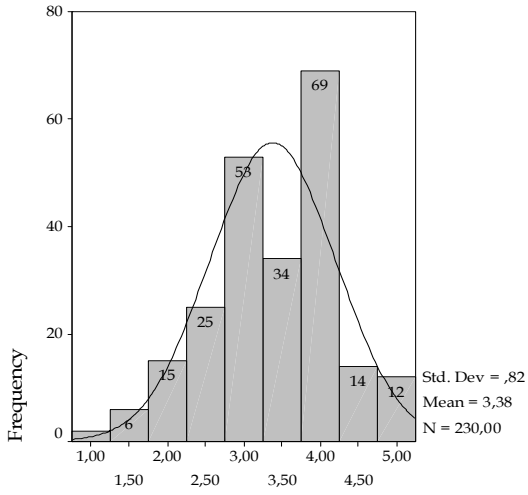

FIGURE 21 Example of a bimodal distribution of population (task interdependence)

Appendix 12. Equality of the population variances

TABLE 30 Levene's test of homogeneity of variances (ANOVA)

Work characteristics	Work experience as a researcher	Work experience in the group	Size of the group
Individual process characteristics			
Preference for teamwork	**F(2, 217) = 4.994, p = .008**	F(2, 211) = .2.932, p = .055	F(2, 228) = 1.334, p = .266
Participation in decision making	F(2, 217) = .467, p = .627	F(2, 211) = .294, p = .745	F(2, 228) = 1.809, p = .166
Goal similarity	F(2, 214) =.044, p = .957	F(2, 208) = .2.262, p = .107	F(2, 225) = 2.663, p = .072
Social support	**F(2, 215) = 3.463, p = .033**	F(2, 209) = .474, p = .623	F(2, 226) = 1.616, p = .201
Task interdependence	F(2, 216) = 1.231, p = .294	F(2, 210) = 1.200, p = .303	**F(2, 227) = 4.694, p = .010**
Outcome interdependence	F(2, 215) = 1.216, p = .298	F(2, 208) = .258, p = .773	F(2, 225) = 1.094, p = .337
Group process characteristics			
Group potency	F(2, 216) = 2.968, p = .053	F(2, 210) = .529, p = .590	F(2, 227) = .726, p = .485
Cooperative group norms	**F(2, 217) = 5.838, p = .003**	**F(2, 211) = 3.323, p = .038**	F(2, 228) = 1.889, p = .154
Team self-management	F(2, 217) = .248, p = .781	F(2, 211) = .399, p = .672	**F(2, 228) = 4.749, p = .010**
Trust	F(2, 217) = 1.369, p = .257	F(2, 211) = 1.200, p = .303	F(2, 228) = .075, p = .928
Conflict			
Relationship	F(2, 214) = 1.620, p = .200	F(2, 207) = 1.143, p = .321	F(2, 224) = 1.732, p = .179
Task	F(2, 214) = 2.356, p = .097	F(2, 207) = .534, p = .587	F(2, 224) = .988, p = .374
Process	F(2, 213) = .919, p = .401	F(2, 206) = .004, p = .996	F(2, 223) = .414, p = .661
Conflict norms	F(2, 217) = .749, p = .474	F(2, 211) = 1.561, p = .212	F(2, 228) = .082, p = .922

Note. Unequal distribution of population variances shown in bold.

Appendix 13. Outliers in regression analysis

TABLE 31 Outliers by dependent variable in regression analysis.

Dependent variable	Case number	Std. Residual	Does/Do the elimination of outlier(s) change the results of the original analysis?
Individual process characteristics			
Team-oriented behaviour	217	-6.80	No.
Social support	22 227	-3.71 -3.07	Yes. However, in the new model multicollinearity between variables was higher than in the original one. Hence, the original model was retained.
Participation in decision making	217	3.35	No.
Outcome interdependence	191	-3.62	Yes. However, the changes were very modest and in the new model a new outlier emerged; hence, the original model was retained.
Task interdependence	89 139	-3.81 -3.07	Yes. However, the changes were very modest and in the new model multicollinearity between variables was higher than in the original one; hence, the original model was retained.
Group process characteristics			
Group potency	110	-3.12	Yes; Although the new model had the same predictors as the original one, the new model was accepted as it had a higher coefficient of determination.
Cooperative group norms	113 163	-3.33 -3.52	Yes. In the new model one predictor, original effect of which was difficult to interpret, was eliminated; hence, the new model was accepted.
Interpersonal trust	93 170 210 223	3.25 -3.08 6.13 -3.01	Yes/No. First, all of the outliers were removed, which changed the model by adding a new predictor (relationship conflict). However, the new model had a much greater problem with multicollinearity than the original; hence no changes were made to the original model. Case 210 was then removed as it was the most obvious outlier. However, this elimination hardly changed the original model. Altogether, the original model was retained.

(continues)

TABLE 31 (continues)

Conflict			
Task conflict	40	3.75	Yes. The outliers were eliminated as doing so increased the coefficient of determination without changing the model itself. Hence, the new model was accepted.
	81	3.67	
	93	3.58	
Conflict norms	12	-3.15	Yes. A new model was accepted, although the model itself was unchanged. In the new model the coefficient of determination was a little higher than it was in the original model.
Conflict	93	-3.10	No.
resolution	210	-3.98	

Appendix 14. Multicollinearity in the models generated by stepwise multiple regression analysis

TABLE 32 Tolerance indices and VIF-values obtained from different models

Dependent variable/variables included in the model	Collinearity statistics	
	Tolerance Index	VIF
Team-oriented behaviour		
Group potency	**.47**	**2.13**
Cooperative group norms	.54	1.84
Participation in decision making	.78	1.29
Task conflict	.71	1.40
Position in the group	.94	1.06
Task interdependence		
Position in the group	.87	1.11
Outcome interdependence	.83	1.21
Cooperative group norms	.85	1.17
Gender	.92	1.09
Outcome interdependence		
Social support	.65	1.55
Task interdependence	.87	1.15
Experience in the group	.96	1.04
Goal similarity	.86	1.16
Trust	.64	1.57
Participation in decision making		
Team-oriented behaviour	**.48**	**2.07**
Team self-management	.91	1.10
Discipline	.74	1.35
Conflict resolution	.60	1.66
Process conflict	.67	1.50
Group size	.70	1.43
Social support		
Group potency	.52	1.91
Cooperative group norms	.58	1.80
Participation in decision making	.81	1.24
Goal similarity		
Team-oriented behaviour	.60	1.67
Outcome interdependence	.87	1.15
Conflict resolution	.62	1.63
Team self-management		
Participation in decision making	.96	1.04
Discipline	.96	1.04
Cooperative group norms		
Team-oriented behaviour	**.44**	**2.26**
Social support	**.50**	**2.02**
Trust	.57	1.71

(continues)

TABLE 32 (continues)

Group potency		
Team-oriented behaviour	**.42**	**2.39**
Social support	**.50**	**2.00**
Conflict resolution	.60	1.68
Team self-management	.94	1.07
Trust		
Process conflict	**.41**	**2.46**
Conflict resolution	.56	1.79
Task conflict	**.43**	**2.30**
Cooperative group norms	.57	1.76
Conflict norms	.63	1.59
Relationship conflict		
Task conflict	.56	1.77
Trust	**.44**	**2.29**
Discipline	.99	1.01
Cooperative group norms	.62	1.61
Process conflict		
Task conflict	.53	1.90
Trust	**.48**	**2.11**
Gender	.98	1.02
Team-oriented behaviour	.56	1.79
Task conflict		
Process conflict	**.48**	**2.10**
Relationship conflict	.51	1.97
Trust	**.40**	**2.53**
Conflict norms	.62	1.61
Team-oriented behaviour	**.47**	**2.12**
Conflict norms		
Conflict resolution	.62	1.63
Team-oriented behaviour	.60	1.68
Discipline	.99	1.01
Outcome interdependence	.88	1.14
Conflict resolution		
Team-oriented behaviour	**.46**	**2.16**
Trust	.56	1.77
Conflict norms	.61	1.64
Group size	.89	1.13
Participation in decision making	.63	1.56

Note: Tolerance index ≤ .50 and VIF-value ≥ 2.00 are bold.