

INTERNATIONAL EVALUATION 2008

**NATIONAL RESEARCH CENTRE FOR WORKING
ENVIRONMENT
DENMARK**

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1. Preface

This evaluation report concludes the evaluation committee's commitments in relation to the international evaluation 2008 of the National Research Centre for the Working Environment (NRCWE). The content of the report is the result of an intensive working period from February to end of September 2008.

The readers of this report should be aware of the fact that the chapters comprising the evaluation on strategic field level are written by the evaluator in charge of the respective fields, to some extent opening for differences in style and formulations. This does explicitly not mean that aspects specifically highlighted for some strategic fields not are equally developed on other strategic fields, and vice versa, but rather reflects the individual evaluator's prioritizing on what to emphasize.

The members of the evaluation committee would like to express our gratitude for the opportunity we were given to learn to know the Centre, and for the confidence given us both from the Board of Governors at NRCWE, who commissioned the evaluation, and from the NRCWE staff who have displayed their competences and shared their experiences with us.

The evaluation committee would also like to thank the academic secretary for the evaluation committee, Merete Bugge, for excellent assistance during the evaluation period.

The evaluation committee members have very much appreciated the work, and we hope that the results from this evaluation will contribute to inspiration, and to a continued positive development of the NRCWE.

Oslo, October 1st 2008

On behalf of the evaluation committee,



Pål Molander

Chairman

2. Background – NRCWE evaluation 2008

2.1. Citations from the “Terms of reference” for the NRCWE evaluation 2008

On 4th October 2006 the Danish government decided to restructure and merge some universities and government research institutes. Among the government research institutes that were reorganized was the former National Institute of Occupational Health (in Danish Arbejdsmiljøinstituttet, abbrev. AMI) which became The National Research Centre for the Working Environment (NRCWE). In accordance with this decision it was also decided that The Danish Council for Strategic Research would conduct a quality assessment of the research of NRCWE. Also, the government decided that a certain share of NRCWE’s present government funding should be exposed to competition from 1 January 2009 and onwards. The quality assessment will serve as basis for a decision on the size of this share. The share of NRCWE’s government funding will, in practice, be transferred to the Danish Working Environment Research Fund. NRCWE can submit bids for this fund on equal terms with other research organizations.

The Ministry of Science, Technology and Innovation (VTU) and the Ministry of Employment (BM) have subsequently agreed that the international evaluation of NRCWE, which was to take place in 2009, will take place in 2008, so that the evaluation can be part of the basis for the decisions about the level of exposure to competition from 2009.

VTU will conduct a broad evaluation in 2009 of the whole process of restructuring and merging of universities and government research institutes in accordance with the government decision on 4th October 2006 and in accordance with decision V9 of the Danish Parliament. The results of the international evaluation of NRCWE will be included in this general evaluation.

The evaluation will be carried out in accordance with the executive order regulating evaluation of government research institutes.

The purpose of the evaluation is to assess the quality and relevance of the research and the dissemination of research results, and in addition – because of new tasks laid on NRCWE – to assess whether NRCWE meets the goals in the government decision of 4th October 2006 regarding the reorganizing of NRCWE, the contribution to further education, and the counselling and assistance to the Ministry of Employment. Furthermore, the various fields of research should be assessed in relation to their potential regarding the decision on exposure to competition.

Also, the evaluation should give recommendations for improving the organization and the strategic path of NRCWE. The evaluation and the recommendations are expected to address the various fields of research as well as NRCWE as a whole.

The criterion of relevance refers to NRCWE’s organizational and political framework. This means that the research, the dissemination of research results, and the government tasks will be assessed with regard to the demands and needs of the Department of the Permanent Secretary of the Ministry of Employment, The Danish Working Environment Authority and the other important actors in the working environment field. The demands and needs are expressed in e.g. the national strategy for the working environment and the management performance contract. The relevance of the contribution to further education is assessed in relation to the demands and needs of the universities.

2.2. Evaluation committee

Pål Molander, Chairman

Molander is Research Director General at the National Institute of Occupational Health (NIOH) in Norway, where he is responsible for the research strategy, priorities and administration. He is highly involved in the institute’s contact with ministries, authorities and stakeholders. Molander

is also an adjunct professor at the University of Oslo. Molander obtained his PhD in analytical chemistry in 2000, and joined NIOH in 2001 as a researcher in occupational hygiene. Beside his interest in occupational health and working environment in general, Molander is still executing active research within the fields of occupational hygiene, toxicology and to some extent epidemiology.

Chairman of the evaluation committee, and responsible for coordination of evaluation on Centre level. Responsible for the evaluation of the strategic fields "Noise" and "New technologies", including writing of the respective field specific chapters 6.6 and 6.7 in this report.

Torsten Björkman, PhD in Sociology from Uppsala University in 1981, is now Professor Emeritus in Leadership from the Swedish National Defence College and in Work Sciences at the Royal Institute of Technology. He is also Senior Consultant at Castor Analys, Stockholm, with assignments as expert, not the least on the board of surveys, for instance Chairman of the Evaluation of Swedish Work Science 2004-2006 and one of two experts on the Evaluation of Academic Leadership in 2008 for the Swedish Agency for Higher Education.

Responsible for evaluation of the strategic field "Organization and management", including writing of the field specific chapter 6.5 in this report.

Paulien Bongers, PhD is manager research of the Business Unit Work and Employment of TNO, manager of the department Work, Health and Safety and co-director of Body@Work, Research Center Physical Activity Work and Health TNO VUmc. She holds an academic chair on prevention of work related musculoskeletal disorders at the Free University Medical Center, Department of Public and Occupational Health. She has conducted several large scale epidemiologic studies in the field of work and health and has been a member of several international projects and committees. Her recent studies are on the most cost-effective strategy for interventions on prevention of work-related problems, return to work and stimulation of physical activity. She is (co) author of several systematic reviews on risk factors, on effectiveness of interventions and on the interplay between psychosocial factors, individual factors and physical factors and is one of the most cited authors on these issues.

Responsible for evaluation of the strategic fields "Occupational accidents" and "Absence and exclusion", including writing of the respective field specific chapters 6.1 and 6.2 in this report.

Gustav Caffier, Dr. sc. med., is the head of the research unit "Work design for physical strains, musculoskeletal disorders" at the Federal Institute for Occupational Safety and Health (BAuA) in Berlin, Germany. He is a medical doctor specialised in physiology and occupational medicine. Since 1988 he is engaged in investigating work-related musculoskeletal disorders, especially back and upper extremity problems. He is active in the National Initiative "New quality of work" (INQA) and is a member of the Integral Prevention Action Group in Germany.

Responsible for evaluation of the strategic field "Work-related pain in muscles and joints", including writing of the respective field specific chapter 6.3 in this report.

Stein Knardahl, M.D. from the University of Oslo and Ph.D. from the Faculty of psychology, the University of Bergen in 1984. Research director of the department for occupational musculoskeletal disorders at the NIOH in Norway, and leader of the project "Work, health, and participation in working life". Has been adjunct professor at the Dept. of psychology at the University of Oslo for 15 years. Has coordinated and chaired the research programs of work and health of the Norwegian research council. Research interests are effects of psychological and social work factors, mechanisms of chronic pain, musculoskeletal disorders, and "stress" and cardiovascular disease.

Responsible for evaluation of the strategic field "Psychosocial working environment", including writing of the respective field specific chapter 6.4 in this report.

Merete Bugge, M.D., research scholar at the NIOH in Norway, has served as academic secretary for the evaluation committee.

2.3. Evaluation procedure

The evaluation committee was appointed and received the terms of reference February 2nd, 2008. The first meeting of the committee was on March 13th, where the evaluation process was planned and a meeting with the NRCWE management was held. Site visits at the Centre were executed on June 3rd and 4th (NRCWE internal interviews) and stakeholder interviews were held on June 19th. The Centre was asked to provide and deliver specific written information about the NRCWE prior to the site visits. As the terms of reference instructed the committee to evaluate the Centre performance related to the national strategy of working environment, the committee chose to collect information related to each strategic field separately. Both written information and interviews were therefore collected for strategic fields, in addition to on Centre level.

On Centre level information about personnel, publications, budget, external funding, organization and management, formal contact with stakeholders, involvement in external scientific networks, procedures for project initiation and evaluation, dissemination of research and knowledge, as well as a self-evaluation of the Centre's current situation were requested.

On strategic field level the committee requested written information such as employee lists, projects, publications, budget and funding, data on student mentoring, contact with and counseling of external partners, and copies of the 5 "best articles" in the evaluation period. For each strategic research field the committee also asked for a self evaluation of strengths, weaknesses and potential threats, information about the field's intervention research activities, and plans for the future.

According to appointment of the evaluation committee, the evaluators were responsible for one or two of the strategic fields each (see chapter 2.2). Interviews on strategic field level were (I) meeting with one "NRCWE expert" appointed by the NRCWE, representing the field. The whole evaluation committee was present. (II) Meeting with 3-4 researchers, including a PhD-student, in a second interview. This second interview was administered by 2-3 members of the committee with special interest for this strategic field. In addition, the NRCWE management, including the Director General, was interviewed by the whole committee.

Before the stakeholder interviews on June 19th an interview guide was distributed to all stakeholder representatives. The guide included a questionnaire which was filled in by all the participating representatives and was handed over to the committee.

3. Working environment - National strategy and priorities

The overall political framework for the National strategy in this field is the report *The working environment of the future* (only in Danish) from April 2005 and the subsequent *Report on future working environment 2010 – new priorities for the working environment* from December 2005. This latter prioritizing was made by the Danish government in accordance with recommendations by the social partners in the Working Environment Council. The basis for the reports was prepared by the NRCWE in cooperation with the Working Environment Authority and the National Board of Industrial Injuries.

The report outlines four major areas for prioritization, with the following justification:

- Industrial accidents – because of its potential serious consequences for employees, the enterprise and society. These may include death, loss of ability to work, permanent injury, long-term absenteeism due to sickness, as well as risk of exclusion from the labour market. Industrial accidents have also been rendered priority in the EU.
- Psychological working environment – because of its health consequences, and its consequences for enterprises in the form of sickness absence. The problems are widespread and increasing. The area has also been rendered priority in the EU.
- Noise – is given priority in a wide context: Both the well-documented working environment problem of high-level noise causing hearing loss, with serious consequences for the individual's health, quality of life, and ability to work; but also the not yet fully identified impacts of lower-level disturbing noise. Disturbance from noise is an increasing problem for many employees.
- Musculo-skeletal disorders – these are especially significant for absenteeism due to sickness and health-related early retirement, and they represent costly and widespread problems. Risk factors exist both in enterprises and outside work, and general preventive measures are needed. There have been great efforts over many years, e.g. aiming at manual repetitive work (MRW) and heavy lifting. The importance of musculo-skeletal disorders is expected to continue in the future. Within the framework of a new national plan, a prevention strategy aiming at reducing sickness absence related to musculo-skeletal disorders should be developed.

4. The National Research Centre for the Working Environment – The NRCWE

4.1. Description

The NRCWE is an independent research centre under the Danish Ministry of Employment. The legal basis of the NRCWE and the other government research institutes is the law on Government Research Institutes of the Ministry of Science, Technology and innovation. The NRCWE's principal tasks according to the Centre by-laws are conducting working environment research and disseminating knowledge of the working environment.

The vision of the Centre is to be the national centre for *Research in prevention with the purpose of promoting health and safety at the workplace*, which implies:

- A centre that provides a relevant research-based knowledge platform to ensure healthy and inspirational working conditions in accordance with social development and the needs of the working environment system and companies
- A centre with inter-disciplinary working environment research of a high international level
- A workplace strong on knowledge with committed employees

4.2. Organization and management

Until 2006 the NRCWE was known as the National Institute of Occupational Health (NIOH) – or in Danish “Arbejdsmiljøinstituttet “(AMI), and was one of many research institutes organized under the Danish ministries. When the Government in 2006 decided to reorganize the research sector, most research institutes were reorganized as university departments. The NRCWE, however, kept its former connection to the Ministry of Employment, partly due to the Centre's important role as advisor to the Ministry.

To secure the quality of the NRCWE research even when organized outside the universities, a new board was appointed, with members from the three largest universities, and the Centre was instructed to increase collaboration with the universities.

The NRCWE is organized directly under the Ministry of Employment, and the chairman of the board, presently Prof. Kjeld Møller Pedersen, is appointed by the Government. The NRCWE leadership is the Director General, and the Deputy Director General and the Director of Research in staff. Three Directors of Research coordination have the direct administrative leadership of the research projects, and a Director of Communications has the responsibility for the external knowledge dissemination.

The research at the NRCWE is organised in projects. The various research projects are clustered with related research projects in so-called project groups. Currently there are a total of 17 project groups. Both the size and number of research projects in the project groups vary considerably.

The activities of the project groups are managed by annual performance contracts with detailed information on budgeting of resources and working expenses, scientific production (publications), cooperation with universities, teaching activities and applications for funding.

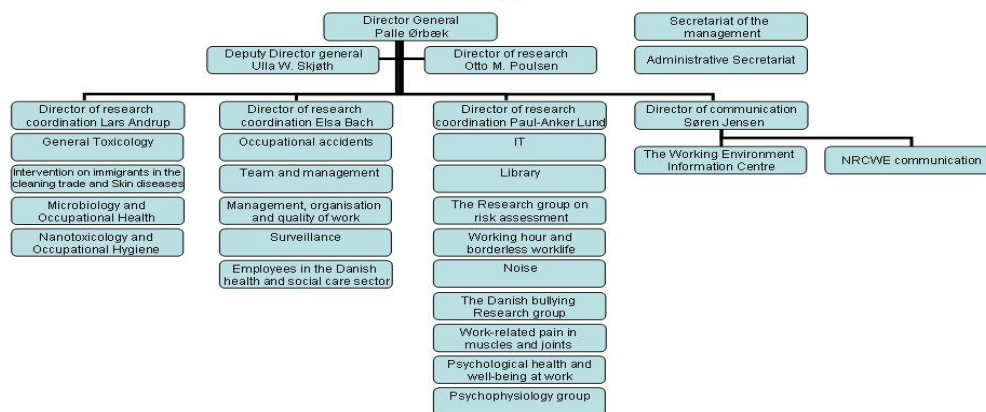
The project groups are organised in three clusters of research, which are administered by the Directors of Research Coordination. The current 17 project groups cover the 7 strategic research fields. However, the research clusters under the Directors of Research Coordination do not exactly match the strategic research fields. The three Directors of Research Coordination act as controllers of the project groups and coordinate the research conducted within and between their research clusters. The Directors of Research Coordination are part of the group of

managers and thereby act as liaisons between the project groups and the top management. The group of managers has weekly meetings and daily briefings.

Although the Directors of Research Coordination have the overall responsibility for managing the project groups, the project leaders carry out the day-to-day management of the project groups.

The reorganizing of the Centre and the new strategy have implied several major changes in the organization. The old department structure is erased, and a project organization with a matrix structure has been established. Implementation of the strategy has resulted in termination of several research fields and the establishment of new research areas.

NRCWE organisation



4.3. Research strategy

The NRCWE's undertaking can be split into 4 main purposes, which are apparent in the National Budget: Research, Working environment surveillance and preparedness, Dissemination of knowledge, and Undergraduate and postgraduate education.

The NRCWE long-term research objectives are based on the prioritization given in the National Strategy as well as on new issues identified by the Centre's working environment surveillance.

Every second year the research strategy, with a four to five years perspective, is revised. The Board of Governors elaborates the research strategy after discussions on at least two consecutive meetings, typically comprising a seminar. The strategy gives clear directives on which research fields are given priority, and selects topics within the research fields. In principle the research is multidisciplinary at the Centre. In the current strategy (for the period 2006-2010) 7 research fields have been selected and prioritized. Research within non-prioritized research topics will only be taken up if there is a demand for it from the authorities.

The current strategic fields are (in non-prioritized order): *Occupational accidents, Absence and exclusion, Work-related pain in muscles and joints, Psychosocial working environment, Organization and management, Noise, and New technologies*. In addition, it is an overall goal that studies on intervention and implementation shall be conducted in all strategic fields.

4.4. Key numbers

The primary source of income for the Centre is basic funding from the Danish government. However, as the level of basic funding has been stable during the evaluation period, increased

expenses have been financed by income from politically prioritized grants, in addition to a considerable increase in self-financing activities. The share of basic funding is reduced from 70% in 2005 to 63% in 2007 (Table 1). Likewise, the share of basic funding of research activities is reduced during the evaluation period, from 50% in 2005 to 37% in 2007 (cfr. Table 2).

Table 1: Overall annual account 2005 – 2007

Mio. dKr	2005	2006	2007
Income	93.0	97.8	105.1
Basic government grant	64.9	66.0	64.9
Self financing activities	0.4	1.5	1.8
External funding			
Politically prioritized grants	4.0	6.9	15.2
Research fund grants	23.7	23.4	23.2
Total	27.7	30.3	38.4
Costs	91.8	98.0	104.9
Result	1.2	-0.2	0.2
Savings	6.5	7.7	7.5
Accumulated savings	7.7	7.5	7.7
External funding in percent of costs	30%	31%	37%

Table 2: The external funding in percent of direct research costs

Mio. dKr	2005	2006	2007
Total direct research costs	47.7	51.3	55.8
External funding			
Politically prioritized grants	4.0	6.9	15.2
Research fund grants	20.0	19.9	19.8
Total	24.0	26.8	35.0
Total external funding in percent of direct research costs	50%	52%	63%

The proportion of basic funding differs considerably between the 7 strategic fields, the extremes being *Noise*, with 91% basic funding, and *Absence and exclusion*, with 8% basic funding. However, as the strategic fields also are very different with respect to size, the field receiving in sum the main part of internal financing is *New technologies*. This field has a share of 68 % basic funding, and receives half of the internal research budget (~10 millions dKr).

Table 3: Total direct costs and external funding on strategic fields 2007 (dKr)

External funding in pct. of total direct cost					External funding in percent by type	
	Total cost	Int. Funding	Ext. Funding	Ext. %	Politically prioritised grants	Research fund grants
Occupational accidents	3.807.610	1.767.062	2.040.548	54	0	100
Absence and exclusion	16.001.395	1.352.737	14.649.658	92	89	11
Work-related pain in muscles and joints	4.519.762	3.143.357	1.376.405	30	0	100
Psychosocial working environment	9.263.253	1.872.666	7.390.587	80	18	82
Organization and management	5.949.190	1.248.992	4.700.198	79	16	84
New technologies	14.768.607	10.032.420	4.736.187	32	0	100
Noise	1.506.589	1.374.079	132.510	9	0	100
TOTAL	55.816.407	20.790.313	35.026.093	63	43	57

The number of employees has increased with almost 10% from 2005 to 2007, mainly due to an increase in the number of researchers.

Table 4: Employees

Employees (man-years)	2005	2006	2007
Managers	7	7	7
Researchers	65	74	73
PhD Students	12	13	16
Technical staff	25	24	26
Administrative staff	18	18	19
IT and communication	10	9	10
Others	3	1	2
In total	140	146	153

4.5. Stakeholders

The NRCWE's major stakeholders are the users of research based knowledge and research partners.

In addition to the Ministry of Employment and its agencies, important users are the social partners, which are represented at high level in the board of governors of the NRCWE. The Director General of the NRCWE takes part in the meetings of the Working Environment Council, which is a forum of social partner representatives counselling the Minister of Employment on Occupational Safety and Health (OSH)-related matters. Furthermore, the NRCWE cooperates with the Association of Preventive and Health Services in Denmark and other working environment advisers.

4.6. Dissemination of knowledge

The NRCWE researchers contribute to education both through mentoring of students on master and PhD level at the Centre, and by teaching on undergraduate and postgraduate levels at the universities.

Table 5: Mentoring of PhD, bachelor and master students

Period 2005-2008	PhD students		Bachelor and master	
	Finished	Ongoing	Finished	Ongoing
New technologies	5	10	17	2
Organization and Management	1	8	*	21
Noise	0	1	*	1
Work-related pain in m & j	5	7	*	4
Occupational accidents	2	0	*	2
Psychosocial working environment	3	5	*	26
Absence and exclusion	3	4	*	20

*Numbers not given

In addition to student teaching and mentoring, knowledge dissemination to stakeholders, users and the general public is prioritized. The NRCWE seeks to adapt its dissemination efforts to the users by making it recipient-oriented, effective and targeted at specific groups. There is continuous development of the infrastructure for collection, quality assurance, editing, and spreading of research based working environment knowledge.

The target groups of the NRCWE's dissemination efforts are:

- Scientists, experts, and students nationally and internationally (Scientific communication).
- Work environment advisers, counsellors and consultants and experts in companies and organizations (User-oriented communication).
- The press, TV/radio, magazines, portals, and other media (News-oriented communication).
- The working environment system, i.e. the Ministry of Employment, the social partners, the Working Environment Council and its sector working environment councils are also major recipients of knowledge, although this typically takes place via direct contact between the user and the NRCWE management or researchers.

The home page of the NRCWE, www.arbejdsmiljoforskning.dk forms the basis of the communication efforts of the NRCWE. The central themes of the home page are news about research results, presentations of research projects, summaries of the research conducted by the NRCWE, data from the working environment surveillance conducted by the NRCWE, and various publications by the NRCWE. Many of the presentations and summaries are available in English. The homepage had app. 1.4 million unique external visits in 2007 and has been rated among the best research sites in Denmark by the Ministry of Science, Technology and Innovation for several years.

Another communication medium is the electronic newsletter, which the NRCWE distributes on a weekly basis. There are more than 3.000 recipients of the newsletter.

Finally, the home page of the Working Environment Information Centre (WEIC) www.arbejdsmiljoviden.dk and the journal "Working Environment", published by the WEIC, serve as indirect communication media for the NRCWE. The WEIC is a division of the NRCWE and has as its mission to collect and disseminate work environment knowledge from all relevant sources, including the NRCWE. By working together with the WEIC and using the communication media of the WEIC, the knowledge generated by the research of the NRCWE can reach a broader audience than would otherwise be possible. The effectiveness of this cooperation has been secured by making the Director of Communication the manager of both the WEIC and the communication unit of the NRCWE. The WEIC is not included in the present evaluation.

4.7. Collaboration and networks on Centre level

4.7.1. National

At Centre level the NRCWE collaborates closely with its major stakeholders.

A large and growing number of research activities take place in public and private organizations, which apart from being objects of research also are end users of knowledge. It is estimated that the NRCWE has carried out studies in more than 250 companies during the previous few years.

The NRCWE is engaged in active strategic cooperation with all major universities (Copenhagen University, Aarhus University, Technical University of Denmark, University of Southern Denmark, Aalborg University) based on formal cooperation agreements between the chairman of the board (or the Rector/Chancellor) of the university and the chairman of the board (or the Director General) of the NRCWE. The directors of the NRCWE meet twice a year with the deans of Copenhagen University in order to facilitate cooperation at faculty and institute level. Topics dealt with are the development of research cooperation, affiliation of the NRCWE researchers to

the university as lecturers, the NRCWE contributions to lecturing and development of educations, the NRCWE mentoring of PhD and master students, and sharing of infrastructure. The three largest universities each have a representative in the board of governors of the NRCWE.

In order to add a clinical dimension to the research on health-related effects, the NRCWE draws actively on the competence of the occupational health clinics at the university hospitals. These are currently being reorganised as a consequence of a reform of the structure of local governments and regions.

4.7.2. International

International cooperation at Centre level is primarily oriented towards the other national OSH institutes through the Partnership for European Research in Occupational Safety and Health (PEROSH). The members are 12 European occupational safety and health research institutes with formal national roles to play in their countries (Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain and the United Kingdom). The former AMI was one of the “founding fathers” of PEROSH and the Director General of the NRCWE is appointed chairman 2007-2008. The NRCWE chairmanship has completed an innovative development process of PEROSH with decisions on establishment of a secretariat in Bruxelles, pooling of resources in common cross-country research projects and formal cooperation with EU-agencies (the European Agency for Safety and Health at Work and the European Foundation for the Improvement of Living and Working Conditions).

Also, the NRCWE represents the Danish Ministry of Employment in the EU financed NEW OSH ERA ('New and Emerging Risks in Occupational Safety and Health - Anticipating and dealing with change in the workplace through coordination of OSH risk research' – part of the European Research Area) which aims to create cooperation between OSH funding institutions in the member countries. The NEW OSH ERA consortium includes 18 leading public agencies, ministries and research organizations. The Finnish Institute of Occupational Health coordinates the consortium and the European Agency for Safety and Health at Work plays an important part in the project.

Furthermore, the NRCWE takes part in a number of international expert groups, such as SCOEL (Scientific Committee on Occupational Exposure Limits) of the European Union, the Nordic Expert Group for occupational exposure limits (NEG) and the OECD Working Party on Manufactured Nanomaterials (WPMN).

4.8. Quality and relevance assurance

4.8.1. Project evaluation and initiation procedure

To ensure that all projects are within the strategic borders of the NRCWE all applications for external funding has to be approved by the Research Director before submission.

New project ideas are generated through a combined top-down and bottom-up process. In the top-down process the Director General and/or the Research Director defines a theme and general research questions based on contacts with stakeholders and other research institutions. A senior scientist with relevant scientific competence is appointed to generate the detailed projects description including budgets etc. At the same time two internal scientific reviewers are appointed.

The bottom-up process is driven mainly by senior researchers/professors who will suggests new ideas for research projects either in line of previous projects or based on contacts with the international research front. The ideas are discussed with the Director General and/or the

Research Director, who approve(s) the further pursuit of the ideas.

4.8.2. Documentation of procedures

To support the project planning process the NRCWE has developed a series of tools and educational packages. The main tool is a detailed manual for planning and execution of large projects (in Danish “NFA's procesværktøj til planlægning af store projekter”). This tool consists of two parts:

- Guideline for exchanging scientific ideas and obtaining scientific criticism during the process of project planning, including writing the applications for external funds. The central element is the appointment of two critical reviewers among the Centre’s experienced senior researchers/professors. The reviewers are not members of the project group, but they have the specific duty to scrutinize the project description critically, and to provide advice for improvements. The guideline describes in detail how the project group should collaborate with the reviewers. The overall aim is to optimize the scientific quality of the projects.
- Paradigm for the project description/protocol. This paradigm contains an elaborated list of elements to be considered both in the planning and execution of large research projects. This paradigm is an important platform for organizational learning, i.e. new experiences made during execution of the projects are discussed in internal scientific groups (the expertise forums) and with the Research Director.

To supplement the manual for planning and execution of large projects a series of specific tools, and an education package, have been developed. The tools are related to the budgets to be used in applications for external funds (spreadsheet including wage tariff’s for different personnel groups etc), standards for collaboration contracts with industry or external research institutions taking part in the project, standards for submission of projects to be approved by central authorities (i.e. ethical approval or register approval). The education package includes internal biannual courses in project management as well as in how to write good applications for research funds.

No specific tools for evaluation and follow-up of projects have been presented to the evaluation committee. However, these aspects are presumably addressed in the researchers’ performance contracts which incorporate detailed information on project goals including scheduled scientific publication (chapter 4.2.).

5. Stakeholder interviews

5.1. Procedures

In order to evaluate the Centre's standing among central representatives for the NRCWE target groups the evaluation committee carried out stakeholder interviews. The stakeholders were nominated by the NRCWE based on a selection specified by the committee. The stakeholder interviews were executed by the committee in plenum, with the exception of two telephone interviews carried out by the committee chairman alone.

The NRCWE nominated a total of 10 stakeholders representing the Ministry of Employment (secretariat), the National Working Environment Authority (management and the Office for Knowledge base), Occupational health hospital departments (Occupational Health Clinics at Bispebjerg and Herning hospitals), Social partners (the Confederation of Danish Employers and the Danish Confederation of Trade Unions) and Occupational health services (the Association of Preventive and Health Services in Denmark and the Knowledge Advisors, Danish Business Advisors Federation).

The interviewees were in advance presented with an interview guide and questionnaire covering central assignments described in the by-laws and the strategy document for the NRCWE in the evaluation period 2005 – 2008, as well as in the terms-of-reference for the present evaluation. For some of these aspects, the interviewees were asked to grade the NRCWE performance in relation to their expectations by a scale from one to four. These grades were only used as a base for further elaboration of points of view, and will not be presented in this report.

5.2. Relevance and effect

The general impression of the Centre among the interviewed stakeholders is very positive, both with regard to research, surveillance, and communication to the society. Many of the stakeholders emphasized their satisfaction with the NRCWE prioritizing and direction over the last few years, especially pointing out that the Centre to a much larger extent than earlier has opened up to its surroundings and become more attentive and responsive.

The NRCWE strategies and prioritizing are in general in high accordance with the preferences of the stakeholders and their expressed needs for knowledge in this field. The NRCWE was credited for its adaption to national strategies and official national research needs, which obviously has attracted broad approval from the stakeholders.

On the other hand, a minority of the stakeholders expressed moderate concerns about what was perceived as the Centre's strategic adjustments towards available funding sources and national strategies rather than pure scientific motives. However, they did not give specific examples of such adjustments or new traces for the Centre to follow.

The stakeholders also expressed that their potential to influence the NRCWE priorities and activities in general had increased over the last years, although most of them claimed that they had no influence on the Centre strategies to any large extent. Several of the stakeholders also highlighted the increased focus on interdisciplinary research as highly relevant and welcome, and that such research approaches should be further explored in the future.

In general, the stakeholders were satisfied with the scientific quality of the NRCWE research and the dissemination of results. The NRCWE performance on most of the present strategic fields was rated as fulfilling or even exceeding the stakeholders' expectations. However, some stakeholders stressed that the NRCWE activities in accident research can be further improved, especially with regard to usefulness of results. Some of the stakeholders maintained that the research at the Centre in the field of leadership and management has not yet attracted much attention or generated applicable results of use for the Danish society. Some of the stakeholders were also looking forward to experience more directly applicable results from the NRCWE

research on interactions between the working environment and labor market conditions, including recruitment, working hours, retention, absenteeism, exclusion, workability and productivity, although it was expressed that results so far from this interdisciplinary field appear to be promising.

Especially the Ministry and the National Working Environment Authority pointed out the importance of the Centre's role as scientific experts and appreciated advisors for policy makers and authorities within this field. On the same side, the Centre appears to have a very strong reputation among the stakeholders for being an independent institution of high integrity with no unwanted attachments to the Ministry or the National Working Environment Authority. The connection to the ministry as a department of government was highlighted as a factor of success as compared to an organization as a university department, and it was expressed by several that another connection of the NRCWE than ministry attachment would potentially have contributed to less focus and less convenient access to the sought knowledge for the stakeholders. The Centre was also recognized for having a balanced relationship to the social partners, and for being a national gathering point and knowledge Centre within this field. It was looked upon as positive and effective that all the main scientific knowledge within this field was gathered within one institution, making access to knowledge for the stakeholders easier.

All the stakeholders were positive to the anticipated collaboration between the NRCWE and universities in Denmark. Many claimed that this collaboration so far only was in an initiating phase with positive prospects, while others pointed to already established collaboration with several universities on specific projects. Expanded collaboration between the NRCWE and the occupational health clinics was also mentioned by several as a desired development.

The level of international collaboration was pointed out by many of the stakeholders as an asset for the Centre, and especially joint research projects with EU funding were mentioned as driving forces for the future development of the NRCWE. While many of the stakeholders were very satisfied with the international engagement at the NRCWE, others pointed out that the full potential of their international collaboration had not materialized and that such activities should further expand in the future.

The stakeholders were almost entirely united in their opinion on the financial situation for the NRCWE, with the exception of the representatives from the ministry who obviously did not express any strong opinions in this regard. It was pointed out that a higher degree of basic funding than today from the ministry would have been welcome, making the Centre less vulnerable to changes in accessibility to external funding. On the same side, it was expressed that some level of competition is good for the NRCWE. A distribution of 40-25 and 60-75% between external and basic funding, respectively, was expressed by several of the stakeholders as ideal for the NRCWE in the future.

Most of the stakeholders called attention to the positive influence from the Director General personally, as well as his management at the Centre, on recent changes in strategies and organization. The Director General was by several of the stakeholders identified as a critical factor behind what was described as the transformation of the Centre. The changes in profile, strategies and organization are highly acknowledged by the stakeholders, and appear to have contributed to the creation of a stable platform for existence by performing high quality research of relevance for stakeholders and the society in general. This is clearly illustrated by several of the stakeholders who claimed that their use of knowledge generated through the Centre is increasing.

Expressions as *integrity, high standards, scientific, inspiring, useful, not too theoretical, no political colour, neutral, on the right way, successful change, understanding the mechanisms of society, adaptive to changes in society, service oriented, open minded, quick deliverance, cooperative and shows initiative* were mentioned by several during the interviews.

6. Evaluation – Strategic fields

6.1. Occupational accidents

6.1.1. Introduction

Occupational accidents is one of the prioritized areas for the Danish government and included in the 2010 action plan for the improvement of health and safety at work. Even though injury rates and degree of injury are still important, the main focus of the current research is on reduction of in the associated lost working days and early retirement. In line with the national priorities the management of NCRWE has declared that they consider *Occupational accidents* to be a strategic field. The focus of the research in this strategic field is on four prioritized sectors and three themes. The prioritized sectors are construction, transport, manufacturing and health care. The themes are:

- Surveillance of work accidents: i.e. surveillance and measurement of work accidents, injuries, safety and safety climate in various branches and trades
- Workplace related safety activities, i.e. understanding the existing cultural and organizational aspects of work place safety through application of qualitative research methods derived from the social and human sciences
- Evaluation of workplace interventions and methods for accident preventions in order to improve knowledge of effectiveness of safety prevention and interaction of different prevention methods.

6.1.2. Organization and management

The group concerned with research on occupational accidents is quite small. This despite the fact that it is a strategic field of which the importance was emphasized by the stakeholders and the management of NCRWE. Due to a recent departure of one of the group members the group seemed to have been reduced below the desirable critical mass.

Staff should not decrease any further in order to preserve the minimal critical mass to conduct research in this strategic field. Otherwise merging with one of the research groups now included in absence and exclusion should be considered. However, when the group succeeds in acquiring additional funds, for which good perspectives are available, and has established a good network of collaboration it may be wise to extend the current personnel.

The group does not have a very senior (professor) leadership.

6.1.3. Key numbers (personnel, budgets, projects)

The staff of the research group addressing this strategic field consists of 4 senior researchers, one researcher, one project researcher and one research assistant of which three are employed on a contract base. The budget is 3.8 million Danish Crones of which 54% is externally funded. This budget it is one of the smallest investments in the strategic fields of the NRCWE. At present five projects are ongoing.

6.1.4. Use of resources as compared to the NRCWE's strategy

The group has had some difficulties to attract funds although *Occupational accidents* was among the prioritized topics on the program of the funding agency. Due to the fact that very recently a substantial grant has been acquired the continuation of the research group seems to be guaranteed.

Research in safety culture and safety management has a short and not very strong academic tradition. This is not very different in academia itself. Therefore this is a difficult field to generate

a large amount of scientific output and compete for research funds. In the view of the management, the research group received sufficient support to establish their research in this field, since external funds were potentially available. However the research group has not perceived the management as supportive at all times and has been going through difficult times.

In addition, in this field both qualitative and quantitative research are conducted in different scientific environments. This is an extra difficulty in acquiring external funding for the projects. Integrating qualitative and quantitative research has proven to be quite a challenge also in other research area's.

Most likely one of the research proposals will be granted, which will create a better resources situation in the near future. We recommend that management and the research group openly discuss the complexities of generating output and acquiring research funds in this field and search for future ways for a constructive collaboration in order to be more successful in the future. This requires clear insights in the conditions, a stimulating role of the management but also a high degree of responsibility and self management in the job of the research group.

6.1.5. Collaboration and networking

6.1.5.1. National

- Technical University of Denmark, Department for Leadership and Production
- Technical University of Denmark, Risø National Laboratory
- Roskilde University, Centre for Work Life Studies
- Copenhagen University, Department of Psychology
- Department of occupational medicine, Herning Regional Hospital

6.1.5.2. International

- Occupational safety team, Finnish Institute of Occupational Health
- Occupational and Environmental Medicine, Göteborg University, Sweden
- Department of Research & Occupational Health, Administration for Occupational Health & Safety, Iceland
- International Research Institute of Stavanger, Norway
- Faculty of Psychology, Unit for psychometric research, University of Valencia, Spain
- Department of Health Promotion and Behaviour, University of Georgia, USA
- Faculty of Industrial Engineering and Management, Technion, Israel Institute of Technology

The group has been successful in setting up an extensive collaborative network (national and international). This is of great value and presents opportunities for future (inter)national projects. Focus on acquiring such international projects, for instance in EU programs, is recommended. This process should be facilitated by the NRCWE but starts with initiative of the project group i.e. carefully reading the appropriate programs and building a consortium with the collaborating partners and preparing a proposal and building up experience during the process.

6.1.6. Scientific output

Table 6: Scientific output – Occupational accidents

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	4	1	6	3	14
Papers in ISI Web of Science	3	1	5	2	11
Review articles (in ISI Web of Science) (included in the above)	0	0	0	0	0
Citations (with self-citations)	13	1	2	0	16
Citations (without self-citations)	8	0	1	0	9
Citations per paper (with self-citations)	4.3	1	0.4	0	1.5
Citations per paper (without self-citations)	2.7	0	0.2	0	0.8
Scientific articles in national journals (peer-reviewed)	0	0	0	0	0
Articles in national journals (not peer-reviewed), included popular science publications	0	1	0	0	1
Conference/meeting abstracts	2	18	7	2	29
Books and books chapters (included reports)	6	3	0	0	9

Given the size of the current group, the scientific output is quite substantial. One must bear in mind that it is not so easy to get papers published in this field, except for the quantitative analyses of occupational accidents. In addition, output has increased in the last years with sufficient output in 2007 which compares well with universities and other high-ranked academic institutions executing research in this field. This is a promising development. We encourage further collaboration in new PhD projects. Such projects are always a good driving force behind scientific output.

6.1.7. Research quality

The research group expressed their intention to further integrate quantitative and qualitative research. Although not easily done we strongly recommend to continue along this line. Since this is also the explicit ambition in several other strategic fields, i.e. *Absence and exclusion*, this need not be an activity conducted solely by this research group. Starting point for the synergy should be strong scientific projects in both areas.

Given the size of the group the focus on four prioritized sectors and three themes seems to be quite broad and further limitation may be wise.

In addition close collaboration with other groups in the Centre must be sought in order to efficiently deal with methodological matters both for quantitative and qualitative research and in the mean time conduct research that merits a separate strategic field in this area.

6.1.8. Research relevance

The impact of this strategic field is not only on policy making but also in certain sectors, companies and in small and medium sized companies. Several stakeholders have emphasized their support for this strategic field due to this reason.

6.1.9. Stakeholder involvement and use of research

Stakeholders seem to have slightly different opinions on the relevance of this strategic field and rated the relevance from very high to not so high. One of the stakeholders expressed a high interest in the strategic field as such but did not think that the results of the current research met these high expectations.

Thus also from the stakeholders point of view an increase in the effort from the Centre to make this strategic field into a success was expressed.

6.1.10. Conclusions and recommendations

Occupational accidents is one of the strategic fields prioritized by the Danish government and along this line established as a strategic field by NCRWE. The importance of the field was supported by some of the stakeholders. The group concerned with research on occupational accidents is quite small and partly dependant on external funding. Recently the group acquired additional external funding. This new funds and the successful establishment of a network of collaboration may mark the change to new perspectives for this research group. If the management of the NRCWE agrees on these future perspectives we think that some investment seems necessary in order to allow for a successful development of this strategic field in the future. We support such an investment. Staff should not decrease and preferably increase in order to preserve the minimal critical mass to conduct research in this strategic field. Otherwise merging with one of the research groups now included in absence and exclusion should be considered.

Given the size of the group this focus still seems to be quite broad, and stronger prioritizing of projects may be wise. In addition close collaboration with other groups in the Centre must be sought in order to efficiently deal with the research that merits a separate strategic field.

The group has the ambition to combine qualitative and quantitative research. We recommend addressing this issue in a broader context so that different groups in the organization can exchange experience and ideas on how to do this.

We see chances for expansion of the research in this field in EU projects. The group has been successful in setting up a collaborative network. The group should try to utilize this network for EU tenders. We also encourage making use of the network to start new PhD projects, in order to enhance the scientific output.

Since research on safety management and safety climate is rather new and does not have a strong academic tradition, the group and the management should openly discuss the best strategy for the future to further increase scientific output and successfully apply for external funds.

6.2. Absence and exclusion

6.2.1. Introduction

Absence and exclusion is not one of the articulated strategic fields of the NRCWE. In the strategy it is formulated as the main overall goal of the Centre. Thus prevention of absence is a general strategic research field for the NRCWE and the theme is part of most research projects. For this evaluation several teams have been grouped under this heading. These groups conduct research on the mechanisms behind absence, return to work (RTW), and exclusion as well as on intervention studies to promote staying at work and enhancing return to work. Part of the research has a focus on two specific sectors in society with a high rate of absence and early retirement, i.e. cleaning and health care. Thus the research in this field takes place in four groups (research teams):

- Epidemiologic research based on surveillance data (a)
- Intervention studies aimed at enhancing return to work (b)
- Intervention studies targeted towards immigrants in the cleaning trade (c)
- Research, mainly intervention studies, focusing on the Danish health and social care sector (The "SOSU" research program) (d)

The epidemiologic research is based on national registers covering the entire population and on large scale surveys of representative samples. This data collection is funded through contracts with the Ministry of Employment. The research with the data is funded through internal funds and through external grants. The research in the three other intervention areas is funded through politically prioritized funds from the Danish Parliament.

In fact 92% of the research in this field is funded by external sources, which is very high but given the quite structural nature of the external funding the situation is favourable for the conduct of these large scale studies. The fact that the NRCWE has succeeded to acquire such funds underlines the societal relevance of the research.

The results of the epidemiologic research underscore the importance and relevance of certain risks and target groups and thus identify areas to focus on for future research. This potential has been utilized well to attract funds for additional research in this field.

This potential to support grant application with facts that underscore the importance and relevance of the topic should however not be limited to this strategic field but applies to all areas of the NRCWE and maybe utilized more.

6.2.2. Organization and management

This field combines many disciplines and has extensive collaboration with other groups in the Centre. This multidisciplinary nature is of great value dealing with these themes, however it also leads to considerable overlap with other strategic fields, which is illustrated by the fact that for instance several publications mentioned under this strategic field are also mentioned under other fields, for example *Work-related pain in muscles and joints* and *Psychosocial working environment*.

The epidemiologic research group was formed in 2007 and is lead by a newly recruited professor to strengthen the use of the vast amount of data for epidemiological research. In our view the epidemiology group has a well profiled and distinct position, which has merit in its own and as a support unit for other strategic fields. We do support recent efforts to expand the groups' support of research quality and methodology in other fields such as *Work-related pain in*

muscles and joints and *Occupational accidents* and think that these efforts should continue and be strengthened in the future.

The other three research teams in the strategic field that focus on interventions seem to have considerable overlap with each other and with the intervention studies in other strategic fields i.e. *Work-related pain in muscles and joints* in the Centre. The research groups b and c seem to be large project teams rather than research teams with different projects. These groups could have been grouped together in a team called 'effectiveness of interventions' for instance. This may have other disadvantages (i.e. size) so the current arrangement may be reasonable. However we have some concern about re-inventing the wheel in different groups in this strategic field and elsewhere in the Centre. We therefore suggest to somehow arranging exchange of knowledge and good practices between the researchers involved in the large scale intervention studies.

6.2.3. Key numbers (personnel, budgets, projects)

The current staff of the research group under this strategic field consists of 1 professor, 10 senior researchers, 2 statisticians, 2 data managers, 9 research assistants (5 academic assistants, 4 research assistants), 1 research associate, 1 researcher, 1 IT assistant and 3 PhD students. In total 30 staff. Recently four senior researchers have left or will leave within the next month or two. These are not included in the numbers mentioned. The researchers mentioned also work for research projects in other strategic fields.

An impressive number of large scale surveys, cohort- and intervention studies are going on in these research groups.

The epidemiology group has recently been strengthened with a professor who stimulated the output of the group. The self evaluation indicates that there is still a need for (senior) epidemiologic staff but that they are difficult to acquire. This calls for extensive epidemiologic training of existing staff and collaboration with other national and international epidemiologic groups.

6.2.4. Use of resources as compared to the NRCWE's strategy

The budget spend on the research in this strategic field in 2007 (wages and other activities) is 16.001 thousand dKr of which 92% is external funding. This external funding has a long-term character otherwise this situation with 92% external funding would not be desirable.

6.2.5. Collaboration and networking

6.2.5.1. National

The self evaluation includes a long list of collaborative national partners. Such as several university groups, for instance University of Copenhagen (Departments of Public Health, Anthropology and Psychology), University of Århus (Dept. of Epidemiology) and hospital groups such as Department of Occupational and Environmental Medicine, Department of Work Environment, Storstrømmens Sygehus, Næstved, Department of Occupational and Environmental Medicine, Bispebjerg Hospital and the Danish Rehabilitation Group.

This collaboration with the university departments is quite substantial including combined PhD projects.

6.2.5.2. International

The list of international collaborative partners is even more extensive. This also includes several epidemiology departments of university groups such as Turin University, Harvard University,

Whitehall-group and university groups involved in research on immigrants or health and social care workers such as University of Wuppertal (Project on work environment and the ageing workforce), Tufts University, Boston (Assessing and Controlling Occupational Health Risks to Immigrant Workers); University Medical Centre, Groningen, the Netherlands; OVO – a Nordic R&D network aiming at stimulating research into the relations between rationalization, quality of work, and the working environment in the health sector etc.

Some involvement in EU project is mentioned but this seems relatively recent and on a modest scale. I.e. an application for a joint EU programme within the 7th Framework Programme entitled “Nursing Home Quality Indicators (NHQI) assessment system for quality of work, care and the organization” and the project proposal: Studies in quality and cost of long-term care for the elderly, directed by professor Tor Iversen at the Institute of Health Management and Health Economics at the University of Oslo, Norway.

We think that the potential of the large databases, the experience with the RCT’s of the interventions and the research on migrant workers for collaboration in EU projects or other international consortiums is substantial. We therefore recommend intensifying attempts to acquire international funds in this strategic field.

6.2.6. Scientific output

Table 7: Scientific output – Absence and exclusion

	2005	2006	2007	2008	2005-8
Papers in international peer reviewed journals	24	24	28	13	89
Papers in ISI Web of Science	22	21	22	11	76
Review articles (in ISI Web of Science)	0	1	2	0	3
Citations (with self-citations)	127	66	15	1	209
Citations (without self-citations)	89	46	9	1	145
Citations per paper (with self-citations)	5.3	2.8	0.5	0.1	2.3
Citations per paper (without self-citations)	4.0	2.2	0.4	0.1	1.9
Scientific articles in national journals (peer-reviewed)	0	0	0	0	0
Articles in national journals (not peer-reviewed),including popular science publications	4	11	3	0	18
Conference/meeting abstracts	13	19	18	7	57
Books and book chapters (included reports)	7	9	15	3	34

The research output in the different topics combined in this field varies a lot. The epidemiology group has the highest output and the output in intervention research is growing. For the research on immigrants scientific output is limited, this deserves specific attention. However, we think that there is potential for an increase in this respect and that there are already several initiatives to strengthen scientific output in all four research teams combined in this strategic field. Further stimulation of collaboration between the epidemiology group and the other groups will in our view enlarge the synergy in this field.

6.2.7. Research quality

The general impression is that the research in this field is diverse but of good quality that compares well with universities and other high-ranked academic institutions executing research in this field. The groups involved in this strategic field are an interesting combination of etiologic and surveillance research and research on effectiveness of interventions. These two 'branches' of epidemiologic research with focus on work and health issues form a valuable part of the Centre's research portfolio. It combines high scientific quality with considerable policy relevance. The long term investment in data collection comes to pay off in the sense that it is possible to address current societal questions with scientifically sound analyses of high quality data.

Below we will briefly address the separate research groups:

- *Epidemiologic research based on surveillance data*

As was said earlier the Centre has a good track record to establish large databases that can be linked to national registers through the Danish system of personal identification numbers. These data are a rich source for epidemiologic research on an array of relevant research questions and for generating hypotheses for new research projects. In addition the results of these studies contribute significantly to the national surveillance of the working environment. The data have been used to identify high risk jobs, to analyze trends over time in the Danish work environment, and identifying occupational risk factors.

We think that it would be wise to not only focus on health outcomes but expand the research to other factors related to absence and exclusion from working life such as sustainable work ability and worker performance and productivity.

- *Return to work (RTW)*

We support the fact that the current RTW projects use the RCT paradigm. Recently several RCT's in this field have been conducted and published. Collaboration with other groups in the EU and for instance Canada should receive sufficient attention in order to learn from previous studies and thus build on the scientific base for successful interventions.

We think that research on cost effectiveness would be a valuable addition to these studies and we would recommend adding this in future studies. When there is insufficient expertise to do so, the Centre should either acquire new personnel, train existing personnel or seek collaboration.

- *Immigrants in the cleaning trade*

Due to the complex nature little research has been done among immigrants in the cleaning sector or elsewhere. This makes this research project quite unique in the scientific world. In addition this issue of work and health and general health in this so called precarious work is making a rapid march to the top of the policy agenda also in the EU. Therefore, we support the expansion in 2007 of the intervention research on occupational skin disease with broader research on immigrants in the cleaning trade.

Furthermore, musculoskeletal disorders seem to be a problem for cleaners and collaboration on interventions designed to prevent these disorders should be pursued. Given the characteristics of the target groups this research group also conducts qualitative research. In the self evaluation the intention is expressed to further integrate qualitative and quantitative measures. We do support this ambition but realize that it is not easily done due to very different scientific traditions. Therefore we recommend giving this serious attention.

- *The "SOSU" research program*

The "SOSU" research program established in 2003 is one of the larger and older projects within the strategic field *Absence and exclusion*. The research group was set out to establish a research base to enhance reduction of sick leave and early retirement, and increase job satisfaction, motivation and well-being in the less educated job groups in the health and social care sector (i.e. nurses aides and orderlies) in order to counteract the rapidly increasing personnel shortage in these sectors. Within this program two large cohorts were established in 2004, 'The Danish Health Care Worker Cohort' with all new graduates from the training schools for social and health care helpers and assistants in 2004. The second cohort covers approx. 10.000 employees in the Danish elderly care system. The project has now moved on to conduct and evaluate interventions.

We would like to compliment the group with their time consuming investment in this research infrastructure which now has a high potential for substantial scientific output and high quality data to support future policy decisions. As expressed by the group the potential for scientific quality has not fully been exploited. We like to support and emphasize the importance of the extra efforts needed to reveal the full scientific potential.

6.2.8. Research relevance

The impact of the results from the study groups combined in *Absence and exclusion* is impressive. This concerns for instance the data on determinants of long term absence and of early retirement. These results were the main input to the national, governmental sickness-absence programme that was published during the site visit.

In addition the SOSU project has impact on several policy decisions on quality of care within the social and healthcare sector for instance the large scale quality reform in 2007 (a three party Agreement on measures to improve quality and work environment within the public sector). This societal interest is expressed in the structural finances that were allocated to the project in this strategic field.

6.2.9. Stakeholder involvement and use of research

The fact that stakeholders with different roots in society (for instance employers- and employee associations and government representatives) agree on the fact that the research results from the NCRWE are 'without political colour and not disputed' and therefore very helpful in addressing societal problems, is in our view the result of long-term investment in high quality data collection and sound research. This feature should be guarded and treated without compromise.

6.2.10. Conclusions and recommendations

To conduct research in order to decrease absence from the work force and increase inclusion is the main overall goal of the Centre. This means that all research in the Centre somehow needs to contribute to this goal. The research groups addressed in this chapter explicitly contribute to this goal by generating results on the determinants and mechanisms behind absence, return to work and exclusion as well as on intervention studies to promote staying at work and enhancing return to work. Part of the research has a focus on two specific sectors in society with a high rate of absence and early retirement, i.e. cleaning and health care. The research in this strategic field is therefore very important for the future strategy of the NRCWE.

The general impression is that the research in this field is diverse but of high quality that compares well with other high-ranked academic institutions. The groups involved in this

strategic field are an interesting combination of etiologic and surveillance research and research on effectiveness of interventions.

The scientific output by the group is good and has been growing in recent years. However, the output in the research groups within this field differ and as expressed in the self evaluation the potential for scientific output in the studies focusing on immigrants in the cleaning trade has not been fully exploited. We like to support extra efforts to utilize this potential and continue to increase the scientific output in this area.

The evaluation committee very positively judges the investments in the time consuming long-term research projects and data collection infrastructure which now has a high potential for substantial scientific output and high quality data to support future policy decisions.

In order to fully utilize this potential additional investment in personnel in this field maybe appropriate. If this is not possible due to the tight labour market for instance for epidemiologists, this justifies extensive epidemiologic training of existing staff and collaboration with other national and international epidemiologic groups.

In addition we do support the recent efforts to expand the groups' support of research quality and methodology in other fields such as *Work-related pain in muscles and joints* and *Occupational accidents* and think that these efforts should be continued and strengthened in the future. Further stimulation of collaboration between the epidemiology group, and the other groups of the NRCWE will in our view enlarge the synergy in the Centre. Therefore we suggest to strengthen the collaboration between the research groups in the Centre dealing with large scale interventions studies and to somehow arrange exchange of knowledge and good practices between the researchers involved in these studies.

We also think that it might be wise to not only focus on health outcomes but expand the evaluation to other outcome variables related to absence and exit from working life such as work ability, worker performance and vitality. In addition research on cost effectiveness would be a valuable addition to these studies and we would recommend adding this in future studies. This may require personnel with different capabilities or additional collaboration.

The cohort studies can generate data to support grant applications with facts and figures that underscore the importance and relevance of the topic. This potential should not be limited to this strategic field and might be utilized more in all areas of the NCRWE.

We think that the potential of the large databases, the experience with the RCT's of the interventions and the research on migrant workers, for collaboration in EU projects or other international consortia is substantial. We therefore like to recommend intensifying attempts to acquire international funds in this strategic field.

The stakeholders in particular expressed their appreciation for many of the projects in this strategic field and were very positive about the impact of the results in society. They indicated that when facts and figures are beyond debate it is much easier to reach consensus on the policy direction. This is quite a compliment for the research in this strategic field.

6.3. Work-related pain in muscles and joints

6.3.1. Introduction

Work-related pain in muscles and joints is one of the prioritized strategic fields at the NRCWE. The main strategy is the investigation of effective interventions for prevention of work-related musculoskeletal disorders. The intervention focuses on physical exercise obtained by physical training or cognitive-behavioural guidance. It is based on the role of physical exercise in improving musculoskeletal health.

The (new) strategy was introduced in 2006 in connection with the Government decision to restructure the NIOH. It is basically different from the former ergonomic approach centered on diminishing of physical risk factors at work and ergonomic design of the workplace. A large amount of work has been performed in this field. However, a breakthrough in prevention with clearly reduced sickness absence and early retirement from work has not been achieved.

The shift in strategy was accompanied by large changes in the profile of the research group. Basic research activities as well as physiologic and ergonomic competences were largely transferred to Danish universities. There was a nearly complete loss of seniority. The two leading senior researchers of the group left their positions at the NRCWE. A young researcher was newly engaged as a team leader in March 2008.

It is expected that the new strategy clearly improves the effectiveness of MSD prevention. There is a large support by all parties of stakeholders. The situation for funding is much better than for the "old" ergonomic research suggesting an appropriate financial basis of the intended research.

6.3.2. Organization and management

The strategic field *Work-related pain in muscles and joints* is organized in a project group according to the project organization model (one of 17 at the NRCWE).

Currently the group consists of 13 people. The team is engaged in (1) large randomized controlled intervention studies at the worksite, (2) prospective epidemiological studies combining data from national surveys, registers for sick-leave and pension, and physical exercise measures, and (3) physiological laboratory measurements of the effects of interventions. There is a good infrastructure with well equipped laboratories for measuring muscle activation, circulatory responses, mechanical and structural aspects.

Collaboration exists with other strategic fields, particularly with *Absence and exclusion*. There is special support in analysing register data and in epidemiology. Further support within the different fields of musculoskeletal health (engineering, physiology, medicine, sports and movement science) comes from cooperation with national and international research institutions and universities. Details will be given in the coming paragraph 6.3.5.

Recently there was a loss of relevant competence and seniority due to the shift of the leading senior researchers Gisela Sjogaard and Karen Sogaard to national universities. Compensation was reached by maintaining the collaboration with the leaving senior researchers in the main projects (FINALE, VIMS). Further support comes from the competence forum for work-related pain in muscles and joints. In addition, there is a close and well appreciated support and scientific guidance by the leaders of the NRCWE as indicated in the group and expert interviews. And although the newly appointed researchers have little experience they compensate with a lot of enthusiasm. Support in methodological respect and statistical data analyses will be obtained from other groups in the Centre. It is intended to strengthen the collaboration with those with expertise in epidemiologic design and analysis of large scale evaluation studies in the Centre or strengthen this expertise within the musculoskeletal research group.

6.3.3. Key numbers (personnel, budgets, projects)

The field has got 13 employees plus 2 (external) senior researchers in part-time engaged in the FINALE resp. VIMS project. There is a good gender balance (6 males, 7 females) and demography (50% < 40 years). The group is well qualified, 5 of the researchers have PhD degrees and 2 are PhD students. Two of the employees are also members of another research group of the Centre which shows that there is an internal mobility between the different groups.

Out of the 13 employees in the group, there is only one senior researcher. Eight of the researchers, PhD students included, have limited contracts. Four will even leave in 2008 or have already left, four others will follow until 2010/2011. In this way a nearly complete loss of the existing research workforce of the strategic field may happen until 2011. In addition, 9 members of the scientific staff (senior researchers, researchers, research assistants) left the group during the evaluation period 2005 – 2007, while the two leading senior researchers left their positions early in 2008. The consequences have been dealt with by maintaining the collaboration with the senior scientists, intensifying other University collaboration, intensifying internal guidance and appointment of new and enthusiastic personnel. However, for a stable future development the workforce should be extended, preferably with an experienced researcher, intensified collaboration with the epidemiology groups or additional epidemiologically or statistically experience personnel.

The budget of *Work-related pain in muscles and joints* is the third-lowest of the NRCWE after the *Noise* and the *Occupational accident fields*. There is a total of 4.519.762 dKr which amounts to 8% of the total of the Centre. 3.920.388 dKr is spent for wages and 599.374 dKr for working activities in the strategic field. In addition, there is an amount of external funding of 1.376.504 dKr which takes a percentage of about 30% of the total expenses. This fraction of external funding is estimated as “good” by the employees of the group but is in the lower range compared to the other strategic fields of the NRCWE.

There are 5 projects in the research field. Two of them have already been finished (RAMIN, SPA), two are running (FINALE, VIMS) and one is scheduled for 2009. All projects are large scale randomized controlled intervention studies investigating the effectiveness of different types of physical exercise on the prevention of work-related musculoskeletal disorders.

6.3.4. Use of resources as compared to the NRCWE’s strategy

The NRCWE strategy plan for 2006-2010 emphasizes *Work-related pain in muscles and joints* as one of the seven prioritized strategic fields. The strategy lists research, counselling the Ministry, sharing of knowledge and contribution to education as the main tasks in the strategic fields.

Research in the musculoskeletal field is directed at the importance of pain and discomfort from muscles, tendons and joints for absenteeism and early retirement. It is based on the broad international consensus that musculoskeletal pain is basically multifactorial which includes individual factors, leisure time and psychosocial factors in addition to physical work activities. The aim is the development of effective intervention methods for prevention and rehabilitation in the work situation. Main task is the 5 large scale intervention projects investigating the effects of physical exercise on the relief and prevention of musculoskeletal pain. The research is highly productive as shown by the high number of publications in international peer reviewed journals (53), articles submitted (15), conference abstracts (58), and books or book chapters (9). Details will be given in the coming paragraphs 6.3.7 and 6.3.8.

Counselling activities concentrate on support of the Danish Work Environment Authority. Annually there are 2 – 4 meetings aiming at information transfer in the field of physical activity, work demands and prevention of MSD. In addition, there are direct presentations to the occupational health professionals. Counselling is also part of the projects which all have closely related (supervisory?) workgroups including members of the different parties of the labour

marked (employers, trade unions, enterprises etc.). Further activities (participation in boards, panels, direct requests etc.) are not indicated in the information received.

Sharing of knowledge is performed through thematic meetings, workshops, presentations, publications in public and professional journals, scientific publications and the internet. In all projects, mid-way and final reports are written to inform the involved enterprises and social partners. The information centre further communicates the knowledge to all relevant end-users. The high number of communications to the public (74) underlines the value given to sharing of knowledge in the strategic field.

Contribution to education is also well developed. Some of the PhD students and researchers are involved in teaching at the University of Copenhagen. The group has been involved in the establishment of the Danish Graduate School in Public Health Science (2004 – 2005) and is engaged in the National PhD education in public health (International PhD course “Physical activity and leisure time in a health perspective”). Four members of the group are engaged in supervising PhD, Bachelor and Master students. Currently there are 7 ongoing PhD students connected to the research projects of the group, two of them from the NRCWE and five from other Danish Universities. Five others finished their PhD degrees in the evaluation period. In addition, there are 2 ongoing Bachelor students and 2 ongoing Master students.

6.3.5. Collaboration and networking

The group is focused on the role of physical exercise in prevention and rehabilitation of musculoskeletal pain. This is only a small part in the multifactorial development of musculoskeletal disorders. Therefore collaboration and networking is an essential condition to get a “critical mass” and consistent results in the field.

6.3.5.1. National

The researchers seem to have good contacts with the national Danish universities. There are close cooperations in the ongoing projects FINALE (SDU, AAU, AH, KU) and VIMS (SDU, KU). Another important partner is the Bispebjerg Hospital (project RAMIN). FINALE seems to be an extraordinary example of networking with 5 collaborating universities, one PhD student at each university, and an international Scientific Board following the project. This implies a close cooperation with universities involving exchange of persons, equipment and PhD students.

A special collaboration exists with the senior researchers who left the NRCWE recently for positions at SDU and AU, respectively. Their participation in the ongoing projects ensures maintenance and transfer of competence within the group and opens for extensive collaboration with SDU and AU.

6.3.5.2. International

The projects are well-linked to institutions and universities in Sweden (Linköping Universitet, Norrlands University Hospital), Norway (Norwegian University of Science and Technology) and The Netherlands (University Medical Centre Groningen). Further international contacts or collaborations are not indicated in the informations received. So the general impression is that the group is not that involved in international networking. This contrasts the international publication activity and participation in international and EU projects (MUSIC, NEW) in former time. One explanation might be the change in the strategic field with international contacts not reactivated after release of the leading researchers. On the other hand, the changed field might not have got enough time for establishing new contacts.

6.3.6. Scientific output

In the evaluation period a total number of 48 papers have been published in peer-reviewed journals. In addition, 15 papers are submitted or in press, respectively. The papers are mainly published in high impact and well recognized journals. Considering the fact that the papers have been published rather recently, the number of citations is regarded as high. Taken together with the high number of contributions to conferences (58) and of publications to the public (74), the scientific production within the field is regarded as high.

Table 8: Scientific output – Work-related pain in muscles and joints

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	12	17	12	7	48
Papers in ISI Web of Science	12	17	12	6	47
Review articles (in ISI Web of Science) (included in the above)	1	1	0	0	2
Citations (with self-citations)	88	78	13	0	179
Citations (without self-citations)	71	57	10	0	138
Citations per paper (with self-citations)	7.3	4.6	1.1	0.0	3.8
Citations per paper (without self-citations)	5.9	3.4	0.8	0.0	2.9
Scientific articles in national journals (peer-reviewed)	0	1	0	0	1
Articles in national journals (not peer-reviewed), including popular science publications	1	0	0	0	1
Conference/meeting abstracts	17	23	18	0	58
Books and books chapters (included reports)	1	7	0	0	8

6.3.7. Research quality

The scientific quality of the research executed in the project group is regarded as good. The majority of papers from the evaluation period have been published in international peer-reviewed journals. The many publications in high-ranked and well recognized journals indicate a high level of research quality that compares well with universities and other high-ranked academic institutions executing research in this field. However, most of the articles are concerned with physiological and ergonomic aspects, and even in the 2008 publications and forthcoming papers less than 50% are related to the new strategy on exercise-based intervention. So, most of the material reflects research before the change of the strategic field.

The situation is somewhat better in regard to the 5 articles self-evaluated as “best” of the period. “One-year randomized controlled trial with different physical-activity programs to reduce musculoskeletal symptoms in the neck and shoulders among office workers” and “Effect of two contrasting types of physical exercise on chronic neck muscle pain” may be considered representative of the current research in the group. We got the impression during the interviews that the motivation among the researchers is high and that relevant research projects in the new field have been initiated.

A further aspect of research quality is assessing the national and international cooperation. The number of active collaborators as described in paragraph 6.3.5 illustrates that the research group is an attractive research partner, indicating a high level of scientific quality.

Another indication is the large external support that the group has managed to attract for the recent projects. The ability for funding of randomized controlled studies at the worksite has

shown to be much better than for physiologic studies. This indicates a high interest in, and quality of, these studies. In contrast, low-quality studies would not get good funding.

A further point is the reviewer activity for scientific journals. As indicated in the informations received, the researchers of the group are regular reviewers in a broad range of international journals.

6.3.8. Research relevance

Musculoskeletal disorders are a major problem in Denmark and all over the world. They imply a great burden on economics, public health and workability. Therefore, there is a large interest in knowledge about effective interventions. The subject is equally relevant for politics, social partners, enterprises and the single individual.

Until now the work in this field was centered on diminishing the risk factors at work and ergonomic design of the workplace and working conditions – approaches centered on ergonomics. Intensive work was performed in this field but a breakthrough in prevention has not been reached. By changing the strategy, a new approach was introduced. It focuses on the role of physical exercise in improving musculoskeletal health. The aim is to develop effective exercise-based interventions for prevention and rehabilitation of musculoskeletal disorders in occupational settings.

The 4 projects of the group rank rather high in this field. All are large randomized controlled intervention studies at the worksite. RAMIN and SPA focus on shoulder-neck pain in office workers. SPA investigates the effects of long-term training (1 year) but RAMIN those of short-term training (12 weeks). VIMS focuses on exercise adjusted to the physical capacity and health state of the individual in relation to the daily workload. FINALE is a combined project of register studies, ergonomic + physical training + cognitive behavioural interventions, and physiological studies on the causes of reduced physical workability. The latter is highly important for getting scientific evidence of the proposed interventions.

The overall impression from the received information is that improving the musculoskeletal health and workability by physical exercise intervention is the exclusive theme of the research group. There is no indication on other topics or projects. However, a breakthrough in MSD prevention is unlikely to occur by improving knowledge on physical exercise intervention alone. Deficiencies exist in a broad range of fields. Areas of relevance are for instance science-based risk evaluation, causality, work relatedness, knowledge transfer. There is a need for research to increase knowledge in all these fields. The committee acknowledges that that the group cannot cover all topics of MSD, and that it is appropriate to focus and chose when resources become scarce. In order to serve as a national competence centre, however, there is a responsibility of the NRCWE to maintain competence in all these fields. Otherwise a lack of expertise may occur, hampering the progress in prevention and rehabilitation of MSD.

6.3.9. Stakeholder involvement and use of research

The stakeholder interviews showed that the area was highly prioritized and there were high expectations from all groups of stakeholders. However, the research in the strategic field was not equally evaluated by some of the stakeholders. Whereas the representatives from politics, employer organizations and trade unions voted very positive, there was some reservation by the OSH practitioners.

The differences might be explained by the recent change in the strategic field from the “old fashion” biomechanical risk/ ergonomics research to the individual pain response/ exercise intervention research. It is highly expected that this new approach results in a breakthrough of the effectiveness of musculoskeletal prevention. On the other hand, the “old risks” are still

present and represent a major factor in OSH practice and clinics. There is a need for research to keep current knowledge from all kinds of exposure. Otherwise a loss of expertise in standard fields may occur. There is an obligation of the NRCWE as the leading knowledge provider to observe these requirements. The differing evaluations by the stakeholders might indicate that the research group has to improve its communication on the intentions of the field. On the other hand, the evaluation in 2008 might be too early because of the near-term change of strategic field and insufficiently predictable superiority of the new approach.

6.3.10. Conclusions and recommendations

The researchers working within the strategic field *Work-related pain in muscles and joints* are engaged in intervention research. The main strategy is the investigation of large-scale work-site interventions using physical exercise for prevention of MSD. The aim is the development of effective methods for prevention which reduce sickness absence and early retirement from work. This strategy focuses on individual-level primary prevention and secondary prevention. It was introduced in connection with restructuring the NIOH and corresponds to the recommendations of the 2005 evaluation on strengthening intervention research. The research is newly established at the NRCWE, there is a good cooperation and networking within the Centre and with Danish universities and research institutions, the results are expected to be highly relevant for the prevention and rehabilitation of musculoskeletal disorders at the worksite.

To achieve the strategic goal, the research ought to be maintained and strengthened.

A breakthrough in MSD prevention is unlikely to occur by research on physical exercise intervention alone. Deficiencies exist in a broad range of fields, e.g. science-based risk evaluation, causality, work relatedness, knowledge transfer. There is a need for research to increase knowledge in all these fields. The NRCWE as the leading knowledge provider is obliged to follow these requirements. Otherwise a lack of expertise may occur, hampering the progress in prevention of MSD.

The group seems to have a problem in maintaining the scientific workforce. 11 members of the scientific staff left the group during the evaluation period 2005 – 2008, including senior researchers. On the remaining 13 employees there is only one senior researcher, and 8 researchers have limited contracts expiring till 2010/2011. The massive loss of qualified personnel and competence may have huge consequences for the scientific workability. Although the Centre has invested in dealing with these problems by preserving and starting intensive collaboration, recruiting new personnel and intensifying guidance, this seems not sufficient. Stabilization of the existing workforce, opening for new seniority, and application of new PhD students is recommended.

In addition, the expertise on epidemiologic study design and data analysis should be strengthened by intensifying collaboration with the epidemiology group or by acquiring such expertise in the group. In Case of strengthening the collaboration with the epidemiology group of the Centre, the capacity of that group should be enlarged in order to fulfill this role satisfactorily.

The research quality is rated rather high as estimated from the high number of peer-reviewed publications, the high-ranked collaborations and research partners, and the high amount of funding realized for the research projects. However, most of the results reflect research which has been done before introducing the new strategy, and in that perspective the evaluation in 2008 might be too early because of the near-term change of the strategic field.

Because of the great economic burden of MSD, the topic is of high relevance for politics, social partners, enterprises, and also for the single individual. The research projects of the group rank all rather high in this field. The area is highly prioritized and supported by all groups of

stakeholders. On the other hand, the mechanical and psychosocial exposures at work constitute risk factors for musculoskeletal disorders and remain targets for primary prevention. "Classical risks" like lifting, carrying, high forces, repetitive tasks etc. are still present and represent a major factor in OSH practice and clinics. In order to serve as a National Centre, it is essential that the NRCWE maintains competence pertaining to exposure factors at work, possible mechanisms, and various health effects.

The recommendation is to secure a solid knowledge base on exposure factors and effects in addition to the new strategy, thereby improving the science-based knowledge of OSH practice. Otherwise a loss of expertise in standard fields may occur.

Cooperation and networking with the national Danish universities is well developed. There are close cooperation in the research projects. In recent years, considerable resources of the strategic field were transferred from the Centre to the universities. Under these conditions networking is an essential measure to get a "critical mass" and consistent results in the field.

International collaboration seems not that developed in the field. Except for the Nordic countries and NL, there are only sparse international activities. An explanation might be the change of the strategy with a loss of contacts after starting the new field. New contacts will possibly establish when the time goes on.

We suggest an intensification of communicating the intentions of the strategic field, attracting more attention of the international scientific community.

Sharing of knowledge is well performed through publications, meetings, workshops, presentations and other activities. Participation in education may be considered as a special field of knowledge transfer. The group is engaged in University teaching, education in public health science, supervising of PhD, Bachelor and Master students.

Another field in sharing of knowledge is the internet. The group provides a lot of detailed information, fact sheets, articles etc. that can be downloaded. However, the English version of the website gives reason for misinterpretation of the conditions of the strategic field. The name of the English version website does not equal the name of the strategic field, and the attached staff differed from the one given in the source material. The Danish version of the website, which is most relevant for Danish stakeholders, was updated. Nevertheless, we recommend an update of the English version of the website according to the current conditions.

6.4. Psychosocial working environment

6.4.1. Introduction

The term “Psychosocial” is rather diffuse with several meanings. It is used as a general term often including exposures, processes, and/or effects.

Psychosocial factors, psychological and social factors, include both task-level factors and social interactions, both individual-level and group-level factors. The interface with organizational (and management) factors is vague. Organizational factors may contribute to psychosocial factors and be a result of psychosocial factors. Furthermore, psychosocial factors interact with other exposures, and may even to some extent determine the effects of other exposure factors.

It seems that the strategic fields are guidance principles formulated by the external Danish stakeholders. The research is directed and organized by projects and project groups (see fig 1). Since the *Psychosocial working environment* field clearly overlaps all other fields with the possible exception of *New technologies*, it is difficult to evaluate this field per se.

The research of psychological and social factors is helped by Danish regulations calling for mandatory assessment of psychological and social work environment. This necessitates that some (independent) institution like the NRCWE develop and maintain competence in conducting, interpreting, and using assessments. The mandatory assessment should motivate businesses to undertake surveys and this must facilitate recruiting businesses to the NRCWE's studies.

6.4.2. Organization and management

The organization of the NRCWE seems to promote bringing people with complementary competencies together, which is good.

This strategic field is covered by six research groups:

- Development of the Copenhagen Psychosocial questionnaire, version II (COPSOQ-II) (1)
- Bullying research (2)
- Working hours and work family conflict (3)
- Psychological health and well-being (4)
- Psychophysiological research (5)
- Work-place assessment research (6)

It seems that groups 2 and 3 are defined by exposures studied, group 4 is defined by outcomes (effects) studied, group 5 by mechanisms and mediators of health. Groups 1 and 6 seem to be defined by development of methods.

Research on *Absence and exclusion*, *Organization and management*, and possibly *Work-related pain in muscles and joints*, *Accidents* and *Noise* include psychological and social exposure factors (8 of 23 persons in this field also work for other fields). Several articles reported under the psychosocial work environment field pertain to sickness absence. Furthermore, none of the research groups listed focus specifically on *Absence and exclusion*. This raises the question how the strategic fields are taken into account in organizing groups and projects. For scientists performing research at the international level, it is probably most effective to consider the strategic fields as requirements underlying all activities, rather than as strict organizational boundaries.

For a field that includes both psychological and social exposure factors and psychological outcomes, and overlaps with several other strategic fields, it is crucial to find the persons with the right competence and motivation for each project. It seems that the competence fora for discussions during the planning phase of projects are working well for this field. The directors of research coordination need to have solid knowledge not only of people working in her/his project groups, but also of persons working under other directors of research coordination.

6.4.3. Key numbers (personnel, budgets, projects)

Personnel: The list of employees “connected to the strategic field” lists 24 persons:

- 1 professor
- 9 senior researchers
- 4 PhD students
- 6 research assistants
- 4 laboratory technicians

The internationally recognized researcher Professor Tage S. Kristensen terminated his contract with the NCRWE at May 31st, 2008, hence the field is currently searching for a new professor.

Several of the personnel are also working in other strategic fields:

- 5 senior researchers
- 1 PhD student
- 2 research assistant

Budget: For 2007, this field spent DKR 9 263 253. Of this amount DKR 7 390 587 (80%) was externally funded.

Projects: 17 projects are listed (two of these were terminated in 2007).

6.4.4. Use of resources as compared to the NRCWE’s strategy

We have little information of costs of the individual projects. With overlap with other projects that are listed under other strategic fields, it is not possible to evaluate whether funding is adequate for individual projects. The psychological-and-social-factors field is of central importance to several of the Centre’s strategic goals. Given that 80% of the funds are external it seems that overall productivity is high relative to the resources spent in the field.

In spite of many adequate epidemiological studies showing that psychological and social factors at work significantly increase the risk of cardiovascular disease and other health problems, there is little knowledge of mechanisms. Hence, knowledge of causation, pathogenesis, time frame, and buffer factors is lacking. Without knowledge of time from exposure to effect, epidemiological studies may suffer from inadequate time resolution of measurements that are unable to discover associations between exposures and effects. Furthermore, without this knowledge health services focus on other factors like diet and exercise. Therefore, there is a need for research on psychophysiological effects of work. The NCRWE is in a beneficial situation having competence both in work factors (exposures) and in physiological responses. The psychophysiology group needs to be supported by the NCRWE leaders by continued internal funding and by communicating this field to stakeholders and to the public.

6.4.5. Collaboration and networking

6.4.5.1. National

The projects/personnel have extensive collaboration with University departments, departments of occupational medicine and private consultants.

6.4.5.2. International

The projects/personnel have extensive collaboration with University departments in many countries (75 listed). Prof Tage S Kristensen was very active at the international scene, and it is a challenge to maintain all relations over time.

6.4.6. Scientific output

The psychosocial work environment field clearly overlaps with all other fields with the exception of *New technologies*. Therefore, it is difficult to evaluate the production pertaining to psychological and social working environment. Therefore, this evaluation is based on the production by authors listed under this strategic field.

Table 9: Scientific output – Psychosocial working environment

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	26	25	22	4	77
Papers in ISI Web of Science	25	24	20	4	73
Review articles (in ISI Web of Science) (included in the above)	0	1	1	0	2
Citations (with self-citations)	167	89	20	0	276
Citations (without self-citations)	128	71	14	0	213
Citations per paper (with self-citations)	6.7	3.7	1.0	0.0	3.8
Citations per paper (without self-citations)	5.1	3.0	0.7	0.0	2.9
Scientific articles in national journals, peer reviewed	1	1	3	0	5
Articles in national journals (not peer-reviewed), including popular science publications	22	9	3	1	35
Conference/meeting abstracts	28	36	32	5	101
Books and book chapters (included reports)	21	15	15	2	53

Fourteen of the international peer review articles were published in journals with impact factor > 3.

It is not possible from the information received to assess the productivity of individual research groups. There are few articles on bullying so far, but several publications should result from ongoing longitudinal, prospective studies.

6.4.7. Research quality

Generally, the published research in this strategic field is of high quality and compares well with universities and other high-ranked academic institutions executing research in this field. Many articles have been published in leading occupational health journals. Ten articles have been published in journals with impact factor > 3.

It is not possible to evaluate the research quality of individual research groups, since this strategic field overlaps with other fields.

Four of the research groups perform ongoing longitudinal projects, both prospective studies and interventions with follow up assessments. Internationally, there is a need for longitudinal studies with adequate scientific methods to reach conclusions of effects of psychological, social, and organizational factors on health and well being. Such studies are time consuming and require large resources.

High research quality translates into (1) new knowledge and (2) conclusions that may be trusted. It is very important for the quality of knowledge of Danish working life that the NRCWE take on the challenges of such complicated, long-term studies. It is essential that stakeholders realize the much longer time-frame and cost of longitudinal studies.

The NRCWE have two fairly unique resources enabling high quality research on psychological and social factors at work: (1) The NRCWE own and control the Danish national survey on work environment and health. This enables the NRCWE to include question scales of adequate validity and relevance to important research subjects and to use the data for its research. (2) The NRCWE have contributed to the development and use of questionnaire types that measure a broad spectrum of work factors and not only “classical” factors like quantitative demand, control, and social support. The NRCWE participated in the development of the General Nordic questionnaire for psychological and social factors at work (QPSnordic, Dallner et al., 2000), and developed the Copenhagen psychosocial questionnaire (COPSOQ, Kristensen et al., 2005). The principle of assessing many specific factors enables finding new associations between work and health/wellbeing.

Therefore, the NRCWE possess the potential for conducting research of high international level quality in the future, if allowed to perform longitudinal studies. Fixed maximum funding time periods (e.g. 3 years) may preclude performing high-quality prospective studies.

One potential threat to research quality is if demands for output of a high number of articles or demand for “quick answers” are met by studies with cross-sectional surveys on work factors associated with subjectively reported mental states (satisfaction, distress, “energy”, etc). Such studies are necessary to generate hypotheses, but reporting behaviour may influence both the assessment of exposure and outcome in such a way that associations are inflated. Another potential threat to research quality is the inclusion of outcomes that are subjective reports of poorly defined general constructs (e.g. “stress”).

6.4.8. Research relevance

These activities have very high relevance to working life. One may always question the choice of exposure factors to focus. Both competence (existing and potential) and problem significance must determine what is studied. It seems a good choice to focus on bullying and working hours and work family conflict. Since Denmark requires businesses to assess their work environment, the Centre has a unique opportunity to perform work-place assessment research, which should be of great practical use.

Epidemiological methods generally only permit establishing risk factors. The competence of the Centre provides a unique possibility to gain knowledge of how work may influence health and performance (psychophysiological research). This is highly relevant in producing objective data

on responses to work factors, to elucidate precursors of health problems or performance deficits, and to document cause-effect relationships.

The outcomes studied, psychological health and well-being, sickness absence and exclusion, musculoskeletal disorders, are all of great significance to both employees and employers in all Scandinavian countries.

Interventions and natural experiments (e.g. changes in businesses) provide the possibility to test the significance of occupational factors by robust research design. Furthermore, knowledge of effects of practical interventions may provide the knowledge base to improve working life in individual businesses. Intervention studies are often time-consuming and costly, but the NRCWE seems ready for an increased priority of intervention studies.

6.4.9. Stakeholder involvement and use of research

This strategic field overlaps with several other fields, hence stakeholder involvement is great even if not specifically addressing “psychosocial working environment factors”. The findings and knowledge acquired in this field is communicated to stakeholders and to the public and seems to evoke great interest. Assessment of psychological and social factors is mandatory by regulations and this should contribute to stakeholder interest.

6.4.10. Conclusions and recommendations

This strategic field overlaps with several other fields, hence it is a significant part of many aspects of work, health, absence, and exit from work. The NRCWE has built considerable competence in this field, and has had a large output of studies of good quality.

The NRCWE has developed unique resources that enable high-quality research in the future. The evaluation committee concludes that these resources should be maintained, developed, and exploited by securing longer-term funding of projects. Furthermore, studies of interventions (and natural experiments) and in psychophysiology should be encouraged.

The organization of research projects and groups seems to function. The output with each strategic field seems to be adequate (or very good). However, one might consider forming research groups that more closely reflect strategic fields.

6.5. Organization and Management

6.5.1. Introduction

The strategic field *Organization and Management*, founded in 2006, is the latest of the fields of research at the Centre. It has grown rapidly and has now, two years after it started, got 14 employees and 17 projects. The researchers in this field have already published an impressive number of various texts and given many communications to the public. One of the stated objectives of our evaluation is to judge the pros and cons of transferring parts of or the whole NRCWE to Danish universities. The field *Organization and Management* illustrates the opposite; some projects and experts have been transferred from the Technical University of Denmark, DTU, to the NRCWE and seemingly quite successfully so.

We do not share the assessment in the self evaluation from the researchers within this field that “the emerging field of Management and Organization is a new issue in the area of research in work environment”. The field might be new at the Centre but not in Working Life Research. Organization and management and its importance for the quality of work might have gained political importance in Denmark lately, but the research in the field forms a classical part of work environment studies. It has a rich history in the Scandinavian countries, since the forties and onwards. Dominant themes have been critical analyses of Taylorism and its organizational manifestations and an ardent advocating for different forms of decentralization and self-management. Internationally the origin of the field can at least be traced to the late nineteenth century. Both of the themes and “strings” of interest, which are mentioned in the self evaluation, have a very long history outside the Centre; particularly the second one, the study of “Firm strategies, management and organization connected to work environment”. The first one “The Influence of work environment efforts on enterprise actions” is a smaller field in a historical perspective but equally old as the first one.

The fact that the field is well established outside the Centre and that many researchers at universities and other organizations also work with *Organization and Management* and its repercussions on work environment, for instance at DTU (at their mega department DTU Management in particular) and at the Copenhagen Business School, CBS, (in particular at their Department of Organization and their Department of Operations Management), makes it easier to benchmark the research in this area at the Centre. A further argument for such comparisons is that the majority of the employees of the field at the Centre have a past at either DTU or CBS. International benchmarking is a tougher challenge due to the vastness and richness of the field and the existence of so many similar institutes and centres with which to compare the NRCWE.

6.5.2. The profile of the field of *Organization and Management* at the NRCWE

Generally speaking most of the research in this Janus faced field, organization and management, used to be dealing with best-practice, the winning competitiveness. To a large extent it still is, a theme often named “Excellence-research”. When quality of work aspects of organization and management for ordinary employees are highlighted, the research has often had a critical and negative twist. All too intense or too extended work, micromanagement and lack of influence, monotony and lack of stimulation and development, have all been typical themes for the findings. The latter kind of research is often referred to as “Elend-Forschung”, not only in German but also as a new loan word in English and many other languages. The field is in other words often polarized and its integration and coherency a challenge of some magnitude. Are they good at that within the group of organization and management researchers at the NRCWE?

Which parts of this broad field are represented or covered at the Centre? In their self evaluation they talk of two “strings” (already presented) and two main research groups. The two groups of researchers in the field are “MOWE” (Management, Organization and Working Environment), the big group, and “Team and Management”, the considerably smaller one. Seen in the context of

Scandinavian Work Life Research we would expect participation and self management and other forms of work place democracy being at centre-stage at a research group at the NRCWE. From an International or Anglo-Saxon perspective a more likely focus would be safe and sound and “healthy” workplaces. Is the sometimes used add-on to the name of this field at the Centre, “Organization and Management and Quality of Work”, indicating that the Anglo-Saxon tradition dominates?

How does this field, new at the centre, old in Academia, fit into the overall structure of research at the Centre? How does it, for instance, differ from the well established field *Psychosocial Working Environment* and in particular their research group on work-place assessment? These two fields at the Centre seem to be rather closely related, but in which way, complementary or competitively?

In our final comments (6.5.10) we will try to answer all the questions above concerning the status of this field at the Centre.

6.5.3. Key numbers (personnel, budgets, projects)

The strategic field *Organization and Management* was founded in 2006. Ten of those employees connected to this field started at the Centre in 2006 or later. Only 4 employees have a few years longer history at the Centre than at the field. The group is well qualified; 8 of the researchers have PhD degrees and 3 are PhD students, or now in June due to a successful dissertation, 2. This field has a project secretary of its own; without her extraordinary competence the rapid growth of the field would have been impossible, according to all employees interviewed. The other research groups at the NRCWE are entitled to draw on secretarial assistance from the NRCWE Service Centre. From the NRCWE website it appears to be some discrepancy of researcher belonging to this field as compared to the source material provided to the committee from the NRCWE. The internal mobility at the Centre between different fields seems to be rather high and maybe the affiliation to the research fields is not that important for many of the employees.

It has huge consequences, however, for the “numbers” for this field, particularly those for productivity, if publications from these researchers are associated with another strategic field that might overlap. We have chosen to use the source material in the evaluation of this strategic field rather than information from the the website as combining website and source material would lead to “double-booking”. Our conclusions regarding this field rest on the assumption, that the source material contains the most recent data for our evaluation. A corollary is that the Centre’s English version of the website is not completely updated and to some extent misrepresents the fields at the Centre. Of the 17 projects in this field, strikingly many are headed by a limited number of researchers.

6.5.4. Use of resources as compared to the NRCWE’s strategy

The strategy lists *Organization and Management* as a prioritized field of research but is not very specific when it comes to its content. In the void of guidance our evaluation must be very general. The field is well-functioning in the sense that it is focused on research and counseling concerning organization and management of interest for the stakeholders. The field is well financed and funded. The researchers as a group are productive and well represented in international scientific publications in the field. We will return to the more detailed evaluations of quality and relevance in the coming paragraphs 6.5.7 and 6.5.8.

6.5.5. Collaboration and networking

The Centre is a small player in the field of *Organization and Management*. Even if we restrict our comparison to Copenhagen less than 1 percent of the researchers in the field are employed by

the NRCWE. This is a strong argument in favour of cooperation and networking. If the field at the Centre is defined as a subfield of *Organization and Management* its percentage share of the subfield might increase.

6.5.5.1. National

The researchers of this field at the NRCWE seem to have good contact with their old Alma Maters, DTU (cooperation in 7 projects) and CBS (cooperation in 3 projects). Another important partner is a consultancy firm, TeamArbejdsliv, cooperating in 3 projects. The founders of TeamArbejdsliv have a background from Roskilde University Centre, RUC, and have a track record within the old Danish work environment surveillance and improvement system, BST (BedriftsSundhedsTjeneste).

6.5.5.2. International

The overall impression of the network of cooperating International projects, institutions and universities, is very favorable. The group is participating in many and prestigious networks. That is true for some of the projects at the Centre in particular: WORKS has got 12 International partners, HIRES 10, AMICA 5, Managing teams 4, DAVID 3.

6.5.6. Scientific output

The publications from this field jump-started already in 2006 with many conference abstracts. The quantitative growth of publications, articles as well as book chapters, accelerated in 2007 and the same seems so far to be true of 2008.

Table 10: Scientific output – Organization and management

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	0	2	8	2	12
Papers in ISI Web of Science	0	1	6	1	8
Review articles (in ISI Web of Science) (included in the above)	0	0	0	0	0
Citations (with self-citations)	0	3	0	0	3
Citations (without self-citations)	0	2	0	0	2
Citations per paper (with self-citations)	0	3	0	0	0.4
Citations per paper (without self-citations)	0	2	0	0	0.3
Scientific papers in national journals, peer-reviewed	0	0	2	0	2
Articles in national journals (not peer-reviewed), including popular science publications	0	2	5	2	9
Conference/meeting abstracts	1	8	6	15	30
Books and book chapters, including reports	1	1	7	6	15

6.5.7. Research quality

This field at the NRCWE undoubtedly exhibits high productivity and quantity. The number of articles in international peer reviewed articles (12), articles in-press (5), and submitted (19), conference abstracts (32), peer reviewed books or book chapters published (11), those not reviewed (5), popular science publications (9) and (60) publications to the public.

Quantity of output is impressive; what can we say of its quality? If we focus on their publications the task is simple, since so many of them have been peer-reviewed for high ranking journals. The researchers of this grouping at the NRCWE have published numerous texts of good quality. A trickier question is to evaluate to what extent their achievements reflect the new initiative, forming *Organization and Management*, and to what extent these achievements reflect investments and efforts made in an earlier period. The preliminary answer is that much of what is now reaped was sown before the founding of this field. The projects BEST, “The work environment in the future”, and “Managing Teams” existed before the foundation of the field but are now housed by it.

By reading the five articles of the period, self evaluated as “best”, we gain a favorable opinion of the qualifications of especially three of the researchers in the field, but evaluating the quality of research done in the field is hampered by the fact that four of the articles build on work done before the formal formation of the field at the NRCWE. Some of this work was done at some other field at the Centre, while some was done somewhere else, for instance at DTU.

“From Conflict to Shared Development: Social Capital in a Tayloristic Environment”, co-authored by NRCWE authors, relies heavily on DTU research. It demonstrates some of the profound knowledge that one of the recruited senior researchers has brought to the group, but this very well-written article is foremost an analysis of data from a DTU project in 2001-2003 about work within outsourced Danish bus transportation before the field was formed at the Centre. It merits DTU more than the NRCWE, but merits it does.

One of the other nominated papers “Success or failure? Interpreting and understanding the impact of interventions in four similar worksites”, with three out of four authors including the primary author from the NRCWE, is also produced prior to the strategic shift at the NRCWE. The article was published in 2006 and its data are of course collected before that. It tells more of the quality of research at the field *Psychosocial Working Environment* than about *Organization and Management*.

An article more representative of the present research group is “The effects of transformational leadership on follower’s perceived work characteristics and psychological well-being: A longitudinal study.” The primary author is from the Centre and the paper is written while working in this new constellation at the NRCWE. One other internal NRCWE author of this paper does not belong to the *Organization and Management* strategic field, while the remaining two are external collaborators.

A third aspect of academic quality is assessing the individuals in the group. We have already established that the two groups have published an impressive number of articles, meeting abstracts, books and book chapters as well as communications to the public. But from that we cannot conclude that all researchers in the field have good publication records. Lopsided publication lists are common in research groups, with the seniors as the heavy-weights, but this group is extreme. If we for instance look at articles, (published, in-press and submitted), four of the researchers are authors of 34 of the 38 articles (87 %) from this field comprising 13-14 employees. If we focus on the 60 communications to the public, one of the researchers alone did half of them, while another did almost a third.

6.5.8. Relevance of research

When we analyze the communications to the public, it is striking to find so many of them, a fourth, dealing with one and the same topic, defining the true nature of the management philosophy called “Lean”. This concept was introduced by the famous International Motor Vehicle Program (IMVP) at MIT in 1988 to give a new and more generalized name to the Toyota production system and its quest for eliminating waste (“muda” in Japanese). A complication is of course that the concept, since its introduction two decades ago, has become rather blurred by being used by millions of practitioners all over the world in all walks of life. Now the concept is particularly hot in the Public Sector but quite often used as a euphemism for down-sizing. The communications from the NRCWE, alas mostly judging from the titles only, seem to strike a rather optimistic note, lean does not necessarily mean “mean” or stressful. - Another favored theme in the communications is team leadership. For this theme the messages seem to have been more double-edged and conditional. Social capital and stress in various forms are other concepts frequently communicated to the Danish public.

The 17 projects all seem to rank rather high on relevance. DAVID and CSR focus on small enterprises. AMICA focuses on improving working conditions in call Centres, project 253 those in the slaughterhouse industry, project 242 knowledge work. “Managing Teams” is a project about how changed leadership behaviours may improve the working environment. Some projects have a broad focus on health, well-being and improving the working environment in general, for instance HIRES about “Health In REStructuring”. WORKS is also a project that focuses restructuring and how it affects working environment and working conditions. Four projects specifically target psychosocial working environment: BEST exploring how to work with improving psychosocial working environment, LEANUS, exploring how to give positive attention to the psychosocial environment in a lean implementation process, project 297 that studies the relationship between psychosocial work environment and productivity, project 287 is a study of how to improve the psychosocial working environment with special emphasis on psychosocial risk management.

A general observation is that improving the psychosocial work environment is a very important theme for this field. In efforts to improve the work environment it would be strange to exclude the psychosocial one, but since there is another field at the NRCWE, that is named *Psychosocial working environment*, the focus on psychosocial work environment in this field also might look like some kind of overlap. Another observation is that the importance given to work environment is indisputable in all 17 projects. Organization sometimes seems to be used as a synonym to company or public authority, not aiming at the way they are organized. Management is often given the meaning of leaders or leadership, not referring to the combination of leaders and their staff resources in personnel and different administrative, economic and technical command and control systems. Economy and technology does not loom large in many if any of the projects in the field, but they are certainly extremely important to those who are responsible for management as practitioners. “Management” is in other words often used as a synonym for “leadership”, not referring to the whole system that governs an organization.

6.5.9. Stakeholder involvement and use of research

During the stakeholder interviews we got the impression that this area of research was not very well known by some of the stakeholders. This area did not seem to be very salient or prioritized from a stakeholder perspective, at least from stakeholders on the board. That surprised us since we think that the researchers in this field are very keen on being relevant and complying with the Strategy of the Centre.

One explanation of this lack of interest and confirmation from some stakeholders might be the vagueness of the field, another that the field has not got enough time for establishing its

priorities or niche. The vaguer the name the longer branding might take though, especially given the cognitive closeness to the field of *Psychosocial working environment*.

The research results from the many projects in the field have been very well used in the academic world. The scale and scope of publications is well above what would be considered good at universities and academic institutions executing research in this field. We assess that the Danish social partners generally speaking have been well served by this group of researchers in gaining a better understanding of how to implement working environment improvements. But the lack of stakeholder enthusiasm might indicate that this group of researchers have to improve in communicating their change management findings. Still the time for our evaluation of this group and its many projects is an early one, remembering that the group started in late 2006.

6.5.10. Conclusions and recommendations

Organization and Management is still a very young field at the Centre. Some of the challenges we have discussed in our evaluation will be solved soon enough by the course of time. The field will for instance be more well-known and established as time goes by.

In the self evaluation the risk of “overheating” is highlighted and the high temperature is explained by referring to the “explosive” growth of the field. In our interpretation “overstretch” is a more obvious problem. We think that 17 projects are too many for the present group of researchers in the field. We recommend prioritizing and reducing the number of projects within *Organization and Management* and thereby mustering its resources.

In the introduction we stated that we thought the domestic benchmarking would be easy. *Organization and Management* occupies a niche not equally strong at DTU and CBS, as far as we know, namely a strong focus on working environment and quality of work. Comparing organization and management research between the NRCWE and the two universities is quite difficult though, to a large extent due to the content of research at the NRCWE. At the Centre management is often used as code for leadership. Internationally there is an intense debate on the differences between management and leadership, a debate that does not seem to be lively at the Centre. Presently *Organization and Management* is close of being a misnomer. We think the name *Organization, Leadership and Quality of Work* would be more descriptive and give a better understanding of the importance of integrating these phenomena.

The uneven distribution of publishing and public activity by the members of the field partly reflects seniority and length of employment, but only partly so. The high productivity of the group depends heavily on a few of its members, which makes the group more vulnerable. Our recommendation is for the leading personalities in the field to help the other employees to publish and/or publish more often.

Our screening of the projects and the publications earmarked as *Organization and Management* did show considerable overlap with the field *Psychosocial Working Environment*. For meeting this challenge there are several options, for instance merging the two fields or making this field more profiled in areas where *Psychosocial Working Environment* is not so qualified, for instance in economic and technical analyses. We recommend making this field more profiled. If not a merger would be better than the present vagueness, overlap and duplication of work.

The lack of knowledge of and enthusiasm for this field from some stakeholders may partly be solved by the passing of time. But the problem might go deeper. Some stakeholders do not appreciate the strengths of the group because they think that *Psychosocial Working Environment* deals with the same problems and studies. Such objections might be solved by mustering and profiling at the Centre. But if some stakeholders think that this group and field has delivered too little of relevance that objection must be met by delivering. We recommend that the field highlights its findings concerning implementation; what needs to be done to make the social

partners, organizations and individuals “swallow the pill of improving the working environment”, a knowledge the Centre has promised to deliver.

Would the stakeholders get better advice on organization, management and quality of work, if the resources of this field at the Centre were transformed to university departments instead of being kept intact? For this particular field we think that answering it now would be too early. The field has been in operation for less than two years. Our guess at this stage of development would be: No, the stakeholders would not over all get “better” advice from university departments. They would most likely get more varied and sometimes contradictory answers, but often they would not get any answers at all. A certain effect would be a tougher job for the NRCWE to keep its focus on the development of safety, health and well-being within Danish working life.

6.6. Noise

6.6.1. Introduction

Noise is one of seven strategic fields at the NRCWE in the period 2006-2010. The NRCWE has also earlier explored research on noise with special emphasis on noise in relation to hearing impairment. From 2006 the focus has been directed towards exposure to low-intensity noise below the hearing impending level with negative effect on well-being and productivity, rather than on higher intensity noise causing hearing damages, especially addressing individual factors associated with noise annoyance, performance decrement and stress reactions and social consequences of noise exposure. This new direction has been motivated by the conclusions in the national report *Noise from human activities*, March 2006, which emphasized the need for surveys of noise and nuisances in the working environment to highlight the coherence between noise, stress, dissatisfaction, reduced productivity and absence due to illness. This new direction requires a more multidisciplinary approach than earlier research executed at the NRCWE within the noise field, including contributions from e.g. social sciences.

6.6.2. Organization and management

The strategic field noise is organized in a project group according to a project organization model (one of 17 at the NRCWE). This noise project group is one of the smallest at the NRCWE, comprising only five persons. One of the senior researchers has been working extensively within the noise field for several years in addition to being responsible for animal experiments at the NRCWE. The two remaining senior researchers joined this field after the reorientation in 2006, with their previous scientific merits and main competence from other research fields.

6.6.3. Key numbers (personnel, budgets, projects)

The noise research group currently comprises three senior researchers, one PhD student, and one technician. The senior researchers state that approximately 50% of their working hours are dedicated to this topic, giving approximately 1.5 senior researcher-years devoted to research within this field annually.

In 2007 the total budget for this strategic field was approximately 1.5 mill. dKr. This is approximately 2.7% of the total NRCWE budget directly spent on research activities in 2007. The external funding rate for projects in this field in 2007 was 9% of the total budget.

Two research projects are currently carried out within this project group. However, the researchers has recently been received grants for a large project from the Danish Working Environment Research Fund, bringing both research activity level and external funding rate up to a competitive Centre level.

6.6.4. Use of resources as compared to the NRCWE's strategy

Noise is one of four working environment challenges pointed out in the governmental Report on future Working Environment 2010 from December 2005. Accordingly, the NRCWE strategy plan for 2006-2006 emphasizes noise as one of seven prioritized strategic fields.

The two projects currently carried out appear to be focusing mostly on hearing impairment factors, in accordance with former strategies. One of these projects is to be finalized in 2008. However, the newly granted research project appears to be central for future activities within the *Noise* field, fitting well into the new strategic thinking. The rather low internal funding rate of 2.7% in 2007 for this field (see 6.6.3) must therefore be considered in light of the recent reorientation.

Three senior researchers devoting approximately 50% of their working hours to this field might be considered as a rather limited prioritization when compared to the other strategic fields at NRWCE. However, two “new” senior researchers have been allocated to this field after the implementation of the new strategic plan, illustrating the increased focus on this field and the direction towards more multidisciplinary research approaches.

6.6.5. Collaboration and networking

6.6.5.1. National

The project group collaborates with several universities and hospital departments.

6.6.5.2. International

The project group collaborates intensively with several departments at Lund University in Sweden. This collaboration appears to be very fruitful and should continue in the future. The project group is also associated with the NoiseChem group, an EU project on hearing loss from exposure to organic solvents.

6.6.6. Scientific output

Table 11: Scientific output - Noise

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	2	2	4	2	10
Papers in ISI Web of Science	2	2	3	1	8
Review articles (in ISI Web of Science) (included in the above)	0	0	0	0	0
Citations (with self-citations)	6	5	1	0	12
Citations (without self-citations)	3	4	0	0	7
Citations per paper (with self-citations)	3.0	2.5	0.3	0.0	1.5
Citations per paper (without self-citations)	1.5	2.0	0.0	0.0	0.9
Scientific papers in national journals (peer-reviewed)	0	0	0	0	0
Articles in national journals (not peer-reviewed), including popular science publications	1	1	1	0	3
Conference/meeting abstracts	2	6	0	5	13
Books and book chapters, including reports	0	1	0	1	2

Twelve scientific papers dealing with noise have been published in peer reviewed journals in the evaluation period 2005-2008, while one and three papers have been accepted and submitted for publication, respectively. Most of the papers from the evaluation period are dealing with themes related to the former strategy. However, among the later publications (including submitted papers) low-intensity noise related topics are being addressed. When considering the limited personnel resources on this field and the reorientation towards research on other noise related topics, the scientific production within this field is considered reasonably well. This appears to be partly due to collaboration with other institutions. Improved publication rates should be expected in the near future, especially the number of papers with the primary author from the NRWCE.

6.6.7. Research quality

The quality of the performed research related to low-intensity noise is currently difficult to assess, as projects have been initiated very recently. Earlier work on hearing impairment related topics, however, is of high quality and has been published in well-respected international journals and compares well with universities and other academic institutions executing research in this field

The current project group appears to be harmonious and enthusiastic, and its joint scientific merits from all (previous) fields, including *Noise*, are very good, which ideally should make the group capable of producing interdisciplinary high-quality research within this field also in the future. It appears that the project group is capable of successful competition for externally funding, and that the new research topics under study are about to give results. The evaluators have the impression that the “new” senior researchers in the project group have responded positively to the building of new competence in close collaboration with the more experienced noise researcher in the group. The project group appears to be well organized, and should constitute a promising platform along with the external collaborators in Denmark and in Lund, Sweden for high-quality research on low-intensity noise in the future. Given the limited size of the project group, external collaboration, as well as collaboration within the NRCWE, is considered critical for future success in this field.

6.6.8. Research relevance

Noise is still a considerable problem in the working environment. Although noise related hearing impairment still is a challenge in the work life, we know a lot about the factors and mechanisms causing these damages. However, knowledge on low-intensity noise below the hearing impending level with negative effect on well-being and productivity is scarcer. Thus, there is need for such interdisciplinary research internationally. The NRCWE with its infrastructure, facilities, multidisciplinary competence and good relations to the social partners has special qualifications for performing such research. Noise is one of four working environment challenges pointed out in the governmental Report on future Working Environment 2010 from December 2005, and is thus regarded highly relevant for the Danish working environment.

6.6.9. Stakeholder involvement and use of research

The project group has been presenting noise related topics, arranged seminars and symposiums as well as participated in campaigns in collaboration with the Working Environment Authority, social partners and occupational health services and clinics. The importance of focusing on noise at the NRCWE was stressed during several stakeholder interviews, especially by the employees' associations. The stakeholders were in general positive to the NRCWE's research in this field and their opportunities for influence and involvement.

6.6.10. Conclusions and recommendations

The scientific outcome from the low-intensity noise commitment has not yet materialized to any great extent. However, the organization of the project group, the established collaboration with internal and external partners along with the reputation among stakeholders appears to be promising for the future. Lacking and complementary competence appears to be covered by collaborators internally and externally, and such collaboration is considered a necessity also in the future.

Although the size of the group is very limited, two senior researchers of totally three have recently been assigned to the field. It is assumed that they will still need some time to adapt thoroughly to their new field of interest. Thus, at present stage it might be of importance to establish roots rather than further expansion. However, we encourage the Centre to allow the senior researchers to allocate more than the present 50% of their working hours to this field. We also encourage the NRCWE to arrange for availability of other internal and complementary personnel resources in the projects when needed.

It is of high importance that the project group continues to obtain research grants to a level comparable to other strategic fields at the Centre. If the future research applications turn out successful further access to technical staff should be considered. A strong stakeholder interest and thus availability of external funds is necessary to maintain investment in this strategic field and expand to a minimum critical mass. Without such strong stakeholder support such a small group seems vulnerable and less fragmentation of resources of the Centre might be preferable.

The production of PhD and master candidates has been low within this field. New PhD projects should therefore be a goal, as well as increasing the scientific output of work related social- and health effects from exposures to low-intensity noise.

6.7. New technologies

6.7.1. Introduction

New technologies is one of seven strategic fields at the NRCWE in the period 2006-2010. The NRCWE has earlier focused on physio-chemical characterization, microbiology and toxicology in a broader extent, and has high scientific competence and scientific output within these fields. In 2005 a narrower strategic focus on emerging occupational health risks was chosen, and health related issues in relation to so called new technologies were identified as a potential future health risk of importance for the Danish working life. In 2006, after the establishment of the governmental Report of the future Working Environment from December 2005 where challenges related to future new technologies were addressed, the strategic area *New technologies* was established at the NRCWE.

The largest theme in *New technologies* is the potential occupational health risks from exposure to engineered nanoparticles during manufacturing, use or handling products containing nanoparticles. The research work in relation to risk assessment in nanotechnology is divided into five areas:

- Exposure and physical characterization of particles
- Chemical structural characterization and reactive chemistry
- Molecular biology, DNA damage and occupational cancer
- Allergy and adjuvants toxicology
- Reproductive toxicology

These areas of interest were identified based on the NRCWE's established competence within these areas in general, aiming at exploring the expertise on occupational nanotechnology related problems at hand. This new direction requires more multidisciplinary approaches than earlier research executed at the NRCWE.

In addition, a limited research program aiming at potential working environment consequences of new "green" technologies such as microbially based insecticides in greenhouses and agriculture and using biofuels in power plants has been established as a part of the strategic field *New technologies*.

6.7.2. Organization and management

The strategic field *New technologies* is organized in 2 separate project groups (out of totally 17 at the NRCWE) within the same project cluster:

- Nanotoxicology and occupational hygiene
- Microbiology and occupational health

A separate project group, general toxicology, is also associated to the strategic field, mainly covering the NRCWE's activities in regulatory toxicology with contributions from the NRCWE's researchers within the *New technologies* strategic field.

6.7.3. Key numbers (personnel, budgets, projects)

The nanotoxicology and occupational hygiene project group consists of 12 scientists, including two professors and one adjunct professor, while the microbiology and occupational health

project group more or less contains only one scientist. Technical staffs of eight and two persons, respectively, are associated with the project groups.

In 2007 the total budget for this strategic field was approximately 15 mill. dKr. which is approximately 26.5% of the total NRCWE budget directly spent on research activities, and approximately 50% of the basic fundings spent on research activities. The external funding rate for projects in this field in 2007 was 32% of the total budget. For 2008 the external funding rate is exceeding 50%.

Eighteen research projects are currently ongoing within the *New technologies* strategic field, divided into 14 and four projects within the nanotoxicology and occupational hygiene and the microbiology and occupational health project groups, respectively.

6.7.4. Use of resources as compared to the NRCWE's strategy

New technologies is one of seven strategic fields at the NRCWE in the period 2006-2010, based on possible new risk factors arising from technological developments in the bio- and nano areas. Those were outlined in the governmental Report of the future Working Environment from December 2005.

The study of potential health risks from occupational exposures to engineered nanoparticles is a new and challenging field, demanding infrastructure, personnel resources and financial power in order to succeed. Exploring this novel field in a sustainable and competitive manner is more resource demanding than research based on surveys, requiring e.g. advanced instrumentation together with highly skilled operators.

This type of research, with clear elements of basic research, will often suffer from limited availability of research funding than more obviously applied and short term based research projects. In that light an external funding rate of 32% (increased to >50% in 2008) is highly acceptable. The personnel working within this strategic field shall also give general advice to the government authorities and other stakeholders in the fields of physical and chemical hazards in general, where the NRCWE does not perform research of its own at present stage.

The use of resources spent on the strategic field *New technologies* as compared to the NRCWE's strategy appears reasonable weighed at the moment. However, when this field matures more and the need for initial investments is not that critical, the fraction of 50% of the basic research fundings for this particular field might be reduced if the accessibility to external funding continues to develop in a positive direction.

6.7.5. Collaboration and networking

6.7.5.1. National

The project groups collaborate extensively with several institutes at the universities of Copenhagen, Aarhus, Aalborg and Roskilde, as well as with the Danish Technical University. Collaboration with technological institutions with special competence in developing nanotechnology is regarded as especially important, providing opportunities for early interactions with potential exposure situations. This might be an asset in the health based nanotechnology research at the NRCWE.

6.7.5.2. International

The researchers in the project groups have a tradition for extensive collaboration with international partners and have a large network. With regard to the nanotechnology field they have managed to establish a large international network of collaborators within a relatively short period of time, including participation in EU projects and applications for EU projects. The researchers are also participating in several committees within the field of occupational hygiene and toxicology.

6.7.6. Scientific output

In the evaluation period a total number of 114 papers have been published in peer-reviewed journals, divided into 98 and 14 papers belonging to the nanotoxicology and occupational hygiene and the microbiology and occupational health project groups, respectively. The papers are mainly published in high impact and well recognized journals. In addition, 14 and four papers are submitted or are in press, respectively. Considering that the papers have been published rather recently, the number of citations is regarded as high.

Table 12: Scientific output – New technologies

	2005	2006	2007	2008	2005-2008
Papers in international peer reviewed journals	29	25	39	21	114
Papers in ISI Web of Science	28	24	36	20	108
Review articles (in ISI Web of Science) (included in the above)	1	2	4	0	7
Citations (with self-citations)	241	148	62	3	454
Citations (without self-citations)	168	58	27	1	254
Citations per paper (with self-citations)	8.6	6.2	1.7	0.2	4.2
Citations per paper (without self-citations)	6.0	2.4	0.8	0.1	2.4
Scientific articles in national journals (peer reviewed)	0	1	0	0	1
Articles in national journals (not peer-reviewed), including popular science publications	13	27	24	7	71
Conference/meeting abstracts	50	37	30	5	122
Books and book chapters, including reports	6	4	3	0	13

A large number of the papers are, however, originating from former projects not included in the present strategy, as a natural result of the rather recent reorientation. Nevertheless, a number of 23 papers related to nano issues have already been published or been submitted to publication. According to researcher statements during the interviews a large number of papers are also in the pipe line.

The scientific output from the two project groups is considered very good, especially for the microbiology and occupational health project group which consists more or less of only 1 researcher. The nanotoxicology and occupational hygiene project group has also managed to produce a remarkable number of scientific papers within this new field considering the recent reorientation. Several of these papers have already attracted citations.

6.7.7. Research quality

The scientific quality of the research executed within the nanotoxicology and occupational hygiene project group is regarded as very good and compares well with universities and other high-ranked academic institutions executing research in this field. The majority of the papers that have been published during the evaluation period have, however, originated from former activities that are not prioritized presently. Several of these papers are certainly of excellent quality. However, in light of the new strategy and the recent exploration of a new research topic, the quality of the more recent activities and papers concerning engineered nanoparticles is regarded as more important for this evaluation. We got the impression during the interviews that the motivation for the restructuring of the strategy towards nanotechnology among the researchers was high, and that important and highly relevant research projects on this new field already have been initiated and have to some extent resulted in new knowledge and publication of scientific papers of high quality.

It appears that the researchers have been successful in applying their research competence and experiences on nanotechnology research. The researchers have a wide variety of complementary competence of high standard, including aerosol physics, analytical and atmospheric chemistry, toxicology and molecular biology. The NRCWE also has infrastructure in the shape of advanced instrumentation, equipment for studies in field at workplaces or in-house, as well as access to both animal and human exposure models. In alliance with both national and international collaborators it appears that the NRCWE has created a solid and promising platform for further high quality research on nano-issues in the future. Already at the present stage the NRCWE can be considered among the leading international institutions within this fast evolving field.

The microbiological research at the NRCWE has traditionally been strong. This field has during the last years been reduced to one active researcher, now focusing on new "green" technologies such as microbially based insecticides in greenhouses and agriculture and using biofuels in power plants. In light of the limited size of this project group, both the scientific output and the quality are very good.

Both projects groups have proven the ability to attach well qualified master and PhD students, which often are driving forces for scientific quality and quantity.

6.7.8. Research relevance

Health issues in relation to engineered nanoparticle exposure are not a large occupational health problem in Denmark or internationally at the present time. It is regarded as an emerging issue, as the use of nanotechnology is expected to rise worldwide. There is a well founded concern regarding possible negative health effects after inhalation of such particles, but there is a lack of scientific knowledge.

Denmark, as many other countries in the world, has large ambitions in the field of nanotechnology. Therefore, the Ministry of Employment has included potential health hazards from new technologies in their Report of the future Working Environment from December 2005, as well as arising possible problems related to biotechnology.

The research at the NRCWE on these topics is regarded as highly relevant both for the Danish and the international society. However, one should not neglect the fact that a lot of unsolved problems - challenging also from a scientific point of view - remains in connection with traditional physical and chemical occupational exposures both in Denmark and internationally. In that regard the NRCWE taking on research within the *New technologies* field at the expense of research on current problems must be considered as a narrowed-down sharpening of the area of commitment, making available possible preventive actions before these new industry branches evolves. The downside of this strategy is that traditional occupational hygiene and toxicology

fields receive less attention and might become less readily available for the stakeholders. The change in strategic focus of the Centre is, however, well appreciated by the committee. Preserving such competence is not the responsibility of the NRCWE if they do not receive budget and incentives to do so.

6.7.9. Stakeholder involvement and use of research

The members of the project groups have presented scientific and popularized topics in numerous arrangements for stakeholders, and are present as experts and members in numerous boards of relevance to the authorities. During the interviews the stakeholders expressed that they in general were positive to the NRCWE's research in this field and their opportunities for influence and involvement. Many of the stakeholders were members in the reference groups of the research projects. Furthermore, most of the stakeholders were very positive to the sharpened focus on research within the *New technologies* field at the expense of research on present problems, while some would have preferred to preserve additional activities on other physical and chemical exposures as well and expressed their concern about this issue.

6.7.10. Conclusions and recommendations

The effort towards executing research on nanotechnology and occupational health related issues at the NRCWE is strong and powerful. It appears that the Centre is about to succeed in its efforts of retraining the highly skilled scientific staff to meet new challenges within this new and exciting field. Although the reorientation is quite recent, project activities and some scientific results have already appeared. The NRCWE should proceed in this direction.

It is the committee's impression that the ongoing and planned activities, the established national and international network of collaborators, as well the in-house competence and infrastructure constitute a very promising platform for future activities. Especially the contacts with technical environments developing new engineered nanomaterials are of importance and should preferably be pursued and further strengthened. This is of importance in order to have access to new materials and technologies that can be a potential future risk for Danish and international workers. Further collaboration with international research environments should also continue in the future.

It is also of importance for the NRCWE to perform field based research on these topics, aiming at assessing risks at workplaces as soon as the technology is mature and is in industrial use, and the scientific tools and methodologies are developed and available. The NRCWE should focus on this aspect in addition to all the required methodology development and model experiments that remain to be done.

The research on microbiological aspects of "green" technologies is at present dependent on one researcher, and must be considered vulnerable. The NRCWE should over time consider strengthening this area with a second researcher if such problems are considered to be of value for the Danish society.

The toxicological experts at the NRCWE are considered to be of a very high standard. This is of importance for the Centre in its advisory role for the authorities and the social partners on topics related to physical and chemical hazards. Educating such experts is a time consuming process. After the reorientation towards utilization of efforts on new technologies only, this educational process at the NRCWE might appear to have become more difficult. Since many of the central experts at the NRCWE educated under "the old school" are not easily replaced, the NRCWE should in the future prepare for competence transfer in this field, as well as maintaining the international network that is still active on research on these topics.

Finally, the term *new technologies* is not very accurate in describing the activities belonging under this strategic field. The term *new technologies* brings about associations to many topics, most of them not in line with the *new technologies* activities at the NRCWE. Hence, the use of this expression at the NRCWE for the activities described herein might be considered misleading. Furthermore, in a fast evolving society *new technologies* may rapidly become *old technologies*. The NRCWE can favorably consider renaming this strategic field into something more descriptive.

7. Evaluation – Centre level

7.1. Strategic leadership and organization

The Centre has reorganized during the past 2-3 years according to the new strategy, and is now structured as a matrix-like project organization. All ongoing projects are managed through performance contracts. To most of the employees the reorganization has resulted in substantial changes of the organization of work, leadership, and to some extent also a change of field of interest.

The evaluation committee found it complicated to get an overview of the organization of the NRCWE with different project groups, project clusters and expertise forums independent of the different strategic fields. However, the employee interviews revealed that the employees themselves seemed to find the organization rational. In general those interviewed reported satisfaction with the organization and their belonging.

The strength of a matrix organization is its flexibility in establishing and closing of projects. This supports the general practice at the NRWCE of temporary research themes. According to the performance contracts, a project has to be completed with the settled number of publications within the project period, and idea generation and financing for new projects should be in the pipeline prior to project conclusion. On the other hand, it can be challenging for the researchers to engage with other colleagues in cross-project activities such as the development of fundamentally new projects, especially when many of the researchers take part in two or more projects at a time. This can be especially demanding in interdisciplinary projects belonging to various strategic fields, research clusters, research groups and expertise forums.

The present organization of the NRCWE probably has not yet materialized its full potential, and it is too early to make very firm conclusions through an evaluation. Therefore the NRCWE organization should continue in the present track for some more time, before being subjected to a new evaluation. So far the organization appears to fit well with the chosen research strategy. Internal multidisciplinary collaboration has increased after the organizational change, which is good and in accordance with the strategy. Such collaboration is a means to address multifactorial problems and is not a goal in itself. Multidisciplinary collaboration can sometimes be challenging from an organizational point of view. At the NRCWE there are thematic overlaps between the project groups, and the Centre might consider a sharper profiling of the strategic fields simultaneous to stimulation to the aspired multidisciplinary collaboration between and within the projects.

The committee also suggests that the NRCWE evaluate the benefits of the six established expertise forums, whether they facilitate debate and development of multidisciplinary methods, approaches and projects across existing projects. In a challenging matrix organization these forums may play an important role, but it seems that they have not yet found their subsistence level, calling for reorientations or initiation of other organizational moves to obtain the effects sought.

Some of the basic science oriented researchers have left the NRCWE after the reorientation of strategy, and have to some extent been replaced by younger and less experienced personnel. This change appears to have been managed fairly well. The committee is impressed by how loyally and determinedly most of the employees seem to comply with the new strategy and with the Centre management. The staff emerges as highly motivated and enthusiastic, signalling positivity towards new research priorities and opportunities. We have no doubt that this successful implementation of a new organization is in a large part due to a strong and clear strategic Centre leadership. Our impression is that the Director General and the top management are universally trusted in the Centre.

In a period of great change and reorganization this probably has been the best way of driving the process effectively and thoroughly. However, the committee will point to the fact that the Centre

now is entering a new phase of consolidation, and that the needs of the staff in this new phase may be more of backing and support than of the strong strategic leadership. We will advise the Centre directors to be aware of these human needs (motivation, celebration of success, teambuilding etc.) in the future, to keep up the high motivation and enthusiasm among the staff.

The role of the Directors of project coordination is central at the NRCWE, acting as controllers of the project groups and coordinating the research conducted within and between the research clusters. Their role as liaisons between the project groups and the top management is important and equally challenging. During the employee interviews the committee got the impression that this function can be further developed, although the degree of satisfaction varied to some extent between members of the different project clusters. The committee recommends that these positions are strengthened in the future, with a stronger focus on human resources leadership.

7.2. Contact with authorities and stakeholders on a strategic level

The research conducted by the NRCWE reflect the current and future needs for research of the stakeholders and society as a whole (i.e. strategic research). The board of governors approves the research strategy on basis of recommendations from the top management. The strategy gives clear directives on which research fields are given priority and what kind of research within the research fields is given priority. The current seven research fields have been selected and prioritized among a large number of potential research topics, and research on other topics will only be initiated if there is a demand for it from the authorities.

It is clear that the NRCWE in general and several NRCWE employees are in contact with authorities and stakeholders almost on a regular basis, providing service and knowledge to the working life. Networking with stakeholders is important in order to identify research needs and demands and external funding, and to ensure general visibility. Some research groups at the NRCWE are very strong on this parameter, while others clearly have potential for improvement.

The stakeholders express that they in general are very satisfied with their influence on the NRCWE on strategy making and that the Centre is adaptive to stakeholder needs and changes in the society. The committee agrees with such statements. It is a recurrent theme between the national strategy and the NRCWE strategy. The committee has got the impression that the national strategy also to some extent is based on the NRCWE input. Hence, the NRCWE strategy seems to balance the best utilization of the NRCWE resources and competence for scientific research with the needs for the Danish society. The committee clearly sees that this approach has positioned the Centre firmly among the stakeholders and has resulted in a clear focus for the future.

The strategy of the NRCWE has a great focus on research close to the workplaces as well as on integrated multidisciplinary research and interventions, with a shifting of outcome focus towards attitude, behaviour and implementation of knowledge in addition to occupational health. Furthermore, the strategy opens for research on emerging risks such as engineered nanoparticles. The stakeholder interviews revealed that such strategic thinking was much appreciated by the stakeholders.

On the other hand, the committee can point out highly relevant research topics for the Danish society that the NRCWE does not prioritize or has closed down. Such concerns were also expressed by some of the stakeholders. However, it is the opinion of the committee that the NRCWE selection of research topics is well anchored between needs expressed by stakeholders and scientific relevance within the limitations of the available economic resources. The Centre by itself cannot be responsible for not prioritizing all relevant fields when they do not receive financial support to preserve their role as a national expertise centre on all topics to the full extent.

The primary users of research based knowledge in the Ministry of Employment are the Working Environment Authority and the National Board of Industrial Injuries with whom the NRCWE meets every quarter at Director General level in order to coordinate activities. Other important users of the NRCWE are the social partners, which are represented with senior representatives in the board of governors of the NRCWE, just as the Director General of the NRCWE takes part in the meetings of the Working Environment Council, which is a forum of high level social partner representatives counselling the Minister of Employment on OSH-related matters. Furthermore, the NRCWE cooperates with the Association of Preventive and Health Services in Denmark and other working environment advisers. A large and growing number of research activities take place in the shape of intervention studies in public and private organizations, which apart from being objects of research also are end users of knowledge. It is estimated that the NRCWE has carried out studies in more than 250 companies during the previous few years.

The Centre appears to have the required autonomy to fulfill the national assignment as the national research institute within this field, implying scientific and political freedom and independence. Although the stakeholders claim to have increasing possibilities for influence on the NRCWE strategy making and that the Centre has evolved towards being more adaptive to stakeholders needs, the committee has not observed any signs of unwanted control of activities or opinions. It appears that all changes in strategies and organization have been motivated by the Centre itself in order to fulfill their national role in the best possible manner within the given framework conditions in a changing Danish society.

The Director General of the NRCWE takes part in weekly meetings of the group management of the Ministry of Employment, in which issues of common interest is openly discussed. Our impression, both from interviews with the Director General and with the Ministry and Working Environment Authority representatives, is that these meetings are of high value for all parties, as information about work environment issues and research results can be distributed with least possible delay from the Centre to the authorities. Moreover, the Ministry's working environment questions and need for advice can be met in short time. As communication is frequent and close, all partners have possibility to influence each other.

From a scientific point of view it might be claimed that this potential frequent political influence on the NRCWE may seem unhealthy. However, as long as research methods and results are not subjected to political influence it is the committee's opinion that such close collaboration is a very good example of making use of scientifically derived knowledge in policy making. Furthermore, this practice represents a unique possibility for the NRCWE to adapt quickly to research themes of high relevance to the Danish working environment authorities. As long as these choices are not in conflict with balanced priorities from the social partners, potentially dislocating the NRCWE towards being a tool for the authorities only, this framework is making the NRCWE's possibilities to have knowledge-based influence on decision makers attractive on a European scale. The committee is confident that these matters are handled in a very balanced manner at present, both by the NRCWE and the authorities. The NRCWE should carefully preserve this position in the future, but should be sensitive to not become too closely linked to the Ministry.

7.3. Scientific output

The scientific output from the Centre is high, and is increasing. The committee recognizes that this evolvement is a response to the increased focus on scientific publication at the Centre. However, the output from most fields still reflects research performed before the organizational and strategic change, and in this respect this evaluation is performed too early to evaluate fairly the scientific output in the new organization with a new focus. However, by considering papers in the pipeline the committee has the impression that the increased focus on scientific productivity is preserved through the reorientation, and that the positive trend in outcome of

scientific publications most likely is to continue in the years to come. Despite the high and increasing scientific output of the NRCWE, not all fields are equally successful. The Centre should continue to pay attention to research groups with lower publication rates per researcher year than average, aiming to identify and solve limiting factors behind this loss in scientific productivity.

The committee has performed a bibliometric analysis of the publication history at the NRCWE during the evaluation period. Data collection has been carried out on the basis of the supplied publication lists from the NRCWE by combining the lists on Centre level and the lists from the different strategic fields. The publications included in the data set are articles, review articles, letters and editorial materials, as covered by Web of Science from Thomson Scientific (Internet version). We have not included articles in press or e-publications ahead of print without full bibliographic information. The citation counts were executed in May/June 2008 in Web of Science.

The publication list differs slightly from the supplied publication list on Centre level, as “Epub ahead of print” articles are counted in the year of the final publication, national scientific papers are excluded from the list, and some articles in the publication lists from the strategic fields were not included in the list on institution level and thus have been included. Furthermore, there was a slight difference between the combined original lists provided by the NRCWE and the results when searching in Web of Science for publications from the NRCWE. Some articles from the original lists were not retrieved because the address field did not include the name of the Centre (13), while supplementary articles retrieved from Web of Science with the Centre address were not found in the supplied lists from the NRCWE (24). Our dataset was adjusted to only include records from the provided lists. Finally, some scientific journals are not covered by Web of Science, making inclusion of in total 284 out of 314 published scientific papers (91%) in the evaluation period in the analyzed data set. In table 13, the publication score for the NRCWE for the period 2005-May 2008 is presented.

Table 13: Publications at the NRCWE 2005 – May 2008

	2005	2006	2007	May 2008	Sum
Papers in international peer reviewed journals	80	85	98	50	313
Papers covered in Web of Science	76	80	85	43	284
Review articles (in Web of Science)(included in the above)	4	6	6		16
Editorial material and letters (included in the above)	1	3	1	1	6
Percentage of papers in Web of Science	95 %	94 %	87 %	86 %	91 %
Citations (with self-citations)*	542	353	98	4	997
Citations (without self-citations)*	393	247	56	3	699
Citations per paper (including self-citations)**	7,1	4,4	1,2	0,1	3,5
Citations per paper (excluding self citations)**	5,2	3,1	0,7	0,1	2,5
Paper per researcher-year	1,2	1,3	1,5	-	
Papers in domestic peer-reviewed journals	2	5	6	-	13
Popular communications in Danish	49	69	67	20	205
Conference proceedings	106	120	86	10	322
Ph.D. Theses	4	5	4	1	14
Books and book chapters, included reports	7	11	9	-	27
Articles not cited (including self-citations)**	3	12	33		
Articles not cited (excluding self-citations)**	5	20	47		
Percentage of articles not cited (including self-citations)**	4%	15%	39%		
Percentage of articles not cited (excluding self-citations)**	7%	25%	55%		

*A self-citation to a paper is a citation in which the citing and the cited paper have at least one author in common (either first author or a co-author)

** We stress that the number or percentage of non-cited papers concerns the given time period. Within longer citation timeframes, more papers are expected to get cited. The citation window is too short give meaningful information about the citation rate for the last years.

In the period from 2005 to May 2008, 313 papers were published in 162 international peer reviewed journals. They got cited 997 times in total, and 699 times when excluding self-citations. The mean impact score in the period is 3.5 citations per paper when self-citations are included. In the period 2005-2007, about 20% of the publications covered in Web of Science are not cited. When not limiting the citation statistics to articles published in the period 2005-2008, the NRCWE papers have been cited more than 6.500 times during the evaluation period 2005-June 2008. Most of these citations are of course related to papers produced well before this period, but it is still an indication of quality that almost 2.000 international scientific papers, which are considered as very good, refer to NRCWE papers yearly. The average number of published scientific papers per researcher year during the former evaluation period covering the period 2000-2004 was 1.14. In the period 2005-2007 the corresponding average is 1.33. There is an increasing tendency within the evaluation period, illustrated by the increase to average 1.5 papers per researcher year in 2007. Additional 13 papers in 4 domestic scientific journals, 14 PhD theses and 27 books/book chapters/reports were published in the evaluation period.

Trend analysis of the scientific output at the NRCWE in the period 2005-2007 as compared to earlier years based on hits in Web of Science confirms a stable increasing scientific productivity over the period, and also a pronounced increase in the citation level for the last periods, as illustrated in table 14.

Table 14: Statistics of the NRCWE publications 2005- May 2008

	1999-2001	2001-2003	2003-2005	2005-2007
Number of articles in WoS	162	189	217	231*
Number of citations	312	319	502	623
Citation per paper	1,93	1,69	2,31	2,70

*All papers appearing in Web of Science in the period are included

Table 15 shows which papers from the NRCWE that have attracted most citations so far among the papers published in the evaluation period. As illustrated, a substantial number of these papers are dealing with themes that no longer are prioritized at the NRCWE.

Table 15: NRCWE papers ranked by citations 2005- May 2008

	Citing papers (including self- citations)
Wolkoff P, Nøjgaard JK, Troiano P, Piccoli B: Eye complaints in the office environment: precorneal tear film integrity influenced by eye blinking efficiency. <i>Occup Environ Med</i> 62:4-12, 2005	28
van der Auwera GA, Andrup L, Mahillon J: Conjugative plasmid pAW63 brings new insights into the genesis of the <i>Bacillus anthracis</i> virulence plasmid pXO2 and of the <i>Bacillus thuringiensis</i> plasmid pBT9727. <i>BMC Genomics</i> 2005;6(1 03).	24
Wolkoff P, Wilkins CK, Clausen PA, Nielsen GD: Organic compounds in office environments - sensory irritation, odor, measurements and the role of reactive chemistry. <i>Indoor Air</i> 16:7-19, 2006	24
Andersen LL, Tufekovic G, Zebis MK, Crameri RM, Verlaan G, Kjaer M et al: The effect of resistance training combined with timed ingestion of protein on muscle fiber size and muscle strength. <i>Metabolism</i> 2005; 54(2):151-156	23
Nøjgaard JK, Christensen KB, Wolkoff P. 2005: The effect on human eye blink frequency of exposure to limonene oxidation products and methacrolein. <i>Toxicol Lett</i> 156:241-25 1.	21
Vogel U, Overvad K, Wallin H, Tjønneland A, Nexø BA, Raaschou-Nielsen O: Combinations of polymorphisms in XPD, XPC and XPA in relation to risk of lung cancer. <i>Cancer Lett</i> 222:67-74, 2005	20
Hansen ÅM, Høgh A, Persson R, Karlson B, Garde AH, Ørbæk P: Bullying at work, health outcomes, and physiological stress response. <i>J Psychosom Res</i> 2006; 60(1):63-72.	19

Kristensen TS, Hannerz H, Høgh A, Borg V. 2005: The Copenhagen Psychosocial Questionnaire - a tool for the assessment and improvement of the psychosocial work environment. Scand J Work Environ Health 31:438-449	18
Søgaard K, Gandevia SC, Todd G, Petersen NT, Taylor JL: The effect of sustained low-intensity contractions on supraspinal fatigue in human elbow flexor muscles. J Physiol 2006; 573(2):51 1-523	18
Hansen R, Sæbø M, Skjelbred CF, Nexø BA, Hagen PC, Bock G, Lothe IMB, Johnson E, Aase S, Hansteen I-L, Vogel U, Kure EH: GPX Pro1 98Leu and OGG1 Ser326Cys polymorphisms and risk of development of colorectal adenomas and colorectal cancer. Cancer Lett 229:85-91, 2005	18

The 313 papers published within the evaluation period were published in 162 different international peer-reviewed journals, of which 131 are indexed in Web of Science. Of the 284 out of 313 papers covered by Web of Science, 173 papers (61 %) were published in journals with impact factor > 2. In table 16, the journals with most published articles in the evaluation period are listed with their impact factor (2007).

Table 16: Journals ranked by number of published NRCWE papers 2005 - May 2008

Journal title	Record count	Impact factor (2007)
OCCUPATIONAL AND ENVIRONMENTAL MEDICINE	16	2.82
EUROPEAN JOURNAL OF APPLIED PHYSIOLOGY	13	1.75
INDOOR AIR	13	2.89
SCANDINAVIAN JOURNAL OF WORK ENVIRONMENT & HEALTH	11	1.39
MUTATION RESEARCH-FUNDAMENTAL AND MOLECULAR MECHANISMS OF MUTAGENESIS	10	4.16
JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE	8	2.10
INTERNATIONAL ARCHIVES OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH	7	1.48
BMC CANCER	6	2.71
CANCER LETTERS	6	3.40
CONTACT DERMATITIS	6	2.77
AMERICAN JOURNAL OF INDUSTRIAL MEDICINE	5	1.60
ATMOSPHERIC ENVIRONMENT	5	2.55
ANNALS OF OCCUPATIONAL HYGIENE	4	1.49
BMC MUSCULOSKELETAL DISORDERS	4	1.32
INTERNATIONAL JOURNAL OF CANCER	4	4.56
JOURNAL OF APPLIED PHYSIOLOGY	4	3.63
JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH	4	2.96
SCANDINAVIAN JOURNAL OF PUBLIC HEALTH	4	1.22
WORK AND STRESS	4	2.09

Researchers at the Centre publish extensively with both national and international partners. The indicators of scientific collaboration in this report are based on the analysis of all addresses in the papers published by Centre employees. The NRCWE is collaborating with authors working in about 20 countries. Table 17 presents the originating countries of the co-authors' institutions from papers published in the evaluation period. Besides the Nordic countries, USA, the Netherlands, Canada, Germany and China are important co-publication partners for NRCWE researchers.

Table 17. Countries of collaborating authors

Country/Territory	Record Count	%
SWEDEN	34	12.1 %
USA	29	10.3 %
NETHERLANDS	16	5.7 %
NORWAY	13	4.6 %
CANADA	7	2.5 %
GERMANY	7	2.5 %
PEOPLES R CHINA	7	2.5 %
ENGLAND	6	2.1 %
FINLAND	6	2.1 %
ITALY	6	2.1 %
AUSTRALIA	5	1.8 %
SWITZERLAND	5	1.8 %
BELGIUM	3	1.1 %
FRANCE	3	1.1 %
POLAND	2	0.7 %
JAPAN	1	0.4 %
NEW ZEALAND	1	0.4 %
SCOTLAND	1	0.4 %
SPAIN	1	0.4 %
TAIWAN	1	0.4 %
WALES	1	0.4 %

Source: Web of Science

In the period 2005-May 2008 the NRCWE has published papers with researchers from approximately 200 institutions. Tables 18 and 19 give the most frequent collaborating national and international institutions, respectively. In the domestic list, both universities and occupational health clinics are well represented.

Table 18. The most frequent Danish collaborating institutions

Institution name	Record count	%
UNIV COPENHAGEN	40	14.2 %
UNIV AARHUS	29	10.3%
AARHUS UNIV HOSP	21	7.5%
DANISH CANC SOC	21	7.5%
BISPEBJERG HOSP	16	5.7%
UNIV SO DENMARK	12	4.3%
COPENHAGEN UNIV HOSP	10	3.5%
NATL INST PUBL HLTH	6	2.1%
NATL UNIV HOSP	6	2.1%
HILLEROD HOSP	5	1.8%
ROSKILDE UNIV CTR	5	1.8%
TECH UNIV DENMARK	5	1.8%
UNIV ROSKILDE	5	1.8%
AALBORG HOSP	4	1.4%
BISPEBJERG UNIV HOSP	4	1.4%
CENT HOSP HILLEROD	4	1.4%
DANISH BLDG RES INST	4	1.4%
HERNING HOSP	4	1.4%
RIGSHOSP	4	1.4%

Source: Web of Science

Table 19. The most frequent international collaborating institutions

Institution name	Record count	%
UNIV CALIF (US)	21	7.5%
UNIV LUND HOSP (SWE)	8	2.8%
SHENYANG MED COLL (CHN)	6	2.1%
FINNISH INST OCCUPAT HLTH	5	1.8%
NATL INST WORKING LIFE (SWE)	5	1.8%
ROESSINGH RES & DEV (NL)	5	1.8%
TELEMARK HOSP (NO)	5	1.8%
TELEMARK UNIV COLL (NO)	5	1.8%
ULLEVAAL UNIV HOSP (NO)	5	1.8%
LIAONING TUMOR HOSP (CHN)	4	1.4%
CHALMERS (SWE)	4	1.4%
NORWEGIAN INST PUBL HLTH	3	1.1%
SWISS FED INST TECHNOL	3	1.1%
UNIV GOTHENBURG (SWE)	3	1.1%
UNIV ZURICH HOSP (SUI)	3	1.1%

Source: Web of Science

Every journal in the Web of Science database is categorized in one or more subject areas. An analysis of the subject areas in the journals in which the papers are published can give an indication of the disciplinary orientation. The output from the NRCWE in the evaluation period is spread over 67 indexed fields. The most frequent fields are showed in table 20.

Table 20. Output per field 2005- May 2008

Subject Area	Record Count	%
PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	84	29.9 %
TOXICOLOGY	38	13.5 %
ONCOLOGY	29	10.3 %
SPORT SCIENCES	28	10.0 %
PHYSIOLOGY	25	8.9 %
ENVIRONMENTAL SCIENCES	20	7.1 %
GENETICS & HEREDITY	17	6.0 %
ENGINEERING, ENVIRONMENTAL	13	4.6 %
BIOTECHNOLOGY & APPLIED MICROBIOLOGY	12	4.3 %
CONSTRUCTION & BUILDING TECHNOLOGY	12	4.3 %
NEUROSCIENCES	11	3.9 %
PHARMACOLOGY & PHARMACY	9	3.2 %
ORTHOPEDICS	8	2.8 %
ENGINEERING, INDUSTRIAL	7	2.5 %
PSYCHOLOGY, APPLIED	7	2.5 %
REHABILITATION	7	2.5 %
ALLERGY	6	2.1 %
DERMATOLOGY	6	2.1 %
ERGONOMICS	6	2.1 %
RHEUMATOLOGY	6	2.1 %
MEDICINE, GENERAL & INTERNAL	5	1.8 %
METEOROLOGY & ATMOSPHERIC SCIENCES	5	1.8 %
MICROBIOLOGY	5	1.8 %

Source: Web of Science

7.4. Research quality

The research quality at the NRCWE is in general very high, and compares well with universities and other high-ranked academic institutions. However, not all fields are developed to this standard yet. In addition, many of the scientific publications from the evaluation period descend from activities that are no longer prioritized. Nevertheless, very good papers in the new strategic fields have already appeared, making promises for the future.

The committee considers as strength for the NRCWE that focus is on attaining scientific quality at university level within precisely defined fields that are derived from a clear-cut research strategy developed to meet current and future research needs. However, the shift in strategic fields may result in a drop in publications in high impact journals, because for instance journals on psychosocial health are not ranked as high as cancer journals.

Measures of the scientific quality (such as publication rates in international peer reviewed journals, citation rates, impact factors of journals, ability to attract external funding in competition with other national and international research groups) are frequently monitored at the Centre and are important factors in performance contracts with the Ministry of Employment, in internal performance contracts between management and the research groups, in regular individual career development discussions between the Director General and the researchers, as well as in annual salary evaluations. Mentor programs and courses in academic writing have been targeted at relevant researchers in order to improve international publication rates. The increased focus on research quality and quantity is indicated by the recent increase in number of annually published papers per researcher years at the Centre to a level of 1.5 in 2007. Increased focus on publication may very well result in increased research quality through the peer-review processes. However, as the Centre has high ambitions with regard to increasing publication rates, special attention should be directed towards the challenge associated with initiating demanding research projects where scientific publishing is not easily and immediately accessed.

The research infrastructure at the Centre is very good, and the establishment of large national databases secures longitudinal data input for promising and applicable research in the years to come. The NRCWE has an ambitious investment strategy and intends to be in possession of state-of-the-art laboratory equipment and IT. Strong scientific competences and a state-of-the-art infrastructure are of utmost importance in order to be an attractive research partner. Larger infrastructure investments are prioritized at the Centre in relation to the entering of annual performance contract between the Director General and the research groups. Sharing of research infrastructure is included in the cooperation agreements with the universities.

The researchers at the NRCWE are in general very competent and capable. It appears that the NRCWE has managed to recruit a staff capable of balancing the cross-pressure between the requirement for quick ad-hoc ministerial counselling and the requirement of in-depth research with long-term perspectives. The NRCWE has multidisciplinary competence and the major research fields of the national OSH strategy are covered by senior researchers. An indication of this can be extracted from the bibliometric analyses of NRCWE publication in the evaluation period divided into various fields classified by Web of Science, which affirm the multidisciplinary characteristics of research executed at the Centre, with the major area of interest within the field of public, environmental, and occupational health. Furthermore, internal interdisciplinary collaborative activities have increased at the Centre. This has reached a level that appears reasonable for an institution like the NRCWE.

A number of internationally recognized scientists, especially in the fields of *Work-related pain in muscles and joints* and *Psychosocial working environment*, have either gained professorships at universities or retired. The NRCWE has recruited a number of young senior researchers in these key fields. This process appears to have accompanied a simultaneous change of generation and strategy. Loss of seniority, experience, and overview has been replaced with enthusiasm and

talent. Some scientists who have left maintain collaboration with the NRCWE. It is too early to conclude how the turnover of personnel will affect the output of the NRCWE.

It is a weakness that some of the scientific fields are small and vulnerable to personnel turnover. The committee therefore suggests that when these fields have proven to be able to attract external funding to also increase the internal support and thus increase the critical mass in these research fields. The NRCWE is currently recruiting professors in the fields of *Psychosocial working environment* and *Organization and management*. The employment of these two professors and of a senior researcher with clinical experience in the field of *Absence and exclusion* further completes the adjustment of the competence profile to the requirements of the current strategy. The committee also recommends that the NRCWE invests (i.e. by increasing senior staff) in the relatively small research groups committed to the strategic fields *Occupational accidents, Musculoskeletal disorders* and *Noise* if they prove to be able to attract sustainable external funding in the future.

As most of the attention the last years appears to have been directed towards building a new organization after a major organizational and strategic change, less energy appears to have been put into detailed planning of future research and innovation. The need for consolidation of the Centre is understandable, but we will recommend some more detailed prospective thinking in the time to come beyond the higher strategic level and short term planning. The role of the expertise forums was to initiate such thinking, but the committee is of the opinion that these ambitions have not yet materialized to any great extent. A clearer focus on these important elements might certainly improve the research quality at the Centre even more in the future.

7.5. Relevance of research and effects on society

Due to its firm position as an independent Centre among the social partners, close relations with the Ministry and the National Working Environment Authority as well as close adaption to national strategies and priorities, the NRCWE impact on resolving societal questions and support policy decisions is regarded as high. Close collaboration with the Information Centre at the NRCWE opens more and promising perspectives.

Most of the large scale intervention studies have outcomes in the field of health, and further studies may include more emphasis on cost effectiveness and other outcomes such as work ability, and worker performance in order to improve stakeholder usability even further.

7.6. Dissemination of research and knowledge

The Centre appears to be very aware of its responsibility as a national competence Centre for working environment. Many channels of knowledge dissemination are utilized regularly. Among many important channels the Director General's weekly meetings with representatives of the Ministry stands out as important for the Centre. In these meetings an opportunity exists to communicate new knowledge about working environment issues directly to decision makers of the Danish society. Our impression, through interviews with both the Director General and Ministry representatives, is that this close cooperation is of great importance to both parties.

Training of new researchers is important to secure continuity of the research field. Senior researchers at the NRCWE seem to be aware of this responsibility, and many students, both at the NRCWE and at the Universities, are mentored by NRCWE researchers. Several of the senior researchers also teach on a regular basis at University courses. This activity varies somewhat between the strategic fields, but is high at the Centre as a whole.

As regards dissemination of knowledge to the general public, much of the Centre's activity is based on websites and e-mail newsletters. It is the committee's general impression that the website is good and informative, and that the NRCWE is prioritizing these activities. For the

international audience, however, some weaknesses on the English version on web site were identified. The most striking is that at several places, under the heading “News”, notices from 2004 and 2005 were found. We suggest that the NRCWE also updates the English version of the website, or reduce the level of ambitions on the English version towards something more descriptive with fewer needs for continuous updating and maintenance.

NRCWE researchers also disseminate research results and general knowledge directly to stakeholders and end-users on a regular basis through lectures at seminars and conferences, popular scientific publications and through direct communication based on enquiries. The target groups appear to be content with this service provided by the Centre.

In total, the NRCWE disseminates their research and knowledge extensively through many channels, and great efforts are made in making this information available for all parties. The NRCWE appears to have reached the general public with their information by numerous and frequent appearances in electronic and printed media as well as in radio and television news.

7.7. National and international networking and collaboration

Strategic cooperation with the universities, the occupational health clinics and international networks has contributed to the establishment of scientifically strong multidisciplinary teams even in fields where the NRCWE does not have all the relevant competence in-house. The national and international collaboration of the NRCWE is regarded as very good. However, there is some unused potential for further national and international collaboration.

The NRCWE management encourages close ties with universities aiming to improve the competences of researchers through research, lecturing and mentoring, in addition to giving access to university infrastructure and future researchers at the NRCWE. Collaboration also makes NRCWE equipment and infrastructure available for universities, resulting in cost-effective utilization of resources for the Danish society. Furthermore, teaching by NRCWE researchers at universities is an asset in academic education of future researchers in this field. The committee considers that the NRCWE has made teaching and supervision to universities available to a sufficient extent, and has as well contributed to undergraduate, postgraduate and PhD-education at the universities according to the expectations. During the evaluation period 54 PhD students and at least 92 bachelor/master students are or have been supervised by NRCWE researchers, respectively. The number of supervised bachelor/master students is most likely higher as only bachelor/master students graduated during the evaluation period from the field *New technologies* has been reported (Table 5).

The collaboration with universities in Denmark appears to be increasing in accordance with the expectations from Ministries and stakeholders. This fact is clearly illustrated by the bibliometric analyses of the NRCWE scientific publications in the evaluation period demonstrating that the NRCWE has published more than 100 papers in co-authorship with domestic university personnel. Several of the stakeholders had the opinion that this collaboration can be further expanded in the future, when the effects of the recent collaboration agreements with universities have materialized. Especially the collaboration with technical institutes at the universities in the field of engineered nanoparticles seems promising for the future.

The publication statistics also reflect that the NRCWE has strong ties with a large number of recognised universities, hospitals and agencies in Europe and the USA, illustrated by co-authorships with researchers from foreign institutions on more than 150 papers during the evaluation period.

The committee highly appreciates the role the NRCWE has taken on the European arena, especially through its representatives' responsible participation in international OSH forums like PEROSH and NEW OSH ERA. The Centre has, through its recent chairmanship, been a driving

force in developing PEROSH towards an operative network, and is regarded as an important and collaborative organization in the international OSH environment.

On the strategic field level the international activity is more diverse at the NRCWE, with some groups having developed large international networks whereas others concentrate on national cooperation. Our general impression is that the possibility for EU funding of projects has not yet been extracted to its full potential throughout the Centre. During the researcher interviews several claimed that the reason for not aiming higher for EU funding was the time and resource consuming application process, and that the NRCWE was not able to provide sufficient academic administrative assistance within the Centre. These statements were disproved by the the NRCWE management during interviews, also pointing at available national resources in this regard. The committee suggests that the Centre carefully examines possible practical and administrative obstacles limiting the researcher's enthusiasm for applying for EU funding, including improved announcing of available aiding resources internally and externally.

7.8. Financial situation

Resources from basic funding at the Centre are unevenly distributed among the various strategic fields. The strategic field *New technologies* consumes almost 50% of the internal funding allocated directly to research at the Centre in 2007, while *Work-related pain in muscles and joint* receives 15%. The other strategic fields receive 6-9% of the internal research funding in 2007.

The Centre's financial contributions to the various fields reflect not only the activity levels but also differences in need for staff and resource consuming activities. The *New technologies* field is an example of a resource demanding field since both laboratory equipment, infrastructure in general, and running costs are expensive.

The differences in basic funding are, however, to some extent outweighed by the availability of external funding. In total, the Centre's use of resources on the different fields seems to be reasonable in accordance with the strategic priorities. However, the Centre should continue to examine critically the access and ability to external funding for projects within the different strategic fields, aiming at adjusting imbalances or even sharpening research profiles if external funding is not available and internal funding is not sufficient to reach a critical amount. If the *New Technologies* field proves to continue the positive development in attraction of higher rates of external funding in the years to come, and required initial investments in this new effort are carried out, the need for sustained basic funding to this field to should be critically examined in the future.

Both the universities and the NRCWE have benefited from the government decision that NRCWE must collaborate with the universities, through a closer and more systematic interaction than previously. However, regarding the pecuniary benefits of the government decision, the NRCWE and the universities appears to not have been treated on equal terms. Additional government funding in order to increase the standing of Danish research in a globalised world, e.g. new concepts for indirect costs to make it more attractive to engage in international fundraising, has been strictly for the universities. The NRCWE has not been given formal access to these additional sources.

In the Danish national advisory and funding system for research and innovation, which is administered by the Ministry of Science, Technology and Innovation, the NRCWE has had difficulties in obtaining funding for large OSH research projects. This also pertains to the EU framework programmes on research and technology. The NRCWE therefore take part in consortia with universities and private enterprises in order to carry out the OSH related part of broad and large health or environmental research programmes.

The research of the NRCWE ranges from "oriented basic research" via "generally directed applied research" to "specific applied research" (OECD definitions). When needs for knowledge

are perceived as important by stakeholders, funding is usually made available through research councils or through contracts directly with a research institute. However, research questions may also favorably be generated by scientists who interact with the international knowledge front and by the users of knowledge (stakeholders). The NRCWE has a certain degree of basic funding for such purposes.

The external funding relative to direct research costs has increased from 50 to 63% in the period from 2005 to 2007 at the NRCWE. This is illustrating the Centre's ability to obtain funding in competition with other research institutions, but is also reflecting the increased availability of funding from the national Work Environment Research Fund through the strategic reorientation of the NRCWE.

The success of funding of research depends to a large extent on the competence of the processes of selecting projects and research groups to receive funding. In addition to research goals, potential applications, and usefulness of the project outcome, methods, feasibility, and competence of research groups must be assessed. Therefore, the question of taking out a share of the NRCWE's present government funding and subjected it to open competition for any institution, depends to some extent on the competence of the decision makers of the Danish Work Environment Research Fund.

In this regard it is important to highlight that endusers of knowledge and stakeholders usually are not scientists and cannot be fully updated on the newest and/or on very complex research problems. Hence, they depend on understanding what scientists and advisors communicate to them for making strategic decisions on research priorities. Furthermore, mass media pressure may motivate stakeholders' choices. Therefore, it is important that a national research center can control sufficient funding to pursue new research questions (e.g. new potential threats), and to develop methods that their scientists consider significant.

Many of the stakeholders stressed that the present level of external funding is above the optimal level of an institution like the NRCWE, which has a special responsibility for execution of long-term research and building of competence in this important field with special requirements for stable funding, independent of changes in availability of external funding and political climate. The committee certainly shares this opinion, and does not recommend any further exposure to competition of the NRCWE basic funding. The Centre is already competing for funding at a level that stimulates to the desired quality improvement and cost efficiency. Increased exposure to competition does in our opinion not increase the potential for further quality improvements, and even if the NRCWE is getting in turn the eventual outsourced funding through the competition process, it is assumed that a certain fraction of the finances is lost on the way due to administrative costs associated with the funds administration. It is a fact that externally funded projects seldom are covering all cost consuming activities in relation to the project, for instance administrative expenses, often making the need for co-financing from the NRCWE to externally funded projects required. This is a major weakness, because the NRCWE co-financing of externally funded research ties resources to externally determined research themes and thereby undermines the capacity of the NRCWE to independently initiate research in strategically important fields.

The committee therefore suggests that the optimal basic funding rate for the NRCWE in order to fulfil its national commitments should be at least on the same level as at present stage.

8. Overall conclusions and recommendations

In light of the recent strategy shift and reorganization of the NRCWE it is important to call attention to the fact that many of the implying major changes at the Centre still are in progress and not yet have had the opportunity to materialize to their full potential. The evaluation has been carried out keeping this limitation in mind.

The main conclusion from the evaluation is that the Centre is moving along the new strategic pathways well in accordance with incentives and plans. The committee recommends the NRCWE to continue in these tracks according to the anchored strategic frameworks in the years to come.

The research strategies and projects at the Centre are in accordance with national priorities and strategies. The NRCWE output is highly appreciated and looked upon as valuable by stakeholders as social partners, working environment advisers, enterprises and authorities, and the strategic direction is in accordance with stakeholder requests and expressed needs. The applicability of the scientific output from the NRCWE among the different stakeholders is increasing. It is the opinion of the committee and of most of the stakeholders that the strong strategic leadership of the Director General personally has been a critical success factor behind the recent transformation of the Centre. As much of the attention the last years has been directed towards building a new organization after a strategic change, less energy appears to have been put into detailed planning of future research and innovation within the strategic framework. NRCWE is now entering a more operational phase, and the committee recommends the Centre to devote more attention to the midterm future.

The NRCWE is providing scientifically based knowledge to the Ministry of Employment and the National Working Environment Authority to an extensive and increasing content, and thereby contributes substantially to the formulation of policies and the exercising of authority within this field. The Centre should preserve this role in the future.

The committee can point out highly relevant research topics for the Danish society that the NRCWE does not prioritize or even has closed down. Such concerns were also expressed by some of the stakeholders. However, it is the opinion of the committee that the NRCWE selection of research topics is well anchored between stakeholder needs and scientific relevance. The Centre by itself cannot be responsible for not prioritizing all relevant fields when they do not explicitly receive financial support to preserve their role as a national expertise centre on all topics to a full extent.

The collaboration with universities in Denmark appears to be increasing in accordance with intentions and expectations. This increased collaboration is however still in an initiating phase but has positive prospects and should be firmly established in the future aiming to identify projects and activities where both parties can benefit substantially from collaboration. The committee considers that the NRCWE has made teaching and supervision to universities available to a sufficient extent, and has contributed to undergraduate, postgraduate and PhD-education at the universities according to the expectations.

NRCWE researchers collaborate extensively with national and international researchers within a wide range of research fields. However, there are some differences on the strategic field level regarding especially international activities. The committee highly appreciates the role the NRCWE has taken in the European arena, and recognizes the Centre as an important and collaborative organization in the international OSH environment. However, our general impression is that the possibility for EU funding of projects not yet has been extracted to its full potential throughout the Centre. The committee suggests that the Centre carefully examines possible practical and administrative obstacles limiting the researcher's enthusiasm for applying for EU funding, including improved announcing of available aiding resources internally and externally.

The NRCWE disseminates their research and knowledge extensively through many channels, and great efforts are made in making this information available for all parties. The NRCWE appears to have reached also the general public with their information by numerous and frequent appearances in various media. Close collaboration with the Information Centre at the NRCWE opens even more and promising perspectives. This potential should be fully utilized to optimize the impact of NRCWE research on society.

The research quality at the NRCWE is high, and compares well with universities and other high-ranked academic institutions. The scientific output from the Centre is also high, and is increasing. However, the output from most fields still to some extent reflects research performed before the organizational and strategic change. However, the committee has the impression that the increased focus on scientific productivity at the Centre has been preserved through the reorientation, and that the positive trend in outcome of scientific publications most likely is to continue in the years to come with a clearer profile on new priorities. The scientific output from all fields is not equally successful and the Centre should continue to pay attention to research groups with lower publication rates per researcher year than average, aiming to identify and solve limiting factors behind this loss in scientific productivity.

The research infrastructure at the Centre is very good and in accordance with requirements from the strategic priorities, providing a good platform for the research activities. The IT and scientific instrumentation infrastructure are of high standard, and the establishment of large national databases secures longitudinal data input for promising and applicable research in the years to come. The focus on infrastructure is regarded as an asset and competitive edge for a research institute like the NRCWE and should be preserved in the future.

The strength of the established matrix-like organization at NRCWE is its flexibility and increased incentives for multidisciplinary collaboration. On the other hand, the organization is complex with potential challenges for the researchers to feel a sense of belonging to their organizational base. All in all the new organization appears to fit well with the chosen research strategy and the organizational needs. The aspired multidisciplinary collaboration, which beyond doubt has increased substantially as a consequence of the new strategy, might however be even further stimulated by a sharper profiling of the strategic fields. As the Centre now is entering a new phase of consolidation and production, the future needs of the staff may be more of backing and support than of strong strategic leadership. We will advise the Centre management to be aware of this and put increased emphasis on people management and coaching leadership in the years to come.

The researchers at the NRCWE are very skilled with high competence within the prioritized areas as well as in working environment topics in general. The NRCWE staff is capable of managing both counseling of stakeholders and scientific productivity, and emerges as highly motivated and enthusiastic, signaling positivism towards new research priorities and opportunities. The committee is impressed by how determinedly most of the employees comply with the new strategy. The substitution of highly skilled senior researchers with younger researchers in some strategic fields during the reorientation appears to have been managed fairly well.

It is a weakness that some of the scientific fields only have a next-to critical mass and consequently are vulnerable to personnel turnover. The committee therefore recommends that the NRCWE invests (i.e. by increasing senior staff) in the relatively small research groups committed to the strategic fields *Occupational accidents*, *Work-related pain in muscles and joints* and *Noise* if they prove to be able to attract sustainable external funding in the future. This would increase the critical mass of the research capacity in these strategic fields to a more desirable level. This may be balanced by a reduction of the internal funds of the *New technologies* field in the future since this strategic field consumes almost 50% of the internal funding in 2007 and has proven to be able to attract higher rates of external funding in 2008 and presumably in the years to come.

Most of the stakeholders pointed out that the present level of external funding is above the optimal level of an institution as the NRCWE and that a higher degree of basic funding than today from the ministry would have been welcome, making the Centre less vulnerable to changes in accessibility to external funding. On the same side, the stakeholders did express that some level of competition is good for the NRCWE. A distribution of 30 and 70% between external and basic funding, respectively, was expressed by several of the stakeholders as ideal for the NRCWE in the future. The committee also is of the opinion that the optimal basic funding rate for the NRCWE in order to fulfil its national commitments should be at least on the same level as the present one. Increased exposure to competition does not increase the potential for further quality improvements in the opinion of the committee.