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Interventions for safe and healthy work

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I: Eklöf M & Törner M (2002) Perception and control of occupational injury risks in fishery. A pilot study. *Work and Stress,* 16(1), 58-69

II: Törner M & Eklöf M. Participatory analysis of accidents and incidents as a tool for increased activity in safety work among fishermen. A pilot intervention study. Accepted for publication in *Work and Stress*

III: Eklöf M, Ingelgård A, Hagberg M (2004) Is participative ergonomics associated with better working environment and health? A study among Swedish white-collar VDU-users. *International Journal of Industrial Ergonomics* 34, 355-366

IV: Eklöf M, Hagberg M, Toomingas A & Wigaeus Tornqvist E (2004) Feedback of workplace data to individual workers, workgroups or supervisors as a way to stimulate working environment activity. A cluster-randomized controlled study. *International Archives of Occupational and Environmental Health*
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V: Eklöf M, Hagberg M. Are simple feedback interventions involving workplace data associated with better working environment and health? A cluster randomized controlled study among Swedish VDU workers. *Submitted*

Contents

1. Introduction

1.1 The problem areas generally

This thesis is about: 1) Individual and social factors that may influence activity to modify the working environment, 2) general characteristics of how working environment change processes are organized, and their associations with working environment and health, and 3) interventions designed to stimulate activity to modify the working environment and their effects in terms of activity, working environment and health.

The studies were made in two different kinds of work; fishery and office visual diplay unit (VDU) work. Fishery is one of the most injury stricken fields of occupation. Still, fishermen often do not give priority to preventive safety work. Aspects related to activity in such preventive work are focused by studies I and II in this thesis. Musculoskeletal complaints are common among VDU workers. Aspects relevant for the prevention of such complaints are focused by studies III, IV and V in this thesis. Studies II, IV and V were intervention studies. The interventions were directed at the process of problem analysis and decision making with respect to preventive action. There was also an ambition to integrate efforts of researchers, occupational health services, supervisors, and workers in this process.

The disposition of this introduction will be as follows: After some terminological notes, the general causal context of occupational safety and health problems will be outlined. Some special attention will be given to psychological, social, and organizational factors in relation to occupational safety in general and in fishery in particular. Special attention will also be given to ergonomic, psychosocial and individual factors as predictors of musculoskeletal disorders among VDU workers. After this, perspectives on prevention and intervention are outlined. Special attention will be given to safety intervention research in fishery, ergonomic intervention research among VDU-users, and stress prevention research. Special attention is also given to a common type of working life intervention: Feedback.

1.2 Some terminological notes

Since the term “accident” may have connotations that imply unpredictability and unpreventability, it has been suggested (26) that it should not be used. This is because many “accidents” may be predicted as well as prevented. A generally accepted alternate term does not seem to exist, however. Hagberg *et al* (46) suggested that “occupational injury” should be defined as “any damage inflicted to the body by energy transfer during work with a short duration between exposure and the health event…”. In this thesis, the word “injury event” will be used to denote an unintentional event where someone was injured (in which case the duration between exposure and health effect was short). If the event did not result in injury, but could have done so if intentional or unintentional circumstances had not prevented this late in the chain of events, I will speak of a “near-injury event”. Events (or stable working conditions and –behavior) may have health effects that do not show until after repeated or prolonged exposure (46). This category of events may among others

include events that may be linked to musculoskeletal disorders and psychological stress (of course, many events involving psychological stressors do not imply any transfer of physical energy; they must be understood in terms of information that implies some threat to the individual). I will call such events "exposure episodes".

The word "interventionist" will be used to denote persons who enter an organization or group with the explicit intention of influencing it.

The term "VDU-work" will be used to denote work performed using visual display units, in the case of studies III, IV and V this involved personal computers.

The term "working life intervention" is used to denote interventions that are implemented in a working life setting, as contrasted to clinical settings.

1.3 The causal context of work-related safety and health problems

1.3.1 A general perspective

Occupational safety and health are commonly thought to be multifactorially determined. Individual, social, organizational, technological, physical, economical and societal conditions, or "factors", are thought to interact in ways that may influence the risk of injuries or other health problems. Similarly, the activity to prevent health problems may be influenced by constellations of such factors. Although researchers may present theoretical models for occupational health, e.g. (17; 57; 115; 122), organizational preventive activity e.g. (40), or interventions, e.g. (12; 66; 122), few, if any, studies are able to encompass the totality implied by the theoretical models. The studies in this thesis are no exception to this.

Some features of causal models will be summarized in this section. Features of models for prevention and intervention will be summarized in section 1.4.

Emphasis on systems: The theoretical models usually assume complex patterns of interaction between causal factors, implying that a systems (62) perspective is necessary in order to understand why health and safety problems occur. Before and during an injury/near-injury event or exposure episode various conditions may act to influence the outcome. A key feature is that injury/near-injury events or exposure episodes are not seen as isolated phenomena. Rather, they are seen as related to factors of different natures and at different distances temporarily and spatially from the immediate events during which harm occurs.

System components are of different natures: Factors of different kinds can contribute to unsafe or unhealthy working conditions and –behavior: Physical environment, workload, work organization and formal power distribution, technology, individual psychological characteristics (e.g. personality, or working-technique), interpersonal relations, social norms and cooperation, incentives, recruitment, the way occupational safety and health is managed, organizational culture, the way an organization interacts with its environment, legislation, or other society-level phenomena (4; 9; 25; 57; 93)

A time perspective: Conditions that may influence the probability and outcome of an injury, near-injury event or exposure episode can be operative at different points in time. Generally, one may speak of "pre-event" "event" and "post event" (9). The "pre-event" phase may be analyzed further. Backström (7) discussed "lack of control" (a point in or segment of time when a work system can be said to become unstable;

this can occur already during the design of the system), “loss of equilibrium” (a point in time where the instability becomes evident and some corrective action is necessary) and finally “loss of control” (the point in time at which the injury-inflicting forces come out of control). Unless something intervenes at this point, injury-inflicting forces may reach individuals, causing an injury or exposure episode.

General risk factors vs. specific risk factors: Risk factors may influence the probability of specific injury types (e.g. slippery decks, or inadequate working technique) or influence the risk of injuries more generally (e.g. product or production system design without concern for ergonomics).

Power to influence is heterogeneously distributed between individuals and parts of a work system. The design of working environments and behavior in them may be influenced by decisions and behavior at higher levels of organizational (e.g. budgets), or societal (e.g. legislation) hierarchy as well as decisions and behavior on lower levels, e.g. in workgroups or by individual workers or supervisors. Decisions may have more or less far reaching consequences for environment and health.

As implied by the above, safety and health problems may be difficult to fully understand and predict. In consequence, suitable prevention methods may be difficult to find.

1.3.2 Psychological, social and organizational factors in safety research

Safety research has considered personality, attitudes and cognitive factors on the individual level as well as social and organizational factors. Combinations of such factors are considered in the context of “safety climate”.

Personality is usually defined in terms of “traits”, which are seen as enduring psychological characteristics in terms of “recurring regularities and trends in a person’s behavior” (51) that may be useful for differentiating among individuals. Associations between traits and involvement in injury events have been studied. For example, a general tendency to accept risks has been found to be associated with increased risk of injury due to road crashes (111). But more generally, results in this field have been inconsistent and inconclusive (71). This may in part be explained by the fact that other individual as well as situational factors play a role in determining if an individual gets involved in an injury event. As long as traits are regarded as stable characteristics and considering the inconsistent research findings, occupational safety interventions into personality seem less promising. This does not exclude the possibility that in individual cases personality characteristics may increase the risk of involvement in injury events, or that some intervention into personality may decrease such risk. In the latter case, however, we are speaking of therapy, not working life interventions.

An attitude is another type of individual characteristic. An attitude can be said to involve an evaluative position towards a psychological object (i.e. ”something”) (3). Positive attitudes towards workplace safety, low acceptance of risks and risk taking as well as low fatalism have been reported to predict lower injury rates in organizations (71), but social norms as well as specific situational factors are thought to influence the degree to which individual attitudes are actually expressed behaviorally (29). This makes attitudes unreliable as predictors of behavior.

Safety research has also studied associations between cognitive factors and involvement in injury events (71). Failure to attend to and/or properly interpret sensory clues to risks may lead to acute risk exposure and injury. Situations of hurry and stress may affect attention and cognitive processing negatively, thereby increasing the risk for errors. In cognitively oriented stress research (72) as well as safety research (84), concepts have been developed that refer to cognitive processes of appraisal in stressful or hazardous situations (situations implying threat to values and interests of the individual) as well as behavior tendencies in such situations. Coping refers to the way in which the individual deals with stressful (e.g. hazardous) situations. The degree of problem-focused coping (actively attempting to control risk factors) is, according to theory, influenced by primary appraisal (perceived personal risk; severity of problem), secondary appraisal (perceived manageability of the threat/problem), individual characteristics such as locus of control (97), and coping resources such as material resources, skills and social support. Perceived manageability is seen as a key factor for problem focused coping. Unless perceived as manageable, the problem will not be actively dealt with.

Social factors may include norms and distribution of authority. For example, norms in favor of safe behavior may be associated with social reinforcement of such behavior. Distribution of authority determines the influence that behavior and attitudes of an individual may have in a group. Supervisor, peer and team support for safe practices have been reported to be associated with lower injury rates (71).

Finally, organizational factors have been considered in the occupational safety context. The existence of safety regulations, recommendations, and routines are among these. The design of the individual job may involve exposure to risks (71).

The concept “safety climate” combines factors of the kinds described above. Flin et al (40) reviewed 18 measures of safety climate. Common features of these measures were identified: 1) Management and supervisor attitudes and behavior with respect to safety, 2) organization of safety work, safety policies and regulations, standard of safety equipment (“safety system”), 3) risk perception, risk behavior, attitudes and personality dispositions towards risks (“risk”), 4) work pressure, balance between production and safety, and 5) competence and skill in the workforce, and among supervisors and managers. Note that adequate technology is implied as important for safety. The standard of technology has obvious implications for safety; fallible equipment may lead to risk exposure and injury. The ability and willingness to implement safe equipment and use it safely probably depends on the kinds of psychological, social and organizational factors discussed above as well as the interplay between ergonomic characteristics of the equipment, the characteristics of the individual user and situational demands.

1.3.3 Safety research in fishery

Fishery is one of the most injury stricken fields of occupation (114). Still, fishermen often do not give priority to preventive safety work. Economic considerations are predominant in this context. In order to maintain an acceptable income, the fishermen go to sea in increasingly severe weather conditions or may overload their boats to secure a large catch (80). Research into the role of psychological and social factors in safety among fishermen is rare, but factors such as perceived risk, attitudes, and

cultural norms favoring fatalism and risk acceptance have been claimed to counteract active safety work and rather be directed towards handling the job, in spite of the risks (114). The relative importance of these predictors seems to be beyond present knowledge. Murray *et al.* (81) studied relations between fatalism (external locus of control), anxiety, and worries, respectively, and injury exposure as well as activity in safety work, among Newfoundland fishermen. Results concerning injury exposure were inconclusive, but associations between fatalism and anxiety, respectively, and activity in safety work were suggested.

Study I was designed to explore whether similar results could be found among Swedish fishermen; study II included an attempt to study these aspects on a more specific level, using a case study approach.

1.3.4 Ergonomic, psychosocial and individual factors as predictors of musculoskeletal disorders among VDU workers

Musculoskeletal complaints are common among VDU workers. Such complaints have been found to be associated with ergonomic as well as psychosocial factors (59) at work (14; 47; 86). Stress is another common problem in working life that is related to psychosocial factors and may be associated with musculoskeletal complaints (95). Consequently; both aspects of work stand out as possible areas for interventions. Ergonomic and psychosocial factors involve several specific aspects, e.g. workplace design, individual working technique, psychological demands, decision latitude and social support, that may interact in creating specific exposure conditions and health outcomes (116). Ergonomic and psychosocial conditions at the individual workplace may in turn be influenced by more general organizational conditions, e.g. business trends, innovations in production technology, management trends (17; 21; 88).

Individual factors may be of different kinds. Working technique, body size, weight, muscle mass, general physical fitness, gender and age may be associated with variations in exposure to mechanical load, particularly in combination with standardized workplace or job designs. Constitutional or acquired biological and psychological vulnerability, as well as socioeconomic factors, may also be associated with variations in risk for musculoskeletal disorders (20). Since psychological stress is thought to play a role in the etiology of musculoskeletal disorders, all individual psychological characteristics studied in stress research may be relevant, e.g. type-A behavior, hardiness, locus of control, neuroticism, sense of coherence (100), and overcommitment (103). An individual factor that is of concern in ergonomics is working technique. Working technique in VDU-work may be defined in terms of movement patterns, positions, and degree of muscular tension during work (76). Different aspects of working technique have been found to be associated with physical load and symptoms (76).

Focusing on individual differences in occupational health research may be interpreted as encouraging “victim blaming”. Furthermore, ergonomics is about fitting the task to the human, so although individual characteristics may play a role, the analysis of problems and the design of ergonomic working life interventions may focus entirely on job design, workplace design, and other environmental factors. However, instruction and training in working-technique may be part of working life

interventions. Prevention may also include examinations during recruitment in order to avoid employing persons judged to be vulnerable to the exposure involved in a job.

Although individual psychological characteristics may play a role, the feedback intervention study among VDU workers (studies IV&V) reported in this thesis did not consider other individual characteristics than working technique.

1.4 Working life interventions for safe and healthy work

Since the causal context of safety and health problems is complex, preventive interventions must somehow manage this complexity. This means that there are many types of intervention focuses, strategies, and problems. I will attempt to present a number of important perspectives on interventions, with special attention to psychological and organizational aspects. The latter is important because human thinking and decisions determine how working-environments and behavior in them emerge.

1.4.1 Some general aspects

Focus on details or focus on systems: Working life interventions may be aimed at individual characteristics, the design of individual jobs, individual workplaces, or specific pieces of equipment. On the other end of the spectrum are approaches involving entire organizations. One may discriminate between individual level, group level, and organization level interventions (21). The latter approaches are similar to approaches adopted in organizational development (25; 47). Furthermore, organization-wide intervention approaches may involve many kinds of specific sub-interventions designed to influence different types of relevant factors (93). This complexity makes cause-effect conclusions uncertain. Although intervention research with direct relevance for occupational health, as well as research on organizational development, which may include health related aspects, has been carried out for decades, the evidence base for occupational health interventions is still claimed to be unsatisfactory (121).

Primary, secondary and tertiary prevention: A time perspective may also be applied to interventions. They may be designed to prevent any exposure to health risks during work (e.g. designing production systems with consideration for ergonomics; this occurs early in time), to minimize impact of exposure (e.g. protective equipment and health promotion; this occurs later), or to alleviate the consequences of exposure (e.g. physiotherapy) (121).

Passive and active prevention: Prevention of injury events or exposure episodes can be active or passive. Passive prevention is directed towards creating working conditions where technology and organization are such that workers are protected against injury or exposure by structural factors. Safety is not dependent on individual skill, cautiousness, etc. Active prevention, on the other hand, requires worker action to avoid risk factors and is dependent on individual skill, etc. (4; 9). Interventions can be designed to achieve active as well as passive prevention. Passive prevention for all conceivable risks in a work system requires strictly structured work design: all possible behavior must be foreseen. Such work design may be impossible to implement in fishery and office VDU work and may in itself involve exposure to risk (low job control).

In practice, activity for safe and healthy work is likely to include a mixture of primary, secondary, tertiary, passive, and active prevention strategies. Environmental factors may be modified while intervening into individual skills, techniques, attitudes etc. simultaneously (121). “System-wide” intervention strategies often have this character (25).

1.4.2 Preventive measures are preceded by decisions to implement them

Before any modification aiming at passive or active prevention is implemented, it must be decided upon. In this sense, all prevention is basically active: Some actor(s) must make skillful decisions in order to implement good preventive measures. In consequence, this may be an intervention target. This focus is relevant for the intervention studies presented in this thesis.

Research into individual as well as organizational decision making (106; 107) has demonstrated that human capacity to manage complex information in making judgments and decisions is limited. And, as discussed above, the management of occupational health involves complex information. Furthermore, structural and social factors may influence the quality of information processing and decision making. For example, there may be no time and no suitable place to process working-environment information, lack of knowledge about working-environment and health, inability to communicate effectively within and between categories of organization members, and prioritized goals (e.g. short-term outcome in terms of performance or money, interests of some subsystem within an organization) that compete with working-environment goals (47; 70; 75; 88).

The general goals of working life interventions into decision-making are to improve the availability and quality of the information used in the process, and to improve the cognitive and social processes during which information is generated and processed. Interventions into information availability and quality can be designed to provide information from an external source. Feedback is such an intervention. To provide information about occupational safety and health is another example. But interventions may also focus on the participant’s own ability to generate information based on their own experience of work (12; 45; 101).The processes of problem analysis and decision-making can be intervened into normatively by implementing standardized methods (25). Feedback of working-environment and working behavior data, including recommended procedures for analysis and decision-making, is an example of this (82; 98). Processes can also be intervened into in a less normative way. A basic principle can be to support the participants´ ability to identify problems in the process of problem analysis and decision making as it looks in normal practice (12). Schein´s model of process consultation in organizations is an example of a framework for such an intervention approach (101). A central aspect of the interventionist role is to support the generation of “actionable knowledge” (5), i.e. information, that participants can accept as valid, about specific conditions that are observable, describable and within reasonable control of the participants. Simultaneously, the interventionist must be careful to avoid excessive anxiety that may be caused by some issue under discussion or behavior among participants, since this may divert attention from the problem under consideration and weaken the cooperation among participants and with the interventionist.

The relations between the parties involved in problem solving and decision making can have different characteristics (12). One type of relation may be that between an expert and a non-expert, in which the expert party strives to transfer some of his expertise to the other party. This kind of relation may be directly directive, i.e. modifications are specified, or more directed towards transferring information that the non-expert party is supposed to use to manage his problems. Similar relations are implied by concepts such as "top-down" or "push" (19). A "top-down" or "push" intervention strategy implies relations in which some hierarchically or otherwise superior party imposes change upon an inferior party, specifying what should be modified, why, and how. In this regard, these approaches are similar to expert strategies. Their success builds on the premise that the superior or expert party in fact knows best. Considering the uncertainty surrounding how to predict or prevent problems related to injury, musculoskeletal health, or stress (see 1.4.4 & 1.4.5), it is obvious that these are risky strategies – perceived mistakes in expert suggestions or decisions from the top may make serious implementation appear less motivated. The element of coercion and/or manipulation that may be perceived by the inferior party may also foster resistance to change, which may also cause ineffective implementation.

Another type of relation may be of a more collaborative nature, in which both parties are seen as having different but equally valuable expertise in relation to the problem (12). This latter type of approach, when involving representatives from all parts of a work system, that may have something to do with a working-environment problem, may be referred to as "participatory". Some arguments for participation are: 1) Different employee categories may have unique information valuable for problem analysis, 2) effective cooperation may result in better analyses and solutions, 3) participation increases the probability that analysis and solutions are perceived as exhaustive, adequate and fair, which may increase the probability that solutions are implemented according to intention, 4) poor influence over decisions has been identified as a risk factor for health problems, and 5) it is in accordance with general democratic values. Much intervention research has emphasized the benefits of a participatory approach, e.g. (47; 56; 68; 98; 108; 122). Within a participatory process, ergonomists or other specialists may have different roles, see above. Participation may itself have different characteristics. Haines et al. (48) discussed that it can 1) be permanent or temporary, 2) be more or less integrated into normal organizational structures, 3) be direct or indirect (via representatives), 4) involve groups, departments, or entire organizations, 5) be associated with decision-making power, or be consultative only 6) involve a more or less broad range of occupational groups and hierarchical levels, 7) be more or less voluntary, 8) vary in kind of focus: from workplace specifics to work organization and strategies, 9) involve part(s) of or the entire process from problem identification to implementation and follow-up. Study III in this thesis used the concepts participation and integration to cover aspects 1, 2, 3, 4 5, 6, and 8 (33). The mentioned aspects are basically structural. A participative process may be structured to be permanent, direct, involve decision making authority etc., but still fail to achieve genuine participation in the sense that valid information is actually generated and processed, as discussed above (5; 45; 70).

1.4.3 General organizational characteristics may influence intervention effects

Just as exposure to risk factors as well as health may be determined by many conditions, changes in exposure or health may be multifactorially determined. One basic distinction can be made between 1) what was changed (e.g. degree of power centralization, integration of work processes, or standardization (54)), 2) how change was managed, e.g. individual opportunities to learn (78); structural and social support for innovation and learning (35); worker participation (47; 48) location of initiative (19); perceived alignment between change goals and job task/role performance (11).

Research reviews have concluded that the application of planned, behavioral science interventions in organizations, often have failed to demonstrate desired effects (90; 93). A similar observation has been made regarding interventions against musculoskeletal disorders specifically (104). Reasons suggested for this is that individual, social, organizational, and societal factors may moderate effects of interventions or in themselves be strong explanatory factors behind environmental or health effects (44; 88; 99; 104). Employee participation and empowerment, management support, and the degree to which health aspects are considered when (re)designing jobs or workplaces are among these factors (30; 47; 68). All have to do with how change is managed, but also imply changes in power centralization and integration of work processes.

With such observations as a background, the idea of generally applicable, standardized intervention or change methods has been questioned (11; 19; 45). Instead, the idea that successful change must be dependent on organization members´ ability to find solutions that are suited to fit their particular organization at a particular time has been discussed This idea is expressed in the concept “organizational learning” (28). Such learning is thought to be more likely if the change processes in an organization are characterized by participation, continuous feedback processes, reflection, experimentation and an orientation towards the improvement of organizational performance (56). This does not mean that expert knowledge and theory are worthless, but that they are not sufficient for successful change. A learning orientation may be contrasted to a “programmatic” change strategy, where predictable change is thought to result from specific preplanned interventions into specific problem areas (55).

The idea about the importance of general characteristics of change processes implies that specific interventions should be evaluated with some degree of control for such general characteristics. Furthermore, the idea implies that specific interventions may have little effect in themselves – only when applied in the context of a specific change strategy will they have effect.

Quantitative studies are desirable in order to gain knowledge about the strength of associations between the factors mentioned above (participation and empowerment, management support, and the degree to which health aspects are considered when (re)designing jobs or workplaces) and outcomes in terms of working environment and health. Ingelgård and Norrgren (56) found associations between what they called a “learning strategy for change” and improvements in”quality of working life” that were attributed to recent change processes. A ”learning strategy for change” was defined in terms of employee participation, management support, and integration of working environment and core organizational concerns. “Quality of working life” was

defined in terms of working climate, cooperation, job involvement, and job content. Their results implied that the study of intervention effects should consider participation and integration as potential factors behind observed effects. In the study by Ingelgård and Norrgren (56), subject matter experts from the organizations included in the study provided survey data. Such ratings may be biased, because worker participation, management support, and concern for the working environment, when designing workplaces and jobs, are claimed by experts to be "success factors" and are required by Swedish working environment legislation. Subject matter experts already "know" what factors contribute to success (and what is legal) and may therefore bias their ratings in accordance with this knowledge.

Study III in this thesis was a further exploration of associations between employee participation, management support, and integration of working environment and core organizational concerns, on the one hand, and working-environment and health indicators on the other.

1.4.4 Intervention research in fishery

Intervention research in fishery is rare. Normative safety programs in fishery, based on systematic problem analysis and involving legislation, education and technological aids, have been reported to be successful in reducing fatalities (22; 74). On the other hand, Swedish occupational health engineers and researchers engaged in injury prevention among Swedish fishermen (113) have expressed frustration over the ineffectiveness of normative, expert-strategy safety interventions among Swedish fishermen (telling them what they ought to do in order to work more safely). An intervention strategy that would actively engage participants and put some emphasis on problem analysis and decision making, that is, a participatory approach, was seen as desirable. Such a strategy was also motivated by research findings that pointed towards the importance of social and cognitive factors in understanding safety-related behavior (34; 40; 71; 81; 92; 127).

1.4.5 Intervention research related to VDU ergonomics and stress

Westgaard and Winkel reviewed ergonomic intervention research published 1996 or earlier (122). The most common type of preventive intervention tested among VDU-workers concerned redesign of workplaces, aiming at reduced mechanical exposure. Redesign could be combined with ergonomic information to workers, physiotherapy, job redesign, participatory ergonomics, working-technique training, physical exercise, stress-control program and new management system. Results from studies of such interventions suggested effects in terms of reduced musculoskeletal symptoms, and, in some instances, reduced load or improved subjective workplace characteristics. Another type of intervention concerned physiotherapy, working technique education, physical exercise, or rest breaks. That is, interventions designed to "strengthen" the individual only. The results suggested reductions in symptoms. Due to methodological weaknesses, strong conclusions about effects were difficult to draw, but the review concluded that reducing identified risk factors and "strengthening" workers at risk while using a participatory strategy appeared as the approach most likely to succeed in reducing health problems.

Ergonomic intervention research among VDU-workers published after Westgaard and Winkel´s review (1; 2; 15; 27; 64; 85; 104; 125), including some controlled studies, has focused workplace redesign, ergonomics information, working technique training, and stress management workshops (39), achieved in various degrees of cooperation between ergonomics experts and organization members. Generally speaking, symptom reduction, ergonomically improved workplaces and/or reduced mechanical load has been suggested by the results.

Interventions into stress specifically may focus on stressor exposure reduction through job redesign or individual-level improvements in the ability to manage stressors or symptoms. The latter kind of intervention may focus behavioral, e.g. relaxation or exercise, or interpersonal skills, or cognitive aspects, e.g. planning one´s own work, reappraising one´s own priorities. Job redesign may be combined with individual-level behavioral or cognitive interventions. Interventions may be designed according to expert strategies or participatory strategies. Generally speaking, positive effects in terms of symptoms and coping skills have been suggested to result from all intervention types, but negative findings have also been reported (38; 68; 79; 90; 96; 108; 117; 118).

One reason for some of the uncertainty surrounding intervention effects can be the relative scarcity of controlled studies with good internal validity. Validity problems may be an effect of the contextual complexity in which working life interventions take place. In most instances mediating steps must lie between direct intervention effect and exposure and health outcomes. During this process, a variety of factors may moderate intervention impact. To give a simple example: VDU-workers are taught an ergonomically sound working technique. This must be transferred to and applied during real work. This may be difficult due to e.g. speed requirements and tension due to stress. No change in exposure or health is observed, although the technique may have been ergonomically sound and learned properly. In line with this, the adequacy of health effects or exposure outcomes, with complex causal background, that are commonly used as evaluation variables, has been questioned. It has been identified as desirable to study variables that illuminate processes of initiation and implementation of change in behavior or exposure to risk factors (44; 69; 88; 104).

In sum, given the presently available knowledge, it is not possible to specify exactly what modifications or interventions will lead to improved exposure or health in a specific context. Guided by general knowledge about ergonomics and psycho-social factors, interventionists and participants in occupational health work must test modifications and learn from experience. Such activity may increase the probability that, in the long run, exposure conditions and health improves. In practice, learning from experience in ergonomic intervention work may be difficult due to lack of any systematic follow-up after interventions (123). Studies IV&V exemplify one possible element in systematic follow up: controlled effect studies. Study II is an illustration of another possible element in intervention follow up: Process studies.

1.4.6 Feedback as a working life intervention technique

Feedback in the sense that is relevant in this thesis is an intervention technique directed at processes associated with problem analysis and decision-making and has

been used in occupational health as well as organizational performance contexts (25; 37; 77; 98).

A feedback intervention may be defined as "actions taken by (an) external agent(s) to provide information regarding some aspect(s) of one's task performance" (66). In the present context the "task" is to behave safely at work and arrange work so that such behavior is possible. The "action" referred to may be part of everyday leadership and cooperation (94), but may also involve specific planned interventions where data relevant for safe behavior and safe environment is collected and fed back. The basic theoretical idea is that feedback that indicates deviation from task performance goals will lead to improved goal attainment. Research results concerning effects of feedback interventions have been contradictory (66; 67; 82). This may be explained with reference to a number of factors that may mediate between feedback and task performance effects. The listing below is a simplified variant of a model proposed by Kluger and de Nisi (66):

Relevance and validity of feedback. Feedback should be accepted as valid, relevant and consistent with other sources of information.

The existence of (attractive) performance goals against which feedback can be compared. Inconsistent and conflicting goals make comparison complex and its results difficult to predict.

Feedback content. The degree to which feedback information is interpreted as indicating (undesirable) deviations from performance goals (which may be complex).

The nature of feedback. Unspecific, evaluative and/or interpersonally communicated feedback may direct focus towards central values such as self-esteem and divert attention from feedback and specific task performance.

Emotional reactions to feedback. Unpleasant emotions as well as low or high arousal evoked by feedback information may decrease the cognitive ability to find solutions to improve goal-attainment.

Motivation to act in the pursuit of better goal attainment: The degree to which it is believed possible and desirable to change task behavior successfully. This is influenced by individual characteristics (skill, individual goals, and personality) as well as appraisals of environmental conditions such as task difficulty, availability of structural resources and social support. The feedback information may not indicate how performance-standard discrepancies could be eliminated. Experimentation to find adequate behavior may, as long as it is unsuccessful, lead to impaired performance and, in the long run, doubts about the possibility to improve performance.

An interesting feature of this model of mechanisms influencing feedback effects is that feedback could lead to improved as well as worsened performance. Feedback that indicates negative deviation from goals could lead to improved performance. But feedback that indicates positive deviation from goals could lead to worsened performance! This could happen if recipients interpreted feedback as indicating that they performed better than necessary. In consequence, a feedback effect study should not only study effects on those participants that received feedback indicating negative deviation from goals, but also on participants that received feedback indicating positive deviation. From a practical perspective, the average degree of goal attainment in groups of participants in feedback interventions can therefore serve as a practically relevant outcome. This approach was applied in studies IV&V.

In a practical working life intervention perspective, the basic idea of feedback is to provide information about aspects of work that may reinforce motivation to introduce modifications and upon which decisions about working-environment modifications can be based (25; 36; 82; 98). Such modifications are thought to have a potential to improve the working environment because they are supposed to be based on well-informed reasoning by motivated persons in a supportive organization. In practice, feedback is intended to draw attention to undesirable conditions, e.g. the presence of some risk. In that respect, feedback resembles risk communication. Research based principles for risk communication have several components common with the feedback principles listed above (119). Research has indicated that feedback in itself may be a weak intervention (10; 82; 83). To secure dissemination of information, motivation building, organizational support and effective decision making processes, extensive arrangements (that together constitute a ”survey feedback intervention”) have been recommended (25; 82; 98). These recommendations can be understood as expressing the principles listed above. The recommendations cannot easily be followed in more everyday occupational health work involving feedback. It would require more time and power to influence organizational practice than may be available to interventionists or individual organization members. It must therefore be regarded as uncertain that working life feedback interventions that do not adhere to complex survey feedback methodology will, in the short run, lead to improvements in exposure or health. In consequence, more everyday feedback interventions should not be evaluated only in relation to exposure or health outcomes. A fair evaluation should consider effects on activity to try modifications that may enable learning from experience. But, although improvements in exposure and health may not be likely to be caused by a simple feedback intervention, such effects are what ergonomists, employers and employees desire. It is therefore also of interest to study if such effects can be attributed to simple feedback interventions.

Feedback may be given to individual workers, entire workgroups or representatives (workers or managers) of groups. Feedback to groups is often used in survey feedback designs (25; 82; 98). But a group setting may be complex to manage for the interventionist and groups may be hampered by defensive processes (5; 70). Feedback to supervisors may ensure that feedback information is discussed with persons with decision authority and responsibility for working environment. An earlier study (77) found that feedback to groups generated more ideas, but feedback to group supervisors resulted in more implementation of ideas. The results suggested that feedback to individuals in a leader position might be more likely to result in action. Feedback to individual workers has traditionally been a common practice among Swedish ergonomists. Individual feedback to workers or supervisors may be less demanding in terms of communication process management. Only two persons are involved and the feedback information may be more specific. Individual feedback may also be perceived as less threatening since shortcomings indicated by the feedback information will not be discussed in public. This may be particularly relevant for supervisors. In sum, feedback may be given in different settings and there is no definitive argument in favor of any specific variant, as long as large-scale survey feedback designs are not considered.

1.5 The aims of this thesis

General aim: The general aim of this thesis was to contribute to the research-based knowledge about individual psychological and social factors that may influence activity to modify the working environment, general characteristics of how working-environment change processes are organized and their associations with working-environment and health, and interventions designed to stimulate activity to modify the working environment and their effects in terms of activity, working-environment, and health.

Study I: Although the specific roles psychological factors may play in the context of occupational injury causation remain unclear, there is evidence that such factors are of importance when trying to understand why occupational injuries occur. Psychological factors may also be related to activity in safety work. Studies from other fishery nations have suggested that activity in safety work among fishermen may be counteracted by low perceived risk, fatalism and risk acceptance.

The specific aim of study I was to explore associations between experience of injury and near-injury events, perceived personal risk, perceived manageability of risks, technical knowledge, fatalism and risk acceptance, respectively, and activity in safety work among Swedish fishermen.

Study II: Since cognitive and social factors are of interest for occupational safety and health, they may be important intervention targets. Participatory, talk-based, interventions in fishery have, to our knowledge, not been scientifically reported. Therefore, the aims of study II were:

1. To study the feasibility of and processes during a participatory intervention for activity in safety work among Swedish fishermen.
2. To study effects on perceived manageability of risks, risk acceptance and activity in safety work among participants.

Study III: Employee participation, management involvement, and integration of ergonomics and other organizational concerns: associations with working-environment and health The aim of this study was to explore cross-sectional and prospective correlations between employee participation, management involvement, and integration of ergonomics and other organizational concerns, respectively, and working-environment and health indicators, in groups of white-collar VDU users. The working-environment and health indicators were quality of modifications made, psychosocial factors, comfort during work, emotional stress, and physical complaints.

Studies IV & V: Feedback techniques are part of the established toolbox of working life interventionists, but controlled studies of their effects are not easy to find. Therefore the specific aims were to test whether feedback and discussion of ergonomic and psychosocial working environment data during one short session with individual, groups or supervisors of white-collar VDU workers had effects on: 1) Activity to modify workplace design, working technique, and psychosocial aspects of work (Study IV), 2) the quality of implemented modifications in workplace design or working technique, or psychosocial aspects (Study V), 3) psychosocial factors (Study V), 4) comfort during computer work (Study V), 5) emotional stress (Study V), and 6) Prevalence of musculoskeletal symptoms and eye discomfort (Study V).

2 Methods

2.1 Intervention design and implementation (studies II, IV & V)

2.1.1 Intervention study among fishermen (study II)

After an introduction seminar at which general discussions about safety in fishery were held and results from study I were presented, the participating crews were divided into two groups with initially 3 crews in each (6-8 persons), according to home harbor.

The following agreements were made between researchers and participants: 1) experiences and reflections among participants should be the major working material at group meetings; 2) participants were responsible for providing such material; 3) injury/near-injury event diaries should be used regularly; 4) a near-injury event should be defined as an event that could have resulted in injury, had the circumstances not prevented this; 5) all crews should make up a specific safety action plan at the end of the meeting period.

Over a 10-month period each group met 6 times for 1.5 to 2 hours. A psychologist and an ergonomist well acquainted with fishery and its language led the meetings. Their role was to facilitate expression of experience and reflection by posing questions and to make sure each event was worked through (see below). The strategy built on ideas about process consultation (101) and focused on how participants worked on their task (analysis of injuries/near-injury events, analysis on how injuries/ near-injury events and hazards were and could be managed and actual behavior in pursuit of risk reduction), not general social processes in the group or individual characteristics. The second strategy was to avoid giving expert advice except in instances where such advice was explicitly asked for in connection to some specific problem under discussion. An OHS engineer took part in order to make technological support directly available.

Between meetings, all injuries/near-injury events during work were to be noted in a diary kept aboard. All injuries/near-injury events noted or remembered were analyzed and discussed during the group meetings. The discussion leaders made sure that the following aspects were worked through for each event: 1) description of event; 2) identification of basic factors (the basic cause of the injuries/ near-injury events, e.g. equipment poorly fixed) and releasing factors (conditions that simplified for the basic cause to act, e. g. rough seas, that made the loose equipment move about); 3) classification of causal factors as technological, organizational or individual; 4) discussion of how the event and its consequences were coped with; 5) for each causal factor: discussion of preventive measures.

2.1.2 Feedback intervention study (studies IV&V)

The intervention was intended to stimulate and guide action to modify the working environment. Specifically, it was designed to provide normative information about computer ergonomics and psychosocial factors, to feed back information concerning the ergonomic and psychosocial situation among participants and to provide a forum for discussion of these matters. The intervention was implemented by experienced physiotherapists specialized in ergonomics. These did not present lists of suggested

measures but supported the participants´ own analysis of the feedback information and their discussion of it.

Three feedback conditions were used: Individual feedback to each individual in the group (i.e. one feedback session per individual), one-session feedback to the group supervisor alone and one-session feedback to the entire group with the supervisor present. Feedback meetings were planned to last for approximately 1 hour (this was decided after consulting twenty Swedish ergonomists about how much time their clients were likely to allocate for feedback meetings) and were held within a month after collection of baseline data (to ensure freshness of feedback information).

Feedback was given orally and through printed brief reports to all feedback recipients. Overhead-presentations were used at group feedback meetings. Overheads were also given to the supervisors in the supervisor feedback condition, to be subsequently used if the recipients should find this suitable. The information included: 1) Self-reported extent of VDU work, 2) self-reported physical complaints ≥ 3 days the last month (neck, shoulders, arms, hands or lower back; eye complaints; headache), 3) comfort (60) during VDU work the last month (with reference to keyboard placement, placement of input device, screen placement, working area, working position, chair, general light conditions, light conditions at the workplace, daylight screening, noise level and indoor climate), 4) expert-evaluated ergonomic standard, based on ergonomic observation data, (49) of workplace design (chair, table, screen placement, keyboard placement, placement of input device, vision conditions), and working technique (at the keyboard and with the input device). The evaluations were expressed in terms of "non-optimality", which meant that at least one observed characteristic of an aspect did not match expert-defined ergonomic criteria. 5) Psychological demands, decision latitude, social support (59; 110), and self reported overtime work (all referring to the last month). Definitions of all these variables and general information about their relevance to working environment and health were provided at the feedback meetings. Data came in the form of group mean values and frequency distributions. In the individual feedback condition the results for the individual in question were also reported. Reference data from another study among other Swedish computer users were provided (61).

The ergonomists noted disturbances during feedback sessions (few disturbances were reported), session duration (average 38 min. for individual, 61 min. for supervisor and 85 min. for group feedback) and how the time was distributed between psychosocial aspects, and workplace design/working technique (similar in the 3 feedback conditions; ≈50/50).

2.2 Participants

2.2.1 Questionnaire study among fishermen (study I)

The respondents were not randomly selected or according to special criteria, but were fishermen with whom the project group came into contact through other projects, or who contacted the fishermen's occupational health services for yearly routine health check-ups (table 1). Mean age was 44 years and standard deviation 11 years. Years of experience as fishermen ranged between 1 and 48, the mean being 25 years and the standard deviation 12 years. 74% of the respondents resided on the west coast of

Sweden, 9% on the Swedish east coast, 10% on the south coast, while 7% were fresh water fishermen. 86% of the responding fishermen had a spouse (or equivalent), and 53% had children under the age of 18. 23 % stated that they were alone on board (single crew). 67% were skippers, counting the single crew. 80% were owners or part owners of the fishing vessels.

Table 1. Study types, studied occupations, number of participants, gender distributions and age ranges.

Study #	Type of study	Occupations	Number of participants	Gender	Ages
I	Cross-sectional questionnaire study	Swedish fishermen	92	Men	17-62
II	Case study, intervention process study, quasi-experiment	Swedish fishermen	11	Men	17-55
III	Cross-sectional and longitudinal questionnaire study	Swedish white-collar VDU-users	399	64% women	20-65
IV	Cluster randomized controlled intervention study	Swedish white-collar VDU-users	273	65% women	20-64
V	Cluster randomized controlled intervention study	Swedish white-collar VDU-users	304	65% women	20-64

2.2.2 Intervention study among fishermen (study II)

Potential participants were identified among fishermen known by the researchers or within their professional networks. Nine active crews from the Swedish west coast were contacted, 3 refused to participate due to lack of interest. Eleven persons participated at group meetings (tables 1 & 2). Seven persons provided baseline questionnaire data, 6 provided follow up data, the 7th could not be reached. Follow-up interviews reached 10; the 11th could not be reached. In interviews 7 reported that genuine safety interest motivated participation, while 3 reported to have “followed along”.

The modest sample size was mainly due to the practical difficulties in recruiting fishermen to our relatively time-consuming intervention. This in turn had to do with the fact that no tradition of participatory safety work of this kind existed in Swedish fishery and that fishery is an uncommon occupation.

Table 2 specifies attendance at group meetings, participation in interviews and participation in both baseline and follow-up questionnaires.

Table 2. Meeting attendance, participation in interviews, and participation in both baseline and follow-up questionnaires

	Members in group 1								
Meeting #:	1	2	3	4	5	6	7	8	∑ persons
1	X	X	X	X	X		X		6
2	X	X	X	X		X			5
3	X	X	X		X	X			5
4	X	X	X	X			X		5
5	X	X	X		X	X			5
6	X	X	X		X	X	X		6
∑ meetings	6	6	6	3	4	4	3	0	.
Interview	X	X	X	X	X		X		6
Questionnaire	X	X	X	X					4

	Members in group 2						
Meeting #:	1	2	3	4	5[a]	6[a]	∑ persons
1	X	X	X				3
2	X	X					2
3	X	X					2
4	X	X					2
5	X	X	X				3
6	X	X	X	X			4
∑ meetings	6	6	3	1	0	0	.
Interview	X	X	X	X			4
Questionnaire		X	X				2

[a]: These members quit fishery before the meeting period

2.2.3 Feedback intervention studies (IV & V)

Eight ergonomists (7 women) with experience from workplace intervention work were recruited from the researchers´ networks and were given special training in data collection and feedback techniques (≈6h). Additional support to the ergonomists was provided at individual meetings (≈2h) and otherwise when needed during the entire study period.

Participating organizations were recruited by the ergonomists. Eligibility criteria for organizations were: 1) they should be among the normal clients of the participating ergonomists. This meant that personal contact between ergonomist and organization representatives was already established. The organizations should 2) be known by the ergonomists to have concern for the ergonomics of computer work; 3) accept randomization (including a control condition) and be able to contribute 4 workgroups to the study; 4) accept that the intervention would not involve expert suggestions for modifications; 5) accept that individual participant data were identified, making a repeated measures design possible.

Management and human-resource (HR) representatives helped to identify suitable groups. Eligibility criteria for groups were: 1) all workers should be white-collar; 2) computer work should be common (specific criteria were not applied); 3) the ergonomics of VDU work should be a relevant problem for the group, as estimated by the management and HR representatives; 4) they should be organizational subunits, each with its own supervisor; 5) they should have 6-20 members (a group size of about 8 was considered ideal); 6) group members and supervisor should meet organizational eligibility criteria 3-5.

The samples analyzed in studies IV and V were drawn from the same pool of participants, but two individual-level criteria were used. These criteria were applied

because retrospective self-reports of working conditions were used. For study V participants should have worked at least 4 months at their present workplace at baseline. For study IV the criterion was 6 months. This was because study IV concerned the number of working-environment modifications made during the 6-month periods before and after baseline.

The participants who did not attend feedback meetings were not on that ground excluded from analysis.

Individual participation was voluntary and all participants were informed about the project design.

Recruitment, interventions and data collection were performed November 1998-January 2000. The following trades were represented: Banking (3x4 groups), transport (4 groups), manufacturing industry (4 groups), software engineering (4 groups), public administration (2x4 groups) and wholesale (4 groups). All organizations were located in the southwestern part of Sweden. For details concerning organization, group and individual level participation at different stages of studies IV&V, see Figure.

1. Recruitment of organizations and groups 12 organizations invited to join study 2 could not comply with randomization. 1 refused without giving reason. 4 groups per organization selected (n=36). Information about refusals not available			
2. Randomization 4 study conditions. Stratified by organization			
Individual feedback	Feedback to supervisor	Group feedback	Control (no feedback)
n=9 Md groups size 10 (8-15) 97 persons	n=9 Md group size 10 (8-16) 106 persons	n=9 Md group size 11 (6-18) 98 persons	n=9 Md group size 10 (7-17) 95 persons
3. Baseline			
n=9 Md group size 10 (8-15) 95 persons; 2 absent	n=9 Md group size 10 (8-14) 100 persons; 6 absent	n=9 Md group size 10 (6-17) 92 persons; 6 absent	n=9 Md group size 10 (7-17) 94 persons; 1 absent
4. Feedback			
n=9 Md group size 10 (7-15) 92 persons received feedback; 3 quit job	n=9 Group size not relevant; all 9 supervisors received feedback	n=9 Md group size 9 (6-17) 88 persons received feedback; 4 absent [a]	.
5. Follow-up (6 months after feedback)			
n=9 Md group size 9 (6-11) 82 persons; 6 absent 3 quit job 1 missing data for effects	n=9 Md group size 10 (5-13) 83 persons; 9 absent 7 quit job 1 quit study	n=9 Md group size 9 (5-13) 83 persons; 7 absent 1 quit job 1 quit study	n=9 Md group size 9 (5-17) 81 persons; 11 absent 1 quit study 1 missing data for effects
6a. Analyzed for study V			
n=9 Md group size 9 (5-11) 76 persons; 78% of randomized; 6 did not meet criterion [b]	n=9 Md group size 9 (4-12) 77 persons; 73% of randomized; 6 did not meet criterion	n=9 Md group size 8 (5-13) 76 persons; 78% of randomized; 7 did not meet criterion	n=9 Md group size 8 (4-16) 75 persons; 79% of randomized; 6 did not meet criterion
6b. Analyzed for study IV			
n=9 Md group size 9 (5-11) 73 persons; 75% of randomized; 9 did not meet criterion [c]	n=9 Md group size 8 (1-12) 65 persons; 61% of randomized; 18 did not meet criterion	n=9 Md group size 7 (5-12) 69 persons; 70% of randomized; 14 did not meet criterion	n=9 Md group size 7 (1-16) 66 persons; 69% of randomized; 15 did not meet criterion

Notes: [a]: These participants were not excluded from analysis due to non-compliance. [b]: Should have worked at present workplace since at least 4 months before baseline

[c]: Should have worked at present workplace since at least 6 months before baseline

Figure. Participant flow through the stages of studies IV & V

All participants used computers during work. Group level background data at baseline (for the participants who took part in the entire study and fulfilled the individual level eligibility criteria) revealed no major imbalance between study conditions (table 3)

Table 3. Baseline group-level background data for the analyzed samples in Studies IV & V

	Individual feedback n[a]=9	Supervisor feedback n=9	Group feedback n=9	Control n=9
		Gender (% women)		
Median	67	67	88 (83)	83 (86)
Min; max	0; 88 (100) [b]	22 (29); 100	31 (33); 100	0; 100
		Age (group means)		
Median	46 (48)	46 (43)	43	40 (41)
Min; max	36; 54	36; 55 (54)	34; 53	30; 49 (48)
		Education (% university level)		
Median	20	20 (25)	20 (17)	33 (20)
Min; max	0; 64	10 (0); 44	0; 40	0; 80
		Employment form (% conditional employment)		
Median	100	100	100	100
Min; max	73; 100	88 (100); 100	63 (50); 100	20; 100
		Normal working time/week (group means)		
Median	38	38	39	36 (37)
Min; max	34 (33); 40	35 (32); 42	33 (30); 44	36 (26); 43
		% of working hours at computer (group means)		
Median	67	79 (70)	73 (71)	71
Min; max	48; 98 (97)	53 (50); 100	48; 91 (90)	57 (55); 99 (100)
		Hours overtime latest month (group means)		
Median	7	10	7 (9)	8
Min; max	0; 11	1 (0); 25 (20)	3; 19	4 (0); 20 (17)
		Number of not optimal workplace design aspects per individual (group means; could vary 0.0; 6.0) [c]		
Median	3.5	2.8	3.3	[d]
Min; max	1.0; 4.3	1.0; 4.3	2.4; 4.0	[d]
		Number of not optimal working technique aspects per individual (group means; could vary 0.0; 2.0) [c]		
Median	1.3 (1.2)	1.3 (1.4)	1.4	[d]
Min; max	0.5 (0.6); 2.0	0.4 (0.5); 2.0	0.5; 2.0	[d]
		Worker participation in efforts to improve the working environment (group means; could vary 0.0; 4.0)		
Median	2.2	2.2 (2.1)	2.2	2.2
Min; max	1.6 (1.7); 3.3	1.6 (1.2); 3.0	1.7; 3.1	1.8; 3.1 (3.2)
		Integration[e] (group means; could vary 0.0; 4.0)		
Median	2.3	2.4 (2.2)	2.3	2.2 (2.1)
Min; max	1.5; 3.7	1.5 (1.8); 3.2	1.2; 3.3 (3.4)	2.0; 3.4

[a]: Number of groups. [b]: Participants who had worked at least 4 months (study V) or 6 months (study IV; if different from figures for study V- figures in parentheses) at their workplace at baseline and provided follow-up data. [c]: see 2.1.2 [d]: Data not available. [e]: The degree to which working environment issues and traditional core organizational issues were integrated (2.5.3)

For the sample in study IV the study conditions were also similar with respect to comfort, psychosocial factors, and physical symptoms (table 4). Corresponding figures for the sample used in study V are shown in the results section.

Table 4. Baseline group-level values for comfort and psychosocial factors. Sample analyzed in Study IV.

	Individual feedback n=9	Supervisor feedback n=9	Group feedback n=9	Control n=9
	Job demands [a] (group means; could vary 1.0; 4.0)			
Median	2.8	2,8	2.8	2.9
Min; max	2.4; 3.3	2.4; 3.2	2.0; 3.3	2.5; 3.2
	Decision latitude[b] (group means; could vary 1.0; 4.0)			
Median	3.0	3.0	2.9	2.8
Min; max	2.0; 3.4	2.2; 3.3	1.7; 3.2	2.2; 3.4
	Social support [b] (group means; could vary 1.0; 4.0)			
Median	3.4	3.0	3.4	3.1
Min; max	2.8; 3.8	2.8; 3.6	2.1; 3.7	2.8; 3.8
	Comfort, ergonomics [c] (group means; could vary –4.0; 4.0)			
Median	1.1	1.5	1.4	1.2
Min; max	-0.3; 2.8	0.3; 2.4	0.7; 2.9	-1.8; 1.9
	Comfort, physical [c] (group means; could vary –4.0; 4.0)			
Median	1.1	1.0	1.1	0.9
Min; max	-0.4; 2.1	-0.6; 1.7	0.3; 1.6	0.2; 1.8
	Physical symptoms [d] (group means; could vary –4.0; 4.0)			
Median	27	50	40	20
Min; max	0; 67	25; 100	14; 83	0; 100

Notes: [a]: Lower value=more positive conditions. [b]: Higher value=more positive conditions. [c]: Higher value= better comfort. [d]: Neck, shoulders, arms, hands, lower back, eyes or headache at least 10 days the last month.

2.2.4 Questionnaire study on characteristics of working-environment change processes (study III)

The initially selected participants (n = 462) were all employees in the groups that took part in the feedback intervention studies (IV&V), plus all employees from one group representing finance and three groups from a food industry. The latter groups also took part in feedback interventions but were not included in the randomized study. Altogether 444 (96%) persons provided baseline data. Three subsamples were used in study III. 1) Baseline sample: Because this study concerned organizational conditions beyond the individual working situation and also involved retrospective self-reports, having at least 4 months' experience of the present workplace was applied as a criterion for inclusion. A total of 399 (86% of initial n) met this criterion. 2) Follow-up sample: Follow-up data were provided by 379 workers (82% of initial n). At follow-up, all had worked at least 6 months at their present workplace. 3) Prospective sample: The number of follow-up participants who also fulfilled the 4-month criterion at baseline was 342 (74% of initial n). Self-reported background data and group size data for these samples are shown in Table 5.

Table 5. Background data for the sample used in Study III

	Baseline n = 399	Follow-up n = 379	Prospective n = 342
Proportion of women	64%	66%	67%
Educational level: % university	24%	25%	25%
Employment form: % conditional	91%	95%	95%
Age (yrs): mean (SD)	43 (11)	44 (11)	44 (11)
Normal working time/week (hrs): mean (SD)	38 (7)	38 (6)	38 (7)
Group size: mean (min; max)	10 (5; 19)	9 (5; 17)	9 (4; 16)

SD = standard deviation.

2.3 Randomization and blinding (Studies IV & V)

The four groups from each organization were allocated to the four study conditions by drawing of lots (performed by the author, who at this point had no specific information about the groups). The organization factor was balanced across study conditions. The matching of ergonomist and group was not random but each ergonomist gave feedback in all three variants. All participating workers and supervisors were anonymous to the author but not to the ergonomists (but no names, just id-numbers, were printed on questionnaires). Neither the ergonomists nor participants were blind with respect to study condition.

2.4 Measurement variables and data collection

2.4.1 Questionnaire study among fishermen (study I)

A questionnaire was designed for use among fishermen specifically. Before data were collected, the contents and wording of the questionnaire were discussed with representatives from the fishing community. The questionnaire covered the following:

Background variables: Age, civil status, parenthood of under aged children, experience of fishery, type of fishery, geographical region and ownership of the fishing vessel and role aboard (skipper/non skipper).

Injury/near-injury event experience: This area was covered by 5 items referring to: 1) personal exposure to injury making medical care or sick leave necessary, 2) personal exposure to injury not making medical care or sick leave necessary, 3) personal exposure to near-injury event(s), 4) experience from situations where someone else aboard was injured to an extent that necessitated medical care or sick leave, 5) experience from situations where someone else aboard was injured but not to an extent that necessitated medical care or sick leave. The questions were formulated with reference to work in fishery during the latest 3 years. Response format was yes/no.

From these items the compound variable “injury/near-injury event experience” was construed. Respondents who gave a “yes” response to at least one of the items in this area were classified as having injury/near-injury event experience.

Based on factor analysis (34), indices of the following were computed as raw score means:

Perceived personal risk: Risks associated with ten different working situations (unloading, hauling of gear, work in engine room, walking on deck, ladder or stairs, shooting of gear, embarking or disembarking, catch handling on deck, boxing in cargo hold, repair work or work by the quay, cleaning of vessel/gear) covering all work related activities on board were rated by the respondents. The activities were selected through an analysis of serious injuries in Swedish fishery, performed in a previous study (114). In this study all injuries leading to more than 30 days of sick listing, permanent disability or death, reported to the Swedish Labor Market No-fault Liability Insurance from July 1st 1983 – June 30th 1995, were studied. In the analysis of these injuries, activities in which the victim was engaged at the time of the injury were categorized into the ten groups of activities used in study I.

The form of the items in the present questionnaire was: "How high do you estimate the risk that you will be injured in connection to…?" The six-point scale end points were "very low risk" and "very high risk".

Perceived manageability of risks: Ratings were made of perceived manageability of risk, associated with each of the aforementioned working situations, with technical equipment or working methods. The form of the items was: "Accident or injury risks associated with … can be reduced with technical equipment and working methods". The six-point scale end points were "not at all correct" and "entirely correct".

Sufficiency of technical knowledge and skills related to equipment on board: The items referred to 1) technical equipment on deck, 2) in cargo hold, 3) engine room and 4) equipment for navigation and supervision of fishery operations and catch. The form of the items was: "To what degree do you consider yourself to have sufficient technical knowledge to manage the technology presently used on board in the following areas…". The six-point scale end points were "not at all sufficient" and "entirely sufficient".

Fatalism: Degree of agreement to the following 2 statements: "Some higher power or luck protects me", "Fate, luck or other people's actions determine whether I will be injured or not". The scale end points were "not at all correct" and "entirely correct".

Risk acceptance: The items were: "You have to learn to live with the risks at work", "a fisherman should be able to take care of himself", "a fisherman should be prepared to take risks"," a fisherman should enjoy challenging the forces of nature", "even if accidents happen, the risk is so small it's not worth thinking about". The six-point scale end points were "not at all correct" and "entirely correct".

Activity in safety work: This area was covered by 4 items: "I try to find methods and equipment to improve safety", "The crew co-operates to improve safety", "In our team, we often discuss how to improve safety", "It is an important part of the job to learn more about how to improve safety". The six-point scale end points were "not at all correct" and "entirely correct".

All indices had an internal consistency (Cronbach α; (24; 120) of >.70, except fatalism (α=.63; inter-item r=.46)

Data collection: The data collection period was 8 months (1997-1998). The questionnaire was distributed to 71 fishermen during their visits to the occupational health services (all who visited during the data collection period) and to 21 fishermen

during meetings with the authors or two occupational health engineers. The completed questionnaires were collected at the same occasions. Responses were given anonymously. The response rate was 100%. The rate of internal dropout was generally less than 5%.

2.4.2 Intervention study in fishery (study II)

In study II the same measures of perceived manageability of risks, risk acceptance and activity in safety work as in study I were used. Baseline questionnaire data were collected at the introduction seminar, before any survey results were presented. Follow up questionnaire data were collected by the authors immediately after the final group meeting.

Follow up interviews by telephone 2 months after the intervention period covered motives for participation, opinions about the intervention design and intervention process, the existence and content of safety action plans and effects attributed to participation. A researcher not further involved in this project and with whom the participants had had no previous contact performed the interviews.

During each meeting (including visits on board ships, where arrangements that had played a role in injuries/near-injury events could be observed) the group leaders took notes on: 1) behavior that expressed cognitions, attitudes and emotions in relation to safety issues or the intervention itself; 2) descriptions of how injuries/near-injury events and identified hazards were managed behaviorally; 3) intensity of communication, distribution of activity during meetings and inter-crew interaction; 4) adherence to agreements concerning participant roles (See section 2.1.1); 5) reporting of injuries/near-injury events (see section 2.1.1). Observations were systematized shortly after meetings.

The intervention and data collection period was 1998-1999.

2.4.3 Feedback intervention study (studies IV & V) and questionnaire study on characteristics of working environment change processes (Study III)

In this section only outcome measures that were used in studies III, IV and V, and independent variables in study III will be described. Other measures were used for feedback purposes only and were described briefly in the intervention design section. Group level measures were used in the analyses. The construction of these measures will be detailed below.

Proportion of workgroup members who reported any working environment modification (study IV): In the baseline and follow-up questionnaires the participants indicated (yes/no) if they during the previous six months had experienced modifications (implemented by themselves or some other agent) with respect to 15 working environment aspects. Seven items were classified under the term “ergonomics”: 1) Visual conditions, 2) noise level or indoor climate, 3) new keyboard or input device. 4) work area, chair or table, 5) working postures, 6) screen placement, and 7) placement of the keyboard or input device. Participants who answered “yes” in any of these respects were classified as having experienced ergonomic modification(s). The remaining 8 items were classified as psychosocial: 1) Work tempo or amount, 2) conflicting job demands, 3) demands for skill or inventiveness, 4) Influence over decisions, 5) social support from colleagues, 6) support from supervisor, 7) time spent

at the computer, and 8) performance and reliability of the computer system. The latter two variables were put in this class because they were related to psychological variation at work and technical dependency, respectively.

Participants who answered "yes" in any of these respects were classified as having experienced modification(s) regarding psychosocial aspects.

For each group, the proportion of workgroup members who reported any modification in ergonomics and psychosocial aspects, respectively, was computed.

Average number of modification-types per individual in a group (study IV): Individual level measures of the number of reported modification types were obtained by summing the number of specific aspects in the ergonomic and psychosocial areas, respectively, in which modifications were reported. The possible variation was 0-7 for ergonomic and 0-8 for psychosocial aspects. Group means for these variables were computed.

Quality of modifications (Studies III & V): Quality of modifications in the ergonomic and psychosocial environments was defined in terms of employee satisfaction with modifications made. For each aspect listed above, the participants rated the effect on their working situation that they attributed to the occurred modifications. The response alternatives were "a big impairment", "a certain impairment", "no change", "a certain improvement", and "a big improvement". For each respondent, two mean values were computed, one for ergonomic aspects and one for psychosocial aspects. The internal consistency for quality of modifications in ergonomics was .89 at baseline and .88 at follow-up. The internal consistency for quality of psychosocial modifications was .90 at baseline and .92 at follow-up. Group level means were computed and used in subsequent analyses.

Psychosocial factors (Studies III & V): Psychosocial factors were measured according to the model suggested by Karasek and Theorell (59; 110): Psychological demands (5 items), decision latitude (6 items) and social support (6 items). The internal consistency was: Psychological demands: .70 (baseline) and .73 (follow-up); decision latitude: .73 (baseline) and .66 (follow-up); social support: .88 (baseline) and .85 (follow-up). Group level means were computed and used in subsequent analyses.

Emotional stress (Studies III & V): Emotional stress was measured using a mood adjective checklist, designed for use in working life settings (65). Stress was a dimension ranging from negative valued mood states of high activation (e.g. "stressed") to positively valued mood states of low activation (e.g. "relaxed"). For the six adjectives in the checklist, respondents indicated the degree to which they had experienced the mood in question during work the latest month along a six-point verbally anchored scale with endpoints "very, very" and "not at all". The internal consistency was: .88 (baseline) and .92 (follow-up). Group level means were computed and used in subsequent analyses. Note that, due to technical problems, no stress data were collected in one organization (Public administration; 4 groups).

Comfort during computer work (Studies III & V): Comfort during computer work the last month, with reference to 11 aspects related to general physical environment, workplace design and working positions, was rated by participants along a 9-point scale ranging from –4 (very, very bad) to +4 (very, very good). Two indices were computed as item score means. The first of these was called "comfort: physical environment" and included items referring to general light conditions, light conditions

at the workplace, daylight screening, noise level and indoor climate. The internal consistency was .71 (baseline) and .75 (follow up). The second comfort index was called "comfort: ergonomics" and included items referring to keyboard placement, placement of input device, screen placement, working area, working position and chair. The internal consistency was .88 (baseline) and .90 (follow up). Group level means were computed and used in subsequent analyses.

Musculoskeletal symptoms and eye discomfort (physical complaints) (studies III & V): Physical complaints were measured by means of questionnaire self-reports on how many days during the past month participants had experienced pain or discomfort in the head, neck, shoulders, shoulder joints/upper arms, upper back, lower back, elbows/forearms, wrists, hands/fingers, or eyes. Complaints were reported separately for each body part. The proportion of group members who reported a complaint frequency of more than 10 days for any body part was computed.

*Characteristics of working-environment change processes (integration and participation) IV***:** The participants were asked to rate a number of characteristics of the working environment change processes at the workplace. In all, there were 16 items, 13 of which were used by Ingelgård and Norrgren (56) to measure "learning strategy for change" and "top management involvement in change processes". Three items were designed specifically for this study. All items had the form: "To what degree are the efforts to change the working environment at your workplace characterized by the following: …" (for item content, see Eklöf et al. (33). The response alternatives were "to a very high degree", "to a fairly high degree", "to a fairly low degree", and "not at all". Based on factor analysis (33) two indices were computed as item score means.

The first index was called "integration of working environment issues and traditional core organizational issues" (will be referred to as "integration") and was based on items referring to management support for efforts to improve the working environment, consideration of organization, productivity, and quality issues in efforts to improve the working environment, the breadth of these efforts, and the degree to which they were planned in detail. This was seen as a measure of the degree to which efforts to improve the working environment were being integrated with traditional core concerns of an organization, namely, how to organize work and how to achieve productivity and quality. To actively engage in this is a core task of management. Cronbach's alpha was .95 (for baseline and follow-up). Group level means were computed and used in subsequent analyses.

The second index was called "employee participation and empowerment in efforts to improve the working environment" (will be referred to as "participation") and was based on items referring to employee participation and empowerment in efforts to improve the working environment. Cronbach's alpha was .85 (baseline) and .83 (follow-up). Group level means were computed and used in subsequent analyses.

Data collection: All data were collected after randomization. Questionnaire data collection was managed by the ergonomists at group meetings in the workplace. Ergonomic observation data (for feedback purposes only) were collected at the individual workplaces. The ergonomists were instructed to interfere with or comment on the subjects as little as possible during observations. In the feedback conditions, questionnaire data as well as ergonomic observation data were collected, in the

control condition only questionnaire data. Scarcity of study resources motivated this imbalance. Follow-up data included a questionnaire only, except for groups in the control condition that wished to have ergonomic observation data collected (n= 4). These groups also received feedback at a later time. This possibility was acknowledged during the recruitment phase.

2.5 Data analysis

2.5.1 Questionnaire study among fishermen (study I)
Correlations were Pearson, partial or point-biserial. Multiple regression was performed using the stepwise method (criteria: entry: $p<0.05$; removal: $p>0.10$). SPSS 10 was used.

2.5.2 Intervention study among fishermen (study II)
Interview responses and observations during group meetings were classified according to which study aims(s) they were relevant for. Injury/near-injury event data were classified using the format described in the intervention design section. For the observations (except injury/near-injury event data and attendance) only the qualitative dimension was considered. For interview data quantitative information was also considered.

For changes in perceived manageability of risks, risk acceptance and activity in safety work (questionnaire data), differences between baseline and follow-up were computed. The number of participants for which increase and decrease in values was observed were identified.

The data source will be indicated in the results section; interviews, observations or questionnaire.

2.5.3 Questionnaire study on characteristics of working-environment change processes (study III)
Correlations between characteristics of change processes and quality of modifications, psychosocial factors, and symptoms were computed as bivariate and partial Pearson correlations. Baseline correlations were analyzed using the baseline sample, while the follow-up sample was used for follow-up correlations and the prospective sample for the prospective correlations. Because this study focused conditions of workgroups rather than individual characteristics or individual jobs, all measures used in correlation analyses were aggregated at the group level. For example, one aim was to study whether group level characteristics of change processes correlated with the average stress level in groups. The procedures used to aggregate data were described in the Measures section. P-values $< .05$ were considered statistically significant. SPSS 10 was used to perform the analyses.

2.5.4 Feedback intervention studies (IV & V)
For all outcomes, measures of change were computed by subtracting baseline values from follow-up values. These were tested for homogeneity across study conditions using Kruskal-Wallis tests (102). Intervention effect was defined as difference vs. controls with respect to change from baseline to follow-up. Pairwise comparisons

between control and intervention conditions were performed to identify such effects, using Mann-Whitney U tests (102). SPSS 10 was used for these analyses. The error rate was controlled using the sequentially rejective Bonferroni test suggested by Holm (52). This test protects the overall error rate while being less conservative than the traditional Bonferroni procedure. In this case, where 3 pairwise comparisons for each effect were made, the procedure was: 1) Arrange the p-values for the 3 pairwise comparisons in ascending order. 2) Is the lowest p-value ≤ alpha/3 (alpha is the overall error rate)? If yes, reject the null hypothesis associated with this p-value. If no, accept all 3 null hypotheses and terminate the procedure. 3) Is the second lowest p-value ≤ alpha/2? If yes, reject the null hypothesis associated with this p-value. If no, accept this and the remaining null hypothesis and terminate the procedure. 4) Is the highest p-value ≤ alpha? If yes, reject the null hypothesis associated with this p-value. If no, accept the corresponding null hypothesis. The alpha level was set at 0.10.

3 Results

3.1 Questionnaire study among fishermen (Study I)

Thirty-seven percent of the respondents had been injured in fishery during the last three years. Sixty-two percent had experienced injuries or near-injury events involving themselves or others.

On average, the responding fishermen did not seem to perceive their job to be associated with high risks. Risks at work were perceived to be manageable to a fairly high degree (table 6). The results concerning technical knowledge and skills suggested confidence about sufficiency of technical knowledge (table 6). On the average, the respondents tended towards a low degree of fatalism, a moderate degree of risk acceptance and relatively high activity in safety work (table 6).

Table 6. Means and standard deviations of indexes for perceived manageability of risks, risk perception, activity in safety work, risk acceptance, technical skills, and fatalism.

Index	Mean	S.D.
Perceived manageability of risks	4.5	1.0
Risk perception	3.0	0.8
Activity in safety work	4.7	1.0
Risk acceptance	3.2	1.1
Sufficiency of technical skills	4.6	1.0
Fatalism	2.5	1.3

Means could vary between 1 and 6, higher value indicating more manageability etc.

Bivariate correlations between the indices, injury/near-injury event experience and background variables, respectively, and activity in safety work reached significance ($p < .05$) for perceived manageability of risks ($r=.32$; $p=.001$) and perceived sufficiency of technical knowledge ($r=.25$, $p=.014$). All other variables except single crew ($r=.14$; $p=.096$), ownership of vessel ($r=.07$, $p=.25$), civil status ($r= .12$, $p=.14$) and fatalism ($r=-.12$, $p=.12$) correlated 0.0 with activity in safety work.

Perceived risk, perceived manageability of risks, risk acceptance, sufficiency of technical skills, fatalism, age, injury/near-injury event experience, civil status, parenthood of children under 18, years as fisherman, single crew, ownership of the fishing vessel and role aboard (skipper/non skipper) were used as predictor variables in a multiple regression analysis, with activity in safety work as dependent variable. In the final model (table 7), all predictors except perceived manageability of risks, perceived sufficiency of technical knowledge and civil status were eliminated.

Table 7. Multiple regression (Stepwise, final model) of perceived manageability of risks, sufficiency of technical skills and civil status on activity in safety work.

	B	95% c.i. for B	Beta	t	p
Constant	*2.5*	*1.20; 3.72*		*3.90*	*.000*
Perceived manageability of risks	.36	0.15; 0.57	.37	3.38	.001
Sufficiency of technical skills	.29	0.09; 0.48	.33	2.96	.004
Civil status	-.71	-1.30; -0.13	-.28	-2.46	.017

$R= .48$; $p= .000$
$R^2= .23$
Adj $R^2= .20$

Among the final predictors, civil status was significantly associated with sufficiency of technical skills (r=.30, p=.004). Of the variables in the sufficiency of technical skills index, only sufficiency of technical knowledge related to equipment for navigation and supervision was significantly associated with activity in safety work (partial correlation, controlling for the remaining technical knowledge items = .45; p= .000). The other two items had partial correlations of -.11 and -.05 with activity in safety work.

3.2 Intervention study among fishermen (Study II)

3.2.1 Arenas for discussion and exchange of experience

Observations: One group initially had eight members. One never attended, two attended three times. This meant that at least five participants were present at the meetings. The other group initially had six members. Two (one crew) never attended, one attended once and one attended three times (table 2). In the latter group attendance was so small and irregular (half of the meetings were held with only 2 participants) that an effective inter-crew interaction could not be achieved. In the former group, attendance was more regular and interaction was more frequent between as well as within crews.

Initially, the knowledge about fishery among the group leaders was "tested" by group members. After "approval", the group leaders were accepted as such and their interventions met no visible resistance.

Both groups reported and discussed incidents/accidents according to the intended structure, guided by questions from the group leaders.

It happened that participants expressed frustration and embarrassment over how they managed safety. Such openness seemed to inspire other members to participate with their own feelings and thoughts on the matter. This kind of process seemed to create an air of increased motivation towards activity in safety work.

During one meeting a junior crew member claimed that unsafe practices were conserved because the skipper had a conservative attitude. Such behavior may be associated with risk of being perceived as challenging the entire role and authority of the skipper. Instead of encouraging such risk taking, the group leaders made questions intended to get focus back on the specific incidents and possible specific preventive behaviors. This was a way of protecting and reinforcing the existing working alliance between crew members, instead of putting it to risk by allowing processes that may have led to "loss of face" and subsequent maneuvers to "save face".

At times the discussion tended to deal with factors beyond the scope of the project, e.g. fish prices and fishery politics. These discussions presented an opportunity to air feelings of frustration and powerlessness. In these situations the strategy from the discussion leaders was to avoid lingering on issues beyond the scope of the project, by making questions to get focus back on potentially manageable things. Such diversions from occupational safety issues took up little time and were not a problem.

Interviews: All respondents appreciated the opportunity to exchange ideas and experience with other crews. Several wished that more fishermen with long experience had participated.

All respondents stated that they had felt free to express observations and thoughts. Some thought that the activity among some of the fishermen had been too low. On the other hand, it was noted that: “fishermen are not that used to talking much”.

Six of the respondents approved of the number and frequency of the meetings (6 meetings in 10 months), while 2 felt that the meetings were too many and too frequent. All respondents considered the duration of the group meetings to have been adequate.

All respondents were interested in continuing the meetings in the discussion groups after the intervention in co-operation with the OHS services.

3.2.2 Structured documentation and analysis of incidents/accidents

Observations: Several incidents had not been noted in the diaries but were remembered during meetings.

Interviews and observations: Diaries tended to be kept on the bridge and were thus not immediately available when events occurred. Often the skipper or an especially interested crewmember was perceived as responsible for diary keeping and the extent to which it was practiced depended upon the activity of this person.

Interviews: The diaries had been used at some time by five of the participants and four of these intended to keep using them after the project. Eight participants considered diaries to be a good idea (incidents got documented, documentation was made available to other crew members, overview over incident types and frequency was facilitated) while the remaining two felt that the diaries were unnecessary – “important events are remembered anyway”.

Observations: At all meetings except one, incidents/accidents were reported and analyzed. Several serious incidents were reported during group meetings, but were so common that they were not seen as incidents but part of the normal and therefore not noted in the diary. Particularly slips and falls belonged to this category. The participants gave the impression of being well aware of the chain of events leading up to an incident. The distinction between basic and releasing factors was not always clear to the participants, however. Potential releasing factors that were impossible to avoid, such as weather or the presence of slippery matter on deck, could be seen as basic causes. This could lead to the false conclusion that prevention was impossible.

3.2.3 Technical expert support

Observations: Support from the OHS engineers was requested and provided concerning means to increase friction between feet and ship (more suitable boots and a way of covering slippery surfaces with high friction matter), hearing protectors with built-in radio communication facility and improved trawl board fixations. All requests grew out of previous analysis of incidents. In order to be accepted, proposed solutions had to be robust and practical rather than technologically sophisticated but with unproven reliability.

Interviews: More information on possible sources of economic support for safety improvements and information on how to go about applying for such funding was requested by respondents.

3.2.4 Occurred injury/near-injury events and their causes

Observations: Incidents/accidents where crew members were jammed or hit were most common (table 8). Heavy parts of equipment (trawl, otter board, hook, block, engine, piles of fish boxes) that came out of control, or broken wires were causes of these. Slips and falls, caused by fish, oil or other slippery matter on deck, by combination of smooth walking/standing surface and footwear unsuitable for such surfaces, by a poorly fixed chair on the bridge or by failure to notice an open lid, were also common (table 8).

Table 8. Classification of injuries/near-injury events reported during group meetings.

Type of occurrence	n
Crew member got jammed or hit	24
Slips or falls	15
Ship leaking	2
Ship unmanageable	1
Physical overload on crew member	1
Sum	43

Weather, ship motions, stream conditions and their interactions were the most common releasing factors behind injuries and near-injury events. Deficient work methods, manifested in confusion or inadequate behavior, as well as poor equipment function due to neglected maintenance were also relatively common (table 9).

Technological imperfections (events could have been avoided with better technology) were the most common basic causes of injuries and near-injury events, but conscious risk taking, lack of good routines and poor maintenance of equipment were also identified as frequent causes (table 9).

Table 9. Releasing factors and basic causes of reported injuries/near-injury events.

Releasing factor	n
Weather/ship motions/stream conditions	16
Deficient methods	10
Equipment poorly maintained	8
Circumstances beyond control of the fishermen	4
Hurry/exposed position	3
Faulty decision	1
Physical overload	1
Sum	43
Basic cause	**n**
Technical layout chosen from effectiveness but without consideration to safety	16
Conscious risk taking, disregard of normal routines	7
Absence of basic technical safety solutions (e.g. slip resistance)	6
Technical arrangements without sufficient safety (e.g. worn hooks)	5
Lack of good routines (e.g. check list for greasing of machinery)	5
Equipment poorly maintained	2
Equipment damaged during fishing activity (e.g. trawl caught in sea bottom)	2
Sum	43

3.2.5 Management of injury/near-injury events and their causes

Observations: The following quote illustrates a common observation during group meetings: “While it is happening you are totally focused on sorting out the situation. Afterwards you joke harshly about it to keep fear at a distance”. A striking obser-

vation was that crews repeatedly experienced the same type of incident without taking any preventive measures. It happened that participants expressed frustration over the tension between being aware of risks and the economically necessary focus on productivity. Frustration and embarrassment were also expressed over the fact that safety measures well known to be necessary often were not implemented, even after repeated discussions in the groups. Suggested explanations for this were: Lack of time ('to-do-lists' were written but only the most urgent matters got seen to, families also demanded time), difficulty in finding a practical solution and lack of authority in the crew (difficult to influence decisions if you are not a skipper; some skippers are conservative).

Interviews: It was a general opinion that money severely restrained the possibility of safety improvements.

Observations: Participants were aware that not being well acquainted with routines or setting aside routines may lead to vastly enhanced risks, since safety depends on that everyone is doing things the way he is expected to and knows where the hazards are. This was often a problem after some time of absence from work and due to new crewmembers. A common way to handle these problems was to "take it a bit easy" for some time until everybody felt "run in". For some work operations that were known to be risky no set routines were reported to exist or considered possible.

3.2.6 Safety action plans

Interviews: No plans for future improvements in safety were reported to exist at follow up.

Observations: The most clearly defined plan entailed testing and evaluation on three of the participating vessels of a type of slip resistance that previously had not been used in fishery. Less slippery boots were also tested. However, one crew had just bought a new ship with improved safety and one crew was about to buy a new ship and was not motivated to take measures on the present one.

3.2.7 Activity in safety work

Questionnaire: Four (of 6) respondents reported increased and one reported decreased activity in safety work.

Interviews: All but one of the respondents attributed increased general interest in safety, more interest in searching for hazards and a higher degree of participation in safety work on board to participation in the project. Four of the respondents reported that they had become more aware of consequences of accidents because safety at work was now more often reflected upon and discussed.

Observations: During the final group meetings, participants stated that they thought and discussed more about safety, followed routines more carefully and were more active in fixing safety related problems on board. These changes were attributed to participation in the project.

3.2.8 Perceived manageability of risks and risk acceptance

Questionnaire: One respondent reported increased and five reported decreased perceived manageability of risks. Four respondents reported decreased and two reported increased risk acceptance.

3.3 Participation and integration, and their relation to quality of modifications, psychosocial factors, and symptoms (Study III)

Descriptive data for integration and participation are given in table 10, and for the dependent variables in table 11.

Table 10. Group level descriptive data on integration and participation

	n	Mean	SD	Min-max[a]
Participation, baseline	40	2.2	0.4	1.5–3.3
Participation, follow-up	40	2.1	0.3	1.4–3.2
Integration, baseline	40	2.3	0.5	1.4–3.7
Integration, follow-up	40	2.3	0.4	1.5–3.4

[a] Could vary: 1.0; 4.0.
SD = standard deviation.

Table 11. Group level descriptive data for quality of modifications, psychosocial factors, and symptoms

	n	Mean	SD	Min; max
Quality of modifications	.	.	.	.
Ergonomics, baseline	40	3.7[a]	0.4	2.2; 4.5
Ergonomics, follow-up	39	3.8[a]	0.4	2.6; 4.3
Psychosocial, baseline	40	3.4[a]	0.3	2.6; 3.9
Psychosocial, follow-up	40	3.4[a]	0.4	2.0; 4.1
Psychosocial factors	.	.	.	.
Demands, baseline	40	2.8[b]	0.3	2.0; 3.3
Demands, follow-up	40	2.8[b]	0.2	2.4; 3.4
Control, baseline	40	2.9[b]	0.3	1.7; 3.4
Control, follow-up	40	2.9[b]	0.3	2.3; 3.4
Social support, baseline	40	3.2[b]	0.3	2.1; 3.8
Social support, follow-up	40	3.3[b]	0.3	2.5; 3.8
Symptoms	.	.	.	.
Comfort: ergonomics, baseline	40	1.3[c]	0.8	–1.1; 2.8
Comfort: ergonomics, follow-up	40	1.4[c]	0.9	–2.0; 3.0
Comfort: physical, baseline	40	0.9[c]	0.7	–0.6; 2.1
Comfort: physical, follow-up	40	1.0[c]	0.7	–1.1; 2.2
Stress, baseline	37	2.6[d]	0.5	1.6; 3.6
Stress, follow-up	40	2.7[d]	0.5	1.8; 3.9
Physical complaints, baseline (% members)	40	51	17	23; 88
Physical complaints, follow-up	40	47	19	8; 83

Means could vary [a]:1; 5; [b]: 1; 4; [c] : -4; 4; [d]: 0; 5.
SD = standard deviation.

Participation and integration were strongly intercorrelated (table 12)

Table 12. Group level correlations between participation and integration

	1	2	3	4
1. Integration, baseline		.84	.88	.74
2. Integration, follow-up	.84		.76	.86
3. Participation, baseline	.88	.76		.81
4. Participation, follow-up	.74	.86	.81	

At baseline, follow-up, and prospectively, participation was bivariately correlated with demands (–), social support (+), and stress (–). At baseline, participation was also correlated with comfort, ergonomics (table 13).

At baseline, follow-up, and prospectively, integration was bivariately correlated with social support (+), and stress (–). At follow-up, and prospectively, integration was correlated with demands (-). At baseline, integration was correlated with comfort (table 13)

Neither the quality of modifications nor the proportion of group members who reported physical complaints was correlated to participation or integration (table 13).

Results from partial correlation analyses (33) showed that when controlling for integration, participation was correlated only with demands (-) and stress (-) (baseline), social support (+) (follow-up) and comfort: ergonomics (+) (prospectively). When controlling for participation, integration was not correlated with any of the dependent variables.

Table 13. Bivariate correlations between participation and integration, respectively, and working environment and symptom indicators

	Participation			Integration		
	Baseline r [a]	Follow-up r	Prospective r	Baseline r	Follow-up r	Prospective r
Quality of modifications	.	.	.	.	.	.
Ergonomics	.24	–.26	–.21	.14	–.18	–.26
Psychosocial	.16	.20	.27	.08	.11	.15
Psychosocial factors	.	.	.	.	.	.
Demands	–.41	–.45	–.45	–.24	–.44	–.36
Control	.31	.00	.17	.31	.01	.08
Social support	.53	.55	.53	.56	.44	.59
Symptoms	.	.	.	.	.	.
Comfort: ergonomics	.43	.20	.15	.39	.10	–.01
Comfort: physical	.29	.15	.08	.33	.20	.09
Stress	–.69	–.63	–.58	–.63	–.60	–.56
Physical complaints	.14	.17	.18	.19	.07	.11

[a:] Correlations > /.32/ had p-values < .05

3.4 Feedback intervention study among VDU-users (Studies IV &V)

3.4.1 Modification activity and quality of modifications

Baseline values for modification activity are shown in tables 14 and 16. In absolute figures, decrease in proportion of workgroup members who reported any modification was observed for ergonomic aspects. This trend was less marked for psychosocial aspects (table 14). Inter-condition variation with respect to change from baseline to follow-up was observed for proportion of workgroup members who reported any modification in ergonomic aspects (table 14). All feedback conditions differed positively from controls in this respect (table 15). For proportion of workgroup members who reported any modification in psychosocial aspects, no inter-condition variation with respect to change was indicated (table 14). Therefore, no pairwise comparisons were made for this variable.

Table 14. Baseline values and change to follow-up in proportion of workgroup members who reported any modification in working-environment or working technique to have occurred during the previous 6-month period

Type of modification:	Study condition (all n=9)	Baseline Median Min; max	Change [a] Median Min; max (%-units)	Change [a] Mean ranks for Overall test
Ergonomic	Individual feedback	67% 36; 100	-11 -33; 33	21.4
	Supervisor feedback	83% 14; 100	0 -33; 75	22.9
	Group feedback	90% 40; 100	-10 -43; 40	19.4
	Control	86% 50; 100	-33 -100; 10	10.3
	Overall test (Kruskal-Wallis): Chi-sq = 7.90; p= .048			
Psychosocial	Individual feedback	89% 50; 100	0 -50; 11	17.7
	Supervisor feedback	88% 29; 100	0 -11; 43	22.2
	Group feedback	75% 43; 100	0 -29; 25	21.1
	Control	90% 71; 100	-11 -100; 6	13.0
	Overall test (Kruskal-Wallis): Chi-sq = 4.35; p= .226			

[a:] Proportion at follow up minus proportion at baseline

Table 15. Change in proportion of workgroup members who reported any modification in ergonomic aspects to have occurred during the previous 6-month period. Pairwise comparisons between intervention and control conditions.

Study condition (all n=9)	Change [a] Mean ranks Intervention/ Controls	p [b]	Critical p-value for overall alpha = .100 [c]
Supervisor feedback	12.5/ 6.5	.017	.033
Individual feedback	12.4/ 6.6	.021	.050
Group feedback	11.8/ 7.2	.062	.100

[a:] Proportion at follow up minus proportion at baseline.

[b]: Pairwise comparisons, intervention vs. control; Mann-Whitney U, 2-tailed.

[c] : Sequentially rejective Bonferroni test (see 2.5.4)

For change, in absolute figures, with respect to average number of modification-types per individual in a group in the ergonomic as well as psychosocial areas, the general trend was negative (table 16). Inter-condition variation was detected only for change in average number of psychosocial modification types (Table 16). Pairwise comparisons indicated that the supervisor feedback condition differed positively from controls (Table 17).

Table 16. Baseline values and change to follow-up in average number of modification-types per individual in a workgroup during the previous 6-month period.

Type of modification:	Study condition (all n=9)	Baseline Median Min; max [b]	Change [a] Median Min; max	Change [a] Mean ranks for Overall test
Ergonomic	Individual Feedback	1.2 0.6; 6.0	-0.4 -4.0; 0.3	19.6
	Supervisor feedback	2.0 0.1; 6.8	-0.5 -4.5; 1.1	19.4
	Group feedback	2.4 0.4; 3.9	0.0 -2.0; 1.8	22.4
	Control	2.0 1.0; 4.8	-1.1 -4.6; 0.0	12.6
	Overall test (Kruskal-Wallis): Chi-sq = 4.20; p= .240			
Psychosocial	Individual feedback	2.8 1.1; 6.0	-0.8 -3.0; 0.4	15.7
	Supervisor feedback	2.5 0.7; 5.8	0.4 -1.3; 1.0	26.0
	Group feedback	2.8 1.3; 5.0	-0.5 -2.0; 0.7	19.2
	Control	2.6 2.0; 4.6	-0.9 -2.8; 0.6	13.1
	Overall test (Kruskal-Wallis): Chi-sq = 7.64; p= .054			

[a:] Workgroup mean at follow up minus workgroup mean at baseline.

[b]: Could vary 0.0; 7.0 for ergonomic aspects and 0.0; 8.0 for psychosocial aspects

Table 17. Change in average number of psychosocial modification-types per individual in a workgroup during the previous 6-month period. Pairwise comparisons between intervention and control conditions.

Study condition (all n=9)	Change [a] Mean ranks Intervention/ Control	p [b]	Critical p-value for overall alpha = .100 [c]
Supervisor feedback	12.3/ 6.7	.024	.033
Group feedback	11.4/ 7.6	.121	.050
Individual feedback	10.2/ 8.8	.596	.

[a:] Group mean at follow up minus group mean at baseline.

[b]: Pairwise comparisons, intervention vs. control; Mann-Whitney U, 2-tailed.

[c]: Sequentially rejective Bonferroni test (see 2.5.4)

The overall tests for change in quality of modifications indicated no intergroup variation (Table18).

Table 18. Baseline values, change and difference vs. controls in group-level quality of modifications

Type of modification:	Study condition (all n=9)	Baseline Median Min; max [b]	Change [a] Median Min; max	Change [a] Mean ranks for Overall test
Ergonomic	Individual feedback	3.78 3.4; 4.1	-0.20 -0.8; 0.4	12.9
	Supervisor feedback	3.54 3.2; 4.0	+0.17 -0.3; 0.7	20.2
	Group feedback	3.90 3.5; 4.3	-0,05 -1,1; 0.6	17.8
	Control	3.67 2.2; 4.1	+0.28 -0.4; 1.8	23.1
	Overall test (Kruskal-Wallis): Chi-sq = 4.67; p= .215			
Psychosocial	Individual feedback	3.49 3.0; 3.9	-0.29 -1.2; 0.5	13.1
	Supervisor feedback	3.32 3.1; 3.9	+0.12 -0.4; 0.3	19.4
	Group feedback	3,36 3.0; 3.8	-0.02 -0.5; 0.6	17.9
	Control	3.34 2.6; 3.6	+0.32 -0.3; 0,8	23.6
	Overall test (Kruskal-Wallis): Chi-sq = 4.53; p= .210			

[a:] Workgroup mean at follow up minus workgroup mean at baseline.
.[b]: Group means; could vary: 1.0; 5.0.

3.4.2 Psychosocial factors

The overall test indicated intergroup variation for change in social support (Table 19). Pairwise comparisons intervention vs. controls indicated a positive difference for feedback to supervisor (Table 20). No intergroup variation was indicated for change in psychological demands or decision latitude (Table 19).

Table 19. Baseline values, change and difference vs. controls in group-level psychosocial factors

	Study condition (all n=9)	Baseline Median Min; max[b]	Change[a] Median Min; max	Change[a] Mean ranks for Overall test
Psychological demands	Individual feedback	2.77 2.4; 3.3	+0.16 -0.3; 0.5	21.3
	Supervisor feedback	2.80 2.4; 2.9	-0.02 -0.1; 0.4	16.2
	Group feedback	2.75 2.0; 3.2	+0.02 -0.2; 1.3	18.2
	Control	2.87 2.4; 3.0	+0.11 -0,3; 0.3	18.4
	Overall test (Kruskal Wallis): chi-sq. = 1.08; p= .783			
Decision latitude	Individual feedback	2.96 2.1; 3.4	-0.02 -0.4; 0.2	14.8
	Supervisor feedback	2.98 2.4; 3.3	+0.07 -0.3; 0.3	18.3
	Group feedback	2.86 1.7; 3.1	+0.09 -0.0; 1.3	20.6
	Control	2.86 2.5; 3.4	+0.09 -0,1; 0.4	20.3
	Overall test (Kruskal Wallis): chi-sq. = 1.69; p= .639			
Social support	Individual feedback	3.35 2.8; 3.8	-0.13 -0.3; 0.8	13.9
	Supervisor feedback	3.17 2.9; 3.6	+0.07 -0.1; 0,5	24.7
	Group feedback	3.36 2.1; 3.8	+0.17 -0.2; 0.4	21.8
	Control	3.16 2.8; 3.8	-0.03 -0.2; 0.2	13.6
	Overall test (Kruskal Wallis): chi-sq. = 7.65; p= .054			

[a:] Workgroup mean at follow up minus workgroup mean at baseline.
[b]:Group means; could vary: 1.0; 4.0

Table 20. Change in social support. Pairwise comparisons between intervention groups and controls

Study condition (all n=9)	Mean ranks for change[a]: Intervention/ Control	p[b]	Critical p-value for overall alpha = .10[c]
Supervisor feedback	12.4 / 6.6	.019	.033
Group feedback	11.7 / 7.3	.077	.050
Individual feedback	9.2 / 9.8	.825	.

[a:] Workgroup mean at follow up minus workgroup mean at baseline.
[b]: Pairwise comparisons, intervention vs. control; Mann-Whitney U, 2-tailed.
[c] : Sequentially rejective Bonferroni test (see 2.5.4)

3.4.3 Symptoms

Overall tests did not indicate any intergroup variation change in comfort during computer work (Table 21), emotional stress, or musculoskeletal symptoms and eye discomfort (Table 22).

Table 21. Baseline values, change and difference vs. controls in group-level comfort

Comfort:	Study condition (all n=9)	Baseline Median Min; max[b]	Change[a] Median Min; max	Change [a] Mean ranks for Overall test
Ergonomics	Individual feedback	1.03 0.2; 2.8	+0.24 0.9; 1.3	18.7
	Supervisor feedback	1.40 0.8; 2.6	+0.20 -0.8; 1.6	19.9
	Group feedback	1.65 0.7; 2,4	+0.14 -0.5; 1.5	17.9
	Control	1.27 -2.0; 1.9	+0.22 -0.6; 0.9	17.5
	Overall test (Kruskal-Wallis): chi-sq. = 0.27; p= .967			
Physical	Individual feedback	1.08 -0.2; 2.3	-0.19 -1.4; 0.6	15.6
	Supervisor feedback	1.02 -1.1; 1.6	+0.24 -0.9; 1.6	24.6
	Group feedback	1.02 -0.2; 1.6	+0.05 -0.8; 1.1	17.2
	Control	0.75 -0.1; 1.8	+0.01 -0.8;0.9	16.6
	Overall test (Kruskal-Wallis): chi-sq. =4.07; p= .254			

[a:] Workgroup mean at follow up minus workgroup mean at baseline.

[b]:Group means; could vary: -4.0; 4.0

Table 22. Baseline values, change and difference vs. controls in group-level emotional stress and physical symptoms

	Study condition	Baseline Median Min; max	Change [a] Median Min; max	Change [a] Mean ranks for Overall test
Emotional stress (All n=8)	Individual feedback	2.51 [b] 1.6; 3.1	+0.20 -0.4; 0.9	17.4
	Supervisor feedback	2.41 2.0; 3.2	-0.12 -0.5; 0.3	11.7
	Group feedback	2.63 1.6; 3.6	+0.20 -0.6; 0.5	15.5
	Control	2.47 1.9; 3.4	+0.41 -0.5; 0.8	21.4
	Overall test (Kruskal-Wallis): chi-sq.= 4.48; p= .214			
Physical symptoms [c] (All n=9)	Individual feedback	27 [d] 0; 60	+9 [e] -20; 25	20.5
	Supervisor feedback	50 20; 75	0 -25; 50	18.2
	Group feedback	36 11; 67	0 -17; 25	18.6
	Control	33 18; 50	0 -50; 33	16.7
	Overall test (Kruskal-Wallis): chi-sq. =0.60; p= .896			

[a]: Follow-up minus baseline

[b:] Group means; could vary: 0.0 ; 6.0.

[c]: Pain or discomfort in eyes, head, neck, shoulders, arms, or hands ≥ 10 days the latest month.

[d] : % of workgroup members.

[e]: %-units

4 Discussion

The disposition of this section will be as follows: First, the results will be discussed in a common context. After this, the studies will be discussed separately before conclusions and some thoughts on further study will be stated. Methodological concerns will be discussed mainly in the study-specific sections.

4.1 General discussion

4.1.1 Risk awareness and manageability

The results from study I suggested that perceived manageability of risk factors increases the probability that preventive action will be taken. In a similar fashion, feedback theory (66) states that the problems indicated by feedback should be perceived as manageable in order to make any behavioral effect occur. The main aim of the intervention in fishery was to put a focus on the manageability of safety problems (although the results from study II implied that it may not have been entirely successful in that respect). In order to do that, the safety problems had to be identified, so there was a focus on risk awareness also, maybe too much. The feedback intervention had its main focus on risk factors, or conditions implying some undesirable state of affairs. The short discussion time was intended to give space for thoughts about manageability. The results from the feedback study indicated effect on two out of four aspects of activity to modify the working environment. On the premise that risk awareness is weakly related to preventive action also among office workers, these results are understandable.

In the intervention study in fishery, a striking finding was that safety problems that, from the interventionists´ perspective, appeared easily manageable by means of some technical or organizational modification were not actively tackled. The explanations given for this could be interpreted in terms of "low priority", which in turn may be an expression of the appraisal that the threats imposed by the safety problems in question were in fact managed "good enough", implying that the degree of risk acceptance among the participants was, in fact, quite high. This must not necessarily have been an expression of traits or "culture", but an effect of practical and economical everyday necessity in fishery. Fishery is a kind of small-enterprise where individual income is directly related to catch. Interest may be focused more directly on short-term economy than on safety, particularly costly preventive measures of a more passive character that may not be economically profitable unless it can be proven that some costly injury would have happened if prevention had not been implemented. Interestingly, measures for passive slip-prevention were implemented after repeated analysis of slip-related injury events, including discussion about possible consequences of serious slip-related injuries, and expert support concerning ways of slip-prevention. This suggests the following interpretation: The desirability of prevention was made more salient, perceptions of manageability were strengthened, and action was taken.

The most salient effect of the feedback intervention concerned activity to modify workplace design and working technique. This may be understood from the fact that the interventionists were experts in ergonomics and that the most specific and

normative feedback information concerned workplace design and working technique. But one may also ask: What is manageable for supervisors and workers in an office? Is it the overall performance goals and resource allocation, which may determine job demands? Is it job content or decision authority? It is a reasonable assumption that it is easier for workers and supervisors to modify workplace design and experiment with working technique. Social support may also be more likely to be possible to influence by group members and their supervisor. It is also interesting to note that the quality of modifications did not seem to be affected by the feedback intervention. This finding is not surprising considering the general uncertainty concerning what could be done to reduce stress as well as what could reduce musculoskeletal problems in the individual case.

4.1.2 Participation and integration

The results from study III suggested that higher levels of participation and integration of working-environment and other core organizational concerns do not necessarily predict better working environment and health outcomes. Instead, certain working environment characteristics (lower job demands, better social support, and less stress) may be necessary in order to achieve participation and integration. One may speculate that if organizations do not have enough competence to design and/or implement ergonomically and psychologically sound workplaces and jobs, participation/ integration is not enough to achieve success. This is supported by the intervention study in fishery, which was participatory and had as a major concern how to integrate safety concerns into everyday work: It is uncertain whether this lead to actual improvements in occupational safety. The most substantial safety improvements were into reduction of the risk for slips and falls during fishery, and this was the result of cooperation between interventionists and participants. And in this case, the interventionists played an active role in suggesting solutions after participants had identified the problem. The participants were psychologically prepared for change. This is an aspect that speaks in favor of interventions that may be flexible and adapt their strategies to the needs and readiness of participants instead of implementing a standard package.

The results presented in this thesis can be interpreted as illustrating the importance of effective collaboration between experts and organization members. This is supported also by results from a number of intervention studies related to ergonomics (1; 6; 15; 64; 85; 125); positive results were found for interventions where occupational health specialists informed and guided participants about good ergonomic solutions. For example, Nevala-Puranen et al. (85) noted that improvements in working technique was unlikely to result from workplace redesign only. Worker training and support from experts seemed necessary to achieve better technique.

Participation, integration, feedback techniques, and process interventions may be valuable features in intervention work, but organization members should not be left by themselves to find out how to improve occupational safety and health. Although they may know “where the shoe pinches”, they may not always know how to make it fit better.

The findings from the feedback study (i.e. feedback to supervisors was associated with the widest range of effects) do not imply that participatory ergonomics should be

abandoned. Rather, they highlight the importance of well-informed and motivated leaders, which is most probably a necessary prerequisite also for effective participatory ergonomics. Furthermore, the simple group- or individual worker feedback interventions studied here can be said to be participatory ergonomics only in a very limited sense (48). Full-scale survey feedback interventions (25; 98) would come more close to being exponents of participatory ergonomics.

4.1.3 Effects studies vs. process studies

The intervention studies represented two different methodological approaches. The process-oriented intervention study in fishery involved several intervention occasions and generated specific information about problems and possibilities of safety work among fishermen. Its major drawback (as an intervention effect study) was poor internal validity. More valid conclusions concerning intervention effects will require a more controlled study. On the other hand, the longitudinal design involving prolonged contact between researchers and participants made relatively close observation of problem identification and subsequent action possible. Such observations are essential in order to learn about intervention processes and factors related to the feasibility of interventions but may be difficult to manage in a larger scale study.

The feedback intervention study was stronger in terms of internal validity, but gave no process information. Such information would have been valuable e.g. for the understanding of why little change occurred in intervention groups and why negative change occurred in control groups. Adherence to established survey feedback intervention designs would have made process data available, since such designs include several intervention occasions. The feedback intervention studied here used a simplified procedure and involved only one intervention occasion. From an intervention perspective, this had to do with feasibility and economy and could be regarded as reasonable, bearing in mind that it was intended to represent a technique for everyday occupational health service work. From an experimental study perspective the simplifications of classical survey feedback design was something of a necessity in order to obtain experimental control. This was however not achieved in full. There were several potential validity problems that made interpretation of results difficult because it was hard to estimate their likelihood and magnitude.

Another problem with the feedback study, and working life randomized controlled trials (RCT:s) generally, may be the external validity. This is because the constraints imposed through randomization and standardized intervention procedures may not correspond to the realistic everyday conditions that interventionists or participants face in working life. It may be unrealistic to expect that persons outside laboratory or clinical settings are able and willing to apply standardized procedures when facing situation-specific problem constellations and demands in different occupational contexts. Thus, intervention procedures with effects proven in an internally valid study may not be possible to implement according to original specification in real-life settings. The internally valid evidence may therefore have limited practical value. It should be noted, however, that the RCT presented here used a very simple intervention procedure, designed to be similar to “ordinary” interventions.

I think that process oriented and experimental intervention studies are equally necessary. Process studies are useful for getting information about the feasibility of

different intervention components and preliminary evidence concerning their specific effects. Stronger effect evidence could then be obtained through experimental study of specific promising components. Finally, evidence based packages of such components could be combined into more complex interventions according to specific needs.

4.2 Questionnaire study among fishermen (Study I)

The aims of study I were to explore associations among injury event experience, personal risk, perceived manageability of risks, perceived sufficiency of technical knowledge, fatalism, risk acceptance and self-rated activity in safety work among Swedish fishermen. It used a cross sectional design that does not warrant any conclusions about causality.

4.2.1 Results

Injury/near-injury event experience was not correlated to activity in safety work. This implies that the fishermen did not effectively learn from experience, suggesting that an objective for safety work should be to support such learning.

Perceived risk level did not predict activity in safety work. As a consequence, interventions aimed solely at increasing perceived risk seem less promising in safety work among fishermen. Witte *et al.* (126) found that a high score for perceived threat predicted active safety behavior. However, the same authors concluded that efforts to increase perception of threat should, to be effective, be accompanied by efforts to promote perceived efficacy of safety measures.

In the present study perceived manageability of risks predicted higher activity in safety work. A similar relation was found by Goldberg *et al.* (42), who noted that activity in safety work was higher among workers having received safety instruction and perceiving co- worker support in relation to safety work. It is also in congruent with theory regarding risk behavior (72; 84). This result suggested that activity in safety work could be stimulated through analyses of injuries and near-injury events, in order to clarify how the courses of events could be influenced and modified. Another suggestion was that activity in safety work might reinforce perceptions of manageability, possibly forming a positive feedback loop.

We expected that having some kind of family responsibility would be positively associated with activity in safety work, particularly in a dangerous occupation such as fishery. Our results suggested that civil status might predict activity in safety work. Specifically, being single appeared to predict higher activity in safety work. This finding was contrary to our expectations and seemed inconsistent with research (8; 41) that has indicated higher injury rates among singles. We cross-validated our regression model using randomly selected 70% subsamples (not reported here) and found civil status to be an unstable predictor however.

Self-rated technical competence (as an index variable) appeared as a predictor in the final regression model. However, partial correlation analyses on the specific variable level showed that self rated technical competence regarding equipment for navigation and supervision, but not the two other items in the technical competence index, was (significantly) associated with activity in safety work. It thus appeared that general perception of technical competence was in fact not a good predictor of

activity in safety work. Instead, a specific aspect of such competence, which in turn may be an expression of some individual or occupation-specific characteristic not measured in this study, appeared to predict activity in safety work.

4.2.2 Sample

The study used a convenience sample. Readers should be aware that due to the fact that respondents were recruited among fishermen who participated in occupational safety and health projects or attended health check-ups, our sample may be unrepresentative with respect to the safety related variables in this study. After comparing background data of our sample with corresponding data from the population of Swedish fishermen, we concluded that our sample was representative except concerning age and residence area (34). Age was uncorrelated with activity in safety work. Residence area may be related to the variables under study here due to influence from local work cultures in fishery.

4.2.3 Measurement variables and analysis

Concerning empirical validity of our measures of risk perception, perceived manageability of risks and technical competence, no criterion was available to us and thus we have no information about empirical validity. Our measures of activity in safety work, risk acceptance and fatalism suffer from the same weakness. We also suspect that the latter measures may suffer from social desirability bias, since data collection was managed by occupational health specialists and, for some data, in the context of an occupational health project.

These problems illustrate a dilemma of applied research in occupational groups with particular culture and working conditions. Generally applicable and proven instruments may not be very suitable in terms of operationalisation and may also be so general that within-occupation variation becomes small. Also, difficulties to obtain large and/or representative samples may limit the possibilities to perform technically sound method development work.

Since our measures of risk perception, manageability of risks, risk acceptance, fatalism, and sufficiency of technical skills were based on self reports, common method variance (23) could account for associations between these measures and activity in safety work, which was also measured by means of self reports. But since both risk perception and risk acceptance correlated 0.0 with activity in safety work, common method variance did not appear to be a problem in this study.

The multiple regression model should be interpreted cautiously since the number of predictors in relation to sample size was large. Sample-specific characteristics and error variance may have made it unreliable in terms of more general validity.

4.3 Intervention study in fishery (Study II)

The aims of study II were to test the feasibility of, to study the processes during and to study some possible effects of an intervention among Swedish fishermen, that was based on documentation, analysis and discussion of occurred injury or near injury events during work.

4.3.1 Results

The intervention design proved sensitive to dropout but was effective with respect to achieving a serious discussion on safety issues. The structured analysis of injury/near injury events worked smoothly and facilitated verbalization of experience, experience exchange and documentation. We think that the focus on specific, identified problems made discussion on distribution of authority, norms and definition of acceptable safety level motivated and natural among crew. The distinction between basic cause and releasing factor was not always clear to the participants and we think the group discussions played a role in making this clearer. A major effect of structured incident reporting was to put problems of incident identification and memorization in focus. Diaries proved to be unreliable in this respect, but may still have a practical value. Slip incidents occurred repeatedly but were normally not noted in diaries or reported spontaneously at group meetings. A previous, more representative, study of injury events in fishery also found falls and slips to be common (114).This suggests that some of he most prevalent hazards were ignored.

Results indicated a large potential for prevention through technical, but also organizational, measures. In order to be accepted, solutions should be robust and practical.

The emotional experience of injury/near injury events seemed to linger and express itself in terms of frustration and embarrassment. It seemed that experience did not motivate direct action to solve problems behind injury events. A similar result was found in Study I. Interaction between structural, social and psychological factors seemed to explain why experience seldom lead to preventive measures, so this should be given priority in further safety intervention work.

Due to the small sample we think that any confident quantitative conclusions are impossible to draw, but the results suggested increased activity in safety work and decreased perceived manageability of risks. The latter may reflect that the group discussions made safety problems more explicit and dealt with difficulties associated with preventive work. A longer or more intensive intervention may be necessary in order to progress from problem orientation to action orientation. We think, however, that the intervention was effective in stimulating activity in safety work and that it initiated some specific measures.

The study indicated that, although sensitive to dropout, participative, talk-based safety interventions in fishery are feasible and may be effective.

4.3.2 Validity

Measures in a strict sense played a minor role in the study. Observations and interview data were more important. The basic validity problems are the same for both kinds of data. Due to the fact that the researchers were also active as inter-ventionists, the information concerning intervention effects may have been biased in favor of positive effects. This fact may also account for possible bias in the registration and analysis of observations. Interview data may also be biased but should be so to a lesser degree since an independent researcher collected them. Questionnaire data were collected with an interval of almost a year, so it seems unlikely that follow-up data should be deliberately faked in favor of intervention

effects, although the possibility cannot be ruled out. I think that a strength of the study was that 3 types of data were used and could be compared.

I think that qualitative information about injuries/near-injury events was valid. As for quantity, my impression is that all injuries were reported but that many near-injury events were not. Embarrassment, self-blame and a tendency to regard common types of near-injury events as normal may explain the tendency to underreport.

A major limitation to this study was the small sample, which was mainly due to the fact that the study was of a pilot character that implied limited resources. Another reason was the practical difficulties in recruiting fishermen to our relatively time-consuming intervention. This in turn had to do with the fact that no tradition of participatory safety work of this kind existed in Swedish fishery. The intervention reached participants that were interested enough in safety issues to participate. So this is the population, biased in favor of safety interventions as it may be. For the same reasons as in study I, residence area may be of concern in study II also. I think that the external validity for study II should be considered mainly with respect to feasibility. I find no reason not to believe that this kind of intervention should be feasible among interested Swedish fishermen generally. As for information concerning management of safety, generalization is more problematic. Larger studies or case studies among crews carefully selected to be representative are desirable in order do draw more general conclusions about the utility of the intervention method.

4.4 Participation and integration (Study III)

The aim of this study was to explore cross-sectional and prospective correlations between characteristics of working-environment change processes (participation and integration) and working environment and health indicators, in groups of white-collar VDU users. The results did not give evidence about causality. But use of data from two points in time as well as across time, gave stronger evidence concerning the stability of the patterns of association.

4.4.1 Results

Participation and integration were mainly associated with job demands, social support and stress. This suggests different but equally interesting interpretations. Firstly, high demands, stress and poor job relations may make participation and integration difficult to achieve (79). Workplaces where demands are lower, support is better and stress is lower may have time and resources to involve workers and managers in participation and integration. This may imply a paradox: in order to improve demands, support and stress through participatory ergonomics, these effects must already be present to some degree! Secondly, participation/integration may be of particular relevance for demands, social support and stress. This kind of interpretation would be in line with the general ideas about the benefits of participation and integration: more well-designed problem solutions and more effective implementation (48). But, as suggested by the weak associations between participation/ integration and the quality of modifications, comfort and control, participation/ integration may not in themselves be sufficient factors behind improvement. One may speculate that if organizations do not have enough competence in designing and/or implementing

ergonomically sound workplaces and jobs, participation/integration is not enough to achieve success, at least in such a limited time span (1 year) as covered by this study. In a longer time perspective, participative/integrative processes may generate enough competence through organizational learning.

The results from this study are generally in agreement with those of Ingelgård and Norrgren (56). However, one difference was that in the present study, integration and participation were weakly correlated with decision latitude, which was partially included (job content) in the "Quality of working life index" used in Ingelgård and Norrgren´s study.

Finally, the results imply that study of interventions aiming at a reduction of psychological demands and stress or an improvement of social support should statistically or experimentally control for integration and participation.

4.4.2 Validity

In this section validity issues related mainly to the measures of participation and integration will be discussed. Other validity issues relevant for study III will be discussed in section 4.5.2.

The component analyses of the items making up the indices of participation and integration in study III produced two components (33). Although the structures were not simple (43), the components could be interpreted meaningfully. It is theoretically possible that participation and employee influence may constitute one dimension, and that the degree to which working environment issues are integrated with traditional core organizational concerns, which in turn are the traditional core concerns of management, would constitute another, logically independent, dimension. The high correlations between factor approximations achieved by computing item means, as well as the results from the partial correlation analyses suggest that in the studied organizations, participation and integration were not empirically independent. Each dimension contributed little to explaining outcome variances when the other dimension was controlled for. These results can be interpreted as giving support to the idea that participation, empowerment, management support, and integration of working environment issues with traditional core organizational concerns tend to covary and together constitute a meaningful construct. This would be similar to what Ingelgård and Norrgren (56) called a "learning strategy for change". However, participation and integration are terms that better describe what was actually measured.

It would be useful to investigate a wider variety of workplaces in order to study whether different kinds of production and organization differ with respect to the relation between participation and integration. Further study should also give indications concerning possibilities to reduce the number of items necessary to measure participation and integration.

The strong correlations between items measuring logically different aspects could indicate poor validity. Mono method bias (23), for instance due to influence from trait affectivity (18) or social desirability, could explain the correlations, at least in part. Mono-method bias cannot be ruled out, but if this were a strong factor, participation and integration would have been expected to be more consistently associated with all outcomes. The idea that trait affectivity was involved is supported by the strong

correlations between participation/integration and stress, which is a measure of emotional or affective state. However, since group level data were used, this interpretation must build on the assumption that trait affectivity should vary systematically between workgroups. This may not be very likely. Social desirability bias could be present if the participants were well informed about the "correct" way of conducting organizational development work. No "change strategy rhetoric" was used when informing participants about this study, but such rhetoric is fairly well known in Swedish working life and the ideas of participation and integration are implemented in Swedish working environment legislation. Still, this should have been less of a problem in this study, where individual employee ratings aggregated at a group level were used, than in Ingelgård and Norrgren's (56) study, in which subject matter experts, who represented the studied organizations and were likely to be informed about legislation, made the ratings.

4.5 Feedback intervention study (Studies IV&V)

The aims of studies IV and V were to test whether feedback and discussion of ergonomic and psychosocial working environment data during one short session with individual, groups or supervisors of white-collar VDU workers had effects on activity to modify the working environment, the quality of modifications made, and working environment and health indicators.

4.5.1 Results

The results should be interpreted cautiously, because several kinds of bias, in favor of as well as against intervention effects, could not be ruled out (see next section). Considering the number of analyses performed (which may introduce a risk for capitalizing on chance), and the potential biases, a cautious interpretation of the results would lead to the conclusion that feedback interventions of the kinds studied here failed to convincingly demonstrate any effect. This would be in line with results from research on survey feedback as a tool for organization development (82; 83). A less cautious interpretation may however allow the conclusion that feedback may be effective in promoting activity to modify ergonomic and, for feedback to supervisors, psychosocial aspects of the working environment. Feedback to supervisors was also associated with increased social support. Since feedback to supervisors required the smallest investment of time, it also appeared as the most cost-effective variant. The finding that feedback to supervisors appeared most favorable is in contrast to earlier survey feedback research (82; 98) that emphasized the importance of group activities in feedback interventions. The finding is in line with Menckel et al (77), whose results indicated that feedback to supervisors were more likely to result in action, as compared to feedback to workgroups. Further evidence on working-environment and health effects from interventions directed at managers only were reported by Theorell et al. (109), see below.

The results from studies IV and V did not support the idea that feedback could explain change in quality of modifications, psychological demands, decision latitude, comfort during computer work, emotional stress, or musculoskeletal symptoms and eye dis-comfort. I do not find these results very surprising. Research on interventions

into ergonomics or stress has demonstrated how difficult it may be to demonstrate effects, and it can be said that in many instances it is not possible, even for experts, to say what specific modifications will lead to improvements in terms of health outcomes. Psychosocial working environment, stress, physical complaints, or discomfort have multifactorial backgrounds. Many of these factors are seen as designed into the job, being aspects of work organization. Other factors are related to individual characteristics such as personality or well-learned habits in terms of working technique. Work organization and individual factors may require prolonged effort and support to change. This may be illustrated by a study from Theorell et al. (109). An intervention, implemented among managers and focusing on psychosocial aspects, was found to have effect on 1 of 3 biological stress indicators and 1 (decision authority; an aspect of decision latitude) of 5 psychosocial working environment indicators - among the employees working under the participating managers. The intervention in question had a volume of 60 hours distributed over one year. The temporal dimension of change processes is emphasized by the Transtheoretical Model of behavioral change processes (50; 63). According to this model, which has been extensively applied in the study of health-related behaviors, change emerges during a process, taking the individual from precontemplation to actual change. This may require a long time. During the process, advantages and disadvantages of as well as likelihood of successful behavior change are considered. Haslam (50) suggested that ergonomics interventions should be designed according to the participants´ readiness for change. The feedback interventions did not specifically consider participant readiness for change. Goal setting may be seen as a process related to readiness for change. Other feedback research has emphasized the importance of combining feedback with goal setting interventions (67). Although the present feedback interventions included some normatively suggested goals communicated by the ergonomists, goal setting was not very strongly intervened into. Feedback to participants with high readiness for change may have had more positive effects, and vice versa. Standardized working life interventions may have different effects on different people. For example, an intervention study among VDU-users observed better effect for younger participants, than for older (15). This implies that interventions ideally should be tailored according to individual needs, or readiness to fully implement new methods and tools or fully engage in some educational intervention.

The simple intervention design may have contributed to weak effects: 1) The intervention did not involve any activity to formulate individual or organizational goals and priorities concerning office ergonomics, aside from general recommendations communicated by the ergonomists, 2) the feedback information was voluminous and some of the information (e.g. psychosocial factors) was abstract, requiring interpretation in order to locate specific problems, and 3) the feedback intervention was implemented during just one short session during which information should be communicated, interpreted, compared with goals and used to guide preliminary action plans. These factors may have interacted in creating cognitively complex feedback sessions. This complexity may have been easier to manage during supervisor-feedback sessions, because supervisors are responsible for working-environment, i.e. obliged to do something about problems, are likely to be more aware of goals, priorities and resources, and are in a position to take decisions. Supervisor

feedback sessions also involved only two persons, so discussions are likely to have been easier to manage for both parties involved.

4.5.2 Validity

A number of methodological concerns in studies III, IV and V will be discussed in this section. These concerns have to do with the measured variables themselves, their use to obtain measures of change in studies IV and V, the design of studies IV and V, and the combination of measures and design in these studies.

Response shift bias. If the properties of the measuring instruments undergo change over time, differences in data obtained at different points in time cannot confidently be interpreted as indicating differences in the measured "reality" (23). Response shift bias (105) refers to a validity problem of this kind, which may be associated with changes in the internal standards that guide participants´ responses to questionnaires. This may have been a problem for all measures of change in studies IV and V. If, due to baseline events and feedback, participants were made more knowledgeable and aware about ergonomics, psychosocial aspects, and health, their ratings of corresponding aspects of their work or their perceptions may have changed even if no change in the "objective" conditions occurred. For example, changes in comfort or pain data may not reflect actual change in the sensory signals behind comfort or pain perceptions or the external or internal conditions that trigger such signals, but changes in the internal standards by which they are evaluated in terms of intensity, quality, frequency, or duration. Also, the internal standard for ratings of quality of modifications and psychosocial factors may have become more demanding as an effect of increased knowledge and awareness about psychosocial working environment and ergonomics. The problem of changed internal standards may be particularly serious if interventions are intended to or may change these standards, as was the case in the feedback studies as well as the intervention study in fishery. If the internal standards became more demanding as an effect of increased knowledge and awareness, one could expect the ratings of working environment and various perceptions to be influenced in a negative direction in the intervention conditions. Such an effect on internal standards seems less likely in the control condition. In sum, if differences in treatment caused changes in internal standards to be heterogeneously distributed between intervention- and control conditions, the observed effects in study V may be biased in favor of controls. However, since only one person per group received feedback in the supervisor feedback condition, this kind of bias may have been less of a problem when comparing controls with supervisor feedback.

Measures of modification activity and quality of modifications: It should be noted that activity to modify working conditions does not mean that the working conditions actually improve. Activity to modify working conditions may be seen as practical experimentation, the results of which should ideally generate another feedback cycle, leading to new experimentation and so forth, eventually resulting in improved health and exposure conditions.

The definition of quality of modifications in the working environment was based on self-reported satisfaction with implemented modifications. Participant satisfaction may however have reflected more than the quality of the modifications made, as

ergonomics experts or experts on the psychosocial working environment might have judged them.

I have no specific information concerning the validity of the kinds of self-reported information about alterations in workplace design, job design and working behavior used here. The main validity problem with self-reported job behavior may have to do with the quantitative dimension, which was not measured in this study. Other researchers have studied the validity of self-report data on occupational activities. Concerning regularly occurring job tasks, Kallio et al (58) found that self-reports obtained through interviews had good validity with respect to the existence of the tasks as such. According to Campbell et al (16), referring to work postures and lifting, self-reports may have acceptable validity with reference to the occurrence of activities. Nordstrom et al (87) found self-reports on work activities of relevance for carpal tunnel syndrome to have acceptable validity in general terms.

Our measures of modification activity and quality of modifications relied on accurate recall of modifications made during the study period and quality ratings of these modifications. Six-month retrospective self-reports were used. Some validity problems are associated with this.

Because the groups in the control condition were not subjected to baseline ergonomic observation data collection and were not given feedback, the initial events, that may have guided recall of modifications, were weaker for these groups. This may have made "time-slice errors" (53; 124), specifically a "telescope effect", i.e. events are recalled to have occurred closer in time than was actually the case, more likely in these groups. A telescope effect may be a source of bias in studies IV and V and may also partially explain the general negative trend observed for modification activity. Any telescope effect may have been stronger at baseline than at follow-up because the time period studied at follow up was delimited by the initial baseline/feedback events which may have guided recall of modifications. Thus, what appears to be a general negative trend may be the result of more accurate recall at follow-up, reducing the proportion of "false positives" due to a telescope effect. But the negative trend may also reflect a real decrease in modification activity. During the study period, stress and burnout emerged as hot topics in the general debate in Sweden. The concern with stress may in turn partly be explained by general trends towards increased time pressure in working life, leaving less energy and time for working environment issues.

Any telescope effect may also be a source of recall bias concerning modification activity and quality of modifications: 1) Differences in treatment may have made it easier for subjects in the intervention conditions to accurately locate recalled modifications in the six month period between the initial baseline/feedback events and the follow up questionnaire. Recall of modifications may have been less accurate among controls because the initial events were weaker. Modifications actually made before baseline may have been recalled as having occurred after baseline. This may have led to overreporting at follow-up in the control condition, in which case observed intervention effects with respect to modification activity may have been biased in favor of controls. Any bias of this kind may have led to underestimation of effects particularly for individual and group feedback. Since the initial events were weaker in the supervisor feedback condition (group members did not get feedback), the comparisons with respect to modification activity between supervisor feedback

and controls may be less biased by a telescope effect. 2) Recall of modifications and the ratings of quality of modifications may partly have reflected the quality of modifications made before baseline. Other research has indicated that events associated with positive emotions may be more likely to be recalled (although not necessarily more accurately) than events associated with negative or neutral emotions (73). If this were the case in this study, the follow-up data on quality of modifications may have been positively biased by the perceived quality of chronologically misclassified modifications actually made before baseline and this effect may have been stronger in the control condition, due to weaker initial events in this condition. This may have biased observed intervention effects with respect to quality of modifications in favor of controls. Such bias may be most serious when considering effects from individual and group feedback. Concerning modification activity, this kind of bias may also have made bias due to a telescope effect, as discussed above, more likely. 3) Collection of observation data may be considered an intervention that possibly increased awareness of workplace design and working technique. Increased awareness was also an aim of the feedback intervention itself. Increased awareness may have made it more likely for future modifications to be remembered. If control subjects were less aware, modifications may have been less accurately remembered. This may have biased observed change with respect to modification activity in favor of the intervention, because there may have been more false negatives among controls. This kind of bias may have been be most likely concerning effects of individual and group feedback. Supervisor feedback could be expected to lead to less general awareness among group members than the other feedback variants. In consequence, there may have been more false negatives with respect to modification activity in the feedback manager condition also. Thus, the comparisons with respect to modification activity between supervisor feedback and controls may be less biased by differences in awareness than the other intervention-control comparisons.

Measures of musculoskeletal complaints and eye discomfort. These measures, as used in studies III, IV and V, was of a general nature and did not measure the total number of days that participants had experienced complaints or discomfort the latest month. They were insensitive to changes in specific symptom-areas. The severity of symptoms was not measured. Measures of severity may have been more sensitive to change. But this may also have made them more sensitive to changes in internal standards that may have been caused by the intervention.

Ceiling effects. Since baseline values for social support were high, a ceiling effect may have caused positive change in social support to be underestimated. This may have deflated observed intervention effects in the group and supervisor feedback conditions. There may also have been a ceiling effect involved when studying modification activity defined as proportion of active group members; baseline values were high.

Regression towards the mean. Regression towards the mean is an effect of imperfect reliability in the outcome measures (13). If study groups to be compared with respect to change over time are not initially homogenous with respect to the variables of interest, regression towards the mean may bias comparisons with respect to change(91). The baseline values for the studied outcomes in studies IV and V showed reasonable homogeneity of distribution across study conditions. But since this

homogeneity was not perfect, observed differences with respect to change may be biased by regression towards the mean. The reliability estimates (internal consistency) for our outcome measures were good (≥.85), except for psychological demands, decision latitude and comfort: physical environment. In consequence, regression towards the mean may have been a bigger problem in these latter variables. But the use of individual ratings aggregated on the group level may have reduced random error in the outcome measures. Statistical methods to manage the regression towards the mean problem exist, but were not adequate here due to the small sample involved and because of the assumptions underlying such techniques (89; 112). The possibility of bias due to regression towards the mean should be acknowledged as a limitation of studies IV and V.

Attribute-treatment interaction. Another problem is that intervention effects may have been different for different subgroups with respect to baseline status. If an intervention variant was effective only for some subgroup or if intervention effects in opposite directions were present in subgroups within the study conditions, the present approach to analysis was insensitive to this. Such a phenomenon has been called "attribute-treatment interaction" (91). Statistical methods to identify effects in subgroups with respect to baseline status exist, but were not adequate here due to the small sample involved and because of the assumptions underlying such techniques (91).

Control group effects. The study was not blind and controls were guaranteed equal treatment after the study period. Negative control group effects such as "demoralization" (23), or the adoption of a "wait-and-see attitude" may, at least partly, have accounted for observed intervention effects. These control group effects could possibly lead to an actual decrease in activity to improve or preserve the working conditions. This may have led to overestimation of feedback intervention effects. They may also have caused controls to be less careful in trying to recall modifications. This may have inflated observed effects with respect to modification activity.

More liberal internal standards may have been caused by demoralization, in which case observed effects may have been deflated (study V). There is also the possibility that, because they were aware of being controls, these groups may have tried to compete with the groups that were intervened into (23). This may have led to an underestimation of intervention effects.

Control group effects could be avoided by making the study blind, but it is hard to imagine how studies of psychological interventions could be made blind. It is impossible if the researchers do not successfully deceive participants about the nature of the studied intervention. Deception may be difficult and ethically questionable and may also be uncovered by participants, in which case the validity of the study is threatened. Double-blind studies appear impossible.

Treatment diffusion effects: Because every group in the control condition belonged to the same organization as three groups in the intervention conditions, treatment diffusion effects may have occurred (23). For example, information provided during feedback may have been communicated to controls. This may have led to underestimation of intervention effects. Diffusion may also have increased the ergonomic awareness among controls. This may have balanced out some bias due to changed internal standards in intervention groups.

Diffusion effects could have been avoided by keeping participants in different study conditions isolated, but this was incompatible with keeping organization or worksite factors under design control.

Reporting bias. Reporting bias, due to the fact that data were collected by the feedback providers, in favor of feedback effects may have caused inflation of observed intervention effects.

Uncertainty concerning active intervention components. The feedback intervention had three main features: 1) Presentation of general information about ergonomics and psychosocial working environment, some of it explicitly normative, 2) Specific information about local conditions (the feedback information), and 3) discussion about these issues. From this study, no conclusion regarding the relative importance of or interaction between these components could be drawn.

Internal validity of the feedback intervention study: Observed intervention effects may be inflated or deflated due to regression towards the mean, recall bias, bias due to changed internal standards, control-group effects and reporting bias. But there were more potential causes for underestimation of intervention effects than causes for potential overestimation. It is difficult to assess which of these possible biases are the most likely and the strongest. They may also have balanced each other out. All potential biases except control group effects were unavoidable when using self-reports, so its reliance upon self-report effect measures should be recognized as a major weakness of these studies. It would have been highly desirable to have had alternative effect data, such as independent observations of workplace design, working technique and job design.

Dropout and external validity: The study population for studies III, IV and V consisted of workgroups of white-collar workers for whom computer work was common, and who had concern with ergonomics and in engaging in research projects. The types of organizations represented the private as well as the public sector and were mixed with respect to type of production. The individual response rate was good considering the longitudinal design and the dependency questionnaire data. It is reasonable to assume that the results can be generalized to organizations similar to those studied.

In study IV, the individual-level criterion for inclusion when computing group characteristics was that participants should have worked at their present workplace since at least 6 months at baseline. This was necessary because the effect variables in this study were based on 6-month retrospective reporting of modification activity. Combined with loss to follow-up this had as a result that two groups were characterized by data from just one of their members. This made the reliability of the characterization of these groups questionable. However, the same conclusions would have been drawn from the results if the 4-month criterion of study V had been applied (31).

Uncertainty concerning practically relevant degree of change. For all outcomes used in studies IV and V, there is a problem that concerns the meaningfulness of any statistically significant effect, as well as statistical power. It is not known what magnitude of change in the measures of modification activity, quality of modifications, psychosocial factors, comfort, emotional stress and physical symptoms really matters in a practical occupational health perspective. Any statistically significant intervention effect is therefore hard to interpret in terms of practical utility.

Furthermore, failure to specify the magnitude of relevant effect makes considerations related to statistical power uncertain. I think that much more attention should be paid to this issue in future research.

Data analysis: In the feedback study (studies IV&V) results were analyzed on a group level. This was because the unit of analysis should be the same as the unit of randomization. This procedure led to loss of power. On the other hand, aggregation of data should lead to reduction of random variance. Such reduction improves statistical power. Data from the same project, analyzed on the individual level, were reported in another publication (32). Corresponding results in that study were largely similar to the ones presented here.

In interpreting results concerning feedback effects we have accepted an alpha level of 0.10. This level was accepted partly because the study involved few study units and the statistical power was expected to be low. But it can also be argued that the consequences of falsely rejecting a null hypothesis in this kind of study are probably smaller that the consequences of falsely accepting it. Feedback of the kinds we have studied is a common phenomenon and will in all probability be done anyway, because Swedish legislation and EU directives require employers to be informed about working environment conditions and because working environment surveys is a standard product of occupational health consultants. Thus, falsely concluding that feedback is effective will probably have no (new) negative effects. But on the other hand, if conclusions based on a less conservative statistical criterion should indicate possible ways of improving the existing practice this might have positive effects. This applies to cost-effectiveness as well as intervention effect as such.

4.6 Conclusions

Among the studied Swedish fishermen, the perceived manageability of risks was positively associated with activity in safety work. Association with activity in safety work could not be demonstrated for injury/near-injury event experience, perceived personal risk, risk acceptance, fatalism, or general technical competence. These results are in discord with other research in fishery that has claimed risk acceptance and fatalism to be associated with low activity in safety work. Participative, talk-based safety interventions were feasible. Structured documentation and discussions made safety problems but also difficulties associated with preventive work more explicit. Effective cooperation between participants and technical experts seemed beneficial in order to stimulate preventive activity.

Among the studied Swedish VDU-users, higher degrees of worker participation and integration of working-environment and traditional organizational performance issues, in efforts to improve the working environment, were associated with lower psychological job demands, higher social support, and less stress. With decision latitude, musculoskeletal complaints, comfort during work and quality of modifications in the working environment, associations were weaker and less reliable. The results suggested that participation and integration were not strong independent predictors for more positive working-environment conditions generally.

Effects on modification activity and social support were observed in a randomized controlled feedback intervention study among Swedish VDU-users. Feedback to supervisors appeared as the most cost-effective feedback variant.

4.7 Further studies

Feedback studies: Can characteristics of the feedback process explain differences in intervention effects? For example: Do feedback variants differ with respect to how much participants learn about working-environment and health during sessions? Do they differ regarding characteristics of the meeting process: openness and perceived meaningfulness? Can differences in these respects explain differences in outcomes? How can simple feedback interventions be improved with respect to goal-setting components, cognitive clarity of content, and the way the process is structured? That is, can it be improved in ways that are possible to manualize?

Interventions based on discussion and process: The general intervention approach is common, for example in stress management. Controlled effect studies of such interventions are desirable.

Participation and integration:

How do participation and integration relate to specific working-environment modification activity, as it occurs at the individual workplace? Although the general ideas about participation would imply that a positive association was present, participative activities may not always lead to more specific modifications, just more discussion and planning.

The general participatory climate may outweigh any effect of relatively minor interventions, such as feedback. It is therefore of interest to study how intervention effects and effects from participation and integration interact.

Although participation and integration may not be independent predictors of better working conditions generally, they may interact with other factors in predicting outcomes. For example, one could hypothesize that symptom severity, participation, decision latitude, and degree of knowledge about ergonomics interact in predicting the quality of working environment modifications.

Relation between modification activity and outcomes: The associations between modification activity and other outcomes should be explored. Such activity should be studied from quantitative as well as qualitative points of view.

Method development into self report-measures as well as alternative techniques seems necessary in order to progress in the research areas of this thesis.

Theoretical foundations for interventions: The theoretical basis for working life interventions into decision-making processes could probably be improved by integrating a few existing, empirically based theoretical models that deal with psychological, social and organizational aspects of health- and safety-related decision making and behavior.

Summary

Eklöf, M. (2004) *Interventions for safe and healthy work.* Arbete och Hälsa 2004:12

The general aim of this thesis was to contribute to the research-based knowledge about 1) individual psychological and social factors that may influence activity to modify the working environment, 2) general characteristics of how working-environment change processes are organized and their associations with working-environment and health, and 3) interventions designed to stimulate activity to modify the working environment and their effects in terms of activity, working-environment and health. The thesis is based on five studies:

Study I

Aim: Explore associations between psychological and social factors, respectively, and activity in safety work, among Swedish fishermen.

Method: Cross-sectional questionnaire study (n=92).

Results: Correlation and regression analyses indicated that the perceived manageability of risks was positively associated with activity in safety work. Association with activity in safety work could not be demonstrated for injury/near-injury event experience, perceived personal risk, risk acceptance, fatalism, or general technical competence.

Conclusion: The results are in discord with other research in fishery that has claimed risk acceptance and fatalism to be associated with low activity in safety work.

Study II

Aim: To test a group-based intervention method for increased activity in safety work among Swedish fishermen: Feasibility, process and results in terms of activity in safety work and perceived manageability of risks.

Method: Structured documentation and analysis of injury/near-injury events. Group discussions about possible preventive measures. Technical expert support available. Case study, process study. Observational, interview, and longitudinal questionnaire data (n=11).

Results: Participative, talk-based safety interventions were feasible. Structured documentation and discussions made safety problems but also difficulties associated with preventive work more explicit. Effective cooperation between participants and technical experts seemed beneficial in order to stimulate preventive activity.

Conclusion: Issues related to manageability should be given more attention in this kind of intervention. Technical expert support concerning ways to manage identified risks valuable.

Study III

Aim: To study associations between degree of worker participation in working-environment change processes, and integration of quality/productivity/organization issues and working-environment issues, on the one hand, and working-environment and health outcomes, on the other.

Method: Swedish white-collar VDU-users (n=399). Questionnaire data from two points in time. Correlation analyses.

Results: Higher degrees of worker participation and integration were associated with lower psychological job demands, higher social support, and less stress. With decision

latitude, musculoskeletal complaints, comfort during work and quality of modifications in the working environment, associations were weaker and less reliable.
Conclusion: The results suggested that participation and integration were not strong independent predictors for more positive working-environment conditions generally.
Studies IV and V
Aim: Study effects from feedback of data concerning workplace design, working technique, psychosocial factors, and musculoskeletal symptoms. Outcomes: activity to modify the working environment, quality of modifications, psychosocial factors, comfort during VDU-work, emotional stress, and musculoskeletal symptoms.
Method: Cluster randomized controlled study among Swedish white collar VDU-users (n(groups)=36). Three feedback variants: To individual workers, to group supervisors individually, or to entire workgroups including supervisor. A simple one session feedback method was used. Ergonomist performed the intervention.
Results: Positive effect with respect to activity to modify workplace design and working technique in all feedback variants. Positive effect with respect to activity to modify psychosocial aspects, and social support, in feedback to supervisor condition.
Conclusion: Effects on modification activity and social support were observed in a randomized controlled feedback intervention study among Swedish VDU-users. Feedback to supervisors appeared as the most cost-effective feedback variant.

Keywords: Ergonomics, Feedback, Fishery, Intervention, Occupational injury, Participatory, Psychosocial factors, Risk perception, Safety attitudes, VDU-work

Sammanfattning (Summary in Swedish)

Eklöf, M. (2004) *Interventions for safe and healthy work.* Arbete och Hälsa 2004:12

Det övergripande syftet med denna avhandling var att bidra till kunskapen om arbetslivsinterventioner för bättre säkerhet och hälsa. Mer specifikt så handlar avhandlingen om 1) individualpsykologiska och sociala faktorer som kan påverka graden av aktivitet för att förändra arbetsmiljön, 2) egenskaper när det gäller hur förändringsprocesser på arbetsmiljöområdet är organiserade och deras samband med arbetsmiljö och hälsa samt 3) interventioner i syfte att stimulera aktivitet för att förändra arbetsmiljön och deras effekter på aktivitet, arbetsmiljö och hälsa. Avhandlingen bygger på fem delstudier.

Delstudie I

Syfte: Studera samband mellan individualpsykologiska och sociala faktorer å ena sidan och aktivitet i säkerhetsarbete å den andra, bland svenska yrkesfiskare.

Metod: Tvärsnittsstudie med enkät (n=92)

Resultat: Sambands- och regressionsanalyser visade att den bedömda hanterbarheten hos olika riskfaktorer bäst predicerade aktivitet i säkerhetsarbete. Uppfattningar om riskers storlek hade mycket svagt samband med aktivitet i säkerhetsarbete

Slutsats: Resultaten kontrasterar mot tidigare forskning som hävdat att accepterande av risker och fatalism motverkar aktivitet i säkerhetsarbete bland fiskare.

Delstudie II

Syfte: Pröva en gruppbaserad interventionsmetod för ökad aktivitet i säkerhetsarbete bland svenska yrkesfiskare: Genomförbarhet, process och resultat i termer av aktivitet och bedömd hanterbarhet hos olika riskfaktorer

Metod: Strukturerad dokumentation och analys av tillbud och skadehändelser. Gruppdiskussioner kring preventionsmöjligheter. Teknisk experthjälp tillgänglig. Fallstudie, processtudie, observations-, intervju- och enkätdata (n=11).

Resultat: Delaktighets- och samtalsbaserade säkerhetsinterventioner bland fiskare var genomförbaraStrukturerad dokumentation och diskussion gjorde säkerhetsproblem men också svårigheter för prevention mer uttalade. Samarbete mellan deltagare och tekniska experter positivt för att stimulera preventiv aktivitet.

Slutsats: Frågor kring hanterbarhet bör fokuseras mer i den här typen av intervention. Teknisk experthjälp kring identifierade problem värdefullt.

Delstudie III

Syfte: Studera samband mellan grad av medarbetardelaktighet, ledningsengagemang och integrering kvalitets/produktivitets/organisationsfrågor med arbetsmiljöfrågor, å ena sidan, och arbetsmiljö och symptom å den andra.

Metod: Svenska tjänstemän som arbetade med persondatorer (n=399). Enkätstudie med två mätpunkter. Korrelationsanalyser.

Resultat: Delaktighet och integrering starkt korrelerade inbördes. Samband med krav, emotionell stress och socialt stöd. Samband med kontrollmöjligheter, komfort, upplevd kvalitet på genomförda arbetsmiljöförändringar och muskuloskeletala besvär var svagare och mindre reliabla.

Slutsats: Resultaten antydde att delaktighet och integrering inte var starka oberoende prediktorer för bättre arbetsmiljöförhållanden allmänt.

Delstudie IV och V
Syfte: Studera effekter (aktivitet för att förändra arbetsmiljön, upplevd kvalitet på genomförda förändringar, psykosocial arbetsmiljö, komfort, emotionell stress och muskuloskelettala symptom) av feedback av resultat från arbetsmiljökartläggning avseende ergonomi och psykosocial arbetsmiljö, kombinerat med information om ergonomi och psykosocial arbetsmiljö.
Metod: Klusterrandomiserad kontrollerad studie bland svenska tjänstemän som arbetade med persondatorer, 36 grupper. Feedback gavs i tre betingelser: Till individuella deltagare, till enbart gruppchefer, till hela arbetsgrupper. En enkel och vanligt använd metod tillämpades. Erfarna ergonomer gav feedback.
Resultat: Effekt rörande aktivitet för att förändra arbetsplatsutformning/ arbetsteknik i samtliga betingelser. Effekt rörande aktivitet inom psykosocial arbetsmiljö och socialt stöd för feedback till enbart gruppchefer.
Slutsats: Effekter på aktivitet för att förändra arbetsmiljön samt på socialt stöd kunde påvisas i en randomiserad kontrollerad studie av feedbackinterventioner. Feedback till enbart arbetsledare framstod som den mest kostnadseffektiva varianten.

Nyckelord: Arbetsskada, Attityder till säkerhet, Datorarbete, Delaktighet, Ergonomi, Feedback, Fiske, Intervention, Participation, Psykosociala faktorer, Riskuppfattning

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