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Construction work and education: occupational health and safety reviewed

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An overview is given of occupational safety and health and of training in the construction sector, summarizing the findings of different researchers. The studies discussed emphasize safety instruction and on the job training at sites, especially the teaching of first aid skills and accident prevention. Construction workers regard occupational training as important in maintaining work ability. Present developments of vocational training with new flexible pathways are described. Rehabilitation needs are found to be a further important target of work ability promotion. The study provides support for comprehensive occupational health and safety measures. New feedback safety measures (LIIKKUVA, TR – safety audit), which are based on goal setting and a follow up in collaboration, seem to improve considerably both the safety and the development of construction work.

Keywords: Safety instruction, on the job training, vocational education, occupational safety and health, construction occupations

Introduction

The importance of safety instruction, on the job training and the integration of occupational safety and health in vocational education has been emphasized in many recent studies, and the occupational training of construction workers is now promoted in most EU countries (Törmälä, 1995). The main developments will now be described, focusing on Finnish educational reform. The paper also discusses new studies on occupational health and safety in construction, pointing to the need of developing branch specific occupational health services.

Three main lines can be discerned leading to the present developments in occupational training of the construction sector. One is based on new regulations, new technology and evident problems of employment in the branch. Another is based on developing aims in education. The third arises from occupational safety and health, where emphasis is growing also in training.

The building sector is characterized by continual change, involving varying technologies, working conditions and the coordination of different interdependent trades and operations (Niskanen, 1993). In the 1990s, the recession accentuated unemployment and recruitment, the main problems of the branch; simultaneously, the International Labour Organization and the European Community introduced regulations on construction work. Due to the hazardous nature of the work, the variety of working conditions and the basic vocational education of the workers, both safety training and on the job training are important at construction sites. However, it is estimated that less than a quarter of the European Union construction workers receive any training in occupational safety and health (EC, 1993).

In the 1990s, vocational education and training in OECD (OECD, 1994a,b) and EC countries has developed generally towards work life oriented flexibility. Sector-specific planning policy in general is strengthened to suit future educational and labour needs. These developments are important in the construction sector due to the large numbers of poorly educated workers.

Training and information in occupational health have been emphasized recently (ISSA, 1994; EC, 1995; WHO, 1995), and new forms of occupational health training are emerging. In the building trades, the importance of integrating occupational safety and health in vocational education has been stressed in EU countries within new legislation (ISSA, 1994).

Construction occupational health and safety

Main developments

New regulations

The general conditions within the construction sector were promoted by the International Labour Organization in 1988 by updating the 1937 standards (ILO convention 167 and recommendation 175) and the guidelines of training (ILO, 1995). After the national legislation of EU Construction Directive 92/57/EEC (on the implementation of minimum health and safety requirements at temporary or mobile construction sites, 1992) and during the subsequent recession, increasing numbers of national research programmes were witnessed in Europe (ISSA, 1994). Concerted promotion of the branch was initiated also in the USA (NIOSH, 1994; Ringen, 1994; Ringen and Stafford, 1996).

Present problems

In the occupational safety and health of the construction industry, the growing importance of preventive measures in the musculoskeletal diseases has been accentuated by the World Health Organisation (WHO, 1995) and explorations (Heeg *et al.*, 1989; Holmström, 1993; Rose and Glimskär, 1994; Saux *et al.*, 1994; Koningsveld and van der Molen, 1997). OSHA, the Occupational Safety and Health Administration in the USA, even proposed a new ergonomic standard specifically for the construction industry, as a result of a recent increase in these diseases.

The rising incidence of musculoskeletal diseases in the construction industry is evident also in Finnish epidemiological and other studies of this sector during the 80s (Leino *et al.*, 1993; TM 1994a; Saloniemi, 1995). However, this is partly due to the registration effect of the change in compensation system (Roto *et al.*, 1993) and the level of these occupational diseases has been decreasing since 1992 (Kauppinen *et al.*, 1995; Karjalainen *et al.*, 1996). The level of musculoskeletal diseases also has moderately decreased generally in Japan, since the 1980s, after the launch of comprehensive countermeasures (Okubo, 1995). Such comprehensive measures were strongly endorsed recently by a large (ten years) follow-up study (Ilmarinen *et al.*, 1995), in line with the meta-analysis of safety programmes by Guastello (1993) and earlier by Saari (1986).

Similarly, in Sweden there is some evidence of a general decrease in the occurrence work-related musculoskeletal diseases. This has been shown in a recent evaluation (Järvholm, 1996) of Swedish overall occupational health, which points out further that great differences between the sectors and between social groups still remain in occupational safety and health. The importance of promoting sector-specific occupational safety and health is implied in these findings.

Safety approaches

The level of occupational safety and health in Sweden has long been high in the construction sector. This is apparent, e.g. in the recently initiated projects of the genders in the construction vocations (Olofsson, 1994) and of adjusting the work tools and methods to different individual qualities and qualifications (B. Olofsson, unpublished; see also Rose and Glimskär, 1994; Holmström, 1993). Positive management, such as increasing individual control over one's own work, and individual adaptation to loading factors in the work as well as participation are also emphasized (Samuelson, 1994). Physical training of construction workers has been used at Swedish sites as a preventive measure since 1989. Programmes with a holistic approach (*helhetssyn*) are now particularly encouraged in the building trade; this means integrated development in work organization, physical environment and rehabilitation (Billing and Stigendahl, 1994). Repetitive work in general has been surveyed in detail (SCB, 1995, $N = 6173$ workers). The construction tasks were characterized by poor working postures and heavy physical load, with some individual influence over the working situation; typically, construction work presupposes continually improved training and professional skills.

In Finland also the construction sector has been studied and promoted, especially in the 1990s. The Finnish occupational health and safety programmes in the construction industry have resulted in numerous improvements (Laitinen and Ruohomäki 1994a–c; Laitenen *et al.*, 1996: see also Hyödynmaa *et al.*, 1986; Haukijärvi and Niskanen, 1989; Saloniemi, 1989; cf. Saarela *et al.*, 1992), even decreasing occupational accidents considerably.

Hyödynmaa *et al.* (1986) found feedback and weekly and targeted inspections to improve site safety. Safety information improved information flow. These activities and the orderly workplaces were concluded to decrease the occupational accidents on site (see also Hyttinen, 1994). Saari *et al.* (1986), on the basis of this and other studies of the TEHO-project concluded that concrete safety targets, follow up, feedback and developing of safety motivation promote safety.

Haukijärvi and Niskanen (1989) studied targeted (scaffolding and falling protection) training at site. However, they found that any improved safety level would return to the previous level in a few weeks. Nevertheless the training was perceived as important by all (95%, $N = 124$ builders) of the workers and foremen. On the basis of further analysis, targeted training was suggested (Haukijärvi and Niskanen, 1989).

Saloniemi (1989) reported that after a safety campaign the majority of the subjects ($N = 871$ construction workers and managers) assessed the campaign to have encouraged the discussion of safety matters (72% of the builders) and to have provided safety information (64% of the builders).

Saarela *et al.* (1992) studied the effects of providing safety information in a booklet and on a noticeboard. They made evaluative observations *post hoc* at two sites and the information was reported positive by the workers, but no improvements took place in the safety practices, a result similar to previous studies.

Niskanen (1993) and Salminen (1995) proposed on the job and safety training vigorously in their studies of occupational safety in construction. Hyttinen (1994) found positively assessed safety management correlated particularly with support and instruction at sites. Both Niskanen (1993) and Hyttinen (1994) advocate collaboration as a basis for safety motivation.

Saari has carried out a long term study of industrial housekeeping in Finland (Saari and Näsänen, 1989) and the new feedback programmes of site safety by Laitinen and Ruohomäki (1994a–c) and Salminen and Saari (1996) are based on it.

Laitinen and Ruohomäki (1994a–c) tested their TR safety audit at two sites throughout the building projects and measured the safety level at different phases of each project. There was a significant improvement in safety at both sites. Salminen and Saari (1996) developed an analogous safety audit (LIIKKUVA) for mobile construction groups. It also was found to improve safety markedly.

At present, Finnish construction safety is promoted primarily through developing occupational health services. Inspection practices also have been reorganized, implementing team work and project groups. The reformed (in 1994) vocational education system is being promoted, and new educational paths and qualifications are now accessible even for experienced workers without vocational education.

Thus, basic new regulations, guidelines and research have been developed for the construction sector in the 1990s. In occupational safety and health, the studies discussed above provide support for comprehensive programmes in general and feedback based safety audits with goal setting in collaboration.

Findings in construction work studies

In construction the risk of accidents is double that of industry in general, and also the incidence of occupational diseases is 50% higher than the average (Samuelson, 1994). In the following, new research is presented on different construction occupations.

Occupational health

The risk of occupational diseases is almost threefold (90/10 000 workers) in the Finnish construction industry compared with the average of all branches (33 cases/10 000 workers in 1994) (Kauppinen *et al.*, 1995). Half of all occupational diseases in construction in 1995 were due to asbestos (Karjalainen *et al.*, 1996). The use of asbestos was discontinued in Finland in 1988. The Finnish Institute of Occupational Health screened workers for asbestos diseases diligently during 1989–1992 (Kauppinen *et al.*, 1995) and improved diagnostics for them. In 1995 (Karjalainen *et al.*, 1996), noise was a major factor in 23% and repetitive strain in 22% of construction occupational diseases.

Leino *et al.* (1993) did not find any differences in chronic diseases between the occupations within the construction sector or between skilled and unskilled older workers ($N = 1039$ workers, aged 40–64 years). The difference between occupations was significant nevertheless in the self-assessed degree of work disability caused by a disease (Leino *et al.*, 1993). The operators of all machines, and the drivers of all cars and trucks had less self-assessed work disability due to chronic diseases than did carpenters, concrete workers and bricklayers. Significant differences between occupations were also found in work ability, where that of machine operators was better than that of plumbers, concrete and construction workers and carpenters (Leino *et al.*, 1993).

In the Leino *et al.* (1993) study the professional skill groups did not differ in work ability. It is remarkable, however, that the skilled construction workers had significantly less stress symptoms (e.g. sleep disturbances, headache, stomach ache) than the labourers. Further, machine operators and renovators had significantly fewer musculoskeletal symptoms than did the cement and concrete workers, who had significantly more back and neck symptoms than other construction workers. The physical load is greatest in the work of masons, in concrete, cement and construction work, in painting and in reinforcement (Palomäki and Lappalainen, 1995).

In older construction workers musculoskeletal diseases most frequently affected work ability (20% of the workers; Leino *et al.*, 1993). Self-assessed problems with vision and hearing caused some disability to a third of the workers and fatigue to a quarter of them

(Leino *et al.*, 1993). Haste in work clearly reduces job satisfaction; repetitive work tasks, and lack of individual control in work also are detrimental (Matikainen *et al.*, 1993). Even a third of the older workers have some disease which they assessed as disadvantageous to their work ability (Leino *et al.*, 1993).

Occupational accidents

Building construction has the greatest frequency of occupational injuries in Finland, in comparison with other sectors (during 1989–1994); the frequency is now threefold, compared with the average of the other branches (TVL 1996). The proportion of injuries was, in 1994, more than quadruple the average (TM, 1994a).

More than a half (55%) of the occupational accidents in building construction happen in the immediate work environment, i.e. the passages and work spaces (Roto, 1993; TVL, 1996). Physical stress, particularly chronic physical stress, is frequently involved (20%; Roto *et al.*, 1993).

Niskanen (1993) found differences between construction occupations in accidents. Also, there were differences between skill groups: more of the accidents of semi-skilled workers (i.e. assisting building workers) occurred during manual lifting, carrying, pulling or pushing, than those of the skilled workers.

Gingras *et al.* (1992) report analogous differences between construction occupations; a longitudinal explorative study during 1976–1986 was carried out on Canadian sites at James Bay ($N = 3405$ builders).

Work experience

It has been postulated (Saloniemi, 1995) that although work experience and fewer injuries generally covary (Salminen *et al.*, 1992), this does not apply in the construction industry because of the mobility of the workers and the changing working conditions. In line with this, Salminen *et al.* (1991) point out that half of the construction accidents and only a third of other occupational accidents occur during the first year of the actual employment. Analogously, according to Girard *et al.* (1995), most occupational accidents (79%) occurred during the first four weeks on the construction site; also Vézina *et al.* (1995) found the inexperienced construction workers much more prone to hazards than the experienced workers and both thus suggest increased on the job training. Barth *et al.* (1993) equally propose security plans, instruction, and necessary qualification to be used in the prevention of scaffolding injuries. Salminen (1995) concludes that the higher accident risk in construction subcontracting could be prevented by sufficient information and other measures at site, started simultaneously with the contract. He emphasizes that the same hazards occur daily far less frequently in the jobs of the construction workers than in other industries and suggests increased training in recognition of these hazards.

Needs for development in work ability promotion

The present Finnish legislation on occupational health and safety stipulates the promotion of work capacity as a part of occupational health services. Matikainen *et al.* (1993) analysed preferences for an improved working life. For older construction workers, the most important factor was better possibilities for rehabilitation (71% of the 1039 workers aged 40–64 years considered this important). Following in importance were more effective occupational health services (61%), reduced work load and haste (59%) and a better work environment (57%).

Construction workers in general regard occupational training as the most important factor in sustaining their work ability (69% of the 1019 construction workers, Mäkelä *et al.*, 1996). Other important factors were rehabilitative groups (48% of the workers), work arrangements (37%) and physiotherapeutic advice and treatment (40%); training in first aid and accident prevention was required by 74% of the construction workers (Mäkelä *et al.*, 1996).

Thus, although the need for safety instruction and occupational training is greatest, rehabilitation needs are distinctly the next important target for development. Further, Matikainen *et al.* (1996) even found a lot of indications of potential, untreated disabilities, affecting work capacity ($N = 1039$ construction workers, aged 40–64 years); they concluded that this finding highlights a need to promote sector-specific occupational health services both in coverage and functions.

Employment promotion

Work ability promotion, through physical activities and the development of professional skills of construction workers, also has been investigated. Basically, the work ability of unemployed builders was found to be equal to that of the employed ones. Intervention activities improved the physical condition and well-being of the unemployed ($N = 109$ construction workers) (Klaus, 1995). In a two-year follow up survey of unemployed construction foremen ($N = 123$) the youngest (under 30 years) displayed a continuously decreasing feeling of coherence (Antonovsky index, a sense of meaningfulness and confidence, thus a kind of well-being; Leino *et al.*, 1993), differing significantly from the older groups (Kaskinen, 1995). Coherence had been found to covary with the work ability of construction workers in an earlier study by Leino *et al.* (1993). Targeted countermeasures for younger unemployed builders thus also seem to be indicated.

Needs for development in the work environment

Saloniemi (1995) compared construction with manufacturing industry in 1984 and 1990, as regards the work environment. Technological changes during this period did not reduce the differences between these branches, and the complaints of repetitive strain, as assessed by the workers, increased in both construction and the other industries from 1984 ($N = 215$ construction workers) to 1990 ($N = 176$ construction workers). This increase was nearly significant in the construction occupations. In both 1984 and 1990 the construction workers ($N = 391$) regarded dust, draft, noise and difficult postures, in this order, as their main problems. The results of Mäkelä *et al.* (1996; $N = 1019$ construction workers) are analogous: dust, draft, cold and noise were the worst problems.

In the surveys of Saloniemi (1995) the construction workers had significantly more complaints about their work environment in general than the other workers. Only repetitive strain was assessed as equally detrimental by both branches. Automation does not seem to have reduced heavy lifts or difficult work postures in the construction trades, and clearly dust and noise have increased from 1984 to 1990, as assessed by the workers.

The untidiness of the work environment was reported (in 1990) significantly more frequently ($p < 0.005$) in construction work than in the other industries (Saloniemi 1995; $N_1 = 176$ construction workers and $N_2 = 380$ industrial workers). Further, Rantanen *et al.* (1993) found even the well-being of the workers and the appraisal by the safety management correlated significantly with the tidiness of the sites ($p < 0.05$). Analogously, skilled workers (Niskanen and Lauttalammi, 1989a) assessed good order at the site as one of the most important factors affecting occupational safety. Older construction workers ($N = 1039$, 40–64 years, Matikainen *et al.*, 1993) regarded poor weather conditions, poor order on the sites, dustiness and untidiness of the work environment, and work load to be the major problems lowering work motivation.

Mäkelä *et al.* (1996) found the hazards of construction work similarly specific: lack of order was regarded as the worst hazard by 27% of the construction workers ($N = 1019$), whereas only 12% of the workers in all other trades were of this opinion. Falls were regarded as the worst hazard by 22% and slipperiness by 22% of the construction workers (Mäkelä *et al.*, 1996). These construction workers felt that the passages and work spaces were in most need of development.

New safety measures

Promoting site order as a safety measure is the aim of the new feedback audits, based on the studies of Saari (1986) and Saari and Näsänen (1989). Both methods, the TR audit (Laitinen and Ruohomäki, 1994a), and the LIIKKUVA method (Salminen and Saari, 1996) were found to improve safety, site order and construction work considerably.

The importance of a reliable safety measure, such as the LIIKKUVA method, for mobile work groups, was also implied in the study of Salminen (1995), on the occupational risks in construction contracting/subcontracting. Multiskilled teams, as a more flexible organization of construction tasks, typical in Sweden (Härdig, 1995), have been studied and proposed by Valta (1996).

The internal safety audit TR (Laitinen and Ruohomäki, 1994a) was developed for weekly inspections on sites, carried out by the supervisor and the workers' safety representative. It was found to initiate safe work practices stemming from the base of reliable and continuing feedback on the safety level observed. The safety index is calculated as a percentage of the correct items in 100 weekly observed items of safety rules on site, and the result is posted as graph on the wall, after four weeks of baseline observations. In this study, after the wall-mounted feedback, the safety index began to rise continuously and significantly (Laitinen and Ruohomäki, 1994a). The index of safety level rose from 59% to 90% at the office building site, and at the apartment house site from 73% to 90% (Laitenin and Ruohomäki, 1994a). The study demonstrated also that it is preferable to measure the conditions following from the working habits than themselves. The goals of the safety programme should be set in collaboration by all the workers. (Laitinen and Ruohomäki, 1994c).

On construction sites new practices are accepted quite slowly, in some months, due to the varying work conditions (Laitinen and Ruohomäki, 1994c). In testing the TR audit the observations were made on the basis of a framework list, worked out in collaboration, and they cumulated according to their actual frequency on the sites ($N = 78$ sites). Thus the main items were also weighted in this order in the total index of safety level. The items in the index in their weighted order are: 1, order and tidiness at site (35% of the total observations); 2, protection against falling (20%); 3, lightning and electricity (18%); 4, scaffoldings and ladders (12%); 5, working habits (9%); and 6, machines and equipment (5%) (Laitinen and Ruohomäki, 1994c).

Safety and health: conclusion

Both Swedish and Finnish studies recommend positive safety management with increasing participation and individual control in further adapting to work load in construction. Next to asbestos diseases, musculoskeletal

disorders and noise induced hearing defects are the main work-related diseases of the construction workers; occupational accidents are an equally frequent risk, and comprehensive countermeasures are proposed for both. As many as a third of the older construction workers have been found to have some disease affecting work ability. The older workers emphasize rehabilitation whereas the builders generally consider occupational training most important in maintaining work ability.

In the studies discussed, construction occupations do not differ as regards the chronic diseases, nor do skilled and unskilled builders. Differences can be found, however, in work ability: drivers and operators of machines have less self-assessed work disability, due to chronic diseases, than other construction workers. Further, the skilled workers have less stress symptoms than labourers. Semi-skilled workers seem to have more accidents than others, and great differences can be found between construction occupations: e.g. assembler's work and mounting of structures involve a high risk.

The work environment, especially passages and work spaces, is the site of more than half of the accidents in construction. Physical stress plays a major role also. Untidiness and dust are big problems on sites. However, safety audits based on feedback and goal setting in collaboration have increased safe working habits.

Tailored training programmes are suggested for young unemployed builders. All the the studies mentioned, recommend increased instruction and information involving on the job training, teaching of first aid skills and accident prevention on the sites.

Training of construction workers

In the development of European vocational education and training structures, the main concepts are the dual system (apprenticeship) in the German-speaking countries, and the new British National Vocational Qualifications, NVQs. Further differences between the countries lie in the openness of the system, the strategies of linking general and vocational education, and in the regulation of the educational provision (OECD, 1994a,b).

Vocational education of the construction sector is being developed in many EU countries, and there is a need to find comparable concepts in elaborating its national structures and contents (Törmälä, 1995).

Qualifications

The British system of vocational education and training with modular vocational qualifications has influenced the systems of other EU countries in general and also the Finnish vocational education reform of 1994. The British Construction Industry Training Board (CITB) has developed since 1993 a modern apprenticeship (CITB, 1994), a flexible training culture, the implementation of construction contextual curricula contents in the basic general education and career promotion.

In Germany the vocational qualifications are regulated by the apprenticeship system (learning of professional skills at work alternating with periods of schooling) and in Sweden with a specific convention defining the necessary vocational education (6800 hours) for a skilled worker (Törmälä, 1995). In Finland an analogous definition is now possible, within the reform of competence-based qualification examinations (1994), independent of the way in which the vocational skills have been acquired. Experienced professionals on the sites without any basic vocational education may now qualify by passing a basic, further or specialist vocational qualification examination, eventually also after some further training. (OPM, 1995).

Developments in the construction sector

The reformed Finnish educational pathways allow a number of individual solutions and multiskill concepts. In Britain, the Construction Industry Training Board (CITB, 1994) has a similar aim of formalizing the previous on-site instruction, mostly the only form of training for entrants in some building sectors, within the NVQ (National Vocational Qualification) system.

In Sweden, the increased demand for competence and quality has led to the growth of multiskilled collaborative team contracts, where the construction workers themselves can arrange the work tasks quite independently (Härdig, 1995). Recently, Valta (1996) and Koningsveld and van der Molen (1997) analogously proposed multiskilled teams, i.e. experts working in pairs or groups and participating also in other tasks when necessary. The occupational safety and health point of view (Olofsson, 1994) points out that working alone and also exposure to physical load should be reduced by broadening of tasks. These loads were found to correlate with negative health effects, especially when combined with high quantitative demands (Olofsson, 1994, $N = 652$ builders). Physically demanding tasks were assessed to create the highest load factor (experienced by one half of the workers). Quantitative demands and working alone were assessed as the next most frequent load factors (by a third of the workers).

Different forms of alternation (short work practice periods within schooling) and apprenticeship are being tried out at present in OECD countries (OECD, 1994a,b) to complement the initial school-based voca-

tional education. This approach is particularly appropriate for the construction industry where the tight time schedules, increasing specialization of tasks and subcontracting have previously tended to separate work life from the formal schooling system (Poikela, 1994; Valta, 1990).

Health and safety guidelines are being implemented in the vocational education of the construction branch in many European countries (ISSA, 1994). In Sweden, vocational training is represented now even in a third of the present study projects in this sector (of 25 ongoing studies; BFA, 1996).

Labour market training and recruitment

Unemployment is an additional challenge in the construction sector. Labour market training is the most important active labour market policy in many OECD countries.

The construction occupations are a considerable sector in labour market training (Mikkonen, 1995). Within it, the building occupations have been found to be the most static, with construction workers retrained mostly in an occupation belonging to the same group of vocations as their own. Labour market training has been found to be quite effective in promoting employment generally: before the recession 75% of participants got a job after the training; during the recession, however, the proportion fell to 50% (Ropponen, 1996). It was found to promote recruitment most strongly in the construction sector. Recruitment difficulties also have been frequent in the building trades (34% of all construction enterprises in 1995 in Finland, the average is 22%; see Sako, 1994; Koningsveld and van der Molen, 1997). The main reason for this seems to be a lack of a specialized qualification or occupational skill.

Safety training and on the job training

The information and training needs in different construction projects should be assessed according to the health and safety plan, now obligatory in the preliminary phase of all projects, on the basis of the EC directive (Myllyntausta, 1994). Specific models of this plan have been developed (Akkers, 1994; Buhr, 1994; Palomäki and Lappalainen, 1995), as only its framework is ordained by the directive.

Task training and ergonomic instruction

Training on construction sites is important also from the ergonomic point of view (Koningsveld and van der Molen (1997); Louhevaara and Smolander, 1993). It is difficult to prevent physical overload if the work ability or the work skills of the worker are at a low level. In order to prevent the overload caused by inexperience, it is essential to train the workers sufficiently, e.g. in teaching new tasks. The management at the sites also should have sufficient training in occupational health and safety aspects to be able to attend to these problems (Barth *et al.*, 1993; Niskanen, 1993; Louhevaara and Smolander, 1993; Hyttinen, 1994; Litasse and Roussel, 1994).

Troup (1995) concluded that a basic ergonomic instruction combined with skill training is the only potentially successful approach e.g. in the prevention of back pain (which is the most frequent musculoskeletal disease of construction workers (Leino *et al.*, 1993; Hartmann, 1996). In the Finn Age study (Ilmarinen *et al.*, 1995), ergonomics, organizational measures and individual health promotion were equally important in enhancing work ability, but only combined with the others, and tailored as a long term project in companies. Kilbom (1995) also emphasizes a comprehensive view of all major risk factors in job improvement programmes of musculoskeletal disorders, analogously to Ilmarinen *et al.* (1995). The holistic approach of the present Swedish construction work place programme (Billing and Stigendahl, 1994) is in line with these views.

Research on training

In current Finnish construction studies safety has been emphasized as a part of skilful job performance (Niskanen, 1993; Hyttinen, 1994). On construction sites, task training (Haukijärvi and Niskanen, 1989; Niskanen, 1993) and safety training (Saloniemi, 1989; Hyttinen, 1994) have been found inadequate. Often, construction workers have had no sector-specific vocational education (Törmälä, 1995). This accentuates further the need for on the job training.

Safety instruction and on the job training are thus essential on sites because of the continually changing, often risky working conditions (Saarela *et al.*, 1992; Barth *et al.*, 1993; Niskanen, 1993; Salminen, 1995), the mobility and varying education of the workforce in this sector (Heeg *et al.*, 1989; CITB, 1995; Törmälä, 1995) and the studies presented above (e.g. Samuelson, 1994; Girard *et al.*, 1995; Vézina *et al.*, 1995). Recently, safety motivation has been promoted also through participation (Litasse and Roussel, 1994; Moir and Buchholz, 1996). The demand for safety and task instruction should, nevertheless, be considered specifically.

Conclusion

Automation does not seem to have reduced the physical loading of construction work. Task and safety instruction is thus a significant ergonomic measure, in helping to prevent the physical overload caused by inexperience

in tasks. Further, a recent evaluation points to a general persistence of sector-specific and social differences in occupational safety and health. Specifically, it is suggested that there is a basic need for training in the recognition of hazards in the construction work environment. Typically, new practices commence quite slowly on sites. It is important therefore to provide continuous support for safety motivation and the commitment of all parties. Flexible construction work arrangements, less working alone, and multiskill work teams are proposed also. In safety programmes, site order is suggested as a basis for goals, set up in collaboration and followed up with continuing feedback. Comprehensive occupational safety and health measures receive support in the studies discussed.

The research on work ability in the sector emphasizes both vocational training and the importance of developing sector-specific early rehabilitational and preventive working models. Significant differences have been found in work ability between construction occupations. Also professional skill groups were found to differ: the skilled construction workers had fewer stress symptoms than the labourers.

Physical loading, poor order, untidiness and dust at sites, cluttered passages and work spaces are the main problems of construction. The risky nature of the tasks, the mobility and the varying education of the workforce entail, in addition to changing working conditions, the need for safety and on the job training on sites. Construction work presupposes continually improved training and professional skills.

The new educational pathways presented allow flexible qualification in work, independently of the way in which the professional skills have been acquired. Labour market training has also been found effective in employment promotion.

On sites the training most needed is safety instruction, teaching first aid skills, and accident prevention. Skill training is important combined with ergonomic instruction, and the need for on the job training arises more frequently than in other sectors; usually a majority of the construction workers have had no training.

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