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Review article

Participatory ergonomics: Evidence and implementation lessons

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ABSTRACT

Participatory ergonomics programs have been proposed as the most effective means of eliminating, or re-designing, manual tasks with the aim of reducing the incidence of occupational musculoskeletal disorders. This review assesses the evidentiary basis for this claim; describes the range of approaches which have been taken under the banner of participatory ergonomics in diverse industries; and collates the lessons learned about the implementation of such programs.

1. Introduction

Participatory ergonomics means actively involving workers in developing and implementing workplace changes which will improve productivity and reduce risks to safety and health - or as Wilson (1995) put it, the "involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable goals". The underpinning assumptions are that: workers are the experts; and, given appropriate knowledge, skills, tools, facilitation, resources and encouragement, they are best placed to identify and analyse problems, and to develop and implement solutions which will be both effective in reducing injury risks and improving productivity and be acceptable to those effected (Brown, 2005). There are many types of participation, including consultative or representative participation where users or elected representatives respectively express ideas or opinions, and management makes decisions (Wilson, 1991). Here, however, we are more concerned with direct participation (Vink et al., 2006) in which workers have some degree of influence over the decisions regarding workplace changes.

According to Noro (1999), the term "participatory ergonomics" was coined in 1984, however it's antecedents are found in the management practices of quality circles and industrial democracy (Brown, 1993; Liker et al., 1989; Nagamachi, 1995; Noro, 1991). A participatory ergonomics program typically employs one or more teams assembled for the purpose of improving the design of work, and the common element is to ensure utilisation of the expert knowledge that workers have of their own tasks by involving the workers, and others potentially affected by proposed changes. Although such programs have typically been primarily focussed on reducing musculoskeletal injuries, participatory ergonomics programs have also explicitly aimed to create more human-centered work (Imada, 2000), to improve organisational climate (Maciel, 1998), or been used as a framework for health promotion (Punnett et al., 2013). Participatory ergonomics may be considered to be a method of work system design and thus, fundamentally, a macroergonomics technique (Brown, 2002; Hendrick, 2002; Kleiner, 2006).

Participatory ergonomics programs have been implemented across a large range of industries and organisations (eg., Hignett et al., 2005), including mining (Burgess-Limerick et al., 2007; Torma-Krajewski et al., 2007), domestic and civil construction (Dale et al., 2016; de Jong and Vink, 2000; de Jong and Vink, 2002; Dennis and Burgess-Limerick, 2009; Jaegers et al., 2014; Vink et al., 1997), and office environments (Haims and Carayon, 1998; Polanyi et al., 2005; Vink et al., 1995) as well as diverse small businesses (Straker et al., 2004); newspapers (Rosecrance and Cook, 2000), health care institutions (Bohr et al., 1997; Carrivick et al., 2005; Evanoff et al., 1999; Rasmussen et al., 2015) and numerous manufacturing sites (Cantley et al., 2014; Guimaraes et al., 2015; St-Vincent et al., 1998, 2001; Nagamachi, 1995; Halpern and Dawson, 1997; Laing et al., 2005; Liker et al., 1989; Motamedzade et al., 2003; Moore and Garg, 1997; Gjessing et al., 1994).

Perhaps as a consequence of the diverse settings in which programs have been implemented and the need for programs to "fit" each organisation or situation (Brown, 2005) there are many variations in the program characteristics, such as the degree and nature of participation (Jensen,1997; Liker et al., 1989), extent of expert facilitation and assistance provided, the nature and extent of training provided to teams (in ergonomics methods and team work), and the tools employed to assist teams identify issues and develop solutions (Kuorinka, 1997; Reynolds et al., 1994; Nagamachi, 1995).

A conceptual framework for defining the range of variations found in participatory ergonomics programs has been proposed by Haines et al. (2002). The dimensions defined (in order of importance,

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according to Hignett et al., 2005) are:

(i) location of decision making power - whether retained by management and informed by consultation with individual workers or groups, or delegated to the workers;
(ii) mix of participants formed for the interventions - front-line staff only, or including technical staff, middle management and/or senior management;
(iii) remit - that is, the extent of the participants' involvement in setting up and monitoring of the participatory ergonomics process, the identification of problems to be addressed, and the generation, evaluation and implementation of solutions;
(iv) role of 'ergonomics specialist/s' - acknowledged as potentially changing and evolving over time, ranging from being a facilitator or leader, trainer, expert team member, or available for consultation as required (or not involved);
(v) nature of worker involvement - varying from direct face-to-face involvement of all affected workers to representative participation of selected workers;
(vi) focus - whether aimed at the level of design of tasks undertaken by individuals or teams, or broader work organisation issues or policies;
(vii) level of influence - variations in the level of the organisation at which the intervention takes place, whether at the level of the work team or department, through to the entire organisation, or indeed, across an industry (eg., Tappin et al., 2016);
(viii) requirement - that is, whether the participation is undertaken by volunteers, or an expected part of a job role, noting that this may vary across group members;
(ix) permanence of the intervention - ranging from a temporary program introduced as means of solving a particular problem, to programs intended to be permanently integrated into the ongoing continuous improvement activities of the organisation.;

Haines et al. (2002) also noted that participatory ergonomics programs may differ in terms of the complexity of the structures in which the activities are embedded. While a single layer structure involving work group/s only might be involved, more complex structures including, for example, a second layer of "steering committee" might well oversee the activities of multiple working groups; and more layers are also possible in large multi-site organisations.

The effectiveness of a participatory ergonomics intervention may well vary as a function of different combinations of these dimensions. The characteristics and level of commitment of the organisations in which such programs are implemented also varies considerably, and these factors are also very likely to influence the outcomes of such programs.

2. Effectiveness of participatory ergonomics programs

Participative ergonomics is reported to have a range of benefits in addition to reduction in musculoskeletal injury risks, such as improved flow of useful information within an organisation, an improvement in the meaningfulness of work, more rapid technological and organisational change, and enhanced performance (Haines and Wilson, 1998; Brown, 1993; Haims and Carayon, 1998). As well as developing more effective solutions, the use of participative ergonomics techniques to derive solutions is believed to result in greater "ownership" by those affected, leading to greater commitment to the changes being implemented (Brown, 2005; Burgess-Limerick et al., 2007; Nagamachi, 1995).

Psychosocial characteristics of work-places such as the workplace culture; high workloads; lack of control; high levels of interpersonal conflict; and poor change management (Gerr et al., 2014; Devereux et al., 2004) both impact on the potential success of a participatory ergonomics intervention (Polanyi et al., 2005; Rivilis et al., 2006) and may be influenced by such an intervention (Macdonald and Oakman, 2015; Vink et al., 1995). A workplace with an existing culture of distrust and adversarial industrial relations, and without any history of worker involvement in decision making, is unlikely to be a fertile ground for participatory approaches to flourish without first addressing these issues (eg., Dixon et al., 2009; Jensen, 1997; Polanyi et al., 2005). However, in absence of such a adverse context, the impact of a participatory ergonomics program in which management and workers work together to improve workplace conditions has potential to further improve the organisational culture and other aspects of the psychosocial work environment (Cole et al., 2005; Laitinen et al., 1998; Maciel, 1998).

The economic impact of workplace ergonomic interventions (regardless of the process by which such interventions were devised) has been the subject of a review (Tompa et al., 2010) which found the strength of the evidence to vary from strong in the manufacturing and warehousing sector, moderate in the administrative and support services sector, and health care sectors, and limited in the transportation industry. The implementation of a participatory ergonomics program at a Brazilian furniture manufacturer was report to lead to a 46% productivity increase attributable to a combination of reducing unnecessary load handling, waiting and transportation; and reduction in manufacturing time (Guimaraes et al., 2015). Nagamachi (1995) reported similarly large productivity improvements in manufacturing case studies while Motamedzade et al. (2003) reported more modest productivity improvements (5% waste reduction, 8% reduction in rework) in a manufacturing context as consequence of introducing a participatory ergonomics program. Reynolds et al. (1994) reported a 17% increase in hourly earnings associated with changes made to a work-station at an apparel manufacturer.

While some research has demonstrated significant effects of implementing a participatory ergonomics program on physical risk factors associated with manual tasks (eg., Straker et al., 2004) most evaluations have focussed on direct health effects. The effect of participatory ergonomics programs on musculoskeletal health have been the subject of three systematic reviews. The outcomes of individual evaluations are mixed. Silverstein and Clark (2004) noted this variability, concluding that participatory ergonomics programs were "often, but not always successful". Cole et al. (2005) reviewed 10 evaluations of the health effects of participatory ergonomics programs, concluding that the studies provided limited evidence that participatory ergonomics programs can have a positive impact on musculoskeletal injury symptoms and compensation costs. More encouragingly, Rivilis et al. (2008) concluded that the "12 studies that were rated as 'medium' or higher provided partial to moderate evidence that PE interventions have a positive impact on: musculoskeletal symptoms, reducing injuries and workers' compensation claims, and a reduction in lost days from work or sickness absence."

More recent evaluations not included in these reviews have also demonstrated mixed results. For example, Haukka et al. (2008) found no systematic effects of a participative ergonomics program involving six 3 h workshops at 119 Finnish kitchens, despite reporting the implementation of 402 ergonomic changes. Cole et al. (2009) reported a multiple case study involving programs of varying details across four production contexts. Production pressures were encountered as a barrier at each site and management commitment varied. Although changes were introduced at each site, no statistically significant effect on health outcomes could be detected. Driessen et al. (2011) reported that an intervention involving a single six hour meeting with 19 working groups in randomly assigned departments across four Dutch companies in diverse industries did not result in subsequently reduced low-back or neck discomfort compared to a control group of 18 departments, although a significant effect on recovery from back pain was noted. Dale et al. (2016) evaluated the implementation of a participatory ergonomics program consisting of six 10 min tool box talks in small construction firms. Issues with commitment to the program were