# KEY FACTORS FOR SUCCESSFUL IMPLEMENTATION OF A PARTICIPATORY ERGONOMICS PROGRAM

by

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Occupational and Environmental Safety & Health

Key Factors for Successful Implementation of a Participatory Ergonomics Program

November 5, 2008

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The University of Wisconsin-Whitewater

**Key Factors for Successful Implementation of a Participatory Ergonomics Program**

Abstract

Inadequate workplace ergonomics can lead to injuries, productivity declines and quality issues. Despite the fact that ergonomics has been researched and implemented in the workplace for the past 20-30 years work-related musculoskeletal disorders (WMSDs) remain as the most expensive category of injuries. It has not been widely understood why some ergonomic interventions are effective at some workplaces while not effective in others. However, one approach can be used to reduce musculoskeletal injuries is participative or participatory ergonomics. Participative ergonomics evolved out of Quality Circles utilized in Japanese manufacturing plants in the 1960s. Participatory ergonomics is defined as the process by which management and labor work together to modify and/or design the work space, task, equipment and environment to better fit an individual's abilities and limitations. A lack of impact is not unusual in cooperative situations involving labor and management. It is quite common for such teams to underachieve and is the point of emphasis of this research study. Inconsistent results indicate the need to better understand the dynamics involved with such a team in order to determine key elements for success. It was the intent of this research to analyze successful ergonomics teams via a survey approach to better understand these key factors. After identifying high-performing participatory ergonomics teams within the manufacturing sector (SIC 20-39), a survey was distributed to thirty-five facilities in the Midwest and California. Twenty-five of these surveys were completed and returned to the researcher. Of the 25 respondents (48%) reported that their participatory ergonomics program had been in place for 10 years or more, 6 (24%) had programs in place for 5-10 years, 6 (24%) had programs for 2-5 years and only 1 respondent (4%) had a program in place for 1-2 years. The data collected showed that an

organization's culture and ergonomic process were two areas indicated to be important to a team's success. Specifically, creating a culture of teamwork and committing to a participative work style were two of the most highly scored items. Other significant findings of this research indicated that the organizations that participated focused on several key areas in order to create and sustain a participatory ergonomics team: create a culture of teamwork, commit to a participative working style, ask affected employees for their input and use formal evaluation tools for assessing ergonomic hazards.

## INTRODUCTION

Work-related musculoskeletal disorders (MSDs) and ergonomics-related injuries remain the single most expensive category of workplace injuries (Neumann, Philips, and Winkel, 2004). In 2004, MSDs accounted for 402,700, or 32 percent, of workplace injuries with days lost away from work (BLS, 2005). Sixty-nine percent of these cases occurred within the service industry. The manufacturing sector accounted for another 20 percent of all total MSD cases. Despite the fact that the number of MSDs is going down (Figure 1), the cost of treating workplace injuries continues to escalate (Figure 2). Worker injuries are now costing employers about one billion dollars each week (Liberty Mutual, 2003). Ergonomics-related injuries accounted for $16.4 billion dollars of the total direct cost of workplace injuries and illness in 2003 (Liberty Mutual).

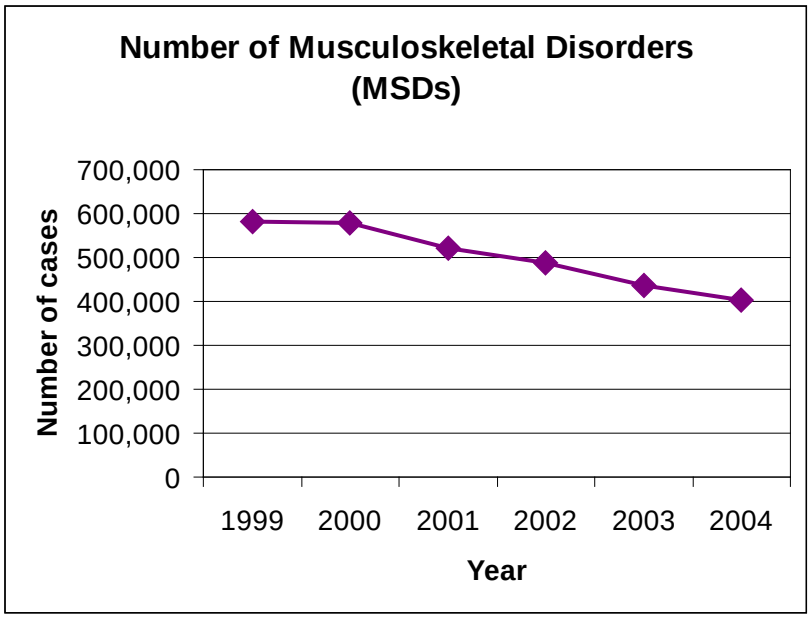


Figure 1: Total number of workplace MSDs in the workplace (U.S.)

Poor ergonomics not only results in direct costs associated with injury treatment and financial compensation, but also in indirect costs such as absenteeism, administrative costs, employee turnover, training, poor employee morale as well as reduced productivity and quality (Alexander and Albin, 1999; WSIB, 2001). Despite a significant amount of research to reduce MSDs in the workplace the problem continues to rage on. Plaguing ergonomic intervention research is a lack of understanding as to why seemingly identical interventions work in some instances but not in others (Karsh et al., 2002).

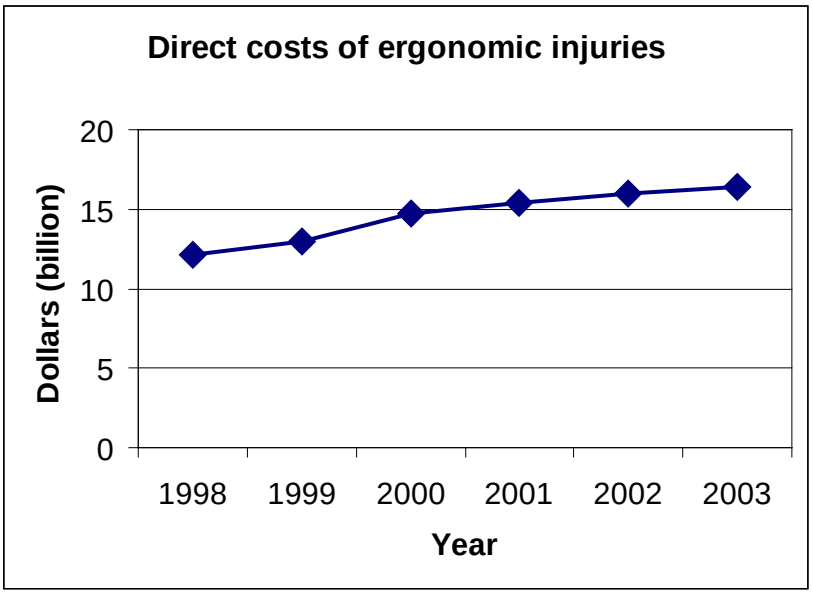


Figure 2: Direct costs of ergonomic injuries in the workplace (U.S.)

Theberge et al. (2006) noted that work-related musculoskeletal injuries are a significant cause of disability in industrialized nations. According to the U.S. Bureau of Labor Statistics (BLS) musculoskeletal disorders accounted for 32 percent of the injuries and illnesses with days away from work in 2004. Zalk (2001) stated that 40 percent of the world's occupational and work-related health costs are attributed to MSDs. Efforts need to be made in both industrialized

and industrially-developing countries to reduce ergonomic hazards. Burgess-Limerick et al. (2003) indicated that participative ergonomics is one approach that can be used to reduce the burden from MSDs. The basic concept of participative ergonomics is to involve workers in improving their workplaces to reduce injury and increase productivity. Wilson and Haines (1990) defined participatory ergonomics as the involvement of people in planning and controlling a significant amount of their own work activities with sufficient knowledge and power to influence both process and outcome to achieve desirable goals. Nagamachi (1995) indicated the need to get active participation from key stakeholders and to obtain an organizational commitment to the participatory approach. Buckle and Devereaux (1999) stated that when the worker is involved it offers a greater likelihood of reducing musculoskeletal problems.

## REVIEW OF LITERATURE

This review has considered the literature relevant to participatory ergonomics published since 1984. The focus has been on discerning the characteristics of successful ergonomic intervention teams, supportive safety cultures, and the organizational social dynamics. Documents for review were sourced from academic and applied literature, and explored the following key topics:

- Definitions of participatory ergonomics
- The participatory ergonomics team process
- Methods used for participatory ergonomic intervention
- Studies on the effectiveness of the Participatory Ergonomics approach

History & background of participatory ergonomics

Drs. Kageyu Noro and Kazutaka Kogi developed the concept of participatory ergonomics during discussions in Singapore in 1983 and the term "participatory ergonomics" was later coined by Dr. Kogi in a further discussion and presented formally at the first Organizational Design and Management Symposium (ODAM) in 1984. Participatory ergonomics (PE) started developing from Quality Control circles in Japan during the early 1960s (Noro, 1991). Such a system utilizes the intellectual assets that are shared within and between companies to solve specific problems within the manufacturing facility. Many of the problems and issues analyzed by the Japanese QC circles were concerned with ergonomics (Imada, 1991). These small groups were trained beforehand to use a six-step process to identify their specific problem: 1) select the theme, 2) set a quantifiable goal, 3) grasp the present situation and analyze all pertinent factors, 4) identify the problem, 5) develop and improve measures to solve the problem, and 6) confirm the effect of the corrective measures (Imada, 1991). Brown (1993) also stated that the development of PE was possibly contributed to by the failure of traditional corporate control methods (Taylorist micromanagement of production processes). Westgaard and Winkel (1997) in their study proclaim Scandinavian data that indicate 30-40 percent of MSDs are work-related and could have been prevented by modifications in the work environment. Westgard and Winkel (1997) also go on to say that the overall organizational culture and level of worker participation are as significant as reducing the workers' exposure to mechanical stressors.

Benefits of participatory ergonomics

Brown (1993) and Haims & Carayon (1998) stated that the potential benefits of participatory ergonomics are thought to include an improved flow of information, an

improvement in the meaningfulness of work, more rapid technological and organizational change, enhanced performance and reductions in work-related health problems. Maciel (1998) reported that participatory ergonomics has also been used to improve work organizational climate. While Imada (2000) stated that it can be used to create more human-centered work. Continuing further he iterated three compelling reasons for involving people in the development of the ergonomic technology: 1) it legitimizes the ideas and experiences that workers have accumulated, 2) people are more likely to support projects for which they feel ownership, and 3) if the end-users implement the technology, they will be able to modify it to solve future problems. Westgaard and Winkel (1997) concluded that effective ergonomic interventions must actively involve the worker, reduce exposure to the stressor and must affect the organizational culture. Haims and Carayon (1998) indicated that participatory ergonomics is one intervention strategy that can simultaneously address both ergonomics and the psychosocial risk factors in the work environment. Lanoie and Tavenas (1996) concluded from their research conducted in Quebec that participatory ergonomics programs can create new ways for the workers and management to carry on a dialogue which in the end can improve the industrial relations environment. Zalk (2001) stated that the premise is that workers know their workplace better than anyone else and this knowledge allows them to develop a more comprehensive approach to their work. The worker knows his workplace better than anyone else and this is an inherent advantage over utilizing an outside ergonomic specialist to analyze the workplace and solving the problems associated with it (Imada, 1991). Organizational leadership needs to allow two-way communication between the workers and management. Maciel (1998) found out that the benefits of such management can be improved quality and throughput, increased job satisfaction and decreased work-related stress. Getty and Getty (1999) stated that establishing a participatory

culture could result in further input from the workers regarding improvements and processes, leading to even further gains in productivity. Hendrick (1991) stated that the benefits of an effective macroergonomics design include improved productivity, safety, comfort, employee motivation and quality of work life. Participation recognizes the worker as a valuable resource for solving problems. Recognizing their expertise improves a workers' self-esteem and can have a positive effect on performance (Imada, 1991). The positive effects of employee participation have been demonstrated many times before. Direct participation in production organizations often leads up to quality improvements in 90% of the cases, reduces throughput times in 60% of the cases, reduces costs in 60% of the cases and decreases worker discomfort (European Foundation for the Improvement of Living and Working Conditions, 1999).

Analysis of ergonomic change team elements

Haims and Carayon (1998) iterated that the value of participatory ergonomic programs is readily understood while the means and methods for establishing an effective participatory program is not. Nagamachi (1995) reported that active stakeholder participation and an organizational commitment to the participatory approach is crucial. Wilson and Haines (1997) concluded that a climate of participation needs to be established, support and resources should be provided, and the participatory ergonomics process should be set up carefully. De Looze et al. (2001) stated that success factors include achieving as direct worker participation as possible and to use a systematic step-wise intervention process. In Japan, companies use quality and safety circles to identify and work on ergonomic issues (Liker, Nagamachi and Lifshitz, 1989). Gadbois et al. (1995) studied ergonomic programs in unionized facilities in France and discovered that they required considerable joint discussion in workplace committees about the

objectives of the committees and the range of problems to be corrected. While here in the United States companies tend to set up independently operating ergonomic teams. According to Haines et al. (2002) participatory groups can include task forces, department level teams and steering committees. Kourinka (1997), Haines (1998), McNeese et al. (1993) and Wilson (1995) have iterated some common tools of participatory work groups: round-robin questionnaires, cause and effect diagrams, brainstorming, mock-ups, computer visualizations, concept mapping, fitting trials, layout modeling, word maps, observations, checklists, measurements and auto-confrontation. In order for an ergonomic team to be effective its members need to be trained and knowledgeable in: structure of the human body, energy expenditure from body movement, ergonomic implications of working postures, fatigue factors, ergonomic relationships between humans and the work environment, psychological implications of job satisfaction, cognitive aspects of work activity, how to improve jobs, ergonomic techniques and communicating their knowledge and experience across all levels of the organization (Kourinka, 1997; Loisel et al., 2001; Nagamachi, 1995).

Analysis of research methods

Theberge et al. (2006) stated that examinations of participatory ergonomic processes have used both quantitative and qualitative approaches in several ways. Moore and Garg (1996) and Bohr et al. (1997) described several key methods to be informal investigation observations and participant questionnaires. Haims and Carayon (1998) promote more formal qualitative methods. Namely, participant observations, feedback evaluation forms and directly interviewing ergonomic coordinators. St. Vincent et al. (2000) used qualitative organizational assessments in the form of participatory culture field notes. Bellemare (2000) used questionnaires and in-depth

interviews to describe influential aspects amongst employees and management leadership during organizational changes. Theberge et al. (2006) used qualitative data collection and analysis methods to describe the dynamics of the participatory ergonomic intervention process, identify elements which influenced participation and compared findings versus participatory ergonomic principles that facilitate or inhibit PE processes. Wells et al. (2000) established an ergonomic "Blueprint" to specify stages in which: opportunities for ergonomic improvement are identified; solutions are formulated, implemented and evaluated; and ergonomic improvements are modified on the basis of the evaluation. One study in 2002 by Burns and Vicente was interested in the social processes involved in change-making in a factory setting and according to a participatory approach. Its key findings were: (1) locally optimal ergonomic designs may not be globally optimal, (2) ergonomists can improve their solutions by understanding the goals of other designers (e.g., engineers), and, (3) future tools to aid ergonomists must be compatible with the constraint-rich environments in which they work. However, the study came up short on how to overcome these constraints. In managing meetings, the Theberge study revealed findings that correlated with others as to training needs concerning the technical aspects of risk assessment (St. Vincent et al., 2001) and the social aspects of risk assessment of project management (Hackman, 1990). And, although participation on ergonomic change teams is commonly indicated (Halpern and Dawson, 1997), few have investigated the differences in representation and connection that workers and management ergonomic change team (ECT) members experienced (Theberge et al., 2006). There is a complicated connection and potential trade-offs between ergonomics, occupational health and safety, efficiency and productivity (Novek, 1992). Labor and management's perspectives on ergonomic issues can differ greatly (Hugentobler et al., 1992) along with how to implement an ergonomic initiative (Polanyi & Cole, 2003).

Participatory ergonomic limitations

The most effective methods need to be employed at the outset of any ergonomic intervention. Theberge et al. (2006) stated that the recurrence of disappointing results underscores the need to better understand the dynamics of workplace interventions. Kourinka and Patry (1995) argue that there is no "single best way" to run a participatory ergonomics program. While Wilson and Haines (1997) caution against easy solutions. In their *Handbook of Human Factors and Ergonomics* they go onto say that interventions can be positive but also cite examples whereby PE is misapplied, cynicism pervades the process, and situations where more problems are generated by PE within organizations. Bohr et al. (1997) found that ergonomic change team (ECT) members face considerable challenges juggling time pressures and showed that there were differences between labor and management members. Westlander et al. (1995) discovered that the tensions between the pressures of production and ongoing organizational innovation for other processes are common in PE processes. Novek (1992) pointed to the complicated connections and possible tradeoffs between ergonomics, occupational health and safety, efficiency and productivity. Ergonomic team facilitators in the Theberge et al. (2006) study emphasized the need to use an "evidence-based" model to guide the participatory process, as the best way both to make informed choices as what to address and to provide justification for the ergonomic team's activities to relevant workplace groups, namely, workers, plant management and corporate management. Communicating the team's activities and progress to the organization as a whole is also a key determinant for success: communicating with and seeking input from workers, discussions of participatory ergonomics activities at shift meetings, a suggestion box and a periodic newsletter that was circulated to all plant employees were all methods employed by the Theberge et al. study. These efforts all were met with limited success.

More “hands-on” methods were more effective. However, not one study defined how effective these measures are. With increasing demands put onto employee’s time and project management, skills are of important value. The most effective methods need to be employed at the outset of any ergonomic intervention. Other potential obstacles to be overcome involve management’s perception of their role and participation within the ergonomic process. In one study, a management representative, whose job dictated that s/he would be a primary participant in the participatory ergonomics project, expressed concern over what this would mean for his/her workload (Theberge et al, 2006). This might indicate that ergonomics is being perceived as just another task with lesser priority over others and not be seen as a company value. Or, the person truly does not have anymore time available to devote to a new assignment or project.

## RATIONALE AND OBJECTIVES

### Rationale

Participatory ergonomics has been increasingly used over the past 20 years to improve working conditions with additional side benefits of increased productivity and product quality (Carrivick et al., 2002). Despite these efforts 40 percent of the world’s work-related health costs are still attributed to MSDs (Takala, 1999). The significance is that the costs due to lost work time, worker’s compensation claims, medical treatments, absenteeism, poor quality of work and lost morale amount to billions of dollars annually (Ciriello, 2001).

Despite the increased utilization not all ergonomics programs are equally created. Unfortunately, many are underutilized, misused or abandoned altogether. Part of the problem is that many don’t consider all of the dynamic human factors. Human factors are viewed here as human characteristics: the physical, physiological and psychological or behavioral aspects that

define us as a species. The success of a participatory ergonomics program is dependent upon the human level of participation for any organization. Additionally, the structure and culture of an organization often dictates how a company responds to an ergonomic intervention effort (Neumann, 2004). Many successful ergonomic interventions have been studied yet when applied across different businesses produce varying results. As Karsh et al. (2001) stated: "A pressing problem that has plagued ergonomic intervention research is the lack of understanding as to why seemingly identical interventions work in some instances but not in others…". Failures appear to be less a failure of the technical system used itself but rather a failure to accommodate the social sub-system within the work environment (Nadin et al., 2001). The intervention fails to wholly integrate with the other business processes.

Most ergonomic interventions address the physical problem and tend to focus on the measurable dimensions. Companies need to look beyond the mere physical layout of the problem and address the stakeholders involved in the process. Key stakeholder participation is an element that needs to be incorporated into all improvement processes (Hatch, 1997): "When individuals are not involved in establishing their goals, they are much less likely to feel motivated to achieve them then when they are allowed to participate in the process." People are very important resources and should be valued by their companies (Noro, 1991). A process is nothing more than the sum of purposeful human activities. Therefore, it makes sense to involve and engage the workforce since most employees have a strong interest in making their work conditions and environment better.

An ergonomic team's effectiveness is critical for continued success and yet a wide range of teams have come up with mixed results (Theberge et al., 2006; Laing et al., 2005). The recurring finding of disappointing impacts of such efforts highlights the need to better

understand the dynamics of workplace interventions (Theberge et al., 2006). Participatory ergonomics is one vehicle to help us better understand the crucial success factors. Saleem (1999) stated that PE is a macroergonomics approach that can be an effective method at the macro or micro-level. At the macro level the ergonomic focus is across the entire organization or work system. Loisel et al. (2001) stated that the advantages of a participatory ergonomics program (PEP) over a traditional ergonomics program are the compilation of skills and knowledge. In short, people learn by doing. Liker et al. (1989) recommends that the history, structure and culture of an organization be taken into account when implementing a PEP. Haines and McAtamney (1995) stated that ergonomic investigations should be considered as a more subjective process within an organization targeting efficiency, profitability and the general well-being of the workforce. Renz (2004) stated that this requires optimizing the relationship between the workers' physical and physiological capabilities and the task demands within their organizational and environmental context.

## Objectives

Work-related MSDs remain the single-most expensive category of occupational injuries and illnesses (Pransky et al., 2000). It is clear from this fact that many ergonomic hazards still exist within the workplace. Participatory ergonomics can be an effective method to alleviate these hazards if properly implemented. It is essential that organizations utilize the most effective and expedient intervention strategies with an eye on sustaining the corrective measures. The main goal for this study is to analyze factors crucial for the successful implementation of a participatory ergonomics program.

Thus, the objectives of this research are to:

1. Identify high-performing participatory ergonomics teams within manufacturing organizations (SIC 20-39);
2. Examine existing participatory ergonomic methods used by high-performing participatory ergonomics teams (SIC 20-39);
3. Provide recommendations that other organizations can use to implement an effective participatory ergonomics program.

## METHODS AND PROCEDURES

This investigation was focused around examining the factors for highly successful and effective participatory ergonomic teams. The correlational approach was chosen for this study since it is designed to determine associations for the existing condition. Correlational research designs are founded on the assumption that the situation is best described as a network of interacting and mutually-causal relationships (Davis, 1997). If there is an association between two variables then there could be a causal connection. However, correlation in itself does not necessarily prove causation. The basic question for correlational research asks what the relationship is between two variables. It was the objective of this study to determine the associational factors that are needed to create an effective participatory ergonomics team. The methodology utilized for carrying out this research consisted of:

- Compilation of relevant knowledge
- Selection and development of data collection tools
- Data Collection
- Data Analysis

After approval was received from the Institutional Review Board of the University of Wisconsin-Whitewater for this project a Pilot Study was conducted.

## Pilot Study

A Pilot Study was developed and a draft questionnaire was administered to two corporate safety managers at several large manufacturing facilities in Wisconsin. The draft questionnaire was sent out to the two companies for the purpose of pre-testing it. For this study, the industrial groups from SIC codes 20-39 were used. Businesses within this broad range represent food, textiles, chemical, metals, electronics and transportation equipment manufacturers. The Standard Industry Classification (SIC) code system was implemented in 1937 by the U.S. Office of Management and Budget to identify an organization's primary line of business. It was developed to facilitate the collection and analysis of business data and to promote uniformity and comparability in the presentation of statistical data. Even though the U.S. Government stopped issuing SIC codes in 2004 in favor of the NAICS (North American Industrial Classification System) most businesses still use them. The draft survey was intended to determine all possible concerns which needed to be worked out and identify any ambiguities and difficult questions. Each question in the pilot survey was developed to gain a better understanding of the successful implementation of a participatory ergonomics program. Based upon the responses from the respective corporate safety managers from these companies, the survey instrument was further refined.

The feedback indicated that some changes needed to be made to the draft questionnaire to narrow the questions and add more specificity to them. This allowed for collection of more pertinent and accurate data. Feedback was only received for seven of the 40 questions

(17.5%). In addition to making the recommended changes three other questions were deleted that appeared unnecessary or redundant upon further evaluation.

## The Study

The study identified elements, methods used and factors associated with highly effective participatory ergonomics teams within manufacturing organizations (SIC 20-39). The intent was also to provide recommendations from the study that other organizations can use to establish their own effective participatory ergonomics team.

### Highly Effective Participatory Ergonomic Teams

The first objective of this research stated that high-performing participatory ergonomics teams will be identified. Initial identification involved selecting companies (SIC 20-39) from WI, MN, IL, IA, MI, OH and CA that have been recognized as having exemplary workplace ergonomics programs. It was my original intent to survey companies within the Midwest. Since less than 25 companies responded to the survey, several companies from outside the Midwest were also contacted to participate. Companies that had VPP (Voluntary Protection Program – OSHA) certification or were mentioned in articles published by OSHA has having "Success with Ergonomics" headed the list. Further criteria to select organizations with high-performing ergonomic teams were the Bureau of Labor Statistics workplace musculoskeletal disorder (WMSD) rate average for the years of 2003-2005. The average for those three years was 4.54 WMSDs per 1,000 employees. Companies at or below 50% (2.27 WMSDs per 1000 employees) of the three-year average incident rate were pursued for the purposes of this study. The rationale behind such a significant deviation from the average is that a program at this level

would be built upon a solid foundation as opposed to success by chance. Objective #1 is related to survey questions i-ix.

Description of the survey instrument

For the second objective a written survey instrument was developed. The survey was designed to gather information from 3 major sections: organizational culture, the ergonomic team process and solution building. These are topics presented in the Participatory Ergonomic Blueprint developed at the University of Waterloo, Ontario, Canada that I desired to learn more about. To construct a valid and reliable measurement instrument, current knowledge of teamwork and ergonomics was evaluated (Stewart, 1999; Grief, 1991; Nachmias and Nachmias, 1996). The survey and accompanying application were sent to the University of Wisconsin – Whitewater Institutional Review Board to gain legal permission to conduct the study. The survey was based upon 3 topic areas: Organizational Culture, the Ergonomic Team Process, and Solution Building. Objective #2 is related to survey questions #1 - #37.

First, thirty-five companies (with more than 100 employees) with successful participatory ergonomic teams from the mainly the Midwest were solicited via phone and electronic mail from September 2007 to March 2008. Second, a phone survey (Section 1 - Appendix A) was conducted initially to contact the person employed to oversee the ergonomics team. This typically was someone in a management or staff position being a Safety Manager, Safety Coordinator or Ergonomics Team coordinator. After explaining the purpose of the study and securing their willingness to participate the company's baseline information was acquired. This consisted of determining and verifying: (1) how long the company has been in business, (2)

number of employees, (3) the number of employees on the participatory ergonomics team, (4) the level of authority that the ergonomic team has, and (5) the company's WMSD rate.

If the organization met the criteria (>100 employees, WMSD rate of ≤ 2.27, had an ergonomic team) then the Safety Manager, Safety Coordinator or Ergonomics Team coordinator was asked to provide more specific ergonomic performance measurements. In the third step data was then obtained in order to assess each organization. The researcher distributed a comprehensive 37-question survey instrument via e-mail. The participants were asked to return the completed survey within 30 days. If the survey questionnaire was not received within 30 days the participants were contacted again via phone and/or e-mail. For each question or statement, participants were required to express their level of agreement on a five point Likert-type scale, where 1 = not at all and 5 = very much. Participants were kept anonymous. Completed questionnaires were returned to the researcher via e-mail and postal mail.

Data was analyzed in order to determine an associational relationship with high-achieving participatory ergonomic teams. Responses were compiled and averages calculated for each of the 3 categories. Higher average scores were perceived as measures that could contribute favorably toward an ergonomic team's success.

## Data Analysis

Both descriptive statistics and analytical statistics were used. Each method was used depending on the situation and needs. All analyses were conducted using QI Macros for Windows. Results are displayed in graphical and tabular form. Upon reviewing the data the researcher chose to break out 4 categories versus the original 3: Organizational Culture,

Ergonomics Process, Solution Building and Reward & Recognition. The three questions related to reward and recognition warranted their own category. This section was of particular interest to the researcher as my assumption was that some people might need incentives to actively participate on ergonomics teams.

## RESULTS

Thirty-five companies were contacted to participate in the survey questionnaire. Responses were received from twenty-five (**71.4%** response rate). The responses to the thirty-seven questions within the questionnaire are summarized in Table 4. Of the twenty-five companies that participated, 17 (**68%**) have been in business for more than 40 years, 7 (**28%**) have been in business from 31-40 years, and 1 had been in business for less than 30 years. 18 companies were large (employing 500 or more employees), 4 (**16%**) were medium sized (employing 251-500 employees) and 3 (**12%**) were small sized companies (employing 250 or less employees). The survey questionnaire was divided into four sections, or factor areas. The average responses to each of the questions in each section can be seen in Table 4.1.

**Table 4 – Descriptive Statistics by Question**

| # | Question (n=25) | Total | AVG | STD | Median | Min | Max |
|---|---|---|---|---|---|---|---|
| 1 | Our organization is committed to a participative working style. | 107 | 4.28 | 0.70 | 4.00 | 3.00 | 5.00 |
| 2 | Where I work, management is committed to fitting each job to the individual's physical capabilities. | 97 | 3.88 | 1.05 | 4.00 | 2.00 | 5.00 |
| 3 | Does the ergonomic change team receive recognition from top-management when they implement an effective ergonomic change? | 79 | 3.16 | 1.25 | 3.00 | 1.00 | 5.00 |
| 4 | Our company encourages teamwork. | 115 | 4.60 | 0.64 | 5.00 | 3.00 | 5.00 |
| 5 | The ergonomics team is looked upon by employees as a valuable resource. | 97.5 | 3.90 | 0.76 | 4.00 | 2.00 | 5.00 |
| 6 | Affected employees' input are solicited prior to an ergonomic change. | 113 | 4.52 | 0.74 | 5.00 | 3.00 | 5.00 |
| 7 | Where I work, there is a high level of job satisfaction. | 90 | 3.60 | 0.49 | 4.00 | 2.00 | 5.00 |
| 8 | Ergonomics-related issues are considered at high-level meetings, not just after some bad event. | 100 | 4.00 | 0.88 | 4.00 | 2.00 | 5.00 |
| 9 | Top management provides adequate staff and financial resources for the participatory ergonomics team. | 94 | 3.76 | 0.83 | 4.00 | 2.00 | 5.00 |
| 10 | Participation on the Team is voluntary. | 104 | 4.16 | 1.25 | 4.00 | 1.00 | 5.00 |
| 11 | Team members receive formal ergonomics training prior to participation. | 114 | 4.56 | 0.64 | 5.00 | 3.00 | 5.00 |
| 12 | Team expectations are clearly stated. | 107 | 4.28 | 0.70 | 4.00 | 3.00 | 5.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | The Team has been given the authority to make ergonomic improvement decisions, within reason. | 107 | 4.26 | 0.61 | 4.00 | 3.00 | 5.00 |
| 14 | Appropriate tools are used to quantify the ergonomic hazard (NIOSH lifting equation, REBA, RULA) | 107 | 4.28 | 1.30 | 5.00 | 1.00 | 5.00 |
| 15 | Is as formal, agreed upon approach used to prioritize ergonomic improvements? | 101 | 4.04 | 0.96 | 4.00 | 2.00 | 5.00 |
| 16 | The effects of proposed ergonomic improvements are calculated before implementation, when feasible. | 93 | 3.72 | 0.96 | 4.00 | 2.00 | 5.00 |
| 17 | All affected employees are informed about an ergonomic solution before it is implemented. | 97 | 3.88 | 1.18 | 4.00 | 2.00 | 5.00 |
| 18 | The Team members feel comfortable raising ergonomic issues with fellow co-workers. | 106 | 4.24 | 0.56 | 4.00 | 3.00 | 5.00 |
| 19 | The Team members feel comfortable raising ergonomic concerns with supervisors. | 104 | 4.16 | 0.68 | 4.00 | 3.00 | 5.00 |
| 20 | The Team has direct discussions with upper management regarding ergonomic recommendations. | 97 | 3.88 | 1.15 | 4.00 | 1.00 | 5.00 |
| 21 | Team members conduct ergonomic audits for their co-workers. | 105 | 4.20 | 0.88 | 4.00 | 2.00 | 5.00 |
| 22 | Team members can see that they make a positive impact on ergonomic working conditions. | 104 | 4.33 | 0.70 | 4.00 | 3.00 | 5.00 |
| 23 | Minutes of meetings and project updates are posted in a visible location. | 87 | 3.63 | 1.41 | 4.00 | 1.00 | 5.00 |
| 24 | The Team establishes annual ergonomic objectives. | 92 | 3.68 | 1.23 | 4.00 | 1.00 | 5.00 |
| 25 | The Team meets its objectives. | 85 | 3.40 | 1.23 | 4.00 | 1.00 | 5.00 |
| 26 | Are incentives in place for meeting the Team's objectives? | 57 | 2.28 | 1.19 | 2.00 | 1.00 | 5.00 |
| 27 | The Team sets a deliverables date for its projects. | 87 | 3.48 | 0.90 | 3.00 | 2.00 | 5.00 |
| 28 | The Team is results-driven. | 97 | 3.88 | 0.76 | 4.00 | 2.00 | 5.00 |
| 29 | The Team members are rewarded in a tangible, visible way for promoting ergonomics. | 55 | 2.20 | 1.13 | 2.00 | 1.00 | 4.00 |
| 30 | The Team members measure the effectiveness of their ergonomic interventions. | 89 | 3.56 | 1.08 | 4.00 | 1.00 | 5.00 |
| 31 | The Team is empowered by top management to drive the ergonomic improvement process. | 92 | 3.68 | 1.01 | 4.00 | 2.00 | 5.00 |
| 32 | A Steering Team formulates ergonomic policy. | 75 | 3.00 | 1.46 | 3.00 | 1.00 | 5.00 |
| 33 | Feasible ergonomic solutions are ranked on their estimated effectiveness. | 81 | 3.24 | 0.99 | 3.00 | 1.00 | 5.00 |
| 34 | Where possible, ergonomic solutions are implemented on a small-scale to judge their effectiveness before being implemented full-scale. | 88 | 3.52 | 1.45 | 3.00 | 1.00 | 5.00 |
| 35 | New equipment and processes are evaluated for ergonomic risk factors before being purchased or installed. | 98 | 3.92 | 1.06 | 3.00 | 2.00 | 5.00 |
| 36 | Guidelines have been developed to incorporate ergonomic information into the management decision-making process. | 91 | 3.64 | 1.11 | 4.00 | 1.00 | 5.00 |
| 37 | Supervisors are actively involved in the ergonomic process. | 90 | 3.60 | 1.10 | 4.00 | 2.00 | 5.00 |

## Table 4.1 Group Statistics

**Factor 1: Organizational Culture** (n=9)
mean = 4.08 Average STD = 0.8104

Our organization is committed to a participative working style.
Where I work, management is committed to fitting each job to the individual's physical capabilities.
Our company encourages teamwork.
The ergonomics team is looked upon by employees as a valuable resource.
Affected employees' input is solicited prior to an ergonomic change.
Where I work there is a high level of job satisfaction.
Ergonomics-related issues are considered at high-level meetings, not just after some bad event.
Top management provides adequate staff and financial resources for the participatory ergonomics team.
Participation on the Team is voluntary.

**Factor 2: Ergonomics Process** (n=14)
mean = 4.08 Average STD = 0.88

Team members receive formal ergonomics training prior to participation.
Team expectations are clearly stated.
The Team has been given the authority to make ergonomic improvement decisions, within reason.
Appropriate tools are used to quantify the ergonomic hazard (NIOSH lifting equation, Rapid Entire Body Assessment, Rapid Upper Limb Assessment, etc.)
Is a formal, agreed upon approach used to prioritize ergonomic improvements?
The effects of proposed ergonomic improvements are calculated before implementation, when feasible.
All affected employees are informed about an ergonomic solution before it is implemented.
The Team members feel comfortable raising ergonomic issues with fellow co-workers.
The Team members feel comfortable raising ergonomic concerns with supervisors.
The Team has direct discussions with upper management regarding ergonomic recommendations.
Team members conduct ergonomic audits for their co-workers.
Team members can see that they make a positive impact on ergonomic working conditions.
Minutes of meetings and project updates are posted in a visible location.
The Team establishes annual ergonomic objectives.

**Factor 3: Solution Building** (n=11)
mean = 3.54 Average STD = 1.078

The Team meets its objectives.
The Team sets a deliverables date for its projects.
The Team is results-driven.
The Team members measure the effectiveness of their ergonomic interventions.
The Team is empowered by top management to drive the ergonomic improvement process.
A Steering Team formulates ergonomic policy.
Feasible ergonomic solutions are ranked on their estimated effectiveness.
Where possible, ergonomic solutions are implemented on a small-scale to judge their effectiveness before being implemented full-scale?
New equipment and processes are evaluated for ergonomic risk factors before being purchased or installed?
Guidelines have been developed to incorporate ergonomic information into the management decision-making process.
Supervisors are actively involved in the ergonomic process.

**Factor 4: Reward and Recognition** (n=3)
mean 2.55 Average STD = 1.2213

Does the ergonomic change team receive recognition from top-management when they implement an effective ergonomic change?
Are incentives in place for meeting the Team's objectives?
The Team members are rewarded in a tangible, visible way for promoting ergonomics.

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Figure 5 shows the age of the ergonomics program for the 25 survey participants. 12 of the 25 respondents (**48%**) reported that their program had been in place for 10 years or more, 6 (**24%**)

had programs in place for 5-10 years, 6 (**24%**) had programs for 2-5 years and only 1 respondent (**4%**) had a program in place for 1-2 years.

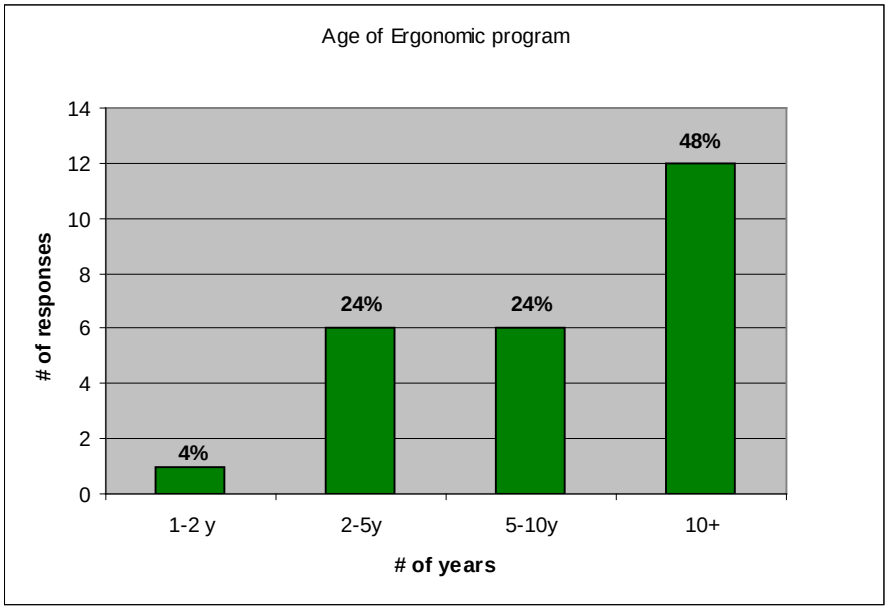


Figure 5. Age of Ergonomic Program.

Figure 6 reports the age of the businesses that responded to the survey. 17 (**68%**) have been in business for 40 or more years, 7 (**28%**) for 31-40 years, and 1 (**4%**) for 30 years or less.

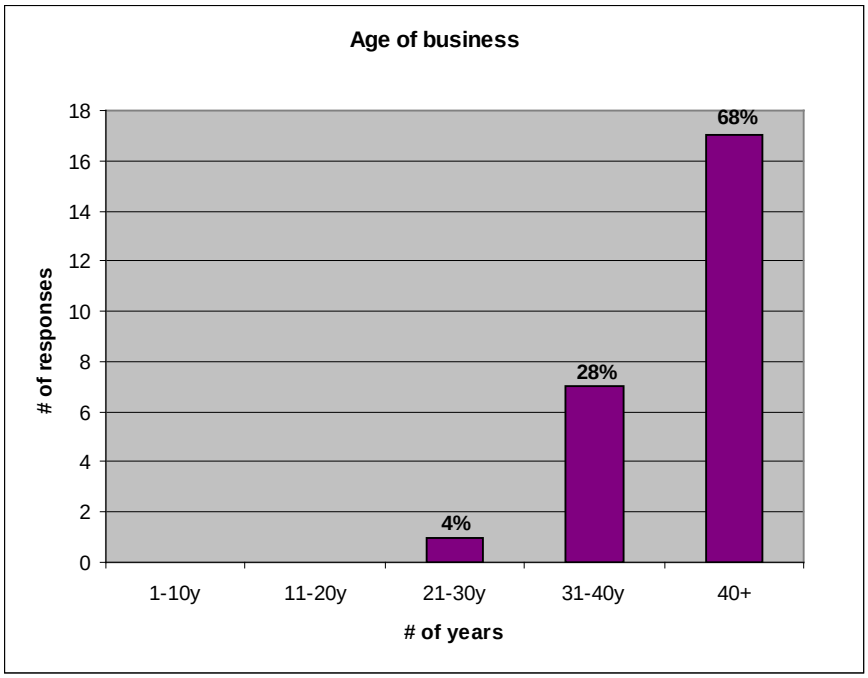


Figure 6. Age of business with ergonomics program.

Figure 7 indicates the number of employees at the responding businesses. 18 (**72%**) had 500 or more employees, 4 (**16%**) employed 251-500 employees, 2 (**8%**) employed 101-250 employees and 1 (**4%**) had 10-50 employees.

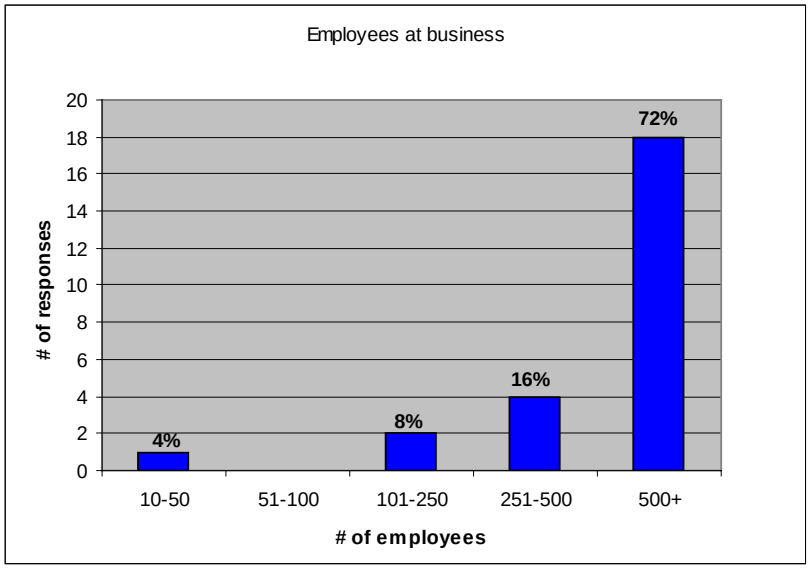


Figure 7. Number of employees

Figure 8 reports the years of ergonomics and safety experience the person has who completed the questionnaire for their company. 10 (**40%**) reported having 6-10 years of experience, 8 (**32%**) have 11-20 years of experience, 3 (**12%**) had 1-5 years of experience, and, another 3 (**12%**) had more than 20 years of experience.

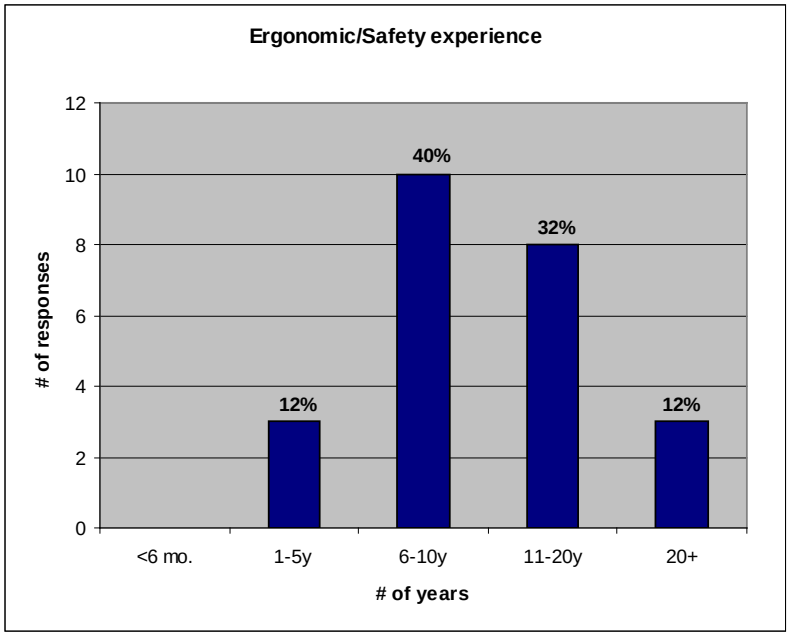


Figure 8. Years of ergonomics/safety experience.

## DISCUSSION

Without a regulatory ergonomics standard workplace requirements are generally limited to OSHA's General Duty Clause 5(a)(1). Unlike the European Union, the U.S.A. doesn't have a standardized regulation for ergonomics in this country. However, OSHA does recognize ergonomic programs as a best practice along with NIOSH and the American Society of Safety Engineers. Usually a company won't implement an ergonomic program until worker's compensation costs increase due to poor ergonomics. In starting a program up it is important to commit to a participative style of working from the start that allows for the building of trust, listening skills, respectful exchange of ideas, brainstorming new ideas, commitment, accountability and results orientation (Wells, 2001.)

Despite the fact that there is no OSHA standard for ergonomics the U.S. General Accounting Office (GAO) in its August 1997 report to Congress found that ergonomic

interventions in the workplace significantly reduce work-related injuries and illnesses. The results of this study seem to indicate that an organization's culture and ergonomic process are preferred in factoring whether a participatory ergonomics team will be successful. Within the section for Organizational Culture the most highly scored responses indicated that a company encourage teamwork, solicit affected employees' input prior to making an ergonomic change, the company is committed to a participative working style, ergonomic issues are regularly discussed at high-level meetings and participation on the ergonomic change team is strictly voluntary. This all seems to lead to the conclusion that employees and management need to work together to solve issues. By asking for affected employees' input prior to making an ergonomic change is one way for management to foster employee interest and participation.

Table 2 shows the overall descriptive statistics for the scores of the four factors.

Table 2. Descriptive analyses of the aggregate factor scores

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| Organizational culture | 9 | 4.08 | 0.8104 | 3.60 | 4.60 |
| Ergonomics process | 14 | 4.08 | 0.8800 | 3.63 | 4.56 |
| Solution building | 11 | 3.54 | 1.0775 | 3.00 | 3.92 |
| Reward system | 3 | 2.55 | 1.2213 | 2.20 | 3.16 |

Organizational Culture

The mean category score is above 4 on the 5-point Likert scale. This could indicate that the overall response to the importance of a supportive organizational culture is quite positive. The highest scored answer occurs for Q4 and Q6 which relate to their company encouraging teamwork and soliciting affected employees' input prior to making an ergonomic change. The

lowest scored answer occurs for Q7 which relates to whether there is a high level of job satisfaction where they work.

Ergonomics Process

The mean category was also above 4 on the Likert scale. The higher scores for this category could also indicate that it is important for creating a successful participatory ergonomics team. The highest scored answer occurs for Q11 which relates to ergonomic team members receiving formal ergonomics training prior to their participation. The lowest scored two answers occur for Q23 and Q24 which report whether meeting minutes/project updates are posted in a visible location and to whether the ergonomic team establishes annual objectives.

Solution Building

The mean category score was lower than the previous two categories but was still above a median score of 3.0. This could indicate that this section is important for establishing a participatory ergonomics team but maybe not as much as the organizational culture and ergonomics process sections. The highest scored answers occur for Q28 and Q35 which related to whether the ergonomic team is results-driven and whether new equipment and processes are evaluated for ergonomic risk factors before being installed and/or implemented. The lowest scored answer occurs for Q32 which asks if a Steering Team formulates ergonomic policy.

Reward and Recognition System

After reviewing the results of the survey three questions related to this topic it was broken out as a separate category. This category came in with the lowest mean score indicating

that possibly it is the least crucial for establishing a successful ergonomics team. The highest scored answer occurs for Q3 which asks if the ergonomic team receives recognition from top-management when an effective ergonomics change is implemented. The lowest scored answers occur for Q26 and Q29 which asks if the team members receive any incentives or are rewarded in any tangible way for promoting ergonomics.

The survey questions with the highest total scores were:

| **Rank** (T = tie) | | **Total** |
|---|---|---|
| #1 | Our company encourages teamwork (Q4) | 115 |
| #2 | Team member receive formal ergonomics training prior to participation (Q11) | 114 |
| #3 | Affected employees' input are solicited prior to an ergonomic change (Q6) | 113 |
| #4T | Our organization is committed to a participative working style (Q1) | 107 |
| #4T | Team expectations are clearly stated. (Q12) | 107 |
| #4T | Appropriate tools are used to quantify the ergonomic hazard (National Institute of Safety & Health lifting equation, Rapid Entire Body Assessment, Rapid Upper Limb Assessment, etc.) (Q14) | 107 |
| #7 | The Team has been given authority to make ergonomic improvement decisions, within reason. (Q13) | 106.5 |
| #8 | The Team members feel comfortable raising ergonomic issues with fellow co-workers. (Q18) | 106 |
| #9 | Team members conduct ergonomic audits for their co-workers. (Q21) | 105 |
| #10T | Team members can see that they make a positive impact on ergonomic working conditions. (Q22) | 104 |
| #10T | Participation on the Team is voluntary. (Q10) | 104 |

Some survey respondents typed in extra explanations to their answers:

- "Budgets play a big role that sometimes hinders our process"
- "We have many different teams, some management teams are very dedicated, some take convincing."
- "Ergonomics is a part of new product/line development and set up."
- "Safety Team involvement is part of annual employee review process."
- "Follow up review of tasks required 30 – 60 days post (ergonomic) change."
- "Yes & no – they say it (empowered by top management) is but doesn't always work that way."
- "Part of capital improvement (ergonomic analysis) checklist prior to purchase."
- "(Ergonomics is an) on-going process."

- "They are responsible for it but not all supervisors are equally active."
- "To some extent" the ergonomic change team receives recognition from top-management when they implement an effective ergonomic change.

The size of the ergonomic team varies. Some consist of 1-3 individuals consisting of an ergonomic professional or safety staffer. Other teams have Safety and Continuous Improvement teams. Threats to the internal validity of this research include: *location threat* – more profitable companies may have better resources to equip themselves; *history threat* – surveyed employees might have a prior bad experience with ergonomic change and inject bias and/or resentment into their answers; *reactivity threat* – respondents might tend to give socially desirable responses that make them look good or seem to be what the researcher is looking for. This may not be a significant threat since it is a *goal to emphasize the positive things that have worked for an employer; implementation threat* – the internal employee who administers the questionnaire might perceive the whole process negatively as being a waste of his/her time and communicate that verbally or non-verbally resulting in an apathetic response to the questionnaire. Some possible controls to address these threats could include: providing an incentive for completing the questionnaire, administering the questionnaire in person (although this might produce a "Hawthorne effect"), randomly assign participants, hold the location constant for all participants and have participants complete more surveys until their responses become constant. A control group could also have been implemented that would have asked the same questions of companies that had an ergonomics program implemented on a mandatory basis without the option for voluntary participation.

Bias

Several forms of bias may exist in the responses to the survey instrument. The respondents may have answered the items in a manner that might reflect them in the best light ("self-lifting bias"). Respondents also could have answered a series of questions with like responses which is known as "Habit Bias." The Hawthorne Effect could also results as the behavior of an individual or a group will change to meet the expectations of the observer if they are aware their behavior is being observed.

## CONCLUSION

In summary, this study was able to identify high-performing participatory ergonomics teams within the manufacturing sector. Through personal phone calls, electronic mail and completed survey questionnaires much was learned about the methods that these teams are utilizing. The significance of this research indicates that the organizations that participated focused on eight key areas in order to create and sustain a participatory ergonomics team:

- Create a culture of teamwork.
- Commit to a participative working style.
- Create an ergonomics team recruiting willing volunteers, set team expectations and then give them the authority to make changes.
- Train the participatory ergonomic team members prior to having them evaluate the work environment for ergonomic hazards.
- Ask affected employees for their input before making ergonomic changes to their work area.
- Use formal evaluation tools for assessing ergonomic hazards.

- Participatory ergonomic team members need to feel that they are making a positive impact.
- Employees need to feel comfortable with raising ergonomic issues with their supervisors.

One surprising result was the response that 40% of the respondents do not have incentives or rewards in place for ergonomic team members. As Norberg (2005) stated, “It’s not just the money that makes high-earners happier than low-earners. If employees experience positive effects or have experienced success in the past that might be more of a motivational factor than financial incentives or rewards. Another explanation could be that the employees who answered the survey questionnaire felt control in their work and life and were more successful due to their sense of optimism (Fredrickson, 1998). Or, another explanation is that most participants that completed the survey questionnaire were ergonomic or safety coordinators and part of their job required them to participate and work toward making positive ergonomic change. They feel it to be part of their job responsibility to implement ergonomic changes without expecting a financial incentive or “pat on the back”.

Successful participatory ergonomics programs are systematic, focused and are integrated into existing processes and operations. They need management commitment and support and provide training for the ergonomic change team members. An ergonomic program must be viewed as a good business decision for it to succeed also.

## Recommendations for Future Research

Based on the results and conclusions of this study, the following recommendations for future research are stated:

1. Investigation could be made to determine the differences between highly successful participatory ergonomics teams and ones that underachieve;
2. Determine the social aspects of ergonomic team participation;
3. Investigate why some teams are dedicated to their cause while others take convincing.

## REFERENCES

Bellemare, M., Allard, D., Mountreuil, S., Marier, M., Prevost, J. (2000). Implementation Evaluation of participatory ergonomics – Proceedings of the IEA/HFES 2000 Congress, USA.

Bohr, P.C., Evanoff, B.A., & Wolf, L.D., (1997). Implementing participatory ergonomics teams among health care workers. *American Journal of Industrial Medicine* 32, 190-196.

Brown, Jr., O., (1985). Proceedings of the Human Factors Society: Some perspectives on participatory ergonomics in high technology organizations.

Brown, Jr., O., (1993). On the relationship between Participatory Ergonomics, performance and productivity in organizational systems. In: The Ergonomics of Manual Work. Marras, W., Karwowski, W., Smith, J., and Pacholski, L. Taylor & Francis, London, 495-498.

Burns, C.M. & Vicente, K.J. (2000). A participant-observer study of ergonomics in engineering design; How constraints drive the design process. *Applied Ergonomics* 31 (1), 73-82.

Carrivick, P.J.W., Lee, A.H., & Kelvin, K.W.Y. (2002). Effectiveness of a Participatory Workplace risk assessment team in reducing the risk and severity of musculoskeletal injury. *Journal of Occupational Health*. 44: 221-225.

Davis, J., 1997. "Correlational Research Methods." Department of Psychology, Metropolitan State College of Denver.

De Looze, M..P., Urlings, I.J.M., Vink, P., van Rhijn, J.W., Meidema, M.C., Bronkhorst, R.E., van der Grinten, M.P., 2001. Towards successful physical stress reducing products: an e evaluation of seven cases. *Applied Ergonomics* 32(5), 525-534.

Erlandsson, A., (2002). Perceived participation – a key factor for successful implementation of a new working concept. Humans in a complex environment. Proceedings of the 34th Annual Congress of the Nordic Ergonomics Society. Wilkmarkshotellet, Kolmärden, Sweden, October, pp. 229-234.

European Foundation for the Improvement of Living and Working Conditions (1999)**:** *Communique July/August*, 1999. Dublin: EFILWC, 2.

Fredrickson, B.L., (1998). What good are positive emotions?, *Reviews of General Psychology* 2 (1998), pp. 300-319.

Gaba DM, Singer SJ, Sinaiko AD, Bowen JD, Ciavarelli AP (2003): "Differences in Safety Climate between Hospital Personnel and Naval Aviators." *Human Factors* 45(2): 173-185.

Gadbois, C., Villatte, R., Bourne, J.P., & Visier, L., (1995). Union assimilation of the ergonomic approach and the transformation of social relations. *Relat. Ind.* 50 (4), 852-872.

Grief, M., (1991). The visual factory, Portland, Oregon, Productivity Press.

Hackman, J., (1990). Creating more effective work groups in organizations. In: Hackman, J.R. (Ed.), Groups that work (and Those that Don't). Jossey Bass Inc., San Francisco, pp. 479-508.

Haims, C.H., Carayon, P. (1998). Theory and practices for the implementation of in house continuous improvement participatory ergonomic programs. *Applied Ergonomics* 29 (6), 461-472.

Haines, H., McAtamney, L., 1995. Undertaking an ergonomic study in industry. In: Wilson, J.R., Corlett, E.N. (Eds.), Evaluation of Human Work, 2nd Edition. Taylor & Francis, London, pp. 1041-1054.

Haines, H., Wilson, J.R., Vink, P., & Koningsveld, E. (2002). Validating a framework for participatory ergonomics (the PEF). *Ergonomics* 45 (4), 309-327.

Halpern, C.A., & Dawson, K.D. (1997). Design and implementation of a participatory ergonomics program for machine sewing tasks. *International Journal of Industrial Ergonomics*. 20, 429-440.

Hatch, M.J., (1992). Organization theory – Modern symbolic and postmodern perspectives, Oxford Press, Oxford. ISBN 0-19-877490-7.

Hugentobler, M.K., Israel, B.A., & Schurman, S.J. (1992). An action research approach to workplace health: integrating methods. *Health Education Quarterly*. 19 (1), 55-76.

Imada, A.S., (1991). The rationale and tools of participatory ergonomics. In K.Noro and A.S. Imada (Eds.) Participatory Ergonomics, pp 30-51. Taylor & Francis, London.

Imada, A.S., (2000). Participatory ergonomics: a strategy for creating human-centred work. *Journal of Science of Labour*, 76(3 Pt. 2), 25-31.

Karsh, B., Moro, F.B.P., and Smith, M.J., (2001). The efficacy of workplace ergonomic interventions to control musculoskeletal disorders: A critical analysis of the peer-reviewed literature. *Theoretical Issues in Ergonomic Science*, 2(1), 23-96.

Kourinka, I. (1997). Tools and means of implementing participatory ergonomics. *International*

*Journal of Industrial Ergonomics*, 19, 267-270.

Kourinka, I., & Patry, L. (1995). Participation as a means to promoting occupational health. *International Journal of Industrial Ergonomics*. 15, 365-370.

Laing, A.C., Frazer, M.B., Norman, R.W., Wells, R.P., Cole, D.C. & Kerr, M.S., The Ergonomic Intervention Evaluation Research Group, 2005. Study of the effectiveness of a participatory ergonomics intervention in reducing worker pain severity through Physical exposure pathways. *Ergonomics* 48 (2), 150-170.

Lanoie, P., and Tavenas, S., 1996. Costs and benefits of preventing workplace accidents: the case of participatory ergonomics. *Safety Science*, 24, 181-196.

Liker, J.K., Nagamachi, M., & Lifshitz, Y.R. (1989). A comparative analysis of participative ergonomics programs in U.S. and Japanese manufacturing plants. *International Journal Of Industrial Ergonomics* 3 (3), 185-199.

Loisel, P., Gosselin, L., Durand, P., Lemaine, J., Poitras, S., and Abenhaim, L., 2001. Implementation of a Participatory Ergonomics program in the rehabilitation of workers suffering from subacute back pain. *Applied Ergonomics*. 32(1), 53-60.

Maciel, R., (1998). Participatory ergonomics and organizational change. *International Journal of Industrial Ergonomics*, 22, 319-325.

McNeese, M.D., Zaff, B.S., Citera, M., Brown, C.E., and Whitaker, R. (1995). AKADAM: Eliciting user knowledge to support participatory ergonomics. *International Journal of Industrial Ergonomics*, 15(5), 345-363.

Moore, J.S., & Garg, A. (1996). Use of participatory ergonomics teams to address musculo-skeletal hazards in the red meat packing industry. *American Journal of Industrial Medicine* 29, 402-408.

"Musculoskeletal Disorders and the Workplace – Low Back and Upper Extremities," Panel on Musculoskeletal Disorders and the Workplace Commission on Behavioral and Social Sciences and Education National Research Council & Institute of Medicine, 2001. National Academy Press, Washington, D.C., pp 17-37.

Nachmias, C., Nachmias, D., 1996. Research methods in the social sciences, Martins Press, London.

Nadin, S.J., Waterson, P.E., and Parker, S.K. (2001). "Participation in Job Redesign: An Evaluation of a sociotechnical tool and its impact." *Human factors and Ergonomics in Manufacturing*, 11(1), 53-69.

Nagamachi, M. (1995). Requisites and practices of participatory ergonomics. *International Journal of Industrial Ergonomics* 15, 371-377.

Neumann, W.P., 2004. Doctoral Thesis. Production Ergonomics – Identifying and Managing Risk in the design of High Performance Work Systems. Department of Design Sciences, Lund University, Sweden.

Norberg, J., (2005). In Defense of Global Capitalism, Cato Institute, Washington.

Novek, J. (1992). The labour process and workplace injuries in the meat packing industry. *Canadian Review of Sociological Anthropology*. 29 (1), 17-37.

Polanyi, M.F., & Cole, D.C. (2003). Towards research-informed multi-stakeholder action on complex workplace health issues: reflections on two WMSD interventions. In: Sullivan, T., Frank, J. (Eds.), Preventing Work-Related Disability: New Views. Taylor & Francis, London, England.

Renz, M.C., Master's Thesis. Laboratory investigation of a simulated industrial task pre- and post-ergonomic intervention. Department of Human Kinetics and Ergonomics, Rhodes

University, 2004.

Rosengarten P., (1995) Learning Organisations and their characteristics: the case of automotive components suppliers in Britain, proceedings of the International Conference – Measuring the reality, Warwick May 17-19, European Consortium for the Learning Organisation.

Saleem, J.J., 1999. Master's Thesis. Quantifying the Participatory Ergonomics effects on training and a work analysis tool on operator performance and well-being.

Singer SJ, Gaba DM, Geppert JJ, Sinaiko AD, Howard SK, Park KC (2003). "The culture of safety: results of an organization-wide survey in 15 California hospitals." *Quality and Safety in Health Care* 12(i2): 112-118.

St. Vincent, M., Lortie, M., Chicoine, D., (2001). Participatory ergonomics training in the manufacturing sector and ergonomics analysis tools. *Industrial Relations*. 56(3), 491-514.

Stewart, R., (1999). Gower handbook of teamworking, Part I, 1-136, London, Gower Publication Limited.

Takala, J., Introductory report of the International Labour Office, International Occupational Safety & Health Information Centre, Geneva, International Labour Office, 1999.

Theberge, N., Granzow, K., Cole, D., Laing, A., The Ergonomic Intervention Evaluation Reseach Group. Negotiated participation: Understanding the "how" in an ergonomic change team. *Applied Ergonomics*. 37(239-248).

Wells, R., Norman, R., Frazer, M., Laing, A., 2001. University of Waterloo Ergonomics Program Implementation Blueprint. http://www.ergonomics.uwaterloo.ca/bprint.html.

Westgaard, R.H., and Winkel, J. (1997). Ergonomics intervention research for improved

musculoskeletal health: a critical review. *International Journal of Industrial Ergonomics*, Volume 20, pp. 463-500.

Westlander, G., Viitasara, E., Johansson, A., Shahnavaz, H., 1995. Evaluation of an ergonomics intervention programme in VDT workplaces. *Applied Ergonomics*. 26(2), 83-92.

Wilson, J.R., (1995). Ergonomics and Participation. In J.R. Wilson and E.N. Corlett (Eds.), Evaluation of Human Work, 1071-1096. Taylor & Francis: London.

Zalk, D.M., (2001). Grassroots Ergonomics: Initiating an Ergonomics Program Utilizing Participatory Ergonomics. Annals of Occupational Hygiene, Volume 45, No. 4, pp. 283-289.

# APPENDIX A

## Participatory Ergonomics Survey Instrument

The purpose of this survey is to identify strategies that successful participatory ergonomics teams use to be effective. If you agree to participate in this study, your participation will last for six (6) months and will involve completing this survey followed by possible follow-up phone calls, site visits and/or e-mail communication. Your participation is voluntary and you may choose to discontinue participation at any time. If you choose to participate, please complete this survey and return it to the researcher. If you decide to participate it is possible that there may be no direct benefit to you. It is hoped that the information gained in this study will benefit society by reducing workplace musculoskeletal disorders while increasing the effectiveness of employee teams created to reduce ergonomic risk. Summaries of the findings will be made available. To receive a summary, please indicate that on the last page of the survey.

All of the information collected from will be strictly confidential. The researcher will not share the information obtained from you with your employer or co-workers. Only aggregated data will be reported. There are neither right nor wrong answers. Please answer each question honestly. Thank you in advance for your time and help.

For any more questions regarding this research, please contact the researcher: Dr. Sang Choi, Associate Professor, Department of Occupational and Environmental Safety & Health, University of Wisconsin-Whitewater, (262) 472-1641 or chois@uww.edu. Or the Institutional Review Board Administrator, Ms. Denise Ehlen, (262) 472-5212 or ehlend@uww.edu.

**SECTION I - Company & Personal Information:**

i. How long has your company been in business?
   a. 1-10 years
   b. 11-20 years
   c. 21-30 years
   d. 31-40 years
   e. 40+

ii. How many employees are in the facility where ergonomics is utilized?
   a. 10-50
   b. 51-100
   c. 101-250
   d. 251-500
   e. 500+

iii. How many years of experience in safety/ergonomics do you have?
   a. Less than 6 months
   b. 1-5 years
   c. 6-10 years
   d. 11-20 years
   e. 20+ years

iv. How long has your ergonomics program been in place?
   a. 1-2 years
   b. 2-5 years
   c. 5-10 years
   d. 10+ years

v. Do you have a problem-solving team that focuses on solving ergonomic issues?
   a. Yes
   b. No

vi. Is there an individual financial incentive for your employees to participate on the ergonomics team?
   a. Yes
   b. No

vii. Ergonomics in our company is a permanent and ongoing continuous improvement initiative.
   (not at all) 1 2 3 4 5 (very much)

viii. Our company's musculoskeletal disorder incident rate is $\leq 2.27$ per 1000 employees.
   a. Yes
   b. No

**SECTION II - ORGANIZATIONAL CULTURE SECTION:**

1. Our organization is committed to a participative working style.(Please circle one)
   (not at all) 1 2 3 4 5 (very much)

2. Where I work, management is committed to fitting each job to the individual's physical capabilities.
   (not at all) 1 2 3 4 5 (very much)

3. Does the ergonomic change team receive recognition from top-management when they implement an effective ergonomic change?
   (not at all) 1 2 3 4 5 (very much)

4. Our company encourages teamwork.
   (not at all) 1 2 3 4 5 (very strong)

5. The ergonomics team is looked upon by employees as a valuable resource.
   (not at all) 1 2 3 4 5 (very much)

6. Affected employees' input are solicited prior to an ergonomic change.
   (not at all) 1 2 3 4 5 (very much)

7. Where I work there is a high level of job satisfaction.

(not at all) 1 2 3 4 5 (very much)

8. Ergonomics-related issues are considered at high-level meetings, not just after some bad event.
   (not at all) 1 2 3 4 5 (very much)

9. Top management provides adequate staff and financial resources for the participatory ergonomics team.
   (not at all) 1 2 3 4 5 (very much)

**SECTION III - ERGONOMICS PROCESS SECTION** (the Ergonomics Change Team will be referred to as the "Team". In the case of multiple teams please complete a questionnaire for each one.):

10. Participation on the Team is voluntary.
    (not at all) 1 2 3 4 5 (very much)

11. Team members receive formal ergonomics training prior to participation.
    (not at all) 1 2 3 4 5 (very much)

12. Team expectations are clearly stated.
    (not at all) 1 2 3 4 5 (very much)

13. The Team has been given the authority to make ergonomic improvement decisions, within reason.
    (not at all) 1 2 3 4 5 (very much)

14. Appropriate tools are used to quantify the ergonomic hazard (National Institute of Safety & Health lifting equation, Rapid Entire Body Assessment, Rapid Upper Limb Assessment, etc.)
    (not at all) 1 2 3 4 5 (very much)

15. Is a formal, agreed upon approach used to prioritize ergonomic improvements?
    (not at all) 1 2 3 4 5 (very much)

16. The effects of proposed ergonomic improvements are calculated before implementation, when feasible.
    (not at all) 1 2 3 4 5 (very much)

17. All affected employees are informed about an ergonomic solution before it is implemented.
    (not at all) 1 2 3 4 5 (very much)

18. The Team members feel comfortable raising ergonomic issues with fellow co-workers.
    (not at all) 1 2 3 4 5 (very much)

19. The Team members feel comfortable raising ergonomic concerns with supervisors.
    (not at all) 1 2 3 4 5 (very much)

20. The Team has direct discussions with upper management regarding ergonomic recommendations.
    (not at all) 1 2 3 4 5 (very much)

21. Team members conduct ergonomic audits for their co-workers.
    (not at all) 1 2 3 4 5 (very much)

22. Team members can see that they make a positive impact on ergonomic working conditions.
    (not at all) 1 2 3 4 5 (very much)

23. Minutes of meetings and project updates are posted in a visible location.
    (not at all) 1 2 3 4 5 (very much)

**SECTION IV – SOLUTION BUILDING:**

24. The Team establishes annual ergonomic objectives.
    (not at all) 1 2 3 4 5 (very much)

25. The Team meets its objectives.
    (not at all) 1 2 3 4 5 (very much)

26. Are incentives in place for meeting the Team's objectives?
    (not at all) 1 2 3 4 5 (very much)

27. The Team sets a deliverables date for its projects.
    (not at all) 1 2 3 4 5 (very much)

28. The Team is results-driven.
    (not at all) 1 2 3 4 5 (very much)

29. The Team members are rewarded in a tangible, visible way for promoting ergonomics.
    (not at all) 1 2 3 4 5 (very much)

30. The Team members measure the effectiveness of their ergonomic interventions.
    (not at all) 1 2 3 4 5 (very much)

31. The Team is empowered by top management to drive the ergonomic improvement process.
    (not at all) 1 2 3 4 5 (very much)

32. A Steering Team formulates ergonomic policy.
(not at all) 1 2 3 4 5 (very much)

33. Feasible ergonomic solutions are ranked on their estimated effectiveness.
(not at all) 1 2 3 4 5 (very much)

34. Where possible, ergonomic solutions are implemented on a small-scale to judge their effectiveness before being implemented full-scale?
(not at all) 1 2 3 4 5 (very much)

35. New equipment and processes are evaluated for ergonomic risk factors before being purchased or installed.
(not at all) 1 2 3 4 5 (very much)

36. Guidelines have been developed to incorporate ergonomic information into the management decision-making process.
(not at all) 1 2 3 4 5 (very much)

37. Supervisors are actively involved in the ergonomic process.
(not at all) 1 2 3 4 5 (very much)

☐ *I would like to receive a copy of the Study Findings when they become available.*

## APPENDIX B

### Companies solicited for their responses to the questionnaire

The following companies were chosen for the stated reasons:

1. Quad Graphics, Pewaukee and, Lomira, WI (SIC 2754) – Listed and described by OSHA as a company with "Success with Ergonomics." Lomira location has 1800 employees.
2. Rockwell Automation, Milwaukee, WI (SIC 3643) – Listed and described by OSHA as a company with "Success with Ergonomics." 5000+ employees at location.
3. GE Healthcare Technologies, Milwaukee, WI (SIC 3840) – 2005 Wisconsin Corporate Safety Award Winner (Wisconsin Council of Safety). Its ergonomic program is key to its safety success. It has helped to reduce the ergonomic related cases 69% in the past four years. 2000+ employees at location.
4. John Deere Dubuque Works, Dubuque, IA (SIC 3531) – Implemented Safety R.O.C.K.S. program (Realigning Our Culture through Knowledge of Safety) to reduce recordable incident rate from 4.3 to 2.0. ~2000 employees at location.
5. 3M, Minneapolis, MN (SIC ) – Has had global ergonomics program in place for over 15 years and expanded it in 2001. Since 2001, have realized a 44% reduction in their ergonomic incident rate.
6. Springs Window Fashions LLC, Middleton, WI (SIC 2531) – 2005 Corporate Safety Award Winner (Wisconsin Council of Safety). VPP Star site. Five teams of 60 employees establish safety policies, conduct incident investigations and ergonomic assessments. The ergonomic team conducts both office and factory workstation analyses. To date it has documented nearly 700 ergonomic improvements in the

facility. Named by Occupational Hazards magazine as one of America's Safest Companies.

6. S.C. Johnson, Bay City, MI (SIC 3081)– Received 2005 Ergonomic Innovation Award from Michigan Occupational Safety and Health Department (MIOSHA).
7. ConAgra Foods, St. Charles, IL (SIC 2013) – Listed and described by OSHA as a company with "Success with Ergonomics." 140 employees at location.
8. DePuy Orthopedics, subsidiary of Johnson & Johnson, Jackson, MI (SIC 3841) – OSHA created a partnership with J&J (New Brunswick, NJ) in 2003 to reduce the incidence and severity of MSDs. J&J's ergonomics program, ERGO, is a "cultural program." Everyone owns the process and includes a six-step Ergonomics Maturity Ladder. Also, has a JOBFIT program to prevent MSDs. J&J was a Robert W. Campbell Award Winner in 2005 (National Safety Council).
10. General Mills, Inc., Cedar Rapids, IA (SIC 2043) – Team oriented approach to safety. No supervisors are used at this facility. Safety Director is on the Board of Directors for the Iowa-Illinois Safety Council.
11. Frito-Lay, Inc., Beloit, WI (SIC 2096)– OSHA recognized as a VPP Star status company in 1997.
12. GE Healthcare Clinical Systems, Milwaukee, WI (SIC 3845)– OSHA recognized as a VPP Star status company in 2001 and 2004 Safety Award Winner (WCS).
13. Rockwell Collins, Cedar Rapids, IA (SIC 3812) – OSHA recognized as a VPP Star status Company. Established an Ergonomics Council in 1993.
14. Kraft Pizza, Medford, WI (SIC 2038)– OSHA recognized as a VPP Star status company in 2003.

15. International Paper Container, Fond du Lac, WI (SIC 2653) – OSHA recognized as a VPP Star status company in 2004.
16. Lucas Milhaupt, Cudahy, WI (SIC 3499) – OSHA recognized as a VPP Star status company in 1999.
17. General Motors, Janesville, WI (SIC 3713) – has implemented a JETT (Joint Ergonomics Technician Team) program.
18. Honeywell Aerospace Operations, Minneapolis, MN – OSHA recognized as a VPP Star status company in 2007. Integrated a Health, Safety & Environment management system into the operation. Safety is managed as an area of business focus along with quality, delivery and cost. Has a fully engaged Safety Committee that is actively involved in the process of continuous improvement.
19. Nestle' Purina PetCare Company, Hager City, MN (SIC 2047) – Has gone 2,668 days without a lost-time injury. The maintenance department has completed 23 years without a lost-time injury. Was recognized by Nestle as their #2 factory in the world for safety performance. They are currently involved in Behavioral Based Safety training for every employed associate.
20. HON Industries, Muscatine, IA (SIC 2522) – Recognized by OSHA as a company with "Success in Ergonomics."
21. John Deere & Co., Horicon, WI (SIC 3524) – Team approach to operations and safety.
22. Georgia-Pacific (Fort Howard) Broadway Mill, Green Bay, WI (SIC 2621) – Recognized as a VPP Star status facility in 1995. In 2006, the mill's Recordable rate is 1.85 and their Lost-time incident rate is 0.24.

23. Phillips Plastics Corporation, Operations Center, Eau Claire, WI (SIC 3089) – 2006 Corporate Safety Award Winner – WCS. The company has been developing an deploying a massive emphasis on ergonomics companywide. Ergonomics has, and continues to be, its main emphasis as a safety objective. Each facility has a safety specialist assigned to address ergonomic concerns to ensure that issues are actively addressed and immediately resolved.
24. Plastic Ingenuity, Cross Plains, WI (SIC 3089) – Thermoforming Institute Safety Award winner.
25. Silicon Graphics, Inc., Chippewa Falls, WI (SIC 3571) – Created "Ergo Hotline" to schedule ergonomic evaluations, internal ergonomic website, support and funding of upper management.
26. Snap-On, Inc., Kenosha, WI (SIC 3444) – Safety is a core belief, company will not "negotiate when it comes to workplace safety".
27. Trane Co., La Crosse, WI (SIC 3585) – VPP site.
28. Applied Materials, Santa Clara, CA (SIC 3559) – Developed a successful global ergonomic program.
29. Red Wing Shoes, Red Wing, MN (SIC 3143) – Began ergonomic program in 1985
30. Ariens Company, Brillion, WI (SIC 3524) – Uses Kaizen events for safety/ergonomic issues; Wisconsin Manufacturer of the Year in 2005
31. Johnson Controls, Holland, MI (SIC 3714) – In 2001, J&J leadership endorsed a strategy that promoted criteria for the mitigation and prevention of ergonomic risk. J&J's approach to ergonomics, ensures that sites which employ all elements of this process will achieve a "Cultural Ergonomics Program."

32. Ford Motor Company, Detroit, MI (SIC 3711) – In 1990, implemented a “Fitting Jobs to People: The UAW/Ford Ergonomic Process” in all 60 production facilities nationwide.
33. PPG, Pleasant Prairie, WI (SIC 2851) – has incorporated various quality tools to facilitate and drive continuous improvement, including: employee involvement in ergonomic teams, completion of ergonomic risk assessments and site ergonomic program assessments.
34. Nevamar, Oshkosh, WI (SIC 2499) – VPP site.
35. BASF, Appleton, WI (SIC 2842) – VPP site.

# APPENDIX C

## Approval Letter from the University of Wisconsin-Whitewater Institutional Review Board

Modification(s) to your University of Wisconsin-Whitewater Institutional Review Board for the Protection of Human Subjects (IRB) protocol *Key Factors for Successful Implementation of a Participatory Ergonomics Program* were approved on 24 April 2007. You may now proceed with your research.

If you should make any future changes in the protocol involving 1) method, 2) subjects, 3) informed consent, and/or 4) subject identification, you must submit a protocol modification. Instructions for protocol modification may be found in the IRB GUIDE.

The case number assigned to this protocol is **C06704066Q**; please reference this number in all future correspondence. You are responsible for maintaining all records related to this project for at least three years after completion of the research project.

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