
Participatory Ergonomic Interventions in Meatpacking Plants

Edited by:

**CHRISTOPHER C. GJESSING
THEODORE F. SCHOENBORN
ALEXANDER COHEN**

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health**

DISCLAIMER

Sponsorship of this document by NIOSH does not constitute endorsement of the views expressed or recommendation for the use of any commercial product, commodity or service mentioned. The opinions and conclusions expressed are those of the authors and not necessarily those of NIOSH.

Recommendations are not to be considered as final statements of NIOSH policy or of any agency or individual who was involved. They are intended to be used in advancing the knowledge needed for worker protection.

This document is in the Public Domain and may be freely copied or reprinted.

**Copies of this and other NIOSH documents are available
from:**

**Publication Dissemination, DSDTT
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513) 533-8573 (fax)**

**For information on other occupational safety and health
problems, call
1-800-35-NIOSH**

DHHS (NIOSH) Publication No. 94-124

ABSTRACT

In-depth reports of intervention projects to reduce ergonomic hazards at three meatpacking plants are described. The projects used a participatory approach involving front-line workers, supervisory personnel and others organized into teams for such problem-solving purposes. The work at each site was directed by university investigators with expertise in ergonomics and, in one case, organizational behavior. They facilitated efforts in team-building and team function and furnished observations of the processes involved and assessments of results. Reports of the three site studies depict a variety of contexts and opportunities for observing the merits of a participatory team approach in dealing with ergonomic problems in the meatpacking industry.

In one case, the intervention advanced the company's initial efforts to develop an ergonomics program, providing training of workers and supervisors selected for teams to direct these efforts. In a second case, the corporate program already included use of ergonomics teams and the report described the team's progress in addressing selected problem operations at one plant site. In the third case, the plant had no prior experience in using a team approach in solving worksite problems and the effort described involved selecting and training the team members to analyze ergonomic problems in their operations and to propose remedies for implementation.

Findings from these various experiences include:

- Successful participatory ergonomics programs require strong in-house direction, support, and ergonomic expertise.
- Training programs must develop both teamwork and ergonomic skills among participants.
- Teams should include supervisors, maintenance and/or engineering staff (who will actually implement

recommended changes), as well as production workers engaged in the jobs being studied.

- Access to information, such as illness and injury data, is vital to proper team functioning.
- Realistic measurable goals need to be set and communicated.
- Evaluation criteria must be planned.

In providing general background for the individual case reports, the document also includes historical material referencing ergonomic problems in the red meatpacking industry and related risk of musculoskeletal injuries, and a review of the literature offering rationale for worker involvement in participatory approaches to problem-solving in workplace settings.

FOREWORD

The National Institute for Occupational Safety and Health (NIOSH) conducts research to identify and evaluate workplace hazards. The objective is to establish a dose-response relationship between an agent and an adverse outcome to establish exposure limits and control measures. NIOSH research has contributed greatly to the knowledge of different occupational hazards and to recommendations aimed at reducing risk-producing conditions. A current priority of NIOSH is the application of effective control approaches to current and emerging workplace problems. In this report, three case studies are described using intervention efforts to control ergonomic hazards found in the meatpacking industry. The cases accent a participatory approach involving front-line workers, supervisors and others to identify and control ergonomic hazards in three different meatpacking plants. Team-building processes and functional activities are illustrated as are the lessons learned from these experiences. This is a forerunner of other NIOSH projects focussed on problem-solving strategies to complement its problem-defining research on workplace safety and health issues.



Linda Rosenstock, M.D., M.P.H.
Director, NIOSH

ACKNOWLEDGMENTS

In addition to the authors of the original case reports and the workers and managers of the meatpacking plants with whom they worked, the editors wish to thank the following persons for their advice, insight, and assistance in developing this project and this document.

Brad Joseph of Ford Motor Company, Bill Hopkins of Auburn University, Ray Donnelly of OSHA, and Mike Colligan, Dan Habes, and Marie Sweeney of NIOSH provided the Peer Review of the original project plan that resulted in the granting of three cooperative agreements to conduct the demonstration studies. Deborah Berkowitz of the United Food and Commercial Workers Union and Deborah Atwood of the American Meat Institute were helpful in the early planning stage by conveying the perspectives and concerns of their respective constituencies.

We also wish to thank Vern Anderson, Phil Bierbaum, Tom Bobick, Mike Colligan, Jim Gideon, Kathy Grant, Dan Habes, Janet Johnston, Jay Jones, Jim McGlothlin, Jack Parker, Marie Sweeney, and Joann Wess, our fellow members of the NIOSH team formed to carry out this project.

Finally, thanks are extended to Patricia Morris of Pat Morris and Associates for her assistance in editing the penultimate draft of this document.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Ergonomic hazards in meatpacking jobs have been well documented. A participatory approach, using "ergonomic teams," has been suggested as an effective way to identify and solve ergonomic problems and reduce musculoskeletal injuries. Ergonomic teams involve personnel from various plant departments working together to identify and improve ergonomic problem areas. This project sought to examine the utility of participatory approaches to solve ergonomic problems through three demonstration studies at meatpacking plants. This document summarizes the findings of this project with introductory material, including a review of worker participation literature, case reports from these demonstrations, and a discussion of the lessons learned.

The literature review yields a set of pointers bearing on the success of using worker participation techniques. These pointers serve as reference markers to discuss the team-building processes and aspects of team performance observed in the three case studies.

The three case reports describe the observations and experiences of three different investigative groups. Each group collaborated with a different meatpacking plant and provided guidance in team building and ergonomic problem-solving processes, and applied various measures to characterize the effectiveness of such efforts.

Both similarities and differences are noted among the reports with regard to factors judged to be of consequence to worker participation and team problem-solving efforts such as management commitment, extent of training in both team building and ergonomic skills, representations on the team and/or higher level groups, information sharing, orderliness of team actions, motivational incentives, and techniques for evaluating results. Among the major lessons learned from the case studies or simply reaffirmed based upon the literature are:

- Sustained participatory efforts in ergonomics problem solving will require strong in-house direction and support plus significant staff expertise in both team building and ergonomics.

- Training in both team building and ergonomics can create the in-house knowledge and team activities reflecting an orderly approach to problem solving, and lays a strong foundation for a program.
- Team size should be kept minimal, but should include production workers engaged in the jobs to be studied, area supervisors, and maintenance and engineering staff who can effect proposed job improvements. Higher level management or labor representatives may also facilitate decision-making but their presence on teams may intimidate front-line workers and limit their input. These people may best serve on second level groups, providing oversight to the team activities and approvals of actions as may be needed.
- Effective team problem solving requires member access to, and sharing of, information bearing on the issues under study. In addition, reports on the team's objectives, progress, and accomplishments need to be circulated to the plant workforce to keep all parties informed about the program. Goals for the program need to be realistic and take account of the fact that solutions to some problems may not be immediately forthcoming. Opportunities to address and solve simpler problems can build confidence in newly formed teams and provide positive motivations about undertaking the tasks involved.
- Means for evaluating team efforts and results need to be written into the overall plan for a participatory ergonomic program. Varied techniques exist for measuring aspects of team building and team function, the perceived level of effectiveness, and performance in both subjective and objective terms. Such data will enable the teams to appraise their progress, provide feedback to affected or interested parties, and make suitable corrections where necessary to improve the overall effort.

TABLE OF CONTENTS

Abstract	iii
Foreword	v
Acknowledgments	vi
Executive Summary	vii
Table of Contents	xi
Background	
Introduction	3
Worker Participation	
Approaches and Issues	9
Case Studies	47
Case Study #1	51
Case Study #2	93
Case Study #3	163
Lessons Learned	187
Bibliography	205

BACKGROUND

INTRODUCTION

**Prepared by: Daniel J. Habes, M.S.E, C.P.E.
Division of Behavioral and Biological Sciences
National Institute for Occupational Safety and Health
Cincinnati, Ohio**

INTRODUCTION

The slaughtering, processing, and packaging of meat has long been an industry associated with a high incidence of accidents, injuries, and illnesses. Loss of limbs and lives to the meat ax was first brought to the public's attention by Upton Sinclair in his influential book, *The Jungle* (1906). Indeed, when the Occupational Safety and Health Act (OSH Act) of 1970 became law, the meat and meat products industry was designated by the agency as one of the five Standard Industrial Classifications (SICs) to receive priority attention as part of OSHA's efforts to target those industries having the highest rates of occupational injuries (U.S. Department of Labor, 1972).

Until recently, meatpacking jobs were performed with many of the same work processes, equipment, and tools that were common at the turn of the century. However, in the early 1980s, meatpacking was one of several industries that experienced recession, followed by a period of restructuring, technological transformation, and reduced demand for industrial workers (Novek et al., 1990). To compete globally, many companies increased production rates and decreased wages. Machine pacing was introduced and more electric and pneumatic-powered hand tools were added. Jobs were fragmented into a series of stereotyped, repetitive motions so they could be performed by lesser-skilled workers. According to the U.S. Department of Labor, 1963 meatpacking wages were about 110 percent of the national average for manufacturing jobs; by 1990, meatpacking wages were about 71 percent of the national average for manufacturing (Bureau of Labor Statistics). Increased efforts to restore profitability in this industry took precedence over other matters including concern for workplace safety and medical management of injured workers. All of these factors combined to increase injuries, illnesses, and worker turnover. Not surprisingly, this also resulted in a deterioration in labor-management relations.

As noted above, meatpacking has always been known as a hazardous occupation. The widespread use of knives, hooks, and circular saws in very cold or very hot environments on slippery, wet floors presents a high risk of slips, cuts and lacerations to workers. These injuries still occur, but the rapid changes in the meatpacking industry have given rise to a fairly new classification of occupational injuries, the so-called “repetitive strain injuries” or the more commonly used term, “cumulative trauma disorders” (CTDs). These chronic, overuse injuries such as tendinitis, tenosynovitis, and carpal tunnel syndrome, which affect the soft tissues and nerves of the upper extremity, are actually *illnesses*, and are recorded as such on OSHA 200 logs. In the late 1980s, the meatpacking industry’s incidence of disorders due to “repeated trauma” was approximately 75 times that of industry as a whole (Sheridan, 1991).

These incidence rates, coupled with a series of record-keeping violations found by OSHA at some meatpacking plants, prefaced unprecedented fines being levied by OSHA on two prominent companies in the meatpacking industry in 1987 and 1988. Both of these companies signed “Settlement Agreements” with OSHA which reduced the fines but, more importantly, the companies agreed to enter into long-term programs aimed at solving their CTD problems by using an “ergonomics” approach. Ergonomics is a multidisciplinary concept rooted in the design of jobs, tools, and work stations to fit the capabilities and limitations of workers. The main elements of these agreements were:

(a) worksite analysis to identify existing hazards or conditions where hazards may develop;

(b) hazard prevention and control to eliminate job hazards through work station and tool redesign, work practice controls, use of personal protective equipment, and implementation of administrative controls;

(c) medical management to eliminate or reduce CTD incidence and severity through early identification and treatment of CTDs; and

(d) training and education to enable employees to actively participate in the prevention of CTDs.

Later, in 1990, OSHA published its *Ergonomics Program Management Guidelines for Meatpacking Plants*, which described these elements in detail, offering them as an approach to problem solving that should be adopted by all meatpacking plants. The document asserted that the keys to success with this approach were top management commitment and worker involvement.

A unique feature of one of the aforementioned settlement agreements was the provision that a grant be made to the National Institute for Occupational Safety and Health (NIOSH) to study repetitive motion illnesses. NIOSH determined that the appropriate use of these funds would be to develop a project demonstrating the processes of forming and using ergonomic teams comprised of front-line workers and supervisors to effect job changes for reducing the risk of CTDs in meatpacking work. This concept, known as the “participatory approach” was inspired in part by the recommendations in OSHA’s *Ergonomics Program Management Guidelines for Meatpacking Plants*, and also by the success of this approach in other hazard control programs.

What follows in this report is an analysis of worker participation roles and issues in using a team approach in problem solving, case studies of how participatory ergonomic interventions were applied in three meatpacking plants, and a discussion of the lessons learned from the experiences.

REFERENCES

- Bureau of Labor Statistics. *Industry Wage Survey and Employment and Earnings*. U.S. Department of Labor
- Novek J, Yassi A, Spiegel J (1990). "Mechanization, the labor process and injury risks in the Canadian meatpacking industry." *Int J Health Services*, Vol. 33, No. 2. pp. 281-296.
- Occupational Safety and Health Administration (1990). *Ergonomics program management guidelines for meatpacking plants*. U.S. Department of Labor, OSHA 3123
- Sheridan PJ (May 1991). "Meatpackers move to cut injury rates." *Occupational Hazards*, pp. 81-85
- Sinclair U (1906). *The Jungle*. New York: Doubleday
- U.S. Department of Labor (May 1972). *Report on occupational safety and health by the U.S. Department of Labor*, pp. 47+

WORKER PARTICIPATION APPROACHES AND ISSUES

**Prepared by: Alexander Cohen, Ph.D.
Consultant
Cincinnati, Ohio**

WORKER PARTICIPATION APPROACHES AND ISSUES

This report has a two-fold objective. One is to elaborate on the processes involved in using a team technique or a participatory approach to define ergonomic hazards in meatpacking jobs, and the second is to evaluate this approach in terms of its merits for proposing effective control measures. Recognizing the dual nature of this effort, this section summarizes the literature on participative approaches in addressing workplace problems, with mention made of their application to workplace safety and health issues in general and ergonomic problems in particular. This material sets the stage for the three case studies described later in this document which are intended to offer new data and insights into these types of interventions.

DEFINITION OF “PARTICIPATORY APPROACH”

The term “participatory approach,” as used in the work setting, has a number of meanings. In this report, its essential meaning is worker involvement. Hence, references to teams, groups, and committees formed to deal with work-related issues (ergonomic hazards in this instance) are assumed to include front-line employees or their representatives. Other members of such bodies may be supervisory-managerial persons, staff from other departments whose duties pertain to matters at issue and outside consultants. Lawler III (1991) characterizes employee participation as the movement of decision-making, information sharing, and rewards from management to lower levels of an organization. References to these and other elements will be apparent in describing the different forms and levels of worker participation below.

RATIONALE FOR WORKER PARTICIPATION

A review of the industrial psychology, organizational behavior, and management literature makes clear the benefits that can accrue from worker involvement in organizational issues, along with some important qualifiers (Lawler III, 1991; Cascio, 1991, Schermerhorn, et al., 1985). In summary, the results indicate:

Enhanced Worker Motivation/Job Satisfaction

An employee's work motivation and job satisfaction are not only increased by added pay but by the opportunities to input into decisions affecting their work methods, everyday job routines, and performance goals. Having control over one's own work is especially satisfying and enhances commitment and quality effort. Positive results, though, are conditioned by a number of factors including:

- The perception that an important work performance matter is at issue, not some trivial concern (e.g., the color of the hallways);
- That the work is interesting and challenging. Worker participation to address a repetitive, simplistic, standard task in and of itself would not be a good candidate unless the concern was to consider job redesign or other changes; and
- The educational level and knowledge of the workforce indicates capabilities for offering meaningful input. Today's workforce, who are better educated than their forebears, have greater expectations about job roles and the relationship to self-esteem through their work accomplishments.

Added Problem-Solving Capabilities

Employee involvement in decisions affecting their work situations can capitalize on their unique and relevant experience.

Indeed, the person doing the job often has the best knowledge of the problem elements and insights into ways to improve the work. Effectiveness can depend upon whether the individuals have the problem-solving skills needed to identify valid solutions and the ability to argue effectively for their adoption. Another factor is whether the issue is a local one in which the group has been empowered to make decisions and take actions or is one having broader implications which require higher level review and approval. If the latter is the case, undue delay or a lack of responsiveness to recommendations can create cynical attitudes about the participative process.

Greater Acceptance of Change

Evidence shows that participation in decision-making regarding a major organizational change can lead to significant reduction in resistance to that change. Creating better understanding of the needs for change through improved communications, and enlisting those affected to help structure the change can do much to gain their commitment to a successful implementation. Lacking these efforts, change can be perceived as threatening job security or having other negative consequences which may be unfounded.

Greater Knowledge of Work/Organization

Taking part in problem-solving of workplace conditions, and decision-making in work design with those in one's own work group and/or with others from different units or areas will invariably increase the employee's knowledge of his or her own job and how it relates to the overall company operation. An important payoff from such interaction can be improved communications and coordination among the members and their respective departments. However, employee training in communication skills may be required for this to occur.

FORMS/LEVELS OF PARTICIPATION¹

Employee participation in work organizations can take a variety of forms. Among the shaping factors are: the nature of the issues requiring consideration; whether the matters are broad-based or specific to a local operation or group; whether the needs for response or action are time limited or necessitate continuing efforts; the abilities of the group most affected; and the organization's prevailing practices for joint labor-management or participative approaches in resolving workplace issues. The degree or level of involvement may also vary. At one extreme may be simple consultations with individual workers or groups to obtain their reactions to ideas from superiors who will make the final decision. At the other may be obtaining worker ideas along with those from management and other affected parties in addressing issues with decisions based on consensus. The fact-finding report from the Commission on the Future of Worker-Management Relations (1994) outlines the variety and scope of employee participation and labor-management cooperation in U.S. workplaces. In this section, common forms of worker participation found in industry are described as are different levels of sharing in decision-making and other factors reflecting the degree of actual worker involvement.

Quality Circles

Quality circles are generally defined as small groups of worker volunteers from the same work area who, with their supervisor, agree to meet regularly to identify, analyze and solve quality and related problems in their areas of responsibility (Lawler III, 1991; Kringsman

¹ The legality of management forming certain groups with employee participants to address productivity, quality, and safety matters has been questioned. The National Labor Relations Act forbids such actions fearing domination of such groups by management. In response, some employers have gone to self-directed work teams, while others are keeping the existing forms but including volunteer employees as members who represent themselves in such groups. The issue may be resolved through court tests or legislation. See LaBar (1993) and the Commission on the Future of Worker-Management Relations (1994) for further details on this subject.

& O'Brien, 1987). They usually consist of eight to ten members who meet once a week during work hours. The volunteers typically receive training in some form of problem-solving techniques as part of this activity.

Use of quality circles is attributed to W. Edwards Deming's introduction of data-based quality control techniques in Japan to rebuild their industry after World War II (Krigsman & O'Brien, 1987). Although originally intended as a program for troubleshooting by engineers, the movement quickly evolved to include line workers in accord with Deming's view that quality must concern every employee rather than be limited to the engineers or the quality control department. The success of Japanese industry in capturing large market shares for their products in the early seventies led American businesses to emulate their techniques. In 1986 it was reported that more than 40% of U.S. companies employing more than 500 workers were using some form of quality circles (Marks, 1986).

As Krigsman & O'Brien (1987) note, quality circles in Japan were focused on performance data and quality control issues. Worker involvement was based on the underlying idea that workers ought to be responsible for the quality of their work and are in the best position to trouble-shoot it. In the U.S., quality circles became more of a participatory management technique intended not only to yield increased productivity and product quality but also enhance employee motivation and job satisfaction. While experiences in the U.S. tended to support these various outcomes, the results were not always up to expectations (Miller & Monge, 1986). For example, Griffin (1988), in his study of U.S. electronic plants, found quality circles to produce initial improvements in job satisfaction, organizational commitment, and performance measures but over time and in the absence of other supportive measures to revert back to original levels. When asked about this end result, quality circle members in this study felt that management was no longer interested in their recommendations. Their supervisors asked fewer questions as to how the group was

functioning and displayed less enthusiasm about evaluating the suggestions which were made. Without continued management support for this program, the early improvements could not be sustained. On this point, Lawler III (1991) and Griffin (1988) view quality circles as a building block to other forms of worker participation which ultimately could create a more participative culture in an organization. Cascio (1991) notes, too, that worker participation programs can die out eventually if the organization does not change in a manner consistent with the democratic values which characterize such practices.

Safety circles represent a variation on the quality circle form of worker involvement, the difference being that the thrust of the group effort is directed to identifying, analyzing and solving safety and related health risk problems in their work area (Cohen, 1983; Edwards, 1983). The National Safety Council (1993) describes a step-by-step approach to establishing safety circles. Needs for management support and resources for implementing recommendations, decision-making authority to be invested in the group, and training of members in safety subjects and interpersonal relationships are duly noted.

Labor-Management Committees

While quality circles are small in size, composed of volunteers from a single work area who are brought together to address problems specific to their job tasks, labor-management committees are more expansive, including elected or appointed members from different areas within an organization, and are charged with a broader agenda. Also, unlike quality circles whose members can actually implement solutions, most labor-management committees only recommend actions which are then forwarded to other parties for concurrence or coordination in determining how and when approved actions can be effected.

Joint labor-management committees offer opportunities to identify areas of mutual concern and to engage in cooperative activities that can reduce the level of traditional adversarial behavior

between the two parties (Office of Technology Assessment, 1985; Lawler III, 1991). Two areas, quality of working life (QWL) and occupational safety and health, have been the focus of much joint committee activity. QWL committees seek ways to improve working conditions to enhance worker job satisfaction and morale with the goal of increasing company productivity. QWL efforts can, for example, encompass recommendations for making a more pleasant physical environment, furnishing educational opportunities during off-job hours, and providing facilities for recreation. In some instances, collective bargaining agreements struck between unions and management have enabled QWL committees to also address certain aspects of job classification and work schedule issues. The reader is referred to Lawler III (1991) for more details and examples of QWL committee work.

Joint labor-management safety and health committees offer opportunities for cooperative problem solving with regard to hazard recognition and control concerns as well as recommending preventive measures (Office of Technology Assessment, 1985). The effectiveness of these groups is the topic of a later discussion.

The membership of joint labor-management QWL and safety and health committees includes representatives from the affected groups. Worker participation may be through elected workers or local union leaders, with management represented by department heads or other key figures. The success of such groups in effecting actions depends upon their own decision-making authority or links to others who have that role. As already noted, the committees make recommendations whose implementation may take the form of establishing task forces or work teams to formulate and carry out specific plans. A byproduct of the committee deliberations and the follow-up actions by these groups is that information is shared widely in the organization, and more channels are opened for communications. As a result, more employees can understand the business better and participate more effectively in problem-solving activities.

Work Teams

Work teams are referred to in the literature as “self-regulating” work groups in that they can make decisions about inventory management, setting production goals, and selecting work methods and quality control procedures (Lawler III, 1991). In some cases, such groups may even determine pay rates and hiring/firing policies. Management maintains oversight of the group’s practices and operations and has the right to challenge any decision that is made. Work teams include all of the employees working in a given area who, with a chosen lead worker or supervisor, are given responsibility for producing a whole product or offering a complete service. Because of their broadened roles, work team members are cross-trained so each can do the various tasks that fall within the domain of the team. Frequently workers rotate their work assignments. Besides the extensive training that may be needed to perform these multiple job functions, work team members also require instruction in interpersonal skills. As explained, these skills are necessary to assure positive, effective interactions among the group members. Indeed, their varied responsibilities demand that work teams meet often to discuss and agree on numerous matters. Experiences with work teams in mining and various product manufacturing companies have demonstrated gains in rate and quality of output, reduced turnover and improvements in overall work efficiency (summarized in Peters, 1989; Lawler III, 1991). There are cases, too, where work teams once established in these establishments did not survive. This appears to be most evident in companies having a more traditional management approach.

Gain-Sharing

Gain-sharing acknowledges worker participation in efforts to improve company economic performance through increasing the sales value of production relative to labor costs (Cascio, 1991). In one such plan, a ratio of the two factors is set based upon past experience which, if exceeded, will result in cost savings to be shared by the employees and management in accordance with some agreed-upon formula. Another plan sets a production/

performance standard which, if met in fewer than the expected work hours, yields the savings for distribution. The participative structure in each instance uses a formal suggestion system inviting worker submissions of ideas to improve work efficiency. Department production and screening committees made up of worker and management representatives review these inputs and select those for implementation. Company experiences with gain-sharing and other incentive plans as reported in the literature show roughly a 20% increase in productivity but at the same time much variability in these results (Guzzo, et al. (1985). In some cases the plans yielded a 75% increase in output and in others a 5% decrease. Success seems to depend upon many factors, such as whether the market can absorb the increased production, the extent to which product costs are controllable by employees, top management commitment and supervisor support of the plan, and the company's openness in sharing financial results and giving other evidence of management's trust in employees.

Levels of Participation

Worker participation can also be viewed along a number of different dimensions. Liker, Nagamachi & Lifshitz (1989), for example, offer models reflecting variations in two dimensions. One is the locus of decision-making, whether made at the management level with consultations sought from affected individuals or groups, or delegated downward with little management involvement. The second dimension is the manner of employee input into such processes; whether each person in an affected group has direct involvement or whether they are represented by others. Quality circles and work teams as described above would appear to fit the model where all workers are involved and have authority to make and carry out decisions. In contrast, joint labor-management committees would be categorized as representative in makeup with authority limited to making recommendations, not actual decisions. By itself, the formal suggestion system inherent in gain-sharing would offer opportunity for direct input but no decision-making power, this being assumed by other committees or retained by management.

As noted by Liker, Nagamachi and Lifshitz (1989), Lawler III (1986) and others, success from worker participation efforts in solving workplace problems, and enhancing productivity, worker motivation and satisfaction is not dependent on any one form of involvement but on what is best suited to the issues to be addressed and the situational factors that are present. Also, certain forms may evolve into others as conditions change which may be important to sustain or further the positive effects seen in such practices.

WORKER PARTICIPATION APPROACHES IN ADDRESSING WORKPLACE HAZARD CONTROL — ISSUES AND KEY FACTORS

Evidence indicating the effectiveness of worker involvement in efforts to reduce work-related risks of injury and disease is reviewed here. Such participation has taken different forms akin to those previously mentioned. Reports documenting the importance of these approaches in cause-effect terms, as well as defining factors of major consequence to successful outcomes, are not numerous. Indeed, field studies in this area do not allow for easy isolation of these variables and their manipulation or comparisons with adequate control or non-treatment conditions. Due caution is thus advised in either interpreting or generalizing results. In this section, worker involvement in general injury and disease control problems is first described, followed by efforts directed to controlling ergonomic hazards. The literature reviewed in these cases is admittedly selective. Its purpose is to illustrate worker participation approaches as applied to these kinds of concerns, highlighting certain aspects of their implementation, and resultant findings.

Joint Labor-Management Safety and Health Committees

The most common institutionalized form of worker participation in workplace safety and health matters is through membership on joint labor-management committees set up for that purpose (Office of Technology Assessment, 1985). Collective bargaining agreements between unions and management, especially after the

passage of the Occupational Safety and Health Act of 1970, contained provisions for the establishment of these committees. The Bureau of National Affairs reported that in 1970, 31% of industrial contracts covering 1,000 or more workers had such provisions. This rose to 39% in 1975, and 45% in 1983. Boden, et al. (1984), in a survey of manufacturing companies having 500 or more employees in one state (Massachusetts), found 67% of the unionized establishments to have a joint labor-management committee addressing safety/health issues and 49% of non-union workplaces to have similar groups with employee-management representations. A 1993 national poll by the National Safety Council found 66% of the respondent companies to have joint committees. The survey acknowledged sampling and other limitations which led the authors to feel that this figure may be higher than the national average.

The more cogent question, however, is whether the existence of these committees has had a positive impact on worker safety and health. The literature suggests mixed findings. For example, Cooke and Gautschi (1981) used data from the state of Maine for compensable injuries and OSHA citations in 113 manufacturing firms during the period 1970-1976. Controlling for the size of the production workforce, business cycle effects, and OSHA citation experience, they found the presence of joint labor-management safety and health committees was associated with a small and non-statistically significant decrease in lost time injuries over the period in question. Similarly, Boden, et al. (1984), found virtually no effect in studying whether the existence of a joint safety and health committee was correlated with either the number of OSHA complaints or serious hazards as measured by citations for 127 Massachusetts manufacturing firms. More detailed study of a sub-sample of companies with these committees, however, showed these outcome measures to co-vary in inverse fashion with the number of the powers of the committee to act, its opportunities to access and review different types of data (hazard/injury/medical reports), and perceptions of a strong management commitment to worker health and safety. The authors concluded that maintaining a joint health and safety committee as a formality yields little results on company

safety and health experience, that its impact is a function of activity level and a company environment truly supportive of its efforts.

Reinforcing this point, California, in 1984 (Bureau of National Affairs, 1984), reported the benefits of organizing joint labor-management committees to conduct self-inspections of safety and health conditions at major construction sites in the state as part of a voluntary compliance program. For work at three sites which employed 200 to 2,600 workers, the injury and illness incidence rate dropped far below those averaged for the construction industry as a whole or the individual employer's rate at other similar projects. At one site, the decrease was from 7.4 cases per 100 full-time workers per year at program start-up to 4.2 cases afterwards. Project managers attributed the improved safety performance to increased awareness of hazards by employers and employees, better communications between the parties, and a belief by the workers that they can influence safety on the job.

Joint labor-management committees by themselves do not appear to be a major determinant in studies contrasting program practices in companies that have exemplary safety and health records with poorer performing cohorts. While perhaps facilitating worker participation, other direct means for promoting worker inputs into the program seem to be more influential than a formal committee. For reasons stated above by Boden, et al. (1984), committees can vary greatly in their activities and roles which can affect workplace safety and health. Most studies comparing program factors in companies with good versus poor safety performance lack for details as to whether there are functional differences between the committees found in the contrasting samples, nor of their relationship to other participative efforts which may be of consequence. A commonly expressed view about safety and health committees is that without them, workers would have little means for involvement in any safety and health activities (National Safety Council, 1993).

Joint labor-management health and safety committees have also been formed nationally to support continuing education of their

respective members and to sponsor research work to address pressing health and safety problems of mutual benefit.

Work Teams for Hazard Control

Case studies and other reports in the popular and technical literature illustrate how work teams and safety circles or equivalent groups, each of small size and composed of worker members engaged in similar jobs and from the same area, have made positive contributions to hazard control efforts (Edwards, 1983; Saarela, 1990; Lanier, Jr. 1992; Lewis, Imada, & Robertson, 1988). Typical is a report by Edwards (1983) who studied the impact of a quality circle (QC) technique on safety issues in a large surface mine. Set-up elements included: forming a screening committee of department heads and a QC-trained facilitator to set ground rules for the plan; composing QCs of 5-8 persons from worker volunteers in four selected departments; and giving QC members plus mine safety committee members eight hours of training on subjects such as brainstorming, data collection, and group dynamics. Subsequent one-hour weekly meetings were held where the QCs focused on problems that would be expected at most mines, i.e., tool shortages, poor communications, unavailability of parts/supplies, lack of support equipment, inadequate housekeeping, etc. The circle members chose a problem they wanted to solve, collected data for delineating its nature, and then offered possible solutions, taking into account cost-effectiveness considerations. A number of recommendations were implemented which had significant effects on both productivity and safety. For departments with circles, the accident frequencies decreased by 18% in before/after comparisons over six-month periods.

Some difficulties in organizing or maintaining work team efforts directed to hazard control have also been noted. For example, a county engineering department reported marked improvement in the safety performance of work crews in one section after adopting a quality circle approach to elicit worker inputs into ways for making their operations safer (Lanier, Jr., 1992). Injury frequency dropped by 52% and their associated costs by 92% after the plan

was instituted for these work crews, who previously had the worst safety record in the department. However, expanding this program to another division within the engineering department proved problematic for a number of reasons. The job routines of these workers did not require a natural team effort, and workers enjoyed their independence in fulfilling their specific responsibilities. As a consequence, the team problem-solving effort was viewed more as a “gimmick” of management. The program was nevertheless implemented, after which team members began blaming each other and management for failure to achieve any positive results. As a remedy, and at the suggestion of the workers and their supervisors, the teams were redrawn to take into account mutual needs for working relationships and compatibility among the partners. This worker input into the program helped reduce the earlier resistance. An 18% drop in injuries was noted after the revamped teams were formed, though costs remained unchanged.

Peters (1989), in reviewing research on organizational and behavioral factors associated with mine safety, mentions a study assessing the benefits of a self-regulated work team as introduced in a Pennsylvania coal mine on an experimental basis. The miners received additional training to make each one capable of performing any job in their section and familiarize each with mine safety laws and violations. Periodic meetings and feedback were used to motivate worker interest in safety. The autonomous nature of the group made each miner responsible for maintaining safe working conditions. Supervisors had responsibility and authority for the safety of their work crews with lesser concerns for production. This mine section showed fewer violations and shutdowns than others in the same mine. The work crews also put into place more safe work practices and were more proactive toward safety than they were before the intervention. Despite these positive findings, however, efforts to expand the program to other mine sections were voted down by the union. One reason for the rejection was the perception that the special treatment given to the experimental group created an elitist attitude among their members which was resented by the miners in the other sections. This effect was unintended but efforts to

overcome the negative fallout were not taken to correct the situation. Peters notes that the intervention efforts in the mine disappeared four years after they were first initiated.

Direct Worker Inputs in Hazard Control

Reports where direct worker inputs have been formally solicited into hazard control programs, as contrasted with using a team or committee approach, are not common. One case study of this type, conducted by Lin and Cohen (1983), is important in showing both the merits of worker involvement for this purpose as well as some limitations. The site was a 500-bed hospital with 1,800 full- and part-time employees where a worker hazard detection program was put into place on a trial basis. Employees were first surveyed to determine their current level of awareness of workplace hazards and the means to control these hazards. This was followed by a campaign to motivate employee reports of hazards by placing forms at convenient places, requiring a prompt follow-up response by safety staff to all such submissions, and highlighting actions taken through newsletters and posters.

Comparisons were made of the hazard reporting rates of employees, the number of recorded staff injuries or illnesses, and the content of the hazardous conditions reported by the employees as related to their recorded injuries and illnesses during a 12-month period before and after the start of this worker-based reporting system. Results showed the frequency of hazard reporting to increase during the intervention period and the frequency of actual injuries and illness to decline during the last six months of this trial after most of the hazard control recommendations had been implemented. This finding suggested an increased safety consciousness among the workers and a consequent reduction in the number of job mishaps. In analyzing the content of injury/illness records with the hazard recognition reports, there were instances of hazard reports far exceeding the recorded cases of related injuries which, in turn, became a basis for prioritizing control needs. Indeed, in several instances during the trial period, accident risk factors identified in worker reports were not acted upon soon enough to prevent injuries from occurring.

On the other hand, there were also instances where some hazards resulting in a high percentage of injury cases went undetected by the workers. Needle puncture wounds and physical exertion/back injury from patient lifting were particularly notable. Because these mishaps are inherent in job routines and procedural in nature, their risks appeared less obvious to the workers than those posed by fixed, physical features in their work environment. This indicated the need for employee training in recognizing functional kinds of hazards to improve their overall hazard recognition skills. The latter was one of the basic recommendations agreed to by management who, being satisfied with the overall findings of the trial, decided to adopt this worker participation effort as a permanent hospital program.

Worker Participation in Ergonomics Problem-Solving
Ergonomics addresses the interaction of job demands and worker capabilities, the aim being to design the work requirements and/or workplace conditions in ways that will optimize productivity and, at the same time, preserve the health and safety of the workforce. While the subject is much broader in scope (Cohen & Dukes-Dobos, 1985), the rising incidence of musculoskeletal disorders of the upper extremities and the unabated numbers of costly low-back problems in U.S. industry have focused ergonomic concerns on these two types of problems. Much is already known about occupational risk factors for these kinds of disorders—forceful exertions, awkward body postures, local contact stresses, and repetitive motions being the major ones (Keyserling, et al., 1991). Some efforts at controlling these hazards through redesigning tools, improved workstation layouts, and the use of less fatiguing work organization methods have been reported, and guidelines have been publicized (Ulin, et al., 1992; Waters, et al., 1993, Grandjean, 1987). Examples illustrating worker involvement in such activities and aspects of their participation are described below.

The automobile and auto parts industries have been the primary sites for participatory ergonomics programs in the U.S. as well as in other countries. Indeed, the tradition of assembly line work with numerous workers engaged in short-cycle tasks requiring

repetitive turning/twisting actions with tools and/or frequent lifting or other forms of manual materials handling, make it a natural candidate for ergonomic study and problem-solving. Reports in the popular literature cite a number of cases where worker participation has been instrumental in successful outcomes. LaBar (1989), for example, describes how the introduction of quality circles in a U.S. tire manufacturing plant, after a takeover by a Japanese corporation, turned around sagging production levels and an increasing injury incidence rate. The quality circles, referred to as Employee Involvement Groups (EIGs), were set up in different departments and run in accordance with Japanese practices, with a steering committee overseeing their activities. While addressing a variety of safety, production and quality control topics, a sampling of improvements made or recommended by these groups indicated a focus on ergonomic problems and solutions. One was to replace an 18-stitches per tire procedure with one requiring just two stitches, thus reducing problems of repetitive motions believed responsible for the excessive number of carpal tunnel syndrome and tendinitis cases found in workers engaged in this task. Another improvement was installing hydraulic systems to lift and turn 115-pound tires for inspection instead of having workers lift them, and using similar powered systems to lift heavy sheets of rubber. The apparent benefits were reductions in the incidence and severity of back injuries. Overall, these and other types of hazard control measures in the plant caused a five-fold reduction in the incidence rate of worker injury over a four-year period after the introduction of the employee involvement groups. Inquiries with senior level management and union members who remained with the company after the takeover credit these and other positive changes to listening to workers' suggestions and getting workers more involved in company activities. Quality circle concepts were instrumental in accomplishing these purposes.

LaBar's (1990, 1992) descriptions of ergonomics efforts in two other automobile assembly plants emphasize the need to train the workforce at all levels to recognize relevant risk factors and early symptoms, the importance of engineering controls, and the role of employees in identifying problem areas and developing solutions.

Regarding the latter, mention is made of over 200 suggestions for ergonomic improvements received from employees during one year at one plant, many of which were implemented. However, the reports are not clear in defining whether there were recognized formal groups where workers interacted with others in providing this input or whether it was done strictly on an individual basis. References to teams, committees, and task forces acknowledge persons from the medical, safety, and engineering departments who appeared to spearhead the hazard control program, with workers advised to report problems to them. Nevertheless, successes are noted. One plant (LaBar, 1992) reported a 50% drop in the number of ergonomic-related injuries one year after the training program, and a 27% reduction in the second (LaBar, 1990).

Unlike the above articles which offer popularized accounts of worker participation efforts in ergonomics activities within the auto industry, Liker, Joseph and Ulin (1991) provide a detailed, critical analysis of such experiences in two auto plants, one engaged in stamping auto parts, the other machining and assembling chassis. The programs, as described, grew out of collaborations between the nation's largest automobile manufacturers and the auto workers' union to study ergonomics issues in their work operations. For this purpose, it was agreed to engage outside parties to offer needed training and consultations. University faculty and staff with specialties in this area played a large role in facilitating the development of programs within the two plants.

The study was undertaken to determine if a participatory ergonomics approach could yield benefits in reducing work-related injuries, given downsizing and the need for the workforce to quickly adapt to new and different production technologies. At the time of the study, both plants were under a threat of closing as a cost saving measure and apparently were only kept open by management and labor efforts to come up with innovative plans which kept them competitive. The two plants were each subdivided into two major areas, with separate ergonomic groups to address their respective problems, propose solutions, and implement

them. An advisory committee was also established at each plant to provide direction for the overall effort and to monitor progress. Three stages of ergonomic program development are described at each plant: laying the groundwork (Stage 1); program development (Stage 2); and maintenance (Stage 3). The authors describe how differences in leadership styles, the makeup and motivation of the advisory committee and the ergonomics group, their training in and use of job analytical methods, and their experience in group decision-making, affected the processes in each of these stages and the resultant outcomes of the program. For example, leaders who were trained in ergonomics but poor at facilitating group processes did little to engage the rest of their group members and thus lost their contributions. Others committed to ergonomics and participative management practices were most effective, based on the satisfaction ratings of members attending meetings and observer ratings of ergonomic project reports and accomplishments at each meeting. Having connections to secure or lobby for outside resources was considered an additional leader asset in that implementation of some of the approved changes required support from other plant departments. In another example, managers and engineer members of ergonomics groups who used their formal authority to assert their views in meetings were found to stifle the inputs of production level members who took a more backseat role. Attendance at regular meetings ultimately dropped off despite efforts to break this pattern of domination. While the few who remained active made recommendations which improved operations, their outputs paled in comparison to the number of workstation improvements made by other groups whose efforts took account of the ideas and views of all group members. In still another example, the ergonomics group which achieved the most active involvement of its members showed more deliberateness in undertaking job analyses and in reaching a consensus on a problem-solving strategy than those groups where the level of participation was less apparent. Though the former group's effort took more time, it yielded more in-depth changes per work station and a greater number actually implemented than that resulting from the latter groups' efforts. Further mention of the Liker,

Joseph & Ulin (1991) report will be noted in a later section dealing with key factors in worker participation efforts to effect ergonomic improvements.

Aside from experiences in the automobile manufacturing industry, descriptions of ergonomic problem-solving activities in warehousing, textile manufacture, and shipping/mail delivery operations have appeared where worker involvement has been emphasized (Lewis, Imada & Robertson, 1988; LaBar, 1992). Of these cases, only the warehousing example will be described here since it offers the most detail and has other features deserving mention.

Embodying a company-wide program for gaining worker input into efforts aimed at enhancing product quality, operational efficiency and workplace safety, a team formed of seven storekeepers who received, stocked and then moved raw materials from the warehouse to the production assembly line noted two problems posing potential hazards. One was that employees engaged in materials movement were subject to undue numbers of injuries. Using a problem-solving process which included analyzing accident and medical reports, it was found that back injuries from lifting constituted the major hazard. Team brainstorming sessions plus use of consultants in materials handling identified major vendor contributions to the problem. Specifically, it was found that vendors routinely exceeded both package weight and size specifications in their deliveries. Some cartons weighed twice the specified load limit and others were so large that they had to be broken down to fit the tote boxes used in the materials handling systems. These factors not only increased the risk of overexertion injuries but required extra labor as well. Steps recommended by the storekeeper team to remedy this problem consisted of debiting vendors for any deliveries received which did not meet the packaging limits, and tagging cartons in violation to alert workers to take added precautions in handling. Both of these recommendations were accepted by management with estimates that back injuries could be cut by 50% and the net gain from the debit charged back to vendors for packaging violations would result in substantial cost savings for this operation.

A second potential hazard noted by forklift operators in this warehouse was that their route of travel posed a risk of pedestrian accidents, especially to other workers who were engaged in product testing and other operations in the same area. During peak times many of these workers stand in the aisles to do their jobs. Adding to the problem were the many blind alleys and intersections where approaching vehicles could not be seen by pedestrians until they were almost directly in front of them. Although there was not a single accident to cite, the forklift truck operators felt strongly that this was a problem that had to be addressed. They proceeded to log near-miss incidents which occurred at a rate of at least one per day. They set a goal of reducing near-misses by 75% and through team brainstorming sessions drew up a list of solutions which were agreed to by consensus. Relocating product test stations, installing mirrors to aid viewing around corners, and redesigning pedestrian walkways were among the remedies offered. After implementing these and other solutions, near-miss observations were repeated and found to have achieved the goal. Through the reaction of one team member, the report acknowledges the team-building experience that took place during this problem-solving effort. Indications of growth of interactive skills and increasing trust, based upon ratings by team members taken over the course of team meetings are mentioned, though no data are actually presented.

In sum, the aforementioned reports of employee involvement in solving workplace health and safety problems in general, and ergonomic hazards in particular, show the merits of such an approach. At the same time, conclusions and generalizations from these results require tempering. For example, because popular as well as scientific periodicals are more prone to publish work showing positive results, cases where worker participation efforts may have failed to produce successful outcomes go unreported. Also, most cases have not controlled for other influences that could be affecting results apart from worker participation per se. Increased management attention to worker groups, irrespective of any efforts to solicit their inputs into work conditions, can

produce positive effects on job performance (see Hawthorne studies described in Schermerhorn Jr., Hunt & Osborn, 1985). However, these and other criticisms notwithstanding, the cases speak for themselves in demonstrating worker contributions to positive hazard control accomplishments.

Indications of Factors Affecting Results

In viewing the literature on worker participation as a whole, certain elements appear common to many of the documented reports on successful application of this approach to workplace issues or problems. The more prominent of these elements, reflecting both organizational factors as well as methodology, are elaborated on below. While systematic efforts to study and assess the significance of these elements in facilitating both the process and outcomes of worker participation remain to be done, some supportive evidence of their importance is noted based upon the cases reviewed earlier as well as other references to be cited. The three case studies described in this report deal with a work team approach for involving workers. Most of the commentary will focus on this form of worker participation with special attention to ergonomic-type problems.

Commitment/Responsiveness of Top Management and Supervisors: Before beginning discussion of a worker participation program, top management's commitment to the program is necessary as is the support of supervisory personnel, union officials or other worker leaders. Expressions of commitment can take various forms. Officials serving on committees which set the overall goals for the program and monitor progress is one expression. Another is a policy which formally delegates authority downward, allowing more worker input into decisions on working conditions. Sometimes called empowerment, this is often done through participation on teams or other working groups set up for that purpose. Still another expression of commitment is their responding to recommendations from such groups in positive ways, and supplying the resources to implement acceptable

solutions. Liker, Joseph and Ulin (1991), in analyzing the ergonomic program experiences at two auto plants, note that committees serving steering or oversight functions for lower level groups should not overreach their roles. The authors describe how one committee undertook some job analyses and dictated suggestions for change which proved infeasible. Such a top-down approach nullifies the whole concept of worker participation and was perceived in that way by the workers. It was later rectified.

The support of middle level supervisors to worker participation efforts can be problematic if they see their usual responsibilities being diluted. Many quality circle efforts started in U.S. plants, though showing some initial benefits, did not last, the suspicion being that resistance of middle managers was one of the factors that led to the program demise. In the successful efforts, supervisors who remained supportive saw their roles as coaching or mentoring workers on ways to improve their job performance. They also assisted worker groups to refine their suggestions and helped in their presentations to top management committees.

Management/Worker Training: Organizational changes enabling front-line workers to have more input into decisions necessitates additional training for both management and workers. For workers, one major need is to improve their communication skills and their abilities to interact with others in group projects. As Lawler III (1991) notes, quality circles and work teams, in particular, require numerous meetings where positive interactions among the worker members and other parties can be critical to effective group action. Training in empowerment techniques now being offered in union-sponsored safety and health courses stress these and other objectives in efforts to promote change for reducing injury/disease risks (Wallerstein & Weinger, 1992).

Management at different levels may also need training in the listening and feedback skills necessary to work with groups of workers who are assuming decision-making responsibilities. Cascio (1991) notes that both groups need to learn the basic interpersonal skills necessary to build respect for each other. On the technical side, and where

emergent problems are at issue, special training for workers, management and supervisory staff may be warranted. Ergonomic hazards fall into this category and most of the reports reviewed above mentioned some form of additional instruction given to both the workers and management to facilitate efforts in defining ergonomic risk factors and ways to control them. Resources for covering assorted training needs must be considered in a worker participation program, including provisions for outside consultants if needed.

Aside from the subject of training, increasing importance is being paid to the manner of instruction in the area of occupational safety and health (Wallerstein & Weinger, 1992; Cohen & Colligan, 1993). Adult learning techniques stressing active forms of instruction through case studies and demonstrations, and targeting issues directly related to the trainees' experiences, appear to have the most merit. Special needs of some who, because of language problems or other deficiencies, have trouble comprehending material are also being met through the use of interpreters or visual aids.

Composition: As already noted, no single form of worker participation meets all needs. The approach depends on the nature of the problem to be addressed, whether it is local to a group or has wider ranging implications, the skills and abilities of those involved, and the desire of the organization for joint labor-management or participative approaches in problem-solving ventures. By their very nature, ergonomic problems, though perhaps specific to a given job or operation, typically require a response that cuts across a number of organization units. Indeed, hazard identification through job task analyses and review of injury records or symptom surveys, as well as the development and implementation of control measures, can necessitate inputs from safety/hygiene, human resource, engineering, maintenance and medical staffpersons plus ergonomics specialists. These specialists, plus workers and management representatives, are considered essential players in any meaningful program effort. In listing possible parties on an ergonomics team, Vink, et al. (1992) also includes members from purchasing units as the issues raised can have implications for procurement actions, e.g., added or revised specifications on new equipment orders.

Drawing front-line workers or their representatives for any work team approach to ergonomic problem solving from the problem areas or operations to be studied is the natural choice. For reasons already stated, their intimate knowledge of the job scene and insights into problems can be tapped for decision making and can facilitate implementation. Emphasizing the importance of this kind of input, some recommend that workers themselves prioritize all proposed solutions in making final decisions or before a final review by experts (Vink, et al., 1992). Supervisors and specialist members of a work team must be careful to not dominate discussion or allow their stature or expertise to intimidate the workers as either will limit their contribution to the group process. Consultants brought in to advise on a problem also present this risk. Rather than dictate solutions to those who know the job through everyday experience, consultants who work with the group to formulate procedures for defining and solving problems are far more likely to produce successful outcomes. These experiences then can build in-house resources for tackling future concerns. For this reason consultants should possess team building skills.

While there is no "correct" size for a work team, a range of 7 to 15 members appears optimal. Larger groups present difficulties in creating effective group interactions and cohesiveness, both considered critical to effective decision making (Lawler III, 1989). Needs for larger representations may be met by setting up parallel smaller groups, and establishing a second level steering or coordinating group to monitor the overall effort as necessary.

Information Sharing: Effective worker participation in problem solving requires having access to information. In terms of addressing hazard control issues, accident records, injury data, and cost figures for proposed control measures need to be made available to those teams expected to come up with feasible recommendations for solving such problems. Knowledge of other department functions and business matters in general may also be essential if the problem being studied and its solution have

broader implications. As already noted, ergonomic issues readily transcend the areas of immediate impact, giving even greater importance to communication and cooperation among the various organizational units and parties involved.

Even more important is that management support for establishing or maintaining work teams be made clear to the participants, and that the value of their activities be appropriately recognized and rewarded. Misinformation or misperceptions can be damaging. Management seen as opting for suggestions from work teams that cut costs or improve productivity without equal regard for those benefiting worker welfare can destroy the program. Cascio (1991) notes that for workers to be convinced that working harder and smarter will not cost them their jobs, they must be assured of job security.

Activities/Motivation: OSHA inspections, citations for violations, and work-related injury or illness statistics, can prompt organizations to take actions for hazard control. Teams or groups formed for that purpose follow a common set of steps, typically these include holding discussions to define the problem, gathering and analyzing data to sort out key elements, and developing and agreeing on recommendations for control actions and plans for implementation. According to the reports of Liker, Joseph & Ulin (1991) and Lewis Imada & Robertson (1988), actions taken by groups reflecting deliberate discussions of ideas, more orderly forms of data collection and use of analytical techniques have better chances of furnishing effective solutions to problems. But these points aside, what can drive the activity level of work teams? What motivates its members to be responsive to their tasks or objectives? The psychology literature indicates that goal setting and frequent feedback marking progress toward goal attainment are potent ways for effecting behavioral actions toward prescribed ends. Applying these ideas, a wealth of studies exist in the occupational safety and health literature showing the merits of goal setting and feedback to enhance safety performance among

worker groups who are at risk (Chhoker & Wallin, 1984; Cohen & Colligan, 1993; Sulzer-Azaroff, et al., 1990). Similarly, several of the worker participation cases described above made mention of goal setting by the work team and using evaluations to determine if and when each goal was met. It is important that the goals be realistic and reasonably attainable. Indeed, early successes can build positive motivations; the opposite can occur if first efforts are met by frustration and failure to see results. Hence, choosing simpler problems for solution at the outset and the more difficult ones later on would be preferable. Other factors are more subtle but nevertheless important. The commitment of the workers and the team leader to the belief that their efforts will make a difference can be a driver. Liker, Joseph, and Ulin (1991) note how the success of worker groups in the ergonomic study at the two auto plants was shaped by leaders who were totally committed to the process of group problem solving. Management's recognition and rewards for accomplishments of the work teams in solving problems can serve to reinforce these actions and further the teams' efforts to tackle other issues. The literature notes, too, that worker participation programs are perceived positively by those members who participate directly; those not involved do not necessarily share the same view.

Evaluation: Reference to feedback and goal attainment presumes that some measurable indicators of team performance are being applied. The ergonomic cases in the auto plants reviewed above used observer and participant ratings of team meetings in terms of satisfaction with their accomplishments, number of work situations studied for problems, and recommendations made and/or actually implemented. These represent process-type measures. Continuation of the program also represents this type of measure although not expressly mentioned in the cases noted above. Outcome indicators such as changes in frequency/severity data of work-related injury and illness before and after forming work teams for addressing

ergonomic hazards have also been used but have limitations. For one thing, in many industries, musculoskeletal disorders from ergonomic hazards remain statistically rare events and lack sufficient variability for meaningful evaluations. For another, use of these measures can necessitate an extended time frame to determine whether the intervention has had any beneficial effects. Other influential factors, apart from work team efforts, may occur in this time period which can confound observations of this type. The cases cited in the general occupational safety and health literature have used surrogate indicators for assessing interventions such as near-misses for accident potential, extent of adherence to safe work practices and/or the use of personal protective devices as evidence of reduced exposure and risk for more chronic disorders (Cohen & Colligan, 1993). In this regard, data on the actual reduction of risk factors or levels of exposure to them could serve to indicate the before/after benefits of ergonomic interventions stemming from work team efforts as well. Also, surveys indicating fewer complaints or less fatigue or discomfort among workers following changes instituted by the work team could be taken as a positive sign of ergonomic job improvement. Of course, without baseline data or control groups to rule out intervening influences, there will be questions as to whether any of the aforementioned changes are truly due to the work team's actions. It is to be stressed that judgments of the efficacy of worker participation in team approaches to ergonomic hazard control or other endeavors will require data collection on measures that are valid reflections of this type of intervention. Table 1 offers a series of pointers in framing worker participation and general team-building programs which summarize the major ideas of this section.

EMERGING POLITICAL/ECONOMIC FACTORS OF CONSEQUENCE

Both political and economic factors have given and continue to give increasing importance to worker input in decisions affecting company business matters and operations. OSHA reform legislation, adoption of total quality management concepts, and the downsizing/restructuring of businesses are particularly relevant to the topic of this report and brief comments stressing the connection are noted below.

OSHA Reform Legislation:

An OSHA reform bill pending in the current Congress includes a provision requiring companies with 11 or more workers to create joint management and employee safety committees (Weinstock, 1991). The rationale is that forming such a group would enhance both the employers' and the employees' commitment to address workplace hazards. Byproducts of this experience are also noted, such as greater workforce morale, increased workers' responsibility for their own safety, and improved trust and cooperation between management and employees. A National Safety Council survey found responses from companies without such committees to agree with these views. At the same time these respondents, and others who have existing worker-management safety committees in their organization, indicated that safety committees were not the only way to increase worker participation in safety and health matters. Other means were surveys, group meetings, and individual suggestions. Perhaps the issue is not so much the form of worker involvement, but to provide appropriate and effective mechanisms to assure worker input. OSHA's current guidelines for establishing a program to deal with ergonomic hazards in meatpacking plants cites needs for employee involvement as members of safety and health committees who could process information to target problem areas, analyze risk factors and make recommendations for corrective action. An all-industry ergonomics standard currently being prepared by OSHA is said to envision similar worker roles as ergonomic team members. Regardless of the outcome of the legislative process, the push for worker involvement in company safety and health programming and practices is apparent.

The Total Quality Management (TQM) Movement:

Adding impetus to worker participation approaches in industrial management practices is the growing acceptance of total quality management (TQM) principles first introduced by W. Edwards Deming and others (Roughton, 1993; Millar, 1993; Mottzko, 1989). Empowering workers to solve problems, help improve processes, and foster ongoing teamwork to ensure quality efforts at each stage of producing a product or providing a service is a key element in the TQM plan. Others are provisions for education, retraining, self-

Table 1. Pointers for Framing Worker Participation and Team-Building Approaches to Problem-Solving from the Current Literature

Issue	Pointer
Management Commitment	<ol style="list-style-type: none"> 1. Top management's commitment and support of worker participation approaches to company problem-solving needs is critical as is the cooperation of lower level supervisors and union officials or recognized worker leaders. 2. Policy declarations on the importance of participative approaches in addressing workplace issues require follow-up management actions to prove credibility. Those having merit are worker memberships on existing or newly-formed groups at various levels within the organization, including those that have authority to make decisions in local areas of operation, providing timely responses to worker-generated proposals for problem-solving and resources to implement solutions. 3. Efforts will be needed to redefine the roles of mid-level supervisors as mentors to workers, to work with them in promoting ideas for work improvement and ways that they can be implemented.
Training	<ol style="list-style-type: none"> 1. Workers and management staff plus others who may be formed into a work team, task group or committee will require additional training to ensure effective joint actions. Workers will need training in communication skills and abilities to interact in group problem-solving tasks; managers in listening and feedback skills. 2. Both workers and managers plus other participant members of a work team or task group should be given the necessary technical training to appreciate the targeted problems at issue. Resources for this and other add-on training should include provisions for outside consultants or experts as may be necessary. 3. Training practices should stress active forms of instruction focused on issues relevant to the trainees' experience. Special needs of those having language difficulties or other impediments to comprehension should be addressed.

Composition	<ol style="list-style-type: none">1. No single form of worker participation can effectively fit all needs. Approaches depend upon the problem(s) to be addressed, whether limited to one group, area or operation or having broader ramifications, the abilities of the workforce involved, and the climate of the organization in terms of using participative approaches in problem-solving.2. Teams formed to address workplace problems which cut across different units in an organization should include representatives from all such groups in addition to impacted workers, management persons and technical consultants as needed. Groups of 7 to 15 persons can afford ample interactions and cohesiveness in actions.3. Precautions should be taken to prevent supervisors/managers, specialists, and consultants on a team from intimidating front-line worker members of a team or dominating discussion.
Information Sharing	<ol style="list-style-type: none">1. Effective worker participation and team efforts to solve problems demand access to information germane to the issues in question.2. As the team participants may represent different operations and be at different staff levels, the success of group efforts can hinge on sharing information.3. Management must be up-front and honest in communicating their support for participative decision making and in acknowledging possible consequences of proposed actions. Worker concerns for job security are certain to raise questions.
Activities & Motivation	<ol style="list-style-type: none">1. Team-building activities invariably include meetings to clarify aspects of the problem, doing data gathering and analyses to isolate causal or contributing factors, developing remedial suggestions and planned efforts at implementation. Procedures reflecting orderly, systematic ways for dealing with each of these elements offer the best chances for success.2. Goal-setting and frequent feedback to mark progress toward the goals in a group's problem-solving efforts are key ways for motivating performance.3. Team leader commitments to the objectives of the group can facilitate accomplishments.4. Management's recognition and rewards for team success in problem-solving work can reinforce and sustain the continued interest of team members.
Evaluation	<ol style="list-style-type: none">1. Team performance efforts need to be evaluated. Suitable process and/or outcome measures should be used for that purpose.2. Surrogate indicators may offer alternatives to more basic measures in cases where the latter data do not satisfy conditions for meaningful evaluations.

improvement of the workforce, leadership roles which support or enable workers to do a better job, and continual striving to improve company operations and productivity. Measuring performance at all stages is implicit to attaining the goal of a total quality effort. Safety and health objectives can be readily folded into the TQM program where work-related injury/illness cases are treated as defects in the quality of the work process. Signs of unsafe conditions, poor work practices and risky worker behaviors are targets for joint worker/management actions aimed at their elimination. Millar (1993) and others, in extolling the virtues of TQM in occupational safety and health, reports that companies who have adopted this style of managing show both a reduction in work injuries and in the number of lost work days as well as an increase in productivity.

Downsizing/Restructuring of Businesses:

The need to remain competitive in global markets and the need to maintain profitability has caused many U.S. businesses to reduce their workforces and restructure their operations. As a streamlining, cost-saving move, layers of middle management or supervision have been removed in many cases, giving work units at lower levels more autonomy in directing operations, including those concerned with workplace safety and health. Greater worker involvement is seen as a key to success in making this change. Paraphrasing the statements of one executive of a major U.S. corporation: "We used to have supervisors watching people, and if something wasn't being done right, the supervisor would walk over and correct it. With fewer management people around, self-directed worker groups must assume responsibility for everything—productivity, quality, safety." (Pg. 30, LaBar, 1993) Additional training for workers is considered crucial to getting workers involved in safety as well as other issues. It is recognized, too, that garnering worker involvement in these efforts can be complicated if layoffs are also occurring within their ranks, causing morale problems. Labor-management cooperation on ways to resolve this conflict will have to be undertaken.

The political and economic factors just described make apparent the trend for workers to have greater inputs in defining and solving

workplace problems. The literature noted previously describes the merits of such an approach and the factors of consequence. What remains is to expand the knowledge base of applications, given that forms of worker participation, the problems at issue, and situational circumstances may all vary. The cases to be presented in this report depict a work team approach in addressing a particular type of problem (ergonomic hazards posing risks of musculoskeletal problems) as found in one industry (meatpacking). Aspects of team building and function are depicted as they may offer greater insights into processes which can lead to positive outcomes. These cases, though limited in scope, may offer added lessons on the dynamics of worker involvement in successful team problem-solving experiences.

REFERENCES

- Boden LI, Hall, JA, Levenstein, Punnett L (1984). "The impact of health and safety committees." *J Occup Med* 26(11):829-834.
- Bureau of National Affairs. "Lower injury rates, costs seen as a result of voluntary compliance, Cal/OSHA states." *Occupational Safety and Health Reporter*, Jan. 5, 1984.
- Cascio WF (1991). "Effect of attitudes and behavior on productivity, quality of work life, and labor-management cooperation." In: *Applied Psychology in Personnel Management*. Englewood Cliffs, NJ: Prentice-Hall Publishers. AMChapter 6.
- Chhokar JS, Wallin JA (1984). "Improving safety through applied behavior analysis." *J Safety Res* 13: 141-151.
- Cohen A, Colligan MJ (1993). "Assessing occupational safety and health training: A literature review." Division of Training and Manpower Development, National Institute for Occupational Safety and Health, Cincinnati, OH.
- Cohen A, Dukes-Dobos F (1985). "Applied ergonomics." In: Vol: 3B *Biological Responses- Patty's Industrial Hygiene & Toxicology* (2nd Edition) Wiley Interscience Publishers, New York, 375-430.
- Cohen, HH (1983). "Employee involvement: Implications for improved safety management." *Prof Safety* No 6:30-35.

- Commission on the Future of Worker-Management Relations (May, 1994). Fact Finding Report U.S. Department of Labor and U.S. Department of Commerce, Washington, DC.
- Cooke W, Gautschi F (1981). "OSHA, plant safety programs and injury reduction." *Indust Relations* 20(3):245-257.
- Della-Giustina JL, Della-Giustina DE (1989). "Quality of work life programs through employee motivation." *Prof Safety* No 5:24-27.
- Edwards S (June 1983). "Quality circles are safety circles." *Natl Safety News* 31-35.
- Grandjean E (1987). *Ergonomics in Computerized Offices*. London: Taylor & Francis Publishers.
- Griffin, RW (1988). "Consequences of quality circles in an industrial setting: A longitudinal assessment." *Acad Mgmt J* 31(2):338-358.
- Guzzo RA, Jette RD, Katzell RA (1985). "The effects of psychologically based intervention programs on worker productivity." *Personnel Psychol* 38:275-281.
- Keyserling W, Armstrong T, Punnett L (1991). "Ergonomic job analysis: A structured approach for identifying risk factors associated with overexertion injuries and disorders." *Appl Occup Erg Hyg* 6:353-363.
- Kringsman N, O'Brien RM (1987). "Quality circles, feedback and reinforcement: An experimental and behavioral analysis." In: *Organization Behavior Management and Statistical Process Control* (Haworth Press) pp 67-82.
- Krause TR, Hidley, JH (1993). "Implementing the behavior-based safety process in a union environment." *Prof Safety* No 6:26-31.
- LaBar G (1989). "Employee involvement yields improved safety record." *Occup Hazards* No 5:101-104.
- LaBar G (1990). "Ergonomics: The Mazda way." *Occup Hazards* No 4:43-46.
- LaBar G (1992). "Succeeding with ergonomics." *Occup Hazards* No 4:29-33.
- LaBar G (1993). "Safety management in tight times." *Occup Hazards* No 6:27-30.

- LaBar G (1993). "Is your safety committee legal?" *Occup Hazards* No 11:35-38.
- LaBar G (1994). "Safety at Saturn: A team effort." *Occup Hazards* No 3:41-44.
- Lanier Jr EB (1992). "Reducing injuries and costs through team safety." *Prof Safety* No 7:21-25.
- Lawler III EE (1991). *High Involvement Management*. San Francisco: Jossey-Bass Publishers.
- Lewis HB, Imada AS, Robertson MM (Oct. 24-28 1988). "Xerox leadership through quality: Merging human factors and safety through employee participation." *Proceedings of the 32nd Annual Meeting, Anaheim CA*. Vol 2:756-759.
- Liker JK, Nagamachi, M, Lifshitz YR (1989). "A comparative analysis of participatory ergonomics programs in the U.S. and Japan manufacturing plants." *Int J Indus Ergo* 3:185-199.
- Liker JK, Joseph BS, Ulin SS (1991). "Participatory ergonomics in two U.S. automotive plants," Chapter 6. In: *Participatory Ergonomics*, Edited by K. Noro, A. Imada. London: Taylor & Francis.
- Lin L, Cohen HH (1983). *Development and evaluation of an employee hazard reporting and management information system in a hospital*. Safety Sciences Report on Contract No. 210-81-3102. Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, WVA.
- Marks ML (1986). "The question of quality circles." *Psychol Today* No 3: 36-45.
- McGlothlin JD, Armstrong TJ, Fine LJ, Lifschitz Y, Silverstein B "Can job changes initiated by a joint labor-management task force reduce the prevalence and incidence of cumulative trauma disorders of the upper extremity?" *Proceedings of the 1984 International Congress on Occupational Ergonomics*, Toronto, Canada, May 7-9, 1984 Vol 1:336-340.
- Millar, JD (1993). "Valuing, empowering employees vital to quality health and safety management." *Occup Health & Safety* No 9:100-101.
- Miller KI, Monge PR (1986). "Participation, satisfaction and productivity: A meta-analysis." *Acad Mgmt J* 29(4):727-753.

- Mottzko SM (1989). "Variation, system improvement and safety management." *Prof Safety* No 8:17-20.
- National Safety Council (1993). *Safety circles*. Occupational Safety and Health Data Sheet 738 Rev.93. 1121 Spring Lake Dr., Itasca, IL.
- Office of Technology Assessment (1985). *Preventing Illness and Injury in the Workplace*, OTA-H-256. Washington DC: U.S. Congress, pp 315-323.
- Peters RH (1989). "Review of recent research on Organizational and behavioral factors associated with mine safety." Bureau of Mines Information Circular 9232, U.S. Dept of Interior, Wash D.C.
- Planek TW, Kolosh KP (1993). "Survey shows support for safety and health committees." *Safety and Health* No 1:76-79. (Also summarized in: Survey of employee participation in safety and health - An executive summary available from the National Safety Council, 1121 Spring Lake Drive, Itasca, IL.
- Roughton J (1993). "Integrating a total quality management system into safety and health programs." *Prof Safety* No 6:32-37.
- Saarela KJ (1990). "An intervention program utilizing small groups: A comparative study." *J Safety Res* 21: 149-156.
- Schermerhorn Jr JR, Hunt JG, Osborn RN (1985). *Managing Organizational Behavior*, John Wiley & Sons, New York, Publishers.
- Sulzer-Azaroff B, Loafman B, Merante, RJ, Hlavcek AC (1990). "Improving occupational safety in a large industrial plant: A systematic replication." *J Org Behav Mgmt* 11: 99-120.
- Ulin S, Armstrong TJ, Herrin GG (1992) "Preferred tool shapes for various horizontal and vertical work locations." *Appl Occup Env Hyg* 7:327-337.
- Vink P, Lourijzen E, Wortel E, Dul J (1992). "Experiences in participatory ergonomics: Results of a round-table session during the 11th IEA Congress, Paris July 1991." *Ergonomics* 35(2):123-127.
- Wallerstein NB, Weinger M (1992) "Health and safety education for worker empowerment." *Amer J Indust Med* 22(5): 619-635.
- Waters, TR, Putz-Anderson V, Garg A, Fine LJ (1993). "Revised NIOSH equation for the design and evaluation of manual lifting tasks." *Ergo* 36:749-776.
- Weinstock MP (1991) "OSHA reform: The push for worker involvement." *Occup Hazards* No 12: 37-39.

CASE STUDIES

PARTICIPATORY ERGONOMICS DEMONSTRATIONS IN THREE MEATPACKING PLANTS

Three year-long demonstrations of participatory approaches to identifying and solving ergonomic problems in meatpacking plants are described in this section. The work at each site was directed by one of three different university investigative groups. NIOSH coordinated and supported these demonstration cases with funds made possible through part of the settlement agreement previously mentioned. In each case, the setting is described with mention made of the plant processes, products, and production volume, the size and nature of the work force, management's level of attention to ergonomic concerns and commitment to solving them through a team approach. The make-up of ergonomic teams, their training and conduct in defining and proposing solutions to ergonomic problems are discussed. Evaluative information is presented concerned with aspects of the team-building process (i.e., interactions of parties represented, quality of leadership, effectiveness of role and functions) and performance (i.e., jobs analyzed, solutions proposed, and implemented). Some data reflecting the benefits gained through implementing the developed ergonomic solutions are given; however, opportunities for making these kinds of observations after the changes were introduced were limited greatly by the relatively short time-frame for the intervention project. One case study elaborates on both plant and corporate changes in workers' compensation and injury/illness statistics that occurred as a corporate-wide ergonomic program progressed over several years.

Two added comments need to be made in prefacing the three demonstration cases. The first is that the reporting of each case is a scaled-down, edited version of a more expansive stand-alone document as received from the university investigators involved. The latter reports were quite voluminous and included much common introductory material which the reader would find redundant. The second comment has to do with the interpretation or significance of the findings from these case studies. It is freely

admitted that the intervention work as reported lacks many of the study design conditions for yielding a reliable and valid research product. Absent were independent control groups for comparisons against the participant teams in establishing whether the expected effects were due to team-directed intervention efforts or caused by other factors unmentioned. The teams themselves were few in number, raising questions about whether they were representative of other situations. Appraisals of their actions and results were in many instances based on subjective or qualitative observations. Additionally, because the time-frame of the interventions was short, any positive effects from the process may be underestimated. Despite these limitations, descriptions of team progress or achievements in meeting objectives did offer some insight into factors that are of consequence in these kinds of approaches. Similarly, evaluations of the ergonomic job changes were also illustrative of useful control techniques. Neither of these outcomes from the case studies reported here should be downplayed in terms of their importance.

CASE STUDY #1

Based on the Final Report of:

**A Cooperative Agreement* with
Department of Industrial and Management
Systems Engineering
Center for Ergonomics and Safety Research
University of Nebraska — Lincoln
Lincoln, Nebraska**

**Michael W. Riley, Ph.D., P.E., C.P.E.
Project Director
David J. Cochran, Ph.D., P.E., C.P.E.
Principal Investigator
Terry L. Stentz, M.A.
Co-Investigator**

**Douglas R. May, Ph.D.
Co-Investigator
Department of Management
College of Business Administration
University of Nebraska — Lincoln**

**Catherine E. Schwoerer, Ph.D.
Co-Investigator
School of Business
University of Kansas
Lawrence, Kansas**

CASE STUDY #1

THE SETTING

The plant site was a pork slaughter and processing facility which has been in operation for over 35 years. The plant slaughters 7,500 to 7,800 hogs per day (about 980 hogs per hour on a single shift) and employs 1,200 people of whom 914 are unionized production workers. About 35% of the worker population live in the town where the facility is located and 65% live within a 50 mile radius. The typical employee is about 38 years old and has been with the company for approximately 10 years.

Plant processing capability includes full edible and inedible rendering operations. Storage capacity for frozen product is 2.15 million lbs. and 12.8 million lbs. for refrigerated items. Processed product capability is 1,000,000 lbs./week of bacon and 1,000,000 lbs. of smoked meats/week. Fabrication capability is 900,000 lbs./week consisting of two shifts of ham boning and one shift of picnic boning. The production line process is divided into eight basic areas: kill, rendering, cut, loading, process, boning, specialty meats, and case ready. All areas operate on first shift. Second shift generally includes all areas of production except the kill and cut floor. Third shift is used for clean-up and certain maintenance activities.

As is characteristic for the meatpacking industry as a whole, production requirements vary seasonally with the heaviest demands occurring during the Thanksgiving/Christmas and Easter holiday seasons. The typical workload during a heavy production period is 10 hours/day, 6-7 days per week for 3-5 months running. At the time of the project, the plant had just completed three years of major facilities and management systems improvements, including a new livestock warehouse, cutting department refrigeration and workstation upgrades, and installation of a new business planning and control system. A major flood occurred during the one-year period of the intervention which destroyed certain areas of the plant and damaged others. Remarkably, sandbagging

efforts were able to control water levels within the building so that only three full production days were lost. The impact on the ergonomics demonstration project was more significant. The timetable was set back 6-8 weeks and even longer on some planned elements.

PRE-EXISTING LEVEL OF ERGONOMICS CONCERNS/ EFFORTS

In November, 1991, thirteen months prior to the start of the intervention project, this company initiated steps toward developing a plant ergonomics program at the site of the study. During this period, university consultants were engaged to train a newly formed 40-member plant ergonomics committee on ergonomic fundamentals. The consultants furnished more problem-specific instruction following a plant tour, videotaping of several jobs and review of plant injury/illness data. Subsequently, the plant ergonomics committee was reformed into five departmental task groups who continued to receive further training on ergonomics and other safety matters given by the company safety and health officials.

In July 1992, the ergonomics task groups had begun work on job improvement projects and to document progress. In August 1992, company management and the union agreed to work with the university consultant group in submitting a proposal to NIOSH to undertake an ergonomics demonstration project which was seen as a way to advance their activities. Coincident with the development of this proposal was the formulation of a set of company guidelines expressing management's commitment to fully support efforts to identify and eliminate ergonomic hazards, to promote total staff cooperation in adopting safer work methods, procedures, equipment and work station designs, and to treat these matters as having the same priority importance as productivity and cost reduction efforts. Employee involvement was acknowledged in the guidelines through employee membership on the task groups already mentioned and employee participation in various program elements such as worksite analysis, work hazard preven-

tion and control, medical management, training and education, and the documentation and monitoring of results. As explained, this expression was taken to mean a team approach in addressing opportunities for ergonomic improvements. The guidelines were approved by company management and the local union leadership in January 1993, which was also the start date for the ergonomics demonstration project.

SCOPE/OBJECTIVES OF THE CASE STUDY

The purpose of the NIOSH cooperative agreement with the university group directing this demonstration was to create functional ergonomics teams that could develop, document and validate ergonomic activities that could reduce cumulative trauma disorders and other related injuries and illnesses in the meatpacking industries. Four phases of activities were designed by the university contractors to meet this goal in one year. They were:

Phase I- Direct/implement efforts on tasks involving program development, team-building and team-training.

Phase II- Assist in team efforts on tasks involving job selection and analysis of problems, and development/implementation of solutions.

Phase III- Survey and evaluate the effectiveness of ergonomics solutions once in place, worker attitudes and perceptions of the ergonomics program, and ergonomics team effectiveness.

Phase IV- Draft a final report of all findings.

METHODS AND OPERATIONAL PROCEDURES

A number of methods were used to satisfy these different tasks and in furnishing technical assistance. The following elaborates on some of these procedures:

Team Formation/Member Selection

The five department-based ergonomics task forces mentioned earlier were established as the participant teams to carry out the

objectives of the program. Each team included 7-9 persons representing production employees, management, medical staff, and maintenance. Employees were selected from those who expressed interest in participating in the program and those who had experience in a number of different jobs within the designated area. The role of management and the medical staff in the start-up phase was to facilitate access to information needed for job and cumulative trauma disorder (CTD) analyses and to readily obtain financial resources needed to make ergonomic changes. Maintenance representatives were involved because they were the personnel that would actually implement the changes. Teams reported directly back to their departments and the plant manager. Teams had autonomy to implement low cost solutions, but needed to document and justify substantial changes to upper management. Such justification usually involved an analysis of the CTDs involved in the affected jobs, number of employees affected, and a cost/benefit analysis of the proposed ergonomic change.

Team Training

Following the teams' formation, the ergonomics task force members participated in team-building sessions designed to enhance their ability to work together, in addition to receiving team ergonomics instruction in defining risk factors for cumulative trauma disorders and ways to prioritize jobs for ergonomic solutions. The ergonomist associated with the human resources group of the corporation and university faculty involved in the project assisted in this training. The team-building activities included: (a) defining a team; (b) determining the goals of an ergonomics team; (c) establishing group meeting rules and team roles; (d) reviewing guidelines for effective group discussion and constructive feedback; and (e) practicing brainstorming exercises and techniques for consensus building. Consistent with the approach advocated by experts in the team-building area (Dyer, 1987; Parker, 1991), the team-oriented skills focused both on how to develop task-oriented skills and interpersonal processes within the group. Forms for documenting team member responsibilities, records of meetings and actions taken, plus other handouts served to reinforce these points.

In reviewing the causes of CTDs (e.g., posture, force, repetition, and the general work environment), the ergonomics training given to the teams emphasized methods for their characterization through the use of videotape and job analysis techniques. The video techniques used a rating system to determine the extent of hand, wrist, arm, and shoulder movement, as well as the position of the back and neck during work. Job analysis included reference to OSHA 200 log entries, observations of job tasks and gaining worker input as to ease/discomfort of certain operations. Practice in job analysis was included. General ergonomics training was later offered to all plant employees.

Team Activities re Defining/Solving Problems

Once formed and trained, each of the five ergonomics teams were encouraged to review, describe, and document on videotape all jobs in their areas of responsibility as a first step in the program. Based on a job description and a review of the job requirements, the most stressful jobs were to be identified for job analysis and ergonomic improvement in accordance with ergonomics team training. The ergonomics teams met formally at least twice every month to develop and review their recommendations for job redesign. Team members also met informally throughout each month to discuss ergonomics issues. Medical staff supplied the teams with information about the frequencies of CTDs for particular jobs. In addition, self-reported physical pain symptoms and primary tool usage data were summarized and presented to the teams by the university investigators in order to facilitate the processes of problem identification. This information, plus their own observations and experience in the jobs, were used by teams to establish priorities and to suggest ergonomic changes. Teams frequently asked for input from employees to aid in the early detection of CTD symptoms and potential problem jobs. Some of the teams found it very helpful to couple the videotaping of each job in their department area and discussions with the employees who performed the jobs. The corporate ergonomics specialist encouraged teams to start with ergonomic changes that could be easily accomplished. Early success built team members' efficacy in their roles as change agents and their credibility with non-team members.

Records of the ergonomic changes in the plant were maintained by each task force with the aid of the corporate ergonomics specialist and university personnel. Photographs and descriptions of changes were posted in the cafeteria area to inform plant employees. While teams were the primary force for change, university faculty members assisted the teams in identifying engineering solutions. Plant maintenance personnel were largely responsible for the implementation of these ergonomic solutions.

TEAM ACCOMPLISHMENTS

The total number of jobs selected for analysis and improvement by each department team is summarized in Table 1 below, as is their status of completion at the end of the one-year project period.

Table 1: Number and Status of Job Projects Undertaken by Teams

Department/Team	# Projects Initiated	Implementation
Boning/Special Meats	14	13 completed, 1 in process
Cut/Loading	17	3 completed, 14 in process
Kill/Rendering	24	21 completed, 3 in process
Process	28	12 completed, 16 in process
Night Shift	21	15 completed, 6 in process

To illustrate the type of information collected and reviewed by each team and the resultant activity that took place in finding a solution for improving a given job, details are given in Exhibits 1-4 of four completed job modifications. Each was from a different department team. The information provided in each instance was taken directly from each team's ergonomics project documentation notebook and involved jobs rated as posing a high risk of ergonomic-musculoskeletal disorders.

EXHIBIT 1: DETAILED ERGONOMICS INTERVENTION EXAMPLE—BONING/SPECIAL MEATS

Job Data

1. **Job Name:** clean square metal tubs
2. **Work Shifts:** 1 & 2
3. **Number of Workers Assigned:** 11
4. **Job/Task Objective:** high pressure wash of metal tubs
5. **Ergo Problem Identification Date:** 10-92
6. **Assigned Priority:** immediate (high risk)
7. **Job/Task Description:** Move metal tanks by mule to tub wash area to steam hose clean. Worker remains outside the tub with steam hose, then push tub to tilt position to drain water out of bottom drain hole. Worker is required to reach and twist to clean lower/bottom tub surfaces. Tub weighs 250-275 lbs.
8. **Physical Stressors:**
 - a) high force (arms, shoulders, legs)
 - b) full extension of upper extremities
 - c) compression load on upper torso from tub edge
9. **Other Stressors:**
 - a) some workers cannot perform job due to physical abilities requirements
 - b) keeping up with line speed (work pace)
10. **Estimated Number of Task Repetitions/Worker:**
pulls, pushes, twists = 4,830/shift; = 24,150/week; = 1,255,800/year
11. **Estimated Work Cycle Task Time:** Not available
12. **OSHA 200 Log Incidence/Severity History:**

<i>1993 Severity of Cases</i>	<i>1993 Number of Entries</i>
OSHA Recordable: 20	CTD Cases: 4
Physician Cases: 16	Injury Cases: 16
Restricted Work Cases: 4	Lost Work Days: 8
Lost Day Cases: 5	Restricted Days: 55
<i>1992 Severity of Cases</i>	<i>1992 Number of Entries</i>
OSHA Recordable: 16	CTD Cases: 4
Physician Cases: 14	Injury Cases: 12
Restricted Work Cases: 5	Lost Work Days: 5
Lost Day Cases: 2	Restricted Days: 44
13. **OSHA 200 Log 1992+1993 Cost Impact:**

Direct Workers' Comp Cost	= \$8305.00
Direct Medical Cost	= unknown
Indirect Cost	= unknown
14. **Expected Production/Safety Factors:**
 - a) job bidding open to more workers
 - b) reduce job overload w/service operators
 - c) increased shelf life of products
 - d) improved sanitation controls (methods)
 - e) reduced risk of accident and injury
 - f) reduced process time to clean

Ergonomic Job Analysis

1. Summary of committee's observations and facts related to ergonomic job stress and problem identification:

Material handling of tubs for cleaning requires extremely high upper extremity and whole body force and awkward posture to move and balance tubs for cleaning. The danger exists that the tub can fall on the worker's legs or feet while cleaning.

2. Summary of possible solutions considered:

- a) mechanical assist design criteria
- b) one person does all the cleaning

3. Final solution estimate of stressor elimination or reduction:

All force required to push, pull, tip and position tubs during high pressure steam cleaning would be eliminated by providing a mechanical/hydraulic lifting fixture.

4. Work Order Date: 4-93

5. Estimated Cost of Solution:

Material= \$ 9,600.00

Labor = \$ 4,758.00

Total= \$14,358.00

Modified Job Analysis and Solution Follow-up Evaluation

Analysis and evaluation in process.

EXHIBIT 2: DETAILED ERGONOMICS INTERVENTION EXAMPLE — CUT/LOAD TEAM

Job Data

- 1. Job Name:** pack loin ends
- 2. Shift:** 1
- 3. Number of Workers Assigned:** 3
- 4. Job/Task Objective:** pack loin end pieces in boxes
- 5. Ergo Problem Identification Date:** 6-93
- 6. Assigned Priority:** immediate (high risk)
- 7. Job/Task Description:**

Empty cartons are lined with plastic and carried to line. Loin end pieces or sirloin pieces (approx. 3 lbs. each) come off conveyor from the center cut saw. Pieces fall into a stainless steel tub which stands 42 inches off of floor surface. About 4,200 loin end cuts are processed per day. The workers use a metal hook to snag each piece individually, lift it out of the tub, then pack and arrange the loin ends in one carton, and sirloins in a different carton (15 pieces per carton). The cartons are placed on a stand. Once each box is filled the worker labels the box, lifts the box, carries it to a scale, checks weight, lifts again and takes it to a conveyor where it then goes to the cooler.

8. Physical Stressors:

- a) forward bending at the waist
- b) extend legs and toes to reach work
- c) static hand grip
- d) flexion and extension of the shoulder
- e) high pulling and lifting forces
- f) lift and carry load
- g) high repetition

9. Other Stressors:

None identified

10. Estimated Number of Task Repetitions/Worker:

pushes, pulls, twists = 4,200/shift; =21,000/week; =1,092,000/year
boxes processed/worker = 280/shift;= 1,400/week; =72,800/year

11. Estimated Work Cycle Task Time: 160 sec/box**12. OSHA 200 Log Incidence/Severity History:**

<i>1993 Severity of Cases</i>		<i>1993 Number of Entries</i>	
OSHA Recordable:	0	CTD Cases:	0
Physician Cases:	0	Injury Cases:	0
Restricted Work Cases:	0	Lost Work Days:	0
Lost Day Cases:	0	Restricted Days:	0
<i>1992 Severity of Cases</i>		<i>1992 Number of Entries</i>	
OSHA Recordable:	0	CTD Cases:	0
Physician Cases:	0	Injury Cases:	0
Restricted Work Cases:	0	Lost Work Days:	0
Lost Day Cases:	0	Restricted Days:	0

13. OSHA 200 Log 1992+1993 Cost Impact:

Direct Workers' Comp Cost = \$ 0.00
Direct Medical Cost = \$ 0.00
Direct Cost = \$ 0.00

Potential back injury/surgery could be \$50,000/case.

14. Expected Production/Safety Factors:

No significant factors identified.

Ergonomic Job Analysis**1. Summary of committee's observations and facts related to ergonomic job stress and problem identification:**

If possible, the solutions would eliminate or decrease the following motions/actions: bending forward at the waist, hooking and lifting loins, manually carrying 30-45 lb. boxes.

2. Summary of possible solution considered:

- a) install chute to bring empty boxes to the line
- b) install roller table at end of line (lower than conveyor)
- c) relocate conveyor scale to avoid box lifting

3. Final solution estimate of stressor elimination or reduction:

- a) install chute to bring empty boxes to the line
- b) install roller table at end of line
- c) relocate conveyor scale

4. Work Order/Date: #28981/6-93

5. Estimated Cost of Solution:

Material = \$ 7,400.00

Labor = \$ 4,618.00

Total = \$12,018.00

Modified Job Analysis

Modified job analysis and evaluation in process.

EXHIBIT 3: DETAILED ERGONOMICS INTERVENTION EXAMPLE - KILL TEAM

Job Data

1. Job Name: hog shackler

2. Shift: 1

3. Number of Workers Assigned: 1

4. Job/Task Objective: re-shackle hogs that have come loose or fallen from hanging conveyor (live/semi-live)

5. Ergo Problem Identification Date: 8-93

6. Assigned Priority: immediate (high risk)

7. Job/Task Description: Hogs are shackled after stunning on a table and are conveyed to the end of the table. At the end of the table the hogs fall to the floor causing the shackled leg to be picked up by the sticking conveyor chain. Hogs are lifted and conveyed to the next workstation which is the sticker who bleeds the animal. Some hogs (about 200/day) kick the shackle off before the chain lifts them to the sticker workstation. These hogs must be herded and picked up to replace the shackle.

8. Physical Stressors:

- a) bending forward and backward (lower back)
- b) neck forward posture fatigue
- c) arm extension under load
- d) high repetition
- e) lifting

9. Other Stressors:

- a) fear of getting hit or kicked by hogs
- b) fear of getting behind (work pace)

10. Estimated Number of Task Repetitions/Worker:

pulls, pushes, twists = 1,500/shift; = 7,500/week;= 390,000/year

11. Estimated Work Cycle Task Time: 4.5 sec

12. OSHA 200 Log Incidence/Severity History:

<i>1993 Severity of Cases</i>		<i>1993 Number of Entries</i>	
OSHA Recordable:	0	CTD Cases	0
Physician Cases:	0	Injury Cases	0
Restricted Work Cases:	0	Lost Work Days	0
Lost Day Cases:	0	Restricted Work Days	0
<i>1992 Severity of Cases</i>		<i>1992 Number of Entries</i>	
OSHA Recordable:	1	CTD Cases	1
Physician Cases:	0	Injury Cases	0
Restricted Work Cases:	0	Lost Work Days	0
Lost Day Cases:	0	Restricted work Days	0

13. OSHA 200 Log 1992+1993 Cost Impact:

Direct Workers' Comp Cost	= \$ 0.00
Direct Medical Cost	= \$ 0.00
Indirect Cost	= \$ 0.00

Potential cost from a single face or back injury might be \$10,000 to \$50,000. Current job design requiring 200 hogs/day to be re-shackled requires a full-time equivalent employee at about \$28,622/yr (includes benefits). Product (hog) loss (100 "blowouts"/day with stunning and subsequent trim loss) is estimated at \$626,000 annual equivalent loss in product value.

14. Expected Production/Safety Factors:

- reduced re-shackling
- reduced "blowout" product
- reduced risk of injury
- reduced psychological stress

Ergonomic Job Analysis**1. Summary of committee's observations and facts related to ergonomic job stress and problem identification:**

- fear of being injured
- back injury potential
- head/face injury potential
- high repetition (needless work in re-shackling)

2. Summary of possible solution considered:

- have stick chain rail raise the hog before it reaches the end of the table and touches the floor
- add staff to help with overload of re-shackling work

3. Final solution estimate of stressor elimination or reduction:

Shortening of the shackle chain will reduce the need to handle and lift hogs; reduction of injury fear

4. Work Order Date: 9-93**5. Estimated Cost of Solution:**

Material	= \$1,200.00
Labor	= \$1,617.37
Total	= \$2,817.37

Modified Job Description/Analysis

Modified job analysis and evaluation of ergonomic change still in process. Initial review estimated that there has been a 70% reduction in injury risk (as perceived by workers), a 70% reduction in product value loss, and reduced the worker need by 1 person for this work area. Direct annual cost saving due to this improvement is estimated at \$436,000.

EXHIBIT 4: DETAILED ERGONOMICS INTERVENTION EXAMPLE - NIGHT SHIFT TEAM

Job Data:

1. **Job Name:** lean shank trimmer
2. **Shift:** 2
3. **Number of Workers Assigned:** 3-4
4. **Job/Task Objective:** line balancing for trimmers
5. **Ergo Problem Identification Date:** 9-93
6. **Assigned Priority:** urgent (extreme risk)
7. **Job/Task Description:**
Position ham-separate shank meat from shank bone. Remove and trim 95% lean shank from ham-place in tub. When tub is full, twist and turn and dump small tub into large tub-steel knife. Repeat workload 96%.
8. **Physical Stressors:**
 - a) awkward wrist postures under twisting load
 - b) "winging" elbows
 - c) shoulder abduction
 - d) bending forward at the waist
 - e) high grip forces
 - f) cold
9. **Other Stressors:**
 - a) workload pace is 96%
 - b) knives not sharp enough, long enough for job
10. **Estimated Number of Task Repetitions/Worker:**
pushes, pulls, twists= 12,040/shift; = 60,200/week; = 3,130,400/year
11. **Estimated Work Cycle Task Time:**
16.2 sec work cycle; 0.5 sec rest cycle; 16.7 sec total cycle
12. **OSHA 200 Log Incidence/Severity History:**

1993 Severity of Cases		1993 Number of Entries	
OSHA Recordable:	1	CTD Cases	1
Physician Cases:	0	Injury Cases	1
Restricted Work Cases:	0	Lost Work Dayt Cases	0
Lost Day Cases:	0	Restricted Work Days	0
1992 Severity of Cases		1992 Number of Entries	
OSHA Recordable:	0	CTD Cases	2
Physician Cases:	4	Injury Cases (1 was back)	1
Restricted Work Cases:	2	Lost work Days	4
Lost Day Cases:	2	Restricted Work Days	7

13. OSHA 200 Log 1992+1993 Cost Impact:

Direct Workers' Comp Cost = \$421.30

Direct Medical Cost = \$1,113.00

Indirect Cost = \$ not available

Total Direct Cost (WC+medical) = \$1,534.30

14. Expected Production/Safety Factors:

Reduction of work cycle load from 96% to 79% (boner) while increasing workload of trimmer from 80 to 88%.

Ergonomic Job Analysis

1. Summary of committee's observations and facts related to ergonomic job stress and problem identification:

- a) shank boner work cycle load is 96%
- b) trimmer work cycle load is 80%
- c) shank boner physical stressors are present
- d) work load cycle balancing is needed

2. Summary of possible solution considered:

a) IE job work analysis showed inside knuckle trimmers could remove and trim lean shank to reduce shank boner workload and raise workload of trimmers.

3. Final solution estimate of stressor elimination or reduction:

- a) reduced wrist posture/force/repetition stressors
- b) eliminated bending at waist and lifting

4. Work Order Date: Work order not required

5. Estimated Cost of Solution:

Material= \$ 0.00; Labor= \$50.00; Total= \$50.00

Modified Job Analysis

A preliminary evaluation of the modified job estimated that a shank boner work cycle load has been reduced causing a reduction in the bone yield and an increase in the lean shank yield. Since the workload change was incorporated (9-93) it has been estimated that \$14,000.00 in increased lean shank yield has been attained with a concomitant positive change in lean shank work cycle and rest times:

- a) work cycle time from 16.2 sec to 13.2 sec (18.5% decrease)
- b) rest cycle time from 0.5 sec to 3.5 sec (700% increase)
- c) total work cycle time of 16.7 sec stayed the same

EVALUATION OF TEAM EFFECTIVENESS AND PROGRAM OUTCOMES

In addition to the number of jobs for which team-directed solutions were implemented, as shown in Table 1, various other measures and observations served to assess team functioning and performance as well as to gauge its impact. Methods for evaluating team function and effectiveness were:

- Questionnaire surveys of team members who individually rated their team efforts and experiences in undertaking the ergonomics intervention activities.
- University investigators' observations and records of team activities.

Methods for evaluating the impact or benefits of the intervention program included:

- Questionnaire surveys of production employees on attitudes toward the ergonomic program, level of pain and comfort experience resulting from implementing team-directed job improvements.
- Comparisons of the plant-wide and individual department incidence rates for cumulative trauma disorders as recorded in OSHA logs, physician cases, production days lost, and restricted duty days at various time points before, during and at the end-point of the intervention project study.
- Comparisons of plant-wide and individual department rates of absenteeism and turnover at time point before and at the endpoint of the intervention project study.

What follows are descriptions of the data collection procedures and summaries of the results for these two kinds of evaluations.

Measures of Team Function/Effectiveness

Surveys of Ergonomics Team Members: At the one year end-point for the project, team members individually rated questionnaire items as to their perceptions of: a) team success in redesigning jobs and implementing ergonomic changes; b) belief in their capabilities for doing so; c) overall satisfaction with the effort; d) openness in communication among members; e) quality of team interactions in defining goals, developing workable plans and priorities; f) availability of resources to support the team's efforts; and g) personal commitment to the work of the team. Mean results for all 30 team members, using a 7-point rating scale (1=strongly disagree, 2=disagree, 3=disagree slightly, 4=Neutral, 5=agree slightly, 6=agree, 7=strongly agree), are shown in Figures 1-7 as are results averaged for members of each team. In terms of overall ratings, team

Self-Rated Performance by Team

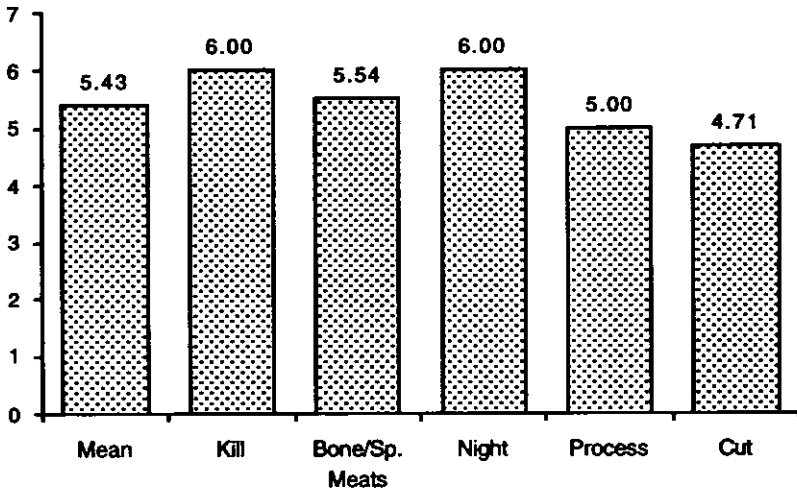


Figure 1. Mean (Overall) and Team Self-Rated Performance Ratings

Ergonomics Efficacy by Team

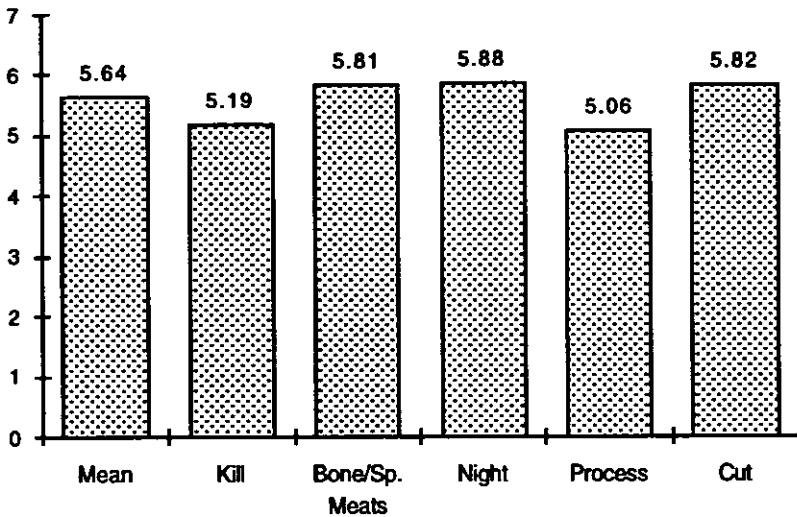


Figure 2. Mean (Overall) and Team Ratings of Self-Efficacy

members as a whole agreed that their teams had been successful overall in generating ideas for redesigning jobs and in implementing those ergonomic changes (Self-Rated Performance Mean=5.43), and expressed somewhat higher levels of beliefs in their efficacy for undertaking such assignments (Team Efficacy Mean=5.64). Members generally felt even more positive about their ability to communicate with one another (Communication Process Mean=5.97) and expressed satisfaction with their teams (Team Satisfaction Mean=5.83).

Communications Process by Team

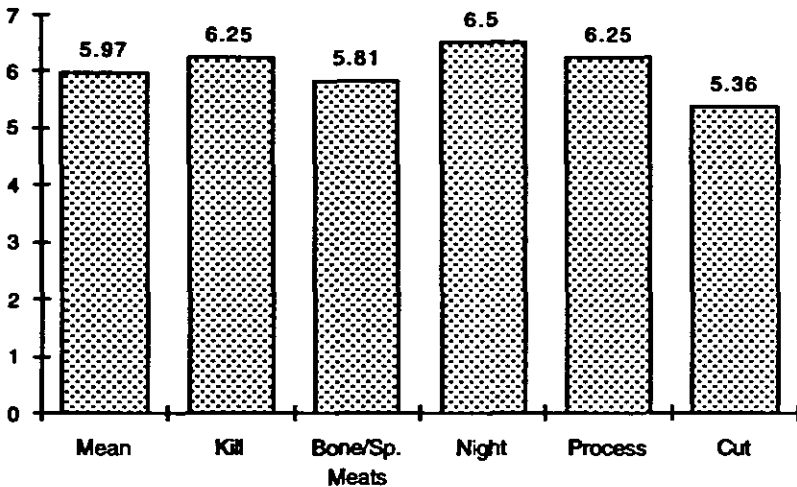


Figure 3. Mean (Overall) and Team Ratings of Communication Process

Team members were less certain that their groups performed well in defining goals, developing workable plans, and prioritizing work (Work Process Mean=5.15) and that they had the necessary information and resources to do their job (Resource Adequacy Mean=5.23). It was assumed that with added help in refining their team work processes and more resources to do their job, the teams should be able to improve their performance given their overall high commitment to their work on the ergonomic teams (Work Commitment Mean=6.22).

Team Satisfaction by Team

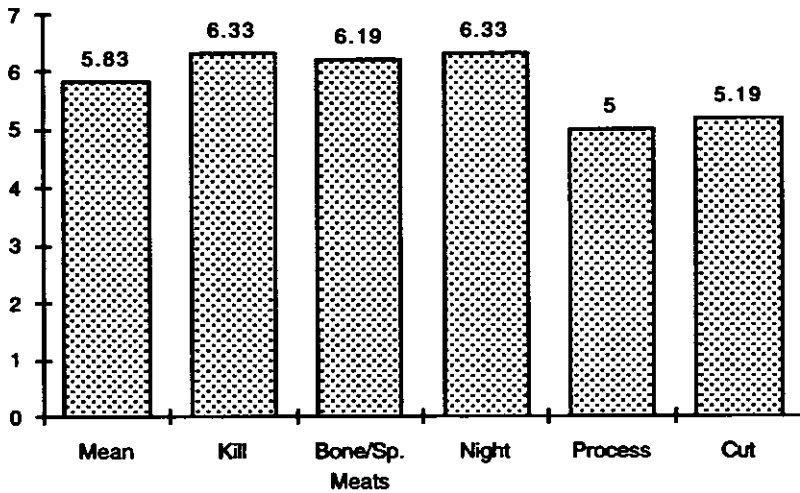


Figure 4. Mean (Overall) and Team Ratings of Team Satisfaction

Work Process by Team

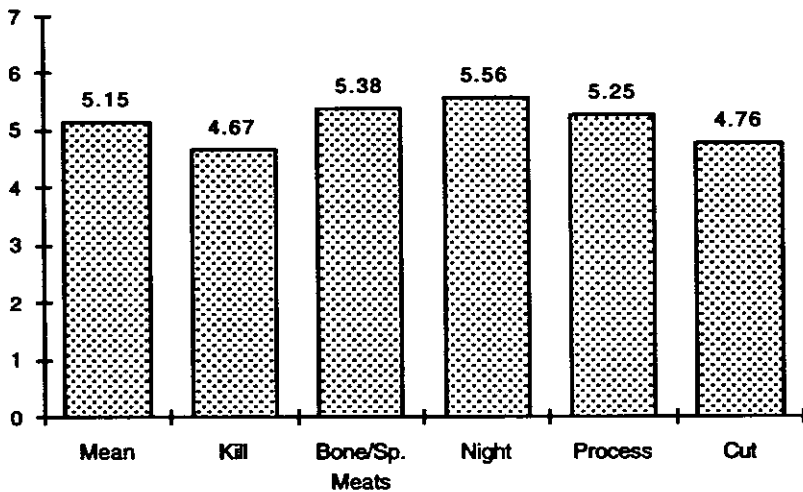


Figure 5. Mean (Overall) and Team Ratings of Work Process

Resource Adequacy by Team

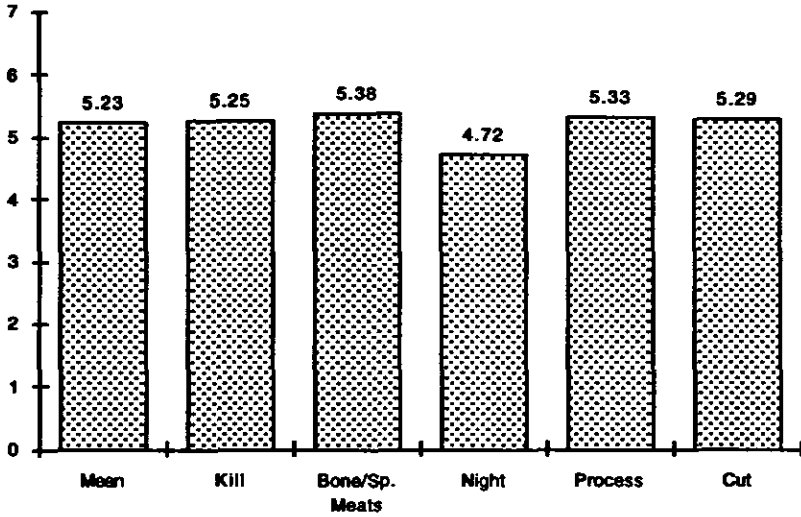


Figure 6. Mean (Overall) and Team Ratings of Resource Adequacy
Work Commitment by Team

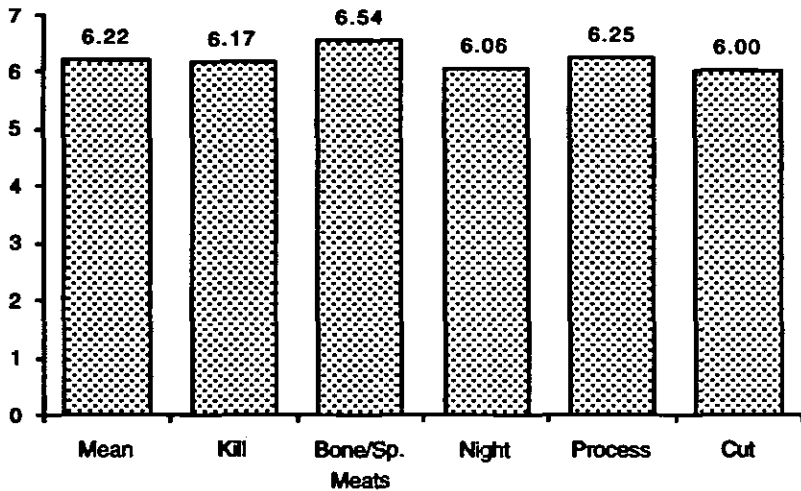


Figure 7. Mean (Overall) and Team Ratings of Work Commitment

Overall, written responses to open-ended questions in the ergonomics team survey suggested that team members felt that a number of factors contributed to the effectiveness of the teams. First, many members mentioned that the diversity of the backgrounds of team members helped them perform better. Thus, teams seem to operate better when they have members from all parts of their department and who have experience in multiple jobs within their department. Secondly, members felt that the ability to listen to one another and talk openly helped them perform effectively. Finally, talking with the employees actually doing the jobs in their department also appeared to facilitate their effectiveness as a team. Written responses to open-ended questions also suggested a number of factors that have prevented the teams from performing optimally. Some groups felt that they did not receive adequate assistance from maintenance personnel in the plant. This was significant since these employees are ultimately responsible for implementing many ergonomic changes. Secondly, there were problems in getting everyone to attend meetings due to production pressures in the plant. Lack of adequate time for team members to work on ergonomics projects was seen as the primary factor inhibiting the teams' productivity on ergonomics. Third, in some groups there was a lack of balance in the workload among members. Some members tried to do too much of the work and group members felt that they could have accomplished their tasks better if work were better distributed among all members.

The survey findings by individual ergonomics teams suggests that some teams appeared to function better than others. The Bone/Special Meats, Kill, and Night Department teams tended to show higher (more positive) ratings in viewing the graphical representations for the various dimensions shown in Figures 1-7. However, even within these teams there was evident room for improvement. Though their ratings of team performance, team satisfaction, and communication were among the highest noted, Kill Department team members perceived needs to improve the quality of their team work processes (see Figure 5) and confidence in

their ability to do such tasks (see Figure 2). Similarly, ratings for the members of the Night shift team suggested needs for greater access to resources to improve their efforts in ergonomic job redesign (see Figure 6).

The ergonomics teams that appeared to function less well were the Cut and Process Teams. Team members of these groups rated themselves the lowest of the five teams in terms of self-rated performance and team satisfaction (see Figures 1 and 4). Members of the Cut team also rated the team low in communication and work processes relative to the other teams (see Figures 3 and 5).

Observations by University Research Staff: Members of the university research team involved in the ergonomics intervention program met regularly with the individual department ergonomics teams and observed their activities during the term of the study. Particular attention was paid to task-related processes, team leadership issues, intergroup cohesion and conflict, plus overall effectiveness. Such observations were largely in accord with those from the team survey data summarized above and offered some basis for the differences in team performance. For example, it was observed that the Bone/Special Meats ergonomics team appeared to be one of the most productive groups, primarily due to an especially strong and highly motivated leader who was clearly an advocate for ergonomic change in the plant. The Kill group worked well primarily because of the democratic style of decision-making adopted by the leader of this group and the clear access to resources needed by the team. Observations also revealed that the job analysis efforts in this group were not as deliberate as they could have been. This group's decisions on ergonomics projects were based mostly on what items were brought to the team's attention and how easy it would be to implement them, versus a more systematic analysis of injury and illness rates for jobs. The Night Shift team was seen as being an effective group in terms of democratic leadership, idea generation, and other internal work processes. However, members of the Night Shift team often had complaints about lack of coordination

with day shift employees. The Cut group appeared to have some differences in perspectives of what issues to address and how to prioritize them. These dynamics led the group to perform less than optimally since little agreement could be reached on what ergonomics projects to focus their attention. Some disagreement also appeared to center on the level of effort given to the ergonomics project by either side of employees and management. The Process team initially had problems establishing their goals and direction regarding ergonomic analyses of the jobs in their area. However, once they systematically videotaped each job in their department and discussed ergonomic-related issues with the employees themselves, the team became much more focused and productive.

It is to be noted that the apparent differences just described among the teams, based on their survey ratings and the observations of the university investigators, parallel their performance outputs in terms of the number of job projects completed through the implementation stage. As shown in Table 1, the Kill, Night Shift and Boning/Special Meats teams, which drew the most favorable ratings and observations, were also the most productive in terms of completion figures. The Process and Cut teams, exhibiting less favorable reactions, had fewer completed projects although the Process group seemed to perform better than originally thought.

Measures of Impact/Benefits

Employee Attitude-Pain Survey: All production employees (approximately 815 employees) were given the opportunity to participate in surveys conducted at two points in time (March 1993 and January 1994). These surveys were composed of both employee attitude, and pain and discomfort questions. Analyses were conducted that compared participants' responses in March 1993 with those in January 1994. 311 employees chose to participate in the first survey (39% response rate), and 202 employees participated in the second survey (25% response rate). The analyses below are based on the 127 employees that responded to both surveys. As to pain indicators, individuals were

asked to fill out a physical symptoms survey adapted from Silverstein (1989). They were asked to indicate if they “had any pain and discomfort that doesn’t go away.” If so, to indicate up to two areas of their bodies where they felt the most pain and then the next most pain. Thus, participants could indicate 0-2 body areas affected by persistent pain. Frequency analyses of this data revealed that in March 1993 the number of people reporting zero, one, and two body areas affected by persistent pain were 48, 9, and 70, respectively. In January 1994, the number of people reporting zero, one, and two body areas affected by pain were 54, 28, and 45. Thus, fewer people were reporting pain, and of those people that did, fewer were reporting pain in two body areas. Overall, the mean number of body areas affected by persistent pain decreased significantly from 1.17 prior to the ergonomics project to 0.93 after the ergonomics interventions.

Employees were then asked to indicate “how well each of the following described their problem: aching, burning, cramping, loss of color, numbness (asleep), pain, swelling, stiffness, tingling, and weakness.” Employees responded to these items on a 1-7 scale with 1=Not at all to 7=Very well. Their responses to these ten items were then tabulated and the average taken for the body areas affected by persistent pain to create an overall index of the “severity” of the pain experienced. Employee pain severity was significantly reduced by the ergonomics intervention in the plant, from 4.24 to 2.86.

With regard to attitudes, employees were also asked to indicate their feelings about the ergonomics program at the plant. They were asked four questions regarding their satisfaction with the program, management’s commitment toward the program, and the effects of the program on employees. Based on a 7-point rating scale (1=very unfavorable to 7=very favorable), employees attitudes toward the ergonomics program were relatively positive (4.72) in March 1993, yet decreased to 4.11 in January 1994. This decrease in attitudes related to the ergonomics program probably represents high, unrealistic expectations for the program initially,

followed by low satisfaction with it once employees saw that jobs were changed more slowly than they had expected.

Analyses were also conducted to examine the effects of ergonomic job changes on employee attitudes and perceptions of pain. Ergonomics teams informed university researchers of the employee identification numbers for those whose jobs had been changed. A total of 39 of the 127 employees who responded to both surveys had some change in their job, tools, or workstation. Thus, the sample was divided into two groups based on whether their job had been changed (N=39) or not (N=89). First, regression analyses were conducted to determine if the two groups were significantly different based on the particular dependent variable at Time 1 (March 1993). Since no significant differences emerged between the groups in these analyses, the employees who did not have their jobs changed served as a control group to compare with the job change group's responses. It was expected that employees who had their jobs changed would have less severe pain overall at Time 2 (January 1994) when compared to those whose jobs remained the same. Accordingly, mean ratings for pain were found to be significantly lower in the job change group (2.39) than in the no job change group (3.11).

It was also expected that those individuals who had experienced some form of job change would feel more positively toward the ergonomics program than those who had not experienced a change. Those who did have a job change maintained a relatively positive attitude toward the ergonomics program (mean rating of 4.46), while those that did not experience a change expressed a less positive attitude (3.96).

Employees' intentions to leave the company were also rated on a 1-7 point scale (1=Strongly Disagree to 7=Strongly Agree) with those scoring high on this scale expressing a desire to leave the company, while those having lower scores were seen as more likely to want to remain. Those who had experienced a job change showed significantly lower intentions to leave the company (3.10)

than those whose jobs had not undergone any form of change as part of the intervention program (3.79).

Plant-wide Reports of Cumulative Trauma Cases, Lost Days, Restricted Duty, Absenteeism and Turnover: Plant-wide data gathered to establish the relative success of the ergonomic effort included OSHA 200 logs of employee injuries and illnesses. From this data, incidence levels were calculated for: Cumulative Trauma Disorders (CTDs), physician-referred CTD cases, lost production days, and restricted duty days. Information was also obtained from company records on the overall amount of absenteeism and turnover in the plant. Findings on these different indicators are summarized and discussed below. The data represent aggregated information for the plant departments of Kill and Rendering, Cut, Process, Boning, Special Meats, and Case Ready.

Cumulative Trauma Disorders (CTDs): One of the most convincing pieces of evidence that the ergonomics intervention program was a success is the reduction in the incidence rates of CTDs in the overall plant. As stated above, data were obtained on the number of total CTD cases in the major plant departments and the relative incidence of CTDs per 200,000 work hours, calculated by the following formula: $(\text{Number of CTD cases}) \times 200,000 / \text{Total Work Hours}$ for the given period of time. Using these incidence rates allowed one to control for any seasonal or annual fluctuation in the number of hours worked and the associated increase in CTDs.

Each of the yearly time periods examined here began on March 1, the beginning of the major thrust of the ergonomics project at the plant site. Only OSHA logs of CTDs from 1991 or later were used because the plant changed its CTD reporting procedures in 1991 when it adopted the new OSHA guidelines for the meatpacking industry. These changes made comparisons to previous years uninterpretable. Recognizing that the effects of the ergonomic changes may take some time to become apparent, incidence rates for the post-intervention period (March 1, 1993 to February 28, 1994) were analyzed in two separate six-month periods. Lower

incidence rates in CTDs were anticipated for the second six-month (labeled 1993b) period of the study, but not necessarily for the first six-month period (labeled 1993a).

As the data show in Figure 8, the incidence rate of CTD cases in the plant rose from 55.30 in the benchmark year of 1991 to 75.46 in 1992. The incidence rate continued to rise in the first six months of the 1993 period to 80.46, but then fell over 27% to 58.64 in the second six month period following the commencement of ergonomic interventions.

Plant-Wide Cumulative Trauma Disorders (Total Cases)

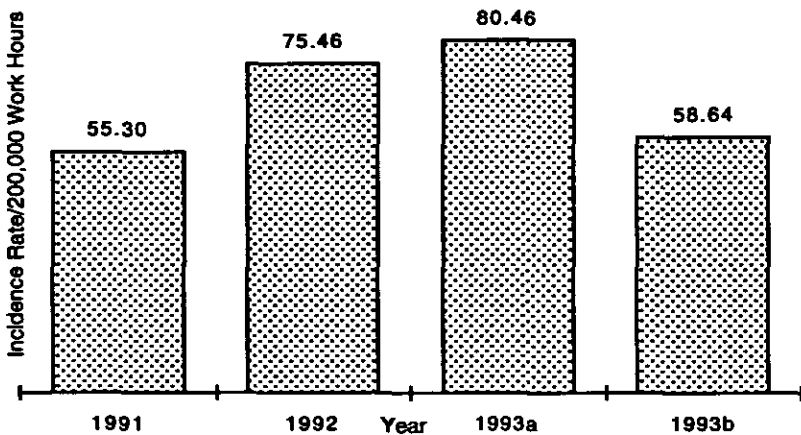


Figure 8. Plant-wide Cumulative Trauma Disorders Incidence Rates

Physician CTD Cases: To assess the impact of the ergonomic interventions on the severity of these CTD cases, incidence rates were examined for the CTD cases that required a visit to a medical physician. Figure 9 shows that physician-referred CTD rate for the 1991 benchmark year was 31.56, rose to 36.74 in 1992 and then began to fall once the ergonomics program was initiated. For the first six months of the 1993 period the physician CTD rate was 35.16, while in the latter six-month period it had fallen to 24.04 (down nearly 32% from the previous time period).

Plant-Wide Physician Cases (for Cumulative Trauma Disorders)

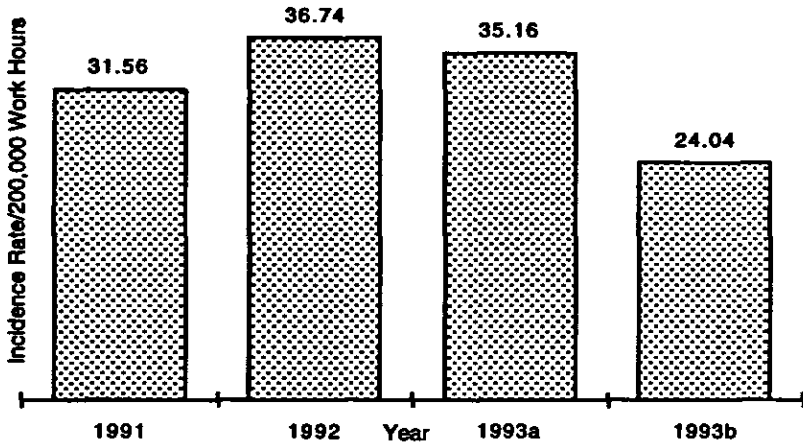


Figure 9. Plant-wide Physician CTD Cases Incidence Rates

Production Days Lost: Two types of data were examined to determine the effects of the ergonomics program on the productivity of plant personnel. One was the rate of lost production days due to CTD cases, the other was “restricted duty days.” As shown in Figure 10, the “production days lost” incidence levels decreased steadily across the 1991-1993 time periods. Discussions with plant management revealed that these decreases were, in part, due to an active effort on the part of plant management since 1991 to reduce the number of production days lost to injuries and illnesses. Medical management personnel mentioned that plant personnel were trying to develop as many “light duty” or “restricted duty” jobs as possible for injured personnel. Thus, these decreases in lost production days should not be interpreted as being totally associated with ergonomic changes in the plant.

Restricted Duty Days: Based on the movement to more restricted duty jobs in the plant when possible, a continual rise in restricted duty days across the 1991-1993 time period was expected. Figure 11 does show that the restricted duty days incidence rate increased

Plant-Wide Production Days Lost (for Cumulative Trauma Disorders)

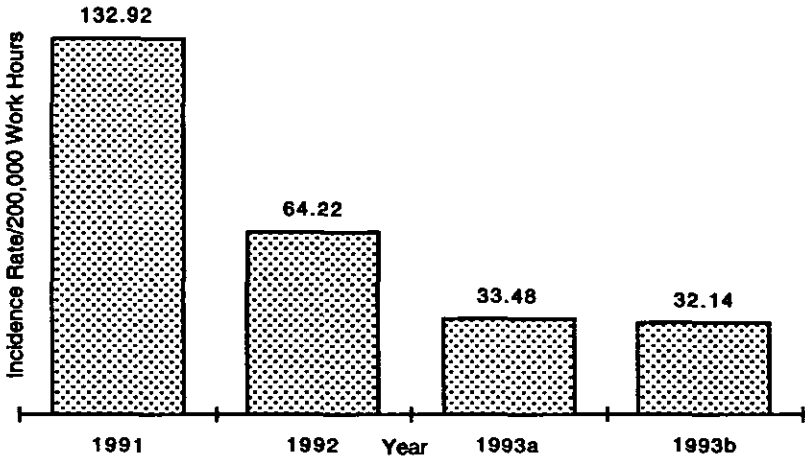


Figure 10. Plant-wide Production Days Lost Incidence Rate

Plant-Wide Restricted Duty Days (for Cumulative Trauma Disorders)

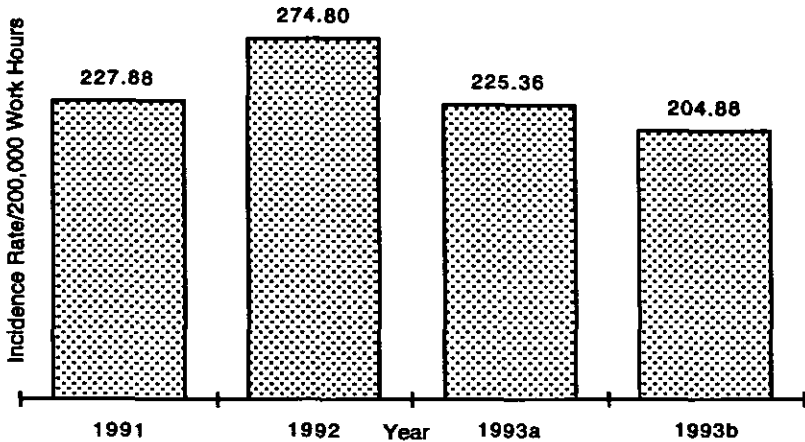


Figure 11. Plant-wide Restricted Duty Days Incidence Rates

from 227.88 in 1991 to 274.80 in 1992. However, after the ergonomic interventions began, the incidence rate of restricted duty fell to 225.36 in the first six months of the 1993 time period, and even further to 204.88 in the second six months of the 1993 period. This latter figure represents a 25.5% decrease in the restricted duty days incidence rate since the 1992 peak. Thus, it appears that the lower severity rates of CTDs also resulted in fewer restricted duty days for plant employees.

Employee Absenteeism: Information was collected on the number of days lost to absenteeism in the plant for 1991-1993. This absenteeism information includes all employee absences from work except vacations, birthdays, and days lost due to industrial illness. As depicted in Figure 12, overall absenteeism did not change much in the time periods of the research study. In 1991, 12.17 days were lost per person in the plant, while in 1992 and 1993, 11.15 and 11.57 days were lost, respectively.

Plant-Wide Employee Absenteeism

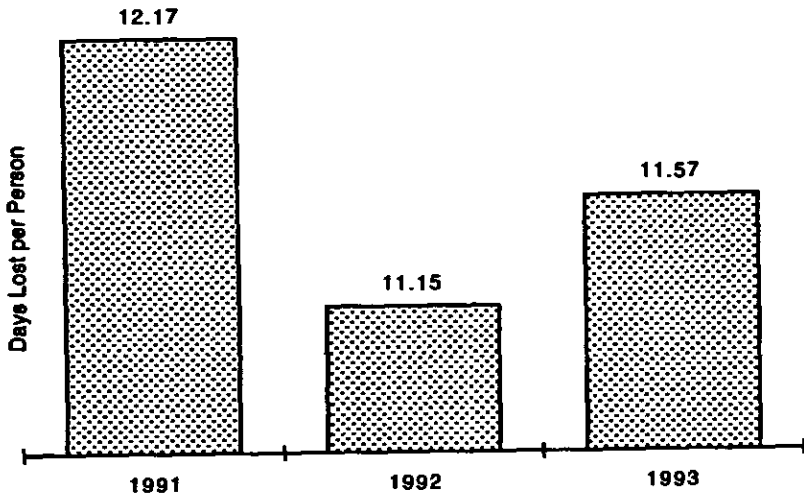


Figure 12. Plant-wide Employee Absenteeism

Employee Turnover: Information was also collected on the number of terminations and the number of employees in each of the departments during each of the years in the 1991-1993 period.

From this information, the turnover percentage was calculated in the plant for time periods of the study. Figure 13 shows that the percentage of turnover in the plant remained steady from 20.77% in 1991 to 20.70% in 1992 before the ergonomic changes took place. After the ergonomics program became active, the plant-wide turnover percentage fell to 17.67% in 1993. Thus, the costs of recruiting, hiring, and training approximately 25 employees may have been saved, at least in part, by the ergonomics project. Conservatively, it was stated that the plant experienced increased retention of employees without an associated increase in CTD incidence levels. Indeed, as noted earlier, CTD incidence rates actually fell.

Plant-Wide Employee Turnover

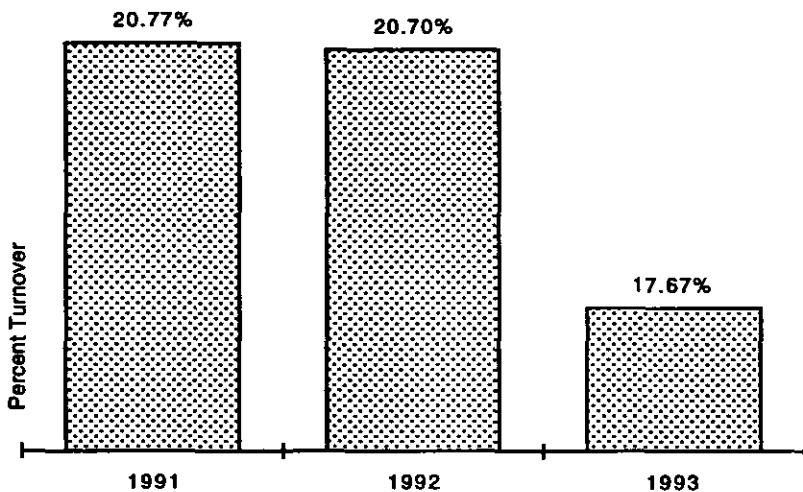


Figure 13. Plant-wide Employee Turnover Percentages

Departmental Reports of CTDs, Physician Cases, Days Lost, Restricted Duty Cases

Cumulative Trauma Disorders (CTDs): Information on the incidence rate of cumulative trauma disorders by plant departments is displayed in Figure 14. The Kill Department tended to have the highest incidence of CTDs of all departments for each of the years. The trend of CTD incidence rates across the four time periods generally reflected the plant-wide changes discussed above. That

is, three of the four departments experienced increases in their CTD incidence rate from 1991 through the first part of 1993. However, incidence rates were lower for the latter half of 1993 for all four departments, with three of the departments (Cut, Kill, and Bone/Special Meats) exhibiting large reductions from the previous six month period (19%, 33%, and 42%, respectively).

**Cumulative Trauma Disorders by Department
(Total Cases)**

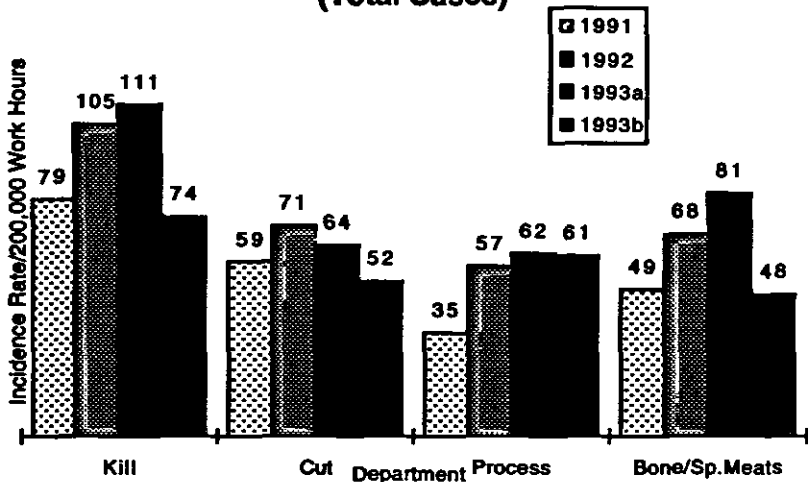


Figure 14. Cumulative Trauma Disorders Incidence Rates by Department

Physician CTD Cases: The objective measure of employees’ CTD severity, the physician-referred incidence rate, is displayed by department in Figure 15. These graphs demonstrate that severity of CTDs experienced by plant personnel decreased across three of the four departmental areas in the latter part of 1993. The largest percentage reductions in physician-referred cases were in the Kill and Boning/Special Meats departments with 51.7% and 47.3% decreases, respectively. In contrast to the other departments, the Process area had a slight increase in the incidence of more serious CTDs.

Production Days Lost: The “production days lost” incidence rate across the departmental areas is depicted in Figure 16. The overall trend in the plant toward fewer production days lost since the 1991

Physician Cases by Department (for Cumulative Trauma Disorders)

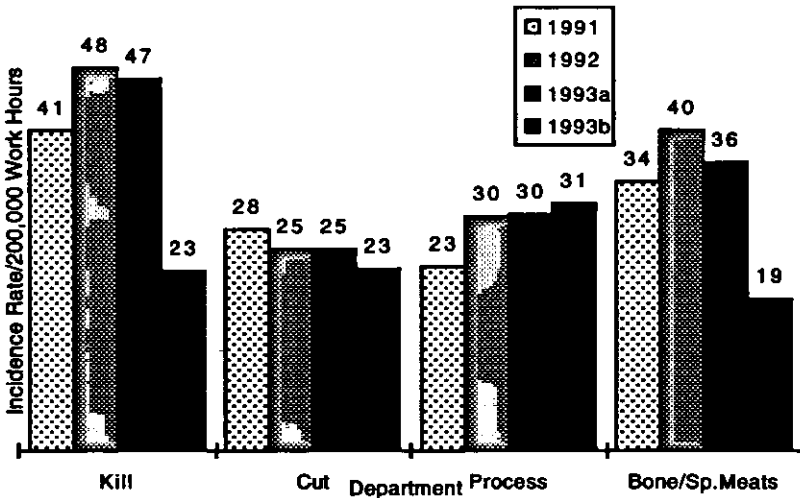


Figure 15. Physician CTD Cases Incidence Rates by Department

benchmark year is reflected in all of the departments except the Cut area. The largest percentage abatements from the first part of 1993 to the latter part of 1993 were again displayed by the Kill and

Production Days Lost per Department (for Cumulative Trauma Disorders)

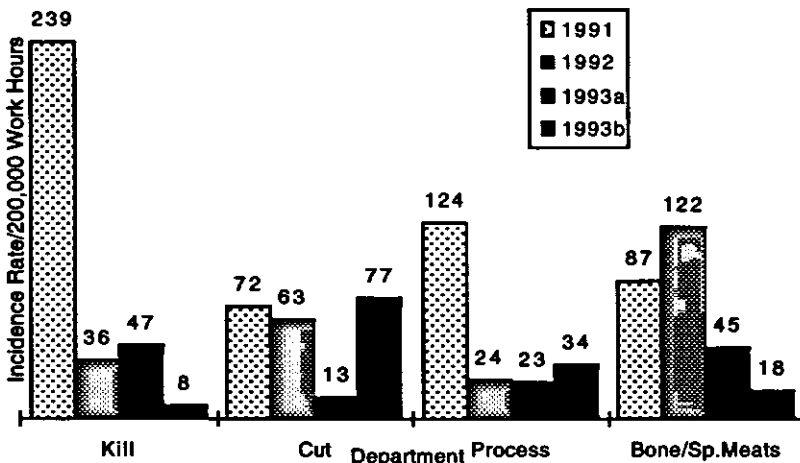


Figure 16. Production Days Lost Incidence Rates by Department

Bone/Special Meats areas which had reductions of 83.9% and 59.2%, respectively. As stated above, these results are likely due to a combination of the plant's change in policies (i.e., reduced lost days due to injuries through developing more light-duty jobs for injured personnel), and the ergonomics program.

Restricted Duty Days: Figure 17 illustrates the restricted duty days for the departments across the four time periods. The plant-wide pattern of an increasing incidence of restricted duty days from 1991 to 1992 and then steadily decreasing figures, is best exhibited by both the Cut and Bone/Special Meats areas. Indeed, the percentage decreases from the beginning six months of 1993 to the latter portion were 44% and 33% for the Cut and Bone/Special Meats departments, respectively. Contrary to this trend, the Process department had consistent increases in restricted duty days, consistent with the increases in CTD severity for this department discussed above.

**Restricted Duty Days per Department
(for Cumulative Trauma Disorders)**

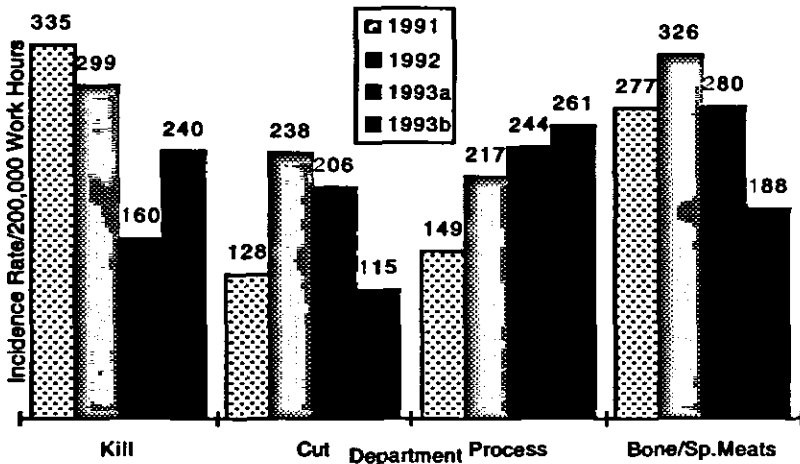


Figure 17. Restricted Duty Days Incidence Rates by Department

Employee Absenteeism: Analyses were also conducted to examine the level of absenteeism per person in each of the departments (see Figure 18). These findings revealed that the Kill and Cut

Employee Absenteeism by Department

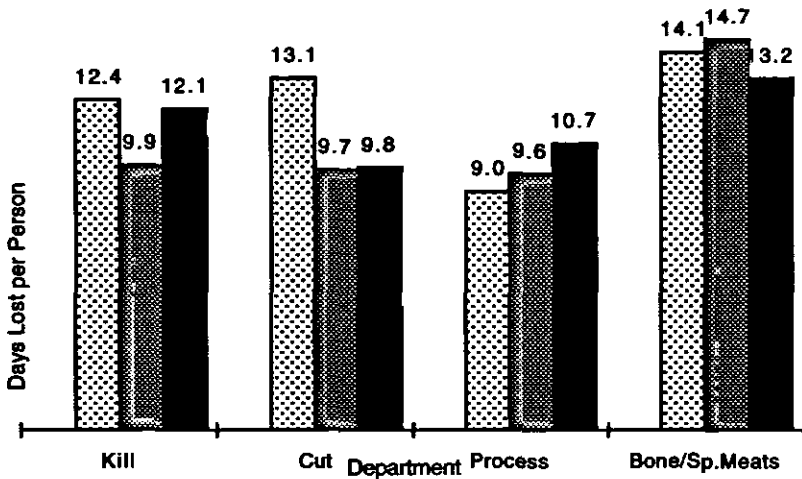


Figure 18. Employee Absenteeism by Department

departments appear responsible for the 8.4% plant-wide decrease from 1991 to 1992. However, in 1992-1993 the effect on the plant-wide absenteeism rate from the 10% reduction in the Bone/Special Meats area was generally negated by increases in the Kill, **Employee Turnover by Department**

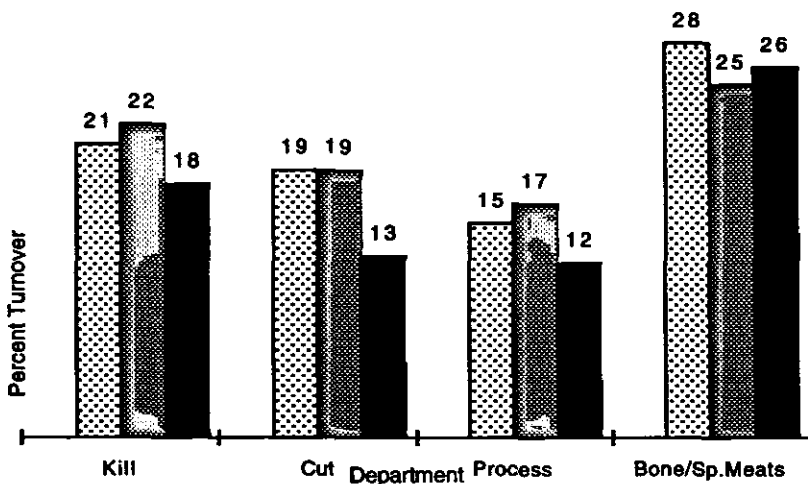


Figure 19. Employee Turnover Percentages by Department

Process, and Cut areas. Process was the only department with consistent growth in employee absenteeism for the study's time periods.

Employee Turnover: The most notable facts about the departmental turnover data shown in Figure 19 is that employee turnover decreased in three of the four departments from 1992 to 1993. Kill, Process, and Cut had reductions of 18.7%, 25.3%, and 32.2%, respectively. There was relatively little change in the turnover rate of the Bone/Special Meats area, which maintained a high turnover rate for all three years.

CONCLUSIONS AND RECOMMENDATIONS

Overall, the ergonomics program in this plant was successful in achieving a number of the objectives set forth at the beginning of the program. The participatory team approach to ergonomics, accenting worker involvement in team efforts to define and solve problems, was implemented. Team functions and effectiveness in carrying out these tasks were assessed and some groups were found to be more productive than others in completing ergonomic job changes having positive effects on CTD problem indicators, but all teams realized success in at least one of these measures. Quality of leadership, cohesiveness of the team, and more deliberate, systematic approaches to decision-making appeared to play key roles in effective team operations, as perceived by the team members and outside university observers.

In terms of beneficial impacts, the information presented here showed both the overall incidence rate and the severity of cumulative trauma disorders to have decreased in the plant as an outcome of the intervention program. Because of these reductions, the plant has also seen a decrease in the incidence of restricted duty days. Finally, turnover among plant employees has declined as well. Information gathered in the employee surveys seems to substantiate that employees are feeling less persistent pain and that the pain they do have is less severe. Analyses of the employee survey revealed that pain severity

decreased, particularly among those who had some form of ergonomic job change. These individuals also expressed fewer intentions to leave the company than those who did not experience some form of ergonomic change. Employees with an ergonomic job change also maintained a more positive attitude toward the ergonomics program than those whose jobs were not changed. A number of specific recommendations emerged from this plant's experience with a participatory ergonomics approach that confirm and give concreteness to certain ideas found in the literature on team approaches in problem solving as well as suggest added thoughts for general consideration. The following elaborates:

- **Team Composition, Reporting Structure, and Leadership:** The ergonomics team composition and leadership are extremely important in establishing effective patterns of member interaction and task processes in the group. The operation of the teams in this research suggested that the inclusion of both top management and labor representatives may make interaction difficult. Teams composed of employees, medical staff and maintenance personnel, with management support, may be more effective than teams that actually include both upper management and employee representatives. Instead, teams could report through department supervisors or other intermediaries to the top plant management. Also, the employee representatives on the team should come from a diverse background of jobs in the department with different levels of experience. Experienced members can discuss what it is like to work in a given job, while relatively new personnel can add fresh insight to job analyses. Finally, teams should be allowed to choose their own leaders from among the employees on the team.
- **Maintenance Staff Involvement:** Having maintenance personnel on the teams should be stressed to any organization implementing the team approach since it is the maintenance personnel that implement almost all of the ergonomic changes. Optimally, maintenance staff should be

given blocks of time that they can dedicate to making ergonomics changes at times when the plant is not in full operation (e.g., weekends or evenings).

- **Smaller Teams with More Ergonomics Expertise:** Employee involvement efforts should consider narrowing the number of members on each team to approximately five so that members can develop greater expertise in the area of ergonomics and be able to discern differences between safety risks and ergonomics risk factors in the plant. Task and social interaction would also be more easily facilitated within these smaller teams. Needs for merging night shift team members with day shift teams should also be considered to facilitate communication and ideas between the two shifts.
- **Continual Training:** To facilitate effective team interaction and ergonomic expertise of team members, continual training should be stressed for team members. Observations here suggest that additional team-building processes and ergonomics training are likely to benefit team members after initial training in these areas.
- **Broad-based Involvement of Plant Employees:** Although the team approach provides representative input, participation should include a broader base of employees in order to identify problem areas and increase the likelihood of acceptance of solutions. Team members indicated informally that their success depended greatly on fellow employees. Indeed, Caplan (1990) has suggested that focus groups of employees be used to get feedback on ergonomic changes before implementation. Pre/post-survey differences revealing less favorable attitudes toward the ergonomics project by the plant population suggests that the initial employees' expectations for the program were not met. Greater levels of communication with employees should be undertaken to avoid unrealistic expectations at the beginning of a program, and then maintained consistently throughout, so that employees are informed of progress on different projects.

- **Team Accountability/Communication with Plant Employees:** Related to the above point, mechanisms should also be in place which allow other plant employees to review the teams' ergonomics projects and the current status on those projects. Thus, the teams become accountable to the employees in their department for making progress on specific ergonomics projects. As such, projects should be posted by priority with anticipated dates of completion.
- **Team Autonomy:** Given this increased accountability to employees, ergonomics teams should also be given greater authority to make ergonomic changes within specific budgetary constraints. Important resources and information should also be accessible to the team. Experienced team employees can particularly help with these issues.
- **Team Functioning:** Teams should be trained and monitored regarding the internal task-based processes discussed above: goal setting, prioritizing projects, and developing workable solutions to problems. Team meeting agendas should be distributed in advance of the meeting.
- **Ergonomics Project Documentation:** Plant management should ensure that ergonomics teams are continually documenting their ergonomics project activities through the following means: written documents, videotapes (before and after), slides, and employee testimonials. This documentation process should be systematic and have a uniform format so that projects and their outcomes can be compared objectively.
- **Release Time and Overtime:** Team members should be formally released at times from other duties to focus solely on ergonomics issues. Opportunities to do some work on overtime should be permitted to avoid resentments being built up among co-workers when members are released from their normal duties to work on "special" projects.
- **More Systematic Job Analysis Needed as Teams Develop:** While at first teams should focus on the identification and implementation of relatively easy ergonomic job changes in order to build team confidence and efficacy, this activ-

ity should not deter efforts at more deliberate, systematic analyses of work conditions or the need to undertake larger scale, more formidable projects as deemed warranted.

- **Address Existing Problems, Then Preventive Measures for CTDs:** Ergonomic interventions should follow the two-stage approach advocated by Adams (1993). The first priority should be to address existing problems with ergonomic solutions. This process should begin with a systematic job analysis process that reviews the stressors present and prioritizes the problems for implementation. Attempts should then be made to prevent CTDs by effectively designing future tools, equipment, and workstations. Employee-driven ergonomics provides a solid base for both stages of ergonomic improvement.
- **Full-time Plant Ergonomist:** The presence of a full-time plant ergonomist can greatly facilitate efforts of the ergonomics teams and assist in developing engineering solutions to designated problems. Without such an internal advocate, many important projects are either never pursued or are dropped due to lack of ergonomics expertise.
- **Management Information System:** Any effective employee involvement effort in ergonomics should provide ongoing feedback and information to the teams responsible for the ergonomics changes and to top plant management. Such information is vital to the detection of worksite hazards and the development of viable solutions to ergonomic-related problems. The teams in the current plant received much of this information from the medical management staff and university researchers regarding incidence of CTDs by type of job and tool used. Efforts must be made to establish an effective management information system that employees can easily learn to use and access when gathering data on ergonomic-related issues.

In summary, the ergonomics intervention project described in this case study was an extensive effort initiated by both plant manage-

ment and university faculty. As evidenced here, the project was successful in demonstrating a team approach to addressing ergonomic problems in a meat-packing environment and in yielding many recommendations for enhancing the process of employee involvement in defining and solving ergonomic problems in this type of work and others as well. The case study also shows that the applications of such efforts carry the potential for significant reductions in workplace illness and injuries.

REFERENCES

- Dyer, W. G. (1987). *Team building: Issues and alternatives* (2nd Ed.). Reading, MA: Addison-Wesley.
- Parker, G. M. (1991). *Team players and teamwork: The new competitive business strategy*. San Francisco, CA: Jossey-Bass.

CASE STUDY #2

Based on the Final Report of:

**A Cooperative Agreement* with
Department of Preventive Medicine
Medical College of Wisconsin
Milwaukee, Wisconsin**

**J. Steven Moore, M.D., M.P.H., C.I.H.
Co-Principal Investigator
Department of Preventive Medicine
Medical College of Wisconsin**

**Arun Garg, Ph.D.
Co-Principal Investigator
Department of Industrial and Systems
Engineering
University of Wisconsin - Milwaukee**

CASE STUDY #2

The Setting

This study involved two components. One was the description of a corporate ergonomics program and assessment of this program's effectiveness. The second part was a demonstration project that examined the activities and performance of two ergonomics teams in a single plant of the corporation.

The Corporation: The corporation and its subsidiaries manufacture, market, and distribute thousands of products, principally fresh, frozen, smoked, cooked, and canned processed meats. These products include sausages, hams, wieners, bacon, canned luncheon meats, shelf-stable microwavable entrees, stews, chilies, hash, meat spreads, and frozen processed products. The corporation's meat and food products manufacturing facilities are located in Iowa, Minnesota, Wisconsin, Texas, Oklahoma, California, Georgia, and Kansas. Internationally, the corporation has operations in the Philippines, Japan, Korea, England, and other European countries.

Corporation employees first organized as a union in 1933. The name of the union changed over the years as a result of affiliations and mergers, but since the late 1970s, the plant workers have been represented by the United Food and Commercial Workers Union (UFCW), AFL-CIO.

In terms of employee benefits, the company established a guaranteed annual wage for its production workers in 1933. This program guarantees all workers a minimum annual wage based on 36 hours per week, even if the actual number of hours worked is less. This plan also guarantees that workers will receive these wages for the 52 weeks following notification of a plant closing. The company established a Joint Earnings Plan, a profit sharing plan for all employees, in 1938. This plan is guaranteed and allows workers with 30 years of seniority, regardless of age, to retire with no reduction in benefits. For years, an incentive system was used to determine worker wages, but in 1978, the corporation and the UFCW reached agreement that led to the ultimate discontinuance of the incentive pay system that had been in effect for 41 years for union workers.

The Plant: The corporation purchased this plant in 1947. At that time, the plant slaughtered and processed beef. The following year, the operations expanded to include pork. In 1977, the plant discontinued its beef operations and since then, the plant operations only include the slaughtering and processing of pork.

This plant has experienced two notices of plant closings (Local Secretary-Treasurer, UFCW, 1993). The first occurred in 1981, shortly after another, newly renovated corporate facility opened. The plant operations were continued when it was agreed to phase out the incentive wage system over the next three years. The plant received another notification of closing in 1988. The closing was limited to the Kill and Cut departments and would have affected 325 production workers. This closing was avoided when a split wage system (one wage scale for slaughterhouse workers and another for the processing workers) was accepted for the slaughtering operations workers.

There are currently approximately 930 workers of whom 830 are production workers. Approximately 778 of these production workers are represented by the United Food and Commercial Workers (UFCW) (Local Secretary-Treasurer, UFCW, 1993). Since the plant has recently hired new workers, not all are currently eligible to join the union. Aside from wages and the wage guarantee plan, union workers at the corporation also receive a full package of health care benefits, the guaranteed pension plan, sick leave benefits, long-term disability benefits, and are covered by a transfer agreement. There have been no strikes at this plant.

This plant is in the midst of a major renovation project. The Kill Department started installing new lines in September 1993. Its renovation should be completed by late 1994. Renovation work related to the Cut Department is scheduled to start in 1994 and to continue into 1995. Many changes related to the ergonomics teams' activities, especially design and layout changes, are scheduled for implementation during the renovation.

In 1985, the line speed of this plant was 625 hogs per hour. The line speed increased to 685 in August 1987, followed by another increase to 711 in April 1988. The speed increased again in September 1988 to 726, then to 741 in September 1990, and increased to 747 in August 1991 before reaching its current rate, 762, in November 1991. Post-renovation, the plant hopes to have the ability to process 1,000 hogs per hour, but no timeline for reaching this goal has been established.

PRE-EXISTING LEVEL OF ERGONOMIC CONCERNS/ EFFORTS

The Corporate Ergonomics Program

The corporation began development and implementation of its ergonomics program in 1986. OSHA citations of other red meat packers and the resulting media attention, as well as a corporate evaluation of workers' compensation costs contributed to the company's awareness of the need for an ergonomics program.

The proposed goal of the program was to: "Establish a company-wide employee-involved continuing program to: reduce the amount of physical stress in the workplace; prevent internal damage to the body; and reduce the cost of work-related injuries and illnesses."

This program was developed primarily by a Corporate Ergonomics Coordinator, an industrial engineer with more than 45 years experience in meatpacking and the processing of pork. Organizationally, he is in the Corporate Operations and Engineering Group. He gained knowledge about ergonomics primarily through industrial engineering methods and layout work, short courses (including the OSHA five-day ergonomics course), and readings. Even though the corporation started developing their program in the mid-1980s, the OSHA Ergonomics Program Management Guidelines for Meatpacking Plants was used as a template for the formal written corporate program. The major reason for this latter choice was the desire to parallel OSHA's format.

In terms of structure, the corporation uses a Corporate Steering Committee to authorize, guide, and support all ergonomics-related activities. The members of this committee include the Vice President for Engineering, the Corporate Counsel, the Vice President of Beef and Pork Operations, the Director of Industrial Engineering, Corporate Safety and Security Manager, the Group Vice President for Operations, and the Corporate Ergonomics Coordinator. The Corporate Steering Committee communicates to individual ergonomics committees within each plant through plant managers. This is done to ensure supervisory as well as employee participation.

The corporation cites four advantages of corporate coordination:

1. It ensures the placement of proper priorities;
2. It facilitates the authorization of resources;
3. It provides a source of motivation for compliance; and
4. It facilitates the sharing of ideas and solutions.

Even though the Corporate Ergonomics Program started in 1986, the written program was not completed, approved, printed, and distributed until July 21, 1992. This written program was communicated to all company personnel.

The following sections summarize the highlights of the corporation's ergonomics program. This information was primarily obtained by review of the written program and discussions with the Corporate Ergonomics Coordinator.

Management Commitment

In 1986, the Chairman, the President, and the Chief Executive Officer of the corporation formalized the company's policy on the issues of safety, health, and ergonomics. This Safety, Health, and Ergonomics Policy focuses on four key elements:

1. Concern about employees' continued health and safety;
2. Commitment to the implementation and maintenance of effective safety, health, and ergonomics programs

- and to the promotion of these programs through employee participation, awareness and education;
3. Through each plant's established committees and programs on safety, health, and ergonomics, the employees are encouraged to participate and provide input to develop and maintain a safe and effective workplace; and
 4. The safety, health, and ergonomics programs are, and must continue to be, an integral part of all of the corporations operations.

Employee Involvement

The corporation's methods to achieve employee involvement include:

- the use of employee surveys, questionnaires, and suggestion procedures in a spirit of cooperation and mutual benefit;
- the use of procedures that endorse prompt and accurate reporting of signs and symptoms (use of an educational videotape and booklet about signs and symptoms, ergonomics, and participation; an encouraging letter from the Corporate Steering Committee; and re-emphasis during the training program);
- interaction with other quality, safety, and health committees; and
- training for all members of each ergonomics committee to develop ergonomic skills (this training is coordinated and given by the Corporate Ergonomics Coordinator).

Program Elements

The corporation's Ergonomics Program closely parallels the OSHA Meatpacking Guidelines. There are four major sections: Workplace analysis; Hazard correction, prevention, and control; Medical management; and Training and education.

Workplace Analysis: The corporation uses its own forms and checklists, injury/illness data, and workers' compensation expense data to target jobs for more detailed analysis. Aside from identifying existing problems (retrospective intervention), this method also allows the ergonomics committees to become involved in planned changes, such as new facilities, processes, materials, and/or equipment (prospective intervention and design). This analysis method also helps the committees identify potential light duty jobs and jobs without apparent hazard. Analysis of these latter jobs (those without apparent hazard) can be deferred to a later time (assigned low priority for committee effort).

Hazard Correction, Prevention, and Control: The corporation uses the following procedure for hazard correction:

1. Targeted corrections are listed;
2. Priorities for corrections are established;
3. Individual assignments are made (*e.g.*, the industrial engineer is to contact a manufacturer to obtain some equipment within one week);
4. Action is initiated;
5. Progress is monitored;
6. Problems that arise are solved;
7. Accomplishments are recorded;
8. Corrected status is maintained; and
9. Successes are shared with other corporate plants.

In terms of prevention and control, the corporation relies on the four traditional techniques of exposure control: engineering techniques, work practice controls, personal protective equipment, and administrative controls. The corporation prefers engineering solutions and believes that engineering techniques are best done during design or modification of work stations, work methods, or tools. Work practice controls include items such as appropriate employee training on work technique, tool care (*e.g.*, knife sharpening), proper body mechanics, proper use and maintenance of power tools, and correct use of ergonomically designed and/or adjustable work stations. Included under the category of personal

protective equipment are safety glasses, helmets, ear protection, gloves, guards, shields, shoes, harnesses, tethers, aprons, scabbards, etc. The corporation has struggled with the issue of personal protective equipment in the context of ergonomics. At this time, it does not mandate the use of back belts or hand/wrist supports as personal protective equipment unless prescribed by medical authorities or specifically requested by an employee. In terms of administrative controls, the corporation applies the following techniques:

- monitoring of machine use and line speed to determine if job demands are compatible with current staffing;
- making and checking for provisions for scheduled rest pauses;
- balancing manpower to expected production;
- ensuring proper job rotation;
- developing and implementing job enlargement;
- ensuring preventive and regular maintenance of equipment;
- a knife sharpening program;
- effective housekeeping and cleanup; and
- avoiding negative environmental factors.

Medical Management: The medical management component of the corporation's Ergonomics Program is defined or summarized as:

“a conscientious attempt to eliminate the risk of development of cumulative trauma disorder signs and symptoms through early identification and treatment and to the prevention of future problems.”

This provision of their ergonomics program includes the availability of first aid and nearby physician and emergency medical care. In terms of specific medical management issues, the following items are specifically addressed:

- accurate record keeping;
- facilitated early recognition and reporting;
- systematic evaluation, treatment, and referral;
- preference for conservative treatment;
- pre-surgical second opinions;
- conservative return-to-work plans;
- systematic monitoring of affected workers (*e.g.*, break-in time and/or work hardening);
- adequate staffing, training, and facilities for medical care; and
- no standardized treatment procedures.

Training and Education: The purpose of the corporation's training and education efforts are to ensure that employees are sufficiently informed about ergonomics principles and injury prevention to be able to actively participate in the corporation's ergonomics efforts. In addition, the training incorporates topics about how employees can participate in the program. The training audience includes all hourly employees (plant and office), engineering and maintenance personnel, supervision, management, and health care providers in all plants. The training is presented in language at an appropriate level of understanding for the target audience. Topics include proper and safe work methods, the physiology and symptoms of cumulative trauma disorders, and means of prevention, coping, or treatment. The training program also includes some measures of training effectiveness (interviews, testing, and observation). Most training topics are generic, but some job-specific training is also incorporated.

Implementation

Since the corporation's ergonomics program has been operating for several years, a certain methodological pattern has emerged in terms of implementation. In general, the Corporate Ergonomics Coordinator first examines the injury investigation reports for a plant or a specific department within a plant. These reports are used to target specific jobs for evaluation. The next step is a Safety and Ergonomics Survey. This survey, completed by all workers

performing all jobs in the plant, asks about the presence of symptoms (lasting aches or sore spots), the perceived cause of these symptoms, the comfort of the workstation, the comfort of tools (if any), miscellaneous questions related to the way the job is performed (*e.g.*, lifting, lighting, pushing, pulling, posture, footing, noise, reach envelope) and other safety-related issues. The responses for each Safety and Ergonomics Survey are reviewed by the industrial engineer assigned to the department. Obvious hazards are addressed immediately. Other identified or suggested problems, such as the presence of musculoskeletal risk factors, are marked for special study. The results of the survey and any corrective actions are communicated to the Corporate Ergonomics Coordinator.

The next step in the methodology is to prepare supervisors and workers at the plant for upcoming study of the ergonomics-related problems identified in the survey. These activities are done by ergonomics teams composed of representatives from production workers, clerical workers, management, supervision, mechanics, and engineers. In general, the production and clerical workers are volunteers that, if represented by a union, would either be selected or endorsed by the union. The committees are structured so that the number of worker and management representatives are balanced. All members of the ergonomics teams are trained by the Corporate Ergonomics Coordinator. This training includes information related to musculoskeletal risk factors, musculoskeletal disorders, and teamwork. Training materials include some didactic material plus a variety of videotapes, booklets, and prepared educational materials that are selected according to the needs of the target audience. Upon completion, each member of the team receives a membership card listing the goals of the program on one side and summarizing a brief list of ergonomic "rules of thumb" on the other. To date, this training has been given to over 5,000 plant employees participating on ergonomics teams. This includes office ergonomics training for over 45 quality groups in the corporation's offices (over 600 people).

Each ergonomics team studies each job in its department using assessment tools developed by the corporation, *i.e.*, a Cumulative Trauma Disorder (CTD) Risk Factor Checklist and a Job Analysis Checklist. The CTD Risk Factor Checklist inquires about the presence of generic risk factors for upper extremity disorders as well as postural stability, unaccustomed activity, work pace, and selected personal characteristics. The Job Analysis Checklist is a one-page checklist that asks about risk factors related to the torso, the hands, the wrists, and the environment in general. This checklist is also being developed so it can be matched to a worker capability assessment, completed by health care providers, to optimize matching of worker capabilities to job demands, especially for workers returning after injury with limited capabilities.

In addition to the assimilation of data from the Safety and Ergonomics Survey, the CTD Risk Factor Checklist, and the Job Analysis Checklist, the ergonomics teams also meet with the workers performing the jobs. One result of this project has been the development of a new worker feedback form. Using the worker feedback form as a guide, one or more team members discuss an individual job and its effects on each worker individually. Following this data collection process, the ergonomic teams summarize their findings, brainstorm possible solutions (*e.g.*, new ideas, new opportunities to apply old ideas or interventions from other facilities), and discuss potential problems associated with the proposed solutions. After the teams reach consensus on the recommended interventions, implementation is discussed with supervisors and their findings documented in writing.

Prior to submitting a recommendation for change to management, the ergonomics teams use a checklist for ergonomic safety and efficiency as an additional level of assessment of the intervention. The topics of this checklist include assessment of effects on the following:

- efficiency and/or productivity;
- future productivity potential;
- job simplification;
- safety;

- improved morale;
- proper environmental parameters; and
- consistency with existing ergonomic recommendations for job design.

The checklist also includes spaces for reviewer recommendations and comments. The checklist is presented to the plant manager and, when approved, referred to the Corporate Engineering Group for consideration. The Corporate Engineering Group reviews the ergonomics team's findings, obtains clarification of any obscure or confusing findings, and prioritizes the recommended interventions. The team leader of each ergonomics committee, usually an industrial engineer, works with the Corporate Engineering Group to sort, assign, and schedule follow-up evaluation. As needed, the teams and/or the Corporate Engineering Group obtains assistance related to design, drafting, ordering, and/or installing new equipment. They may also need assistance in obtaining appropriate approvals (*e.g.*, from the United States Department of Agriculture) and obtaining appropriated funds. All negative comments related to this checklist must be addressed before the plans for intervention are considered acceptable.

When necessary, an ergonomics team can use a task force approach that incorporates a larger scope of human resources at the plant. The ergonomics teams also revisit prior interventions to follow-up on their effectiveness and review new or proposed workstations or operations. The teams also assess and/or monitor all new installations or modifications at the plant to ensure "ergonomic correctness." This may involve administration of one or more of the checklists. Finally, the teams provide information and success stories to corporate headquarters for distribution to other plants.

Communication

Each ergonomics team submits a monthly status report. This report is organized as a standardized agenda to be used for an ergonomics team's monthly meeting. The agenda includes the following items:

- a review of the previous month's injuries, their implications, and related action plans;
- a review of ergonomically-related workers' compensation and medical costs;
- an update of corporate audit progress;
- old plant recommendations;
- new plant recommendations;
- ideas and successes that should be shared with other facilities;
- special topics;
- a review of ergonomic checklists associated with changes that need to be made or have been proposed;
- a review and forwarding of any Safety/Ergonomics Surveys that have been filled out by employees who have performed a new job after three months; and
- any listed suggestions to improve the Ergonomics Program.

At the corporate level, these monthly reports (from all ergonomics teams in all plants within the corporation) are reviewed by the Industrial Engineering Manager and the Corporate Ergonomics Coordinator. This allows them to monitor each plant's or team's activity and progress. Since 1988, the corporation has published a quarterly newsletter entitled "What's New in Ergonomics." The purpose of this newsletter is to communicate news related to ergonomics, report on the status of the ergonomics program, serve as a reminder so that heightened awareness is maintained, and share the experiences of individual ergonomics teams. The newsletter is distributed to all plant managers and all plant ergonomics teams, and team leaders. In general, the plant managers route the newsletter to all superintendents. The list of topics can be quite varied.

Summary

The corporation implemented their Ergonomics Program in 1986. The structure of the program is consistent with the OSHA guidelines for this industry. A Corporate Ergonomics Coordinator oversees,

tracks, and audits the activities of ergonomics teams within each plant. A variety of forms and checklists are utilized to identify musculoskeletal and safety-related risk factors for injury. Parts of these forms also serve as a source of information on employee symptoms. Overall, the ergonomics program of the corporation is characterized by comprehensive scope, structure, and communication.

ERGONOMICS AT THE PLANT

This plant was one of the first sites to implement the corporation's ergonomics program. Activities started around 1986-1987. Organizationally, there is one ergonomics committee that oversees ergonomics activities at the entire plant though each department may have its own ergonomics team that is accountable to the

Department	Number of Job Changes
Bacon Slice	15
Bacon Slice/PFLM	1
Edible Rendering	1
Fresh Sausage	1
G.P.Can Meat	5
Ham Bone	7
Hog Cut	30
Hog Kill	37
Inedible Rendering	1
Market Ship	2
Office	7
Plant	7
Preparation Sausage Manufacturing	6
Quality Control	5
Sliced Smoked Meat	2
Smoked Meats Packing	6
Smokehouse	3
Smokehouse/Cure	1
Storeroom	2
Vat/Trolley Wash	2
Total	141

Table 1. Number of ergonomics interventions made by the plants ergonomics committee according to department.

plant's ergonomics committee. The current ergonomics committee meets twice a month using the corporate program's agenda. The eleven-member committee includes: one production worker, one office worker, one union steward, two maintenance engineers, three industrial engineers, one production supervisor, the personnel/safety coordinator, and the nurse.

Year	Number of Job Changes
1986	2
1987	1
1988	1
1989	7
1990	20
1991	24
1992	54
1993	26
ongoing	3
no completion date	3
Total	141

Table 2. Number of ergonomics interventions made by the plant's ergonomics committee by year of completion.

The ergonomics committee and teams at this plant have been quite active. Tables 1 and 2 summarize the number of projects completed or in progress by department and year, respectively.

SCOPE/OBJECTIVES OF DEMONSTRATION PROJECT

The demonstration project involved working with two ergonomics teams at the plant, a Kill Department team and a Cut Department team, to analyze targeted jobs. The targeted jobs were selected based on previous Safety and Ergonomics Surveys and other analyses (e.g., expensive compensable injuries or high turnover rates) that suggested they were problematic. In addition, none of these jobs had obvious solutions. Both ergonomics teams were charged to analyze these jobs, identify the source(s) of the problems, and develop, recommend, and implement appropriate interventions.

METHODS AND OPERATIONAL PROCEDURES

Team Formation/Member Selection

The Kill Department ergonomics team consisted of three production workers, a supervisor, one of the industrial engineers assigned to the Kill Department, the Corporate Ergonomics Coordinator, and the investigators. The Cut Department's ergonomics team was similar to the Kill Department's team except that the Cut Department had two production workers instead of three. The plant's Manager of Industrial Engineering, the plant Maintenance Engineer, and the most senior industrial engineer of the department also often attended the teams' meetings.

Team Training

The project started with a meeting at the plant. The purpose of the meeting was to clarify the scope and purpose of the project from all perspectives — the management, the union, and the investigators. This was followed by a training session for the ergonomics team members. The training curriculum, delivered by the investigators, included an overview of the demonstration project; the epidemiology, etiology, and development of low-back pain; the epidemiology, etiology, and development of upper extremity disorders; and an approach to solving ergonomics-related problems, including participatory problem-solving techniques. The audience included production workers, supervisors, maintenance personnel, engineers, and management personnel. There was no specific assessment of training effectiveness.

Team Activities re Defining/Solving Problems

Meetings and Their Assessment: After training, the investigators met with the two individual teams, Kill and Cut, to address the targeted jobs in their departments. During the calendar year 1993, there were five such meetings. It should be noted, however, that both committees occasionally met on their own in the interim. In addition, the industrial engineering members of each committee often met with the renovation project consulting firm to discuss

incorporation and implementation of their committee's recommendations. Since the members of both committees had worked together prior to this project and team dynamics were not considered pathological, little time was required for team-building activities.

Meetings were structured according to an agenda. In general, each meeting started with a review of the prior meeting's minutes. The committee's prior work on each targeted job was summarized, new data or ideas discussed, and remaining work identified and assigned.

At the conclusion of the meetings, the participants and the investigators completed meeting assessment forms adapted from Scholtes (1988). These were reviewed by the investigators to determine if changes in committee procedures or politics were necessary. In addition, one of investigators attending the meeting completed a group dynamics checklist, also adapted from Scholtes, (1988) to subjectively assess the functional dynamics of the team and its members. This information was used solely for observational purposes and, in this project, not applied as a means to manage a team member's behavior. At the end of the project, another questionnaire was given to the participants to determine their overall impressions of the meetings.

The Problem-Solving Process

The problem-solving process applied to the targeted jobs during the demonstration project was developed and recommended by the investigators. It was, to a large extent, adapted from problem-solving principles and processes related to quality management (Scholtes, 1988; Deming, 1986; Walton, 1986; Swezey, 1992). The major principles underlying the process include participation, structure, a scientific approach, and decision by consensus. The process involved five phases: problem identification, problem evaluation, solution development, solution implementation, and solution evaluation.

Problem Identification: To a large extent, the problems had been identified through the plant's previous ergonomics committee activities, such as the Safety and Ergonomics Surveys. The targeted jobs represented jobs associated with a large number of injuries, one or more particularly severe injuries, or relatively high workers' compensation expenses. In addition, they were jobs for which the company had no solutions.

Problem Evaluation: The problem evaluation process was particularly structured and emphasized a scientific approach to data collection and analysis. Following a structured method was considered important since some people have a tendency to jump immediately to solution brainstorming or even implementation without full understanding of the job and task requirements or a clear definition of the job's problems. In this project, the selected method involved the following steps: data collection; data analysis; and assessment of the problem(s). Data elements used to describe the job were grouped into background data, exposure data, and effects data.

Background data included a one sentence statement of the purpose of the job, a summary of the associated tasks, the weights or sizes of objects lifted or handled, and a description of the job's work organization (number of exposed workers, job rotation, location on the line, etc.).

Exposure data represented descriptors of the forces or movements to which the workers were exposed. One component was a summary of time-related information. This included data on the production rate (pieces per worker per hour), standard times (allowed man-minutes per piece per worker, job load and calculated cycle time), observed times (cycle time, duration of exertion per cycle, percentage of time of exertion per cycle, and frequency of exertion), and duration per day (hours). Another component of the exposure data collection was a summary of motion- and exertion-related information. This included a Therblig description of the tasks and an estimation of required intensities of exertion using a five point scale.

Associated body postures were qualitatively described. The investigators also characterized the jobs according to their Strain Index rating (Moore & Garg, in-press).

Effects data represented information that reflected the potential effects of the exposures on the workers. Recordable injuries and illnesses were ascertained by review of the OSHA 200 logs for the years 1988 through 1993 (data prior to 1988 was not available). Disorders were clustered into three categories according to anatomical body part: the distal upper extremity (elbow, forearm, wrist, and hand); the shoulder; and the lower back. Days restricted or lost, if any, were noted. Some workers on the teams had performed some of the target jobs and could offer some anecdotal insights into sites where they developed soreness or discomfort. Turnover was also used as an indicator of a potential exposure effect and, by consensus of the committee, was considered a useful indicator of problems associated with the job. A third source of effects data was worker feedback. Members of the ergonomics teams interviewed workers who currently or recently performed the targeted job. The interview followed a consistent and structured format by using a worker feedback survey. This survey incorporated some background information on the worker's affected body part, perceived problems with the job, and any recommended solutions or changes for the job. Once the data were collected, the teams reviewed and discussed the findings and determined the parts of the job that were of most concern.

Solution Development: Solutions were developed to solve the identified problems. A brainstorming technique was used to ascertain ideas, regardless of feasibility, practicality, or other such concerns. Once a list was completed, the group used informal discussion to modify, delete, and prioritize the listed ideas. Eventually, the group reached consensus on the most desirable and reasonable interventions. No formal process, such as voting, was necessary for either team.

Solution Implementation: Implementation of the recommended solutions was primarily the responsibility of the industrial engineer for the area. The engineer initiated and tracked the corporate

intervention evaluation form, contacted product manufacturers to obtain equipment, arranged simulations, and coordinated communications with supervision, maintenance, the renovation consulting firm, and others. The engineer reported on the progress of each job at each meeting.

Solution Evaluation: Given the time frame of this project, there was no opportunity for meaningful post-intervention evaluation for changes developed and implemented by the ergonomics teams. Based on discussion with the committees, however, there are plans to re-evaluate all interventions. It is planned to repeat the Worker Feedback Survey approximately three months post-intervention. This time interval was selected to minimize the potential for the Hawthorne effect — i.e., it was believed that the novelty of the intervention would have largely dissipated by then.

TEAM ACCOMPLISHMENTS

The Kill Department targeted nine jobs for evaluation. The Cut Department targeted twelve. These are listed in Table 3.

Kill Department	Cut Department
Pulling leaf lard	Lifting neckbones
Fleshing hides	Pulling ribs
Snatching guts	Skinning picnics
Tonguing and impaling heads	Scribing loins
Chiseling cheek meat	Hooking sides
Splitting hogs	Pulling loins
Positioning hogs on the	Packing loins
Gambrel table and	Palletizing loin boxes
cutting cords	Hooking bellies
Shackling hogs	Trimming bellies
Removing toe jam	Pulling butts
	Palletizing fresh pork boxes

Table 3. Jobs targeted for the Kill and Cut ergonomics teams.

The Kill Department ergonomics team addressed all nine targeted jobs; however, the team did not feel it necessary to subject all analyses to the entire formal problem-solving process. One intervention was partially installed in September 1993 and the installation of one of the renovated lines began during November of 1993. The Cut Department ergonomics team addressed eight of its twelve targeted jobs. Some were started near the end of the project period and have not completed the problem evaluation phase. No interventions were installed during the project since most involve revised layouts to be implemented with the renovation, but selected components of some intervention plans are in process. There have been no post-intervention evaluations for either team to date.

Results of the analysis of six targeted jobs (three from each department) have been summarized in report form and presented in Exhibits 1-6. Each exhibit attempts to concisely communicate the team's work.

EXHIBIT 1

Job Data

Job Name: Pulling Leaf Lard

Purpose: Remove leaf lard from the inner aspect of the abdominal cavity - improves quality of exposure to ribs - useful for rendering.

Tasks: Pull leaf lard, trim belly with a Whizard Knife, remove the kidneys.

Work Organization: The three tasks are arranged sequentially. The first worker in the line removes kidneys, the next three pull leaf lards, and the final worker uses the Whizard knife to trim the bellies. There are five workers that advance one workstation every 15 minutes.

Exposure Data

Analysis of Time:

Production Data

12.5 seconds per hog (two leaf lards per hog)

18.75 seconds per worker per leaf lard

9 leaf lards per minute

Standard Time Data

0.2133 minutes per hog

Job load = 88%

Recovery = 12%

Observed Time

Cycle time = 6.7 seconds per leaf lard

Duration of exertion = 3.0 seconds

% Exertion per cycle = 45%

Exertions per minute = 18 (two per leaf lard)

Duration per Day

9.5 hours per shift

5.7 hours pulling leaf lard per day

Analysis of Motion:

Grasp and tear loose the lower end of the leaf lard



Regrasp and pull leaf lard from the diaphragm and abdominal wall



Set aside

The workers grasp the lower end of the leaf lard with one hand. It is grasped forcefully with a tightly closed fist because of the low coefficient of friction (they also wear cotton mesh gloves). Stresses to the fingernails and back of the distal interphalangeal joints are significant. Most of these workers have lost parts of their fingernails and one had ulcers on the back side of these finger joints. The workers then supinate the forearm and pull upward to initiate the tear. Two hands are usually used when regrasping and pulling upward to remove the leaf lard. Near completion of the task, the workers hands are at approximately head height. The shoulders are almost flexed to 90°. The tissue is easier to tear during this phase of the task. When torn free, the leaf lard is dropped into a chute below.

Other Observations:

Intensity of exertion	= Hard
Posture	= Fair
Speed of work	= Fair

The Strain Index (Moore & Garg, in-press)

Exposure Factor	Rating	Multiplier
Intensity of Exertion	3	6.0
% Exertion per Cycle	3	1.5
Exertions per Minute	4	2.0
Posture	3	1.5
Speed of Work	3	1.0
Duration of Task per Day	4	1.0
STRAIN INDEX		27.0

Effects Data

Distal Upper Extremity Disorders

Year	Condition	Days Restricted	Days Lost
1988	CTS (right wrist)	13	18
	CTS and epicondylitis (both wrists and lateral elbows)	8	0
1989	None reported	0	0
1990	Tendinitis (right elbow and wrist)	0	0
1991	Flexor tenosynovitis (both hands)	0	23
1992	Discomfort (left wrist)	0	47
	Discomfort (left hand)	0	0
1993	None reported	0	0

Shoulder Disorders

{None reported}

Low-Back Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	Disc syndrome	0	106
	Lumbago	0	0
1990	None reported	0	0
1991	Strain	4	0
1992	None reported	0	0
1993	None reported	0	0

Average Rates (1988 - 1993)

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	20	363
Shoulder	0	0
Lower Back	10	367

Other Injury /Illness Data: One worker developed dermatitis of the left hand in 1991 (restricted for 3 days). Two workers strained their lower extremities. One was off work for 147 days; the other 2 days. Seven workers had lacerations or burns, primarily affecting the right hand. These traumatic injuries were associated with 15 restricted days.

Turnover Data: 10 individuals filled 5 positions in the last 2 years (100% turnover every year).

Worker Feedback Data (n=7)

Perceived problems	Total
Gripping the leaf lard	5
Breaking the leaf lard free	2
Pulling the leaf lard	1
Tearing the leaf lard	1
Rolling the leaf lard	1

Affected Body Part	Right	Left	Bilateral	Total
Neck				2
Shoulders	1	1	3	5
Elbows	1	0	0	1
Forearms	0	1	4	5
Wrists	2	0	2	4
Hands	0	0	6	6
Upper back				0
Lower back				5

Recommended Improvements

{None reported}

The Team's Assessment

- It is difficult to grasp the leaf lard because of its size, consistency, and it is slippery.
- The tight and forceful grasp creates high compression and shear forces on fingers and fingernails when grasping.
- Pulling up the leaf lard stresses the hands, wrists, and low-back.

Solution Brainstorming

- Use an automatic leaf lard puller manufactured by Durand International
- Use a leaf lard starter and/or roller manufactured by SELO
- Use a vacuum with a cutting nozzle
- Cut the lower end of the leaf lard with a knife, then pull manually
- Start at the top of the leaf lard, then pull down
- Cut the leaf lard in the middle, then pull out the halves
- Inject air behind the leaf lard to "loosen" it, then pull out
- Freeze the leaf lard, then break it out
- Use a hand-held skinner to remove it

The Proposed Solution

The plant had previously tried a single SELO unit to tear loose the leaf lard on each side of the hog. This did not work well. As an alternative, it was recommended to use two SELO units — one for right sides and one for left sides. The other solutions were considered less effective or less feasible.

Implementation Status

Two SELO Leaf Lard Starter units were obtained for trial in August 1993. A cylinder malfunction delayed the trial until September 1993. Once implemented, informal worker feedback was favorable. There were no evident adverse impacts on quality or productivity. Both units are scheduled for final installation by the end of the year.

EXHIBIT 2

Job Data

Job Name: Fleshing Hides

Purpose: Remove excess fat from hides so they can be properly salt-cured.

Tasks: Flesh hides

Work Organization: There are two workers that flesh hides regularly plus one relief person that performs this task less than half-time. The work was designed

by the industrial engineers so the fleshers would not keep up with the skimmers (the source of the hides). The relief person would catch up by working while the regular fleshers took their scheduled breaks. In reality, the fleshers work fast to stay up with the skimmers. As a result, they can take more and longer breaks.

Exposure Data

Weight of One Hide: One hide weighs approximately 6 pounds. Its shape is irregular.

Analysis of Time

Production Data

700 hides per hour
350 hides per worker per hour
7.5 hides per minute

Standard Time Data

0.071 minutes per skin per worker
Job load = 86%
Recovery = 14%

Observed Time

Cycle time = 8.0 seconds per hide
Duration of exertion = 4.0 seconds
% Exertion per cycle = 50%
Exertions per minute = 22.5 (three per hide)

Duration per Day

9.5 hours per shift

Analysis of Motion

Grasp, lift, and move one hide from a table to the machine



Lay the hides on the roller, fat side up



Activate the machine



After the cycle, step on a pedal to open the machine



Grasp, turn, and replace the hide on the roller



Repeat machine activation and opening



Catch hide and set aside on a conveyor

Case Study #2

The first action by the Flesher is to grasp one hide from an adjacent table, lift it up, then move it to the fleshing machine. The hides are slippery and amorphous. The Flesher places the hide on the machine. The roller is at approximately waist height. The Flesher reaches up to approximately head height to activate the machine by pressing two buttons. The location of the buttons was determined on the basis of safety concerns. A counting switch is next to the right button. The Fleshers usually reach over to hit the lever right after hitting the button once per cycle. After the machine has cycled once, the Flesher grasps, lifts, turns, and replaces the hide on the roller to remove fat from the other half of the hide. After the hide is in place, the Flesher activates the machine a second time. At the end of the cycle, the Flesher catches the hide and sets or guides it onto a conveyor.

Other Observations

Intensity of exertion	= Somewhat Hard
Posture	= Good
Speed of work	= Fast

The Strain Index

Exposure Factor	Rating	Multiplier
Intensity of Exertion	2	3.0
% Exertion per Cycle	4	2.0
Exertions per Minute	5	3.0
Posture	2	1.0
Speed of Work	4	1.5
Duration of Task per Day	4	1.0
STRAIN INDEX		27.0

Effects Data

Distal Upper Extremity Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	None reported	0	0
1991	None reported	0	0
1992	Discomfort and numbness (both wrists)	25	43
1993	None reported	0	0

Shoulder Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	None reported	0	0
1991	None reported	0	0
1992	Discomfort (right shoulder)	4	0
1993	Overuse syndrome (bilateral)	54	176

Low-Back Disorders {None reported}

Average Rates (1988 - 1993)

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	8.3	567
Shoulder	16.7	1,950
Lower Back	0.0	0

Other Injury / Illness Data: In 1992, one worker suffered multiple fractures and lacerations of the right hand when the hand was caught in the roller portion of the machine. This injury was associated with 236 lost days.

One worker with bilateral wrist discomfort and numbness, recorded in 1992, underwent surgery for bilateral CTS in 1993

medical costs = \$5672

disability costs = \$1733

One worker with the shoulder problem recorded in 1993 as "overuse syndrome" actually had diagnoses of right partial rotator cuff tear, bilateral biceps tendinitis, and bilateral impingement syndromes

medical costs = \$ 1708

disability costs = \$ 1809

In 1993, there have been 424 restricted hours among 5 Fleshers

cost of light duty work = \$4952.

Total cost of 1993 injuries (as of September) = \$15,874.

Turnover Data: Ten individuals filled two positions in the last six months

1,000% turnover per year

7 of the 10 (70%) had injuries

A Quality Issue: The company's customer notified them of problems related to the quality of the hides. Apparently there was either too much retained fat or the skins were too thin. It was suspected that this was related to the workers working too fast.

Worker Feedback Data (n=3)

Affected Body Part	Right	Left	Bilateral	Total
Neck				0
Shoulders	1	0	1	2
Elbows	0	0	0	0
Forearms	1	0	0	1
Wrists	1	0	0	1
Hands	1	0	1	2
Upper back				1
Lower back				1

Perceived problems	Total
Lifting hides from the tables	2
Gripping hides	1
Turning and twisting	1

Recommended Improvements
{None reported}

Previous Interventions

- The aside conveyor was modified so workers only dropped the hides at the end of the second machine cycle. This eliminated one lift plus carrying the hide.
- They tried rubber gloves to improve friction, but the gloves got stiff and cracked.
- They installed light-activated switches, rather than palm buttons, to activate machines.
- They installed distribution conveyors from the skimmers that equitably distribute hides to the two fleshing machines.

The Team's Assessment

- Handling the hides requires forceful grasping.
- Lifting and manipulating hides requires significant strength and non-neutral shoulder postures.
- The work area is very restricted in terms of space.

Solution Brainstorming

- Get out of the business (not feasible – too profitable)
- Add a third machine (there are space limitations, the production rate will eventually increase to 1,000 hides per hour)
- Redesign layout in a manner analogous to the beef industry (space limitations)
- Use no-cut or leaf lard gloves (worked well, but filled with fat and became slippery)

The Proposed Solution

It was possible to redesign the layout and add a third machine:

- hides will be conveyed to one area, then to individual machines
- hides will be presented to workers at the work surface height of machine, this will eliminate the first lift
- install light touch buttons on all machines and place them below shoulder height
- after the last cycle, the hides will drop onto a conveyor (eliminates the last lift)

EXHIBIT 3

Job Data

Job Name: Snatching Guts

Purpose: Remove the internal organs (viscera) from the hog's body cavities.

Tasks: Remove guts, then set aside.

Work Organization: There are three workers that perform this job without rotation.

Exposure Data

Weight of One Set of Guts: One set of guts weighs approximately 26 pounds.

Analysis of Time

Production Data

742 hogs per hour

247 sets of hog guts per worker per hour

14.6 seconds per set of hog guts

Case Study #2

Observed Time

Cycle time = 13.3 seconds per hog

Duration of exertion = 4.0 seconds (guts hand)

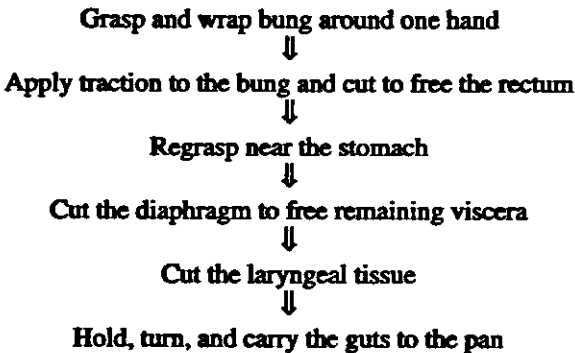
% Exertion per cycle = 30% (guts hand); 100% (knife hand)

Exertions per minute = 4.5 (once per set of guts)

Duration per Day

9.5 hours per shift

Analysis of Motion:



The first two elements of this job require little effort, but the hand that holds the knife is exposed to static, relatively low-force muscular work. The left shoulder is abducted to approximately 90° and internally rotated to wrap the rectum around the hand. Grasping near the stomach the diaphragm is cut and the guts are lifted and transferred to a pan located behind the worker. The pans are approximately at knee height.

Other Observations:

Intensity of exertion	= Very hard (guts hand); = Light (knife hand)
Posture	= Good
Speed of work	= Fair

The Strain Index (Guts Hand)

Exposure Factor	Rating	Multiplier
Intensity of Exertion	4	9.0
% Exertion per Cycle	3	1.5
Exertions per Minute	3	1.5
Posture	2	1.0
Speed of Work	3	1.0
Duration of Task per Day	5	1.5
STRAIN INDEX		30.4

The Strain Index (Knife Hand)

Exposure Factor	Rating	Multiplier
Intensity of Exertion	1	1.0
% Exertion per Cycle	5	3.0
Exertions per Minute	5	3.0
Posture	2	1.0
Speed of Work	3	1.0
Duration of Task per Day	5	1.5
STRAIN INDEX		13.5

Effects Data**Distal Upper Extremity Disorders**

Year	Condition	Days Restricted	Days Lost
1988	CTS (left)	2	1
1989	CTS (bilateral)	25	71
1990	None reported	0	0
1991	CTS (bilateral)	53	13
1992	None reported	0	0
1993	CTS (left)	53	22

Shoulder Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	Rotator cuff (right shoulder)	52	8
1991	Pain (right shoulder)	0	0
	Strain (left shoulder)	0	24
1992	None reported	0	0
1993	None reported	0	0

Low-Back Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	None reported	0	0
1991	None reported	0	0
1992	None reported	0	0
1993	Strain	0	3

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	22.0	1,333
Shoulder	16.7	467
Lower Back	5.6	17

Turnover Data: Eight individuals filled three positions in the last two years (133% turnover per year)

Worker Feedback Data (n=4)

Affected Body Part	Right	Left	Bilateral	Total
Neck				1
Shoulders	0	4	0	4
Elbows	0	1	0	1
Forearms	0	0	0	0
Wrists	0	1	3	4
Hands	0	0	4	4
Upper back				0
Lower back				2

Perceived problems	Total
Inadequate room	1
Difficult to pull bungs out correctly	1

Recommended Improvements	Total
Open the H-bone	2
More room	1
Pull bungs out correctly	1
Develop a new method	1

The Team's Assessment

- Handling the guts requires forceful grasping of a slippery amorphous object.
- Lifting and carrying the viscera with one hand requires significant strength.
- The pan is located behind the worker.
- It is necessary to lift the viscera into the pan.

Solution Brainstorming

The industrial engineers had been working on a proposed solution prior to the ergonomics team's review of this job. The team agreed with the proposed intervention. As a result, there was no solution brainstorming for this targeted job.

The Proposed Solution

The renovated design involves breaking the gut-snatching job into three tasks. The first worker frees the abdominal organs, the second cuts the diaphragm to free the thoracic organs, and the third performs the final cut to free the entire guts from the laryngeal area. The viscera will fall passively into a pan riding on a conveyor below the carcass. This new design and layout eliminates all forceful grasping and lifting. A simulation was arranged and worked well.

There was one major obstacle – the United States Department of Agriculture. The USDA was concerned about the possibility of contamination of the viscera by debris falling from the workers' shoes. In addition, the viscera must stay with the carcass through the inspection process. Both obstacles were eventually overcome and the company has USDA approval to proceed with the renovation.

Implementaion Status

The revised layout is scheduled for installation during 1994 as part of the renovation project.

EXHIBIT 4

Job Data

Job Name: Pulling Ribs

Purpose: Remove ribs from the belly.

Tasks: Pull the rib and set it on the aside conveyor, pack the ribs.

Work Organization: Three workers rotate among these two tasks every 15 - 30 minutes. Two workers pull ribs (using a special knife that requires two hands) while the third packs the ribs (materials handling).

Exposure Data

Rib Data

The average weight of one rib = 3.13 lbs.

The average length of one rib = 15 in.

Analysis of Time

Production Data

765 hogs per hour

765 bellies per worker per hour

4.76 seconds per rib

Standard Time Data

0.0794 minutes per rib per worker

job load = 98.9%

recovery = 1.1%

Observed Time

Cycle time = 4.6 seconds per rib

Duration of exertion = 0.75 seconds

Percent exertion per cycle = 16%

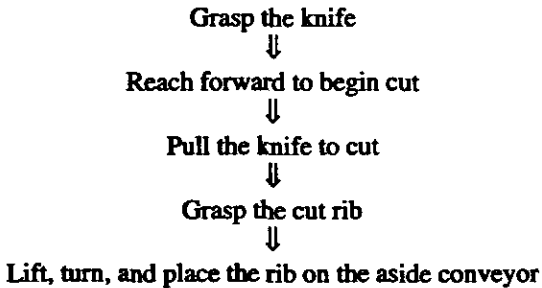
Exertions per minute = 26 (two per rib)

Duration per Day

9.5 hours per shift

5.7 hours pulling ribs per day

Analysis of Motion



The knife is held with two hands. Its design requires that the workers extend and abduct their thumbs to place them on the handle. The thumbs press against the upper part of the handle to provide torque to oppose torque created by the knife blade (cutting through the meat below the little fingers). The forward reach requires some trunk and shoulder flexion. After the cut, the workers grasp the end of the rib with a pinch grasp with the forearm supinated, then lift it to approximately head height, reach forward, turn the rib over, and place it into a trough on the aside conveyor.

Other Observations:

Intensity of exertion	= Somewhat Hard
Posture	= Bad (thumbs abduction and extension)
Speed of work	= Fair

The Strain Index

Exposure Factor	Rating	Multiplier
Intensity of Exertion	2	3.0
% Exertion per Cycle	2	1.0
Exertions per Minute	5	3.0
Posture	4	2.0
Speed of Work	3	1.0
Duration of Task per Day	4	1.0
STRAIN INDEX		18.0

Effects Data

Distal Upper Extremity Disorders

Year	Condition	Days Restricted	Days Lost
1988	Possible CTS	0	0
1989	None reported	0	0
1990	CTS (right)	7	0
1991	None reported	0	0
1992	Tenosynovitis (left fifth finger)	11	0
1993	Pain (right hand, wrist, and arm)	3	0

Shoulder Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	Strain (right shoulder)	42	0
1991	Strain (left AC joint)	31	0
1992	None reported	0	0
1993	None reported	0	0

Low-Back Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	None reported	0	0
1991	Strain	7	0
1992	None reported	0	0
1993	None reported	0	0

Average Rates (1988 - 1993)

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	22.2	117
Shoulder	11.1	406
Lower Back	5.6	39

Other Injury / Illness Data: One team member had performed this job and experienced bilateral radial wrist soreness (suggestive of DeQuervain's tenosynovitis). This job was associated with 68 restricted days in last 12 months.

Total medical costs for 1993 (to date) = \$2400.

Turnover Data:

Ten individuals filled 3 positions in last 12 months (333% turnover per year).

Workers often post in for higher pay.

Worker Feedback Data (n=9)

Affected Body Part	Right	Left	Bilateral	Total
Neck				2
Shoulders	5	0	3	8
Elbows	3	0	0	3
Forearms	2	1	1	4
Wrists	0	2	5	7
Hands	0	0	5	5
Upper back				1
Lower back				3

Perceived problems	Total
Dull knife	6
Pulling the knife	5
Setting the rib on the aside conveyor	4
Thumb pressure	3
Grasping the rib	3
Grasping the knife	2
Bellies pull off the spike conveyor	2
Bone cuts	1

Recommended improvements	Total
Improve the knife handle	5
Change the spike conveyor	5
Change floor stands	3
Get a better knife	2
Lengthen the table	1
Lower the aside conveyor	1
Add a person to the packing task	1
Try gloves	1

The Team's Assessment

- The floor stand is irregular because the ends of the existing mats do not match.
- The existing conveyor designs contribute to the difficulty of the pulling task.
- The ribs are put into the roller with their long axis parallel to the axis of the roller drum. They may be flattened better (thus easier to cut) if rolled the other way.
- The existing knife places the user at a mechanical disadvantage, especially regarding the thumbs (loaded and extended).
- The existing system requires the spike conveyor operator to align the bellies by sight alone. As a result, some bellies come to the pullers with the ribs impaled by the spikes on the conveyor.
- The current technique of setting the ribs aside requires use of pinch grasp combined with poor mechanical advantage (it is held at the end of the rib) and forearm pronation.
- The aside conveyor is located up and away from the worker, thus requiring an extended forward reach, trunk flexion, and lifting to approximately shoulder height.

Solution Brainstorming

- Upgrade the flooring material.
- Design the spike conveyor for a taller worker and install adjustable stands for shorter workers.
- Consider hooking the bellies instead of spiking them.
- Roll the ribs lengthwise.
- Use a light to consistently align bellies on spike conveyor.
Knives (sharpness is very individualized, consider a means to keep the blade warm, reduces friction, consider a new design to eliminate pressure with the thumbs).
- Leave the pulled ribs on the bellies and install some device to push them off
- Place the ribs in a chute next to the puller so it drops to a conveyor
- Add a third worker: two pull ribs and one sets the ribs on the conveyor (2 hands)
- Lower the aside conveyor (not feasible to move it closer)

Implementation Status

- Layout changes have been incorporated into the renovation design plans.
- New flooring material has been installed.

- Work practice changes will be incorporated into the renovation plans.
- A revised knife handle has been designed and a prototype built. Workers recently tried it on the line (November 1993). Overall, the new design addresses the biomechanical issues, but its dimensions need to be changed so the end of the knife does not hit the conveyor during the pull. It is undergoing further modifications.

EXHIBIT 5

Job Data

Job Name: Lifting Neckbones

Purpose: Remove neckbones from the shoulder.

Tasks: Get one shoulder, then remove the neckbone

Work Organization: There are five workers that rotate every 30 to 60 minutes among three tasks: three neckbone pullers, one foot saw operator, one trims front feet. Only one person lifts neckbones for one continuous hour per day. For all others, the maximum continuous duration is 30 minutes. The other two tasks are not considered to be as significant as the neckbone task in terms of musculoskeletal risk factors.

Exposure Data

Weight of One Shoulder:

Average weight of shoulder = 17.4 lbs.

Average weight of one neckbone = 1.7 lbs.

Analysis of Time

Production Data

1,532 shoulders per hour

511 shoulders per worker per hour

Standard Time

0.1166 minutes per shoulder per worker

Job load is 98.7%

Recovery is 1.3%

7.0 seconds per shoulder

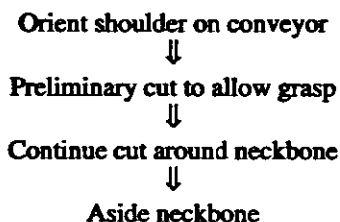
Observed Time

Cycle time (per shoulder) = 6.6 seconds
Duration of exertion per cycle = 3.3 seconds
% Exertion per cycle = 50%
Exertions per minute = 9

Duration per Day

9.5 hours per shift
4.5 hours lifting neckbones per day

Analysis of Motion:



Orienting the shoulder on the conveyor may involve pushing and/or pulling with one hand. Sometimes, the shoulders are stacked, requiring the worker to lift, push, or pull to get to them. The knife is used in one hand. The other hand is sometimes used to provide traction to the neckbone. The workers' posture is generally favorable for the preliminary cut; however, the final cut requires the worker to cut under the neckbone and up the opposite side. This maneuver requires wrist flexion. The neckbones are dropped into a chute.

The Strain Index

Exposure Factor	Rating	Multiplier
Intensity of Exertion	2	3.0
% Exertion per Cycle	4	2.0
Exertions per Minute	3	1.5
Posture	4	2.0
Speed of Work	4	1.5
Duration of Task per Day	4	1.0
STRAIN INDEX		27.0

Effects Data

Distal Upper Extremity Disorders

Year	Condition	Days Restricted	Days Lost
1988	CTS (right)	3	0
1989	Epicondylitis (both elbows)	0	9
	Tendinitis (right elbow)	0	18
1990	None reported	0	0
1991	Discomfort (right wrist)	2	0
1992	Discomfort (right elbow)	22	0
	Pain and numbness (right hand)	1	0
1993	Discomfort (right wrist)	37	0

Shoulder Disorders

Year	Condition	Days Lost	Days Restricted
1988	Bicipital tendinitis (right shoulder)	90	109
1989	Impingement (right shoulder)	40	25
1990	None reported	0	0
1991	None reported	0	0
1992	Tendinitis (right shoulder)	116	61
	Strain (periscapular area)	0	0
1993	None reported	0	0

Low-Back Disorders {None reported}

Average Rates (1988 -1993)

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	23.3	307
Shoulder	13.3	1,470
Lower Back	0.0	0

Turnover Data: 10 individuals posted for 5 positions in last 2 years (100% turnover per year).

Worker Feedback Data (n=10)

Affected Body Part	Right	Left	Bilateral	Total
Neck				3
Shoulders	3	1	2	6
Elbows	3	1	1	5
Forearms	1	0	1	2
Wrists	3	1	4	8
Hands	3	1	4	8
Upper back				2
Lower back				4

Perceived problems	Total
Turning the shoulders	3
Dull knife	3
Too crowded	2
Problems related to the Kill Department	2
Conveyor moves too slow	1
Tables are too low	1
Workstation #1 is bad	1
Duration on the job is too long	1
Difficulty putting neckbones into the chute	1

Recommended improvements	Total
Rotate more frequently	3
Adjust the table height	2
Fix the flooring	2
More space	2
Better quality control from Kill	1
Slow down the line speed	1
Better steeling of knives	1

The Team's Assessment

- This is a skilled task requiring a sharp knife plus good technique.
- The continuous conveyor is part of the problem. If the cut is missed, the worker must follow the shoulder down the conveyor.

Solution Brainstorming

- Knives/Steeling (improve worker education, improve communication with the skilled sharpeners).
- Repositioning shoulders (increase the space between shoulders)
- Uneven floor (install a single mat of new flooring).
- Work surface height (install adjustable work stands).
- Line speed (add a sixth worker, 4 lifters and 2 foot saw operators. this should reduce production rate to 500 shoulders per worker per hour).

Implementation Status

- New flooring has been installed.
- Adjustable work stands and conveyor modifications are being incorporated into the renovation design. The new design should also reduce crowding.
- A sixth worker has been added.
- Knife/steeling education started.

EXHIBIT 6

Job Data

Job Name: Skinning Picnics

Purpose: Remove skin from the picnic.

Tasks: Skinning picnics, Trimming neckbones

Work Organization: There are seven workers that rotate between skinning picnics and trimming neckbones every 2.5 hours (associated with breaks): two trim neckbones (using knives manually), five skin picnics (using skinning machines), three on the left side of the conveyor, two on right side of the conveyor

Exposure Data

Weight of one Picnic: The average weight of each picnic is 9.5 lbs.

Analysis of Time:

Production Data

306 picnics per worker per hour

14.1 seconds per picnic

Standard Time

0.1410 minutes per picnic per worker

Job load is 90.0%

Recovery is 10.0%

Case Study #2

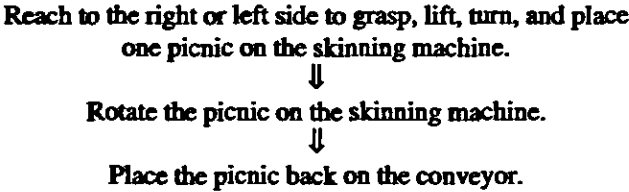
Observed Time

- Cycle time = 13.1 seconds per picnic
- Duration of exertion = 7.4 seconds per picnic
- Percent exertion per cycle = 56%
- Exertions per minute = 13.8 (three per picnic)

Duration per Day

- 9.5 hours per shift
- usually 5.0 hours, but possibly up to 7.5 hours skinning picnics

Analysis of Motion:



The skinning machine is located adjacent to the conveyor carrying the picnics. The workers reach to one side (right or left depending on the orientation of the workstation) to grasp, lift, and carry the picnic to the skinner. Once placed on the skinning machine, the worker primarily guides the picnic over the blades. There may be some additional lifting to reorient the picnic for reskinning. Once skinned, the picnic is placed back on the conveyor.

The Strain Index

Exposure Factor	Rating	Multiplier
Intensity of Effort	3	6.0
% Exertion per Cycle	4	2.0
Exertions per Minute	3	1.5
Posture	2	1.0
Speed of Work	3	1.0
Duration of Task per Day	4	1.0
STRAIN INDEX		18.0

Effects Data

Distal Upper Extremity Disorders

Year	Condition	Days Restricted	Days Lost
1988	Tendinitis (both wrists)	60	203
1989	Epicondylitis (right lateral elbow)	0	0
	"CTD" (both hands)	0	29
1990	Epicondylitis (right lateral elbow)	0	6
	Tendinitis (both wrists and hands)	5	8
1991	CTS (right) {underwent surgery}	32	19
1992	None reported	0	0
1993	None reported	0	0

Shoulder Disorders

Year	Condition	Days Restricted	Days Lost
1988	None reported	0	0
1989	None reported	0	0
1990	Subluxation (left)	0	22
1991	Strain (right)	23	0
	Strain (right)	53	0
1992	Tendinitis (right)	88	134
1993	None reported	0	0

Low-Back Disorders {None reported}

Average Rates (1988 - 1993)

Body Part	Incidence Rate	Severity Rate
Distal Upper Extremity	14.3	862
Shoulder	9.5	762
Lower Back	0.0	0

Turnover Data:

Estimated to be high

Worker Feedback Data (n=11)

Affected Body Part	Right	Left	Bilateral	Total
Neck				3
Shoulders	5	2	2	9
Elbows	0	0	0	0
Forearms	0	0	0	0
Wrists	3	1	0	4
Hands	1	0	5	6
Upper back				2
Lower back				3

Perceived problems	Total
Handling picnics	7
Difficult to adjust machines	1

Recommended improvements	Total
Improve handling of the picnics	6
Install adjustable workstations	5
Adjust the machinery	2
Increase job rotation	2
Decrease job rotation	1
Rotate the machine 180°	1
Improve communication	1

The Team's Assessment

- Improve the picnic handling. If possible, eliminate lifting.
- Allow for adjustable workstation heights.

Solution Brainstorming

Picnic handling

- eliminate the guard rail to reduce the vertical height of the lift
- use a trough instead of a flat conveyor so picnics will not fall off
- install angled workstations to pull picnics off, then push to return to conveyor

Adjustable workstations

- design for a taller worker and raise the shorter ones

Implementation Status

Conveyor modifications

- a prototype is being built
- if successful, it will be incorporated into the renovation design

Adjustable platforms have been incorporated into the renovation design.

EVALUATIONS OF TEAM PERFORMANCE AND PROGRAM OUTCOMES

Measures of Team Function/Effectiveness

One of the purposes of the project was to assess the effectiveness of the participatory approach to solving ergonomics-related problems. The following outcomes were considered to measure this effectiveness:

- Team productivity;
- Number of interventions; and
- Participant feedback.

Team productivity was determined by comparing the number of jobs analyzed by the teams to the number of targeted jobs. The number of successful interventions was considered as a measure of effectiveness; however, during the brief observation period by the investigators, interventions were installed for only a few jobs. Therefore, the number of successful interventions was not used as a yardstick of team effectiveness for this project.

To determine feedback from team participants, a self-administered questionnaire, called the "Participant Feedback Questionnaire," was completed anonymously. The questionnaire included five-point scales (where "1" is very unfavorable and "5" is very favorable) to assess participant ratings for team size, team balance, representation of interested parties, effectiveness of each phase of the problem-solving process, team productivity, team functioning, etc. Participants were also asked to identify obstacles to effective team functioning. It was distributed to all team members at the end of the project. Upon completion, the questionnaires were forwarded to the investigators for tabulation and analysis.

Twelve (eight from Hog Kill and four from Hog Cut) "Participant Feedback Questionnaires" were received. Eleven of the 12 (92%) participants felt that the sizes of the teams were about right and

balanced in terms of management representatives versus worker representatives. All respondents felt that all interested parties were represented on the committees.

Participant ratings of effectiveness for different aspects of the problem-solving process and committee productivity (number of jobs studied) were highly favorable (Table 4). As expected, ratings for intervention implementation were relatively lower since few interventions were implemented during the project period. Regarding perceptions about team functioning, the mean ratings were 4.4 (range: 3 to 5) and 3.5 (range: 3 to 4) for the Hog Kill and Hog Cut teams, respectively.

	Hog Kill (n=8)		Hog Cut (n=4)	
	Mean	Range	Mean	Range
Problem Identification	4.3	4-5	4.0	4
Problem Evaluation	4.4	4-5	4.5	4-5
Intervention Development	3.9	3-5	3.0	2-4
Intervention Implementation	3.6	3-5	2.8	2-4
Intervention Evaluation	4.1	3-5	3.5	3-4
Number of Jobs Studied	3.8	2-5	3.8	3-4

Table 4. Participant ratings of the problem-solving process elements and number of jobs studied on a scale of 1 to 5 (1 = very unfavorable; 5 = very favorable).

Four of the eight Hog Kill team members felt there were obstacles to the team working well. The reasons and the number of individuals citing each reason (in parentheses) included:

- Lack of advanced notice of meetings (3);
- Inconvenient meeting times (2);
- Key people did not attend (1);
- Lack of meeting structure (1);
- People were too busy with other major projects at the same time (1);
- Finding a good meeting place was a problem (1); and

- People shortages made it difficult to get team members to the meetings (1).

Three of the four Hog Cut team members also felt there were obstacles. They cited:

- Poor participation (2);
- Team members were passive or reluctant (2);
- A lack of open discussion (1);
- Key people did not attend (1);
- Non-team members were reluctant to contribute (1);
- Team members were overworked because of conflict with another major project (1);
- A shortage of plant workers made it difficult for some members to attend all meetings (1); and
- A shortage of conference rooms (1).

Mean ratings and ranges for each team's meetings are summarized in Table 5. Overall, the ratings were highly favorable.

	Hog Kill (n=8)		Hog Cut (n=4)	
	Mean	Range	Mean	Range
Good vs. Bad	4.3	3-5	4.3	3-5
Focused vs. Rambling	4.3	4-5	4.5	3-5
Energetic vs. Lethargic	4.0	3-5	3.5	3-4
Satisfying vs. Not Satisfying	3.8	3-4	3.5	3-4
Scientific vs.				
Shooting from the hip	4.0	3-5	4.3	4-5
Cooperative vs. Divisive	4.4	4-5	4.3	4-5

Table 5. Participant ratings of the meetings on a scale of 1 to 5 (1 = very unfavorable; 5 = very favorable).

In terms of the pace of the teams' activities, the Hog Kill team's mean rating was 3.6 (range: 3-5) and the Hog Cut team's mean rating was 3.25 (range: 3-4).

All 12 respondents felt that the information from the workers performing the jobs under study had been sought and adequately represented in the teams' activities. There was similar unanimity among respondents when asked whether they felt that the workers were satisfied with the teams' activities and whether the teams were meeting their goals. Two individuals added remarks that there is still more work to be done. In terms of satisfaction with the plant's ergonomics program, the mean response from both teams was 3.8 (range: 3-5).

When asked about the teams' futures, 75% of the members felt the teams should continue on as they have. Comments associated to this response included:

- "Emphasize strong leadership." (Hog Cut)
- "Maintain strong active leadership." (Hog Kill)
- "Meetings where everyone can attend." (Hog Cut)
- "Meet more often if possible." (Hog Kill)

The other three (25%) recommended that the teams continue on, but change in some ways. Their comments included:

- "More advanced notice for the meetings so we the workers might gather more information to help with problems." (Hog Kill)
- "I feel more emphasis should be put on ergonomic design instead of ergonomic upgrading." (Hog Cut)
- "More workers on the committee." (Hog Cut)

As final comments, the following were noted:

- "I feel this project has improved an already workable ergonomics program and has benefited by our association with the consultant." (Hog Kill)
- "Very good program. This way things do get done even if it takes time." (Hog Kill)
- "I feel especially with the renovation – a committee

will be important in dealing with the new problems related to new equipment and increased line speed. All jobs should eventually be targeted to make them as comfortable as possible.” (Hog Kill)

- “Excellent effort by all – persistence of J.W.’s part as team leader was very effective. I enjoyed participating in such a meaningful and positive committee.” (Hog Kill)
- “Need to insure follow through on all ergonomic problem areas identified.” (Hog Kill)
- “A lot was discussed and things did get done to improve work areas.” (Hog Cut)

MEASURES OF BENEFITS

Assessment of the Corporate Ergonomics Program

There are several potential measures of a program’s effectiveness. Perhaps the most important criteria are whether the program is achieving or has achieved its defined objectives and whether the management and workers believe that the program is worthwhile. Both the Steering Committee and the Corporate Ergonomics Coordinator consider the ergonomics program favorable for both of these criteria.

Both of the above criteria are fairly subjective and difficult to measure; therefore, additional analyses, based on more objective data, have been done in an attempt to quantitate the effects of the ergonomics program on the corporation. These analyses primarily examine changes in injury and illness statistics and workers’ compensation expenses since the program’s implementation. The program’s effects on quality and productivity are also examined, but only qualitatively. Since the impact of the program represents the holistic result of numerous specific interventions, brief descriptions of several of the corporation ergonomic successes are also presented in this section.

One statistic used to monitor trends is the crude annual incidence rate. This is calculated by dividing the total number of injuries and illnesses recorded on the OSHA 200 log for one year by the average number of workers employed during that year, then multiplying by 100. The result is the number of injuries and illnesses per 100 workers per year. Another commonly used statistic is the lost-time incidence rate. This rate is calculated in a manner similar to the crude incidence rate, except that only the number of lost-time injuries are included in the numerator. The result is the number of lost-time injuries per 100 workers per year. Another potential measure of a program's effectiveness is the percentage of recordable conditions that were "ergonomics-related" (e.g., strains, sprains, or repeated motions or exertions). If a program were effective in preventing musculoskeletal disorders, one would predict a decrease in this percentage post-implementation.

From a business perspective, many companies are interested in determining how an ergonomics program might affect workers' compensation costs. Annual workers' compensation costs can be compared either in actual dollars or in constant dollars (adjusted for inflation). Another analysis, related to this same data, examines the annual corporate workers' compensation expenses per employee (per capita workers' compensation costs). This may be useful since the number of workers employed by the company could change over the years. These comparisons are addressed in this study.

It is of interest to examine the effects of ergonomics on quality and productivity. In the meat industry, quality can be measured several ways. One is yield – the amount of meat obtained per hog part. Another measure is related to the appearance of the finished product, such as excessive fat, scoring, or sloppy packaging. Productivity is measured by pounds of meat processed per hour. Line speed is a significant factor in determining a plant's productivity.

Methods

Injury and Illness Statistics: Complete OSHA 200 log data were only available from 1987 through 1993. In general, data for years prior to 1987 were not available because the corporation retains OSHA logs for only five years (consistent with OSHA record-keeping regulations). As a result, it was not possible to examine the effects of the ergonomics program pre-implementation versus post-implementation for all of the injury and illness statistics. Rather, most of the available data describes the changes from one year post-implementation onward. One exception was that the corporation had maintained data for the lost-time incidence rate since 1984, thinking it could be important for future comparisons. As a result, it was possible to compare pre-implementation data to post-implementation data.

Workers' Compensation Costs: The corporation preferred that its absolute dollar figures for annual workers' compensation costs not be published. Data was available for fiscal years 1987 through 1993 (the corporation's fiscal year ends in October). The costs for 1987 were assigned a value of 100%, and costs for years 1988 through 1993 are expressed as a percentage of 1987. To make the comparison as valid as possible, the 1987 costs were adjusted for inflation. According to the corporation's top insurance executive, the company's average annual rate of inflation for medical services was 12% in this time period (Corporate Insurance Executive, 1993). To determine the per capita workers' compensation costs, the actual dollars were divided by the number of workers for that year. As before, the results are expressed as a percentage of 1987, except these figures were not adjusted for inflation.

Quality, Productivity, and Line Speed: No data were available to assess the effects of the corporation's ergonomics program on quality, productivity, or line speed. However, production workers and engineers were interviewed to determine the impact of the ergonomics program on these three issues.

Results

Injury and Illness Statistics: In Figure 1, the crude incidence rate for 1987 was used as a baseline value. Initially, the crude incidence rate increased during the early post-implementation period, then plateaued at a level approximately 30% higher than baseline. This observation is attributed to the company's efforts to promote early reporting of musculoskeletal symptoms and signs (Corporate Ergonomics Coordinator, 1993). In the most recent two years, the crude incidence rate has decreased and is almost equal to the 1987 level.

Figure 2 illustrates the magnitude of the lost-time incidence rates, expressed as a percentage of the 1984 rate (14.9), for years 1984 through 1993 (year-to-date). There has been a consistent and marked decrease in the lost-time incidence rate since the implementation of the ergonomics program. The lost-time injury rate declined by 50% during the first year of the ergonomics program and has continued to show a downward trend in subsequent years. In 1993, the rate was only 11% of that observed in 1984. This dramatic reduction in the lost-time incidence rate was attributed to ergonomics, safety-related improvements, and other factors such as altered assignments for workers recovering from injuries (Corporate Ergonomics Coordinator, 1993).

The percentage of total recordable disorders that were considered "ergonomics-related" are presented in Figure 3. This percentage decreased 31% from 1987 to 1993. In 1987 and 1988, approximately two-thirds of all recordable conditions were due to "ergonomics-related" injuries. Subsequently, this decreased to approximately 40%. It should be explained, however, that this percentage varies from plant to plant. The plants with the lowest percentages, ranging from 9% to 16%, are highly automated canning plants. The plants with the highest percentages, ranging 50% to 66%, are hand-intensive processing and packaging plants.

Corporate Incidence Rate

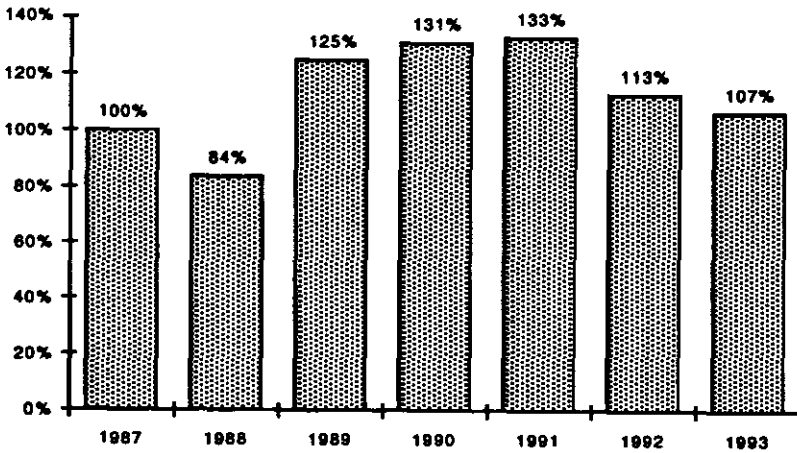


Figure 1. Percentage changes in annual corporate crude incidence rate for the years 1987 through 1993 compared to 1987.

Corporate Lost-Time Incidence Rate

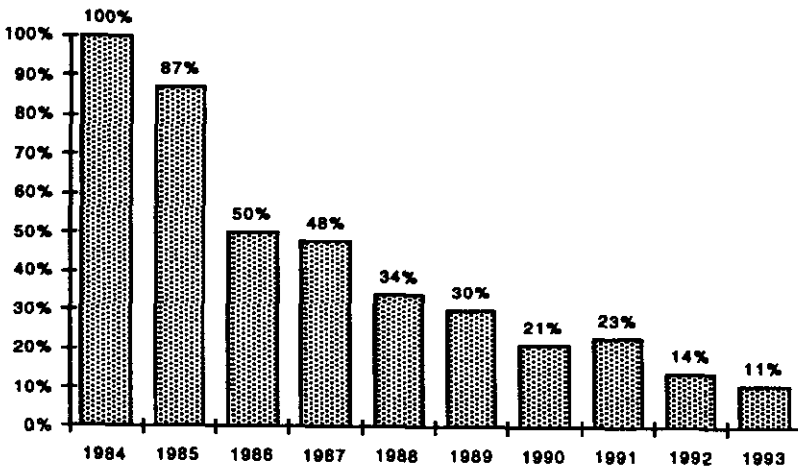


Figure 2. Percentage changes in corporate lost-time incidence rate for years 1984 through 1993 compared to 1984.

Corporate Recordable Conditions related to Musculoskeletal Risk Factors

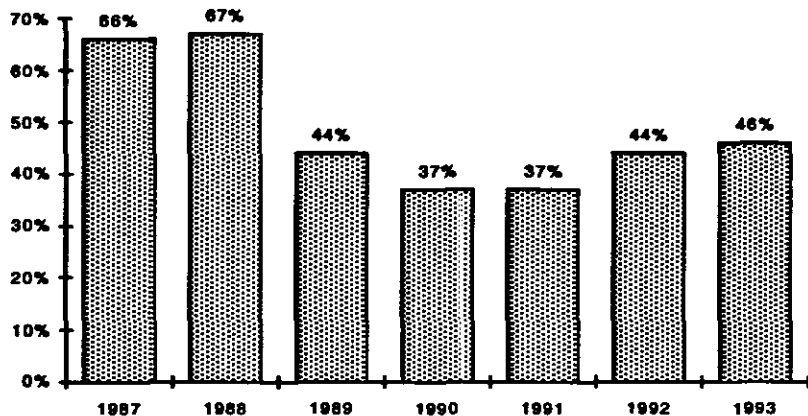


Figure 3. Percentage of total recordable conditions that were musculoskeletal conditions (e.g., strains or sprains) related to musculoskeletal risk factors (e.g., lifting, lowering, or carrying) for the years 1987 through 1993.

Workers' Compensation Costs: Annual workers' compensation costs, expressed as a percentage of 1987 costs, have shown a decrease since 1987 (Figure 4). While the decline has not been particularly steady, there has been an overall decrease in this expense subsequent to implementation of the ergonomics program. The 1993 expenses were 16% of those of 1987 (an 84% decrease). Disregarding inflation, 1993 expenses were 31% of those of 1987 (a 69% decrease). A decrease in workers' compensation expenses had not been observed prior to the start of the company's ergonomics program (Corporate Insurance Executive, 1993).

Figure 5 compares the data for years 1987 through 1993 as a percentage of the 1987 expenses per employee. A progressive decline in per capita expenses is noted, with 1993 unadjusted expenses per employee being approximately 73% lower than those in 1987. These savings in workers' compensation costs have a major

Corporate Workers' Compensation Expense (Constant Dollars)

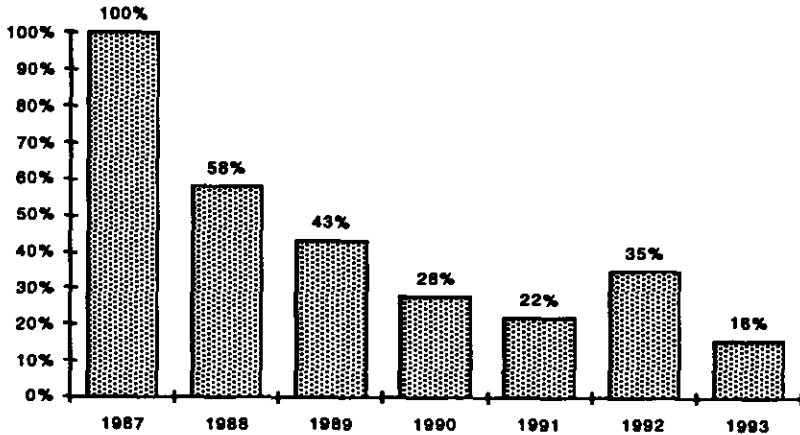


Figure 4. Percentage changes in annual corporate workers' compensation expenses (constant dollars) for years 1987 through 1993 compared to 1987 expenses.

Corporate Workers' Compensation Expense (Unadjusted)

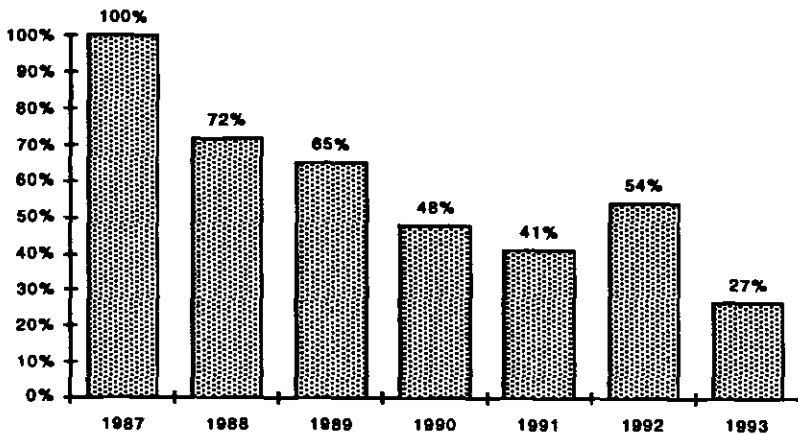


Figure 5. Percentage changes in annual workers' compensation expenses per employee for years 1987 through 1993, compared to unadjusted 1987 figures.

impact on companies' profitability, especially in the meatpacking industry. It is estimated that a \$1,000 expense requires the sale of approximately 35,000 pounds of product for the profits from this sale to cover this expense (Corporate Ergonomics Coordinator, 1993).

Quality, Productivity, and Line Speed: Based on the interviews, no ergonomics-related improvement had ever been associated with a sacrifice in quality. Rather, the experience of the workers and management suggested that ergonomic improvements most likely increased quality. The company believes workers who are less fatigued at the end of the day continue to perform better, such as making better cuts, than fatigued or aching workers (Corporate Ergonomics Coordinator, 1993).

In terms of productivity, the corporation believes that workers without fatigue or discomfort maintain steady output throughout the day compared to workers with fatigue or aches (Corporate Ergonomics Coordinator, 1993). Some interventions have led to significant increases in productivity due to automation, better yield, and reduced number of workers. Some interventions have relieved bottlenecks on a line, such as by improved layout or work simplification, and have allowed better line output without adverse effects or impacts on the workers.

Increasing line speed has not been a goal of the company's ergonomics program. Line speed is primarily determined by sales, economies of scale, and availability of raw materials (Corporate Ergonomics Coordinator, 1993). When increases in line speed are scheduled, the company relies on standard industrial engineering methods to manage the effect on existing bottlenecks. After the line speed has been increased for several weeks, the ergonomic effects are re-evaluated via the Safety and Ergonomics Survey. Identified problems are then addressed as discussed previously.

Ergonomic Innovations: Prior to 1982, deboning picnics required over 25 workers using knives to manually dissect out the bone from the picnic. Aside from the inevitable cuts and bruises, this work was associated with a large number of upper extremity disorders. In 1980, the company started a project to examine the possibility of automating this difficult task. A corporate methods and layout engineer worked with a Dutch food equipment manufacturer to adapt their machinery to the corporation's process. The design is based on squeezing the meat from the bone. Four Deboning Machines were introduced at one plant in 1983. The new process involved four machines and five workers (two operators, two meat inspectors, and a trucker). This equipment was subsequently installed in two other plants. The same principle was later adapted to the deboning of hams and these machines were installed in four plants. This change improved the quality of meat and yield increased slightly, but this slight increase, when multiplied by millions of hogs per year, was significant.

The company has also invented several devices, such as automatic hog splitters and hand-held skinners and markers. These inventions have been licensed for manufacturing and sale by national distributors.

Several devices available from national distributors have been modified for unique applications at the company. Examples include the development of new handles for vacuum carrying devices for manipulating heavy boxes, barrels, or bags, and modifications to Whizard knives (new handles).

The company has also developed a variety of innovations for their own use. These include bacon comb lifters; casing and film roll manipulators, bacon comb sharpeners and straighteners, and belly inverters. Projects nearing installation include automated pulling of loins and automatic trimming of bellies.

Assessment of the Plant's Ergonomics Program

Methods

The long-term effectiveness of the plant's ergonomics activities was evaluated according to changes in the plant's injury and illness statistics and the plant's annual workers' compensation costs. The injury and illness data were tabulated from available plant OSHA 200 logs (1988 through 1993). There was no data available to compare pre-implementation statistics with post-implementation statistics. Crude incidence rate, lost-time incidence rate, and percentage of recordable disorders that were "ergonomics-related" were compared as for the corporate data, using 1988 as the baseline year. Severity rate, the number of days lost or restricted per 100 workers per year, was also examined. The workers' compensation cost data were available for the years 1987 through 1993. These were compared in a manner similar to that for the corporate data.

Results

Injury and Illness Statistics: The crude incidence rate increased by approximately 64% between 1988 and 1991 (Figure 6). This pattern is similar to that noted for the corporation, but the magnitude of the increase is somewhat greater. It is suggested that this increase may drop over time, as noted for 1992 and 1993, but not necessarily to the 1988 baseline level. The lost-time incidence rate increased approximately 70% between 1988 and 1992, and a significant decrease was not observed until 1993 (Figure 7).

The plant's experience differs from the corporation's experience for this parameter, where a decrease in the lost-time incidence rate was noted each year post-implementation of the ergonomics program. Further analysis of the plant's data revealed that there was a shift in the percentage of cases with restricted days as opposed to lost days. Restricted days accounted for 26% of the total lost or restricted days in 1988 versus 60% in 1993. This

Plant Incidence Rate

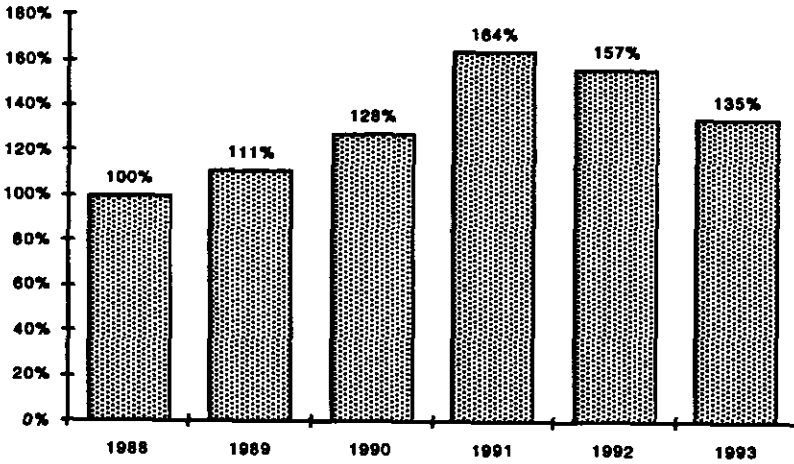


Figure 6. Percentage changes in annual plant crude incidence rate for the years 1988 through 1993 compared to 1988.

Plant Lost-Time Incidence Rate

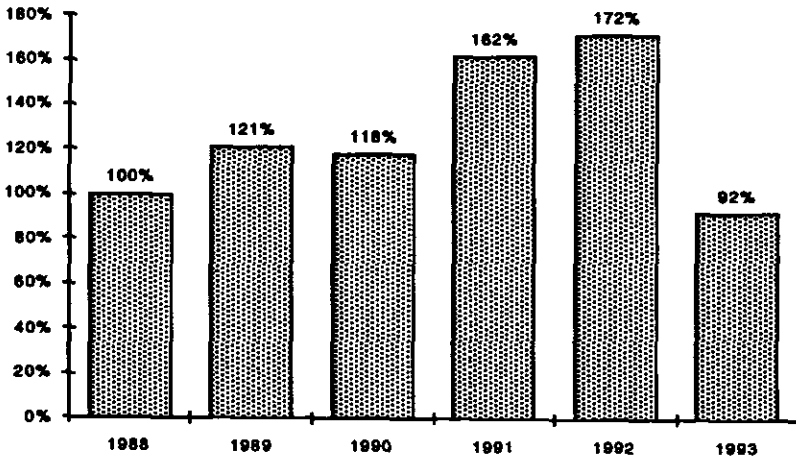


Figure 7. Percentage changes in the plant's lost-time incidence rate for years 1988 through 1993 compared to 1988.

suggests that, in combination with increased early reporting, workers are more readily assigned alternate duty assignments, thus reducing lost days while increasing restricted days.

Figure 8 illustrates the percentage changes in severity rates for years 1988 through 1993, expressed as a percentage of 1988 rates. No consistent pattern is readily evident, but there is some suggestion that the severity rate may have started to progressively decrease in recent years.

The percentage of total recordable conditions that were considered "ergonomics-related" are illustrated in Figure 9. This percentage has been almost constant at 40% during this time period. Unlike the corporate data, there has been no significant decline in this percentage during the observed post-implementation period.

Plant Severity Rate

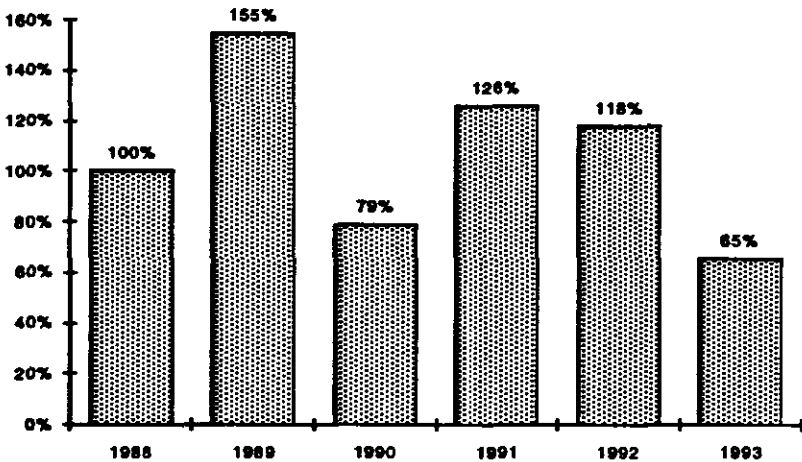


Figure 8. Percentage changes in the plant's severity rate for years 1988 through 1993 compared to 1988.

Workers' Compensation Cost: As shown in Figure 10, there is a clear pattern of decline for annual workers' compensation expenses when compared to adjusted 1987 expenses. The 1993 expenses were 20% of those in 1987 (an 80% decrease). In terms of actual dollars (unadjusted for inflation), the 1993 expenses were 39% of 1987 expenses (a 61%

Plant Recordable Conditions related to Musculoskeletal Risk Factors

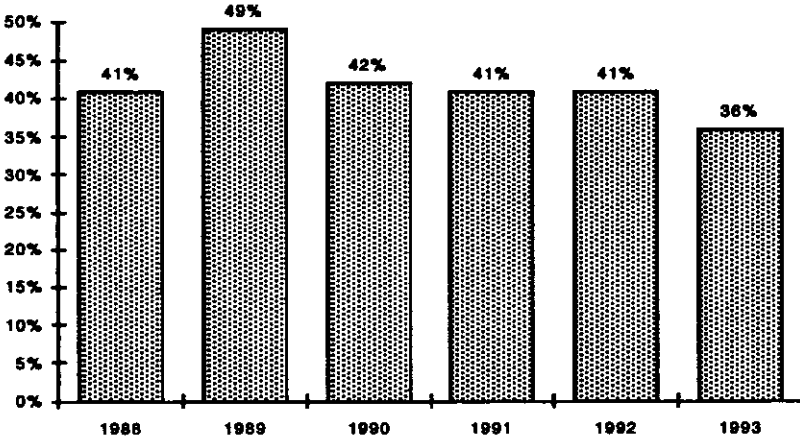


Figure 9. Percentage of total recordable conditions at the plant that were musculoskeletal conditions (e.g. strains or sprains) related to musculoskeletal risk factors (e.g. lifting, lowering, or carrying) for the years 1988 through 1993.

Plant Workers' Compensation Expense (Constant Dollars)

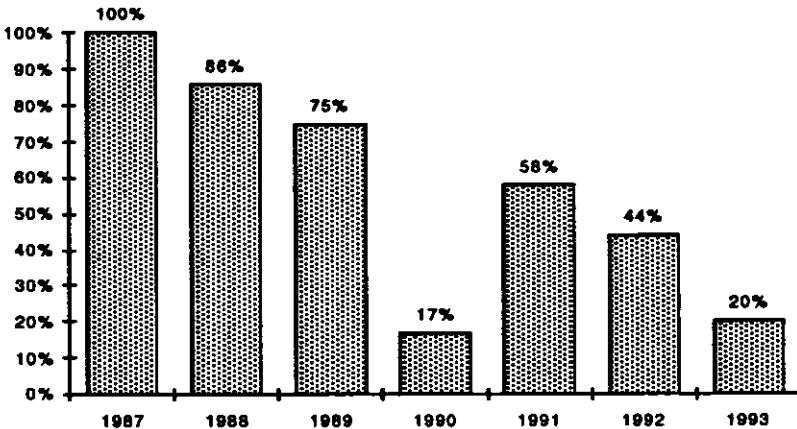


Figure 10. Percentage changes in annual plant workers' compensation expenses (constant dollars) for years 1987 through 1993 compared to 1987 expenses.

decrease). The plant did not experience the same pattern of decrease as the corporation. The corporation noted an almost exponential decrease with greater reductions in the earlier years (1988 to 1990). The plant, however, noted a more linear decrease over time.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this case study was to demonstrate and evaluate the effectiveness of the participatory approach to solving ergonomics problems, especially problems related to the upper extremity, in the red meatpacking industry. The information in this report is primarily descriptive. Since the methodology was not experimental, e.g., there were no control or comparison groups, it was not possible to draw definitive conclusions regarding factors that caused or contributed to the observations.

The corporation involved in this project had clear and explicit documentation of management commitment for a participatory ergonomics program. This commitment was also evident through the methods chosen to implement the program and communicate its results. Employee involvement was incorporated at the time of the program's inception in 1986. As a result, the study plant also relied on participatory ergonomics methodology.

One aspect of the project was to describe the long-term effects of implementing a participatory ergonomics program in a large corporation and one of its plants. This analysis examined injury and illness statistics plus workers' compensation costs. Unfortunately, it was not possible to compare several years of pre-implementation data (pre-1986) to post-implementation data except for one measure, the lost-time incidence rate. As a result, most of the observed changes reflect the corporation's or plant's experience in the years just after implementation of the program.

At the corporate level, the following observations were noted during the years following implementation of such a program:

- A significant increase in the crude incidence rate (at least for several years);
- A marked decrease in the lost-time incidence rate;
- A significant reduction in the percentage of recordable disorders that were “ergonomics-related”;
- A marked reduction in total and per capita annual workers’ compensation costs;
- No adverse effect, and probably a favorable effect, on quality; and
- No adverse effect on productivity and, in general, a means to accommodate required increases in productivity.

In contrast, the plant observed the following:

- A significant increase in the crude incidence rate;
- An increase in the lost-time incidence rate, but a shift from lost days to restricted days;
- No significant change in the severity rate;
- No change in the percentage of recordables that were “ergonomics-related”; and
- An almost linear decrease in annual workers’ compensation costs.

Reasons for these observed differences between the corporation and plant could not be determined in this project, but the unique hazards associated with red meat slaughtering work may be one contributing factor.

The second part of this project involved working with ergonomics teams from two departments in the plant. Overall, this component of the project demonstrated that the use of participatory ergonomics teams that rely on structured problem-solving methods are able to work effectively to address musculoskeletal hazards, especially related to the upper extremities, in the meatpacking industry. Both teams had representatives from production workers, supervision, and management. The teams’ targeted jobs were

some of the most difficult jobs in the plant in terms of number, severity, or cost of injuries and turnover. Subjective assessment of the teams' dynamics by the investigators revealed little need to work on team building or decision-making skills. There were, however, some differences in style between the team leaders. The Kill team leader was more personable, more accommodating to the team, and appeared to be more interested in the program and the problem-solving process than the Cut team leader. To the investigators, this difference contributed to better communication, participation, and enthusiasm among the Kill team than the Cut team. However, both teams were considered productive.

While the problem-solving process used by the teams was prescribed by the investigators, it was observed that the team members seemed to rely primarily on subjective feedback from workers performing the targeted jobs and their own subjective assessments of the jobs. Quantitative ergonomics data and methods were rarely used. It appeared that, for these jobs, the presence of a hazard was undisputed. The injury and illness data plus the worker feedback data were used to identify the body parts most adversely affected by these jobs. Videotapes and the worker feedback data were used to identify task elements that were believed related to the affected body parts. Solutions were then directed at altering these task elements. In general, both teams followed the sequence of steps recommended by the investigators. There were a few circumstances, however, when solutions were recommended prior to completion of data collection and analysis. Given the limited duration of the project, few of the developed solutions were implemented. None of the interventions were evaluated for effectiveness.

The exhibits are presented as documentation of examples of each teams' work. They are summaries that allow others to quickly examine the scope and methods of the team's data collection, data analysis, problem assessment, proposed solutions, and final recommendations. This type of summary can be used as an attachment for an appropriations request or as a reference when subsequent changes

in process or productivity warrant re-evaluation of the job. While not necessarily demonstrated in these six case studies, the investigators noted that it is desirable for the committee to have members that are "hands-on" technicians or engineers that are good at design or layout and can assist in making prototypes and setting up simulations.

REFERENCES

- Corporate Ergonomics Coordinator (1993). Personal communication with the Corporate Ergonomics Coordinator, Case Study #2 Corporation.
- Corporate Insurance Executive (1993). Personal communication with the Corporate Insurance Executive, Case Study #2 Corporation.
- Deming, WE (1986). *Out of the Crisis*. Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study.
- Local Secretary-Treasurer, UFCW, (1993). Personal communication with the Secretary-Treasurer of the Case Study #2 Plant Local United Food and Commercial Workers International Union.
- Moore, JS and Garg, A (in press). "The Strain Index: A method to analyze jobs for risk of upper extremity disorders." *AIHA Journal*.
- Scholtes, PR (1988). *The Team Handbook*. Madison, WI: Joiner Associates Inc.
- Swezey, RW and Salas, E (eds.) (1992). *Teams: Their Training and Performance*. Norwood, NJ, Ablex Publishing Company.
- Walton, M (1986). *The Deming Management Method*. New York, NY: Perigee Books.



CASE STUDY #3

Based on the Final Report of:

**A Cooperative Agreement* with
Department of Mechanical and Industrial
Engineering
Marquette University
Milwaukee, Wisconsin**

**Richard W. Schoenmarklin, Ph.D.
Principal Investigator**

**John F. Monroe
Graduate Research Assistant**

CASE STUDY #3

The Setting

The company is a medium-sized meat processor that has a nonunion production work force. The plant is an all-inclusive beef processing operation located in a metropolitan area. It contains a modern slaughtering plant that processes about 1,000 dairy cows each day (total of 300,000,000 lbs. of beef and by-products per year); a complete whole muscle boning and trimming operation that makes steaks, roasts, and ground beef; and a beef restructuring operation. The restructured beef products are supplied as roast beef to several national restaurant chains. Whole muscle products are sold to hamburger patty makers, fast food chains, meat processors, sausage makers, and the federal government for its school lunch program. In addition, a significant amount of edible offal and other meat by-products are sold in foreign markets.

The plant employs approximately 700 people in its three divisions, at least two thirds of whom are African-Americans and Hispanics. Fifteen to eighteen per cent of the production workers are women. The relationship between management and workers appears to be cooperative.

In the fall of 1993, the company was reorganized under Chapter 11. A group of investors with local economic roots purchased the company. This period of financial instability appeared to have minimal effect on the intervention. Although still committed to the goals of the project, management attention was lower for a brief period of time (approximately one month) while they struggled to ensure the economic survival of the company.

PRE-EXISTING LEVEL OF ERGONOMICS CONCERNS/ EFFORTS

The principal investigator approached the Director of Human Resources and the Manager of Safety at the plant about participation in the project. No ergonomics program existed at that time, and plant management was enthusiastic about participating in this project. They were aware of ergonomic problems in the industry and aspired to establish an ergonomics program in their plant. They were concerned primarily with the upper extremity disorders associated with repetitive motions.

SCOPE/OBJECTIVES OF THE CASE STUDY

The following implementation plan was developed. First, an ergonomics program was set up, consisting of teams that would attempt to decrease the severity and cost of cumulative trauma disorder (CTD) illnesses among plant employees. The effectiveness of these teams would be determined using both behavioral and engineering measures. The behavioral measures included results from climate surveys, while the engineering measures included the physical attributes of the jobs. The type and amount of wrist motion required to cut meat off a bone provides an example of a physical attribute of a meat processing job. The objectives of the plan were:

- Enhanced safety and health of the employees
- Decreased costs of workers' compensation premiums
- Decreased costs of training new workers to replace injured workers
- Improved morale among the employees
- Improved employee safety and health and reduced cost of occupational injuries and illnesses in the entire industry through shared results with other meat processing plants.

METHODS AND OPERATIONAL PROCEDURES

Team Formation/Member Selection

Two ergonomics teams were formed, each to work on a specific task. The two targeted tasks were the bone trimming operation (electric bone trimming department) and the meat stuffing and bagging operation. The members of each team were selected by the principal investigator and plant management. There were 15 members on the bone trimming team and 14 members on the meat stuffing team. Over the course of the year, four team members left due to job transfer or quitting the company. All of the employees who left were production workers. Not all team members attended each meeting, resulting in an average attendance of eight to nine. Most, if not all, production workers attended each meeting.

The teams were composed of management, support personnel, and production workers, providing representation from all staff who had some direct or indirect involvement with occupational injuries incurred on site. The investigators, the Director of Human Resources, the Manager of Safety, two nurses, and the Maintenance Manager sat on both teams. Additional members on each team included five or six production workers and a supervisor. Every effort was made to minimize the hierarchy of the team members and treat each member as an equal. Each team member was encouraged to speak his/her mind, and decisions were made by consensus from the team.

Two team members had difficulty understanding and speaking English, and three members either read or wrote English with difficulty. The inability to communicate in English, either orally or in written form, presented some problems during the meetings when members were asked to fill out surveys. Usually, a co-worker read the questions and answers from the survey to the worker who had trouble reading English. Another problem with language surfaced when a team member was asked to sign a

consent form to have his wrist motion monitored on the bone trimming line. For those members who could not understand or read English, a co-worker who was fluent in English translated the text on the consent form into Spanish. There was also one uncooperative member on one team who sometimes disrupted meetings.

Team Training

The principal investigator led a one and one-half hour training session for each ergonomics team at the beginning of the project. At the beginning of the training session, team members learned information about the plant's injury statistics and workers' compensation claims. Most of the training session focused on the physical aspects of CTDs in the workplace, the risk factors, and how to prevent CTDs through interventions. Training continued throughout the project during meetings when ergonomic issues were discussed by the university investigator and the team members. Provisions for team-building training were limited to the investigator encouraging team members to openly express their thoughts.

Team activities re Defining/Solving Problems

The plant management and the principal investigator targeted two tasks for ergonomic intervention in this project, the bone trimming operation (Challenger knife) and processed meat stuffing and bagging jobs. The bone trimming job was targeted because of the recorded high incidence rate of CTDs and also because it is a job that is performed in most, if not all, trimming and deboning operations in red meatpacking plants throughout the U.S. Results from ergonomic intervention in this job could have widespread benefits throughout the red meat industry. The second targeted job, stuffing and bagging of processed meat, was selected because of several complaints from employees and also the repetitive and forceful wrist actions required for this job, as observed by investigators. Improvements in both these jobs had been attempted before without progress. It was hoped that solutions could be developed through the participatory process.

For each team, the topic for each meeting was decided by the principal investigator, who introduced the topics in the following sequence throughout the project duration. The number of meetings devoted to each topic is also listed.

- Introduction to project (1 meeting)
- Ergonomics training (1 meeting)
- Identification of problems on each team's respective jobs and brainstorming sessions on ergonomic controls (1 meeting)
- Discussion of feasibility, classification, and selection of brainstormed ideas for ergonomic controls (1 meeting)
- Further discussion of selected ergonomic controls (1 meeting)
- Completion and collection of both pre-test and post-test surveys (administered in second, third, and fourth quarters of the project), in addition to status report on project. (3 meetings)
- Final meeting (1 meeting)
- Appreciation party sponsored by management (1 meeting)

During the meetings, the teams developed solutions to problems by consensus. Each meeting usually lasted one hour and took place at the end of the work day (usually around 2 to 3 PM). The principal investigator led each meeting and outlined the topic for that meeting. Then he opened the floor for opinions on the topic. He encouraged every member to speak his/her mind and not feel inhibited. After discussion, a decision was made by the team members by consensus (i.e., there were no voiced disapproval of decisions made by the team, although every member was encouraged to voice his/her opinion during the discussions).

The ergonomic controls were generated by the team members. The principal investigator opened the floor for generation of possible ergonomic intervention controls and strategies. Most

team members contributed ideas, and most of the ideas were suggested by the respective production workers. After all the possible ideas for ergonomic controls were suggested, they were classified into three categories of feasibility:

1. Controls that were easily and inexpensively implemented
2. Controls that had moderate expense and difficulty in implementing
3. Controls that were expensive and difficult to implement

The classification of the controls was made by the supervisors and managers of the respective job, plant engineers, the Director of Human Resources and the Manager of Safety. After the controls were classified, the hierarchy of feasibility of the controls was presented to all team members at the next team meeting. The team discussed the classification of feasibility and then decided by consensus which controls to implement. All team members were free to discuss and challenge the classification and change the classification, providing the other team members agreed to the changes by consensus vote. To minimize cost and enhance feasibility, the selected and implemented ergonomic controls for each of the two jobs were of either low or moderate expense and difficulty.

The ergonomic controls were implemented by the maintenance technician, who was also a member of each team. He responded expeditiously to each team's requests, and he usually implemented each control within one week. The controls were implemented with the cooperation and involvement of the supervisors, managers, and production workers, all of whom were members of the ergonomics team.

Each hourly team member usually was paid overtime (1.5x) for time spent in meetings because the meetings were held after a full day of production. The company also provided facilities to conduct meetings, provided maintenance technicians release time and materials to implement ergonomic controls, and sponsored a party at the end of the project for all those personnel involved.

The Director of Human Resources, who reports to the Chief Operating Officer of the plant, is responsible for the activities of both ergonomics teams. However, in an operational and administrative sense, the teams' activities were led and monitored by the principal investigator. Outside of team meetings, the principal investigator talked on a regular basis with the Director of Human Resources, the Manager of Safety, and the supervisors of the respective jobs. The fiscal and administrative aspects of the team were separated in order to avoid either the perception or occurrence of disproportionate influence on the team from management. The Director of Human Resources intentionally attended only a few meetings to minimize the possibility of exerting disproportionate influence on the team.

Decisions that had a fiscal impact were made ultimately by the Director of Human Resources. However, in every fiscal case, he endorsed the consensus decision made by the ergonomics teams. He also served on each ergonomics team, so he contributed to discussion of the feasibility, selection, and implementation of the ergonomic controls and also made the final decision on costs of each team's activities. He supported the ergonomics teams in the following way:

- Providing money to pay each hourly team member for time spent in meetings (usually overtime pay)
- Changing the normal work operations on the bone trimming and meat stuffing lines to accommodate the principal investigator in data collection efforts (surveys and wrist motion)
- Changing the normal work operations to try out the feasibility of new ergonomic controls (i.e., new Challenger knife)
- Releasing time and money for the Maintenance Department to implement the ergonomic controls
- Being genuinely concerned about the safety and health of the production workers and decreasing the incidence and severity of injuries and illnesses

The ergonomics teams gained credibility among the production workers by including a substantial portion of the teams' members from the targeted jobs. The teams' work was publicized in the plant's quarterly newsletter that is distributed to all employees.

TEAM ACCOMPLISHMENTS

Bone Trimming: The Challenger knife is an electric hand-held knife that trims meat from bones with a circular blade that rotates within an open disc. (Since the start of this project in January, 1993, the Challenger knives were upgraded with a model that features a faster rotation speed and less vibration than their predecessors.) Eight operators, who work side-by-side in 30-inch work spaces, use the Challenger knife to remove meat from bones at the end of the fresh meat line. The operators then push the removed meat through circular cutouts in their work spaces, and the meat falls into containers under the holes. Each operator's production and quality are recorded every hour. Each operator must collect at least 30 lbs. of meat per hour.

The number of hours employees work each week varies according to seasonal changes in the number of dairy cows taken to market. Typically, production increases in the autumn because dairy farmers cull their herds of weak and infirm cows before the long winter season. In the autumn of 1991, the bone trimming operators worked an average of 15 to 20 hours of overtime per week. Of the eight operators, three reported CTD illnesses during Autumn 1991. The problems with the bone trimming operation did not diminish when the workload returned to the normal 40-hour week. Four operators reported CTD illnesses during the first seven months of 1992. (Note: all claims of CTD illnesses due to repetitive trauma were checked and verified as CTDs by the plant nurse).

As indicated in Table 1 the incidence rate of CTDs for the bone trimming operators increased over the last six years, ranging from no CTDs per 200,000 hours of exposure to 74.1 for the first seven

months of 1992. The Director of Human Resources and the Manager of Safety became aware of the hazards in the bone trimming knife operation and were enthusiastic about using participatory ergonomic teams to reduce CTD risk factors and prevent CTDs in the bone trimming operation.

Year	# of wrist CTDs reported on OSHA 200 form	Incidence Rate of Wrist CTDs per 200,000 hours
1988	0	0.0
1989	1	10.7
1990	3	32.1
1991	4	42.7
1992 (first 7 months)	4	74.1

Table 1. Incidence rate of wrist CTDs per 200,000 hours of exposure in the bone trimming operation. Wrist CTDs included carpal tunnel syndrome, tenosynovitis, and tendinitis.

Members of the bone trimming team brainstormed ideas on how to improve the job. All team members were instructed by the principal investigator to feel free to offer any ideas and defer any judgment or evaluation until the next meeting. All of the team members participated in the generation and discussion of ergonomic controls, as demonstrated by the fact that most of the generated ideas were suggested by the production workers. The feasibility of all ideas was discussed at the following meeting, and consensus was reached by the team that the following ideas should be implemented or at least investigated.

Phase I (Simplest and least expensive)

- Move location of Challenger knife motor away from workers' heads
- Extend table for upper level trimmers so they can catch the "good bones" and stack them
- Investigate nonslip gloves

Phase II

- Investigate feasibility of smaller blade on Challenger knife (readily available)

Phase III (more complex and more expensive)

- Modify Challenger knife: angle the blade and add stop to handle
- Investigate feasibility of a chair or lean-to stool
- Investigate feasibility of adding a footrail
- Investigate whether height of table for upper level trimmers needs to be lowered

Because of the short time frame for the project, there was only enough time to implement one phase of ergonomic controls and monitor the members' responses before and after. Because of the potential contribution to CTDs, modifying the Challenger knife was included as a control to be implemented.

Final Ergonomic Controls for Bone Trimming Operation:

- Moved location of Challenger knife motor away from workers' heads.
- Extended table for upper level trimmers so they could catch the "good bones" and stack them.
- Investigated nonslip gloves
- Modify the Challenger knife: angle the blade and add a stop to the handle.

The first two controls were implemented in July. The third control (gloves) was implemented by distributing free samples of alternative gloves, which were donated by a local supplier, to the bone trimming workers. The workers did not feel these new gloves were any better than the gloves they were already using. Implementation of the fourth control was attempted but never completed because of the time required to redesign the Challenger knife.

Processed Meat Bagging Operation: At the end of the line in the Processed Meat Division, a team of four workers fills plastic bags with restructured roast beef with a meat stuffer, weighs them,

closes the stuffed bag with a tipper tie machine, and then loads the bag into a box. The team fills 6,000 to 7,000 bags per eight-hour shift. The stuffer and tipper tie jobs are two tasks that require repetitive hand and wrist movements. The four workers rotate from one operation to the next throughout the day. During an eight-hour shift, each worker operates the stuffer and tipper tie machine for approximately two hours each.

Although there have not been any recorded CTD illnesses in the processed meat bagging operation, the workers in this area have complained several times about sore hands, wrists, and forearms. Considering the number of bags filled each day and the numerous quick wrist motions required to stuff and close each bag, it is plausible that some of these workers may have CTDs in their incipient stage. The Director of Human Resources and the Manager of Safety recognized the potential for CTD illnesses to be caused by this bagging operation and wanted to take early action to prevent development of CTDs.

Members of the meat stuffing team brainstormed ideas on how to improve the job. All team members were instructed by the principal investigator to feel free to offer any ideas and defer any judgment or evaluation until the next meeting. Similar to the bone trimming team, all members participated in the generation and discussion of ergonomic controls. The feasibility of all ideas was discussed at the next meeting, and consensus was reached by the team on a final list of possible controls.

- Replace stand with one that is not as slippery and has a lip on back edge
- Eliminate the four-inch discrepancy between the table top and conveyor belt
- Investigate moving height of meat stuffing machine
- Investigate ways to minimize condensation on stuffing frame to reduce force required to pull bag out of stuffing frame
- Investigate methods to reduce the amount of gripping force required to get the air out and clamp it.

The first two controls on the final list were implemented in July and August. Anthropometric analysis showed that the third control was not necessary. The meat stuffing ergonomics team spent considerable time on the fourth and fifth ideas on the final list. The fourth and fifth items in the final list were intractable problems that had been investigated prior to this study by plant staff. Controls that were suggested by the ergonomics team for the fourth and fifth items either violated USDA rules for meat processing or had been tried before and rejected because they did not work. Some of the suggestions for the fourth item (minimize condensation on the stuffing frame to reduce pulling force) included putting a Teflon coating on the framing box, putting larger holes in the frame box, and using other gripping bags. Most of the suggestions for the fifth item (reduce the amount of gripping force required to clamp the bag) included automation, which had already been implemented on an existing, totally automated meat stuffing line in the plant. Another suggestion was job rotation of workers, which was already occurring on the meat stuffing line.

EVALUATION OF TEAM EFFECTIVENESS AND PROGRAM OUTCOMES

In addition to the two jobs for which team-directed solutions were attempted, various other measures and observations served to assess team functioning and performance as well as to gauge its impact. The team process was evaluated with organizational development principles. Ergonomic factors of repetition, wrist motion, and productivity were also measured before the implementation of the new Challenger knife on the bone trimming line. However, the new knife will be tested on the bone trimming line after the publication of this case study. The workers' wrist motion will be measured shortly after the redesigned knife is installed.

Measures of Team Function/Effectiveness

The organizational development aspects of the team process was assessed with a battery of surveys. Each survey was intended to assess a specific aspect of the team's progress from an organiza-

tional behavior point of view. Among the surveys administered were:

A team meeting survey was administered after each team meeting to determine if any issues needed to be corrected immediately to assure smooth team meetings

A job satisfaction survey to assess the job satisfaction of production workers before and after each phase of ergonomic intervention. Job dissatisfaction may affect a team member's view of the team's progress and may also lower the threshold for reporting pain or injury

An overall climate survey to assess how team members felt about the company and their role in it

A team climate survey to assess how team members felt about the organizational aspects of their ergonomics team, its mission and progress, their role on the team, and their co-members

Each of these surveys consisted of a series of statements. Respondents expressed their agreement or disagreement with the statement on a 7-point scale (7 = strongly agree and 1 = strongly disagree). The following observations were gleaned from the survey results.

The members of both ergonomics team (bone trimming and meat stuffing) felt the meetings were run well. Overall, the team members felt good about the meetings, felt they were run efficiently, and felt they were about the right duration. The participatory nature of the ergonomics teams resulted in an enhanced awareness of the value of each team member's contribution. The team members rated their fellow members' contributions to the team process higher at the end of the project than they did at the beginning. This demonstrated that the participatory team process affected the members' acknowledgment of each other's contribu-

tions positively. This was also reflected in the high marks for respect and treatment received from co-workers. The enhanced value members placed on their co-workers was a major benefit of the team process.

Co-Worker Satisfaction

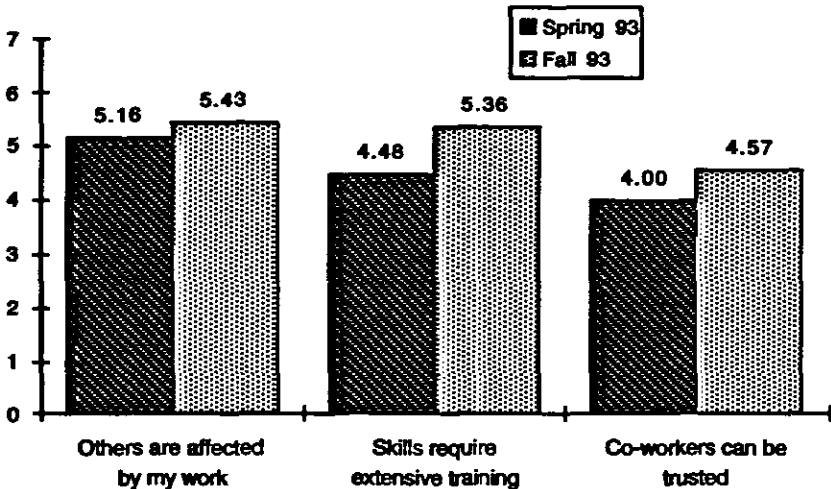


Figure 1. Co-Worker Satisfaction: Mean Responses from All Team Members

In general, the team members felt new ideas could be suggested and discussed freely, and these ideas could originate at the team level. The members felt the team process encouraged questions to be brought out into the open, which could account partially for an apparent increase in team morale among the production workers throughout the project period. The ergonomics training and discussion made the team members more aware of safety issues affecting their work. This probably contributed to a relative reduction in their general belief that good safety practices were being used.

The significant decrease in mean responses to questions that addressed deadlines and openness to discussion of new ideas was probably related to unrealistically high expectations at the onset of the project. The mean score for "team members keep their deadlines" decreased from before ergonomic intervention to after intervention.

The mean score for “the team is open to discussion of new ideas” also decreased. Team members started to feel frustrated in the fall and winter months of 1993, probably due to the fact that only one of the three planned levels of ergonomic intervention was actually implemented. This was due to the investigator’s optimistic expectation that three levels of intervention and all of their required activities, such as administration of surveys, implementation of controls, etc., could be accomplished in one year. Also, the surge in production during the fall of 1993 made it difficult to schedule meetings and to maintain the previous level of resource commitment to the project.

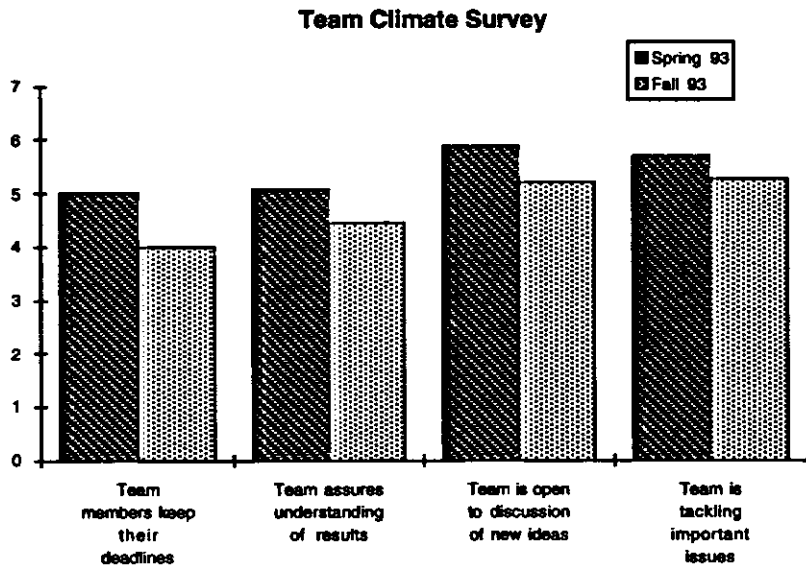


Figure 2. Team Climate Survey: Mean Responses from All Team Members

The team survey suggested that there was little perceived relationship between the work performed at the plant and the work of the team. The purpose of the team and members’ responsibilities were not clearly defined. A decrease in mean score for “the team makes sure to consider safety in the workplace” was probably due to the workers learning more about safe work practices and the cause of occupational injuries and illnesses from the training sessions and discussions, and, due to their enhanced awareness, consequently perceiving their work stations were not as safe as they had believed.

The production team members felt very positive about “coming up with new ideas to replace unproductive ones.” This result is not surprising in lieu of the fact that most of the ideas generated for improving the job came from the production workers. The production workers also felt that the team process “encouraged questions to be brought out openly” and “team members (can) ask for help when they need it.” Interestingly, the non-production members thought the team was ineffective in “coming up with new ideas to replace unproductive ones. The negative response could be due to selecting tasks (bone trimming and meat stuffing) for which the apparent ergonomic interventions became more difficult to implement as the project progressed.

Production Team Climate Survey

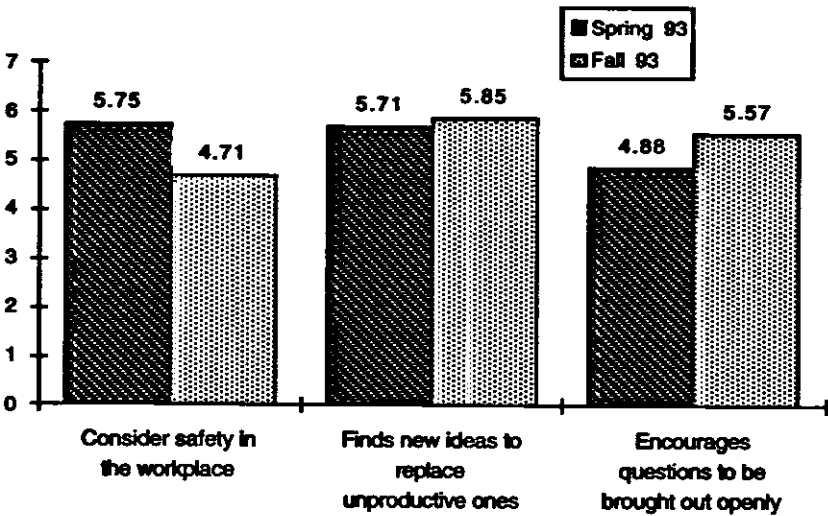


Figure 3. Team Climate Survey: Mean Responses for Production Team Members

In general, the non-production members’ responses to “deadlines,” “team effectively follows up its actions,” and “team delivers on its promises” indicate that the supervisors had high expectations of the team’s capabilities at the onset of the project and may have set unrealistic goals. One way to address the problem of unrealistic expectations is to reassess the goals, and adjust them as the project proceeds and evaluate the time and resources available to integrate the team’s work with the production work.

Comparison of Production with Non-Production on "New Ideas"

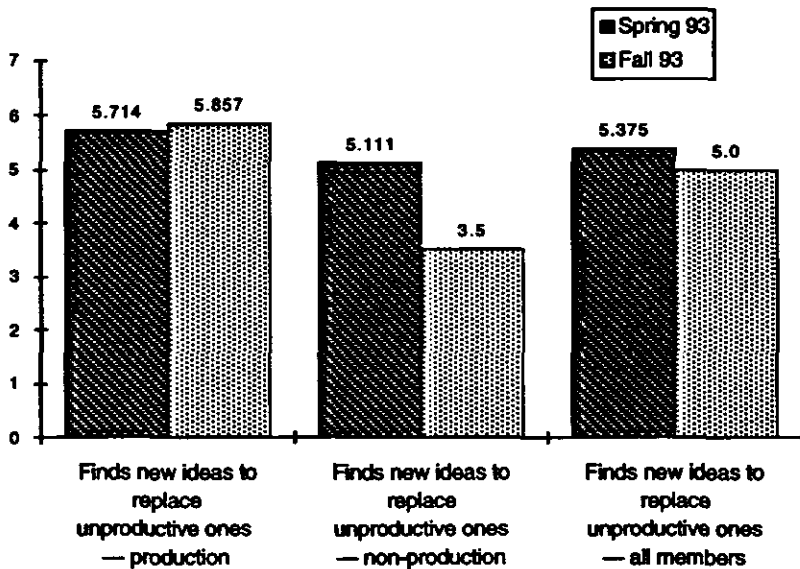


Figure 4. Comparison of Mean Responses from Production and Non-Production Team Members on "New Ideas"

Engineers, supervisors, and the Manager of Safety informally looked at trying to improve the health and safety aspects of the bone trimming and meat stuffing jobs prior to the start of the ergonomics project and found that the jobs were difficult to improve. Although the ergonomics teams did modify some aspects of these two jobs, the ergonomics teams ran into the same problems when they addressed these jobs during 1993. The bone trimming is a physically rigorous job that requires intensive hand and wrist motions while operating the electric bone trimming knife. The team thought the most obvious improvement to the job was redesigning the knife. Two versions of a redesigned knife were tested, and feedback from the affected bone trimming workers was incorporated into a third design, being tested in the summer 1994. Improvements were made to the meat stuffing job, such as replacing the floor stand and leveling the work surfaces. However, the most biomechanically stressful part of the meat stuffing job was tying the top of the stuffed bag. Many ideas were suggested, but none were feasible alternatives to the current method of tying it manually. In retrospect,

the targeted tasks of bone trimming and meat stuffing proved to be too problematic for an inexperienced ergonomics team that wanted to see results quickly.

Measures of Benefits

Symptoms surveys were filled out by the production workers on both ergonomics teams and their health status assessed before and after ergonomic intervention. Each respondent was identified by name. The survey took about three minutes to fill out if there were no discomforts, and about 7 to 10 minutes for every discomfort.

In general, there was a difference in the number of subjects reporting discomfort between pre- and post-test conditions. Of 13 reported areas of discomfort, all except one were in the upper extremity. About half of the reported areas of discomfort were in the fingers, hand, and wrist. The number of discomfort areas reported by the production team members who filled out both the pre- and post-test surveys increased throughout the year. This could have been due to the seasonal surge of production for the bone trimming operators during the fall of 1993, at which time they were working ten-hour days. Another possible cause of the increase in discomfort was the employees' enhanced knowledge and awareness of CTDs.

CONCLUSIONS AND RECOMMENDATIONS

In this case study, production workers were active members of the ergonomics teams and were involved in most aspects of the process except for targeting the tasks for interventions and determining the initial classification of feasibility of controls. However, team members were free to discuss and change the classification, providing the other team members agreed to the changes by consensus vote.

Management provided commitment and support to the participatory ergonomics project, and provided staff time and resources for

implementation of the project. However, the future of the ergonomics team process at this company is uncertain. Although work is continuing to complete the first phase of ergonomic controls on the bone trimming line throughout the summer of 1994, the ergonomics teams and their meetings have not been sustained. One of the overall goals of the participatory ergonomics project was to establish a sustainable ergonomics process at a meat processing plant. To achieve long-lasting improvements in health and safety in their workplace, management must develop and sustain a process that involves both production and management employees on a regular basis.

Although the ergonomics intervention in this plant had shortcomings, the process of participatory ergonomics teams still appears to be an effective method for generating, implementing, and evaluating improvements in the health and safety of the workplace. The ergonomics process needs sufficient time to manifest benefits. One year is typically not long enough to see permanent benefits, and a two or three year trial period is usually recommended, particularly if a number of ergonomic interventions is planned. The benefits of sustaining the ergonomics team process extend beyond improvements in health and safety statistics into the realm of general management-labor relations. Survey data from the past year showed that the team process expanded team members' awareness of the value of each other's contributions, established a forum for bringing up questions and offering suggestions to improve work sites, increased overall morale, and reinforced the notion that groups can discuss ideas effectively and generate solutions to problems.

The participatory ergonomics process should be sustained if permanent positive improvements in the health and safety of workers are going to occur as a result. Recommendations for sustaining participatory ergonomic interventions include:

- Survey team members to gauge team dynamics and attitudes
- Clearly establish the purpose of the team, members' roles, and expectations of outcomes

- **Set realistic goals for the team. Striving for overly ambitious outcomes sets the stage for disappointment among the team members.**
- **Start out with jobs or tasks that offer the opportunity for salient ergonomics interventions that could be implemented easily and inexpensively. These jobs should have high visibility and have ergonomic controls that are likely to produce positive results quickly. Tackling highly visible, relatively easy projects at the beginning of the ergonomics process allows an inexperienced ergonomics team to gain momentum quickly and promotes a positive attitude among the team members.**
- **Assess the effects of the ergonomic intervention multi-dimensionally:**
 - **Monitor epidemiological statistics, such as incidence rate and severity.**
 - **Measure affected workers' attitudes toward any specific change in the job layout, the ergonomics team, and the company.**
 - **Monitor the health status of the affected production workers with discomfort surveys to determine if there are any illnesses in their incipient stages.**
 - **Measure relevant biomechanical factors, such as wrist motion, force levels, posture, or vibration; and monitor changes in production, absenteeism, and quality of work.**

REFERENCES

- Babbie ER (1992). *The practice of social research*. Belmont, CA: Wadsworth Publishing Co.
- Marras WS, Schoenmarklin RW (1993). "Wrist motions in industry." *Ergonomics*, 36(4), 341-351.
- Marras WS, Schoenmarklin RW (March, 1991). "Quantification of wrist motion in highly repetitive, hand-intensive industrial jobs." Final report for research funded by National Institute for Occupational Safety and Health (NIOSH), grants nos. 1 RO1 OH02621-01 and 02.
- Noro K, Imada AS, eds. (1991). *Participatory ergonomics*. London: Taylor & Francis.
- Schoenmarklin RW, Marras WS, Leurgans S (1994). "Industrial wrist motions and incidence of hand/wrist cumulative trauma disorders." Accepted for publication in *Ergonomics*.
- Scholtes PR (1988, 1992). *The Team Handbook*. Madison, WI: Joiner Associates, Inc.



LESSONS LEARNED

**Prepared by: Alexander Cohen, Ph.D.
Consultant
Cincinnati, Ohio**

**Christopher C. Gjessing, B.A.
Division of Physical Sciences and Engineering
National Institute for Occupational Safety and Health
Cincinnati, Ohio**

**Theodore F. Schoenborn, M.A.
Division of Physical Sciences and Engineering
National Institute for Occupational Safety and Health
Cincinnati, Ohio**



LESSONS LEARNED

NIOSH commissioned this project and the three case studies with the hope of showing how participatory approaches could enhance efforts to control ergonomic problems in meatpacking plants and other types of workplaces faced with these kinds of problems. This section is an attempt to draw together the lessons learned from these demonstration cases.

At the outset, it is meaningful to ask whether the meatpacking plants and companies involved in the case studies were typical of the industry. Two of the plant sites for the interventions (Case Studies #1 and #2) are part of large, diversified meatpacking companies. All three were relatively large capacity plants with employment over 700 and with both slaughtering and processing operations. Workers at the two pork plants (Case Studies #1 and #2) were unionized, while the beef plant workers (Case Study #3) were not represented by a union. The two pork plants operated in rural environments and consequently drew workers from the surrounding rural area. In contrast, the beef plant was located in the center of a large metropolitan area. Industry competition affected each of the plants, as none had products sufficiently differentiated from others in the market that they were immune from the demands of the marketplace. Given these and other considerations as noted in the case reports, the study sites, though few in number, appeared to be fairly typical conditions for conducting the demonstrations. Thus, the experiences gained from this work were believed to have relevance to a significant part of the meatpacking industry.

Also, mention must be made again that these case studies and the results gathered from the attempts to solve ergonomic problems are not to be viewed as research efforts. The experiences reported and lessons learned are primarily rooted in observations and surveys which lack control measures in most instances. Nevertheless, the urgency of addressing ergonomic problems in meatpacking gives importance to intervention efforts such as those described in this report.

Pointers or guides in developing participatory and team-building approaches for problem solving based upon the literature were charted in an earlier section of this report (pages 40-41). The table on pages 191-194 summarizes the efforts and results reported in the three case studies in light of these different pointers. The text below elaborates further on these observations in describing the lessons learned from the three case studies. As will be shown, the lessons reaffirm many of these points but also add qualifiers or other considerations.

MANAGEMENT COMMITMENT

Top management commitment and support is key to successful problem-solving efforts involving teamwork and participatory approaches. Variable expressions of this were in evidence in the three cases. For example, the Case Study #2 company had recognized the need for controlling ergonomic hazards several years before the OSHA citations brought widespread public attention to the CTD hazards in meatpacking. This company had taken steps to form a corporate-wide employee-involved continuing program for the purpose of ergonomic hazard control. An experienced industrial engineer with training in ergonomics functioned as the coordinator of the program and trained members of ergonomics committees established at various plants. Moreover, this individual sat on the corporate steering committee which included top management persons charged with setting policies and priorities and allocating resources for the plants making up the corporation. On this basis one could say that ergonomics issues had representation at the highest level of the corporation's management. The company issued policy statements acknowledging management support of ergonomic hazard control measures and promoting employee awareness of and education about such problems. As was noted, the demonstration study in this company offered an opportunity to examine ergonomic program efforts in a plant whose performance appeared, by some measures, to be behind other plants in the same corporation.

Though starting later, the Case Study #1 company also developed formal policies endorsing participatory efforts to attack ergonomics problems, and used inside safety and health personnel with

Table 1. Summary observations in case reports re pointers in worker participation/team approaches to ergonomic problem-solving as suggested by the current literature.

Conditions	Observations
<p>Management Commitment</p>	<p>Case Study #1: Formalized policy on ergonomics hazard control efforts involving worker participation. Plant-wide committee formed to deal with such problems comprising department heads, worker representatives, others instrumental in accomplishing goals. Made resources available to implement team-proposed solutions in a minimal time period.</p> <p>Case Study #2: Instituted program in 1986. Issued formal policy on worker participation in ergonomics problem solving. Designated an ergonomics program coordinator to oversee multi-plant efforts who sat on the top decision-making group of the corporation. Ergonomics committees formed in each plant with representatives from management, workers' groups, and others in position to put into effect proposed changes.</p> <p>Case Study #3: Offered resources to support team-building activities including overtime pay for workers to attend meetings. Ranking managers/directors sat on ergonomics teams with workers.</p>
<p>Training</p>	<p>Case Study #1: Provisions made for training in both team-building and ergonomics problem solving to team members, the latter including opportunities for practicing methods and techniques. General awareness training on ergonomic problems given to all plant employees. Company safety and health officer capable of handling efforts, some university investigator assistance.</p> <p>Case Study #2: Specialty training on ergonomic issues given to team members. Awareness training on ergonomic hazards given to all employees, including office staff, as part of overall corporate policy. Capable corporate ergonomics coordinator assumed responsibility for all such training.</p>

Composition	<p>Case Study #3: Formal training limited in time and focused completely on ergonomics issues. No in-house expertise; handled exclusively by outside university consultant.</p>
	<p>Case Study #1: Team memberships assured inputs from production workers engaged in the problem jobs, supervisory and engineering personnel plus maintenance persons from the same department or a combination who could facilitate data gathering, development and implementation of proposals. Teams were 7-9 members in size and were apparently small enough to be effective, considering overall results reported. Second level, plant-wide ergonomics committee representatives included the purchasing head, which is a recommended practice, and other members who provided close team support (e.g., nurse member supplied injury/medical data in defining problem jobs).</p>
	<p>Case Study #2: With two exceptions, departmental teams were formed similar to Case Study #1 as were the plant-wide ergonomics committee at the intervention site. One difference was the presence of the corporate ergonomics coordinator who served in an advisory capacity at both the team and plant committee level. The ergonomic coordinator's presence at this site and other plants in the corporation suggested close oversight of all company ergonomics activities and possible limits on individual team/plant autonomy.</p>
Information Sharing	<p>Case Study #3: Teams as formed included production workers assigned to the problem jobs plus supervisory staff and maintenance people from the areas of concern. Top plant officials were also members whose presence could have limited openness of discussion and inputs from production workers although one top official was intentionally absent from many meetings so as not to exert disproportional influence on the team. The teams experienced some turnover in production worker members, had to cope with language/literacy limitations of some participants. Reasonable efforts were made to deal with some of these problems.</p>
	<p>Case Study #1: Individual teams received company information on CTD prevalence, worker's compensation claims and costs, sick-absence and employee turnover to assist in defining problem jobs though the means of access and/or mode of data presentation were not described. A direct way for workers to track injuries was recommended. Opportunities to collect other data reflecting risk factors, interviewing workers as to complaints were freely granted. Varied efforts made to publicize and keep all plant employees informed of team's activities, progress, and accomplishments.</p>

Information Sharing (continued)

Case Study #2: It is intimated that teams shared similar data to that noted in Case #1 for the jobs that were preselected by the management and the corporate ergonomics coordinator for study at the plant intervention site. Also the teams had access to ergonomics risk factor information and could collect other information that went into the decisions to focus on these jobs. Monthly and quarterly reports on the team's progress were circulated to other plants in the corporation.

Case Study #3: Team members were provided injury statistics and workers' compensation data at the start of the project, but the teams did not review these records as the project progressed. Team activities were publicized in a quarterly newsletter distributed to all employees.

Activities & Motivation

Case Study #1: Teams attempted to follow an orderly approach in defining and rank-ordering jobs through using injury/medical record data and risk factor evidence, then brainstorming and prioritizing ideas for improvement along with means for implementation. These experiences should build team member skills and lay a strong foundation for future efforts. Proposed solutions took account of ease of implementation, feasibility and cost and opted primarily for engineering changes, a preferred approach. Those actually implemented proved to have positive effects but did not meet the expectations of some teams and the workforce as a whole. This resulted in feelings of dissatisfaction with the overall program. More realistic goal setting would seem indicated.

Case Study #2: Procedures used customized forms, checklists for data gathering on risk factors, and decisions on solutions developed by the company. These gave order to team activities. Teams focused efforts on preselected problem jobs which were recognized as posing difficult problem-solving elements based on earlier attempts. Easier job targets could have provided the teams with some early success and positive motivations; the teams expressed disappointment that proposed changes would take some time to implement.

Case Study #3: Two jobs for study were preselected by management and the investigator. A team was formed for each job. Team activities almost solely directed to brainstorming for solutions which were then prioritized as to feasibility and cost factors. Approach jumps to solution without allowing for much team understanding of the problem. Although some improvements were made to the jobs, some aspects of the jobs had intractable elements making it difficult for the teams to have successes.

Evaluation

Case Study #1: Data collection addressed both team-building and performance issues in ways that showed changes over time, including first indications of positive results of team-generated ergonomic improvements following implementation. Both subjective survey methods and traditional objective measures were included in the evaluation with efforts made to tap not only team responses but the workforce as a whole and to analyze the results in terms of those whose jobs were affected and those not affected.

Case Study #2: Data collection included self-report surveys of team members on how well meetings were run, productivity, representations, quality of leadership and other team-building issues. Data also collected in symptom surveys to corroborate problems and risk factors and set a baseline for determining benefits of improvements along with the more traditional injury/medical data points.

Case Study #3: Surveys of teams concentrated on aspects of member interaction, team effectiveness, and responses to the objectives of the program as a morale builder, some given at the beginning and end of the study period. Data analyzed by different representative groups to show differences in views between management/supervisory staff and production worker team members. Besides symptom surveys, a plan was included to collect measurements of hand/wrist motions before and after some proposed job improvements to offer quantitative indications of the potential benefits of certain job changes in more immediate ways.

supplemental assistance from outside ergonomics experts to drive the efforts. Additionally, resources were made available to successfully implement the first team-generated proposals in minimal time. The demonstration in this case study offered an opportunity to observe early efforts at team-building. The Case Study #3 plant site also provided observations of team-building but had no formal written program as to ergonomics control objectives or employee involvement. This plant, like the other two, offered resources to support team activities and implement solutions judged feasible, even paying workers overtime wages to attend ergonomics team meetings so production schedules were not interrupted (a problem in all three study sites). An outside ergonomics researcher largely directed the resulting team approach, working primarily with the company human resource manager. When compared to the two other case demonstrations, this plant did not appear to make as much progress and the teams have not continued to function.

These cases support the lesson that sustained efforts in ergonomics problem-solving requires strong in-house direction and involvement and significant staff expertise in the subject matter. It is not clear from the case study reports whether the top management support of the participatory approach extended to middle managers or supervisors. Such persons did serve on the various teams formed at the three plant sites, and in that regard they may have played pivotal roles in transmitting proposed solutions to higher level committees or garnering resources to implement proposed solutions.

TRAINING

The literature suggests that to function effectively, ergonomic work teams must be trained both in teamwork skills and skills related to identifying and analyzing ergonomics problems. The three case studies offer varied illustrations of this training. Case Study #1 reported that both types of instruction were provided for the ergonomics teams. Team-building instruction highlighted

group techniques in task analyses, interpersonal processes, and developing consensus. The ergonomics training emphasized risk factors related to CTDs and afforded practice in using videotapes and job analyses to rate different job operations in terms of risk. Apart from this instruction, general awareness training in ergonomics was given to all plant employees via the company safety and health personnel. The Case Study #2 company also trained the entire workforce, including office workers, as part of an overall corporate policy. This instruction was handled by the corporate coordinator of the ergonomics program who, along with the university investigators, gave specialty training in the etiology of CTDs and back disorders and approaches to solving ergonomics related problems at the actual plant site. In this context, mention is made of participatory problem-solving techniques (but with little elaboration, and the report notes that little time was spent in actual team-building activities). In contrast to the varying levels of training and coverage of workers shown for Cases #1 and #2, Case #3 provided ergonomics training to only the team members. This training was handled exclusively by the outside university investigator. This training was one and one-half hours in length, although training continued throughout the project during team meetings. Team-building training was limited to the researcher imploring team members to express their thoughts about problems and solutions openly. Nothing more formal was done, however the report does note that added efforts were made to help team members with literacy difficulties.

Recognizing that the three demonstration cases in participatory ergonomic interventions are limited one-year efforts, the real issue is whether the resultant positive experiences can lead the company to sustain them if they are not already an established practice. Clearly, training activities both in team building and ergonomics problem solving serve that end by creating in-house staff knowledge and resources to carry the program forward. Cases #1 and #2 show every indication that such training will reap those benefits. From the analysis of the university investigator, Case #3 seems unlikely to continue with the teams in light of the limited training given and the plant's dependency on outside persons to provide the knowledge to drive the program.

COMPOSITION

The three case study reports depict both similarities and differences in organizational structure and team formation in undertaking the intervention efforts described. For example, in Case Studies #1 and #2 the ergonomics work teams for the intervention studies were each formed within different departments and these groups reported to a plant-wide ergonomics committee that had responsibilities for the plant's overall ergonomics program. In Case Study #2 however, the plant ergonomics committee at the study site (as well as other corporate sites) were responsive to a higher level corporate steering committee which set organization policies, priorities, and resource allocations. The corporate ergonomics coordinator served as a member of the steering committee and tracked all reports dealing with ergonomic issues within the various plants. He regularly attended plant committee meetings where the activities of the department teams were presented. The size and make-up of both the department teams as well as the plant committees were essentially similar in Case Studies #1 and #2. The teams were five to nine persons consisting of production workers, industrial engineers, and supervisory and maintenance personnel with assignments in the department in question. The corporate ergonomics coordinator also served on the teams described in Case Study #2 in an advisory capacity. The ergonomics committees in both the Case Studies #1 and #2 plants included representatives from management and labor, plus production department heads, industrial engineers, the personnel director, and medical staff. The case study #1's committee also included supply and purchasing managers. In Case Study #3, two teams were formed. The plant manager was a member of one team, and other ranking officers, such as the Director of Human Resources, and the Manager of Safety, on both teams. Each of these two teams also included a supervisor and five to six production workers from the departments chosen for study. In effect, this latter team combined the two tiers of ergonomics committee/team make-up into one. As a consequence, the size of the teams in Case #3 were larger, specifically, 14 to 15 people, although not all team members attended each meeting.

The literature suggests that no single form of participatory problem solving can fit all situations and this seems true in the cases described above. The reported experiences do offer some confirmation of factors that are important to consider in structuring this approach. For example, Case Studies #1 and #3 suggest that for best results department ergonomics teams should not include top plant management or employee representatives who may have other agendas in mind. Their presence on a second level ergonomics committee is more appropriate; for one thing, it reduces concerns about the willingness of individual workers to speak freely in team meetings. Case Study #1 made a particular point about the need to keep team size down to a minimum to promote maximal interaction. At the same time the report mentioned the benefits of having a mix of new and experienced workers as team members to capitalize on fresh ideas as well as those with more seasoning. Team leadership factors and their strong influence on team performance and effectiveness was noted in Case Studies #1 and #2. Case Study # 3 reported both turnover and language/literacy limitations among employee members of its teams. Having other workers help in interpreting and communicating information appeared beneficial but raises further questions about who can best contribute to the participatory problem-solving approach. Stressing this point further, a member of one team strove to be a disruptive influence in team meetings.

Evidently, having direct or indirect access to maintenance people and services was an instrumental factor in team performance, especially at the implementation stage. Hence, their presence as team members bears consideration in structuring an intervention approach.

INFORMATION SHARING

As stated in the literature, effective participative or team approaches to problem solving demand access to information germane to the problem and related issues. Since the problems in this instance dealt with ergonomic hazards and resulting cases of

CTDs in meatpacking jobs, company or plant information on the prevalence of CTD-type injuries, workers compensation claims and costs data, and sick-absence or employee turnover were vital to determining which jobs presented the greatest risk of such disorders and thus were critical targets for control actions. The reports of Case Studies #1 and #2 acknowledge that this information was made available to department teams identifying and evaluating particular target problems in their respective areas. However, the manner of access and its rendition were not detailed. Intimating that there are needs for improvement, a recommendation in the Case Study #1 report is to establish a management information system which can be used by the teams directly in tracking injuries. In Case Study #3 the activity of gathering and analyzing data from medical records and identifying hazardous jobs were performed by management and the university investigator before the teams were formed. This suggests that the ergonomics teams at this site missed out in learning important fundamentals to ergonomics problem-solving work, although the team members later learned information about the plant's injury and illness statistics and workers' compensation claims.

Also in Case Studies #1 and #2, efforts were made to keep all plant personnel informed of the intervention teams' activities through status reports and other issuances. Case Study #1 exhibited photos and descriptions of changes implemented by the teams in the company's cafeteria. Case Study #2 distributed monthly reports of individual team's work to other plants in the corporation and circulated it in a quarterly ergonomic newsletter. This type of reporting gave the program accountability. Though not mentioned, this publicity could also serve to maintain the awareness of the whole workforce to ergonomic hazards and injury risks but at the same time could have unduly heightened the expectations of many that solutions to CTDs and other musculoskeletal problems were immediately forthcoming. As noted particularly in Case Study #1 there was disappointment in the program's progress especially for those whose jobs were not included for study. The lesson here is perhaps to not oversell the effort to the user or affected group.

ACTIVITIES AND MOTIVATION

Overall, team activities in the three case studies could be classified as efforts to:

- a) identify jobs posing significant ergonomic hazards and/or sort out risk factors in those already targeted as being problem jobs;
- b) gather and analyze data from medical records and hazard or symptom surveys to fulfill the needs of (a) above; and
- c) brainstorm and prioritize control options along with plans for their implementation.

Work on these tasks was primarily done in team meetings in all three case studies, and reactions of the participants to the numerous sessions yielded reasonably favorable responses in terms of their conduct and accomplishments. Differences between the three case studies were more apparent in terms of the emphasis given the above types of activities and the manner of approach. For example, the longer history of the ergonomics program in Case Study #2 had generated more formal and orderly approaches to carrying out the above tasks, including the development of customized forms for data gathering and check-lists for decision making. Moreover, through centralized tracking of various injury, medical, and hazard data for departments and plants throughout the corporation, problem jobs for study by department teams could be readily identified.

In Case Study #1, the teams had to first identify and rank-order jobs in terms of critical needs for control based on various data gathering methods, as well as define the risk factors and propose remedial measures for the worst situations. The team experiences in Case Studies #1 and #2 showed an orderly progression of actions in laying a foundation for proposed solutions. Team members' ergonomic knowledge and skills are almost certain to have developed in this process and should solidify this approach

in future company problem-solving efforts. In Case #3 team activities were aimed at brainstorming preselected jobs for solutions which then were prioritized as to feasibility and cost factors. Without experience in gathering and analyzing injury and medical records and identifying jobs posing significant risks, it is uncertain whether the team approach described in Case Study #3 will continue.

Team decision making on solutions in the three cases was by consensus. Two studies (#1 and #3) mentioned prioritization which took into account the ease or difficulty of implementation, other feasibility considerations, and cost. The most recommended control measures accepted for implementation were in the category of engineering remedies (e.g., redesign knives or tools, automate the work tasks or provide mechanical assist devices, modify work station layouts or work surfaces) as opposed to other techniques such as changes in work practices.

Team motivations in the three cases could be expected to be high because of the novelty aspect of the efforts, including the attention paid to them by the outside investigators who collaborated in the intervention effort. Beyond this, there are more questions than answers as to the level of team motivations in the various case studies. For example, the literature acknowledges that selecting less difficult problems and solutions that could yield early successful outcomes would build confidence and satisfaction, especially in newly formed teams. Yet, examples of the jobs targeted for study in Case Study #2 and more notably Case Study #3 for which solutions were proposed did not fall into this category. Indeed, in Case #3, the two problem jobs selected by management and the university investigator had intractable elements based on earlier efforts. Although improvements were made, attempts to improve some aspects of the jobs were ineffective or could not be implemented during the demonstration project. While the interactions among the team members in Case Study #3 reportedly generated positive feelings among team members, the lack of tangible improvements in some aspects of the jobs hindered the progress of the teams. Case Study #1 was able to

implement certain solutions within the time frame, publicize the efforts as already noted, and even report initial results indicating benefits. These should be rewarding to the teams involved; yet the teams' expectations and that of the workforce in general were greater. Setting realistic goals for the teams, providing feedback to their efforts, and communications with the rest of the workforce, including reasonable timetables for progress, could help to allay this problem.

As indicated in the literature and confirmed in the case studies, the role of the team leader is especially crucial to team function and performance. Those who are sincerely interested and enthusiastic about team approaches to problem solving, are personable and democratic in their leadership style, and are intent upon promoting maximal interaction of the members in decision-making appeared to be the most effective.

EVALUATION

As a requirement of the project, each case study was to furnish data on team building and team performance issues used in efforts to address and solve ergonomics job hazards in their respective meatpacking operations. Forms for doing so are described in the various reports. These included surveys to collect member ratings of how well the meetings were run and their perceptions of team effectiveness in terms of productivity, communications, adequacy of resources, commitment to the program objectives, size of group and representations, quality of leadership, etc. Some were administered early and again at the end of the project term to show differences in the team-building process over time. The information gained from these surveys showed positive human relations effects, apart from any benefits to resolving the ergonomics concerns. The worker participants in particular were pleased to be consulted about needs for changes in their jobs. Without exception the surveys did indicate one major problem — scheduling and attendance at meetings in light of production pressures. This conflict begs for an equitable resolution. Policy statements indicating company concerns for health and safety having the same priority as production and cost reductions demand no less.

The aforementioned measures of team functioning and performance were all subjective. More objective indicators included the number of jobs analyzed, solutions proposed, or those actually approved for implementation, all of which seem suitable as in-process type measures. As noted in the reports, the short time frame for the study in many instances precluded data collection that could actually demonstrate the merits of implementing team-directed solutions in terms of reductions in CTDs or other related medical problems. However, Case Study #1 offered some first indications of such effects, and Case Study #2 analyzed workers' compensation data and injury and illness data from a period early in the implementation of the corporate-wide ergonomics program.

Symptom surveys as used in the various cases suggest a way to get early indications of problems and provide appraisals as to whether proposed solutions will be effective in resolving the difficulties. Waiting for data based on traditional OSHA injury reports, medical referrals, and absenteeism or restricted day cases to demonstrate the benefits imposes lengthy delays which may be frustrating to team members in their desire to show that their work is having an impact. One case study (#3) expects to complete a plan to take measurements of hand/wrist motions before and after some proposed job improvements to offer more quantitative indications of effects from certain job changes. In Case Study #1 ergonomic analyses of implemented changes were used to evaluate the controls. Comparisons of pre- and post-intervention ergonomic job analyses provide immediate feedback to the teams about what works.

Clearly, there are different ways for reporting on the participatory teamwork experience and results in ergonomic problem solving. Most important is that evaluation procedures become written into the overall plan for the team efforts, enabling one to appraise progress, provide feedback to affected or interested parties, and make suitable corrections where necessary to improve the overall effort.

Lessons Learned

The distinctions among the three Case Studies in terms of management commitment, training, team composition, information sharing, team activities and motivation, and evaluation methods outline the lessons learned from these demonstrations. It is hoped these lessons will enhance future participatory ergonomic problem-solving efforts.

BIBLIOGRAPHY

BIBLIOGRAPHY¹

- Adams E (January 1993). "Second-stage: Using macro-ergonomics to 'design-out' cumulative trauma risk." *Occupational Health and Safety* 62:40-45.
- Alexander DC (1986). *The practice and management of industrial ergonomics*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
- American Meat Institute (July 24, 1992). *Markets and Marketing Newsletter*.
- Armstrong TJ, Fine LJ, Goldstein SA, et al. (1987). "Ergonomic considerations in hand and wrist tendinitis." *J Hand Surg* 12A(2 pt 2):830-837.
- Armstrong TJ (1983). *An ergonomics guide to carpal tunnel syndrome*. Akron, OH: American Industrial Hygiene Association's Ergonomics Guides.
- Babbie ER (1992). *The practice of social research*. Belmont, CA: Wadsworth Publishing Co.
- Bjerklie S (Aug. 1992). "No way up? Part 1." *Meat & Poultry*, pp. 35-41.
- Boden LI, Hall JA, Levenstein, Punnett L (1984). "The impact of health and safety committees." *J Occup Med* 26(11):829-834.
- Brandon K (1992). "Ergonomics at UAW-Ford." *Occupational Health & Safety* 61(6):44-54.
- Bureau of Labor Statistics. *Industry Wage Survey and Employment and Earnings*. U.S. Department of Labor.
- Bureau of National Affairs (Jan. 5, 1984). "Lower injury rates, costs seen as a result of voluntary compliance, Cal/OSHA states." *Occupational Safety and Health Reporter*.
- Caplan S (1990). "Using focus group methodology for ergonomic design." *Ergonomics* 33:527-533.

¹This bibliography contains all references that appear in this document. Additional references from the original case reports are also included.

- Cascio WF (1991). "Effect of attitudes and behavior on productivity, quality of work life, and labor-management cooperation, Chapter 6." In: *Applied Psychology in Personnel Management*. Englewood Cliffs, NJ: Prentice-Hall Publishers.
- Chokar JS, Wallin JA (1984). "Improving safety through applied behavior analysis." *J Safety Res* 13:141-151.
- Cohen A, Colligan MJ (1993). *Assessing occupational safety and health training: A literature review*. Cincinnati, OH: National Institute for Occupational Safety and Health, Division of Training and Manpower Development.
- Cohen A, Dukes-Dobos F. (1985). "Applied ergonomics." In: *Vol. 3B Biological Responses- Patty's Industrial Hygiene & Toxicology* (2nd Edition) New York: Wiley Interscience Publishers, 375-430.
- Cohen HH, Jensen RC (1984). "Measuring the effectiveness of an industrial lift truck safety training program." *J Safety Research* 15(3):125-135.
- Cohen HH (1983). "Employee involvement: Implications for improved safety management." *Prof Safety* No. 6:30-35.
- Commission on the Future of Worker-Management Relations (May, 1994). Fact Finding Report U.S. Department of Labor and U.S. Department of Commerce, Washington, DC.
- Conroy C (1990). "Work-related injuries in the meat packing industry." *J of Safety Research* 20:47-53.
- Cooke W, Gautschi F. (1981). "OSHA, plant safety programs and injury reduction." *Indust Relations* 20(3):245-257.
- Corporate Ergonomics Coordinator (1993). Personal Communication with the Corporate Ergonomics Coordinator, Case Study #2 Corporation.
- Corporate Insurance Executive (1993). Personal Communication with the Corporate Insurance Executive, Case Study #2 Corporation.
- Della-Giustina JL, Della-Giustina DE (1989). "Quality of work life programs through employee motivation." *Prof Safety* No. 5:24-27.

- Deming WE (1986). *Out of the Crisis*. Cambridge MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study.
- Development Dimensions International. *Team Development Kit Survey*.
- Dyer WG (1987). *Team building: Issues and alternatives* (2nd Ed.). Reading, MA: Addison-Wesley.
- Edwards S (June 1983). "Quality circles are safety circles." *Natl Safety News* 31-35.
- Falck B, Aarnio P (1983). "Left-sided carpal tunnel syndrome in butchers." *Scand J Work Environ Health* 9:291-297.
- Francis D, Young D (1979). *Improving Work Groups: A Practical Manual for Team Building*. San Diego, CA: University Associates, Inc.
- Garg A, Owen B (1992). "Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home." *Ergonomics* 35(11):1353-1375.
- Grandjean E (1987). *Ergonomics in Computerized Offices*. London: Taylor & Francis Publishers.
- Griffin RW (1988). "Consequences of quality circles in an industrial setting: A longitudinal assessment." *Acad Mgmt J* 31(2):338-358.
- Guzzo RA, Jette RD, Katzell RA (1985). "The effects of psychologically based intervention programs on worker productivity." *Personnel Psychol* 38:275-281.
- Imada AS (1991). "The rationale and tools of participatory ergonomics." In: *Participatory Ergonomics*. London: Taylor & Francis, pp. 30-49.
- Jensen R, Houdos TK. *A guide for preventing back injuries among nursing assistants working in nursing homes*. Morgantown, WV: National Institute for Occupational Safety and Health (Unpublished report).
- Keyserling W, Armstrong T, Punnett L (1991). "Ergonomic job analysis: A structured approach for identifying risk factors associated with overexertion injuries and disorders." *Appl Occup Env Hyg* 6:353-363.

- Krause TR, Hidley JH (1993). "Implementing the behavior-based safety process in a union environment." *Prof Safety* No. 6:26-31.
- Krigsman N, O'Brien RM (1987). "Quality circles, feedback and reinforcement: An experimental and behavioral analysis." In: *Organization Behavior Management and Statistical Process Control*. Haworth Press, pp 67-82.
- Kurpa K, et al. (1991). "Incidence of tenosynovitis or peritendinitis and epicondylitis in a meat-processing factory." *Scand J Work Environ Health* 17:32-37.
- LaBar G (1989). "Employee involvement yields improved safety record." *Occup Hazards* No. 5:101-104.
- LaBar G (1990). "Ergonomics: The Mazda way." *Occup Hazards* No. 4:43-46.
- LaBar G (1992). "Succeeding with ergonomics." *Occup Hazards* No. 4:29-33.
- LaBar G (1993). "Is your safety committee legal?" *Occup Hazards* No. 11:35-38.
- LaBar G (1993). "Safety management in tight times." *Occup Hazards* No. 6:27-30.
- LaBar G (1994). "Safety at Saturn: A team effort." *Occup Hazards* No 3:41-44.
- Lanier Jr EB (1992). "Reducing injuries and costs through team safety." *Prof Safety* No. 7:21-25.
- Lawler III EE (1991). *High Involvement Management*. San Francisco, CA: Jossey-Bass Publishers.
- Lewis HB, Imada AS, Robertson MM (Oct. 24-28 1988). "Xerox leadership through quality: Merging human factors and safety through employee participation." *Proceedings of the 32nd Annual Meeting*. Anaheim CA. Vol 2:756-759.
- Liker JK, Joseph BS, Ulin SS (1991). "Participatory ergonomics in two U.S. automotive plants," Chapter 6. In: *Participatory Ergonomics*, Edited by K. Noro, A. Imada. London: Taylor & Francis.

- Liker JK, Nagamachi M, Lifshitz YR (1989). "A comparative analysis of participatory ergonomics programs in the U.S. and Japan manufacturing plants." *Int J Indus Ergo* 3:185-199.
- Lin L, Cohen HH (1983). *Development and evaluation of an employee hazard reporting and management information system in a hospital*. Safety Sciences Report on Contract No. 210-81-3102. Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, WV.
- Local Secretary-Treasurer, UFCW (1993). Personal Communication with the Secretary Treasurer of the Case Study #2 Plant Local, United Food and Commercial Workers Union.
- Marks ML (1986). "The question of quality circles." *Psychol Today* No. 3: 36-45.
- Marras WS, Schoenmarklin RW (1993). "Wrist motions in industry." *Ergonomics* 36(4):341-351.
- Marras WS, Schoenmarklin RW (March, 1991). *Quantification of wrist motion in highly repetitive, hand-intensive industrial jobs*. Final report for research funded by National Institute for Occupational Safety and Health (NIOSH), grants nos. 1 RO1 OH02621-01 and 02.
- Masear VR, Hayes JM, Hyde AG(1986). "An industrial cause of carpal tunnel syndrome." *J Hand Surg* 11A:22-227.
- McGlothlin JD, Armstrong TJ, Fine LJ, Lifschitz Y, Silverstein B (May 7-9, 1984). "Can job changes initiated by a joint labor-management task force reduce the prevalence and incidence of cumulative trauma disorders of the upper extremity?" *Proceedings of the 1984 International Congress on Occupational Ergonomics*, Toronto, Canada, Vol 1:336-340.
- Millar JD (1993). "Valuing, empowering employees vital to quality health and safety management." *Occup Health & Safety* No. 9:100-101.
- Miller KI, Monge PR (1986). "Participation, satisfaction and productivity: A meta-analysis." *Acad Mgmt J* 29(4):727-753.

- Moore JS, Garg A (in press). "The Strain Index: A method to analyze jobs for risk of upper extremity disorders." *Am Ind Hyg Assoc J*.
- Moore JS, Garg A (1994). "Upper extremity disorders at a pork processing plant: Relationships between job risk factors and morbidity." *Am Ind Hyg Assoc J* 55(8):703-715.
- Moore JS (1994). "Flywheel truing: A case study of an ergonomics intervention." *Am Ind Hyg Assoc J* 55(3):236-244.
- Mottzko SM (1989). "Variation, system improvement and safety management." *Prof Safety* No. 8:17-20.
- National Institute for Occupational Safety and Health (April, 1989). Hazard evaluation and technical assistance report: John Morrel & Co., Sioux Falls, South Dakota, HETA 88-180-1958.
- National Safety Council (1993). *Safety circles*. Occupational Safety and Health Data Sheet 738 Rev.93. Itasca, IL.
- Noro K, Imada AS, eds. (1991). *Participatory ergonomics*. London: Taylor & Francis.
- Noro K (1991). "Concepts, methods and people." In: *Participatory Ergonomics*. London: Taylor & Francis, pp. 3-29.
- Novek J, Yassi A, Spiegel J (1990). "Mechanization, the labor process and injury risks in the Canadian meatpacking industry." *International Journal of Health Services*, Vol. 20, No. 2, pp. 281-296
- Occupational Safety and Health Administration (1990). *Ergonomics Program Management Guidelines for Meatpacking Plants*. U.S. Department of Labor, OSHA 3123.
- Office of Technology Assessment (1985). *Preventing Illness and Injury in the Workplace*. OTA-H-256. Washington DC: U.S. Congress, pp. 315-323.
- Parker GM (1991). *Team players and teamwork: The new competitive business strategy*. San Francisco, CA: Jossey-Bass.
- Peters RH (1989). *Review of recent research on organizational and behavioral factors associated with mine safety*. Wash DC: U.S. Dept. of Interior, Bureau of Mines Information Circular 9232.

- Planek TW, Kolosh KP (1993). "Survey shows support for safety and health committees." *Safety and Health* No 1:76-79. (Also summarized in: *Survey of employee participation in safety and health - An executive summary* available from the National Safety Council, 1121 Spring Lake Drive, Itasca, IL.
- Pulat BM, Alexander DC, eds. (1991). *Industrial ergonomics: Case studies*. New York: McGraw-Hill.
- Putz-Anderson V, ed. (1988). *Cumulative trauma disorders: A manual for musculoskeletal diseases of the upper limbs*. London: Taylor & Francis.
- Regensburg RE, Van der Veen F (1990). "Marketing ergonomics within multi-disciplinary project teams." *Ergonomics* 33:553-556.
- Roughton J (1993). "Integrating a total quality management system into safety and health programs." *Prof Safety* No. 6:32-37.
- Saarela KJ (1990). "An intervention program utilizing small groups: A comparative study." *J Safety Res* 21:149-156.
- Schermerhorn Jr JR, Hunt JG, Osborn RN (1985). *Managing Organizational Behavior*. New York: John Wiley & Sons.
- Schoenmarklin RW, Marras WS, Leurgans SE (1994). "Industrial wrist motions and incidence of hand/wrist cumulative trauma disorders." Accepted for publication by *Ergonomics*.
- Scholtes PR (1988, 1992). *The Team Handbook*. Madison, WI: Joiner Associates, Inc.
- Sheridan PJ (May 1991). "Meatpackers move to cut injury rates." *Occupational Hazards*, pp. 81-85.
- Silverstein BA, Fine LJ, Armstrong TJ (1987). "Occupational factors associated with carpal tunnel syndrome." *Am J Ind Med* 11:343-358.
- Sinclair U (1906). *The Jungle*. New York: Doubleday.
- Smith S (May 1992). "Occidental Chemical: Making changes for the better." *Occupational Hazards*, pp. 65-68,.
- Smith WJ (Fall 1990). "Red meat, OSHA's special emphasis program." *Job Safety and Health Quarterly*, pp 21-24.

- Sulzer-Azaroff B, Loafman B, Merante RJ, Hlavcek AC (1990). "Improving occupational safety in a large industrial plant: A systematic replication." *J Org Behav Mgmt* 11:99-120.
- Swezey RW, Salas E, eds. (1992). *Teams: Their Training and Performance*. Norwood NJ: Ablex Publishing Company.
- U.S. Department of Labor (May 1972). *Report on occupational safety and health by the U.S. Department of Labor*. pp. 47+.
- Ulin S, Armstrong TJ, Herrin GG (1992). "Preferred tool shapes for various horizontal and vertical work locations." *Appl Occup Env Hyg J* 7:327-337.
- Viikari-Juntura E, et al. (1991) "Prevalence of epicondylitis and elbow pain in the meat-processing industry." *Scan J Work Environ Health* 17:38-45.
- Viikari-Juntura E (1983). "Neck and upper limb disorders among slaughterhouse workers." *Scand J Work Environ Health* 9:283-290.
- Vink P, Lourijzen E, Wortel E, Dul J (1992). "Experiences in participatory ergonomics: Results of a round-table session during the 11th IEA Congress, Paris July 1991." *Ergonomics* 35(2):123-127.
- Wallerstein NB, Weinger M (1992). "Health and safety education for worker empowerment." *Amer J Indust Med* 22(5): 619-635.
- Walton M (1986). *The Deming Management Method*. New York, NY: Perigee Books.
- Waters TR, Putz-Anderson V, Garg A, Fine LJ (1993). "Revised NIOSH equation for the design and evaluation of manual lifting tasks." *Ergonomics* 36:749-776.
- Weinstock MP (1991). "OSHA reform: The push for worker involvement." *Occup Hazards* No. 12:37-39.
- Wilson JR (1991). "Participation - A framework and a foundation for ergonomics?" *J Occ Psych* 64, 67-80.