Healthy Workplaces

Food Processing Industry Final Report

Technical Report Number: 67-2-2001

August 2001

SHARP
Safety & Health Assessment & Research for Prevention
1-888-66-SHARP

Department of LABOR AND INDUSTRIES

Healthy Workplaces

Food Processing Industry
Final Report

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EXECUTIVE SUMMARY

The Safety and Health Assessment and Research for Prevention (SHARP) Program, at the Washington Department of Labor and Industries (L&I), has completed its study of the food processing industry. Food processing was the first industry to be studied as part of the Healthy Workplaces initiative, funded by the Washington State Legislature in 1999. The study showed that:

1. Companies that had higher "organizational health" also had lower workers' compensation (WC) claims rates.
2. Companies with higher "organizational health" paid higher employee wages, on average.
3. Companies that used a systems approach to health and safety had lower WC claims rates.

The relationship between safety and performance is viewed as a balance of technology, organization, environment, tasks, and the people necessary to perform those tasks. When the relationship is out of balance, performance or quality may be affected and more injuries may occur.

Background on the Healthy Workplaces Initiative

The overall goal of the Healthy Workplaces initiative is to reduce work-related injuries in an industry by five percent. SHARP hypothesizes that:

1. Workplaces with high financial and organizational health will have a high level of employee health and safety,
2. The way a workplace is organized determines financial and worker health, and
3. Identifying "best practices" in the healthiest workplaces and promoting those practices throughout the industry will improve health and safety.

The SHARP program selected the food processing industry as the first to study because of its economic importance to Washington state and its above-average rate of work-related injuries. In 1996, the food processing industry accounted for $9.83 billion in shipped product (13.7% of Washington's total value of manufacturing production), and employed approximately 40,000 workers. However, this industry has one of the highest WC claims rates in the state (17.5 WC claims per 100 workers in 1999, 66% above the rate for all industries combined). For the period 1995 to 1999, there were 24,444 accepted Washington WC claims in the food processing industry. Cost information was available for 17,105 of those claims, resulting in $67.2 million for the five-year period, an average of $13.4 million each year.

The purposes of the study in food processing were to determine what factors make a workplace healthy and to identify health and safety strategies that companies have found to be successful in reducing work-related injuries.

Three Phases of the Study

The study period was from 1999 to 2001. There were three phases to the study: a telephone survey, company site visits, and an educational intervention.

Telephone Survey. An industry-wide telephone survey was conducted. A scoring system was developed to rate the companies "organizational health" according to their telephone responses. Organizational health included communication, productivity, quality, safety and health policies, injury tracking, and philosophy. A total of 142 companies participated in the telephone survey. The response rate was 37%.

Company Site Visits. Site visits were conducted at 19 companies. The purposes of the site visits were to understand health and safety hazards and how workers may be exposed; to determine what measures companies have taken to control exposures; to assess organizational factors including policies and procedures, safety training materials, and perceptions of organizational culture; and, to identify "successful strategies" used by companies that are effective in reducing work-related injuries and illnesses. “Best practices” we observed at the companies included:

- Workplace philosophies that incorporated health and safety from the top down;
- Adopting open door policies to improve communication between management and workers;
- Retrofitting machine guards for older machines and equipment;
- Eliminating contact with chemicals by using automatic mixing and dispensing equipment;
- Completely enclosing noisy processes; and
- Using lift assists to eliminate the manual lifting of heavy objects.

Educational Intervention: We identified hazards that were common among the companies we visited. We developed an educational booklet that described the various safety and health topics, such as organizational factors; hazards such as noise, slips, and falls; information on ways to improve organization, safety, and reduce hazards including successful strategies used by food processors. The educational materials were pilot tested with the 19 companies. Follow-up telephone interviews were completed with 14 (74%) of the company managers. Of the 11 who read the materials, six (55%) responded that the materials were useful, and three (27%) intended to implement some of the suggestions.

Findings and Conclusions

Findings from this study indicate that high levels of organizational health have a positive impact on WC claims rates. In addition, for companies with 11 or more employees, the larger the company the lower the WC claims rate. Also, the average organizational health score for smaller companies was lower than large companies, even after scores were adjusted for size. Companies with higher organizational health scores had a higher average employee wage. Companies that used a systems approach to health and safety had lower WC claims rates.

We were unable to determine financial health using administrative databases because the information was not available at the worksite level. On the advice of the industry association, we used health and safety management as a surrogate for overall organizational health. Having worksite-specific WC claims, hours and revenue data are critical for the accurate assessment of occupational safety and health problems in Washington state.

More attention needs to be focused on small companies to improve management systems and increase safety and health resources. Continued support for inter-agency occupational health and safety training is indicated, particularly for the Washington State Department of Agriculture and Department of Health inspectors who work with food processing companies.

The educational materials developed through this project are being distributed industry-wide. While educational materials can serve as vehicle for sharing successful strategies, using this method alone may not be enough to create change. To facilitate the transfer of successful strategies, a variety of incentives should be tried to motivate companies to change.

Acknowledgements

SHARP is extremely grateful to each of the participating companies in the Healthy Workplaces Project for their assistance and the generous contribution of their time and knowledge.

A number of SHARP staff (current and former) participated in different stages of the food processing study. They include James Baggs, Steven Bao, David Bonauto, Randy Clark, Tammi Clawson, Marty Cohen, Mike Conley, Catherine Connon, Mike Cotey, Christy Curwick, Sharon Drozdowsky, Kim Elwess, Michael Foley, Heather Grob, Niki Howard, John Kalat, Marc Leastman, Christina Marino, Angela Owen, Maureen Pilon, Hieu Pham, Syed Shah, Tom Sjostrom, Peregrin Speilholtz, Caroline Smith, Barbara Silverstein, Arlene Stebbins, Kathleen Rockefeller, Rom Rwamamara, Carolyn Whitaker, Steve Whittaker, and Pat Vincent.

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INTRODUCTION

Technical innovation in an increasingly global marketplace allows the worldwide, instantaneous transfer of complex information. This changing marketplace forces businesses to adopt new strategies in order to remain productive and healthy. To be competitive, Washington workplaces require new strategies in light of these fundamental changes.

In 1999 the Washington State Legislature supported the Safety and Health Assessment and Research for Prevention (SHARP) Program's initiative to determine the factors inherent to "healthy workplaces", and to disseminate information gained from healthy workplaces across industry sectors. The overall goal of the Healthy Workplaces initiative is to reduce work-related injuries in an industry sector by five percent. The initiative was created to test the hypotheses that 1) workplaces with high financial and organizational health would also have a high level of employee health and safety; 2) the way a workplace is organized would be a major determinant of whether it is financially healthy and worker healthy, and 3) identifying best practices in the healthiest of workplaces and promoting them throughout the industry will improve both the safety and health of the industry and, most importantly, the safety and health of its workers.

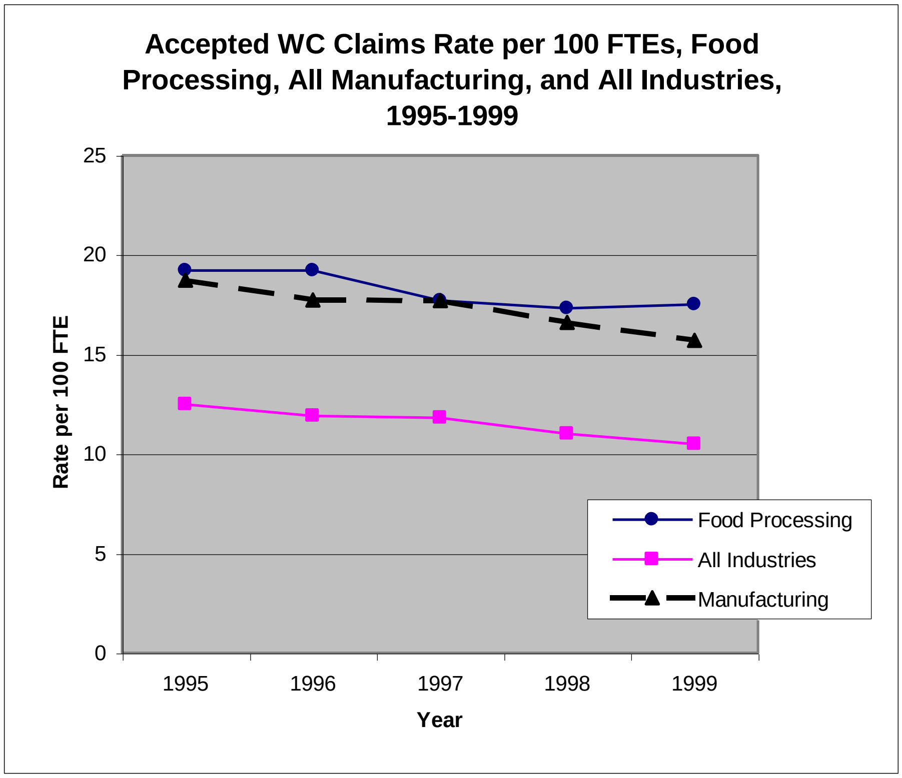
The first industry SHARP studied was the food processing industry. Food processing provides the intermediary step between raw agricultural commodities and the final processed food products sold by wholesale and retail companies. The food processing industry is economically important not only to Washington state, but also to the nation. In 1997, the food processing industry accounted for approximately $421.7 billion nationally in shipped product, employing over 1.1 million production workers.

According to the Washington State Employment Security Department, in 1996, Washington state's food processing industry accounted for $9.83 billion in shipped product (13.7% of Washington's total value of manufacturing production worth over $71.9 billion for that year). In that same year, one quarter of the state's food processing production value came from preserved fruits and vegetables ($2.54 billion). Washington's food processing industry employs approximately 40,000 workers, with the greatest percentage of total employment occurring in the eastern part of the state (food processing employed 2.6% of the total employment on the eastern side of the state, compared to 1.1% on the western side). However, over 4,800 Washington food processing workers are injured each year.

Significance of the Problem

The food processing industry has one of the highest work-related injury and illness rates in Washington state. In 1999, the Washington state workers' compensation (WC) claims rate for the food processing industry was 17.5 per 100 full-time equivalents (FTE), which is 66% above the rate for all industries combined (see Figure 1).

Figure 1. Comparison of accepted Washington state workers' compensation (WC) claims rates for food processing companies versus all industries combined, 1995 to 1999.



Note: WC rate is per 100 full-time equivalents (FTE). One FTE = 2000 hours.
Note: Data are all accepted state fund claims (i.e., figures do not include rates for self-insured employers).

For the period 1995 to 1999, there were a total of 24,444 accepted Washington WC claims in the food processing industry, including both self-insured and state fund claims. Of those 24,444 WC claims, information on the nature, type, and source of injury, as well as cost information were available for 17,105 claims. These 17,105 WC claims cost $67.2 million, an average of $13.4 million each year. Most of these WC claims involved sprains (5,473), cuts (2,917), contusions (2,108), ill-defined symptoms (2,065), and fractures (694). Many of these problems resulted from being struck by objects (e.g., knives, boxes), from overexertion (e.g., lifting), and from falls (e.g., slipped on floor, fell on stairs). It is likely that these numbers underestimate the true number of injuries, in part because we have information for only 70% of the WC claims, but more importantly an estimated 55% of workers with occupational-related illnesses do not file WC claims (Biddle, et al., 1998).

While food processing companies have made advances toward providing safe and healthful workplaces, clearly more work is needed in this area. Because virtually all occupational injuries and illness are preventable, managers must find ways to improve worker safety without compromising productivity and economic performance. Improvements in organizing and structuring work will help provide solutions to these health and safety problems.

The way a company is organized can influence the safety and health practices at all levels. For example, between October 1998 and September 1999, 86 Washington Industrial Safety and Health Act (WISHA) compliance inspections were conducted in food processing facilities in Washington state. These 86 inspections resulted in 381 citations and totaled $86,200 in fines. Of those 381 citations, 51% (n = 195) involved workplace organization issues such as record keeping, safety training, and safety and health programmatic elements. These citations, which could have been averted with minimal financial outlay, accounted for 20% of the total cost.

While other studies have attempted to determine the relationship between workplace injury rate and organizational factors, no such study has been conducted in Washington state's food processing industry.

Purpose of the Study

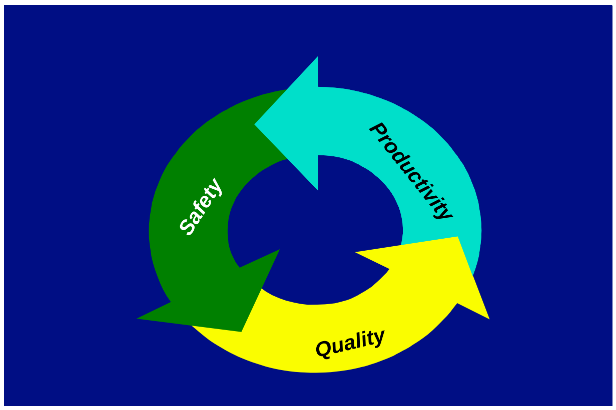
The purpose of this study was to identify the factors that make a workplace healthy, and to identify health and safety strategies that companies have used to reduce work-related injuries.

Specifically, we aimed to:

1) Determine whether administrative databases (from the Departments of Labor and Industries, Employment Security, and Revenue) could be used to identify financially-healthy and worker-healthy workplaces;
2) Conduct an industry-wide telephone survey and compute an "organizational health" score for each food processing company;
3) Compare organizational health scores with Washington WC claims rates, company size, turnover, average wages, and growth;
4) Conduct company site visits to determine and describe successful organizational and safety and health strategies used in the companies; and
5) Develop educational materials as a means of sharing successful strategies industry-wide.

CONCEPTUAL FRAMEWORK

The way a company is organized influences all aspects of the company, including safety and health. Poor organization can result in increased work-related injuries and illnesses, reduced productivity, and compromised product quality.



The Malcolm Baldridge Quality Award criteria for safety systems management are a good indicator of the relationship between worker health, financial health, quality, and productivity (Warrack & Sinha, 1999). The award indicators include leadership systems, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and business results. In their paper, Warrack and Sinha suggest that the relationship between safety and quality is complementary and supportive.

Developing Healthy Workplaces

There are a number of incentives to develop healthy workplaces including:

- Improved primary benefits, such as productivity, quality, and customer service;
- Reduced injury-related costs, including workers compensation, downtime, training, recruitment, etc.;
- "It's the right thing to do;"
- Improved public image;
- Avoidance of third party liability; and
- Reduced chance of regulatory enforcement activities and fines.

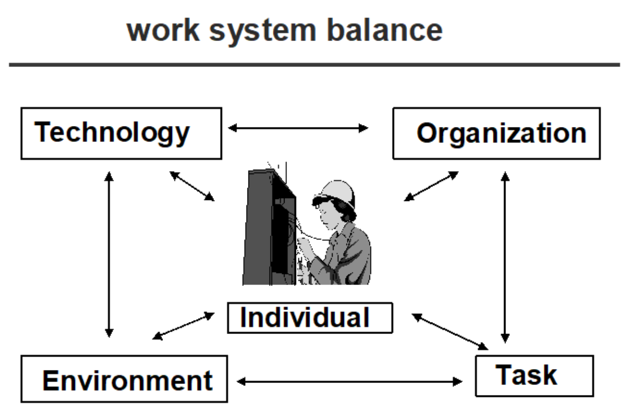
However, not all employers are aware of the connections between safety and performance. With rapidly changing technology and markets, organizational factors may well be the key to enhanced financial health of the workplace. Virtually every organization is faced with the following challenges:

- Continual fast change;
- Global organizational culture and competition;

- Projected shortage of skilled workers;
- Increasing costs;
- Doing more with less;
- Increased diversity of workers and values; and
- “Job security” is gone.

Every workplace has a work system that can be characterized by its technology, organization, environment, tasks, and the people necessary to perform these tasks. Smith and Sainfort (1989) suggest that the connections between these components may be in or out of balance. When any of the connections are broken or out of balance, performance or quality suffers and/or more injuries may occur. Ensuring that these connections are balanced can improve the health of any workplace (see Figure 2).

Figure 2. The work system balance model.



> **Hypothesis: When the work system is in balance, the workplace is both financially healthy and worker healthy.**

Organization

Manuele (1997) noted that an organization’s culture determines the level of safety attained, and management’s commitment or non-commitment to safety is an outward sign of that culture. Often the consequences of organizational restructuring and downsizing are poor health and safety, along with increased injury and absenteeism (Vahtera, et al. 1997). However, a company can improve health and safety and reduce turnover even while performing organizational streamlining if employees participate in the process (Pierce, 1998).

Paul O’Neill, US Secretary of the Treasury, told a national safety summit on March 30, 2001, “*For me, this is not about safety, per se; it’s about leadership. And in truth I get the safety* *from a trilogy of ideas that I think are characteristic of great organizations. They are these: that every person in the organization, every day of their existence, can answer these three questions positively without any reservation:*

1) *I was treated every day with dignity and respect.*
2) *I was encouraged and helped to make a contribution that gives meaning to my life.*
3) *Someone noticed I did it.*

"If you find an organization where all the people can say yes to those three things every day, you really have a high-performance organization. No matter what they do, no matter what kind of business they are in, this is an organization with enormous potential."

O'Neill went on to say *"Safety is not a priority. Safety is a precondition."* Talking about the decreasing lost workday rate during his years as CEO of Alcoa, he continued, *"it is imbedded in an idea about leadership and organization… I think all organizations can get to a point where they're approaching zero* [incidence rate], *but it takes leadership and commitment and understanding of process improvement. And it takes taking away excuses. …And most of what we need to do to get to zero is not about huge investments. Even in the most dangerous environments, it's not mostly about money. It is mostly about process and commitment and orderly learning and constant reinforcement of this being a precondition rather than a priority."* [Georgetown Safety Summit, Washington DC, March 30, 2001.]

The idea that safety has to be a precondition rather than a priority of a company reflects the organizational development research that has been used to identify healthy workplaces. Organizational effectiveness previously focused on meeting profit, production, service, and continuity objectives. Healthy organizations will also be healthy for employees and the communities they affect. The way a workplace is organized holds the key to both healthy productivity and healthy employees (Jaffe, 1995). An example of this is Johnsonville Sausage, as reported in the Harvard Business Review (Strayer, 1990). This company used an organizational design that included supportive flexible structures, profit sharing, employee involvement, responsibility, and authority to make policy. As a result they reported strong improvements in both organizational effectiveness and employee morale.

While providing a healthy and safe workforce is the "right thing to do," it also makes business sense. A focus on prevention keeps healthy workers at work and productive, and enhances recruitment and retention of employees (Vernarec, 1999).

In a review of ten large studies on the relationship between organizational and workplace factors and injury rates, Shannon, et al. (1997) found that lower injury rates were consistently related to six aspects of the organization (Table 1). Employee empowerment referred to employees being expected to "take the initiative", rather than carrying out tasks based on management's instructions. In many ways, the "health and safety organizational" characteristics identified by Shannon, et al., reflect the overall organizational characteristics of the workplace and perhaps can be viewed as a surrogate measure for overall organizational health.

Table 1. Factors consistently related to lower work-related injury rates in 10 studies (adapted from Shannon, et al. 1997).

Categories	Factors related to lower injury rates
Joint Health and Safety Committee	Duration and amount of training of members.
Management Style and Culture	Empowerment of workforce. Long-term commitment of workforce encouraged. Good relations between management and workers.
Organizational Philosophy on Health and Safety	Delegation of safety activities. Active role of top management. Safety audits conducted. Evaluation of safety hazards. Unsafe worker behaviors monitored. Duration of safety training of workers. Safety training on a regular basis. Employee health screening.
Post-Injury Factors	Modified work provision.
Workforce Characteristics	Low turnover. Greater seniority of workforce.
Other Factors	Good housekeeping. Safety controls on machines.

A study of 100 manufacturing plants (Simard & Marchand, 1995) evaluated the factors that increased the likelihood that workgroups would take health and safety initiatives to improve the safe execution of their work and make suggestions to or exert pressure on supervisors to improve safety in the work environment. A participative supervisory approach to health and safety was the most important factor. This was influenced by the supervisor's knowledge and ability to take action and involve the workgroup in prevention activities. Worker willingness to take health and safety initiatives is strongly influenced by top management commitment to develop the health and safety program. Paul O'Neill provided an example of this when Alcoa launched its corporation-wide computer communications system. The first application to go on-line to 259 sites was not finance or marketing, but the real time safety system. Every time there was an injury, 143,000 employees read about it on-line, including the root cause and preventive measures that could be taken. Making safety systems the first application on-line gave the message that safety was a precondition and that everyone was going to care about worker health.

However, organizational change is not a panacea for unhealthy workplaces in crisis (Landsbergis & Vivona-Vaughn, 1995). In a review of new organizational schemes, such as lean production and total quality management in the auto industry, Landsbergis, et al. (1999) found little evidence that these systems "empowered" auto workers, but rather intensified work pace and workload. Where there were ergonomic stressors, increases in musculoskeletal disorders were identified. However, where employees were involved in ergonomic improvements as part of the new organizational scheme, musculoskeletal disorders were reduced. Consequently, poorly functioning organizations should improve job performance by improving job content. Sauter (1990) provides some general "healthy work principles" that should be considered in the organizational design of jobs (see Table 2). These principles may reduce occupational stress levels among employees and improve performance.

Table 2. Job organization principles (adapted from Sauter, et al. 1990).

Aspect of Job	**Healthy Work Principles**
Work load	Match physical and mental demands with worker capabilities and resources.
	Allow adequate recovery time from demanding tasks.
	Increase employee control over the pace of work.
Work schedule	Provide flexibility to make it compatible with outside demands and responsibilities.
	Shift work should be predictable and in a forward direction (day to night).
Work roles	Clearly define roles and responsibilities.
Job security	Reduce ambiguity in job security and career development.
Social environment	Avoid isolation. Provide opportunities for interaction and technical support.
Job content	Provide opportunity to use skills, stimulation, and meaningful work.
Participation and control	Provide opportunity for input into how tasks are performed and decisions made that affect the job.

Technology

The ability to accomplish tasks and the load on the individual accomplishing the tasks are often determined by the technology being used by the worker. New technologies have been sought to improve efficiencies in production in most industries. In some cases, the introduction of new technology has increased workplace injuries. Carriere, et al. (1998) examined the relationship between the introduction of new technologies and health and safety system functioning in the metal fabrication industry that consisted primarily of small employers (97% with less than 20 employees). The most effective companies (lowest injury incidence and severity rates) adopted new technologies faster, but had a more developed technologies infrastructure that included involving employees in the information gathering and decision-making processes regarding the new technologies. Effective companies also informed employees of new technologies prior to their introduction, whereas ineffective companies did not. The effective companies visited other companies, attended trade fairs, and conducted more exhaustive searches of technological information than the less effective companies. More of the effective companies had preventive maintenance programs, provided personal protective equipment to employees, and used occupational health and safety specialists more frequently.

Larson (1998) noted the importance of improved workstation design to accommodate the use of new technologies that increased productivity. The use of employee involvement teams in the development and implementation of new technologies to improve product quality, productivity, and reduce soft tissue injuries was also reported by the Jennie-O Turkey processing plant (Murphy, 1993). These teams, operating in every department, developed and implemented more than 800 improvements in safety, efficiency, and defect reduction within 12 months. The company attributes this success to line workers talking to each other. This is evidence of balance between technology, organization, task, and environment with the individuals.

Tasks

Most jobs contain one or more tasks required to produce a product. Principles for designing healthy job tasks for human-machine systems are included in Table 3 (ISO 6385, 1981; Salvendy, 1994; Sanders & McCormick, 1987; Rodgers, 1986; Karasek & Theorell, 1990).

Table 3. List of principles in designing job tasks.

Adapt the workspace and equipment to account for the dimensions of the operators and kinds of work being performed - with preferred postures (trunk upright, body weight properly supported, elbows at the side of the body, and forearms appropriately supported).
Provide sufficient space for body movements.
Provide variety in tasks and movements to avoid static muscle tension and improve alertness.
Design work to allow machinery to do or assist with highly repetitive tasks.
Put controls within functional reach of the operator. Grips and handles need to suit the functional anatomy of the hand.
Keep loads close to the body and handle with neutral postures.
Use mechanical assists if strength demands exceed the capacity of the muscles required to perform the task.
Do not combine requirements for great accuracy and strength on the same job at the same time.
Avoid requiring extreme postures when tasks require high forces.
Provide adjustable work surfaces and tools where there are multiple users.
Allow as much employee discretion as possible on how to accomplish the tasks.
Design tasks to increase group cohesion and interaction (cells, teams).

Environment

Environment refers to the conditions that may affect numerous individuals in the organization. Typically this includes thermal (hot, cold), chemical, vibratory (noise and vibration), electrical, and mechanical environments (Smith & Sainfort, 1989). Although traditional health and safety practices are usually focused on these environments, healthy workplaces usually extend beyond these environments by conducting total "environmental screens" or audits of functioning systems.

Workplace health and safety problems cannot be addressed successfully in a piecemeal manner. Only fixing hazards as they are discovered may solve the immediate problem, but managers are working in a reactive mode. However, if potentially hazardous situations are discovered before they become hazards, then we have a system that can prevent injuries and illnesses before they occur. This is the basis for a "systems approach" to safety and health.

The following is an example of the systems approach. You find that your car frequently overheats. To "solve" this problem you frequently add coolant to your radiator. However, would you want to drive across the country in your car, knowing that a serious cooling system problem could cause the engine to overheat? A systems approach to this problem involves:

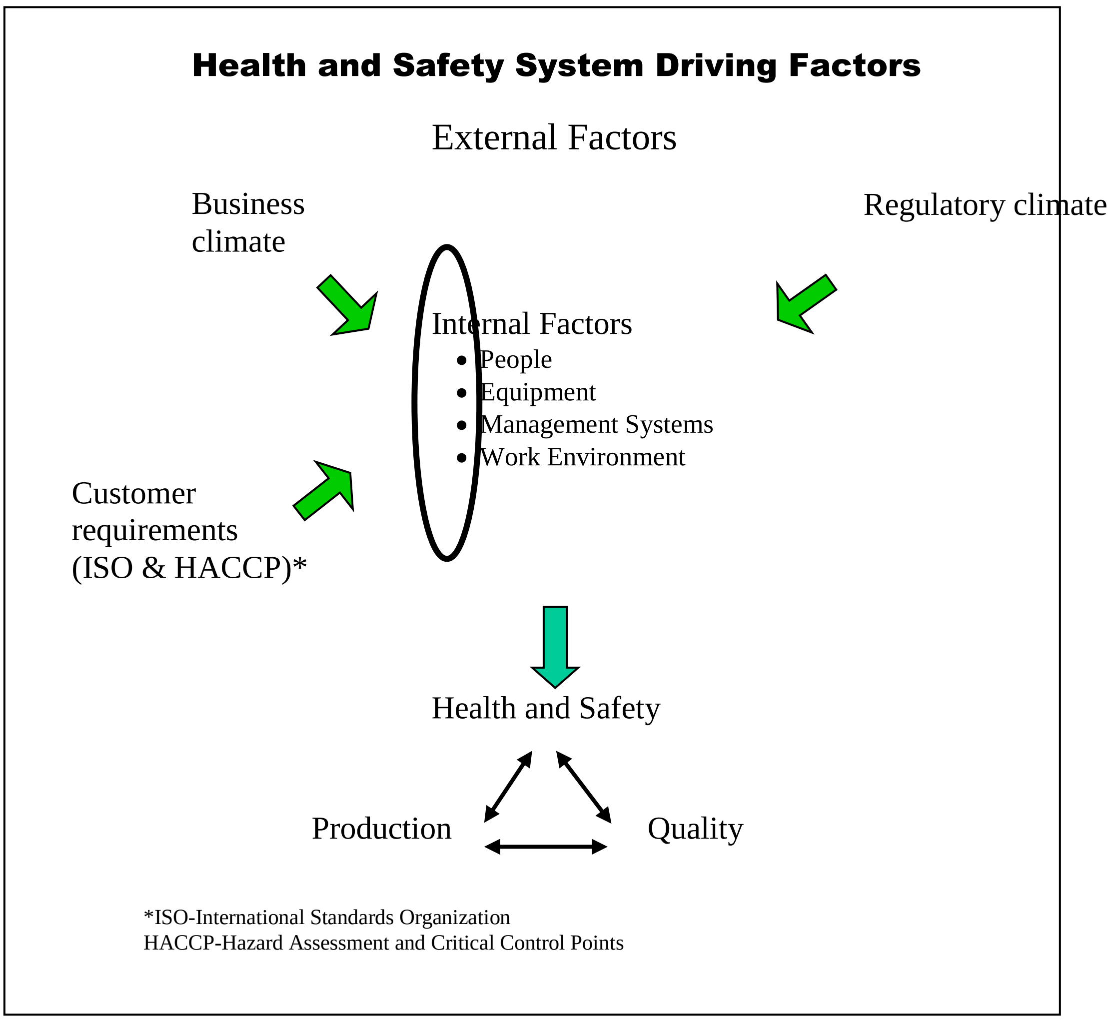
- Fully diagnosing the problem by inspecting the cooling system;
- Fixing the problem that caused the overheating (solving the basic problem or root cause); and

- Starting a preventive maintenance program to address issues before problems arise.

This type of systems approach can be used successfully in the management of the workplace. Health and safety hazards are resolved as they are identified, but they are also prevented from becoming hazards in the first place.

Some key elements of a systems approach are:
- The desire, from management and employees, for a healthy and safe workplace.
- A business plan that has health and safety as a priority.
- A health and safety plan that emphasizes proactive activities for hazard reduction.
- Comprehensive assessments of critical factors that drive the system (see Figure 3).
- Results and recommendations of the assessments are acted upon (hazards abated, new programs enacted, etc.).
- The success of the previous actions are evaluated (many times an outside evaluator can be effective) and adjusted as needed.

Figure 3. Internal and external health and safety system driving factors.



All elements of an operation (including production, maintenance, facilities, physical layout, purchasing, human resources, administration, and the people) are interrelated. Consequently, recognizing that all of these elements play key roles in the success and failure of that operation will yield positive results in quality, productivity, and health and safety.

The approach used to address these hazards is commonly called the hierarchy of controls. This approach attempts to design out a hazard, because a hazard cannot harm anyone if it is not present in the workplace! If the hazard cannot be designed out of a process, then a solution that requires no user-activation is preferred (i.e., an engineering control such as machine guarding or ventilation). If an engineering control cannot be implemented, then the next approach is to use an administrative control, such as job rotation or training. These administrative controls are not as effective as engineering controls at reducing risks, but they can reduce a worker's exposure to a hazard. If none of the previous methods are possible, then personal protective equipment, such as respirators, gloves, hardhats, etc. can be used. This type of control reduces the impact of the exposure, but only if the worker is using the equipment properly. This level of control relies on the worker and management to properly use and enforce the use of the equipment.

Occupational Safety and Health Hierarchy of Controls

1) **Remove the Hazard:** The hazard is no longer in the workplace (e.g., do an activity at ground-level instead of at elevation, outsource the hazardous process to a more appropriate facility).
2) **Engineer out the Hazard:** A solution that is always in-place and doesn't require activation by the user (e.g., install machine guarding, use sound absorbing enclosures).
3) **Administrative Controls:** A control method that requires personal activation or input from people (e.g., hazard avoidance, job rotation, training).
4) **Personal Protective Equipment:** This method doesn't reduce the hazard, but prevents the hazard from directly impacting the worker (e.g., wearing a respirator, wearing ear plugs, wearing cut or chemical resistant gloves).

Individual

All individuals enter the work environment with a variety of inherent and learned strengths and weaknesses. These include cultural background, age, gender, language skills, general health status, motivation, experience, skill level, notions about how to perform the work required, expectations, and ways of interacting with coworkers, supervisors and management. A healthy work environment builds on those strengths and motivations to develop a continuous learning and sharing work environment that rewards creativity, problem-solving initiative, responsibility, and teamwork. Open two-way communication between managers and workers can have the following major benefits:

- Improved employee knowledge of how the entire work system fits together;
- Increased understanding of the employee's role in the organization; and
- The employee learns how they can grow within a supportive work environment.

Open communication and participation are integral to supportive work environments. These environments lead to healthier organizations, which in turn lead to greater productivity and effectiveness (Jaffe, 1995).

Despite the identification of physical and chemical hazards in the workplace, and the methods to control those hazards, work-related injury and illness rates have remained high over the past few decades. This has led researchers to investigate causal factors other than the physical work environment. Factors such as the psychological demands of the job, the degree of discretion that the worker exercises over how the job is performed, and the level of social support that the worker derives from the work environment, all can influence the work environment, as well as a worker's productivity. It is important to note that it is through the study of many workers in a given work environment that these psychosocial factors are measured, and so these psychological states are not to be confused with depression or anxiety, which arise independently of the workplace (Kerr, 1998).

One particularly well-known example of the approach to the psychosocial elements of work, is the "Job Strain Model" developed by Karasek & Theorell (1990). According to this model, *job control* represents such elements as the degree of learning, creativity, skill level, and task variety in a given job, as well as such elements as worker authority to decide how the job is done and at what pace. The other main dimension of this model is *job demand*, which represents the psychological stress to which the job subjects the workers. Job demand incorporates such elements as work pace, work burden (including physical burden), and the amount of time workers are given to complete tasks. It is expected that the degree of control that the worker exercises over their job helps them to cope with the psychological demands of the job. Finally, the interaction of job control and job demand is affected by a third dimension of the model: the degree of *workplace social support* available to the workers. Social support includes such elements as the nature of communications with co-workers and supervisors.

The combination of these dimensions allows jobs to be categorized into a two-by-two matrix whose cells are then characterized as "active", "passive", "low job strain", and "high job strain". Workers can then be studied for the prevalence of certain health disorders, which may be associated with the psychosocial stresses they face on the job. The Karasek-Theorell hypothesis states that the workers with the highest risk for "high job strain" are those who have the highest psychosocial job demand, the least control over their jobs, and receive the least amount of social support in the workplace. In contrast, high demand combined with high control and high support is considered to constitute a "positive stress." This kind of job is considered "active" and the stresses imposed on these workers are considered to be challenging, but not burdensome. These researchers have established a moderate, but statistically significant relationship between high job strain and the probability of cardiovascular disease, independent of other risk factors such as smoking (Theorell & Karasek, 1996). This has been confirmed by the so-called "Whitehall Study" of British civil servants, which found the expected relationship between civil service rank, job control, and cardiovascular disease incidence (Marmot, et al. 1997). Causal mechanisms are still being explored, but the association has led other researchers to study the connection between job strain, as measured by the job demand/control model, and diseases such as musculoskeletal disorders.

Definitions

For the purposes of studying the food processing industry, we used the following definitions:

Healthy workplace: A *healthy workplace* enhances worker performance and human health through a balance of technology, organization, environment, and tasks.

Food processing: *Food processing* companies are those that take raw food materials, process them, and then sell the product. Food processing companies in Washington state belong to the following Standard Industrial Classification (SIC) codes:

- 201: Meat products, including meat packing, sausage and prepared meats, poultry slaughter houses, and egg farms.
- 202: Dairy products, including fluid milk, butter, cheese, and ice cream.
- 203: Preserved fruits and vegetables, including canned and frozen fruits and vegetables, canned and frozen specialties, dried and dehydrated fruits and vegetables, pickles, and salad dressing.
- 204: Grain mill products, including flour, cereal, flour mixes, and pet food.
- 205: Bakery products, including bread, cookies, and crackers.
- 208: Beverages, including malted beverages, wine, liquors, soft drinks, and flavoring extracts.
- 209: Miscellaneous food, including fresh, canned and frozen seafood, roasted coffee, potato and corn chips, macaroni, and spaghetti and pasta products.

SIC codes 206 (sugar and confectionery products) and 207 (fats and oils) were not included in the study because there were too few companies in the state and they did not meet our study criteria for inclusion.

Organizational health: By *organizational health*, we are referring to a scoring system used to measure the following factors: human resource policies and procedures, productivity, quality, communication, commitment, safety programs and training, injury management, and the tracking of injuries.

Financial health: By *financial health*, we are referring to companies that have higher revenue per employee, growth of employment, or higher average wages, relative to industry norms.

Worker health: By *worker health*, we are referring to companies that have lower WC claims rates.

Claims or claims rate: By *claims*, we are referring to accepted state fund and/or self-insured Washington state workers' compensation (WC) injury/illness claims. *Claims rate* is the number of Washington state workers' compensation claims divided by either 100 full-time equivalents, or by 100 employees (employee head count was used as the denominator for rates at the single facility level).

Successful strategies: *Successful strategies* are those strategies that food processing companies used to successfully resolve organizational health and safety problems in their facility. These could include successful management practices/styles; communication systems or approaches that improved productivity, quality, safety and health; or specific technology-based solutions that reduced or eliminated job hazards or risk.

Small and large companies: Small companies are those food processing companies with 10 or fewer employees. *Large companies* are those with 11 or more employees.

METHODS

Sample Selection Methods

Industry Selection

The ultimate goal of this study is to identify management practices associated with "healthy workplaces" and disseminate those practices industry-wide. Given the wide variation in organization and production processes across industries, we focused on one industry at a time. In order to choose our industry, we developed a series of criteria to select industry candidates in which we could have a major impact.

High Hazard Industry
The first criteria we used for industry selection was the extent to which the industry faced significant health and safety issues. Since we do not have direct measures of workplace hazards, we relied on two indirect measures to select our industries: 1) the three-year average claims rate and 2) the three-year average count of claims. Each industry was ranked on these two measures, and their ranks were averaged to generate a "prevention index". Using this approach, the degree of hazard was inversely related to the index level, such that the higher the hazard the lower the score, and vice-versa.

Intra-Industry Dispersion
In a second step, we selected the top 25 most hazardous industries that also exhibited significant variation in size of firms, claims rate, employee turnover, and growth of employment over five years. This approach increased the likelihood that we would see a broad range of practices and improved the chances of identifying and transferring best practices within the industry. This screening process identified the following candidate industries: food processing, aerospace, millwork and furniture manufacturing, and fabricated metal structures.

Industry Structure
A further selection step involved choosing an industry that: 1) consisted of relatively homogeneous products and processes, 2) lacked dominance by any one company, and 3) had the assistance and interest of trade associations and labor representatives. On the basis of these considerations, we selected the food processing industry for study.

Survey Phase

In order to learn about safety and health issues in the food processing industry, we developed a 30-minute telephone survey. A total of 536 establishments were identified as being food processors by the Employment Security Department's (ESD) Quarterly Unemployment Insurance database. After further verification, a total of 385 companies were eligible for the telephone survey.

Sample Frame
In order to be included in our sample frame, establishments had to meet the following criteria:

- Have at least one employee in 1999, **and**
- Be categorized within Standard Industrial Classification (SIC) codes 201 (Meat Products), 202 (Dairy Products), 203 (Canned, Frozen and Preserved Foods), 204 (Grain Mill Products), 205 (Bakery Products), 208 (Beverages), or 209 (Seafood and Other Products).

In order to supplement the information obtained by our survey, the following administrative data were attached to each establishment's record:

- Annual average employment from 1995 through 1999 (from ESD);
- Total wages paid for 1995 through 1999 (from ESD);
- A measure of annual employee turnover from 1998 (from ESD);
- Annual number of workers' compensation claims accepted for 1995 through 1999 [from the Washington Department of Labor and Industries (L&I)]; and
- Total annual cost and days of work lost due to claims accepted for 1995 through 1999 (from L&I).
- Annual gross business income from 1995 through 1999 [from Department of Revenue (DOR)].

Because these data came from separate state agency databases (i.e., ESD, L&I, and DOR), records were linked using a combination of the Uniform Business Identifier (UBI) code and the street address.

Telephone Survey Development
The food industry survey (see Appendix A) covered the following general areas:

- Primary products,
- Management turnover,
- Seasonal variation in production,
- Employment patterns,
- Human Resources policies related to health and safety,
- Lines of communication between management and labor,
- Demographics of the workforce,
- Productivity-enhancing programs,
- Safety programs,
- Employee participation in safety programs,
- Management commitment to safety,
- Environmental hazard programs,
- Accident and injury tracking systems,
- Management's top health and safety concerns,
- Barriers to improving health and safety,
- Strategies identified by management to overcome barriers to improving health and safety performance.

The goals of the industry-wide telephone survey were to:

- Characterize each establishment's level of health and safety performance relative to that of the industry as a whole;
- Compare this level of performance with the administrative measures of health and safety (workers compensation, turnover) and economic performance (wages, growth, revenue) previously discussed; and
- Facilitate selection of companies for the site visit phase, which would represent as wide a range of health and safety performance as possible.

Telephone Survey Administration

In order to protect the identity of the respondents, an independent research company in Seattle, Washington, administered the telephone survey. One week prior to the interview, all food processing establishments were mailed a cover letter, which explained the purpose of the telephone survey, and a copy of the telephone survey. From a stratified random sample, the survey was pilot-tested with 21 companies. After reviewing the pilot information, we revised the survey to clarify questions and to reduce its length to less than 30 minutes. Recognizing the potential burden on smaller businesses, we asked fewer questions of those companies with less than 11 employees.

The independent research company removed company identifiers and linked the administrative data with the data from the telephone survey. The resulting file was transferred to SHARP for data analysis, thereby preserving the participating companies' anonymity.

Telephone Survey Scoring

On the advice of the industry association, we limited our definition of "organizational health" to focus primarily on the health and safety aspects of organizational health, with the assumption that it was a surrogate indicator of broader organizational health. In order to characterize companies by level of health and safety performance, we developed a scoring system for the telephone survey (see Appendix B). The system was based on factors described in the academic literature, overall organizational performance, and professional judgment. Points were awarded in the following categories of questions:

- Human resource practices: Points were awarded for providing health and safety orientation for new employees, conducting pre-placement screening, and providing benefits programs to maintain employee health.
- Communication: Points were awarded when managers reported frequent communication with workers on health and safety matters.
- Safety programs and policies: A set of eight questions relating to safety programs and policies were scored based on the comprehensiveness of the programs and whether the programs were reactive or proactive. Questions covering the makeup and activities of the safety committee, if present, were scored more highly if the committee met frequently, all levels of employees and management were

represented through a democratic selection process, and the committee was proactive. Also, higher points were given for having a safety training program conducted by professionals from several disciplines, if the training program was given to both permanent full-time employees as well as part-time and contract workers (which went beyond the minimum required by regulations), and if the training program was presented in a way that workers with English as their second language could understand.

- Injury and illness tracking: Points were awarded to companies that tracked the number of work-related injuries and illnesses in their facilities.
- Health and safety concerns: More points were awarded if managers discussed hazard exposures or prevention activities among their top three health and safety concerns, rather than simply the three most common types of injuries.

Approximately half of the total points possible consisted of open-ended questions, which required hand scoring. In order to control for inter-rater variation, two members of the project team scored all surveys and the average score was applied. Project team members were in close agreement in their scores for the 21 pilot companies.

Because firms with fewer than 11 employees are exempt from some of the safety activities covered by the telephone survey (such as the requirement to have a safety committee or to keep an OSHA 200 log of injuries), the total number of possible points was adjusted accordingly (i.e., the total scores for large and small companies were normalized to a scale of 100).

Total scores from the telephone survey were compared to administrative measures such as claims rate, days of work lost, employee turnover, and employment growth. It was not possible to construct a satisfactory measure of employee productivity from the answers given to the survey due to the heterogeneous nature of the products as well as the units used by each company to express this output. Finally, scores from the survey were used to validate and to supplement the findings from the 19 establishments visited.

Site Visit Methods

Selection of Companies for Site Visits

After the telephone survey was completed, the independent research company contacted employers to invite them to participate in the second phase of the study: the workplace site visit. The companies were stratified into three groups based on size (under 11, 11-100, and over 100 employees), and the larger companies were weighted more heavily. Our target was to conduct 36 site visits, distributed among the SICs. The independent research group contacted employers until they got a “yes” response for the particular size and SIC category. Permission to release the company names to SHARP was obtained by the independent research company prior to SHARP contacting the survey participants for a site visit. Employers were then contacted to schedule a site visit. The site visit team primarily consisted of a person to conduct the manager interview and administer a written worker survey, an industrial hygienist, an ergonomist, and a safety engineer. All companies received an individual company report of our observations during the site visit.

The site visit was pilot-tested at one food processing facility. All observational tools and survey instruments were also pilot-tested at this facility.

Walk-Through Methods

Industrial Hygiene/Safety Methods

During our opening conference with the company representative, we gathered information on facility processes. Following the opening conference, the team was given a brief tour of the production facility, where we observed the processes, flow of material, and some of the hazards. After the preliminary observations and discussions with management, we chose between three and five processes to observe. We then conducted the observation process on the production floor. A systems approach was used to assess the main hazards, how the companies addressed those hazards, and how any residual hazards could be addressed. All participating companies were offered an additional musculoskeletal hazard consultation, which was conducted during the site visit.

Observational tools (checklists) were used to assess potential physical (safety, noise, and musculoskeletal), chemical, and biological hazards in the workplace, as well as exposure controls. Copies of these forms are attached in Appendix C. The forms were completed by the work process and sometimes by sub-process. An initial assessment of the process was made, including some physical characteristics of the area and the general environment. The hazard assessment sections were arranged in the following order: musculoskeletal, safety, other physical hazards (noise, heat, cold, and radiation), and chemical/biological exposures.

The presence of musculoskeletal hazards in the operation was assessed, in addition to the number of employees exposed for less than two hours per shift, between two and four hours per shift, and more than four hours per shift. The hazards were delineated as manual handling, postural, repetition, and other hazards. Control measures for materials handling, workstation setup/design, repetitive work, and tools were also noted.

Safety issues were assessed by observing guarding (machine and general area), maintenance, housekeeping, materials handling, personal protective equipment, lock-out/tag-out, and confined space procedures. Because many of these aspects of safety were not directly observable during our site visit, no assessments were made on those topics during our walk-through. These areas were rated as being either “poor,” “fair,” “good,” “excellent,” or “not applicable.”

The other physical hazards observed were noise, heat/cold and radiation. These hazards were assessed by noting characteristics of the source, the controls that were in place to potentially reduce exposure, and how the worker interfaced with the hazard. Noise, temperature, and humidity measurements were made where appropriate.

Exposures to chemical and biological materials were assessed by evaluating, 1) the potential for worker exposure, 2) the toxicity of the material, and 3) the controls used to reduce the exposure (engineering, administrative, and personal protective equipment). How employees worked with the materials also was observed. Some screening air sampling was taken for dusts, carbon monoxide, and other gases, where appropriate.

Ergonomic Assessment Methods

Ergonomic assessments were performed if management expressed concerns about work-related musculoskeletal disorders (WMSDs), such as carpal tunnel syndrome and back strain. WMSD hazards (involving the neck, arms, hands, wrists, or back) were assessed by observing manual handling jobs, work postures, and the repetitive nature of the work. Only jobs performed on the day of the site visit were assessed. We recognize that certain hazardous jobs and tasks may not be conducted continuously, so our assessment may be incomplete. The Washington State Ergonomics Rule (WAC 296-62-051) "caution zone" and "hazard zone" checklists were used to evaluate jobs. These criteria were used so that employers could learn whether jobs on their worksite may be of concern under the rule. [Note: Employers in this industry do not need to be in compliance with this rule until 2003 at the earliest.] To identify caution zone jobs and WMSD hazards, a checklist was completed for each job. Caution zone jobs with WMSD hazards require the reduction of the hazards below the criteria level, or to the degree that is economically and technologically feasible. In addition, each job was video recorded, when allowed by the company. Videotapes were also reviewed for the ergonomic assessment. The recommendations given to companies were based on observations made on the day of the visit. Other jobs and tasks not observed on that day should also be evaluated.

<u>Organizational Assessment Methods</u>

Review of Safety and Health Materials

Health and safety materials were gathered from each site and reviewed. Observational tools and checklists were used to record information about the materials. These tools were developed based on information in the health and safety literature.

Manager Interview

On each site visit, our goal was to formally interview the human resources manager, and, if possible to ask additional questions of the safety manager and/or plant manager. For the human resources manager interview, a tool was developed that included questions from the telephone survey on productivity, commitment, policies, and practices (see Appendix D). The purpose of the interview was to gain more in-depth information than was provided during the telephone interview. Topics included the company's programs, safety and health policies, perceptions of risk for various hazards, and successful strategies they used to reduce or eliminate work-related injuries. Also, the manager we interviewed was asked to complete a written survey. The written survey included questions about the manager's perception of organizational factors such as organizational culture, safety leadership, safety diligence, safety training, ergonomic solutions, and return-to-work practices at the company. These survey questions were based on questions from the Disability Prevention Among Michigan Employers Survey (Habeck, et. al., 1998).

Worker Survey
At each company we visited, we attempted to survey approximately 10% of the workers who were working on the day we visited. Worker participation was voluntary. We attempted to select workers from the various production areas in a facility, as well as maintenance workers; however, this was not always possible.

The worker survey included questions about job duties, their perceived risks for various hazards at the facility, their knowledge about Material Safety Data Sheets, use of personal protective equipment, and their perceptions of various workplace organizational factors, health symptoms and job stress (see Appendix E). Questions about organizational factors were based on questions used in a study by Amick, et al. (2000), which had already been tested in a worker population. The job strain questions measured the dimensions of job control and job demand. These questions were based on the widely-used Job Demands-Job Control Model (Karasek & Theorell, 1990). Workers were asked to rate how strongly they agreed (or disagreed) with a series of statements about their job demands and job control. Ratings from the specific statements were then grouped according to their positive or negative influences on each dimension (i.e., job demand, job control, and social support). An overall score was computed for each dimension.

The worker survey was pilot tested among a worker population not in the study sample, and during the pilot site visit. In addition to the English version, the worker survey also was translated into Spanish and Russian versions.

Methods for Systems Evaluation and Systems Index
We adapted a systems evaluation from Alexander & Orr (1992) to rate the workplaces following the site visit (see Appendix F). The criteria we evaluated included the company's use of injury and illness data, workplace audits, maintaining lists of problems, the use of engineering controls, the design of processes, and safety and health training. The different criteria were scored by assigning points for performance as follows: "poor" (score = 1), "fair" (2), "good" (3), and "excellent" (4). Half points were also used. If a criterion was not scored because it "wasn't done" at the facility, that criterion was given a zero value. A systems index (total score) was created for each company by summing all of the criteria scores.

Methods for Evaluating the Intervention

We developed educational materials based on our observations from the company site visits. The educational materials consisted of a series of modules on various health and safety hazards, safety committee, safety training, and workplace organization. Each module described the importance of the problem; how the problem could be fixed, along with successful strategies used by the site visit companies; and a list of resources for additional information.

The educational materials were distributed to the 19 food processing companies that we visited. After mailing the materials, the companies were contacted initially to verify receipt. Approximately four weeks following the mail-out of the materials, we conducted a follow-up phone survey with each of the food processing companies (see Appendix G). The effectiveness of the intervention was measured by the following criteria:

1. At least 60% of the companies would respond positively that they had received and read the educational materials.
2. At least 80% of those who read the materials would respond positively that the materials were clear and understandable.
3. At least 70% of those who read the materials would respond positively that they learned something new from the materials.
4. At least 50% of those who read the materials would respond positively that they found useful “successful strategies” in the materials.
5. At least 25% of those who read the materials would respond positively that they intended to implement some of the suggestions in the materials.
6. At least 10% of those who read the materials would have implemented at least one of the suggestions in the materials.

For the telephone follow-up, a minimum of four calls was attempted for each facility.

Data Management and Analysis Plan

All data for survey and site visits were kept confidential. All company names were stored in locked files and computer files were password protected. The identities of companies that did and did not complete the survey were not available to SHARP.

Descriptive statistics were used to compare frequencies between small and large companies. Small companies were defined as having 10 or fewer employees, and large as having 11 or more employees. For each continuous variable we calculated means and standard deviations within each size group. Analysis of variance (ANOVA) methods were then used to establish if the differences of means observed were statistically significant. The following comparisons were made:

- Organizational health survey score, WC claims rates, average employment turnover, growth, and employee wages, by company size;
- Claims rate by SIC code; and
- Organizational health survey score by site visit status (visited or not-visited).

We calculated group frequencies for categorical variables. Chi-square tests were used to establish the statistical significance of group differences. Regression methods were used to compare organization health scores from the telephone survey with workers’ compensation claim rates, turnover, growth of employment and average wage. We used Poisson regression for tests involving claims rate.

Correlation analyses were performed between the system index and the workers' and managers' organizational and risk perception survey responses, the workers' compensation claims rates, and the organizational health score from the telephone survey.

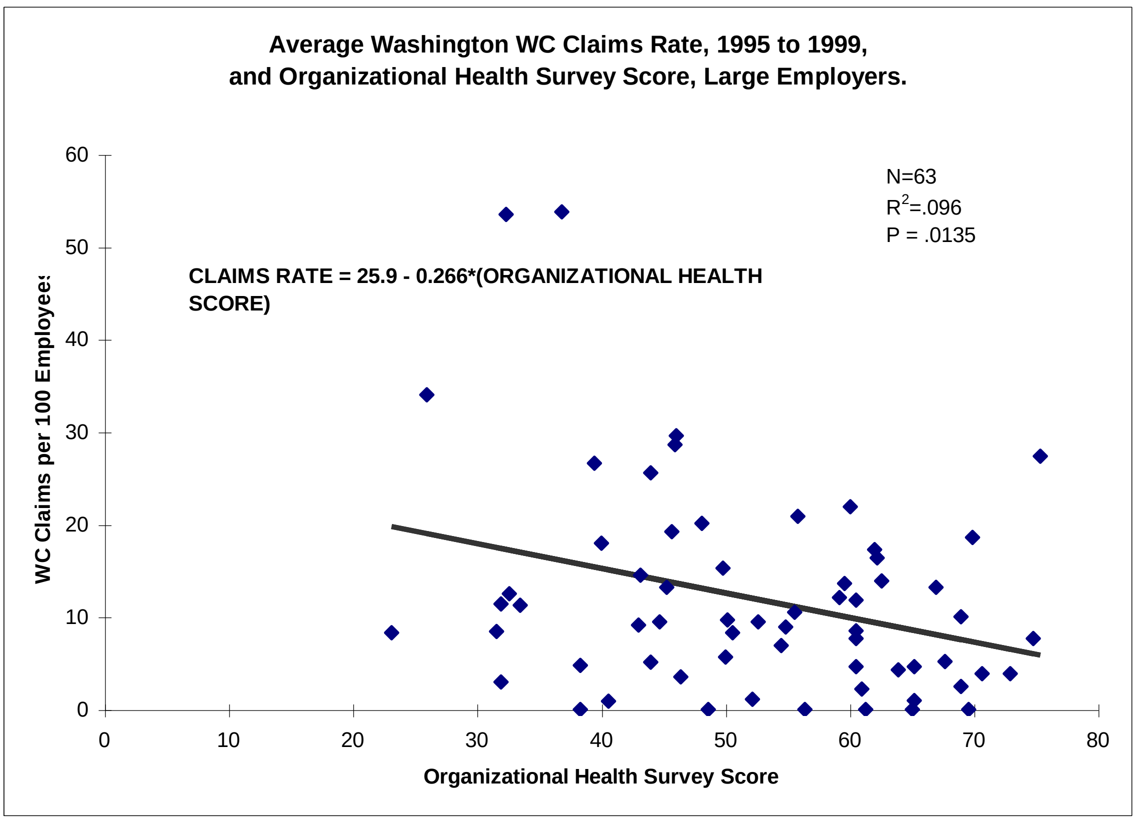
For all statistical tests, we used an alpha level of 0.05 ($p = 0.05$) to detect statistical significance.

RESULTS

Telephone Survey

A total of 142 companies participated in the telephone survey (37% participation rate). Companies were asked questions about human resources policies and practices, productivity, and health and safety programs. An overall score for organizational health, based on respondent perceptions, was calculated and compared with WC claim rates. We found that among companies with 11 or more employees (n = 88), there was an inverse relationship between the claims rate and the organizational health score: the higher the organizational health, the lower the WC claim rates (see Figure 4).

Figure 4. Association between average workers' compensation (WC) claims rates, from 1995 to 1999, and the organizational health scores among large food processing companies in Washington state.



Note: Large companies had 11 or more employees (n = 88). Of the 88 large companies, 63 had WC claims data for 1995-1999, or at least the three most recent years.

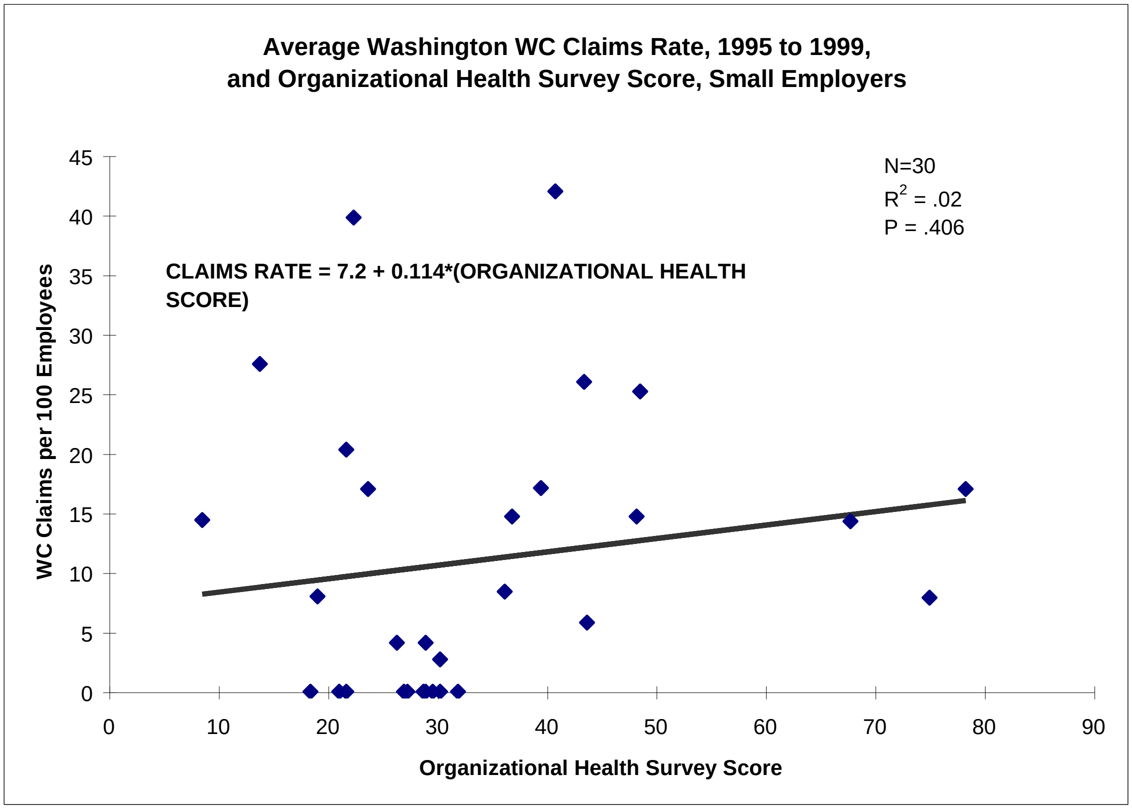
Note: WC claims rate included all accepted state-fund and self-insured WC claims for the participating companies.

Note: WC claims rate was based on head count at the facility. Head count was obtained from Employment Security Department database.

The higher the organizational health score, the lower the workers' compensation claims rate among companies with 11 or more employees.

However, for companies with 10 or fewer employees, there was no statistical association between WC claims rate and organizational health score (see Figure 5).

Figure 5. Association between average workers' compensation (WC) claims rates from 1995 to 1999, and the organizational health scores among small food processing companies Washington state.



Note: Small companies have 10 or fewer employees (n = 54). Of the 54 small companies, 30 had WC claims data for 1995 to 1999, or at least the three most recent years.

Note: WC claims rate included all accepted state-fund and self-insured WC claims for the participating companies.

Note: WC claims rate was based on head count at the facility. Head count was obtained from Employment Security Department database.

We then compared the average organizational health scores with size category of the company and found differences: large companies with 11 or more employees had higher (better) organizational health scores than smaller companies. The average score for companies with 11 or more employees was 52.0 (n=88), and for those with 10 or fewer, the average score was 36.5 (n=54); $p < 0.05$.

Table 4 summarizes the organizational health scores and workers' compensation claims rates for large, medium, and small companies.

Table 4. Organizational health scores and workers' compensation (WC) claims rates for large, medium, and small companies, 1995 to 1999.

Company Size	Organizational Health Score			WC Claims Rate		
	Score	N	p value	Rate	N	p value
Large	57.1	44	p < 0.05	9.21	32	ns
Medium	47.2	44		14.80	31	
Small	33.9	54		11.03	30	

Note: Workers' compensation (WC) claims rate is per 100 employees, for the participating companies.
Note: The p-value is statistically significant at or below 0.05; "ns" is not statistically significant.
Note: For this table, large companies have 50 or more employees; medium companies have 11 to 49 employees, and small companies have 10 and fewer.
Note: The number of firms with organizational health scores is greater than the number of firms with WC claims rate values because only firms with at least three years of existence were included (i.e., firms that only existed in 1998-1999 were excluded from the analyses).

Table 5 lists the average workers' compensation claims rates by SIC codes for the participating food processing companies over a five-year period. Although the claims rate for SIC 201 is higher than that for any other SIC, this difference was not statistically significant, perhaps owing to the small number of companies. For comparison, the last two columns in Table 5 show the average number of WC claims and claims rate per 100 FTEs for all state fund companies in the food processing industry.

Table 5. Average workers' compensation (WC) claims rates for food processing companies by Standard Industrial Classification (SIC) code, 1995 to 1999.

SIC (n=142)	Participating Companies		All State Fund Food Processing Companies	
	N	Claims Rate per 100 employees	Claims per Year	WC Rate per 100 FTEs
201 -- meats	8	24.1	569	26.8
202 -- dairy	5	11.8	137	27.4
203 -- preserved fruit and vegetables	21	10.1	610	14.2
204 -- pet food products	9	11.7	145	19.4
205 -- baking	12	10.3	122	15.2
208 -- beverages	22	8.8	217	14.1
209 -- fish and other	16	12.4	752	18.8

Note: Workers' compensation (WC) claims rates are per 100 employees vs. WC claims per 100 FTEs.
Note: "N" is the number of participating companies for each SIC code.
Note: The WC claims rates per 100 FTE are for state fund claims only. These rates are higher because the denominator uses FTEs, rather than headcount of employees.

We also compared organizational scores and WC claims rates with employment turnover. We found no association between employment turnover and either of these two variables. We also found no association between employment growth and organizational health score.

For the period 1997-1999, the mean average wages for companies with 11 or more employees was $6,203 per quarter, and $3,336 per quarter for companies with 10 or fewer employees ($p < 0.05$). Among companies with 11 or more employees, we compared organizational health scores with the average wages for that same time period, and found that the higher (better) the organizational health, the higher the average wages for the three-year period ($p = 0.01$). This relationship was also true for small companies, but was not statistically significant.

The higher (better) the organizational health score, the higher the average employee wages.

Additional Survey Findings

Additional findings from the industry-wide telephone survey included types of human resources programs, productivity enhancements, health and safety training, and health and safety program elements. Table 6 lists the types of programs available to newly hired workers.

Table 6. Pre-placement programs in Washington food processing companies.

Pre-placement Programs (n = 88)	**Large Companies N**	**(%)**
Health and Safety Orientation	81	(92.1)
Pre-placement Screening	44	(50.6)
Pre-employment Physical Exam	8	(9.2)
Functional Capacity Testing	6	(6.9)
Literacy	0	(0.0)
Drug Screening	28	(32.2)
Prior Food Processing Experience	12	(13.8)
Other	20	(23.0)

Note: Large companies have 11 or more employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Tables 7 and 8 list the type of benefits and productivity-enhancing programs offered by food processing companies

Table 7. Benefits programs in Washington food processing companies.

Type of Benefits (n = 88)	Large Companies N	(%)
Health Benefits	78	(89.7)
Prescription Coverage	43	(49.4)
Counseling	33	(37.9)
Periodic Health Exam	34	(39.1)
Exercise Program	7	(8.1)

Note: Large companies have 11 or more employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Table 8. Productivity-enhancing programs in Washington food processing companies.

Programs to Enhance Productivity (n = 88)	Large Companies N	(%)
Continuous Improvement/Total Quality Management	30	(34.5)
Job satisfaction Surveys	29	(33.3)
Employee Suggestion	70	(80.5)
Employee Appreciation	49	(56.3)

Note: Large companies have 11 or more employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Table 9 compares the availability of training programs between food processing companies with 11 or more employees and those with 10 or fewer employees. Large food processing companies were 18% more likely to have health and safety orientation programs than were small companies [RR = 1.18, 95% CI (1.01, 1.38); chi square = 5.88, p = 0.015]. However, large companies were only 6% more likely to have safety training programs than were small companies (not statistically different). A total of 67 (77%) large companies provided the same safety training to temporary and contract workers as was given to permanent workers (this question was not asked of small companies).

Table 9. Training programs in Washington food processing companies.

Program	Large (n = 88) N	(%)	Small (n = 54) N	(%)	Total (n = 142) N	(%)
Health and Safety Orientation	81	(92.1)	42	(77.8)	123	(86.6)
Safety Training	83	(94.3)	48	(88.9)	131	(92.3)

Note: Large companies have 11 or more employees; small companies have 10 or fewer employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Large food processing companies were more likely to have health and safety orientation programs than were small companies, and both small and large companies were equally likely to provide safety training.

Table10 describes who does the safety training in food processing companies. Small companies were more likely to have the owner conduct the safety training than large companies, and were less likely to have health and safety professionals/consultants conduct training than large companies.

Table 10. Who conducts the safety training in Washington food processing companies.

Training conducted by:	Large (n = 88) N	(%)	Small (n = 54) N	(%)	Total (n = 142) N	(%)
Human Resources	23	(26.1)	1	(1.9)	24	(16.9)
Safety Professional Internal	16	(18.2)	1	(1.9)	17	(12.0)
Outside Consultant	9	(10.2)	4	(7.4)	13	(9.2)
L&I Consultant	5	(5.7)	0	(0.0)	5	(3.5)
WA Dept. of Agriculture	2	(2.3)	0	(0.0)	2	(1.4)
Safety Committee	9	(10.2)	1	(1.9)	10	(7.0)
Owner	10	(11.4)	30	(55.6)	40	(28.2)
Supervisor	33	(37.5)	14	(25.9)	47	(33.1)
Plant Manager	26	(29.6)	11	(20.4)	37	(26.1)
No One	2	(2.3)	3	(5.6)	5	(3.5)

Note: Large companies have 11 or more employees; small companies have 10 or fewer employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Companies with 11 or more employees were more likely to go to WISHA, OSHA, their associations, and the Internet to get help with health and safety issues than were companies with 10 or fewer employees (see Table 11). Companies with 10 or fewer employees were more likely to use the Department of Health (DOH) for assistance with health and safety. Other sources for assistance with health and safety issues included primarily the Washington State Department of Agriculture (WSDA). Note also that large companies were more likely to seek information from multiple sources than were small companies

Table 11. Where Washington food processing companies go for help with health and safety issues.

Get assistance from:	Large (n = 88)		Small (n = 54)		Total (n = 142)	
	N	(%)	N	(%)	N	(%)
WISHA	46	(52.3)	16	(29.6)	62	(43.7)
OSHA	15	(17.1)	4	(7.4)	19	(13.4)
IH/HS professional	13	(14.8)	5	(9.3)	18	(12.7)
Vendor	16	(18.2)	5	(9.3)	21	(14.8)
Association	18	(20.5)	4	(7.4)	22	(15.5)
Internet	12	(13.6)	2	(3.7)	14	(9.9)
University	2	(2.3)	1	(1.9)	3	(2.1)
Insurance Company	7	(8.0)	1	(1.9)	8	(5.6)
Corporate HQ	18	(20.5)	3	(5.6)	21	(14.8)
DOH	4	(4.6)	7	(13.0)	11	(7.8)
Other	18	(20.5)	13	(24.1)	31	(21.8)
Any one of the above	80	(90.9)	39	(72.2)	119	(83.8)

Note: Large companies have 11 or more employees; small companies have 10 or fewer employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Table 12 describes safety incentives used by food processors. The most frequent incentive used by food processors was employee appreciation. Only three companies indicated they used behavioral incentives to encourage safety and health practices. Safety bingo and zero injury programs potentially encourage the non-reporting of work-related injuries. Very few of the participating companies indicated they used these programs.

Table 12. Safety incentives in Washington food processing companies.

Safety Incentives (n = 88)	Large Companies N	(%)
Health and Safety Incentives	26	(29.6)
Team Incentives	5	(5.7)
Employee Appreciation	49	(56.3)
Zero Injury	14	(15.9)
Safety Bingo	3	(3.4)
Behavioral Incentives	3	(3.4)
Awards	13	(14.8)
Other	7	(8.0)

Note: Large companies have 11 or more employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

Twenty-five companies indicated that they did not have a health and safety philosophy; however, four of those companies did have health and safety goals (see Table 13). Thirty-eight (44.1%) of the companies had a written safety audit program.

Table 13. Health and safety program elements in large Washington food processing companies.

Safety Program Elements (n= 88)	Large Companies N	(%)
Philosophy/goals	62	(72.1)
Goals	4	(16.7)
Safety Audit Program	44	(51.2)
Health and Safety Budget	24	(28.9)
Accident Investigations	75	(86.2)
Safety Committee	67	(77.0)
Track Injuries	77	(87.5)

Note: Large companies have 11 or more employees.
Note: Numbers reflect "yes" responses and participants could choose all that apply. Column totals do not add up to 100%.

In addition, 28 (32.2%) employers indicated that they had health and safety training programs that went beyond the regulations. Examples the companies gave included: "*Drug and alcohol programs are not covered by the law, and we do offer mental health programs and that's not mandated*." Other companies indicated that they had, *"Leadership training, sexual harassment* *training, promotion training," and "First aid, everyone gets certified…Lifting training for those working in the frozen area."* Another company offered, "*We cover everything and everything at home and work, such as electrical and fire, wellness and lifestyle they can do at home."*

In regard to ergonomic training that goes beyond the regulations, companies indicated, *"The law just changed, so I'm not sure, but for example we were doing ergonomics before it was required. That kind of thing, we always try to be ahead of the regulations."* Another company said they did, *"In-depth ergonomics training prior to regulation."* Other training included, *training on rotation for ergonomic long term repetitive movements; proper ways of lifting for the protection of workers, extra training for the proper use of knives and scissors*, and *a separate training for everyone.*

Several companies mentioned that their health and safety training programs covered topics such as training to prevent slips and falls, trip hazards, proper lifting techniques, hand safety, and materials handling. One company offered, "*We have a two-hour orientation program that includes lock-out/tag-out, chemical safety, even if (the worker is) not directly involved because they may transfer later and would at least have an overview that includes maintenance."* Companies also indicated, *"Special training was done with particular machines and equipment."* Also, one company indicated they train workers*, "Especially when* (we) *get a new piece of equipment in, we are modernizing our lines. Sometimes manufacturers come in and give training. Signs and books are bilingual and the instruction is bilingual."*

Company Site Visits

This section of the report describes the findings from the company site visits. We conducted site visits in 19 companies. The site visits included a walk-through, an ergonomic assessment, a manager interview, and worker surveys. We observed many important and successful strategies that employers used in their approaches to health and safety.

The following sub-sections of this report describe our walk-through observations of selected major hazards, how the companies addressed those hazards, and how some of the hazards could be more fully addressed.

Machine Guarding

Most of the companies we visited had moving machinery. Many of the moving parts of these machines were guarded, so that workers could not directly contact the machine with their body or clothes. However, some moving parts were not enclosed or guarded. This situation makes it possible for workers to catch fingers, hands, arms, clothing, and hair in the moving parts, which may crush, amputate, or pull the worker into the machine (entrainment).

Most new processing equipment comes with moving parts already guarded. The use of older or remanufactured equipment, or equipment that has had its guarding removed, may expose workers to these machine-related hazards. In most of the companies we visited, we observed employees working safely with and around unguarded machinery. While this is adequate, it is not a reliable method to prevent injuries. It is much more reliable to follow the hierarchy of controls. The best way to reduce the likelihood of injury would be to remove the hazard completely. If this is not feasible, the next best method would be to guard or shield the hazard. If that cannot be done, the next best strategy would be to train the worker. The least acceptable strategy would be to physically protect the worker with protective clothing. When any control is put in place, it must be evaluated for its effectiveness and unintended consequences.

This approach is illustrated in an example of a common exposure -- a tote dump. A tote dump is a pneumatic system that lifts a box or tote that is full of product, and dumps it into the processing line. Frequently the dumps lift the box overhead to dump it, causing a potential "crush zone" beneath it as it is lowered. Using the hierarchy of controls, the following practices may reduce the hazard.

1) Remove the tote dumps from the workplace and get the product on the processing line in another manner (however, this may not be feasible and may cause other hazardous exposures).
2) Place a permanent barrier around the dump that prevents people from entering the area.
3) Place a chain across the entrance to the "crush zone" that can be removed and replaced as access to the area is required.
4) Place the operator and activation mechanisms so the operators have a good view of the "crush zone".
5) Require workers to wear steel-toed boots and hard hats in the area (these solutions may not be very effective.)

In the work sites visited with tote dumps, strategies #3 and #4 were the most commonly used to reduce this hazard. Some of the observed machine-related hazards, consequences, existing solutions, and potential solutions are listed in Table 14.

Table 14. Examples of exposures to machines lacking guarding.

Exposure	Potential Consequences	Current Controls	Potential Controls
Unguarded tote dump.	Crushing injuries to leg or body.	Kept a watch on the area, used a chain to reduce access.	Develop a barrier to prevent access.
Film feeder for packaging machine had no guard.	Crush injury to the hand.	No controls.	Place a guard in front of the feeder.
Unguarded dough mixers.	Crushing injuries to the hand and arm.	Safety interlocks.	Place a guard over the opening of the mixing bowl, though this will prevent workers from easily testing the dough.
Sanitizing processing equipment that is in motion.	Crushing, amputation, entrainment.	Guards were removed to allow for cleaning, so hazard awareness was being relied upon.	Extensive training on the operation of each specific piece of equipment.
A series of rollers designed to squeeze material had a final set of unguarded rollers.	Crushing or entraining a hand or clothing.	The intermediary rollers spun in opposite directions, which prevented foreign objects from being pulled into those rollers.	A guard could be developed that would limit access to the end rollers, but allow workers to do their jobs.
An eight-foot diameter spinning product inspection station was unguarded.	While removing product debris, a worker could be struck by the spinning arms and possibly be entrained for a short distance.	An emergency stop system was present that shut down the station when a bar is struck.	An enclosure could be developed, similar to another of their lines. This would also reduce the noise levels in this area.
Band saws were used to cut frozen product.	Amputation of a finger or hand.	No controls.	It is difficult to guard this operation, but it may be possible to develop a jig to guide the product into the blade or newer equipment may have guarding solutions that could be adapted to these saws.

Slips

The food processing industry uses and discards many liquid (water, oil, etc) and solid materials (plant and animal parts, fat, flour, etc.) in the manufacture of their final products. It is common for these materials to be found on the floor, causing slip hazards in the immediate location as well as other areas of the facility. These materials promote slips by decreasing the friction between the workers' footwear and the floor.

The most effective method to prevent slips is to prevent the material from getting on the floor in the first place or by removing it before it causes a hazard. The next best method is to have a non-slip floor surface. With a liquid, this may be accomplished by having a rough finish concrete floor. With a solid material like animal parts, this strategy may not be adequate. The last line of defense would be to use slip-resistant footwear. If kept clean and free of grease, this type of footwear can reduce the likelihood of slips on wet, greasy, or dusty surfaces. It is always a good idea to use slip-resistant shoes, even if other protective measures are in place. However, they should not be relied upon as the only protection.

This approach is illustrated in a common exposure - water splattered onto the floor from a washing process. Using the hierarchy of controls, the following activities would reduce the slip hazard:

1) Re-engineer the process to prevent water from splashing.
2) Develop guards that prevent the water from splashing on the floor.
3) Drain water away from the workers.
4) Use a flooring material that is slip resistant when wet.
5) Require workers to use slip resistant boots when in the area.

Some of the observed slip hazards, existing solutions being used, and potential solutions are listed in Table 15. Potential consequences of slips range from twisted or strained ankles and backs to severe head trauma, depending on how the worker slips and what they strike if they fall.

Table 15. Examples of exposures to slips on walking surfaces.

Exposure	Current Controls	Potential Controls
Water and plant material on the floor.	A rough concrete floor was used along with slip-resistant boots.	More resources could be put towards preventing the materials from getting on the floor in the first place.
Flour was spilled onto the floor.	A rough concrete floor was in use.	Better transfer methods could be developed and slip-resistant shoes used. Spills could be picked up immediately.
Frozen plant material was on the floor.	A rough concrete floor was in use.	Alternate transfer methods should be used to prevent materials from spilling onto the floor. Slip-resistant footwear will not help in this situation.
Floors were greasy from animal fat.	A flooring material specifically designed to be slip-resistant was used.	The machine dispersing the grease should be shielded to prevent the grease from contacting the floor. The floors should be cleaned with a strong grease removing cleaner, although this may introduce more hazards. Slip-resistant footwear could be effective in this situation if they are kept clean.
Water was used to cool product pumps on the floor and was allowed to flow freely out of the pumps onto the floor.	Slip-resistant quarry tiles were used in this area.	The coolant water should be properly routed via an inline drain or a floor drain without exposing the workers to the slip hazard. Slip-resistant footwear would be feasible in this location.
Frozen animal parts were on the floor from a trimming operation.	A rough concrete floor was in use.	A custom shaped waste receptacle could be developed that prevented waste materials from getting on the floor. Slip-resistant footwear would not be effective for this hazard.
Grease from processing animal parts was on the floor in the production areas as well as the break room and other non-production areas.	A rough concrete floor was in use in the production areas.	Reduce the amount of grease transported through the facility. More aggressive flooring materials should be used for the non-production areas, in combination with a more effective cleaning procedure. Slip-resistant footwear may be effective in this situation, but would need frequent cleaning.

Falls from Elevation

Like many manufacturing industries, food processing has facilities with multiple levels, elevated walking or work surfaces, and stacking of materials at elevation. Working in, walking on, and accessing these areas potentially exposes workers to falls from elevations. Although these activities may be required to make or store product, they can be carried out safely.

The most effective method to prevent falls from elevation is to eliminate the fall hazard. Bringing the operation down to ground level can achieve this, but this approach may not always be feasible. The next best approach would be to fully guard against a fall (e.g. using a comprehensive railing system). The least effective approach would be to use fall protection equipment, which may include a body harness, lanyard, safety line, and anchorage point. These systems do not prevent the fall from occurring, but try to prevent the worker from striking the ground when he or she does fall. When fall protection equipment is used, extensive training is also required to make the equipment effective.

This approach is illustrated in a common fall exposure - accessing high stacked materials in a warehouse. With no controls, the worker climbs onto the stacked materials to access the top layer. Using the hierarchy of controls, the following practices would reduce the hazard.

1) The materials could be warehoused using shorter stacks.
2) A rolling ladder with an access platform and rail system could be used to access the top layer of materials. A personnel lift is another alternative.
3) If there were no other way to safely access the materials, a worker could climb on the product with fall protection equipment.

Some of the observed fall hazards, existing solutions being used, and potential solutions are listed in Table 16. Potential consequences of falls from elevation range from broken limbs to head trauma and death.

Table 16. Examples of exposures to falls from elevation.

Exposure	Current Controls	Potential Controls
A four-foot fall hazard from a loading dock.	No controls.	A removable gate could be installed that could be opened when access to the loading dock is required.
Warehoused product was climbed.	A straight ladder (typical ladder) was used to access the higher levels.	A rolling ladder with work platform could be used.
Elevated mixing stations had openings that were chained, but the chains were not always in-place.	Chains to limit access.	The use of the chains should be enforced. A self-closing gate could also be used.
Boxes were moved from one second-floor area to another using a forklift truck.	Gates were used to guard the area.	If a conveyor system were used to move the boxes, the hazard may be decreased, but jamming may be a problem.
Workers stood on short, adjustable platforms to access the processing line presenting a small fall hazard.	The slight fall hazard was an unintended consequence of an ergonomic solution.	It may be possible to cordon-off the back of the work platforms.

Noise

Many of the companies we visited had noisy operations in part or all of their facility. There are three primary mechanisms that create noise: 1) objects striking one another, 2) something vibrating, and/or 3) the movement of a fluid (air, water, etc.). These are common mechanisms in food processing, since large quantities of raw materials are processed and packaged for shipping. Exposure to noise at the levels measured in many of the facilities can cause noise induced hearing loss if the workers are not adequately protected.

There are four basic ways to reduce noise exposure:

- Purchase quiet equipment,
- Isolate the noisy equipment from work areas,
- Limit the duration of noisy activities, and
- Use hearing protection (ear plugs or ear muffs).

Most of the facilities we visited relied on hearing protection to reduce exposure, but the use of the hearing protection by employees and management was not always ideal. Consequently, it is preferable to reduce the noise level at its source or isolate the noisy operation.

This approach is illustrated in an example of common noise sources such as motors, pumps, blowers, and compressors. This equipment is used to move machines, air, and water throughout the facilities. When in use, they tend to be very loud, but using the hierarchy of controls, the noise levels can be reduced to safer levels:

1) Purchase inherently quieter equipment.
2) Develop noise absorbent barriers to enclose equipment.
3) Enclose noisy equipment in a "sound-proof" room, where no one works on a regular basis.
4) Use sound barriers between the noisy equipment and the workers.
5) Have a hearing conservation program in place that includes worker training, annual audiometry, and hearing protection. Enforce the use of appropriate hearing protection.

Some of the observed noise exposure situations, current solutions being used, and potential solutions are listed in Table 17.

Table 17. Examples of exposures to noise.

Exposure	Current Controls	Potential Controls
Dumping a frozen product into a steel vessel.	The task was performed by one person in an out-of-the-way location while wearing ear muffs.	It may be possible to use a sound absorbing material on the back of the vessel to dampen the noise.
A box processing line created noise as the boxes moved down the line.	Ear plugs were currently being used.	It may be possible to dampen the "box pusher's" mechanism to reduce the noise level.
A vibrating table was used to help break up and convey frozen product to an inspection table.	The table was cycled on and off, which would reduce the noise exposure over time. Workers also stood in noise absorbing booths and used ear plugs.	Placing the vibrating table on special floor mounts will decrease the amount of noise generated.
A number of noisy pumps, blowers and compressors were located in the facility.	Much of the noisy equipment was located in generally unoccupied "sound-proof" rooms.	When new equipment is purchased, its noise emissions should be evaluated along with other measures of performance.
In one transfer room, there were elevated noise levels caused by the conveying and product washing equipment.	The product washer was enclosed which greatly reduces workers' noise exposures. Ear plugs were also worn by some of the workers in the area.	Ear plug use should be enforced.
One processing line was loud because a metal bar struck another piece of metal approximately 400 times a minute.	The operator used ear plugs.	A similar processing line in the area was enclosed that may greatly reduce the noise level. Other materials could also be investigated for the striking mechanism to reduce the noise level. An enclosure may also reduce the machine hazards.
Band saws were used to cut frozen products.	The operators used ear plugs.	Enclosing any or part of the saws' motor will help to reduce the amount of noise reaching the workers' ear.
Workers processed their dusty material in an enclosed area with a great deal of noise produced by moving air used for ventilation.	The workers in this area used ear plugs.	The ventilation system in this area should be redesigned to be inherently quieter.

Chemical and Biological Agents

Most facilities visited did not use hazardous chemicals in the processing of the food. However, in some facilities, the plant or animal material being processed could potentially cause illness in exposed workers. All of the facilities used chemicals for cleaning and sanitizing equipment and surfaces during the day and at the end of the shift. Some of the facilities used ammonia for their coolant systems. There are two main routes of worker exposure to food products or sanitizing agents: inhaling the contaminant and skin contact. The specific health effects resulting from exposure depend on the nature of the contaminant, its concentration, the duration of exposure, and the route of exposure. Modifying any of these factors can lessen the workers' exposures.

Many raw materials in the food processing industry contain allergenic components, such as crab, flour, egg albumin, and grains. Many sensitizing agents can produce irritant reactions in the skin or respiratory tract. The approach used to reduce the chemical and biological exposures is similar to that used for other hazards. The best method is to eliminate the hazard from the work site, which is not feasible for the allergens, but may be possible for some sanitizing agents. The next best approach would be to engineer out the exposure, by using ventilation or another engineering control. The next best approach would be to train workers to identify and handle the hazard safely. The least preferable approach involves using personal protective equipment, such as respirators or gloves. Personal protective equipment should not be solely relied upon because its effectiveness as a control measure depends on the worker using it properly.

This approach is illustrated for exposure to a strong caustic sanitizing agent. Various federal and state agencies give sanitation requirements, but do not specify how the sanitization should be performed or the products that should be used. Using the hierarchy of controls, as shown below, it may be possible to reduce potential exposures to toxic or caustic products:

1) Use a different cleaning agent or a physical or thermal method to clean the area.
2) Enclose the sanitization process.
3) Train workers about the hazards of using the sanitizer.
4) Give the worker adequate personal protective equipment and training to prevent exposure (gloves, goggles/face shield, "foul weather" gear, etc.)

Some of the observed health hazards, potential consequences if a worker is exposed, current solutions being used, and potential solutions are listed in Table 18.

Table 18. Examples of exposures to chemical and biological agents.

Exposure	Potential Consequences	Current Controls	Potential Controls
Exposure to caustic sanitizing agents.	Severe skin rashes and respiratory irritation.	Automated mixers/dispensers were used along with many automated sanitizing processes.	Longer gloves may be used because of the excessive splashing.
Mixing dough may cause exposure to flour.	To sensitive individuals, exposure may cause an asthmatic reaction.	No controls.	Potentially use an exhaust ventilation system to remove the airborne flour while pouring flour into the mixing bowl.
Sulfur dioxide gas was used to sanitize storage vessels.	Acute respiratory irritation and respiratory distress.	Some facilities used a solid form of the product that released sulfur dioxide on contact with water. Respirators were used.	The solid form of the product may be a good solution, but requires further study to ensure workers are not ultimately exposed to the gas product.
Diatomaceous earth, which contains silica, was used as a filtering aid to remove sediments from fluids.	Exposure over long periods of time may cause silicosis.	Respirators were currently used to reduce exposure.	A synthetic filtration aid could be used or an enclosed transfer system used to move the diatomaceous earth from storage to the filtration units.
Dust levels from an animal product were very high in the receiving area.	Respiratory disease, including a pneumonia-like disease and asthma.	The area was ventilated and workers used dust masks.	The ventilation system should be redesigned and the respiratory protection program evaluated and upgraded.

Hazards from Forklift Trucks

Forklift trucks in workplaces are potential hazards from two different perspectives:

- A safety hazard to the operator and others in the area; and
- If they have a combustion engine (powered by propane, gasoline, natural gas, etc.) they may produce deadly carbon monoxide gas.

These small industrial trucks are commonly used to move materials in, around and out of facilities. They often bring raw materials to processing lines in the plant and remove palletized final products to warehousing or to load large trucks for shipping. Their presence among workers on foot raises the possibility of collisions, where the pedestrian fares much worse than the forklift! When forklifts carry heavy, elevated loads, the driver's visibility is compromised and the forklift may become unbalanced. If a forklift overturns, the driver can suffer serious, if not fatal injuries. If the forklift has a combustion engine (powered by gasoline, propane, or natural gas), it may produce deadly levels of carbon monoxide if the engine is poorly tuned or operates in a poorly ventilated area.

There are a number of strategies to reduce the acute trauma and potential carbon monoxide exposures from forklift trucks. The approach used to reduce exposures would be similar to that used for the other hazards, but the acute trauma and carbon monoxide hazards may have to be dealt with independently. One method that would remove both hazards would be to transfer the material using another mechanism, although that alternative should be fully evaluated. Electric forklift trucks could also be used, but that would only reduce the carbon monoxide hazard and introduce other potential hazards. Next, physical barriers or a ventilation system could be constructed to keep the trucks and their exhaust gases away from other occupants and the driver. Next, a range of activities and controls could be implemented that would reduce the hazards, such as: back-up alarms, designated traffic areas, training, preventive maintenance programs, and carbon monoxide alarms. Personal protective equipment could be used, but in some situations may be of little protection. Steel toed boots and hard hats would be the most appropriate forms of protection against acute trauma injuries. Only respirators that supply their own air (air-line or self-contained breathing apparatuses - SCUBA-type units) would be appropriate for carbon monoxide exposures.

This approach is illustrated below with the avoided hazard in parentheses:

1) Use a conveyor belt to move product from completion to warehousing (acute trauma and carbon monoxide).
2) Use electric forklift trucks (carbon monoxide).
3) Train workers in the safe use of forklift trucks (acute trauma and carbon monoxide).
4) Implement a preventive maintenance program that addresses the physical upkeep of the trucks as well as tailpipe emissions (acute trauma and carbon monoxide).
5) Install carbon monoxide alarms in strategic locations throughout the facility or use personal monitors (carbon monoxide).

Some of the observed hazards, potential consequences if a worker is exposed, current solutions being used, and potential solutions are listed in Table 19.

Table 19. Examples of exposures to hazards from forklift trucks.

Exposure	Potential Consequences	Current Controls	Potential Controls
Poorly tuned forklift driving around facility.	Carbon monoxide poisoning, loss of consciousness, possibly death.	Minimal ventilation.	Use electric trucks, increase ventilation, and keep forklift trucks well tuned.
Forklift delivered a large bin of raw material to a worker's station and comes within 2 feet of worker while the worker's back was turned.	Crushing between large bin and workstation, amputation of limb, internal injuries, or death.	No controls.	The bin could be delivered with a conveyor or to a slightly different location using the truck; the receiving worker could be aware of the delivery and have eye contact with the driver.
Considerable forklift traffic in the facility.	Being struck by or run over by a truck could lead to fractures, crushing injuries, or death.	Well-lighted area with truck honking horn as they approached high traffic areas, all trucks use backup alarms.	Use another method to transfer materials.

Confined Spaces

Many confined spaces were observed in the facilities visited. These facilities tended to be larger or dealt with bulk liquids or powders as a raw material or end product as opposed to using and packaging smaller products. The confined spaces had the following properties:

- Limited means of entry or exit;
- Large enough that a person can enter; and
- Not designed to have people continuously in the space.

Some of these spaces had other potential hazards associated with them including atmospheric (too little oxygen or too much of another gas), electrical, and/or mechanical hazards. These spaces were generally silos, large containers, storage vessels, and tanks. Entering and working in them is typically not a problem, unless one of the aforementioned hazards is present. A confined space with a hazard can cause a number of injuries, including severe traumatic injuries or death by asphyxiation.

To remove or reduce the hazards associated with confined spaces, several approaches can be taken:

- Remove the confined space and process materials without bulk storage.
- Ensure that there are no hazards associated with the confined space.
- Develop and implement a comprehensive confined space program.

This approach is illustrated in an example of a large tank used to store water. This tank must be periodically cleaned out. A worker enters the tank and hoses it down with a detergent. Using the hierarchy of controls, the following activities could be conducted to reduce the hazard:

1) Replace the storage tank with an on-demand, high volume system, so that a storage tank is not required.
2) Create an automated system, so the worker does not have to enter the confined space.
3) Implement a tracking/detection system to monitor the confined spaces. The tracking system would identify the requirements for entry and detect worker entry.
4) Use of personal protective equipment to mitigate the potential exposures.

Some of the observed hazards, current solutions being used, and potential solutions are listed in Table 20.

Table 20. Examples of exposures to confined spaces.

Exposure	Current Controls	Potential Controls
Confined spaces were not labeled and no written policy was in place.	Monitoring was conducted prior to entry to measure the oxygen level.	A written policy should be developed and followed.
Confined spaces in large tanks and silos were not labeled.	The day shift workers never entered these areas.	A written policy should be developed and followed.
Several confined spaces.	Signage was used on the outside of the space. Ventilation was used to make them non-permit entry confined spaces. Monitoring was conducted during entry and an attendant is on the outside of the space.	Written programs are required. Processes may be designed to reduce the need for the spaces. Engineering controls and personal protective equipment should be used when entering the spaces.

Ergonomic Assessment

A brief ergonomic assessment was completed during the site visits. Physical risk factors that can contribute to the development of work-related musculoskeletal disorders (WMSDs) were evaluated. "Caution zone" and "hazard zone" jobs were identified, based on the Washington State Ergonomics Rule (WAC 296-62-051). There were similar musculoskeletal risk factors at all companies, but the potential for jobs constituting a "hazard" varied considerably. Most companies had at least one job that could be considered a "caution zone" job, but many also had jobs that had physical risk factors that would qualify at the "hazard zone" level.

Heavy, frequent awkward lifting, particularly during loading and unloading of pallets, was one of the most commonly observed physical risk factors (see Table 21). These jobs typically qualified as "caution zone" jobs. The frequency and duration of heavy lifting may easily raise these jobs from the caution zone level to hazard zone level. In these cases, modifications to the work process would be required to reduce or eliminate the hazardous exposure.

To reduce exposure and improve performance, several companies used lift assists. These can be extremely effective but are sometimes expensive. Engineering controls we observed included:

- Vacuum-lifts to lift product from the conveyor line to the pallet.
- Scissor lifts that raise and lower product so lifts below knee level are eliminated.
- Automatic "depalletizers". This equipment unloads empty containers onto the conveyor, virtually eliminating the need for frequent lifting.
- Most companies utilized job rotation to reduce the amount of time a worker spent lifting.

Highly repetitive motions were frequently observed, often in combination with awkward postures. Many companies had assembly-line organizations, where workers performed tasks repeatedly, at a specified pace with very little opportunity to change their postures. Frequently, these risk factors were observed at hazard zone levels. The most frequently used technique to reduce the repetitiveness of jobs was job rotation. However, in order to be effective and achieve the intended results, closer assessment of the different jobs within the rotation should be completed to ensure that different muscles and positions are being used among the jobs.

It should be noted that most of the companies were aware and knowledgeable of the physical risk factors that were present in their jobs and several have used inventive and innovative interventions to reduce these risk factors. Interventions included:

- In a bottling plant, holders were created to carry multiple bottles, thereby eliminating the need to handle individual bottles.
- Lowering the heights of hooks from which product is hung, thereby eliminating the need to work with the hands above the shoulder.
- Using gravity feed devices to help move product.

Several companies had committees that were actively working to eliminate or reduce physical risk factors in their facilities.

Table 21. Examples of exposures to lifting and repetitive motion.

Exposure	Potential Consequences	Current Controls	Potential Engineering Controls
Awkward postures while repetitively doing a forceful activity.	Shoulder and back injuries could develop.	No controls.	Alter the workstation design and/or alter the method in which the product is processed prior to this worker, so it doesn't require as much force to complete the task.
Lifting heavy bags of waste product.	Shoulder and back injuries could develop.	Job rotation and infrequent lifts	A conveyor system could be designed to move the loose product or the bags.
Lifting large and heavy handfuls of dough to a bucket overhead.	Shoulder, wrist and forearm injuries could develop.	No controls.	A hoist is commercially available to lift and dump a mixing bowl.
Workers lifted heavy boxes from a conveyor belt and stacked them on a palette from ankle level to over the shoulder level.	Shoulder and back injuries could develop.	No controls.	Box weight could be lowered, job rotation could be used, or a lift assist could be implemented.
Palette jacks were used to move large, heavy bins of product.	Shoulder and back injuries could develop.	None present.	An electric palette jack would reduce the force required to push and pull the bins.
Palletized product was unloaded and placed onto a conveyor belt for processing.	Shoulder injuries could develop.	A scissor-lift is used to keep the top of the palette between waist and shoulder level.	An assist device should be investigated to reduce the amount of reaching required by the worker when unloading the palette.
Product was fed onto tubes for storage and shipping. The thumb was used rapidly and repeatedly to feed the product on the tube.	This motion could cause thumb, hand, wrist, and forearm injuries.	A tube extender was developed that reduces the amount of motion required by the worker, though some exposure still exists.	A new method could be found to mount the product onto the tubes.
Workers were sorting product while wearing loosely fitting gloves.	This requires workers to exert more force, which may lead to hand, wrist, and forearm injuries.	No controls.	Use tighter fitting gloves. This will also reduce the likelihood of a glove being caught by a piece of moving machinery.

Organizational Survey

Perceptions of Organizational Factors
A manager was interviewed and asked questions about the workplace at each of the 19 companies we visited. The questions focused on: management procedures, safety and health policies, perceptions of workplace organizational factors, and an assessment of the perceived risk of specific hazards in the workplace. In addition, workers at each of the companies were invited to complete the worker survey. A total of 159 workers from the 19 companies participated in the worker survey. The workers also were asked questions about their perceptions of workplace organizational factors and perceived risk of specific hazards in the workplace, knowledge of various work practices, and their physical health.

Workers felt they had similar opportunities for advancement as management did at their companies ($r = 0.55$, $p = 0.000$), and that the companies encouraged workers and managers to stay with the company ($r = 0.53$, $p=0.000$). However, it should be noted that managers were more positive about the company efforts to retain workers than were the workers themselves (79% vs. 66%, respectively).

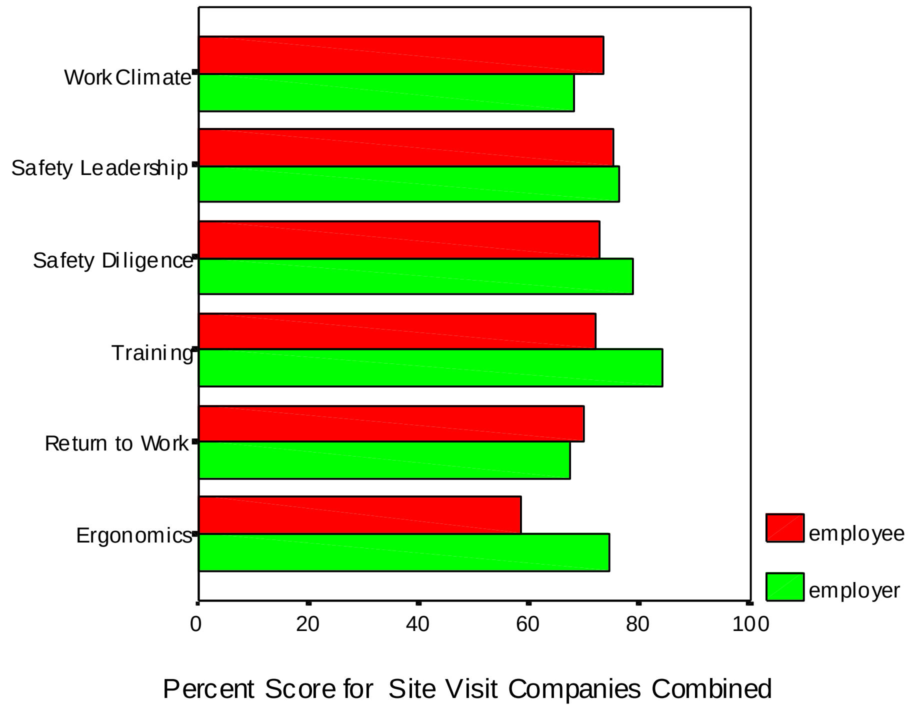
We also compared the percent score given by the managers and the employees for each of the organizational factors and risk perceptions. The following list describes each organizational factor:

- Work climate measures perceptions of employee involvement in company decision-making, whether workers feel comfortable voicing suggestions, and whether working relationships are cooperative.
- Safety leadership involves perceptions of company commitment of monetary and managerial resources to company health and safety.
- Safety diligence involves perceptions of company diligence regarding correcting hazardous working conditions, maintaining equipment, and company follow through when safety and health rules are violated.
- Training represents perceptions of good company training practices.
- Return-to-work involves the perceptions of how the company handles return-to-work practices for injured workers.
- Ergonomics assesses the perceptions regarding the company's achievements in reducing tasks that involve heavy lifting and repetitive movement.

Figure 6 describes the organizational factors rated by the managers and by the employees. The bars represent the percent score (the higher the score, the better the perceived performance).

Employees and managers had similar perceptions of organizational performance, except in the areas of safety training and ergonomic solutions.

Figure 6. A comparison of workers' and managers' perceptions of organizational factors. (Employers, N = 19; Employees N = 159)



While there was variation among individual companies, overall there was close agreement in perceptions between employees and managers among the work climate, safety leadership, safety diligence, and return to work. However, there was a more marked disparity in perceptions of performance on training and ergonomic solutions. Large differences in perception may indicate a need for improved communication between managers and employees.

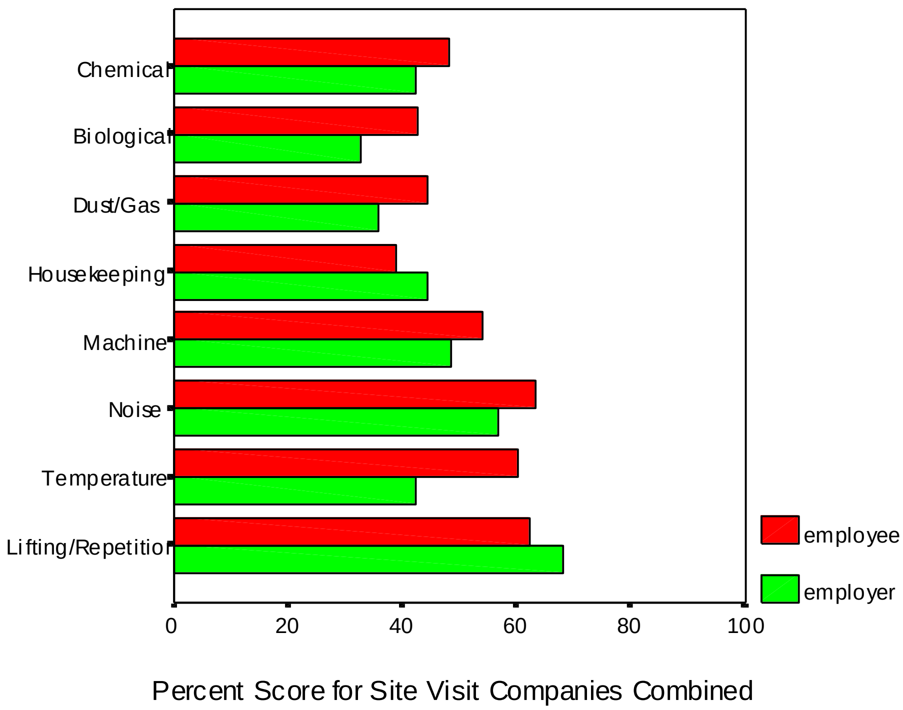
Perceptions of Risk

Figure 7 represents the summary of employer and employee perceptions of risk for selected hazards. In this graph, the lower the score the lower the perceived risk. Perceptions of risks for chemicals, biological agents, dust or gases, housekeeping, machine or equipment, noise, temperature extremes, and lifting or repetitive movement are included.

Employees tended to perceive greater risk for <u>most</u> physical hazards than did employers.

There was general agreement between the workers and managers in that the highest risks in the plant come from machines, noise, and lifting or repetitive movement. Risk perception by the employees slightly exceeds that of the employers for biological, dusts/gases, and temperature extremes.

Figure 7. A comparison of workers' and managers' perceptions of risk. (Employers, N = 19; Employees N = 159)



Large differences between employees and management regarding perception of risks may indicate a need for further training about job risks. Also, disparities in perception of risks may indicate a need for improved communication between employees and management.

Workers and managers were asked what makes a workplace healthy. Both workers and managers indicated that having *a safe, clean workplace* was important. This included provision of safety equipment and personal protective gear. Workers added that having the *"proper equipment and protection available (and used)"* was important.

Both workers and managers felt that having positive attitudes, happy people, and getting along well was important. One manager added, "*Happy workers…people who want to be working will be more productive*…(have) *pride in product.*"

"I think that when your supervisor tells you how to do things, and he shows you the way to do it, it will help to prevent injury."

Workers and managers indicated that communication, caring and listening made for a healthy workplace. Comments included, *"Good communication between management and employee, good people skills."* Workers added, *"Management that listens to employees when potential problems arise and takes positive action to solve the situation…take employee welfare seriously."* Comments from managers included, *"Workers convinced that management cares about them,"* and, *"keeping up on safety and health concerns, getting employees involved*." Both workers and managers commented that *respect for each other* was important in making a healthy workplace.

Both workers and managers thought that training and awareness made a workplace healthy. Workers added, *"Everyone learning the same thing"* was important. Managers indicated that both "*management and employees conscious of safety issues"* made for a healthy workplace.

Systems Evaluation

From our site visit observations, the larger food processing companies tended to have formal written safety guidelines and had more organized health and safety systems in place, while the very small companies did not.

The health and safety management systems include such things as:

- Written health and safety goals and objectives
- Written health and safety policies
- New employee orientation
- Hazard control procedures
- Documented health and safety training
- Health and safety audits, reviews, inspections, etc.

Companies were evaluated on their overall safety and health systems. No significant relationship was found between the organizational health scores (from the telephone survey) and the systems index, but some of the individual organizational factors and risk perception questions were correlated with the systems index, as was the WC claims rate.

Workplaces that used a systems approach to health and safety had lower WC claims rates.

Workers' compensation claims rates for the three-year period were negatively correlated with the systems index ($r = -0.73$, $p<0.01$, for large companies; $r = -0.53$, $p<0.05$, for all companies combined), such that the higher the systems index, the lower the claims rate. The workers' perceptions of the work climate were negatively correlated ($r = -0.74$, $p<0.01$) with systems index (i.e. the higher the rating for safety and health systems, the worse workers perceived the work climate). Workers' perceived risks for noise, temperature, dust, and for their overall risk were positively correlated with the system index (i.e. the higher the systems index, the more workers perceived risk for these exposures). For managers, perceptions of return-to-work, ergonomic solutions, and perception of overall organizational factors were positively correlated with the systems index, though mainly for the large companies (i.e., the higher the systems index, the higher the managers' perceptions of organizational factors). Figures 8a - d highlight some of the relationships between these variables.

Figure 8a. Systems index vs. workers' perception of work climate.

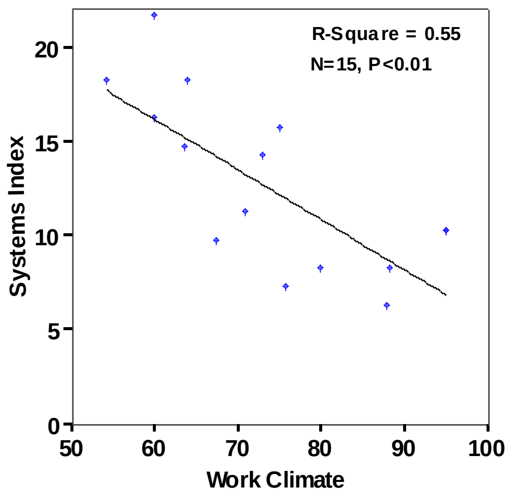


Figure 8b. Systems index vs. workers' total perception of risk.

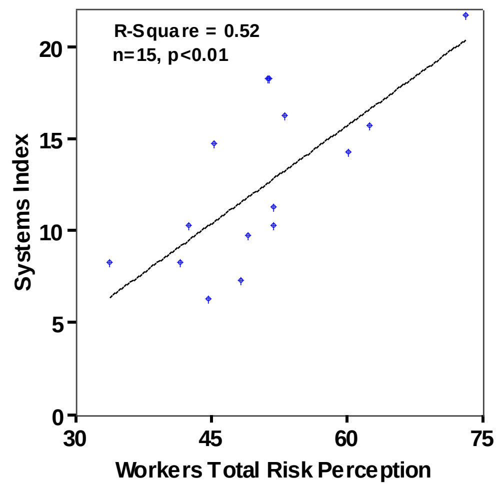


Figure 8c. Systems index vs. total management organizational score (for large companies only).

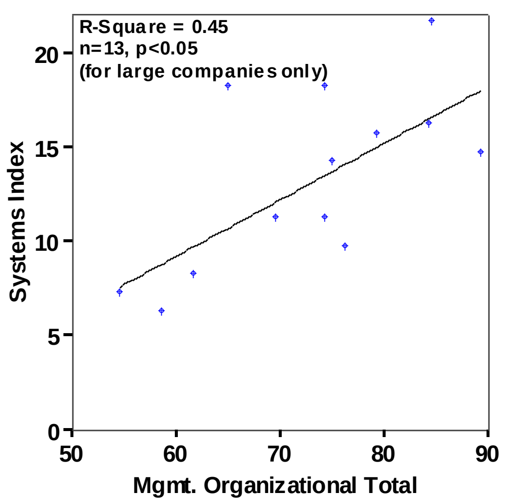
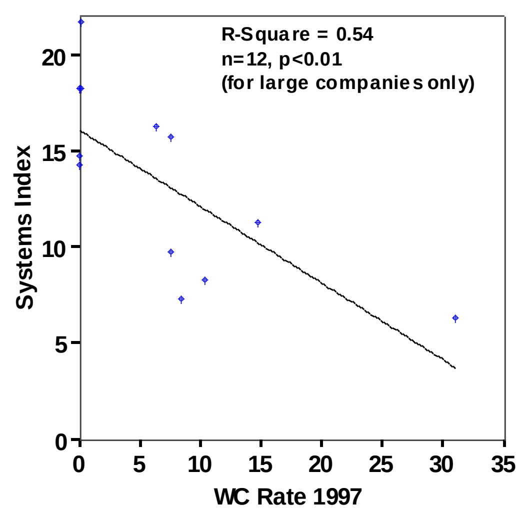


Figure 8d. Systems index vs. workers' compensation claims rates (for large companies only).



Job-Strain and Organizational Health

Workers were asked questions about their job demands, job control, overall job satisfaction, general health, their degree of mental and physical exhaustion at the end of their shift, and their perceptions of the level of various workplace risks. Average scores for these questions, along with workers' and managers' perceptions of organizational factors, were then compared to those for the Karasek-Theorell model (1990). Table 22 summarizes the results of those comparisons.

Table 22. Pearson correlation coefficients for Karasek-Theorell demand/control model elements and other measures of organizational performance.

(n = 17)	Physical Exhaustion	Overall Health	Job Demand	Job Control	Supervisor Listens	Job Satisfaction	Managers' Organizational Health Perception	Workers' Organizational Health Perception
Mental Exhaustion	**0.53** (.03)	**-0.47** (.06)	**0.67** (<.01)	**-.57** (.02)	**-.56** (.02)	**-.53** (.03)		**-.68** (<.01)
Physical Exhaustion		**-.69** (<.01)	**.80** (<.01)	**-.43** (.08)		**-.65** (<.01)		**-.71** (<.01)
Overall Health						**.79** (<.01)		**.51** (.03)
Job Demand						**-.61** (<.01)		**-.77** (<.01)
Job Control					**.77** (<.01)	**.64** (<.01)		**.40** .10
Job Satisfaction								**.69** (<.01)
Workers' Risk Perception		**-.52** (.03)						
Organizational Health Score (phone survey)							**.73** (<.01)	
WC Claims Rate, 1995-1999							**-.48** (.10)	

Note: Numbers in bold are Pearson correlation coefficients; the closer the value is to either 1.00 or –1.00, the higher the correlation. The numbers below each correlation coefficient in parentheses are *p*-values. Only those correlations significant at better than the 10% level are included

Note: All data represent the average of the workers scores at the company level; or are single observations from individual managers. WC claims rate is the average annual accepted WC claims per employee, for 1995-1999.

The correlation between workers' organizational health perception and that of managers was very low (r = 0.07, p = 0.79). This indicated that, in general, workers neither held the same views as managers nor did they oppose them in any systematic way. The same independence between workers perceptions and those of managers held for overall workplace risk (r = 0.18, p = 0.48).

Managers' risk perceptions did not correlate well with any other variable including claims rate. Managers in workplaces with higher claims rates were somewhat more likely to consider their workplace safe, though the statistical significance of this was low.

Most all of the correlations between the Karasek-Theorell variables (Job Demand, Job Control) and the variables on health, job satisfaction and workers' organizational health perception were highly correlated. In particular, the higher the job demand, the lower the workers' perception of organizational factors, and the lower the workers' job satisfaction. By contrast, the higher the job demand, the higher the workers' mental and physical exhaustion. For job control, the more job control workers' had, the lower their mental and physical exhaustion. Also, the more job control workers' had, the higher the workers' perception of organizational health. In addition, higher job control was positively associated with having a supervisor who listened to the workers' concerns.

The more demanding the job, the more workers' felt mentally and physically exhausted, and the lower their job satisfaction.

Educational Intervention

As a result of the site visits, we identified several common hazards and many strategies that employers successfully used to address these hazards and problems in their workplaces. We developed a series of written educational modules that summarized the importance of each problem; ways to fix the problem, including solutions that employers used; and where to get more information. The modules were compiled and were distributed to the 19 companies that participated in a site visit. We then conducted a telephone interview with each company to find out about the usability of the educational materials.

Interviews were completed with 14 (73.7%) of the 19 food processing facility managers. Eleven (almost 80%) of the representatives completing the interview stated that they had read all or part of the educational materials. None of the educational modules were read by less than 8 of the 11 representatives. All of the representatives read the educational modules on ergonomic strategies and controlling noise.

All 11 of the managers who indicated that they had read at least part of the packet responded that the modules they read were clear and understandable.

The managers were then asked whether they learned anything new from reading the modules. Eight (72.7%) responded that they had not learned anything new, while the remaining three (27.3%) responded that they had learned a few things.

- When asked whether they found any of the "successful strategies" in the modules to be useful, 6/11 (54.6%) responded that they had found them useful.

None of the 11 managers were able to implement any of the suggestions from the educational materials during the short time (approximately four-weeks) since they had received it. When asked whether they intend to implement some of the recommendations in the future, three (27.3%) responded that they did intend to do so. The three managers who indicated that they would implement some of the recommendations in the future were then asked whether they saw any barriers to implementation. Two of the managers indicated that time and money were potential barriers; while the other indicated that he/she saw no potential barriers.

Table 23 compares the manager responses with the evaluation criteria.

Table 23. Criteria used to evaluate the effectiveness of the educational materials.

Criteria	Target	Actual
Percentage that read the educational materials.	60%	78.6%
Percentage that found the materials "clear and understandable".	80%	100%
Percentage that learned something new from the materials.	70%	27.3%
Percentage that found the "successful strategies" to be useful.	50%	54.6%
Percentage that intend to implement some of the suggestions.	25%	27.3%
Percentage that have implemented at least one of the suggestions.	10%	0.00%

The 11 managers were then asked how they would rate the overall quality of the materials and were given the following choices: poor, fair, good, very good, or excellent. Four (36.4%) responded that the materials were "good", five (45.4%) responded "very good", and the remaining two (18.2%) responded that the overall quality was "excellent."

When asked about the overall length, one manager thought that the materials were too short and the remaining 10 (90.9%) thought that the overall length was appropriate. None of the managers thought that the materials were too long.

When asked about the overall content of the materials, two (18.2%) responded that the materials were too general and nine (81.8%) thought that the content was appropriate. No one responded that the overall content of the materials was too detailed.

Comments provided by the managers of the food processing facilities were:

- The document could be great for folks without a background in safety.
- As a training tool, each module is of length that can be fit into individual training sessions.
- For companies just getting started, it might be helpful.

DISCUSSION

This study provided important information about safety and health practices within the food processing industry. Managers in the food processing industry demonstrated a remarkable degree of support for this project and admirable concern for worker health and safety. Given that the response rate for telephone surveys is usually between 20-31% (Marketing Research Association, 2001; World Opinion, 2001; Council for Marketing and Opinion Research, 2001), the response rate of 37% for this study demonstrated considerable management commitment. This commitment was also demonstrated in their subsequent cooperation during our field visits.

Study Design

This was our first attempt at an industry-wide approach to studying workplace organization issues. Our methods for industry selection added a unique and important element to our study design. Individual company data allowed us to set criteria for inclusion in the list of candidate industries based upon the number of individual companies as well as the *dispersion* of companies by size and claims rate. This was critical for the objectives of the Healthy Workplaces in the Food Processing study, which included the dissemination of good practices from high-performing companies to the industry as a whole. It was also important to include both small and large companies, as the challenges faced and resources available are different for each group.

The criteria for inclusion in the initial telephone survey were based, in part, on company size as measured by quarterly employment. Many of the data analyses performed on the results of the survey involved administrative data gathered at the company level, such as employment, wages, turnover, and claims rate. One of the strengths of these databases is that they allow the researcher to test hypotheses at the individual company level rather than at the industry level. This allows us, for example to compare claims rates between industries or other groupings because it allows us to estimate not only the *mean* of a given variable but also the *variance*. By linking multiple statewide databases, and comparing employee turnover, wage data, and workers' compensation claims rates, we gained powerful insight into the health of the food processing industry. This is a particular strength of the study design.

However, intensive use of these administrative data has revealed certain limitations that have hampered our ability to perform some analyses. The most important limitations concern the availability of data that are specific to the physical location at which the work was performed. Collection of accurate data is the first step in any occupational health and safety surveillance system. It must be possible to compare information on workplace risk factors, organizational health, and other data gathered through site visits and interviews with such outcome indicators as claims rate. However, for fixed-worksite companies with more than one facility, it is often impossible to calculate a claims rate or to ascribe any of the claims cost data to that particular facility. This limitation reflects the fact that, in general, hours worked are reported only at the account level for each company, rather than separately at the individual business locations. Also, claims are occasionally not reported at the business location level. Because these data are critical for testing the association between facility-specific survey or observational data and worker injury and illness, there is a critical need for claims and hours information to be reported at the facility level.

There is a <u>great</u> need for information on employee hours, WC claims, and uniform business identifiers *at the specific physical location* of the company.

There is also a critical need for periodic validation of each business location's SIC and NAICS code because most researchers use SIC or NAICS coding for their industrial groupings. Using risk class is not a good alternative because this classification system is unique to Washington and is based on occupation and industry *combined.*

Finally, there is a need for a common business identifier that allows the linking of data records *across* state agencies. However, the Uniform Business Identifier (UBI) is limited because it is assigned at the company-wide level, rather than at the physical address level. When researchers need to link data for multiple-worksite businesses, they must resort to matching street addresses, which is often incomplete and inaccurate.

Other strengths of the study design included the use of various components of survey instruments that had been used and tested by others, both in food processing and in worker populations. This adds to the validity of our study by drawing from previously tested instruments. In addition, pilot testing our telephone survey on a small sample of companies allowed us to clarify questions prior to surveying the industry. Likewise, pilot testing our site visit survey instruments and observational tools prior to data collection enabled us to better anticipate any impact our site visit might have on companies.

Another strength of the study design was our use of several data collection techniques. By using data from multiple sources, including an industry-wide telephone survey and company site visits, we were able to gather a more complete picture of the industry processes and potential safety and health hazards. This approach facilitated the targeting of educational materials. Additionally, by using a multidisciplinary team on the site visits, we were able to draw upon skills from different perspectives and provide the companies with expertise in industrial hygiene, safety, and ergonomic assessments.

Study Findings

Our findings about the relationship between organizational health (characterized by an organization's health and safety program) and work-related injuries are consistent with findings from other studies (Shannon, et. al., 1996; Habeck, et al. 1998). While Shannon's study primarily focused on manufacturing companies with more than 50 employees, our study included any company with at least one employee. We considered this to be a strength of our study design because we were able to capture information on an entire industry, including small employers. Thus, we were able to identify differences between large and small employers regarding organizational health. Further, we were able to determine that there was very little difference in workers' compensation claims rates between large and small employers (However, this difference was statistically significant when we defined large employer as 25 or more employees).

Improving organizational aspects of health and safety efforts can reduce injury rates.

In general, company size was not a strong predictor of WC claims rate in this study. However, for firms with 11 or more employees, the larger the firm the lower the WC claims rate. The organizational health score by itself was a mildly strong predictor of claims rate, but only for larger firms. In addition, there was a strongly positive association between company size and organizational health score. Finally, when controlling for size, the higher the organizational health score the lower the claims rate for large firms.

The results from relating the site visit systems evaluation with the various measures of worker and management perception, and claims rates showed four major trends.

- In workplaces where a systems approach to heath and safety was used, workers were less satisfied with their work climate. This may arise because in the workplaces with a systems approach, the workers may have higher expectations for their workplace's organizational climate.

- In workplaces where a health and safety systems approach was used, workers perceived more risk to exposures. This relationship may arise because in the workplaces with a systems approach, workers may be given more awareness training on workplace hazards, so they are more aware of their environment.

- In workplaces where a systems approach to health and safety was used, management viewed their health and safety programs more positively. This relationship may arise from the fact that the companies using the systems approach had health and safety programs in place.

- Workplaces where a health and safety systems approach was used had lower WC claims rates. This relationship may indicate that the systems approach may be able to help predict the claims rates for the large companies. It may also be evidence that the systems approach is reducing hazards.

Numerous physical, chemical, and biological hazards were identified in the workplaces we visited. Many of these hazards had been previously identified and controlled for, but many were not. Companies used a combination of engineering, administrative, and personal protective equipment to control or reduce exposures. We found a combination of manufactured solutions (e.g. machine guarding built-in) and facility developed solutions (e.g. machine guarding fabricated on-site from steel plates). Some of the more effective control strategies reduced multiple hazards simultaneously. The following is a list of some of the more effective controls:

- A product inspection line was covered, both preventing workers from putting their hands into the moving mechanism and reducing the noise produced by the line.
- Many of the facilities had equipment sanitization requirements and used automated mixing and dispensing equipment. This not only reduced chemical exposures, but also reduced the amount of lifting required for the job. *In-place sanitization* (automatically pumping in sanitizer and water without a worker contacting the materials) was also used in a number of locations and further reduced the chemical exposures.
- Developing a slip management program that included providing workers with a large rebate toward the purchase of slip-resistant footwear may not only reduce the probability of slips, but may contribute toward the worker's perception of management. The program was successful because slip-resistant shoes were used in combination with a slip-resistant floor.
- By housing much of the very loud mechanical equipment (blowers, compressors, and motors) in a separate room, one company not only decreased the noise level on the work floor, but may have increased workers' ability to communicate about production issues.

Companies using a systems approach to health and safety attempted to identify the underlying root cause of hazards and developed systems and processes for hazard prevention. This enabled them to function in a proactive, rather than reactive fashion. A few of the small to mid-size companies had made good attempts at adopting a systems approach, but in general these elements were missing from small companies. The small food processing companies hold a large potential for the development of health and safety management systems similar to those used successfully by the large companies.

Each of the correlations between job strain and the variables of workers' health, job satisfaction, and organizational health perception had the expected positive or negative sign, and most were highly correlated with an absolute value greater than 0.5. In particular, high job demand was negatively correlated with workers' perception of organizational health and job satisfaction. It should be noted that these correlations were established even with only 17 records.

Evaluation of the Educational Intervention

At the onset of the evaluation, six process objectives were created to use as criteria for evaluating the effectiveness of the educational materials. Overall, we met or exceeded our target for four of the six process objectives and fell short for the remaining two. In order to reach any conclusions regarding the effectiveness of the educational materials, it's important to look critically at each of the criteria.

First, we had hoped that 60% of those completing an interview would respond positively that they received and read at least some of the educational modules. While we only waited approximately four weeks after confirming that the facilities received the materials before administering the interviews, we were extremely pleased to learn that nearly 80% had found the time to read the materials. Moreover, each of the modules was read by a minimum of eight of the 11 representatives. This evidence seems to indicate that health and safety topics of interest to the food processing industry were covered in the document.

Second, we had hoped that 80% of respondents would find the materials to be clear and understandable. Again, we were extremely pleased that all of the respondents believed that the materials were written in clear and understandable language. Additional comments provided by the respondents indicated that the document was easy to read and concise.

Our third objective was that 70% of those who read the materials would learn something new. Unfortunately, less than 30% responded that that they had learned a few new things, while the majority commented that they did not learn anything new. In general, those who responded that they did not learn anything new added that they had been working in the health and safety field for a long time, and the document may be more helpful for other companies in the food processing industry. Interestingly, companies volunteering for site visits (those completing the evaluation survey) did have slightly higher organizational health scores when compared to companies that did not participate in site visits; however, this difference was not statistically significant.

Many of the companies reported that they knew most of the material already, yet the site visit teams identified hazards at their work sites. This raises the question of why were these hazards not controlled. There may be a lack of motivation for change, lack of financial and organizational support to reduce the hazard, or a perception that the hazard is not serious or important.

Although companies may be familiar with measures to control hazards, these measures are not always implemented.

Fourth, we had hoped that 50% of those who read the materials would respond positively that they found useful "successful strategies" in the materials. A little over half (almost 55%) found the strategies listed in the modules to be useful. Interestingly, the majority of respondents could not remember specifically which strategies they found useful. This finding seems to suggest that even when useful strategies are identified, steps are not being taken to actively work towards their implementation.

Understanding and addressing what motivates change in large and small companies is critical to education effectiveness.

Our fifth objective was that 25% of those who read the materials would respond positively that they intended to implement at least one of the recommendations/strategies in the educational modules. This objective was met, because three (27.3%) responded that they intended to implement some of the recommendations in the future. Again, the respondents could not list the specific recommendations they intended to implement. Two of the respondents indicated that they were planning to distribute the document to their safety committee, or to department managers, to identify strategies for implementation. The third respondent stated the company was waiting for the report from the individual site visit to find areas for improvement, and then would utilize the document to identify strategies.

Finally, we did not meet our final objective that 10% of those who read the materials would have implemented at least one of the suggestions in the materials. Most likely this is because interviews were conducted only four weeks after receipt was confirmed. This did not give facilities enough time to read the document, develop, and implement changes. In retrospect this objective was unrealistic, and we are not surprised at the results.

Overall, food processing facility representatives who read the educational materials found them to be well-written and of good quality. Comments indicated that they were pleased with the materials and appreciated the suggestions and references provided. Despite the overall positive feedback of the document in general, most of the food processing representatives we spoke with did not learn anything new from reading the modules and could not find any specific strategies in the modules that they were planning to implement. While one representative indicated that they were very disappointed, the majority of representatives still believed that the educational materials would be useful to the industry as a whole. Most believed that they did not find the document useful because they already knew the information due to extensive experience in health and safety. Additionally, the general consensus was that the document could be more useful to other food processing facilities lacking this expertise.

Limitations

The workers' compensation (WC) claims rates used in this study included all accepted claims per 100 employees. Usually worker hours would be used as the denominator in calculating claim rates. However, the Department of Labor and Industries hours data were not used because they are recorded at the *account* level and therefore are not correct for estimating rates at a specific location. In our calculations, we used employee head count (obtained from Employment Security Department data) because those data pertain to the specific workplace where the claim occurred. While it is a strength of the study that we looked at claims rates for each facility, the use of headcount as the denominator may lead to an *underestimate* of the true claims rate per fulltime equivalent (FTE) because the number of employees exceeds the number of FTEs by an amount that varies from firm to firm. This introduces a mis-measurement error in the data, which makes it more difficult to detect the true associations between the variables.

Another limitation of the study was our 37% response rate. While this response rate may indicate our findings were less than representative of the industry, we could not verify the food processing status for 97 companies. It is possible that the true response rate was higher had we been able to confirm those 97 companies (excluding those companies yields a 49% response rate).

In addition, our scoring system for the telephone survey may have introduced some bias. We attempted to control inter-rater variation by pairing scorers (two scorers independently scoring the same participants' answers) for the open-ended questions, and scorers largely agreed with each other. Although we weighted the survey with questions about various programs and policies, we accounted for the fact that companies with 10 and fewer employees were not required to have certain programs or safety committees. We adjusted for this by normalizing the scores to a scale of 100 for both small and large companies.

We used a traditional data collection approach to evaluate the mechanisms of organizational change (i.e., telephone survey and an observational site visit). If we expanded our approach to look for the innovators within the industry and focused more on developing stakeholder relationships, we may have gained more insight into specific solutions to industry-wide problems.

Our company site visits were limited in scope and comprised only a single visit per company. If we had visited the companies multiple times over a longer period of time, we may have been able to assist them to develop and implement specific interventions for injury reduction. Also, we were not able to observe seasonal workers.

The financial performance of each company could not be reasonably assessed and financial comparisons could not be made between companies with different products. In addition, the Department of Revenue data did not yield financial performance at individual business locations, so we were not able to adequately measure a company's "financial health." This study did not ascertain the overall organizational health of the workplace, but used health and safety organizational efforts as a surrogate for the broader definition of organizational health. We plan to use alternative strategies to study the next industry for the Healthy Workplaces project.

Several components of the intervention program required further modification. Partnership with a food processing trade association in the future may bring further benefits to safety and health in the food processing industry. Outreach to management (other than safety and health managers) within the food processing companies may initiate the incorporation of safety and health programs into management systems. Facilitating an industry-wide discussion of high-level managers directed towards safety and health issues, while incorporating into the discussion all the other workplace factors necessary to promote a healthy workplace, may be a more active intervention than the "successful strategies" educational materials. These interventions would require significant resources and long follow-up periods to assess their effectiveness in improving safety and health in Washington food processing companies.

CONCLUSIONS AND RECOMMENDATIONS

Organizational Health

This study showed that organizationally healthy workplaces have healthier workers and lower workers' compensation claim rates, at least among companies with 11 or more employees. More attention should be placed on raising awareness and increasing health and safety resources for small companies.

Workers and managers tended to have similar perceptions of organizational health performance, except in the areas of safety training and ergonomic solutions. Differences in perception of organizational health performance may indicate areas where communication and training could be improved. Further research in the area of perception about organizational health performance is needed.

Hazards

Because of the scope of the study, we were not able to investigate the hazard control decision-making process directly. If the elements that allowed one company to adopt a control technology or other hazard reducing process could be identified, these elements could be shared with other companies in order to facilitate their decision-making process. In looking only at the exposures and controls, but not at the motivation for change, it may be difficult to determine why and how change took place. Future work should try to investigate this decision-making process. To facilitate the transfer of successful strategies, incentives may be helpful in motivating companies to change.

Cross - Training

Our findings suggest that food-processing companies utilize inspectors from WSDA and DOH for safety and health information. Using the WSDA and DOH inspectors as informal consultants regarding occupational safety and health of the workers may be a reasonable strategy to improve safety and health in the workplace. We recommend continued support for inter-agency occupational health and safety training, particularly for the WSDA and DOH inspectors.

Educational Intervention

Our findings indicate that the educational materials have value in providing basic solutions and strategies for reducing hazardous exposures in the food processing industry. In particular, the educational materials may be useful for food processing facilities that do not have extensive expertise in workplace health and safety issues. The materials can serve as a vehicle for transferring "successful strategies" to companies that need help reducing exposures and decreasing injuries and illnesses. However, educational materials alone may not be enough to create change. More attention should be placed on understanding what motivates change in small and large companies.

Future Work

The Healthy Workplaces project is directed towards an industry-wide improvement in occupational safety and health by measuring the effect of different organizational components on occupational safety and health. Because this is novel, groundbreaking research, our ability to measure and assess these components will improve with time. Our first steps in studying the food processing industry have provided a basis for the Healthy Workplaces team within SHARP to go forward into the next industry with a keen awareness of the strength and limitations of this type of research. The extraordinary potential of the Healthy Workplaces research will be more fully realized as we progress with our work.

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APPENDICES