Perspectives on Material Handling Practice

Papers in the Perspectives series have appeared in conference proceedings of the Material Handling Institute between 1992 and the present. As such they provide a point of reference as to how the industry is changing as well as insight into accepted practice during this period. In many cases the authors credited have either changed jobs or are no longer in the industry. Some companies as well have been the subject of mergers or reorganization with a new corporate identity.

ERGONOMICS AND TOTAL QUALITY MANAGEMENT AT L.L. BEAN

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ABSTRACT

Like many companies in the mid to late 1980's, L. L. Bean experienced an increase in cumulative trauma disorders, predominantly of the upper extremities and back. As we focused on reducing these injuries/illnesses through an emphasis on ergonomics and other programs (e.g. worksite stretch, physical therapy, education/training, rehabilitation), we also shifted to total quality management as a way of doing business. Many systems internal to L. L. Bean were effected, including job design, performance appraisals, pay, scheduling, and management emphasis, as well as new focus on and accountabilities for health and safety in the production areas. Through this macroergonomic approach we were able to reduce lost-time injuries by (-61%) and (-94%) in our distribution and manufacturing divisions, respectively, from 1988 to 1993.

INTRODUCTION

L. L. Bean employs approximately 4,00-8,00 workers in the manufacturing and mail order distribution of outdoors apparel and specialty products, depending on the time of the year. Like many companies in the United States in the mid to late 1980's, L. L. Bean experienced a

rising incidence of cumulative trauma disorders (CTD's), predominantly of the upper extremities and back. Our worksites had always been clean, well lit, and apparently "safe" - we had few traumatic injuries. However, the emergence of what were considered "new" occupational illnesses, CTD's (sometimes called Repetitive Strain Injuries), changed our perspective on workplace health and safety. Ergonomics became a key strategy in preventing workplace injuries/illnesses, as well as in returning partially disable employees to the work force.

However, successfully addressing the increase in CTD's with ergonomics required a "macroergonomics" approach. It was difficult to explain the rapid increase in cumulative trauma disorders and associated conditions with traditional biochemical or physiological approaches alone. Many other factors, including organizational and work system design issues, would need to be taken into account.

Ergonomics integrated with Total Quality Management, along with our other loss prevention programs, helped us to reduce lost-time injuries/illnesses by (-61%) and (-94%) in our manufacturing and distribution divisions, respectively, form 1988 to 1993.

EXTERNAL ENVIRONMENT

In 1992 the Occupational Safety and Health Administration (OSHA) estimated that 56% of all occupational illnesses were related to repetitive motion, and that ergonomic related problems were also the single greatest lost-time injury in the workplace. OSHA estimated that musculoskeletal injuries accounted for 33-34% of all workers' compensation spending in the U.S. and that the percentage would increase to 50% of all workers' compensation spending by the end of the century. (BNA, 8-26-92)

Because of their increasing prevalence, CTD's have received increased attention from the Occupational Safety and Health, and many professional groups and associations. They have also routinely been written up in the popular media. (Feder 1994, Felsenthal 1994)

However, in the professional ranks there has been some disagreement on how related to work CTD's actually are. Many credible practitioners and researchers are able to document a direct relationship between ergonomic risk factors (e.g. repetition, force, angle of extremities) and CTD's (Sivertein, 1987, More and Grag, 1994). However, other researchers believe the work-relatedness of CTD's is in doubt, and that there is not good scientific evidence to firmly establish a causative relationship. (Hadler), 1992)

For example, in a publish analysis of U.S. West's experience with CTD'S, Hardler (1992) concluded that the 6-8 fold differences in CTD's among plants in different states was due to a complex set of factors. Among them were the labor management relationships at the plants and the responses of the local medical communities. He felt that ergonomic was no a major influence since all the workplaces were ergonomically similar. In a subsequent study of U.S. West's experiences with CTD's, the National Institute of Occupational Safety and Health found that psychosocial factors were as least as relevant as ergonomic factors in U.S. West's increased

incidence of CTD's. This was a view also expressed by the Communication workers of America, the involved union. (BNA, 7/22/92)

In another example involving low back injuries and claims for workers compensation, Bigos (1991) studied over 3,000 workers at Boeing over time. Although ergonomics was examined as one of the risk factors for low back claims, the researchers found that the factors most likely to predict disability from low back pain were disciplinary actions by the employer prior to the low back pain episode and worker dissatisfaction.

Although it was difficult to explain these findings and their influence on the increasing number of CTD's, the predominant view during this time was that CTD's were related to work. This was reflected in the broadening definitions of work-related conditions in many state workers' compensation laws and the United States' Occupational Safety and Health Administration (LSHA). For example, in its meatpacking guidelines, OSHA's definition of occupational illnesses includes the statement "unless the illness was caused solely by a non-work-related event or exposure off-premises, the case is presumed to be work related" (OSHA, 1991).

Whatever the final answer on the relationship of CTD's required a multi-faceted approach. Ergonomics was the cornerstone of most comprehensive approaches of dealing with musculoskeletal injuries. However, one had to look beyond purely microergonomic factors such as bench height and numbers of repetitions to explain the phenomenon of CTD's, and to deal effectively with them.

INTERNAL ENVIRONMENT

During the mid to late 1980's, while in a period of 10-20% annual growth, L> L> Bean focused on increasing productivity in our internal operations. As jobs became streamlined, repetitive activities increased. There was less variety in each job. Employees' paychecks depended on the units they produced in the current week. Employees had disincentives to slow down if their arms became sore. There was also a workers compensation system in place in which employees could receive their take-home pay while out of work once disable, even if the condition was only partly related to work. And due to the streamlining of production jobs, there were fewer jobs in which partially disable employees could continue working.

L. L. Bean 's workplaces had always been clean, well lit, orderly, and traditionally safe.
During this time period we had few serious "accidents" but an increasing number of CTD's. The organizational value on units per hour productivity, pay systems, and the streamlining of jobs counteracted ergonomics programs to reduce CTD'S. This shifted in 1989 when Total Quality Management (TQM) was adopted as a way of doing business at L. L. Bean.

TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is a quality improvement philosophy and management system based on the work of Deming (1986), Juran (1964), and Crosby (1979) in the 1959's. Until 1989, like many good companies, we had utilized Frederick Taylor's (1923) scientific management principles to achieve high production rates. However, in 1989, based on the work of Gavin (1988) and other, we re-focused our efforts on TQM, integrating the best of Taylor's approach with the changes under TQM.

TQM's focus on quality and overall productivity allowed new management in our manufacturing division to re-examine the way its 400 employees had successfully produced shoes and canvas luggage in the past. During this period, TQM was also implemented in our 1,500 employee warehouse and distribution center. In the Distribution Center, bulk items are stored and then individual orders are packed and shipped by mail to customers. Ergonomics and other programs were actively embraced and integrated into ongoing operations. However, it was the framework of TQM that made effective implementation possible.

Total Quality Management at L. L. Bean is based on five principles:

1. Focus on customer needs (both external customers and those "internal customers" who serve the external customers);
2. Top management support and commitment conveyed through all levels;
3. Total involvement of all employees;
4. Effective measurements upon which improvements can be based;
5. Continuos improvement of all processes.

TQM effectively places responsibility for workplace health and safety with area management. Employee Health's mission and objective were aimed at helping area management and employee to achieve and maintain a healthy and safe workplace. To achieve that mission and objective, the right programs needed to be developed (see Figure 1). However it was the effective implementation of those processes by management and employees in the operating areas, supported by upper management, that was central to their effectiveness.

MACROERGONOMICS

Hendrick (1992) defines macroergonomics as a top-down sociotechnical systems approach to organizational and work systems design and the design of related human-system interfaces. Macroergonomics deals with the organizational structure of organizations, including the complexity of its structure, formalization of its jobs and their descriptions, and the centralization of its decision making.

Organizational structures that tend to break jobs into series of repetitive tasks, to streamline their functions, formalize their job description, and narrow their decision making limit the effectiveness of ergonomic intervention. Narrowly defined jobs, little job variability, few jobs into which tired or injured employees can be rotated, and performance evaluation and pay

systems that stress high units per hours all can limit ergonomic intervention to factors such as bench height adjustments and placement of materials.

However many other factors besides engineering are involved in ergonomics problems and solutions. Whether the worker likes their job, the effects or organizational values and culture, and the sociotechnical systems (e.g. pay, recognition) in place also influence employees.
With L. L. Bean's adoption of QTM, a focus on high units per hour was gradually supplanted with a focus on overall productivity. Factors such as job enlargement, job rotation, increased decision-making, greater task variability, and refined performance appraisal and pay systems that rewarded quality and overall productivity were all part of TQM implementation. They also had beneficial effects in reducing CTQ's.

Some of the organizational and program factors that worked in synergy with ergonomics in a macroergonomic framework were:

- Management and employees re-designed pay systems in both divisions to eliminate almost all piece-rate pay systems. Units produced are still counted, but they are factored in at year-end and count for 25-33% of the overall appraisal. Hourly employees were actively involved in the redesign of the pay and appraisal systems.
- There was an emphasis on building complexity into jobs and allowing job rotation and cross training as much as possible. In some manufacturing areas, teams of employees replaced individual operators.
- Ergonomic and overall health and safety education and training programs were conducted for effected employees seeking their understanding and "buy-in" of the efforts to reduce cumulative trauma disorders and other workplace injuries/illnesses.
- It became easier for partially disabled employees to remain in their jobs at reduced production rates.
- Onsite physical therapy was implemented in both divisions, using a group of physical therapists skilled in ergonomics as well as clinical treatment of soft tissue injuries. Many ergonomic improvements resulted from the physical therapist(s) working with the employee, supervisor, ergonomist, maintenance fabricator, and occupational health nurse to fit a job to an injured employee.
- worksite stretch programs were implemented in all the jobs to help reduce the ill effects of repetition and awkward and static postures. Employees stretched for two to three 5 minutes period on the clock. Although it was not always possible to directly measure the effects on unit productivity, management felt there were minimal negative impacts on production.
- Active case management of disable employees was utilized with restricted duty programs to keep disabled employees working as much as possible.
- And perhaps most importantly, managers and supervisors became much more committee to making the above work in their areas. It was their active support that many of us believe made the real difference.

The ergonomic efforts L. L. Bean started in the mid-1980's began to effectively take hold in the late 1980's with the implementation of total quality management. We think our improved

reductions in injuries were obtained because of the TQM/macroergonomic environment created by management and employees.

The overall reduction in injuries/illnesses is consistent with Hendirck's (1992) belief that whereas one ca achieve 10-20% reductions in injuries/illnesses from microergonomic approaches, with macroergonomic approaches one should be able to achieve 60-80% reductions. More practitioners and researchers are recognizing Macroergonomic approaches such as Total Quality Management. (Ferrel, 1992; Hendrick,1992; Kumashiro, 1992; Parenmark, 1992; Soderberg, 1992; Ronney, 1992, Toulouse, 1992)

At the same time, many practitioners in the health, safety, and engineering fields are advocating for TQM as well (Carte, 1994; Krauser; 1993; Manuele, 1991; Peterson, 1994; Roughton, 1993).

However, as important as the overall macroergonomic efforts are, it was critical to have soundly based practical ergonomic programs in place.

L. L. BEAN ERGONOMICS HISTORY

The implementation of ergonomics into companies in the United States has had many problems in the past few years As OSHA began to inspect and cite for ergonomics hazards under its General Duty Clause in the late 1980's, it became apparent that ergonomics was not being implemented properly by many employers. In fact, there were citations in which companies has ergonomics programs in place, or had agreed to develop them, but were failing to make them effective. (BNA, 7/17/91, 8/7/91, 9/11/91, 14/18/91)

It appears that the effectiveness of a company's ergonomics program may largely depend on the organizational context into which it is implemented. At L. L. Bean, ergonomics generally moved through three phases form the mid-1980's to present.

> Phase 1 : Ergonomics was typically focused on improving jobs in which employees had an injury/illness. Emphasis was on reacting to problems as they developed. Training of supervisors, engineers, budget analysts, human resource specialists, and others was accomplished, but there was not yet an effective management systems in place to implement changes.
>
> Phase 2: Ergonomics was applied to jobs more proactively in the late 1980's. Ergonomic design teams were formed including health and safety specialist, engineers, and employees to evaluate jobs for ergonomic improvement. The Engineering Department had pioneered employee design team in the Distribution Center in the early 1980's. It was easy to fit ergonomics into those teams. However, their recommended changes often were deleted during the budgeting process. There was a more formal framework to implement changes, but focus was still on justifying ergonomic changes in relation to overall productivity.

In 1988, an external expert was brought in intensively train six people to videotape, analyze, and use a team approach to make changes in jobs in Manufacturing. (The training was exported to the Distribution division in 1990) The methods helped us learn how t make sound, objectively evaluated, ergonomic changes ourselves. (Wick, 1990) However, whereas we began to see some immediate benefits from this training, the management framework was not yet in place to maximize the effect of ergonomics.

Phase 3 : From the early 1990's to present, ergonomics is increasingly becoming a part of the overall job and work flow design along with productivity an d quality. In TQM, workplace health and safety is an integral part of management and employee performance expectations and rewards. Ergonomics is an integral part of our operations and is being included in increasing degrees in almost all workplace planning and changes

The Engineering Department had always considered ergonomics in its design for work processes. However, instead of designing for the average employee and asking those above and below the average physical dimensions to adapt, we were increasingly designing workplaces to fit a greater diversity of physical sizes, as well as to allow employee to make more postural changes during the shift.

ERGONOMICS METHODOLOGY

As we began to integrate ergonomics into the way we conducted business, two overriding questions drove our progress.

1) Are we applying ergonomic changes to the right job? And
2) Are the ergonomic changes actually resulting in improvements?

The basic framework of our methodology evolved to closely follow the proposed OSHA ergonomic guidelines and other recommended approaches (OSHA, 1991; Keyserling, 1991). We utilized an ergonomics design team approach, depending a lot on participatory ergonomics. The core team included the ergonomic specialist, standards analyst/engineer, occupational health nurse, physical therapist, and a member of our Maintenance Department. In looking at any jobs, the affected employee(s) and supervisor were always included and were an integral part of the process. (Herrick st.al., 1994)

Worksite Analysis

The program started with worksite analysis. We used a combination of method including: monitoring OSHA-200 logs and workers compensation claims; measuring incidence rates; conducting plant surveys; studying reports form supervisors, employees, and health and safety personnel; and other methods. Data collected by the Health and Fitness Specialists as they implemented worksite stretch programs provided additional information on what parts of the body employees felt the most fatigue and soreness.

Hazard Prevention and Control

In jobs where quick foxes (e.g. obvious postural changes) were needed, changes were implemented immediately. However, in situations requiring a more through analysis, a full or partial eight step process was use: (Drury and Wcik,1984)

1. Obtaining buy-in and support from the supervisor and employee(s).
2. Videotaping the job.
3. Analyzing the job and qualifying repetitions, angles of the body, and forces used.
4. Presenting the videotape analysis and result to the Ergonomics Design Team. Using brainstorming and other facilitation techniques, practical solutions were recommended.
5. Cost-justifying the recommended changes.
6. Building a prototype for testing.
7. Implementing the approved prototype.
8. Re measuring the job to make sure improvements were achieved.

Guidelines for changes were (Wick, 1990)

Angles:	As close to neutral position as possible.
Forces:	Grip - less than 25 pounds
	Pinch - less than 8 pounds
Repetitions:	Less than 1,00 damaging motions per hour.
Posture:	Upright seated or standing posture, with reach zones close to the body. Support for upper extremities.
Lifting:	Within NIOSH guidelines. (NIOSH, 1981)

Although there was not enough research to treat the above as rigid standards, they gave us some guidelines with which to target efforts.

Our concern was with new types of hazards: excess force, angle, repetitions, and awkward unsupported postures. Typical conditions that created these were identified:

- incorrect workstation height
- excess repetitions
- excessive lift loads
- awkward reaches
- excessive forces
- incorrect tool angle
- poor grip surfaces

- improper machinery design
- lack of automated machinery
- lack of jig/fixture use
- lack of upper extremity support

Initially many modifications consisted of 2x4's, ½ inch plywood, and angle iron. These modification material, though simple, were inexpensive, easy to install, and very effective. After implementation employees almost always felt the improvement? If not, we would keep working at it.

As awareness and support increased, department budgets for ergonomic improvements also increased. Our solutions became much more creative. In our new facilities, engineers incorporated these improvements in the design phase; often resulting in higher productivity along with more ergonomically designed work places.

Medical Management

The Ergonomics Specialist worked closely with the Occupational Health Nurse and onsite Physical Therapist to help return partially disabled employees to the workplace. Aggressive medical management included pain surveys, early reporting of symptoms, onsite physical therapy, physical case management, an active modified work program, work hardening that transitioned employees into our health and fitness program, and close follow-up of employees with symptoms.

Joint evaluation of the worksite by the affected employee, the supervisor, the ergonomics specialist, an engineer, physical therapist, and/or occupational health nurses helped tailor the worksite specifically to fit the employee's capacities and restrictions. Engineering and work practice controls, administrative controls, and personal protective equipment were used to return the employee to work in his or her own or modified job. Any ergonomic changes made for partially disable employees were evaluated for transfer to other similar jobs.

Education and Training

In the first two years of the ergonomics program, education and training was focused on the ergonomics team, managers, and supervisors. Employees were brought into the process and educated as changes were made to their jobs. Employee insight, participation, and buy-in to any changes were critical. As the ergonomics program progressed, more and more employees were brought into the process.

Evaluation

An evaluation method was instituted to help measure ergonomic changes to ensure we ere making improvements. Although still being refined, we were able to document that in 1990 there were 373 modifications of ergonomic risk factors to 214 workstations in our manufacturing division (many jobs had more than one risk factor modified) that resulted in significant ergonomic improvements. (Rooney, 1992)

In our Distribution Division, much progress has occurred since the formal training in 1990. Many work processes have been analyzed, work stations retrofitted to be made operator adjustable, and material-handling aids installed. The ergonomic processes are well documented and methodology is being developed to quantify improvements. Ergonomics has successfully been incorporated in the upstream planning of our new facilities.

Engineers included numerous ergonomic changes in the design of the receiving and check-in function of anew warehouse (Herrick et. al., 1994). Not only were ergonomic risk factors and injuries reduced, overall productivity was increased as well.

Similar processes and evaluation methods have been developed and are being utilized in out 3,00 employee office areas. With simple changes to 542 workstations in 1991-2, users reported an average 84% improvement in their postural comfort after modifications. (Morency, et. al., 1993)

CONCLUSION

L. L. Bean has made much progress in the last few years but still has much to make. The company is facing stiffer competition in the 1990's. The responsibility is upon all in the company to continue to look for ways to increase the effectiveness and efficiency of our employees and work processes.

It was important for the company to embrace a comprehensive or macroergonomic approach because it is difficult to manage the rapid increases of cumulative trauma disorders and associated conditions with traditional ergonomics approaches alone. Many workplace and psychosocial and political factors have an influence. These factors are outside narrow ergonomic approaches that focus mainly on the physical characteristics of the workplace and its inhabitants. Adopting a macroergonomic approach, with Total Quality Management being one good model, help a company systematically address many of the factors implicated in the causes behind cumulative trauma disorder and associated conditions.

A macroergonomic approach will increase in importance as our workforce ages and as we bring more employees with partial disabilities into the workforce. (e.g. The American with Disabilities Act of 1990 legislates the employment of more partially disable Americans.) Ergonomics has the potential to save money in reducing the cost of poor quality (injuries/illnesses), boosting

productivity, improving the working lives of our employees, and helping to maintain the employment and productivity of partially disable employees.

We feel our major gains are coming from integrating ergonomics and our other loss prevention programs with total quality management. In this macroergonomic approach where organizational features and subsystems are affected along with ergonomic changes to specific jobs and work processes, much larger gains in injury/illness reduction can be obtained than from a narrow ergonomic approach alone.

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Figure 1: Employee Health Mission Statement

Employee Health Mission Statement

To work with area management and employees to achieve and maintain a health and safe workplace, and promote the health, safety, and fitness of employees.

OBJECTIVES:
- Reduce injuries and illnesses.
- Reduce time lost work due to injuries/illnesses.
- Increase overall health, fitness and related quality of life of employees.
- Reduce workers compensation and health care costs.

"RIGHT THINGS" TO ACHIEVE OBJECTIVES.

Prevent Occupational Injuries/Illnesses by:
- Ergonomic Design of Work Stations and Work Processes
- Health and Safety Education and Training
- Worksite Stretch Programs
- Safety/Industrial Programs
- Post Offer Medical Exams

Mange Occupational Injuries/Illnesses by:
- Case Management of disable Employees
- Onsite Physical Therapy
- Transitional Work / Permanent Reassignment for Disabled Employees
- Claims Handling

Prevent and Manage Those Non-Work Related Injuries/Illnesses with Great Negative Impact on Employees and L. L. Bean through:
- Health Risk Appraisals
- Health Classes and Programs

- Health Education and Counseling
- Benefit Bonus Credits

Provide Health and Fitness Programs for General Health Improvement:
- Health and Activity Classes
- General Fitness Assessments
- Four Regional Fitness Centers

Customer-Supplier Alignments with Key Areas

Compliance with Government Regulations