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# 30 Years of Ergonomics at 3M: A Case Study

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**Abstract.** The *added value of* the Ergonomics Program at 3M was found to be improved employee safety, compliance with regulations and reduction of work-related illness, increases in productivity, and quality and operating efficiency. This paper describes the thirty years of existence of this program. For the first twenty years, the program objectives were to: respond to requests for assistance related to work-related musculoskeletal disorder (WMSD) concerns, raise employee awareness of MSDs and ergonomics; educate engineers in ergonomics design; and develop ergonomics teams at manufacturing locations. Since the year 2000, 3M's Ergonomics Program has been in transition from a US-centric and corporate-based technical-expert-led program to a global program applying participatory ergonomics strategies within a macroergonomics framework. During that transition, the existing program requirements were revised, new methods and program tools were created, and expectations for implementation at the manufacturing locations clarified. This paper focuses on the company's manufacturing ergonomics program activities during the past ten years and includes specifics of the program's objectives, risk assessment reduction process, and ergonomics technical expertise development. The main benefit achieved throughout the company is reducing employee injury while also increasing productivity and operating efficiency.

Keywords: macroergonomics, microergonomics, ergonomics programs, corporate ergonomics, participatory ergonomics, MSD, WMSD

## 1. Introduction/Background

Most frequently the documented justification and purpose of a corporate ergonomics program is reduction of work related illness. However, at a very high level, the purpose and responsibility of a company's ergonomics program is to protect the assets of the corporation, including employee safety and health, production quality and productivity, and the company reputation [10], with the most common objective being the identification and management of work-related musculoskeletal disorders (WMSDs). This paper describes the history of the ergonomics program in a Fortune 500 Company and summarizes some benefits realized from the program results.

To identify and manage WMSDs, corporate ergonomics programs vary in design and in implementation based upon business need, organizational structure and operational objectives. However, most contain these basic program requirements[3,5,9,10]:

- Attaining management commitment
- Analyzing ergonomics-related risk and controlling the risk
- Developing technical expertise
- Training and including employees in the program

Historically, new ergonomics programs first utilize a reactive microergonomics strategy, focusing on improving an individual employee's workstation in response to the employee developing and reporting symptoms of a work-related musculoskeletal disorder (WMSD). Over time, many companies, realizing that more efficient and effective results are realized when employees and other business partners, such as engineering, quality, and management, are included

in id entifying and im plementing ergon omics so lutions and programs, transition to a more participatory approach [6]. Finally, some companies adopt a macroergonomics p rogram str ategy th at in cludes er gonomics ex pertise with in co mpanywide business objectives [5,9,10] (Figure 1).

| Strategy | Process and Scope | Measure of Success | Core Competencies | Organizational Location |
|---|---|---|---|---|
| **Micro-ergonomics** Unique solutions to individual problems. | Assess and implement solutions for infrequently occurring or unique ergonomics issues. Often initiated by specific employee request or need. Efforts are conducted locally to meet well-defined specific need. | Resolution of individual's MSD symptoms through workstation redesign or equipment changes. Success is dependent upon knowledge and skill of a technical expert to resolve ergonomics issues. | –Ergonomics Technical Expertise<br>–Training | Expertise provided as part of technical department or contract resource. |
| **Participatory Ergonomics** Collaborative efforts to create solutions to address ergonomics issues that cross department responsibilities. | Cross-functional teams, led by technical experts, identify and implement solutions to complex and interdependent ergonomics issues. Solutions focus on programs, training, and tools. Efforts are | Establishment or revision of processes, jobs, or programs to address cross-functional ergonomics issues. Success is dependent upon collaborative efforts to implement systems and processes, enabling | – Ergonomics Technical Expertise<br>– Management<br>– Leadership<br>– Development<br>–Training<br>Project<br>Collaborative<br>Program | –Leadership from a business or technical department.<br>–Internal or contract expert resource. |

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| | conducted across business organizations. | locations to achieve corporate-wide prioritized objectives. | | |
| **Macro-ergonomics** Strategic focus using ergonomics to achieve business objectives**.** | Create strategic policy, programs, and performance expectations for consistent application of ergonomics to support business objectives and achieve conformance to internal and external requirements. Typically instituted when ergonomics is recognized as an integral part of achieving business objectives and when there are efficiencies to be gained by | Implementation of sustainable, effective, and efficient policy, programs and standards that support ergonomics. Success is measured by achievement of corporate-wide goals and business objectives. | –Strategic Planning<br>–Systems and Program Development<br>–Compliance Assurance | Leadership, from department with global/ corporate responsibility. |

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| | gained by comprehensive, company-wide initiatives. | | | |

Fig. 1. Ergonomics Program Strategies [7]

## 2. Company History

### *2.1. 1980s – early 1990s: Microergonomics*

The 3M Ergonomics Program has followed this typical progression of ergonomics program development. Specific ergonomics technical expertise was added to the Industrial Hygiene Department in the early 1980s. For most of the next 10 years the focus was on raising awareness among all employees and middle and upper management of ergonomics and evaluating and making improvements to individual workstations and equipment in response to employee reports of signs and symptoms of WMSDs.

### *2.2. 1990s: Participatory Ergonomics*

The 3M Ergonomics Program expanded in the early 1990s, and specific requirements were established as part of the company's health and safety plan. At the corporate office, additional ergonomists were hired, and an ergonomics awareness and technical training program was created and deployed at all US manufacturing locations. The expanded program had clearly defined expectations regarding ergonomics for each US manufacturing location, and a formal ergonomics program and ergonomics teams were established. The ergonomics training was conducted by a cross-functional collaboration of corporate ergonomics, engineering, occupational medicine and industrial hygiene staff. The objective was to develop in-plant capability to identify and resolve ergonomics-related MSD injuries in the workplace. Costs and benefits were based upon reductions in workers compensation claims in the US. Technical expertise was provided by the corporate ergonomics staff.

There were positive results from this initiative and many improvements in workstation design throughout the manufacturing locations. Between 1990 and 2000 OSHA ergonomics recordable injuries were reduced by over 70% and lost-time cases reduced by 50%. Additionally, the average ergonomics-related workers compensation claim cost was reduced by over 50%, and lost-time claim costs reduced by 25%. Awareness of ergonomics was increased, but the location-based ergonomics teams were often challenged by frequent turnover and the lack of a uniform risk assessment tool.

### *2.3. Since 2000: Transition to Macroergonomics*

In 2000, two events happened that set the stage for another program transition. First, a Manager of Ergonomics position was created. And second, in response to OSHA's Ergonomics Standard, a thorough review was conducted of the company's program requirements and a survey of each manufacturing location was completed. The survey was developed to determine how well locations were implementing the program requirements in the following four categories:

- Ergonomics Written Program
- MSD Risk Management
- Ergonomics Expertise and Leadership
- Ergonomics Training

There were two key findings from the program review and implementation survey. First, the corporate program requirements were identified as being compatible with the OSHA Ergonomics Standard re-

quirement and would likely meet the standard requirements. Second, opportunities were identified for improving the consistency of ergonomics program execution among the manufacturing locations. These two findings resulted in a number of actions that have transformed the ergonomics program into a global program, fully implemented in over 180 locations, thereby setting the stage for macroergonomics strategies.

The actions occurred in two categories: technical changes and program changes. Technical activities included: identifying and adopting standard ergonomics risk assessment tools; establishing dedicated and knowledgeable location-based ergonomics resources to conduct the risk assessments and identify and implement appropriate controls; and creating and making available numerous ergonomics training programs. Ergonomics was more closely integrated into the company's Environmental Health and Safety (EHS) Management system. This integration included establishing and measuring a company-wide, five-year ergonomics goal that defined performance expectations and increased corporate oversight through a self-assessment system and participation in formal health and safety audits [8]. The following lists the technical tools developed and implemented during the past 15 years:

- 3M Intranet OfficeErgoHelp Website (1998)
- Ergonomics Solutions Database (1998)
- 3M Intranet Ergonomics Website (2003)
- Ergonomics Risk Analysis Tool (2003)
- Ergonomics Design Criteria Tool (EDC) (2005)

Program components include:

- Global Safety & Health Plan Element (1996)
- Ergonomics Innovation Award Process (2000)
- Ergonomics Program (2001)
- Ergonomics Metric (2004)
- Ergonomics in Engineering Design Criteria Standard (2006)

## 3. Management Commitment

Establishing a management position to lead the ergonomics program was one way the company demonstrated commitment both technically and organizationally to ergonomics. The manager's position, by definition, supports a macroergonomics strategy. The manager's responsibility is to: lead the development, coordination, and implementation of the ergonomics efforts at 3M locations worldwide; coordinate and manage work activities; identify ergonomics objectives and assist locations in meeting those objectives through development of programs and assessment tools; demonstrate improvements in employee well-being, production efficiency, and quality improvements; and conduct governance needed to verify locations have adequately met the company's ergonomics requirements. The management leadership position elevated ergonomics organizationally to be on par with other environmental, health, and safety programs. It also provided direct access to the Manufacturing EHS Committee, EHS Managers and Supervisors Leadership, and Engineering Council.

Ergonomics was also fully integrated into the company's EHS Management System. This meant ergonomics received the same oversight and visibility as the other environmental, health, safety, and industrial hygiene programs within the company. Oversight was conducted in three ways. First, each location completed an annual self-assessment review, reporting the status of their ergonomics program. Second, ergonomics was included in the formal auditing process when conducted at manufacturing locations. And third, an EHS Scorecard measured progress toward an ergonomics goal.

## 4. MSD Risk Management

While successful, the sustainability challenges of training ergonomics teams conducted during the 1990s demonstrated the need for a reliable and technically knowledgeable ergonomics resource at each manufacturing location. Since the vast majority of manufacturing locations had fewer than 400 employees, hiring professional ergonomists at each location was not always feasible. However, each location did have a professional safety and/or industrial hygiene resource. Our solution was to identify and standardize on one comprehensive ergonomics risk assessment tool that health and safety staff, as part of their formal job responsibility, could learn and accurately apply to identify ergonomics issues and implement effective solutions. The Ergo Job Analyzer (EJA) was adopted as the required comprehensive MSD risk assessment tool for use in all manufacturing operations.

### 4.1. EJA Tool

The EJA tool is based on information from leading ergonomics texts, research reports, and conference proceedings and is comprised of 40 elements commonly associated with MSD illness, in five general categories [1]:

- 1 medical-response element,
- 2 excessive demands indicator elements,
- 32 body-part ergonomics-risk elements,
- 4 environmental ergonomics-risk elements, and
- 1 cognitive ergonomics-risk element.

The assessment risk-exposure conclusions are based upon observation and direct measurement of tasks performed, which are then compared to the MSD risk exposure tables [1]. The risk tables categorize specific actions, such as carrying or bending, as high, moderate, low or OK MSD risk levels.

Based upon North American injury rates, a high-risk level indicates a 1:2 probability of a medically related case occurring annually. Thus, in a high risk job there is a chance of one worker reporting a medically related case every two years. For moderate risk it is 1:5 and for low risk a 1:20 chance of an annual, medically related case. [1].

### 4.2. Engineering Ergonomics Design Criteria

The EJA Tool is applied to jobs being performed by employees. However, ergonomics guidance for engineers while designing new equipment was also needed. The solution was to translate the EJA risk exposure criteria in to Ergonomics Design Criteria (EDC) that engineers could apply during the design of new equipment. The criteria were adopted into the company's engineering design standards. There are three primary advantages to having the same exposure considerations. First, ergonomics risk exposure categories would be the same for new and existing equipment. Second, EJA-trained resources and engineers could more easily collaborate by having a common "language" regarding ergonomics. Third, communications about the reduction of ergonomics risk were based upon the same criteria, allowing results to be more easily measured and communicated to management.

## 5. Location Resources Development

In support of the new Ergonomics Risk Reduction Process (ERRP), each location designated a health or safety person to become the EJA Resource, and corporate established an EJA training and certification process. The certification process is the quality assurance that the EJA tool is used accurately to identify unacceptable or high ergonomics risk exposure. Certification requires knowledge of biomechanics, physiology, anthropometry, and workstation design through completion of online training, submission of homework, and final testing. Then, attendance at a three-day hands-on EJA Workshop conducted at a manufacturing location is required. At the workshop, attendees learn about and apply the EJA Tool and learn how to use measurement tools (e.g., force meters, goniometers, and pinch gauges) and video to analyze jobs.

To complete certification, each EJA resource must submit evidence of accurately completed EJAs. Three jobs are submitted to the corporate staff for review. Each job must include a completed baseline EJA, risk exposure conclusions, and follow-up EJA verifying implemented changes were effective. To assist the corporate staff in the review, video of the job being performed is also provided. Certification is completed with the presentation of a Capstone Project. This presentation summarizes one job improvement project and includes the baseline risk assessment findings, solutions considered and chosen, cost/benefit analysis, and follow-up risk assessment conclusions. The capstone projects are presented at corporate-led ergonomics e-meetings, supporting sharing of best practices throughout the company.

## 6. Results

It was unnecessary for every job in every manufacturing location to be analyzed using the EJA Tool [3]. The Company's ERRP provided a framework to prioritize which jobs had the potential of unacceptable or higher gonomics risk (Figure 2). The Potential High Risk Job Pool (PHRJP) worksheet was created to help locations prioritize and create action plans. Each location completed an internal PHRJP worksheet, created a list of existing jobs with the potential of ergonomics-related risk, and created their own prioritization plan and implementation schedule. Consideration was given to: jobs with a history of

first aid or WMSD recordable cases in the past two years; employee complaints related to ergonomics; evidence of excessive job demands through use of conditioning or stretching programs or job rotation; or jobs that the health and safety staff considered to be the physically hardest jobs in the plant. Each location was responsible for completing the location's PHRJP, and the total number of jobs identified became the location's job improvement commitment for the five-year ergonomics goal.

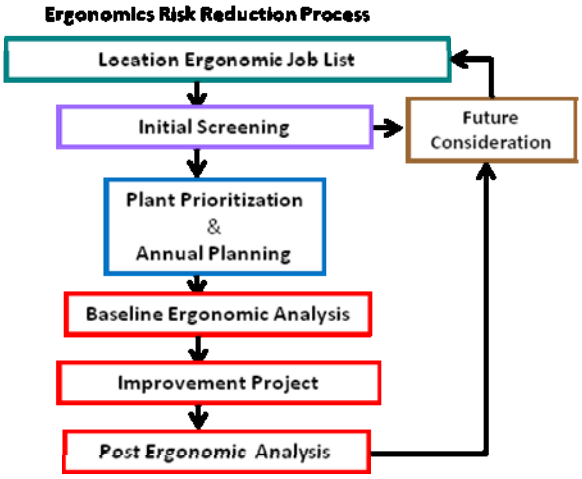


Fig. 2. Ergonomics Risk Reduction Process

### 6.1. Five Year Ergonomics Improvement Goal

In 2003, the company established a five-year ergonomics improvement goal to reduce by 75% the highest risk WMSD exposure by 2008, as measured by the EJA Tool. The number of targeted jobs for locations varied from 4 to 82 based upon the results of the location's PHRJP. And, based upon the location's targeted job number, quarterly performance was measured and reported on the company's EHS Scorecard.

### 6.2. Results

At the conclusion of the goal's 5-year period, 73% of the identified highest risk exposures were eliminated through implementation of a combination of work redesign, engineering controls, and administrative controls. In US locations since 2004 at the start of the period, there has been a 55% reduction in the ergonomics case incident rate, a 74% reduction in restricted-time case incident rate, and a 40% reduction in lost-time cases incident rate (Figure 3) from the rates in the late 1990s.

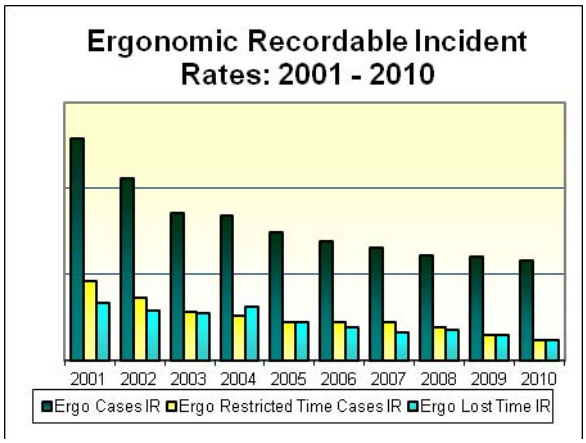


Fig. 3. Recordable Incident Rates from 2001 to 2010

### 6.3. Ergonomics Award

An internal company-wide Applied Ergonomics Innovation Award (AEIA) is a venue for sharing successful ergonomics improvements. The AEIA is an annual process recognizing the most innovative and successful ergonomics improvements in three categories: Best New Engineering Design, Best Adaptation of an Existing Workstation, and Best Solution for Less than $1,000. Submissions are judged by EJA-certified resources and corporate staff using the following criteria: risk reduction, innovation, sustainability and replicability of solutions. Costs associated with these award submissions break down into the following categories:

| | |
|---|---|
| $0 | 33% |
| $1 - $500 | 16% |
| $501 - $1,500 | 13% |
| $1,501 - $20,000 | 15% |
| $20,001 - $40,000 | 13% |
| Over $40,000 | 11% |

Many project submissions include productivity, quality, or operating efficiency improvement information. Over 500 award applications describing successful solutions are posted on the company's intranet EHS website and are available for all to reference.

### *6.4. Risk Assessment Data*

Over 2500 jobs have been analyzed using the standard job assessment tool. A detailed analysis of these jobs is being conducted. This analysis will include: identification of specific ergonomics issues by type of equipment and a better understanding of the correlation between specific physical action and WMSD injury. This understanding will provide clarity as to which risk exposures present the highest impact on employees' health and well being.

### *6.5. Reflection*

3M's Ergonomics Program has evolved during the past 30 years. The summary provided in this paper is not a controlled case study but is a representative case study of how one company's program transitioned from a microergonomics focus, responding to employee reports of discomfort and injury, to macroergonomics, integrating the program into associated business objectives. Results from the ergonomics program cannot be isolated from other internal business initiatives related to quality, product development and production or isolated from external impacts such as the global business climate. And certainly, these other events also influenced the results [13]. On the other hand, the ergonomics program was specifically focused on achieving these results and undoubtedly played a primary role.

## 7. Conclusion

The future of ergonomics in any company is dependent upon adding value to the company. This study shows the added value ergonomics contributes to the company in improving employee well-being as demonstrated by the reduction of WMSDs. However, identifying the influence that ergonomics has on productivity and quality improvements as well as operating efficiency is possible and necessary for the long-term viability of the program. A macroergonomics strategy is essential to the long-term viability of an ergonomics program and creates a value proposition beyond cost avoidance of WMSDs. When benefits are based solely on MSD illness reduction, programs will eventually lose value and may even fail to maintain management support. Ergonomics must demonstrate added value when incorporated into quality, productivity, and efficiency initiatives.

Macroergonomics, by definition, embraces collaboration across and within business partners. This cross-functional collaboration demonstrates the value of applying ergonomics knowledge to a partner's own business objectives and builds value to business productivity and improvements in operating efficiency and quality. Only then does ergonomics provide sustainable and significant value to business and become a core part of "how we do business."

## References

[1] Auburn Engineers, *Ergo Job Analyzer User Guide*, Auburn Engineers, 2003.

[2] Dul, J, Neumann, W, Ergonomics contributions to company strategies, *Applied Ergonomics*, 40, 2009, 745 – 752.

[3] GAO/HEHS-97-163 *Worker Protection: Private Sector Ergnomics programs Yield Positive Results,* Government Accounting Office, *1997.*

[4] Haro, E, Kleiner, B Macroergonomics as an Organizing Process for System Safety, *Applied Ergonomics*, 39, 2008 450-458.

[5] Hendricks, H Applying Ergonomics to Systems: Some Documented "Lessons Learned", *Applied Ergonomics*, 39, 2008 418-426.

[6] Herrera S, Huatuco, L, Human Factors and Ergonomics in Manufacturing & Service Industries 21 (3), 2011, 227-243.

[7] Larson, N, (2006). Macroergonomics in Global Corporations "Going Global" In O. Brown Jr. and H. W. Henrick (Eds.), *Human Factors in Organizational Design and Management – VIX.*

[8] Larson, N, (2008). Macroergonomics in Global Corporations "How to Get it Done" In O. Brown Jr. and H.W. Henrick (Eds.), *Human Factors in Organizational Design and Management – VIII.*

[9] NIOSH *Elements of Ergonomics Programs.* 1997.

[10] OSHA Ergonomics Program Standard 1910.900, Occupational Health and Safety, 2000.

[11] 3M Internet http://www.3m.com, 2010.

[12] US Dept. of Labor Ergonomics Program Management Guidelines for Meatpacking, U.S. Department of Labor. OSHA 3 123, 1993.

[13] Vink, P., Imada., A., Zink, K., Defining Stakeholder Involvement in Participatory Design Process, *Applied Ergonomics,* 39, 2008, 520 – 526.