Ergonomics Case Study:

The DOW Chemical Company's Use of the "Six Sigma" Methodology

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The Problem:

Reducing Musculoskeletal Disorders:

Ergonomics-related injuries, including musculoskeletal disorders (MSDs) caused by repetitive strains, continue to be a serious problem for employers. In 2002, ergonomics-related injuries accounted for a third of all workplace injuries involving missed work time, with an average absence of nine days per injury.[1] The resulting worker injury claims and loss of productivity are estimated to cost $13 to $20 million per year for U.S. employers.[2]

As computer workstation users spend more and more time at desktops, the risk of MSDs occurring has increased. Yet, as illustrated below, in many companies there are inherent difficulties and concerns associated with addressing this increased ergonomics risk.

For example, Tricia, the Environmental, Health and Safety (EH&S) Leader for the Specialty Chemicals Business of The Dow Chemical Company, wants to reduce MSDs among computer workstation users throughout her business' various divisions and operations. Before she can understand what changes to make in either the workstations or the work practices in those divisions, she must identify the root causes of MSDs among the operators.

Although she has some theories, Tricia does not know for sure what factors are causing or contributing to the employees' MSD complaints. Only by knowing the root causes can she implement with confidence controls that would achieve positive results.

Tricia also suspects, but is not sure, that many of the root causes of MSDs are the same across the different operations and divisions in her business. Because of constraints on both her budget and time, Tricia would like to design one basic program that is flexible enough to implement company-wide. She also knows that any reductions achieved under the new program must be sustained over the long term, and she is concerned that over time employees and managers will "backslide" on their commitment to the program and return to their ergonomically risky behaviors.

Fortunately for Tricia, she could refer to a similar project successfully undertaken by the Design and Construction function of The Dow Chemical Company, which is discussed in the case study below. This project, which utilized a problem-solving methodology called "Six Sigma," offered an innovative way to address Tricia's concerns for the development and implementation of a sustainable program to reduce MSDs throughout her business.

A Solution:

The Dow Chemical Company's Innovative Use of "Six Sigma":[3]

Avoiding ergonomics-related injuries is an important component of The Dow Chemical Company's ("Dow" or "the Company") overall emphasis on safety and health. Dow is a science and technology company that develops, manufactures and provides various chemical, plastic and agricultural products and services for customers in over 180 countries. In 1994, Dow adopted a set of voluntary 10-year EH&S goals to dramatically improve the Company's performance by 2005. These goals call for a reduction in the Company's reportable injury and illness rate by 90 percent to 0.24.

In 2000, the company identified an opportunity to improve its injury rate within the Dow Design and Construction business unit. Dow Design and Construction ("DDC") is responsible for managing the design and construction of Dow's facilities worldwide. Because DDC's approximately 1,250 workers (including employees and contractors) work primarily at desktop workstations, where they spend the majority of their time working at computer keyboards, they were increasingly susceptible to ergonomics injuries. While the

[1] March 2004 U.S. Department of Labor News Release regarding Bureau of Labor Statistics Survey of Occupational Injuries and Illnesses.
[2] "A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back," The National Institute for Occupational Safety and Health.
[3] This case study was developed from information provided by Karen Kearns, Industrial Hygiene Specialist, and Mark Spence, Manger, North American Health and Safety Regulatory Affairs, The Dow Chemical Company.

rate of ergonomics-related injuries among the DDC workers was low (only three were reported in 1999), the Company chose to make proactive improvements before ergonomic injuries increased in number or severity.

Dow's EH&S function decided to address ergonomic injuries at DDC using the "Six Sigma" problem solving methodology. Six Sigma is a disciplined, process-oriented approach to problem solving, adopted by Dow and many other companies, which emphasizes the reduction of defects in processes, products and services by applying a four-step improvement methodology. Because Six Sigma emphasizes sustainable results over short-term fixes, Dow has found it particularly useful for EH&S projects. Following the steps prescribed under Six Sigma, Dow developed a Six Sigma project team, which first defined the primary contributing factors to MSDs in the DDC function, and then sought to reduce those factors by 70 percent. While each of the four steps of the Six Sigma project are outlined below, a more detailed discussion of the Six Sigma methodology appears at the end of this case study.

Step 1: Measure

Once the Six Sigma project team developed its charter and defined its task, it then began by defining the current process. First, the team the sequence of events from workstation assignment to task performance and potential injury. They next identified a series of key variables affecting the process outcome that included:

- user attributes (such as daily time at workstations)
- user behaviors (including posture, force, and duration of use)
- environmental factors

In this phase of the Six Sigma method, the "defect"– a measurable outcome of the process for which improvement is desired – is defined. While the true "defect" for this process would be the occurrence of an ergonomic injury, there were so few at the start of the project that measuring a statistically significant improvement was going to be difficult. Therefore, the key process variables identified were taken as the "defect," and a goal of 70 percent improvement (reduction) in the baseline level was set for the project. Scored surveys of DDC workstation users were developed and conducted on the variables identified and used to measure the baseline defect level.

Step 2: Analyze

Accurately identifying the root causes of a problem, which in turn leads to more effective improvements, is an essential function of the Six Sigma methodology. Therefore, the project team next analyzed the collected survey data to determine differences in the workstations, work environments, user training, and behavior at the different DDC sites. The team then identified possible root causes underlying these variables using several of the Six Sigma tools and methodologies, including: brainstorming, 'fishbone' diagramming, a work performance matrix, and Antecedant-Behavior-Consequence and Balance of Consequences analyses. After developing a list of possible root causes, the team used additional Six Sigma tools and methodologies to identify probable root causes and validate them. For example, one possible root cause identified was a failure of the employee to recognize the importance of ergonomics compliance to his or her personal well-being. This root cause was validated by the employee survey, in which many of the employees expressed an attitude of "it won't happen to me."

Other key root causes validated through this process were the lack of adjustable furniture at some worksites and a lack of "ownership" in personal safety on the part of the employee. The team also determined that ergonomics was not emphasized by DDC to the same extent as other, more immediate, safety issues, such as the use of personal protective equipment in hazardous environments.

Step 3: Improve

After determining the most significant root causes through analysis and validation, the project team developed a series of improvements to correct the identified root causes, including both work-related and personal risk

factors. Workstation deficiencies were easily addressed by implementing a workstation upgrade plan. Elevating workstation ergonomics to the same level of importance as other personal safety and health issues was a more challenging improvement. However, the team elevated the focus on workstation ergonomics by improving awareness on the part of management and employees and by altering employee behavior and work habits through increased accountability.

The project team developed a novel approach to raising employee awareness by collecting a series of personal testimonials from other employees and posting them on the Company's intranet site. These testimonials were supplemented by more traditional communications, including regular work group safety meetings, training, and increased ergonomics resources. At each facility, the company also designated Ergonomic Focal Points and Ergonomic Contacts, DDC workers who volunteered to receive specialized training and be available as a first point of contact for ergonomic concerns and questions.

The team addressed employee behavior by providing feedback to individuals, creating a specific channel for early reporting of discomfort, and developing a health assessment program to address the early warning signs of potential MSDs. Employee personal accountability was addressed by implementing a "Safety First" mentality that stressed ergonomics as a key issue in personal safety and not a separate stand-alone topic.

These improvements are not static, but are a part of an ongoing ergonomics safety and health process. For example, while furniture improvements have been implemented, it is understood that the workstations will continually evolve to meet the employees' changing needs.

Step 4: Control

After the immediate improvements were implemented, the project team developed a long-term control plan designed to sustain the achievements. The control plan took the sequence of events which might contribute to an injury, as outlined in the Measure step, and added a series of performance standards, measures, responsibilities, and contingency plans. For example, in the original sequence, an employee was instructed to attend ergonomics training when starting a job, but there was no control measure to ensure this took place. Under the control plan, the employee is now required to attend the training within 30 days of job assignment, and the designated Ergo Contact at the job site is alerted and follows up with the employee if the employee fails to attend within that timeframe. Each step in the sequence has a similar control, ensuring that the improved process is followed long after the conclusion of the project.

Results of the Project:

DDC made immediate improvements in the identified risk factors, which have been reduced 64 percent since the baseline measurement and by more than 45 percent overall. These improvements have been well received by the DDC's management and workers, and employees are proactive in addressing discomfort and have a better understanding of the personal benefits of ergonomics. As improvements like these have been repeated throughout the Company, the severity of ergonomics injuries has declined. In 2001, 53 percent of the Company's ergonomic injuries resulted in lost work time or advanced medical treatment. However, in 2003, only 30 percent of ergonomic injuries were this severe; the remaining 70 percent of cases required only first aid or precautionary measures.This, in turn, has contributed to Dow's 2005 goal of reducing the Company's reportable injury and illness rate by 90 percent to 0.24.

Moreover, by virtue of the Six Sigma Methodology's emphasis on long-term control, the project has developed an ongoing process that will help the DDC sustain its immediate results and continue to improve. The positive results of this project have been shared with Tricia and other EH&S managers at other business units, leading to similar projects throughout the company.

Dow believes that using Six Sigma for EH&S projects such as these enables employers to develop program improvements based on measurement and analysis, rather than speculation, resulting in a more cost-efficient and sustainable fix that will yield benefits indefinitely. Rather than undertaking costly trial and error attempts

at solutions, the Company was able to identify the root causes of ergonomic injuries with confidence and make improvements to the ergonomics program in a systematic and sustainable way.

Six Sigma Methodology

The Greek letter sigma (ó) is used in mathematics to represent standard deviation, or how much a process varies from its average value. Under the Six Sigma methodology, deficiencies are described in terms of "defects" per million opportunities, with the score of 6ó equal to 3.4 defects per million opportunities. Six Sigma uses the following four-step process known as MAIC (Measure, Analyze, Improve, Control) to significantly reduce defects in processes, products, and/or services:

Step 1: Measure - clearly define the process to be improved and the "defect" for the project, and identify a clear and appropriate measure for the "defect."

Step 2: Analyze - determine the root causes of the defect.

Step 3: Improve - develop solutions to address the root causes and validate process improvement.

Step 4: Control - implement a long-term strategy to ensure that the improvements are sustained.

The methodology can be applied to any process that allows the measurement of benefits and improvements in defect reduction, whether in the manufacture of a product, the delivery of a service, the control of costs, or the management of injuries and illnesses.

Dow has adopted the Six Sigma methodology to accelerate the company's improvement in quality and productivity. Dow has expanded the use of the Six Sigma approach to help manage aspects of the Company's operations beyond production and quality, including the safety and health of its workforce. Some of the projects to which Dow has applied the Six Sigma methodology include:

- reduction of repetitive stress injuries
- reduction of motor vehicle accidents
- improved safety for visitors (especially contractors)
- site logistics risk reduction
- off-the-job safety process improvement

These projects have been key components of Dow's 2005 Environmental, Health and Safety Goals, which include reducing Dow's reportable injury and illness rate by 90 percent to 0.24.

As the example in our case study illustrates, Dow's Environmental Health and Safety (EHS) function has found the Six Sigma methodology particularly useful in identifying and validating root causes that are hard to discern because of their subjectivity, and in focusing improvements to an ergonomics program in ways that caused measurable improvements. Moreover, since the Six Sigma process includes implementation of controls to ensure that achievements are sustained over a long-term period, the Company expects to realize the benefits of its efforts for years to come.

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