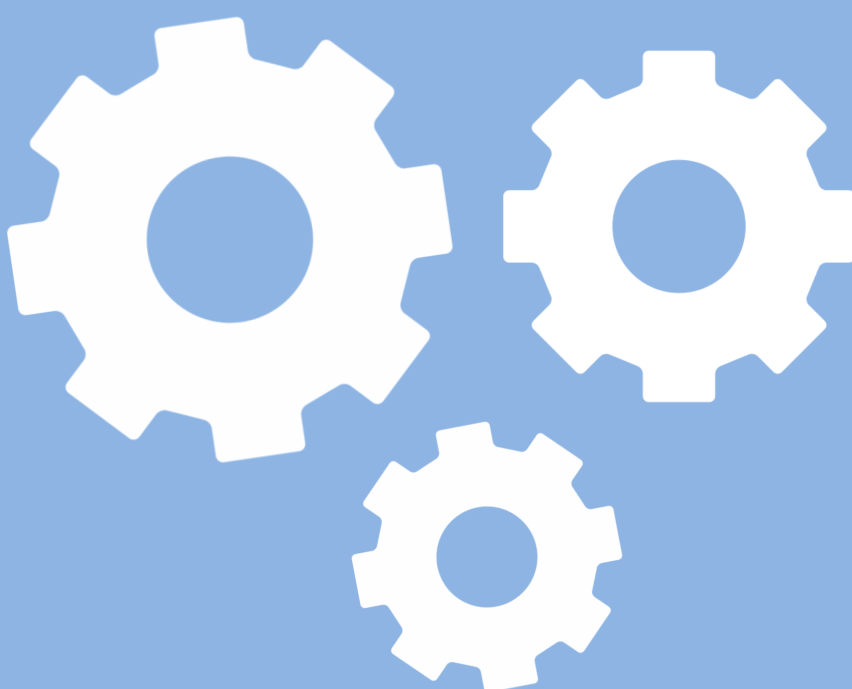
ERGONOMICS PLUS | Think **Prevention**

A Safety Manager's Guide to ERGONOMICS



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Understanding Ergonomics at Work

We believe a comprehensive "whole person" strategy is needed for effective injury and MSD prevention. **Why?**

Because a variety of risk factors are involved in the formation of MSDs, some of these risk factors are the responsibility of the workplace, while others are the responsibility of the worker. It's true that we make a mistake when we ignore individual risk factors that can lead to MSD, and fail to educate and motivate our team to know and accept responsibility for prevention. But it's also true that we can't afford to neglect our responsibility as health and safety leaders to provide a safe and efficient workplace for our team. Implementing a great ergonomic improvement process is a part of the company's commitment to building a culture of excellence in workplace health and safety.

Ergonomics Defined

Ergonomics is the science of designing work tasks to fit the worker, keeping in mind the capabilities and limitations of the human body. An effective ergonomic improvement process seeks to identify and eliminate any deterrent to maximum work capacity, and limit worker fatigue and discomfort while improving process efficiency and productivity.

Jobs and tasks that are frustrating, uncomfortable, or inefficient are typically not ergonomically correct.

- Ergonomic **problems** result in productivity, efficiency, quality, and safety **problems**.
- Ergonomic **improvements** result in productivity, quality, and safety **improvements**.

The **GOAL** of ergonomics is to prevent worker fatigue and discomfort that can lead to potential MSDs, and to make the company more competitive and successful in reaching its goals.

Good Ergonomics = Good Economics

There is great value in implementing an ergonomic improvement process!

Some of the benefits include:

- Lower injury rates and MSD incidences.
- Reduction in human costs associated with MSDs.
- Reduction in company direct and indirect costs associated with MSDs.
- Improved worker safety.
- Increased worker comfort.
- Reduced worker fatigue.
- Increased productivity from making jobs easier and more comfortable for workers.
- Improved product quality. Studies have shown a corresponding relationship between good ergonomics and improved product quality. On the other hand, poor ergonomics leads to frustrated and fatigued workers that don't do their best work.
- Reduced absences because workers will be less likely to take time off to recover from muscle soreness, fatigue, and MSD-related problems.
- Reduced turnover as workers are more likely to find an ergonomically designed job more satisfying and within their physical capacity.
- Prevention is a shared responsibility. When workers see that the company is serious about eliminating ergonomic risk factors in the workplace, improved worker morale will result and workers will be more likely to address the MSD risk factors under their control.
- Ergonomics plays an important role in building a culture of safety, health, and wellness.

How to Recognize Ergonomic Risk Factors in the Workplace

Recent studies in the field of ergonomics identify both occupational and non-occupational risk factors which lead to MSDs. The most important factor that results in the formation of MSD is the balance between local soft tissue fatigue and the individual's ability to recover from this fatigue. Sufficient blood supply is a critical factor in controlling local soft tissue fatigue. If an adequate supply of blood flow is maintained to the soft tissues performing work, metabolic balance can be sustained and excessive fatigue can be prevented. One important key to maintaining this critical balance is the relationship between work and human factors.

Ergonomic Risk Factors

Risk factors related to work activity and ergonomics can make it more difficult to maintain this balance, and increase the probability that some individuals may develop a MSD.

The major **workplace ergonomic risk factors** to consider are:

- High Task Repetition
- Forceful Exertions
- Repetitive/Sustained Awkward Postures

1. High Task Repetition

Many work tasks and cycles are repetitive in nature, and are frequently controlled by hourly or daily production targets and work processes. High task repetition, when combined with other risks factors such high force and/or awkward postures, can contribute to the formation of MSD. A job is considered highly repetitive if the cycle time is 30 seconds or less.

Control methods to consider:

- **Engineering Controls** – Eliminating excessive force and awkward posture requirements will reduce worker fatigue and allow high repetition tasks to be performed without a significant increase in MSD risk for most workers.
- **Work Practice Controls** – Providing safe & effective procedures for completing work tasks can reduce MSD risk. In addition, workers should be trained on proper work technique and encouraged to accept their responsibilities for MSD prevention.
- **Job Rotation** – Job task enlargement is a way to reduce duration, frequency and severity of MSD risk factors. Workers can rotate between workstations and tasks to avoid prolonged periods of performing a single task, thereby reducing fatigue that can lead to MSD.
- **Counteractive Stretch Breaks** – Implement rest or stretch breaks to provide an opportunity for increased circulation needed for recovery.

2. Forceful Exertions

Many work tasks require high force loads on the human body. Muscle effort increases in response to high force requirements, increasing associated fatigue which can lead to MSD.

Control methods to consider:

- **Engineering Controls** – Eliminating excessive force requirements will reduce worker fatigue and the risk of MSD formation in most workers. Using mechanical assists, counter balance systems, adjustable height lift tables and workstations, powered equipment and ergonomic tools will reduce work effort and muscle exertions.
- **Work Practice Controls** – Work process improvements such as using carts and dollies to reduce lifting and carrying demands, sliding objects instead of carrying

or lifting, and eliminating any reaching obstruction to reduce the lever arm required to lift the object.

- **Proper Body Mechanics** – Workers should be trained to use proper lifting and work techniques to reduce force requirements.

3. Repetitive/Sustained Awkward Postures

Awkward postures place excessive force on joints and overload the muscles and tendons around the effected joint. Joints of the body are most efficient when they operate closest to the mid-range motion of the joint. Risk of MSD is increased when joints are worked outside of this mid-range repetitively or for sustained periods of time without adequate recovery time.

Control methods to consider:

- **Engineering Controls** – Eliminate or reduce awkward postures with ergonomic modifications that seek to maintain joint range of motion to accomplish work tasks within the mid-range of motion positions for vulnerable joints. Proper ergonomic tools should be utilized that allow workers to maintain optimal joint positions.
- **Work Practice Controls** – Work procedures that consider and reduce awkward postures should be implemented. In addition, workers should be trained on proper work technique and encouraged to accept their responsibility to use their body properly and to avoid awkward postures whenever possible.
- **Job Rotation** – Job rotation and job task enlargement is a way to reduce repeated and sustained awkward postures that can lead to MSD.
- **Counteractive Stretch Breaks** – Implement rest or stretch breaks to provide an opportunity to counteract any repeated or sustained awkward postures and allow for adequate recovery time.

The Bottom Line

Systematically recognizing and controlling ergonomic risk factors is an important part of your company’s commitment to providing a safe place of work for all team members.

Ergonomic Considerations – Head to Toe

An ergonomics process systematically identifies and minimizes ergonomic risk factors.

Following are ergonomic considerations for different parts of the body, from head to toe. Each body part has its potential MSDs and ergonomic design principles for prevention.

Head / Neck

The nerves of the body enter the head through the neck. With such sensitive wiring passing through such a mobile structure, potential for problems is high.

Potential MSDs

- thoracic outlet syndrome
- tension neck syndrome
- cervical disc disease

Ergonomic Design Principles

- Allow for tallest workers
- Avoid forced forward head posture
- Natural posture is to look down slightly
- Avoid narrow viewing angles and visual obstructions

Shoulders

Shoulder MSDs are associated with postures that place heavy loads on its muscles and tendons.   Since the arm provides a very long lever, holding even small loads in the hand with the arm held away from the body will quickly result in shoulder fatigue and discomfort, and place substantial stress on the tendons in the shoulder.

Potential MSDs

- rotator cuff tendonitis
- bicepital tenosynovitis
- frozen shoulder syndrome

Ergonomic Design Principles

- Place items and parts between shoulders and waist height
- Avoid reaches above shoulder and reduce any excessive reaching
- Avoid greater than 45^{o} shoulder flexion and abduction

Elbows

The elbow is actually two different joints. It raises and lowers the arm (flexion and extension) and also acts as the pivot point for forearm rotation (pronation and supination). There are numerous vulnerable soft tissues (tendons, nerves, blood vessels) that pass though the elbow to reach the forearm and hand.

Potential MSDs

- lateral and medial epicondylitis
- radial tunnel syndrome
- cubital tunnel syndrome

Ergonomic Design Principles

- Normal work (medium weights) work surface designed to just below elbow height
- Precision work (light weights) raise surface above elbow height and provide upper extremity weight bearing support when possible
- Heavy work place work surface 6-8" below elbow height

Wrist / Hand

The wrist is an incredibly mobile joint that contains numerous tendons, nerves, and blood vessels, which service the hand and are vulnerable to MSD.

Potential MSDs

- tendonitis
- carpal tunnel syndrome
- ganglion cysts
- trigger finger
- DeQuervain's

Ergonomic Design Principles

- Maintain neutral posture
- Avoid repeated or sustained flexion and ulnar deviation
- Avoid repeated or sustained pinching and allow for small hands when designing gripping tasks and selecting hand tools
- Allow plenty of access space for large hands

Lower Back

The back is a flexible curved column composed of a series of bones (vertebrae) separated by shock absorbing discs. The structure is held together by a large number of muscles and ligaments. Acting together, they give the spine the ability to bend and twist. The spine protects the spinal cord and acts as a distribution center for the nerves.

Potential MSDs

- degenerative disc disease
- fatigue strains (muscle or tendon) and sprains (ligaments)

Ergonomic Design Principles

- Avoid repeated lifting that requires excessive forward bending
- Avoid sustained forward bending

Legs

Very little research exists on the relationship between work activities and lower extremity MSDs. However, there are some MSDs associated with the legs, and ergonomic design principles that we should keep in mind.

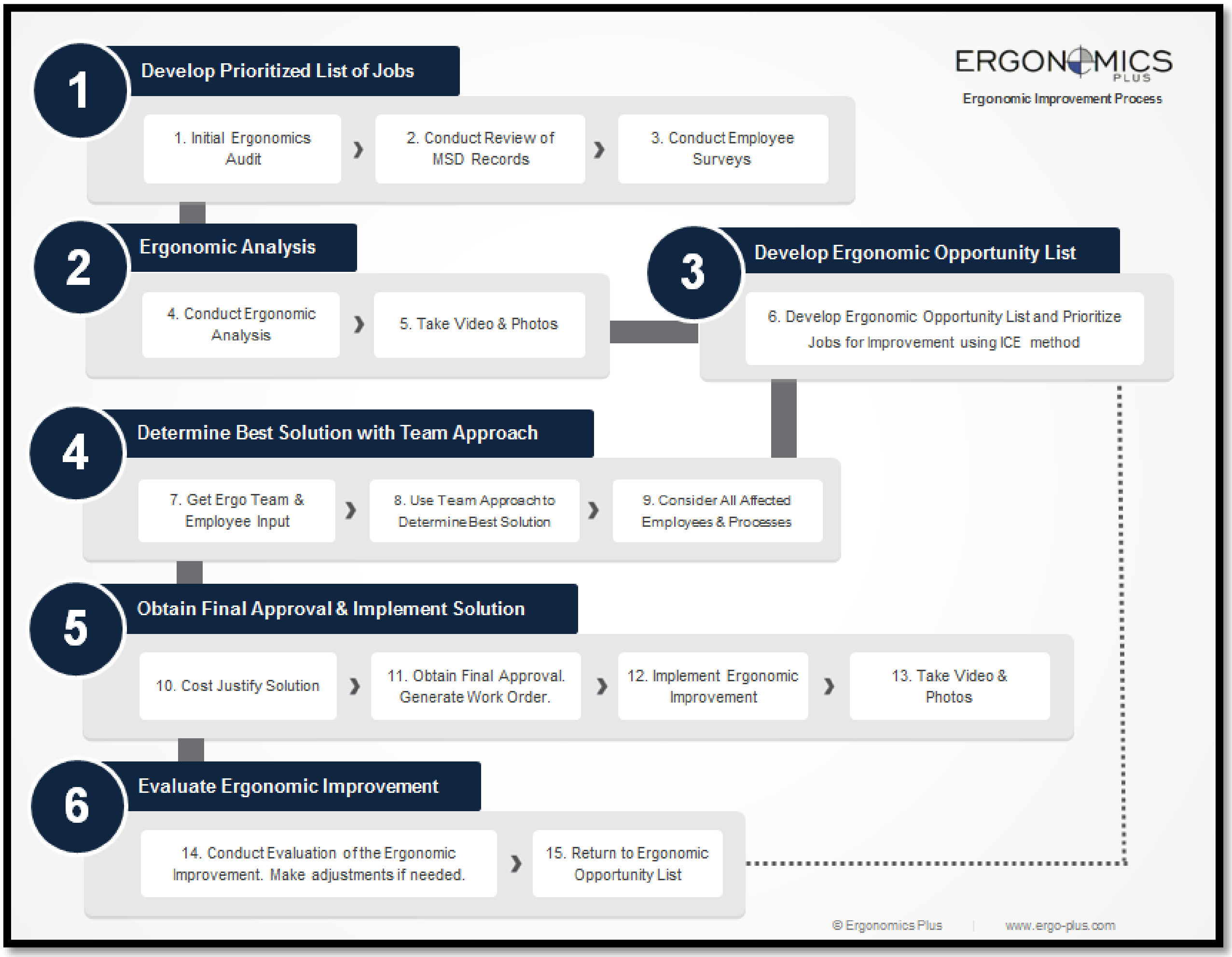
Potential MSDs

- plantar fasciitis
- tarsal tunnel syndrome
- Tailor's Bunion

Ergonomic Design Principles

- Avoid foot actuation if possible
- Avoid repeated walking up and down steps
- Avoid mechanical stress on the legs
- Allow for long legs
- Provide adjustments or footrests for shorter legs for prolonged sitting

Ergonomics Improvement Process



1. Develop Prioritized List

The first step in this process is to develop a prioritized list of jobs to analyze.

This prioritized list should be developed by the injury prevention specialist and the ergonomics improvement team based on:

1) An initial facility tour and general ergonomic walkthrough audit. This facility tour will give the team a general sense of the job demands in each area and allow the team to become familiar (if not already) and knowledgeable about area operations, work practices, and potential MSD risk factors.

2) A review of injury and MSD history. Existing injury information from OSHA logs, safety and medical records, insurance, and other information sources should be reviewed to help identify trends and departments or jobs with risk factors that may be contributing to injuries.

3) Data and information collected from employee surveys. The real experts for identifying ergonomic risk factors and improvement opportunities are… (insert drum roll here)… the people who perform the job each and every day! Employee surveys are a great way to gain perspective on ergonomic risk in the workplace.

Here is a sample survey:

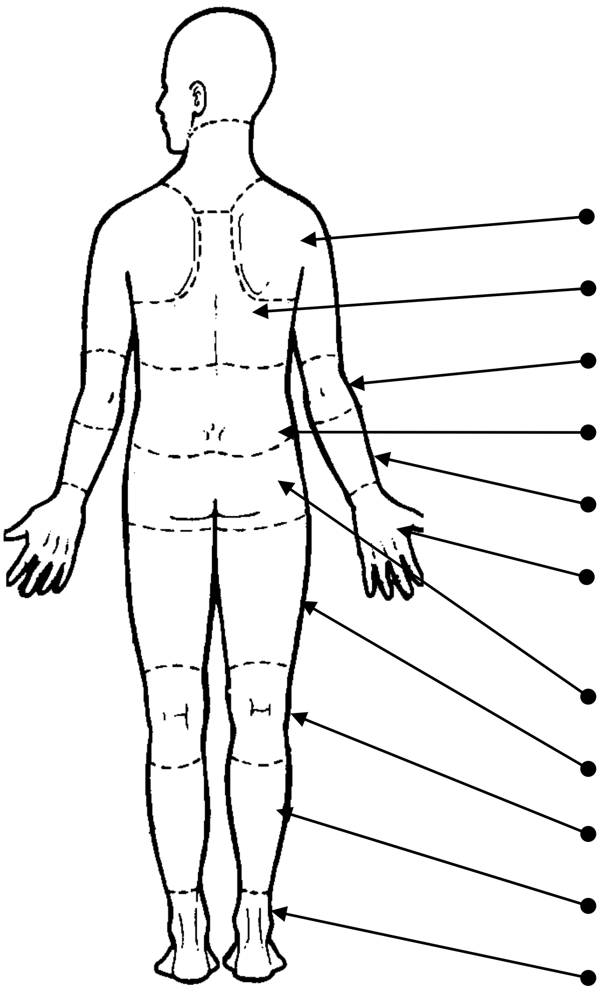
Employee Survey: Sample

Physical injury in the workplace is preventable!! The real expert for preventing wear and tear at work is **YOU**. You alone feel the physical stress of your job day in and day out. The following questions were developed to give you an opportunity to express your ideas or concerns regarding ergonomics. We would like to know if you think there are any ergonomic risks associated with your job, and what you think can be done to reduce or eliminate any risks. All information you choose to share will be kept ***confidential.***

Name (optional): ____

Department: __________ Job: _______________________________________

Do you experience excessive fatigue or discomfort in any part of your body as a result of your day-to-day work activities? For those body parts affected, please circle the score which you feel best describes your level of comfort (1 is the most comfortable and 5 is the most uncomfortable) when performing your job. If you never experience discomfort when performing your job, please check the not applicable (N/A) box.



	N/A	☺			☹	
Neck	❑	1	2	3	4	5
Shoulder(s)	❑	1	2	3	4	5
Mid Back	❑	1	2	3	4	5
Elbow(s)	❑	1	2	3	4	5
Lower Back	❑	1	2	3	4	5
Forearm(s)	❑	1	2	3	4	5
Wrist/Hand(s)	❑	1	2	3	4	5
Hip(s)	❑	1	2	3	4	5
Thigh(s)	❑	1	2	3	4	5
Knee(s)	❑	1	2	3	4	5
Lower Leg(s)	❑	1	2	3	4	5
Foot/Ankle(s)	❑	1	2	3	4	5

Page 2

Of the job tasks you perform in your job, list the ones that you feel have potential for excessive strain or fatigue. Tasks that include lifting, extended reaching, bending, gripping, or sustained standing, may be ones that cause you problems. Please use the following scale to rate the level of exertion you feel is required to perform this task.

0-------1-------2-------3-------4-------5-------6-------7-------8-------9-------10
light moderate hard very hard

JOB TASK **RATING**

1. ____
2. ____
3. ____
4. ____
5. ____

Please list any suggestions you have with regard to how any job or task can be made less physically stressful and easier to perform.

1. ____
2. ____
3. ____
4. ____
5. ____

Would you like to have the ergonomics team evaluate your work area and methods? Y or N

Do you have any other comments or suggestions that you would like to discuss?

____
____
____
____

Thank you for taking the time to complete this survey. We will use this information to determine work areas and practices that could contribute to excessive fatigue and discomfort. Our goal is to prevent injuries and provide the safest workplace possible.

Thank you!!

2. Ergonomic Analysis

After the initial prioritized list of jobs is complete, the next step in this process is to perform an ergonomic analysis of each job using objective ergonomic assessment tools.

Review of Recommended Ergonomic Assessment Tools:

1) Rapid Entire Body Assessment (REBA) - This tool uses a systematic process to evaluate whole body postural MSD and ergonomic design risks associated with job tasks. A single page form is used to evaluate required body posture, forceful exertions, type of movement or action, repetition, and coupling. A score is assigned for each of the following body regions: wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.

2) Lifting Calculator - Developed by the Washington State Department of Labor and Industries and based on NIOSH research related to the primary causes of back injuries. This lifting calculator can be used to perform ergonomic risk assessments on a wide variety of manual lifting and lowering tasks, and can be also used as a screening tool to identify lifting tasks which should be analyzed further using the more comprehensive NIOSH Lifting Equation.

3) NIOSH Lifting Equation – This is a tool frequently used by occupational health and safety professionals for a more comprehensive assessment (when compared to the WA State Lifting Calculator) of manual material handling risks associated with lifting and lowering tasks in the workplace. The primary product of the NIOSH equation is the Recommended Weight Limit (RWL), which defines the maximum acceptable weight (load) that nearly all healthy employees could lift over the course of an 8 hour shift without increasing the risk of musculoskeletal disorders (MSD) to the lower back.

4) Washington State Ergonomic and MSD Risk Assessment Checklist - This tool is designed to evaluate ergonomic risks factors including awkward postures, highly repetitive motions, high hand force, repeated impacts, lifting, and hand-arm vibration. The Caution Zone Checklist is used as a screening tool. If there are no positive findings identified, the job is regarded to be safe; otherwise a moderate risk is indicated and the job should be evaluated further using the Hazard Zone Checklist. Positive findings with the Hazard Zone Checklist indicate immediate actions should be taken to reduce the risk.

5) Liberty Mutual Manual Material Handling Tables (Snook Tables) - The Snook Tables outline design goals for various lifting, lowering, pushing, pulling, and carrying tasks based on research by Dr. Stover Snook and Dr. Vincent Ciriello at the Liberty Mutual Research Institute for Safety. The tables provide weight/force values, for specific types of tasks that are deemed to be acceptable to a defined percentage of the population. This is done by comparing data for each of the specific manual handling tasks against the appropriate table.

6) Rapid Upper Limb Assessment (RULA) - This diagnostic tool assesses biomechanical and postural load requirements of job tasks/demands on the neck, trunk and upper extremities. A single page form is used to evaluate required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist, and section B for the neck and trunk. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.

Note: As ergonomic assessments are completed, be sure to capture the current state by taking pictures and videos of the ergonomic risks that are identified by the evaluation process. These can be used later to compare and document ergonomic improvements that have been completed.

3. Develop Ergonomic Opportunity List & Prioritize Jobs for Improvement

The next step is to develop a list of ergonomic opportunities, and prioritize this list in order to select jobs for the improvement process.

Making ergonomic improvements in the workplace requires prioritizing actions. Decisions must be made regarding which jobs and processes to invest in and redesign. These decisions need to be based on business priorities. If you don't have a way to prioritize, precious time and resources may be wasted.

One way to prioritize jobs is to determine the severity of MSD risk. The ergonomic assessment will allow you to compare ergonomic action or design limits against the actual job task requirements. For example, the NIOSH Lifting Index (LI) is a method of determining severity of risk. The Lifting Index is calculated to provide a relative estimate of the level of physical stress and MSD risk associated with the manual lifting tasks evaluated by comparing the recommended weight limit (RWL) for lifting tasks with the actual weight lifted to perform the job in the current state. The higher the LI, the greater the MSD risk from the lifting task.

Taking it a step further, a very helpful tool that we've used effectively for setting ergonomic improvement priorities is the **"ICE"** prioritization tool. ICE is an acronym for the three factors that should be considered when setting priorities to direct the efforts of the ergonomics improvement team:

Impact – Can be measured in things like injury cost savings, increased productivity, enhanced quality, really any benefit derived from the proposed ergonomic improvement. What is the impact?

Cost - Cost must also be considered because it is a critical component of any operation. With limited funds, companies must choose wisely among various alternatives. Even the greatest idea might not be pursued if the cost is too high. What is the cost?

Effort - Should be considered in terms of resources available and time required. How difficult and time consuming will this be?

The ICE tool uses weighted values for each of these three factors to help establish priorities in an objective, straightforward manner. The higher the total of these values, the higher the priority.

ICE	Impact	Cost	Effort	**TOTAL**
High	2	0	0	
Low	0	1	1	

The tool uses a matrix format (see chart above) with impact, cost and effort appearing as column headings. Each of these factors must be evaluated and classified as either high or low. As you can see, if the impact is high, the numerical value is 2; if it is low, the numerical value is 0. In the next column, if the cost is high, the numerical value is 0; if it is low, the numerical value is 1. In the third column, if the effort required is high, the numerical value is 0; if it is low, the numerical value is 1. The rationale for valuing high impact greater than low cost and low effort is that an opportunity's perceived impact typically drives business decisions more than the other factors.

Adding the numerical values associated with each of the three decision factors can yield five different scores, which appear in the "total" box.

The highest possible score is 4, as shown here:

ICE	Impact	Cost	Effort	TOTAL
High	**2**	0	0	**4**
Low	0	**1**	**1**	

A score of 4 is classified as an extraordinary opportunity. It is considered extraordinary because it can generate a high impact with low cost and low effort. Such opportunities do not appear often, so they should be acted upon immediately.

The second highest score is 3, shown here:

ICE	Impact	Cost	Effort	TOTAL
High	**2**	**0**	0	**3**
Low	0	1	**1**	

An opportunity with an ICE score of 3 represents a strong opportunity that can generate a high impact with either low cost or low effort which should be acted on as soon as possible.

A score of 2 is shown here:

ICE	Impact	Cost	Effort	TOTAL
High	2	0	0	**2**
Low	**0**	**1**	**1**	

The mid-level priority score of 2 is an opportunity that provides either a high impact with a high cost and effort, or a low impact that can be achieved at low cost and effort. The chart above shows the scoring for a low impact opportunity with low cost and effort.

Any opportunities that score a 1 or 0 on the ICE prioritization tool likely should not be pursued in the near term. In fact, anything scoring 0 may never be pursued. However, the list of ergonomic opportunities with priorities should be kept in the event that technology, cost, business strategy or something else important to the organization changes in the future.

The ICE prioritization tool is useful for sorting through the ergonomic opportunities that have been identified and need to be accomplished, but compete for the same resources or a limited pool of resources. I would encourage you to consider adding ICE prioritization to your ergonomic improvement process.

4. Determine Best Solution with a Team Approach

After the ergonomic opportunities are prioritized, it's time to determine the best engineering or administrative controls to implement. This process takes a team approach.

Information and input should be gathered from affected employees, members of the safety and/or ergonomics team(s), supervisors, and process managers and/or engineers to determine the best solution to the problem that has been identified. All potentially affected job tasks, work processes, and employees should be fully considered when contemplating physical changes and control measures. It's important to ask and consider how any proposed engineering controls will affect the entire process, both upstream and downstream.

5. Obtain Final Approval and Implement Best Solution

If significant capital or human resources are required for the ergonomic improvement, you will need to obtain project approval from the management or leadership team. In these situations, it's important to make a compelling business case for the ergonomic improvement using cost justification to prove a return on investment (ROI).

To help quantify the value of ergonomics, the Washington State Department of Labor & Industries developed a very useful cost-benefit calculator based on epidemiological data. The calculator allows you to compare up to three ergonomic improvement options, and estimates the benefits and payback periods for each option. To learn how to use this cost-benefit calculator, see the section in this manual entitled **"Cost Justification for Ergonomic Improvements".**

6. Evaluate Ergonomic Improvement / Make Adjustments if Needed

Subjective

After the ergonomic improvement has been implemented, it's important to conduct a survey of all affected parties to obtain feedback to see if any adjustments are needed.

You can use a short survey to solicit the opinions and perspective of affected employees regarding the effectiveness of this ergonomic improvement.

Ask affected employees to rate the **level of physical exertion** required by this job task before and after the ergonomic change based on this scale:

0 ------- 1 ------- 2 ------- 3 ------- 4 ------- 5 ------- 6 ------- 7 ------- 8 ------- 9 ------- 10

very light light moderate very hard

Use a scale of 0 - 10. (0 - 2 = very little physical exertion required, 3 - 4 = light or minimal physical exertion required, 5 - 7 = moderate physical exertion required, 9 - 10 = heavy physical exertion required)

Physical exertion rating **before** ergonomic improvement: ___________

Physical exertion rating **after** ergonomic improvement: ___________

Ask for additional comments (positive or negative) from employee regarding ergonomic changes: Use survey results to determine if the ergonomics team should consider any modifications or further improvements to this job task or process. If no modifications or further improvement opportunities are necessary for this job, you are now ready to go back to the top of the prioritized ergonomic opportunity list for your next project!

Objective Evaluation

In addition to obtaining subjective information from employees, it's also important to conduct a repeat ergonomic assessment to objectively determine and document risk factor reduction or elimination. Review your original ergonomic assessment to determine the evaluation tools and methods that were used, and then repeat the assessment using the same tools and methods. This will give you an objective comparison that is apples to apples, and allow you to quantify reductions in MSD risk.

Cost Justification for Ergonomic Improvements

Many ergonomic improvements can be implemented with low capital expenditures. However, when an ergonomic improvement requires a larger capital expenditure, cost can become a barrier to implementation. In these situations, it's important to make a compelling business case for the ergonomic improvement using cost justification to prove a return on investment (ROI).

To help quantify the value of ergonomics, the Washington State Department of Labor & Industries developed a very useful cost-benefit calculator based on epidemiological data. The calculator allows you to compare up to three ergonomic improvement options, and estimates the benefits and payback periods for each option.

Step-by-Step Directions

The calculator is intended to be used under the following conditions:

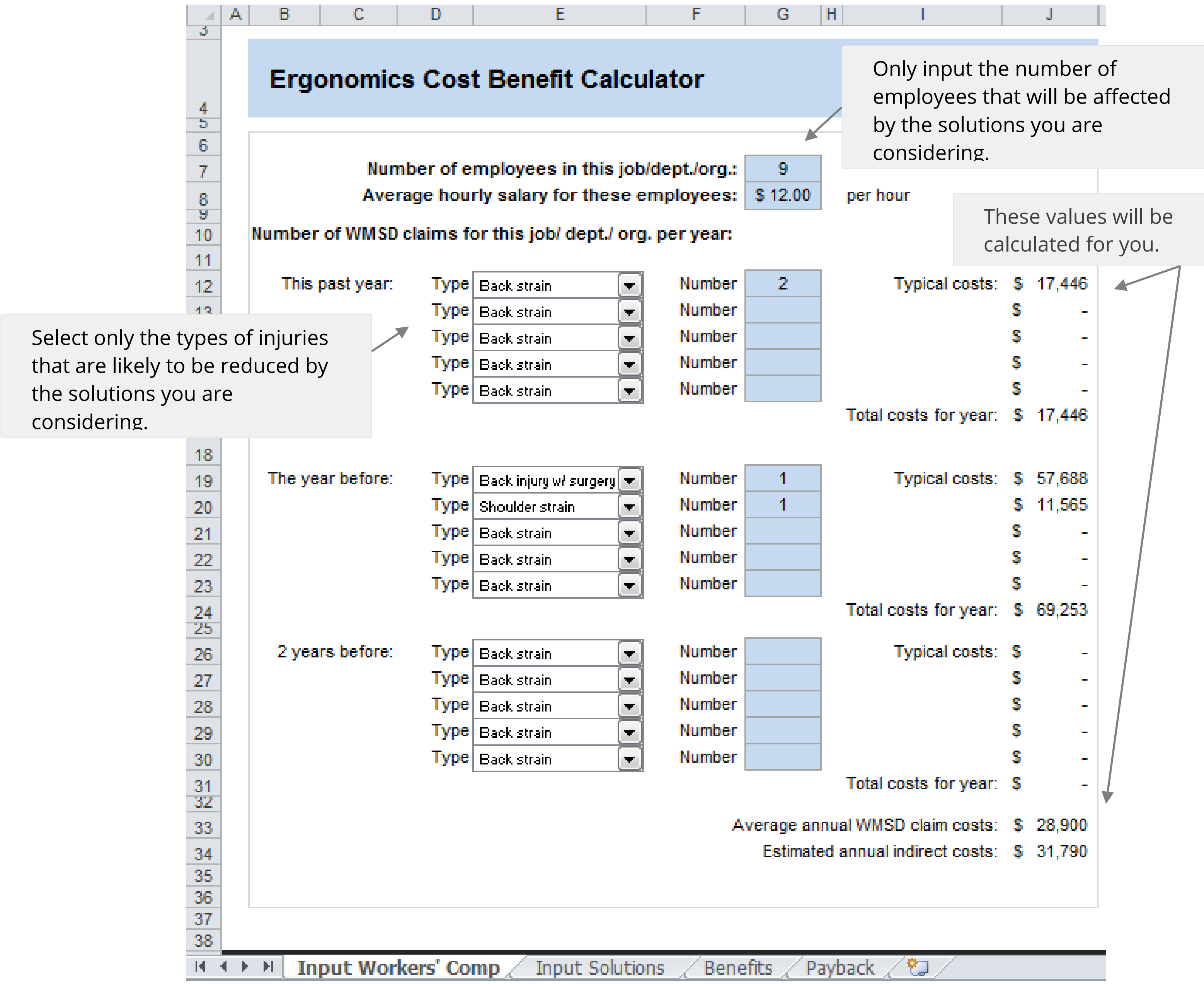
- Your company directly pays the costs of workers' comp claims (i.e., self-insured).
- You have an active ergonomics program and you pretty much know what you're doing.
- You're considering implementing one or more ergonomics solutions to address specific problems (e.g., back and shoulder injuries from lifting).
- You'd like to evaluate a few different options.
- You're expecting a payback period of less than one year. (The payback period is the time that it takes for the benefits of a solution to pay for the costs of implementing it. Most ergonomics solutions have a payback period of less than one year.)

(Scroll to the bottom of this section for a more complete listing of the calculator's assumptions)

Step 1: Input Worker's Comp

The first step is to enter the number of employees affected by the ergonomic improvement, their average hourly salary and each injury associated with the job. The rest of the spreadsheet will be calculated for you.

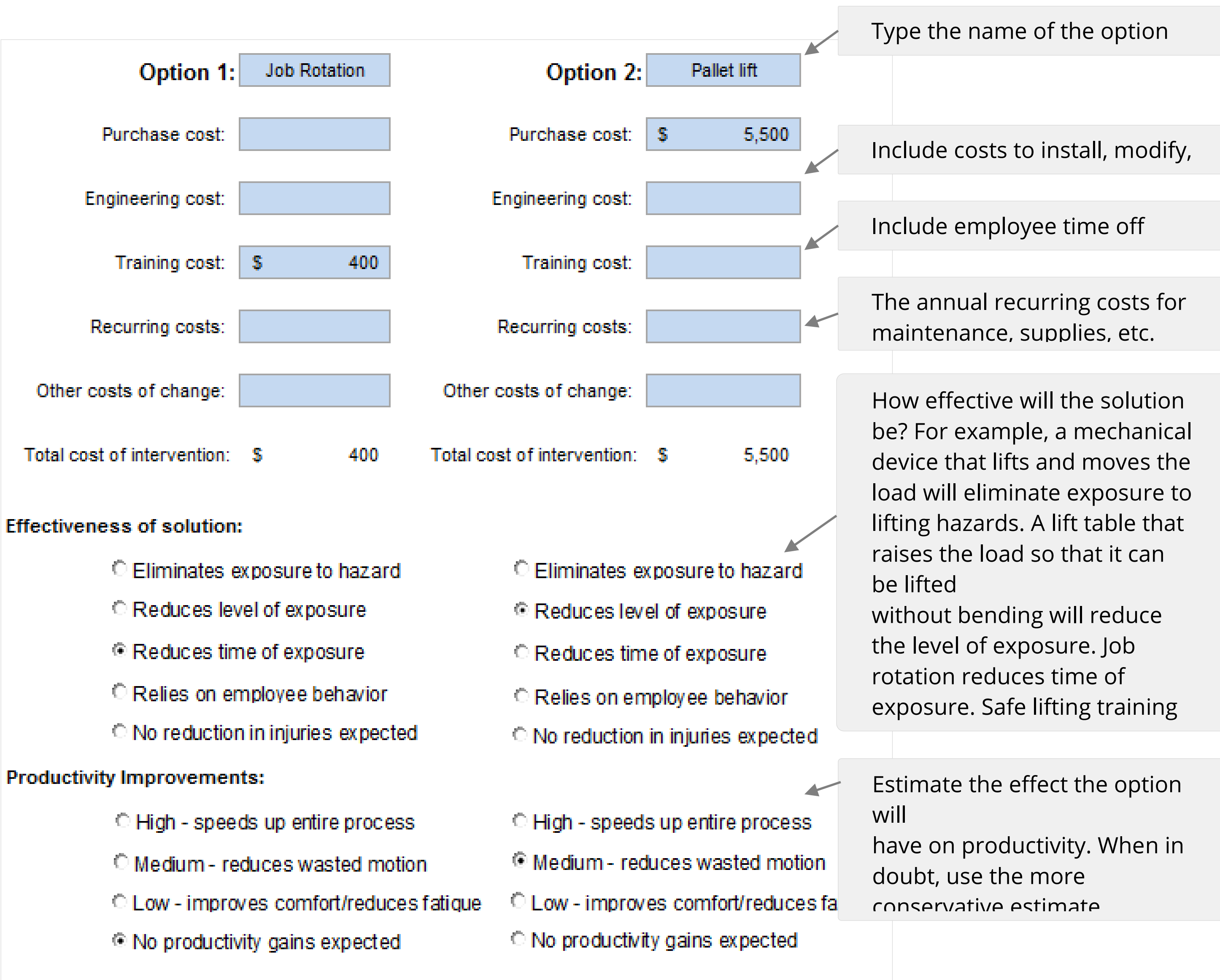
An example is pictured below:



Step 2: Input Solutions

Step 2 is to input details of the solutions you are considering as well as the estimated effectiveness and productivity improvements of the proposed solutions. The calculator allows for up to three options.

An example is pictured below:



Step 3: Benefits

Estimated benefits from the solution options that you input are calculated automatically and presented in the 'Benefits' tab. Total estimated annual savings are the potential savings the first year after implementing that solution option. Estimated savings over three and five year periods are also calculated. The cost of

Estimated benefits for solution options

Option 1	Job Rotation	
Reduction in claims:		15%
Reduction in workers' comp costs:	$	5,780
Reduction in indirect costs:	$	6,358
Increase in productivity:	$	-
Other estimated savings:		
Total estimated annual savings:	$	12,138
Total estimated savings over 3 years:	$	36,414
Total estimated savings over 5 years:	$	60,689

Option 2	Pallet lift	
Reduction in claims:		40%
Reduction in workers' comp costs:	$	11,560
Reduction in indirect costs:	$	12,716
Increase in productivity:	$	9,180
Other estimated savings:		
Total estimated annual savings:	$	33,456
Total estimated savings over 3 years:	$	100,367
Total estimated savings over 5 years:	$	167,279

implementing the solution is not subtracted out (i.e., these are *not* net savings). Estimated net savings are shown on the 'Payback' tab.

Productivity Improvement Estimates	
Level of Increase	**Percent Increase**
High - speeds up process	10%
Medium - reduces wasted motion	5%
Low - improves comfort / fatigue	3%

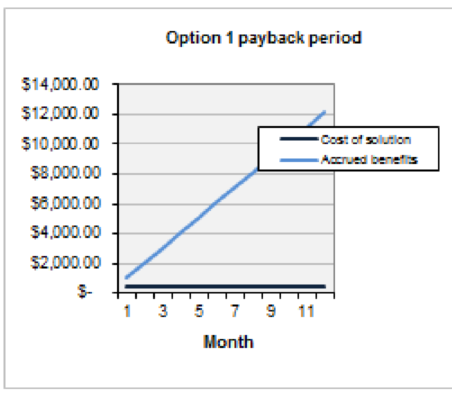
Solution Effectiveness Estimates	
Type of Solution	**Reduction in claims**
Eliminates exposure	70%
Reduces level of exposure	40%
Reduces time of exposure	15%
Relies on behavior	10%

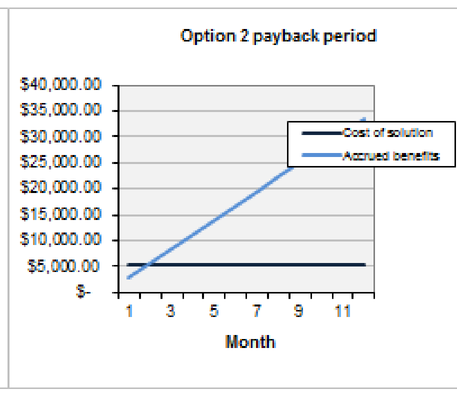
Step 4: Payback

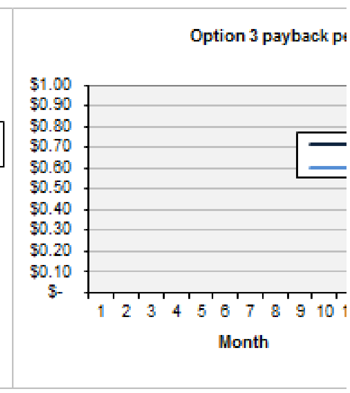
Total costs, total benefits, and net benefits for the first year are shown on this tab. The payback period is calculated, and shown graphically for each option. Most ergonomic solutions have payback periods of less than one year. If you find a payback period that is significantly greater than one year, you should use a cost-benefit calculator that allows you to factor in depreciation and a discount rate.

Payback Period

	Option 1	Job Rotation	Option 2	Pallet lift	Option 3	
Total first-year cost of control:	$	400	$	5,500	$	-
Annually recurring costs:	$	-	$	-	$	-
Estimated annual benefits:	$	12,138	$	33,456	$	-
Estimated payback period:	0.03	years	0.16	years	-	years
Estimated net benefits after 1 year:	$	11,738	$	27,956	$	-
Estimated net benefits after 3 years:	$	36,014	$	94,867	$	-
Estimated net benefits after 5 years:	$	60,289	$	161,779	$	-







Calculator Assumptions

Intended Use:

- Self-insured company.
- Implementing solution(s) in defined area (i.e., not a company-wide program).
- Company has active ergonomics program with all recommended elements and solutions will be effective.
- Can compare up to three options.
- Expecting payback in less than one year (i.e., not considering depreciation, discount rate).

Injury costs:

- Average costs from 2004 SHARP report on WMSDs.
- Average costs used instead of actual company costs because recent injuries may not have incurred eventual total
- Cost of claim.
- Three years of experience used to be consistent with workers' comp.

Indirect costs:

- From OSHA e-tool: http://www.osha.gov/SLTC/etools/safetyhealth/mod1.html
- Less expensive claims have proportionally higher indirect costs.
- $0 - $2,999 = 4.5 x claim cost
- $3,000 - $4,999 = 1.6 x claim cost
- $5,000 - $9,999 = 1.2 x claim cost
- $10,000+ = 1.1 x claim cost

Effectiveness of solutions:

- Based on Oxenburgh's (1991) assumptions & review of 250 case studies of ergonomics interventions.
- Effectiveness estimates were taken from the low end of the range to be conservative.
- Solutions that eliminate hazard (e.g., lift equipment, semi-automation) 70% effective.
- Solutions that reduce level of exposure (e.g., adjustable workstations, reduced weight of lift) 40% effective.
- Solutions that reduce time of exposure (e.g., job rotation) 15% effective.

- Solutions that rely on employee behavior (e.g., training only, team lifting) 10% effective.
- Percentage reduction in claims = percentage reduction in claims costs = percentage reduction in indirect costs.

Productivity benefits:

- Employers pay for 2,000 hours per year per worker, at $x.xx per hour.
- Workers are not 100% productive, and may be only 85% productive or less under non-optimal work conditions.
- Ergonomics solutions can help to regain some of the lost 15% productivity by improving work conditions and
- Increasing efficiency.
- Median increases in productivity for successful controls from the case studies in the 15% to 20% range, but how
- Productivity measured not known, probably varies widely.
- Conservative estimates were chosen.
- High productivity increase – 10%, medium = 5%, low = 2.5%.
- Value of productivity equal to annual cost of worker salaries multiplied by percentage increase in productivity.

Design with Ergonomics in Mind

Management commitment to MSD prevention involves both reactive and proactive ergonomics. To this point, we have discussed an ergonomic improvement process that is reactive in nature. Although evaluating and improving existing work task and process design is important, certainly the most cost-effective approach to workplace ergonomics is to establish a robust proactive program. A proactive approach to ergonomics emphasizes primary prevention of MSD through recognizing, anticipating and eliminating risk factors in the design and planning stages of new work processes. Can you answer "yes" to the following questions? If not, you have some work to do in making your ergonomic improvement process proactive.

1) Have engineers responsible for work process design received special training on MSD prevention and ergonomics?
2) Are the ergonomics specialist and/or ergonomics team involved in new process development and design?
3) Do engineering specifications exist for new and modified equipment, jobs, and processes?
4) Is ergonomics specification approval required prior to capital expenditure and/or implementing new work production processes?
5) Are affected employees involved in the design process?
6) Is consideration given to affected upstream and downstream production processes?

The following checklist is designed to help engineers and those involved in process design evaluate what is needed and should be considered for a good ergonomic workstation design. Note: This checklist is unable to anticipate all variables and complexities and all possible combinations of people, work tasks, equipment, and work environment. Please recognize these limitations. However, use of this checklist, along with an understanding of the principles of ergonomics, will give you guidance on workstation design to maximize productivity and minimize employee fatigue and discomfort that could eventually lead to a MSD.

Industrial Ergonomics Design Checklist

Lifting & Material Handling Design

Can the vertical height of material handling be designed to be adjustable to the optimal handling heights for each worker? If not, are workers able to accomplish manual material handling tasks in an acceptable vertical range as determined by the NIOSH Lifting Equation?

Are mechanical lifts and turntables used where feasible?

If adjustability is not practical, are the material handling and lifting tasks performed in a vertical height above the knees and below shoulder level?

Can the horizontal distance between initial and final points of lifting tasks be decreased? Or, can the start of the lift be moved closer to the worker's body? When reaches exceed 16", lifting and holding should be replaced with sliding if possible. Or, a mechanical lifting or assist device should be considered. If sliding or a mechanical assist is not feasible, the vertical height should be no greater than the optimal height. In many cases lowering the vertical height to the lower end of the acceptable vertical range can significantly reduce the stress on the arms when excessive reaching is required.

Can the shape of any containers be changed to allow material handling with the load held close to the body?

When objects are to be lifted and transferred between two points in the sagital plane (front to back), can the distance be adjusted to where no twisting without an opportunity to pivot is required? Critical distances are 24 to 48 inches; repeated lifting with 180 degree twisting and turning without foot pivoting should be avoided in this critical distance range.

Can hoists, cranes, conveyors, work carts, or other types of material handling devices be used for transporting heavy and bulky components within and between workstations?

Workstation Design

Can the worker be seated or can a sit/stand option be provided? Consider a seated or sit/stand workstation for high repetition and low force work with minimal reaching and movement requirements.

Is the height of the work surface adjustable?

For standing workstations, is the hand working height for normal assembly tasks between 36” and 48” (optimal fixed height = 42”)?

For standing workstations, is the hand working height for smaller precision assembly tasks between 40” and 52” (optimal fixed height = 46”)?

Can workers perform job demands with arms and elbows close to the body and wrists in a neutral position? Are there any physical obstructions that increase the reaching requirement?

Are seated workers provided with a good ergonomic chair or stool with adjustability, lumbar support and swivel features?

Can sustained static muscular work be avoided? Can elbow, wrist, arm, foot, and backrests be provided where needed to avoid static work?

Are materials supplied in a logical sequence?

Is there proper lighting for the task? Is task lighting provided where needed?

Are anti-fatigue mats provided for standing workstations?

Is the space adequate for the smallest and largest worker for reach and clearance?

Hand Tool Design

Are hand tools operable with straight wrist position?

Are hand tools powered where feasible?

Are hand tools counter balanced if weight is excessive? (Power grip tools should weigh < 4.0 lb., precision grip tools should weigh < 1.0 lb.)

Are hand tools equipped with handles shaped to contact as much of the hand and finger as possible? Do tools have a grip span between thumb and forefinger of less than three inches? (Optimal power grip span is 1.25 inches for males and 1.75 inches)

Are hand tools designed to eliminate sharp edges or ridges that might impair circulation or exert pressure on the nerves, and to eliminate pinch points?

Are hand tools designed to keep vibrations, torque, and “kick” within limits outlined in the Ergonomics Plus HAV evaluations and control guide?

Are hand tools designed to direct any cold air exhaust away from the hand?

Are hand tools designed to keep noise level within OSHA approved limits?

Visual Displays

Is the display correctly located for good posture, easy arm and foot reach, and clear viewing for all workers?

Can required data be easily and quickly obtained?

Is data readily visible without requiring awkward head/neck postures?

For standing workstations, is the top line of the screen within the acceptable range of 58" – 71" above the standing surface?

For seated workstations, is the top line of the screen within the acceptable range of 35 – 46" above the floor surface?

Is the viewing distance between 18" – 30"?

Is the pointer simple and non-obstructive?

Are displays located near its corresponding control?

Controls

Are controls within easy operating reach and operable with good posture such as wrists neutral and elbows close to the body?

Are push buttons or switches used repetitively for machine start cycle designed ergonomically to eliminate excessive force (greater than 3.4 lb.) and holding time (greater than 1.5 seconds)? If not, can the buttons or switches be replaced with a door switch? If not, can the buttons be replaced with an ergonomic cycle switch that requires no force to activate?

Does the control design conform to function?

Are levers used for continuous adjustment?

Are hand controls used for precision and speed?

Are foot controls used for power?

Is the control function logical? For example, does the leftward control movement give leftward unit movement and vice versa?

Do similar controls have similar functions?

Are controls shape-coded for good grip and easy identification?

Are controls consistent with population stereotypes?

Are controls labeled clearly?

Are controls color-coded between machines, operation, and departments?

About Ergonomics Plus

Ergonomics Plus was founded in 1989 as a one-man operation with the mission of preventing costly and painful musculoskeletal (soft tissue) injuries and improving human performance for local companies. Since those humble beginnings, we've grown into a nationwide consultancy, helping thousands of people across the United States remain healthy and productive at work every day.

Although we continue to grow and evolve as a company, our mission has never changed: We're dedicated to helping you and the workers at your company achieve high levels of human performance.