# TABLE OF CONTENTS

**Agenda**  
Objectives  
Follow-up activities  
Action plan  
Resources  

**Tab 1**  
Introduction  
What is ergonomics?  
Where does ergonomics come from?  
Acute versus cumulative injuries  
CTD  
Applications for ergonomic principles  

**Tab 2**  
Why ergonomics?  
Labor benefits  
Management benefits  
Injury trends  
CTD recognition  
Cost  

**Tab 3**  
Anatomy & physiology  
Definitions  
Common CTDs  
Back injuries  
Blood flow  
The spine  
Different kinds of spinal injuries  

**Tab 4**  
Risk Factors  
Historical/Trend analysis  
Definitions  
Repetition  
Forceful exertion  
Direct mechanical pressure  
Static posture / insufficient rest  
Awkward posture  
Environmental stressors  
Risk factor synergy  

**Tab 5**  
Problem Evaluation  
Worksite analysis methods  

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Revised: September 2005
<table>
<thead>
<tr>
<th>Tab 6</th>
<th>Ergonomic controls</th>
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<td>Design strategies</td>
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<table>
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<th>Appendices A &amp; B</th>
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| Tab 8 | One-hour Safety Presentation |
AGENDA

8:30  Introduction to class

Tab 1  Introduction
      What is ergonomics?
      Where does ergonomics come from?
      Acute versus cumulative injuries
      CTD
      Applications for ergonomic principles

Tab 2  Why ergonomics?
      Labor benefits
      Management benefits
      Injury trends
      CTD recognition
      Cost

BREAK

Tab 3  Anatomy & physiology
      Definitions
      Common CTDs
      Back injuries
      Blood flow
      The spine
      Different kinds of spinal injuries

Tab 4  Risk Factors
      Historical/Trend analysis
      Definitions
      Repetition
      Forceful exertion
      Direct mechanical pressure
      Static posture / insufficient rest
      Awkward posture
      Environmental stressors

12:00 – 1:00  LUNCH

1:00  Risk Factors (continued)
      Review of risk factors
      Risk factor synergy

Tab 5  Problem Evaluation
      Worksite analysis methods

BREAK

Tab 6  Control Strategies
<table>
<thead>
<tr>
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<th>Ergonomic controls</th>
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<td>Administrative actions</td>
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<td></td>
<td><strong>Conclusion and questions</strong></td>
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<td></td>
<td><strong>Evaluation</strong></td>
</tr>
</tbody>
</table>

4:30 **DISMISS**
Course Objectives:

♦ Basic awareness of ergonomic applications in the industrial workplace;
♦ Ergonomic risk factors;
♦ Basic control measures and design principles as they relate to risk factors;
♦ Selling ergonomics to the whole organization;
♦ Regulatory information and applicable ergonomic guidelines.

Follow-up Activities:

♦ Reduce injury or discomfort through applying ergonomics principles back in the workplace.
♦ Share information from the class with co-workers.
♦ Use the ergonomics materials from the student manual in my workplace.
♦ Present the one-hour presentation to co-workers.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Other people involved</th>
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</table>
Resources Available from the Division of Safety & Hygiene (DSH) Libraries
(800) 644-6292      (614) 466-7388
library@bwc.state.oh.us
www.ohjobwc.com

Safety training:
- Safety talks, outlines and scripts - DSH Safety leader’s discussion guide, Training Center’s One-hour safety presentations, reference books, web resources
- Videos – hundreds of safety and health topics
- Books and articles on training techniques

Machine and equipment safety:
- Safety standards (ANSI, NFPA, CGA)
- Books and articles on power presses, material handling equipment, lockout/tagout, etc.

Sample written programs:
- DSH program profiles and sample written programs
- Reference books
- Internet resources

Illness and injury statistics:
- Statistics from the U.S. Bureau of Labor Statistics
- National Safety Council’s Injury Facts
- National Institute of Occupational Safety & Health (NIOSH) studies

Hazard communication and chemical safety:
- Chemical safety information
- Material safety data sheets (MSDSs)
- Sample written programs
- Videos
- Internet resources

Safety standards
- American National Standards Institute (ANSI) standards (including standards for construction, machinery and equipment, personal protective equipment)
- National Fire Protection Association (NFPA) fire codes (including the Life Safety Code and the National Electrical Code)
- Compressed Gas Association (CGA) standards

Other topics of interest (books, articles, magazines, videos and standards):
- Confined spaces
- Electrical safety
- Job safety analysis
- New employee orientation
- Powered industrial trucks
- Respiratory protection
- Safety culture
- Scaffolds

Directories and lists of vendors of safety equipment

Occupational Safety & Health Administration (OSHA) regulations

Manual of Uniform Traffic Control Devices (MUTCD)

Recommendations of useful Internet sites

BWC publications
Saving You Time and Research

Requests for copies of OSHA standards, information on starting a safety committee, a video on accident investigation techniques -- these are some of the thousands of inquiries BWC’s Division of Safety & Hygiene (DSH) libraries receive each year.

DSH has two libraries to serve you:
- The central library in the William Green Building in downtown Columbus;
- The resource center and video library located at the Ohio Center for Occupational Safety and Health (OCOSH) in Pickerington.

Both libraries are open 8 a.m. to 4:45 p.m., Monday through Friday. Your need for information does not require a visit to the library. You can phone, fax, or e-mail your requests and receive a quick response.

The central library provides free information services on the topics of occupational safety and health, workers’ compensation and rehabilitation.

The OCOSH resource center provides similar services for those who visit OCOSH for meetings and training center classes.

The video library offers an extensive collection of videotapes to supplement your organization’s safety and health training program. It is a convenient and popular source for Ohio employers to borrow quality occupational safety- and health-related training aids.


Central library
30 W. Spring St., Third Floor
Columbus OH 43215-2256
1-800-OHIOBWC
(614) 466-7388
(614) 644-9634 (fax)
library@bwc.state.oh.us

OCOSH resource center
13430 Yarmouth Drive
Pickerington OH 43147
1-800-OHIOBWC
Resource center (614) 728-6464
Video library (614) 644-0018
Introduction

WHAT IS ERGONOMICS?

There are many definitions of ergonomics:

- The study of the laws of work.
- Fitting the task to the worker rather than forcing him/her to adapt to the working environment.
- Designing the workplace to prevent occupational injury and illness.
- The process of identifying and preventing work related musculoskeletal disorders.

Working definition:
The process of balancing job demands and the limitations of the human body
WHERE DOES ERGONOMICS COME FROM?

Ergonomics is a field of study combining several disciplines.

**Occupational Biomechanics:** The study of mechanical behavior as it applies to the human body when physical work is performed.

**Physical Sciences:** Any of the sciences, such as physics and chemistry that analyzes the nature and properties of energy and nonliving matter.

**Anthropometry:** The study and technique of human body measurement.

**Biological Sciences:** The study of life and life processes, including the structure, function and growth of living organisms.

**Work Physiology:** The study of the functions and reactions of the human body in relation to the stresses caused by performing various physical tasks.

**Behavioral Sciences:** Sciences such as sociology, psychology, or anthropology, that seeks to discover general truths about human social behavior.

**Engineering Psychology:** Experimental psychology/cognitive engineering applied to the study of man-machine systems which considers research issues, methodological matters, and principles of design and training in terms of contemporary aircraft, highway, industrial and health-care systems.

**Engineering Sciences:** The scientific principles applied to practical ends as the design, construction and operation of efficient and economical structures, equipment and systems.
ACUTE VERSUS CUMULATIVE INJURIES

*Acute Injuries* are the type of injuries that traditional safety deals with preventing. These injuries result from a single event that has a clear cause-effect relationship.

Example: If a person cuts his/her finger, it is very simple to determine the cause. The individual usually knows:
- what cut the finger;
- what they were doing when they were cut;
- what they were doing just before the injury occurred;
- who was around them at the time of the injury, and so forth.

*Cumulative Injuries* result from multiple events over a period of time. However, a specific event may have been “the last straw” for the previously weakened system, thus giving the appearance that the problem is acute rather than chronic. {Stephen Konz. “Work Design; Industrial Ergonomics”, Third edition. 1990}

Example: You probably know someone that has stepped off of a curb, hopped out of a truck, or picked up a small item from the floor and had shooting, debilitating pain in their back. At first glance this may seem like an acute injury. However, the act of picking a small bolt up off of the floor is not a dangerous act. And, it is obvious (since we all do similar activities daily) that it is not the sole cause of this injury. This action, that was associated with the pain, is simply that “last straw” that “broke their back”. There were probably thousands of insults and injuries to this back before it reached the injury point. This is a classic example of a back injury that could be classified as a *cumulative trauma disorder*. 
CUMULATIVE TRAUMA DISORDERS

Cumulative Trauma Disorders (CTDs) are injuries and illnesses that develop over time. Most of the damage that causes them occurs before any symptoms become evident. Common CTDs are carpal tunnel syndrome (CTS), tendonitis, epicondylitis, and many back and neck injuries.

The Cumulative Trauma “Bucket” analogy helps to demonstrate why it is so difficult sometimes to predict who will develop a CTD, when a person will develop a CTD, or what will cause a CTD.

The “Bucket” represents an individual’s body and the amount of stress & strain, and wear & tear that it can handle without undue complications and illness. Everyone has a different size bucket. The size of the bucket can also change day to day, based on their overall stress level, how much sleep they got the night before, if they have recently been sick, etc.

The Healing Valve represents the body’s ability to heal itself. The rate at which it heals can vary from day to day based on the person’s overall health and stress levels.

The liquid in the bucket represents the Trauma (stress and damage) accumulated by the body which needs to be healed. This Trauma is the result of every day living, work, illness, etc.

The Job Valve represents the input of Trauma into this system from the job. Realistically we cannot eliminate this input completely. However, it can be controlled, to some degree, by properly adjusting the work environment.

The reason for taking all practical steps possible to reduce the flow from the Job Valve is that if the Bucket overflows, the employee will develop a Cumulative Trauma Disorder.

The volume of the bucket, the healing rate, and other sources of trauma that take place off the job are uncontrollable by the company, increasing the difficulty of prevention. That is why, in addition to the reduction of the Job Valve’s flow rate, education should be provided to the employees so they are able to participate in protecting themselves.
APPLICATIONS FOR ERGONOMICS PRINCIPLES

Ergonomic principles can be applied in almost all aspects of the workplace, including:

- **Material Handling Operations**
  Wherever someone is lifting, lowering, pushing, pulling, or carrying on the job there is potential to utilize ergonomic principles to improve the job and reduce the potential for injury.

- **Computer / Office operations**
  Since computers have entered the workplace, the number of work related injuries for the office has risen. As the work performed changes from a paper system to a computer based system adjustments must be made.

- **Control and Display design**
  Almost every worker uses some kind of display or readout. There are important design considerations that will improve the readability of the display or dial. This has an indirect impact on everything from productivity to injury rates.

- **Workplace / Workstation design**
  When is the best time to look at ergonomic issues in the workplace? In the design/inception phase! It is always cheaper and more efficient to do it right the first time, before anyone gets hurt.

- **Assembly / Repetitive hand intensive operations**
  Repetition is one of the risk factors associated with cumulative trauma disorders. Whenever assembly work is performed, the tasks should be reviewed to identify any and eliminate ergonomic problems.
- All other work/play/life

  If it hasn’t been listed above and you have employees doing it then there is a good probability that there are ergonomic principles that could improve the task or reduce the potential for injuries. And, the same information that is given to the employees to protect themselves on the job will be useful to them off the job as well.
Why Ergonomics?

Consider that you are working for a company who has implemented an employee based —management supported ergonomics process. List below the benefits that can be realized by both Labor and Management for cooperating on such an effort.

LABOR BENEFITS

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MANAGEMENT BENEFITS

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The application of ergonomic principles is a win-win scenario for both management and labor.

◆ LABOR BENEFITS

Career Longevity
You can control your career destiny.

Safe Working Conditions
Safe working conditions allows everyone to work with minimum fatigue. This in-turn will give you more energy for other activities. Minimizing pain on the job allows a worker to focus on the tasks of the job.

Quality of Life
Ergonomics can provide long-term benefits. You should retire from work able to enjoy your hobbies and activities pain-free for the rest of your life.

Morale
Ergonomics can help make your job less stressful so that you can concentrate on other things rather than your discomfort. Employees’ morale may also be uplifted if they “see” that the company does care about how the workers are feeling while performing a job.

◆ MANAGEMENT BENEFITS

Production
When ergonomic principles are properly applied, many obstacles to efficient production are removed. It has been shown that production can be positively impacted when ergonomics is applied.

Some examples of production benefits of proper ergonomically designed jobs are:
- Less fatigue
- Elimination of bottlenecks
- Reduction of bottlenecks
- Increased throughput
- Optimization of cycle time
- Help in meeting deadlines
- Well designed jobs
- Increase in profitability & competitiveness
Quality
As mentioned earlier, when an employee has an ache or pain, his/her mind is not on the task at hand. Removing the causes of those pains will mean greater focus on the job, resulting in higher quality. This is true for all jobs where quality of the product or service is important.

Some examples of quality benefits of proper ergonomically designed jobs are:
- Less scrap and re-work
- Increased efficiency
- Reduction of rushing and shortcuts
- Less fatigue
- Improved customer satisfaction
- Better accuracy

Compliance and Guidelines
There are two ergonomic regulatory issues in Ohio. The General Duty Clause
OSHA can, and has, levied fines against companies for ergonomic issues using the general duty clause.

The general duty clause states: “Each employer shall furnish to each of his employees employment and place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employee.”

There are also some guidelines that may be useful to refer to as starting points for various ergonomic issues (reference and contact information appears in Tab 8).
- NIOSH Elements of Ergonomics Process, 1997
- OSHA Meatpacking Guidelines, 1990
- ANSI HFS-100/1988: VDT’s
- ANSI Z-365: Control of Work-Related CTD, 1995

Worker’s Compensation / Loss Prevention
The ergonomic benefit that is probably the most commonly discussed is the reduction in medical and compensation costs associated with an injury.

Ergonomics can:
- Prevent the injuries/illnesses from occurring in the first place,
- Reduce the frequency of claims,
• Reduce Workers’ Compensation premiums,
• Reduce absenteeism,
• Reduce turnover.
INJURY TRENDS

Loss Time Injuries By Type of Cause
(NSC Accident Facts 98)

What kind of injuries can be affected by ergonomic principles?

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What conditions in the workplace have caused these high rates of CTDs?

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BACK INJURY TRENDS

(U.S. Bureau of Labor Statistics)

What factors are contributing to the back injuries?

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Numbers of Injuries

Percentage of Total Injuries

Total Recorded Injuries

% of Recorded Injuries That Involve Back Injuries
<table>
<thead>
<tr>
<th>Job Category</th>
<th>1996</th>
<th>1997</th>
</tr>
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<tbody>
<tr>
<td>General building contractors</td>
<td>6.2</td>
<td>4</td>
</tr>
<tr>
<td>Computer, office equipment</td>
<td>58.1</td>
<td>63.7</td>
</tr>
<tr>
<td>Aircraft, parts</td>
<td>117.6</td>
<td>138.2</td>
</tr>
<tr>
<td>Motor vehicles, equipment</td>
<td>444.8</td>
<td>435.8</td>
</tr>
<tr>
<td>Meat packing</td>
<td>921.6</td>
<td>1191.6</td>
</tr>
<tr>
<td>Bakery products</td>
<td>98.5</td>
<td>77.1</td>
</tr>
<tr>
<td>Textile mill products</td>
<td>84.1</td>
<td>73.5</td>
</tr>
<tr>
<td>Apparel, other textile products</td>
<td>137.1</td>
<td>131.4</td>
</tr>
<tr>
<td>Personnel supply services</td>
<td>6.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Computer, data processing</td>
<td>12.8</td>
<td>12.6</td>
</tr>
<tr>
<td>Legal services</td>
<td>20.7</td>
<td>10.8</td>
</tr>
</tbody>
</table>

Incidence rates = No. of illnesses per 10,000 workers

What jobs in your facility would be considered “CTD High Risk” jobs?

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**COST**

How much do the injuries cost?

**Claim Cost By Part Of Body**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Upper Back</td>
<td>$10,641</td>
<td>$14,037</td>
</tr>
<tr>
<td>Multiple Trunk</td>
<td>$7,070</td>
<td>$17,988</td>
</tr>
<tr>
<td>Lower Back</td>
<td>$11,645</td>
<td>$12,696</td>
</tr>
<tr>
<td>Knee</td>
<td>$12,428</td>
<td>$10,120</td>
</tr>
<tr>
<td>Head/CNS</td>
<td>$10,120</td>
<td>$21,601</td>
</tr>
<tr>
<td>Foot/Toe</td>
<td>$7,460</td>
<td></td>
</tr>
<tr>
<td>Chest/Internal Organs</td>
<td>$7,002</td>
<td></td>
</tr>
<tr>
<td>Ankle</td>
<td>$7,425</td>
<td></td>
</tr>
</tbody>
</table>

According to the National Safety Council Accident Facts 1998 the average workers compensation claim filled in '95 and '96 was $11,434.

What are other costs of work related injuries?

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The above costs represent direct costs. Direct costs are the costs of medical care and compensation for lost work time. Indirect costs must also be taken into consideration.

Indirect costs are generally considered to be approximately 4 to 20 times the direct costs for a given claim.
Anatomy and Physiology

To understand the capabilities and limitations of the human body it is important to understand the musculoskeletal system and the various disorders that can develop from excessive stresses. This section will explore the various “ergonomic related” injuries most commonly found in industry today.

DEFINITIONS:

Muscles  exert forces to create movement and to hold the body in various positions

Bones  provide the framework to which muscles, ligaments and tendons attach

Ligaments  connect bone to bone

Tendons  attach muscle to bone

Nerves  allow signals to be transmitted to and from the brain

Veins/Arteries (Vascular)  allow for proper blood circulation

CUMULATIVE TRAUMA DISORDERS

The typical injuries that are associated with ergonomic hazards are cumulative trauma disorders. These are injuries, as explained earlier, that result from mechanical forces damaging the structures of the body.

Carpal Tunnel Syndrome (CTS) is the most widely known and talked about Cumulative Trauma Disorder (CTD). Unfortunately, this notoriety has also resulted in a fair amount of misinformation about CTS. Today, if a person has a pain between their fingertips and their shoulder, they assume that they have CTS. Because of this, it is important to understand the development of the disorder.
The Anatomy
Most of the movements of the hand are controlled by muscles in the forearm. They are tied to the various bones of the hand via tendons. These tendons are held close to the bones of the wrist by the carpal ligament at the point where the wrist bends. In areas where the tendons lay on bone or may rub against other tendons, they are surrounded by Synovial Sheaths. The synovial sheaths keep the tendon surrounded by fluid to reduce friction and prevent irritation.

The Carpal Tunnel
The carpal tunnel is an opening through the wrist surrounded on the back side of the hand by the bones of the wrist, and on the front, by the carpal ligament. This opening is roughly the size of a dime. The tendons travel through this opening that facilitate making a fist. The Median Nerve, which is one of the three major nerves to the hand also runs through this opening. This nerve only transmits information from the shaded area of the hand.

The Syndrome
CTS is a problem that develops over time just like all CTDs.

Stage 1 is Tendonitis. The first signs of a problem are typically a sore, achy wrist. It may start either after a long day, or possibly at night. Initially, the symptoms are sporadic. This is called Tendonitis, which is simply the swelling of the tendons.

Stage 2 is Carpal Tunnel Syndrome. The swollen tendons put pressure on the Median Nerve. This is when the numbness and tingling begins. This sensation only manifests itself on the palm side of the thumb, the index finger, the middle finger, half of the ring finger, and the related palm area.

Some other examples of cumulative trauma disorders associated with ergonomic problems are listed in the following tables.
**COMMON CUMULATIVE TRAUMA DISORDERS**

<table>
<thead>
<tr>
<th>TENDON DISORDERS</th>
<th>BODY BART</th>
<th>SYMPTOMS</th>
<th>CONTRIBUTORS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendonitis</td>
<td>non-specific</td>
<td>dull aching, discomfort with specific movements, tenderness to the touch</td>
<td>force/tension, repetition</td>
<td>a form of tendon inflammation when muscle/tendon unit is repeatedly tensed</td>
</tr>
<tr>
<td>Tenosynovitis</td>
<td>non-specific</td>
<td>pain, inflammation</td>
<td>extreme wrist deviation, repetition @ 1500-2000 movements per hour</td>
<td>repetitive-induced tendon injury involving the synovial sheath; sheath produces excess synovial fluid</td>
</tr>
<tr>
<td>DeQuervain’s Disease</td>
<td>side of wrist, base of thumb</td>
<td>pain, inflammation</td>
<td>firm grips and motions, radial deviation</td>
<td>tenosynovitis in tendons connected to muscles on back of forearm that pull the thumb away from the hand</td>
</tr>
<tr>
<td>Trigger Finger</td>
<td>finger</td>
<td>snapping movement, finger remains flexed</td>
<td>pinch grip, repeated use of finger, hard or sharp surface</td>
<td>tendon sheath of finger sufficiently swollen to lock tendon in sheath</td>
</tr>
<tr>
<td>Epicondylitis</td>
<td>elbow &amp; shoulder</td>
<td>inflammation, pain radiates from elbow down forearm</td>
<td>hand supination against resistance-extension, impact or jerky throwing motions</td>
<td>tendonitis effecting vulnerable unsheathed tendons of the elbow and shoulder</td>
</tr>
<tr>
<td>Rotator Cuff Tendonitis</td>
<td>shoulder</td>
<td>pain, functional impairment</td>
<td>moving arm away from side, elbow abduction, repeated overhead motions</td>
<td>wear and tear contributes to thickening of tendons and bursae</td>
</tr>
<tr>
<td>Ganglionic Cyst</td>
<td>non-specific, often wrist</td>
<td>bump under the skin</td>
<td>extreme wrist deviation, repetition</td>
<td>form of tenosynovitis, sheath swells up with synovial fluid</td>
</tr>
<tr>
<td>Bicipital Tendonitis</td>
<td>biceps, shoulder joint</td>
<td>pain, tenderness in bicipital groove</td>
<td>flexion and supination of forearm</td>
<td>tendonitis in the bicipital groove</td>
</tr>
</tbody>
</table>
Repeated or sustained work activities expose the nerve to pressure from hard, sharp edges of the work surface, tools or nearby bone, ligaments and tendons.

<table>
<thead>
<tr>
<th>DISORDER</th>
<th>BODY BART</th>
<th>SYMPTOMS</th>
<th>CONTRIBUTORS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal Tunnel Syndrome</td>
<td>hand, wrist</td>
<td>pain, numbness, tingling, loss of dexterity, weakness</td>
<td>repetition, wrist flexion, motion through poor postures</td>
<td>compression of median nerve through the tunnel, resulting from tenosynovitis of finger tendons</td>
</tr>
<tr>
<td>Pronator Syndrome</td>
<td>forearm</td>
<td>tingling, pain</td>
<td>wrist and elbow flexion</td>
<td>compression of the median nerve in forearm</td>
</tr>
<tr>
<td>Cubital Tunnel Syndrome</td>
<td>elbow</td>
<td>pain, numbness, tingling</td>
<td>resting elbow on sharp edge, reaching over an obstruction</td>
<td>compression of the ulnar nerve below notch of elbow</td>
</tr>
<tr>
<td>Guyon Tunnel Syndrome</td>
<td>hand, wrist</td>
<td></td>
<td>prolonged flexion and extension of wrist, repetitive forces on palm</td>
<td>entrapment of ulnar nerve as it passes through Guyon tunnel</td>
</tr>
<tr>
<td>Radial Canal Syndrome</td>
<td>forearm</td>
<td>decreased sensation, pain</td>
<td>passive stretching, resisted extension of middle finger</td>
<td>compression of radial nerve at the lateral epicondyle</td>
</tr>
<tr>
<td>Anterior Interosseus</td>
<td>forearm</td>
<td>pain in forearm, weakness in thumb/index finger pinch</td>
<td>repetitive, forceful activities</td>
<td>compression of median nerve by forearm muscles</td>
</tr>
<tr>
<td>Syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Interosseus</td>
<td>forearm</td>
<td>pain in forearm, weakness of extensor muscle</td>
<td>repetitive, forceful activities</td>
<td>compression of radial nerve by the supinator muscles in forearm</td>
</tr>
<tr>
<td>Syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflex Sympathetic</td>
<td>non-specific</td>
<td>burning, pain, swelling, sensitive to cold</td>
<td>over activity of sympathetic nervous system</td>
<td>progression from CTDs</td>
</tr>
<tr>
<td>Dystrophy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISORDER</td>
<td>BODY BART</td>
<td>SYMPTOMS</td>
<td>CONTRIBUTORS</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Thoracic Outlet Syndrome</td>
<td>shoulder, upper arm</td>
<td>numbness, pain, tingling, loss of strength, loss of dexterity; may involve entire upper extremity</td>
<td>shoulder abduction, shoulder adduction, repetitive reaching overhead</td>
<td>general term for compression of the nerves and blood vessels between the neck and shoulder</td>
</tr>
<tr>
<td>Vibration Syndrome</td>
<td>hand</td>
<td>cold, pale, numb hands, tingling fingers, loss of sensation and feeling</td>
<td>cold temperatures, segmental vibration</td>
<td>tiny blood vessels and nerves of the hand constrict; common exposures come from large power tools</td>
</tr>
</tbody>
</table>
BACK INJURIES

Work related back injuries fall into two primary categories:

1) Muscular injuries
2) Spinal Column injuries

Muscular injuries
Of the two we can recover most easily from muscle injuries. A pulled muscle, if the individual is injured while doing the normal duties of his or her job, is a warning that the back is not strong enough to do the work. Proper exercises should be obtained from a doctor, physical therapist, or occupational therapist that knows the individual’s back history and job duties.

Blood Flow
Other than being in good physical shape, the best precaution that an employee can take, to reduce the chance of pulling a muscle, is to warm-up before performing lifts. When the individual is sitting, driving, on break, or any other activity not demanding a lot of back effort, the muscles are in a resting state of minimal blood flow. The muscles have only enough blood flow to maintain health, not enough to perform heavy lifting.

If the person jumps right into lifting from this state, there is a delay before the blood flow can catch up to the demand of dynamic work (work where the muscle is flexing and relaxing repeatedly). During this time the muscle must use reserve energy in the cells to perform the lifting.

The cells only have a minor amount of reserve power (only enough for 2 or 3 good exertions). The problem develops later when the individual is required to do some period of static work (where the person is made to hold a posture or weighted object for an extended period of time). With static work the muscle remains flexed or extended, cutting off all blood flow. This is what the muscle was saving that reserve for and if it is not there the muscle quits. It is when the first muscle quits (there are over 200 muscles in the back and torso) that a muscle is pulled.

Stretching will go a long way in preventing the early depletion of the energy.
The Spine

The three main components of the spine are the vertebrae, spinal cord, and the discs. The weak links in this system are the discs.

There are two important factors which must be considered when dealing with the spine. First, the discs have no direct blood supply which means that all nutrients must be transmitted from the surface of the vertebra. Therefore, the discs actually take longer to heal than bones.

The second factor is that there are no nerve connections to the discs. This means that when the disc is injured you don’t know it. Because you are not aware of the injury, you do not make any changes and keep doing what you normally do, making the healing process even slower.

Since the discs and surrounding bone heal slowly, and are aggravated by sustained activity, scar tissue is formed. This scar tissue impedes the flow of nutrients to the disc, causing increased degeneration as time progresses.
THE DIFFERENT KINDS OF SPINAL INJURIES

Age

Autopsy evidence has shown that all of us, if we live long enough, will have degeneration of the discs. Each of us will eventually do enough things that are bad for our backs to cause some damage.

Unfortunately, we can easily do that same amount of damage in a much shorter time. It is a function of the stress placed on these discs during our everyday lives. It is the habits that we have while lifting, sitting, standing, sleeping, etc. that make our backs age faster than the rest of our bodies.

A “slipped disc”

A “slipped disc” is an improper name for this spinal injury. What actually happens is that a degenerated (shrunken) disc is not big enough to fill the gap between the vertebrae above and below it. This is also known as a subluxation in chiropractic circles. When the person lifts while bending and/or twisting, one of the discs is forced out of alignment. The pain is usually caused by the pinching of one or more of the nerves coming off of the spinal cord at that vertebrae.

A medical doctor will probably give pain medication and prescribe exercises. A chiropractor will move the vertebrae back in place and hopefully give you exercises to do. From a medical treatment standpoint, the key to minimizing the risk of future pain reoccurring from this injury, is to build up the muscles around this area of the spine. These developed muscles will help hold the vertebrae in place. The individual must continue these exercises or risk a recurrence of the pain.
A ruptured or herniated disc

This is the worst type of spinal injury involving the discs. Here, a small area of the disc has become weakened. The pressure on the disc causes this weak area to bulge. This bulge, if minor, or in a non-sensitive place around the spine, will not immediately cause a pain. However, it is when the bulge presses on sensitive tissue or directly on a nerve that the pain develops. The primary treatment for this condition is surgery. Typically, even after surgery, there is pain or discomfort.
RISK FACTOR IDENTIFICATION

Risk factors are those characteristics of a task or action that increase the odds of the person developing a cumulative trauma disorder.

HISTORICAL / TREND ANALYSIS (reactive measures)

To find the jobs that should be checked for ergonomic concerns, reviewing existing records will help identify those target jobs. There are many types of records to check.

What are some records that your company has that might help identify areas of ergonomic concern?
Injury/Illness Records can help pinpoint those jobs with a history of actual ergonomic related injuries.

- OSHA 200 log
- Incidence Rate
- First-aid logs
- Accident Investigations
- Workers’ Compensation

Production/Quality Records can help identify operational deficiencies that might be related to ergonomic concerns.

- Seasonal Trends
- Quality Control
- Model Changes
- Bottlenecks
- Material Flow
- Plant Layout

Personnel Records allow identification of jobs that have the highest:

- Turn-over Rate
- Absenteeism
- Number of Grievances

Employee Surveys allow the employees to participate in identifying problem jobs. Keep in mind, however, that once they are asked they will expect to see action in the near future.

- Symptoms survey
- Early reporting mechanism
- Suggestion award program

DEFINITIONS

Once target jobs have been identified, then the risk factors present at those jobs must be identified. Risk factors are those characteristics of a job that might contribute to the onset of aches/pains and/or injury. There are several ergonomic risk factors that may be present at a work area.

Repetition - is the most recognized risk factor associated with ergonomic problems.
A task can be considered repetitious if the employee is performing the same short duration task or many short duration tasks with similar actions without appropriate rest to the body. Guidelines are available; for example, some define repetitive as:

<table>
<thead>
<tr>
<th>When the body part is:</th>
<th>The Repetitiveness is classified as:</th>
</tr>
</thead>
<tbody>
<tr>
<td>idle most of the time</td>
<td>Very Low</td>
</tr>
<tr>
<td>frequently pausing, waiting for equipment</td>
<td>Low</td>
</tr>
<tr>
<td>in steady motion</td>
<td>Medium</td>
</tr>
<tr>
<td>in rapid motion</td>
<td>High</td>
</tr>
<tr>
<td>in constant rapid motion, difficult to keep up.</td>
<td>Very High</td>
</tr>
</tbody>
</table>

**Forceful Exertion** – is the force exerted by the body to perform an action. The higher the force, the greater the potential to develop injuries. There are some guidelines available to help us assess how much force is too much. For example, Mathlowetz (1985) and Kroemer (1994) suggest that a worker required to use a pinch grip using the thumb and index finger to pick up an object should not exceed 12lbs of applied force for an occassional task and not exceed 4lbs of applied force if it is a repetitive task. It takes approximately 2lbs of applied force to pick up a paper clip; therefore, the amount of force exerted my a worker does not have to be great to present a risk of stress on the body.
**Direct Mechanical Pressure** – is the force exerted by the environment (tools, tables, guarding, protective equipment, etc.) on the body. Pressure on the body can restrict blood flow, damage nerves, and reduce range of motion. *Vibration* (hand/arm and whole body) is a form of direct mechanical pressure. It aggravates both nerve and tendon disorders, increases required grip exertion with tools, interrupts blood flow, and can cause some damage to the internal organs.

**Static Posture/Insufficient Rest** - The muscles and other tissues of the body utilize reserve energy/blood nutrients and oxygen when a person performs a task. This energy reserve takes longer to build up than it takes to deplete and even longer the more depleted the reserves are. Also, the replenishing of the reserves can not happen while the tissue is working.

**Awkward Posture** – is classified as any posture that an operator’s joint must be in during a task that is non-neutral. A neutral posture for a joint is one that allows the muscles around the joint to be evenly balanced. The following pictures illustrate neutral and non-neutral postures for various body parts:

---

Oversimplification of the neutral posture for standing and seated tasks
NECK/HEAD POSTURES

WRIST POSTURES

ELBOW POSTURE
NOTE: Leg postures are considered non-neutral when standing on one leg, kneeling, or squatting when performing a task.

Environmental Stressors can affect Cumulative Trauma Disorders by accelerating the effects of other risk factors. Environmental risk factors include:

- **Cold temperatures** decrease the circulation and can increase the effects of an existing nerve disorder.
- **Hot temperatures** tax the circulation system and increase the amount of recovery time for each task.
- **Light** can affect the postures of an operator. If the light levels are too high, glare can be created and
force the employee to compromise the neutral posture to see the work. If the light levels are too low, the operator may need to lean forward to properly see the work.

The presence of one or more risk factors does not guarantee that any given individual will develop a problem. It simply means that there is a greater potential.

**RISK FACTOR SYNERGY**

Risk factors have more than a cumulative effect. When two or more risk factors are present in a task, the risk is more than the sum of the two individual risks, increasing the potential for injury. The two have a multiplying or synergistic effect on each other.

![Diagram of Force & Frequency](image)

In the study represented by the graph above, multiple risk factors increased the potential for injury four times greater than when there was only one risk factor. High force alone raised the potential for injury 6 times normal. When high force and high frequency were both present on a task the injury potential was not 10 times but 37 times normal!
RISK FACTOR IDENTIFICATION EXERCISE:

For the examples shown (e.g., slides/videos/digital pictures), identify the ergonomic risk factors that you see present.
PROBLEM EVALUATION

There are many techniques for evaluating problem jobs and determining the causes of the problems. The following is a basic overview of some of the more common techniques. For a more in-depth study of these techniques, take the Advanced Ergonomics course (see OCOSH literature for more information on this course offering).

WORKSITE ANALYSIS METHODS (proactive measures)

► Task Analysis is an outline or set of instructions for sequenced actions to accomplish a task. It may also be referred to as Work, Job, or Method Analysis. Many companies may already utilize some form of task analysis for purposes of setting the rate on a job, determining the cost of the product, or developing job descriptions.

The objective of an Ergonomic Task Analysis is to identify work methods by individual components and evaluate for risk factors.

The benefits of a task analysis are:
- It can provide a formal comparison between task demands and human capabilities.
- It can uncover deficiencies easily overlooked, and prompt us to ask more questions about the job.
- It can provide detailed documentation for re-evaluation, training, and comparison to other jobs.

Task analysis major steps:
1) Designate the job to study
2) Collect data (observe, videotape, interview)
3) Capture data
   - Document on forms
   - Identify risk factors
4) Formulate control measures
Checklists are shorthand tools that help to collect and quantify risk factors. Checklists are rarely if ever valid pass/fail measurement devices. They are best used as comparative gauges. The checklist is used to pinpoint:

1) how far a particular job is from perfect; and
2) what components of the job need to be improved.

There are many forms of checklists available.

**Very detailed Checklists:**
Some are very detailed with specific questions. Typically these lists derive a total score by counting the numbers of questions that were answered by a yes/no response. These lists can be many pages long.

Although detailed checklists require minimum training for their use, they are typically specific to a particular industry or type of task. This means that one facility may need to use multiple checklists, which makes it difficult to use the scores to compare the severity of risk between different jobs.

**One-page checklists:**
These measure severity of specific risk factors for each body part.

Although one-page checklists require a fair amount of training to be used, they can be used across the board on all types of jobs. It can therefore be used to set priorities for an entire facility.

**Analysis Tools**

National Institute for Occupational Safety and Health (NIOSH) Lifting Model

It was developed as an evaluation tool to assist individuals in assessing lifting tasks. The outcome of the model is to determine a recommended weight limit (RWL) where a "normal" worker would not likely injure their back while performing the lifting task. The NIOSH Lifting Model does provide an objective means to evaluate a lifting job; however, there are some restrictions for when the model can be applied. The NIOSH Lifting Model does not apply for any task that includes lifting/lowering with the following conditions:
• with one hand,
• for > 8 hours,
• while seated or kneeling,
• in a restricted work space,
• unstable objects,
• while carrying, pushing, or pulling,
• with wheelbarrows or shovels,
• with “high speed” motion (faster than 30 in/sec),
• with unreasonable foot/floor coupling (<0.4 cof), or
• in an unfavorable environment (temp <66° or >79° F).

The following graphic depicts the variables and equations that constitute the NIOSH Lifting Model equation.
NIOSH Lifting Model:

Variables:

- $H =$ horizontal location from midpoint between ankles to the center of the load at origin of lift (inches)
- $V =$ vertical location of the hands at the beginning of lift measured from floor to hands (inches)
- $D =$ vertical travel distance from origin to destination (inches)
- $F =$ average frequency of lift (lifts/minute)
- $A =$ angle of asymmetry - angular measure of how far the object is displaced from the front of the worker’s body at the beginning of the lift (degrees)

Calculations, where:

- $LC =$ load constant = 51 lbs
- $HM =$ horizontal multiplier = $\frac{10}{H}$
- $VM =$ vertical multiplier = $1 - (0.0075 \left| V - 30 \right|)$
- $DM =$ distance multiplier = $0.82 + \left( \frac{1.8}{D} \right)$
- $AM =$ asymmetry multiplier = $1 - (0.0032 \times A)$
- $FM =$ frequency multiplier = FROM TABLE
- $CM =$ coupling multiplier = FROM TABLE

therefore:


(the amount of weight that nearly all healthy workers could lift for up to 8 hours without an increased risk for developing low back pain)

$$LI = \text{lifting index} = \frac{\text{Load Weight}}{RWL}$$

- $\{1.0 < LI < 3.0 \text{ changes should be considered - some workers may be at risk}\}$
- $\{LI > 3.0 \text{ changes may be needed immediately- nearly all workers appear to be at increased risk}\}$
OSU/BWC Lifting Guideline for Return To Work

The Ohio State University, with support from the Ohio Bureau of Workers’ Compensation, developed the following guidelines for lifting when returning to work. The attached graphics provide lifting limit guidelines for those with low back disorders (LBD). These data are based upon laboratory studies of 110 subjects. The guideline is based on low frequency lifts of about 1/minute.

Note: The maximum weight recommended under the best circumstances for those with a LBD is 25 lbs and that has a medium risk of re-injury.

To use the guide:

1. Determine the angle of asymmetry (the task twisting angle associated with the lifting task – it doesn’t matter if the twist is to the left or to the right). Use the chart that corresponds to the appropriate asymmetry category (< 30° between 30° and 60°, or between 60° and 90°).

2. Determine the region of the maximum horizontal reach distance from the spine and vertical lift origin from the floor for each lift.

3. The shade in each zone indicates the degree of risk for a LBD:

   - Light = low risk
   - Dotted = medium risk
   - Dark = high risk

   (Low risk indicates spinal disc compressive loading of < 3400 N, medium risk indicates compressive loading between 3400 N and 6400 N, and high risk indicates compressive loading of > 6400 N or shear loading > 1000 N.)

   These charts can be used as follows:
1. Employers can use these guidelines to evaluate lifting tasks and make changes to the design or to the weight of the object being lifted to minimize the risk of re-injury during manual material handling tasks.

2. The medical community, in communication with the employer, can use these guidelines to assess a LBD patient’s readiness to return to work, thus minimizing the risk of re-injury.

Table 1.

**RTW Guideline for Lifts of +/- 30 Degrees of Origin Asymmetry**

- Determine region (zone) of the maximum horizontal reach distance from spine and vertical lift origin from the floor for each lift
- Shade in each zone indicates degree of risk for LBD (light = low, dotted = medium, dark = high)
- Select weights corresponding to light shading within each zone to minimize risk of recurrent LBD (LBD group averages functional performance 13% LMM probability)

Table 2.
RTW Guideline for Lifts between 30 and 60 Degrees of Origin Asymmetry

- Determine region (zone) of the maximum horizontal reach distance from spine and vertical lift origin from the floor for each lift
- Shade in each zone indicates degree of risk for LBD (light = low, dotted = medium, dark = high)
- Select weights corresponding to light shading within each zone to minimize risk of recurrent LBD

(LBD group averages functional performance 13% LMM probability)

Table 3.

RTW Guideline for Lifts between 60 and 90 Degrees of Origin Asymmetry

- Determine region (zone) of the maximum horizontal reach distance from spine and vertical lift origin from the floor for each lift
- Color in each zone indicates degree of risk for LBD (light = low, dotted = medium, dark = high)
- Select weights corresponding to light shading within each zone to minimize risk of recurrent LBD

(LBD group averages functional performance 13% LMM probability)
In development: Data version 5/02.

**Video Taping Techniques**

Video taping is a useful tool for ergonomic evaluations for many reasons:

- It allows a permanent record of the job to show before and after conditions.
- It allows multiple people to perform a task analysis without causing a major disruption.
- It allows much more thorough analysis of a task.
- It uncovers differences in technique.

**What to include:**
- name of company and location of taping
- date of taping
- videographer’s name
- either name the task being recorded during taping or keep track on paper.

**Tips on taping:**
- Take a full body shot of the employee. Include the surface on which the employee is standing or seated.
- If several employees are performing the same task, tape at least three employees.
- Try to tape the “worst case”, “best case”, and the average situations.
- Following the long shot, zoom in to focus on the area or function of greatest concern, if known.
- Video tape the employee from all sides, if possible (front, back, both sides)

**Taping Duration:**
- Videotape each task long enough to show what is being evaluated.
- For cycle times less than 30 seconds, tape 10 cycles.
• For cycles greater than 30 seconds, tape at least one cycle.

Note: In the Advanced Ergonomics class offered through OCOSH you are encouraged to bring in a video of a problem job for the class and instructor to view. This gives you a chance to have 20 or more people give you the benefit of their ideas and experience. It also lets you leave with a start on solving one of your ergonomic problems.
CONTROL STRATEGIES

OVERVIEW OF CONTROL STRATEGIES

Engineering Controls are permanent modifications to the working environment to reduce or eliminate a recognized ergonomic risk factor. Common types of engineering controls include:

- Workstation design
- Tool Design
- Process modification
- Mechanical Assistance devices

The most important consideration when making an engineering change to a job is to include the employees that will be using the modifications. They must:
- understand why the change is being made,
- feel as if they have had input into the change
- understand that the first modification is not perfect and that their input will be critical to making the project work.

Administrative Controls are managerial decisions that will minimize exposure to the risk factors without removing them. Typical Administrative controls include:

- Training
- Job Rotation
- Pacing
- Policy
- Job Enlargement

Administrative controls can be put in place until an engineering solution can be developed.

Band-Aid Solutions (or ergonomic snake oil?) are things such as wrist splints. Wrist splints should not be used on the job unless the individual is under ongoing care and monitoring of a physician or physical therapist. Many products have had the term ERGONOMICS added to them by the marketing people. However, any tool or item can be used in a good or poor ergonomic fashion. What makes a job poorly designed, from an ergonomic standpoint, is not how a given item was designed, but how it works in conjunction with the task at hand.

ERGONOMIC CONTROL TECHNIQUES

Anthropometry is the technology of measuring and quantifying various human physical traits such as size, weight, proportion, mobility and strength.
Engineering Anthropometry is the application of anthropometric data to equipment, workplace and job design to enhance the efficiency, safety, and comfort of the operator.

Anthropometry is specifically used to ensure the work design is compatible with the worker's body, and to safeguard from point of contact hazards.

Anthropometric data is provided as percentiles. An example would be that the height of the 50th percentile male is listed as 69.1” in the anthropometric data table. This means that exactly one half of the population falls below this height and half above. The 5th percentile female is listed as 59.3”. This means that 5 percent of the female population is under this height and 95 percent are above.

**Anthropometric Design Strategies:**
- Design for the extreme
- Accommodate reach for the short and fit for the tall
- Design for the worker population
- If the worker population does not change, design the work areas to be adjustable to accommodate those workers.
- Design for a range/adjustability
- Whenever possible, design a work area to include adjustability to accommodate the 95th percentile male and the 5th percentile female neutral postures.

Setting work heights has other considerations as well:
- The proper positioning depends on the type of work being done.
- The size (dimensions) of the work piece must also be taken into consideration.
DESIGN STRATEGIES

Back Protecting Strategies:

- Bending at the waist should be avoided. Objects to be lifted should be located between knuckle and shoulder levels. Avoid placing loads on the floor.
- Reach distances should be minimized. Reaching to the other side of a pallet places 10 times the compression on the spine as lifting close to the body!
- Twisting should be eliminated. Twisting, while lifting, stresses the spine, as well as requiring the least capable muscles in the torso to do most of the work.
- High speed or acceleration/deceleration should be avoided. The faster the object is moving, the greater the effective weight of the object.
- Minimize pushing/pulling – if one must be done, pushing allows a person to get in better alignment to use both hands to exert the force, allows entire body weight to be used more effectively, and improves stability in case of slipping.
- Minimize load weights
- Slide objects
- Lower loads rather than lift
- Use gravity
- Avoid double handling
- Use suitable containers
- Provide comfortable hand holds
- Remove constraints/obstacles

Tool Design Considerations:

- Tool/Target
  The design of the tool and the orientation of the target should be complementary. The combination should promote the operator to work the majority of the time in a neutral posture.
• **Hand Tool Design Risk Factors**
  - Awkward or forceful gripping
  - Twisting or bending of the wrist
  - Static arm postures
  - Excessive tool weight
  - Excessive vibration
  - Repetitive triggering actions
  - Heavy trigger pressure
  - Mechanical stresses on the hand and fingers
  - Exposure to the hand and wrist for heat and cold

• **Power Tools Tips & Controls**
  - Use tool balancers
  - Reorient work
  - Use angled tools
  - Use in line tool for vertical work
  - Use pistol grip for horizontal work
  - Use dyna-swivel couplings for air tools
  - Use adjustable workstations
  - Handles should be 4"-5" long
  - Utilize vibration and torque dampening features
  - Handle diameter should be 1.25" to 2"
  - Control exhaust at the exit point

• **Trigger Design**
  - Minimal 1" long to allow for activation by 2 fingers
  - 3 to 4 finger triggers should only be used on suspended tools,
  - Trigger should be activated by index or middle finger,
  - Avoid thumb triggers on highly repetitive operations

• **Torque reduction strategies**
  - For a pistol grip tool use reaction torque limiting devices if the torque exceeds 24 in-lbs.
  - For a straight or in-line deriver, use reaction a reaction torque exceeds 14 in-lbs.
  - For right angle power tools with torque exceeding 42 in-lbs. Use an articulation arm, or some other positive means of reaction torque limiting devices.
- Manual Tool Dimensions

![Image of screwdriver and pliers with dimensions](image)

\[
A \geq 4'' \quad B = \text{(for power grips) } 1.5'' \quad C = \text{3'' to 3.5'' (for precision operations)} .45''
\]

- **Workstation Design Considerations:**

  **Facts about Sitting**
  - On average, sitting erect places 50% more compressive force on the spine than standing in a comfortable, erect posture.
  - Sitting in a poor posture can double the amount of compressive force that is placed on the spine when standing in a comfortable, erect posture.
  - Sitting reduces blood flow to the back muscles.

  **Advantages of Standing**
  - Encourages movement and changes in posture, which promotes blood circulation.
  - Allows body weight and strength to be used more effectively.
  - Encourages the person to move the feet rather than twisting or leaning with the upper body.

- **Standing Workstations Design Considerations**
  - Work height should vary based on the type of work being performed. The more precise the work the higher the workstation.
  - Always account for foot clearance.
  - Avoid sharp edges that may come into contact with the operator.
  - Provide anti-fatigue matting if the employee will spend most of the time standing without moving.
Seated Workstations Design Considerations

- Work height should vary based on the type of work being performed. The more precise the work the higher the workstation.
- Ensure that there is no mechanical pressure from the front edge of the seat on the back of the leg.
- Ensure that there is enough room for the knees and feet under the work surface.
- Any seated individual should have a chair or stool that provides good, adjustable lower back support.
- Avoid sharp edges that may come into contact with the operator.
- Height of the chair or workstation should be worker adjustable if there will be more than one employee working at the same station at different times.
Sit/Stand Workstations Design Considerations

- Sit/stand chairs give the employee the ability to take their weight off of their feet when working at a standing workstation. The sit/stand stool is not sat on but leaned against.
It is best utilized when the employee is required to frequently move around to retrieve parts but most of the time is spent stationary. A normal stool would require the operator to climb up and down repeatedly and would not be practical.

**Environmental Considerations:**

- **Illumination/lighting** – ensure sufficient lighting is present for each operation.
  - Increased overhead lighting may be required
  - Task lighting may be an alternative
  - Diffusers for lighting fixtures may help if too much light is a concern or if glare is a problem
  - Blinds or curtains can be placed over windows to help eliminate glare problems due to outside light
  - The location of a work area may need to be evaluated to determine if moving the work area/materials/equipment might minimize lighting concerns.

- **Temperature** – too hot or too cold of a work environment can be stressful on workers.
  - If conditions are too hot, consider providing fans, air conditioning, allowing lightweight clothing to be worn (if safe), and/or sufficient breaks in a cool environment.
  - If conditions are too cool, consider providing local heat enhancement (e.g., portable heater), heat suits, allowing more clothes to be worn (if safe), and/or sufficient breaks in a warm environment.
  - If the temperature concerns result from tool exhaust, consider modifying the tool exhaust location to minimize the direct flow onto the worker’s body.
ADMINISTRATIVE ACTIONS
Administrative controls reduce the exposure to the hazard, but don’t usually eliminate it.

Training: Training is essential to the ergonomics process. It can take many forms and serve many purposes:

Awareness Training: Training should be given to all employees to make them aware of:
- the company’s commitment level to improving ergonomics,
- the procedures for participating in the ergonomics process, including
  - how to notify someone of a problem,
  - how to make a suggestion
  - how they will be able to follow the problem or suggestion through the evaluation process
  - how they can help with the process
- the risk factors that they may be exposed to on the job
- the symptoms and progression of CTDs that are of concern,
- the proper treatment of those CTDs and how the company will help.

Supervisor Training: This training will be an expanded version of the Awareness training. The goal is to provide the supervisors with a thorough understanding of the issues so that they can handle any questions. They should also be able to express any concerns and understand where they fit into the process.

Team Member Training: Any persons that will be responsible for the addressing ergonomic problems in the facility should be trained as a group so that they can work out the companies approaches and definitions to various situations. They also need a thorough understanding of the tools and techniques that will be used in the facility for data collection and problem solving.

Upper Management Training: This should be given to all decision makers so that they understand the importance of ergonomics to their departments. The goal is to ensure that they will understand how ergonomics will improve their bottom line numbers and how they can support the process.

Engineer/Maintenance training: These two groups control how the jobs are designed, setup, and run. They need to understand that they play a key role in the success of the process. They also need to know the importance of working with the team members at all stages of modifications or additions to the line.

Job Rotation: Job rotation is a standard administrative safety approach for reducing the amount of time an individual is exposed to a hazard that has yet to be eliminated. Some important characteristics of effective job rotation are:
- The employees should be rotated to a task that does not involve exposure to the primary risk factors present in the previous task. The goal of the
rotation is to reduce exposure of the individual to the hazard and give their body time to recover from those stresses. If possible, the rotation should take the individual to a task that does not even utilize the body parts involved in the risk exposure

• The rotation should occur as frequently as possible. Minimally, the rotation that occurs every other day or week should not be considered as an ergonomic intervention.
• Employees should have input into the rotation schedule. The schedule should be determined based on risk factors and exposures. Once set, the schedule should be followed with periodic review for any modifications that might be necessary.

**Pacing:** Pacing is a method of minimizing exposure to repetitive risk factor elements by controlling the speed of production. This is not very popular with production managers since slowing line or work speed typically has a negative impact on production.

**Methods, Policy, Guidelines:** This involves a formal statement of how a task should be performed. Many times, it is found that within a group of operators, there are several techniques or methods being used to perform the same task. This is commonly a result of multiple individuals training new hires, and passing on their own styles. This is very evident when looking at the same tasks performed on different shifts.

Typically, there are elements of each method that incorporate fewer risk factors then others. By setting a formal policy on methods, a team can determine the best techniques for performing the tasks and establish that as the official way to do the job. **NOTE:** To make this work select individuals must be set to train all new hires and periodically re-evaluate employees as needed.

**Job Enlargement:** By increasing the number of tasks performed by an operator, the time spent doing the elements of the task that contain the risk factors is reduced. This is a kind of internal rotation. The operator's exposure time to a particular risk can be reduced
Quick Exposure Check (QEC)

QEC has been designed to:

■ assess the changes in exposure to musculoskeletal risk factors of the back, shoulders and arms, hands and wrists, and neck before and after an ergonomic intervention
■ involve the practitioner (i.e. the observer) who conducts the assessment, and the worker who has direct experience of the task
■ indicate change in exposure scores following an intervention

The QEC Guide gives more detailed information about each question and the background to QEC.

Worker’s name: ________________________________________________________________

Worker’s job title: ______________________________________________________________

Task: _______________________________________________________________________

Assessment conducted by: _______________________________________________________

Date: ______________________ Time: ________________________________

Action(s) required: _____________________________________________________________

For more information on the Quick Exposure Check contact:
The Robens Centre for Health Ergonomics
European Institute of Health and Medical Sciences
University of Surrey, Guildford GU2 7TE
Telephone 01483 689 213
www.surrey.ac.uk/robens/erg

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### Observer's Assessment

#### Back

**A** When performing the task, is the back (select worse case situation)

- **A1** Almost neutral?
- **A2** Moderately flexed or twisted or side bent?
- **A3** Excessively flexed or twisted or side bent?

**B** Select **ONLY ONE** of the two following task options:

**EITHER**

For seated or standing stationary tasks. Does the back remain in a **static** position most of the time?

- **B1** No
- **B2** Yes

**OR**

For lifting, pushing/pulling and carrying tasks (i.e. moving a load). Is the **movement** of the back

- **B3** Infrequent (around 3 times per minute or less)?
- **B4** Frequent (around 8 times per minute)?
- **B5** Very frequent (around 12 times per minute or more)?

#### Shoulder/Arm

**C** When the task is performed, are the hands (select worse case situation)

- **C1** At or below waist height?
- **C2** At about chest height?
- **C3** At or above shoulder height?

**D** Is the shoulder/arm movement

- **D1** Infrequent (some intermittent movement)?
- **D2** Frequent (regular movement with some pauses)?
- **D3** Very frequent (almost continuous movement)?

#### Wrist/Hand

**E** Is the task performed with (select worse case situation)

- **E1** An almost straight wrist?
- **E2** A deviated or bent wrist?

**F** Are similar motion patterns repeated

- **F1** 10 times per minute or less?
- **F2** 11 to 20 times per minute?
- **F3** More than 20 times per minute?

#### Neck

**G** When performing the task, is the head/neck bent or twisted?

- **G1** No
- **G2** Yes, occasionally
- **G3** Yes, continuously

### Worker's Assessment

#### Workers

**H** Is the maximum weight handled MANUALLY BY YOU in this task?

- **H1** Light (5 kg or less)
- **H2** Moderate (6 to 10 kg)
- **H3** Heavy (11 to 20 kg)
- **H4** Very heavy (more than 20 kg)

**J** On average, how much time do you spend per day on this task?

- **J1** Less than 2 hours
- **J2** 2 to 4 hours
- **J3** More than 4 hours

**K** When performing this task, is the maximum force level exerted by one hand?

- **K1** Low (e.g. less than 1 kg)
- **K2** Medium (e.g. 1 to 4 kg)
- **K3** High (e.g. more than 4 kg)

**L** Is the visual demand of this task

- **L1** Low (almost no need to view fine details)?
- **L2** High (need to view some fine details)?

* If High, please give details in the box below

**M** At work do you drive a vehicle for

- **M1** Less than one hour per day or Never?
- **M2** Between 1 and 4 hours per day?
- **M3** More than 4 hours per day?

**N** At work do you use vibrating tools for

- **N1** Less than one hour per day or Never?
- **N2** Between 1 and 4 hours per day?
- **N3** More than 4 hours per day?

**P** Do you have difficulty keeping up with this work?

- **P1** Never
- **P2** Sometimes
- **P3** Often

* If Often, please give details in the box below

**Q** In general, how do you find this job

- **Q1** Not at all stressful?
- **Q2** Mildly stressful?

*Q3** Moderately stressful?

* **Q4** Very stressful?

* If Moderately or Very, please give details in the box below

---

* Additional details for L, P and Q if appropriate

- **L**
- **P**
- **Q**
Guidelines for lifts involving trunk-twisting angle* of +/- 30 degrees

*Angle in which the person doing the lifting will twist (left and/or right).

- Choose a column indicating whether the person has a lower-back disorder (LBD) or not (Healthy).
- Determine the region (zone) of the maximum horizontal reach distance (measured from spine to hands) and the vertical lift origin from the floor for each lift.
- The color-coded zones indicate degree of risk for LBD (green = low, yellow = medium, red = high).
- To minimize the risk of recurrent injury, change the lifting conditions so that the lifting weight is in the green area.

- Maximum safe load:
  - 35 pounds
  - 70 pounds
  - 40 pounds

- Horizontal reach distance from spine:
  - 12 inches
  - 24 inches

- Vertical lift origin:
  - Shoulder
  - Waist
  - Knee
  - Floor

- Weight of lift (pounds): 10, 15, 20, 25
**Guidelines for lifts involving trunk-twisting angle* between 30 and 60 degrees**

*Angle in which the person doing the lifting will twist (left and/or right).

Choose a column indicating whether the person has a lower-back disorder (LBD) or not (Healthy).

Determine the region (zone) of the maximum horizontal reach distance (measured from spine to hands) and the vertical lift origin from the floor for each lift.

The color-coded zones indicate degree of risk for LBD (green = low, yellow = medium, red = high).

To minimize the risk of recurrent injury, change the lifting conditions so that the lifting weight is in the green area.
Guidelines for lifts involving trunk-twisting angle* between 60 and 90 degrees

*Angle in which the person doing the lifting will twist (left and/or right).

- Choose a column indicating whether the person has a lower-back disorder (LBD) or not (Healthy).
- Determine the region (zone) of the maximum horizontal reach distance (measured from spine to hands) and the vertical lift origin from the floor for each lift.
- The color-coded zones indicate degree of risk for LBD (green = low, yellow = medium, red = high).
- To minimize the risk of recurrent injury, change the lifting conditions so that the lifting weight is in the green area.
The main goal of the Division of Safety & Hygiene is the reduction of accidents and illnesses in the workplace. Toward this goal, the One Hour Safety presentation is designed to support the delivery of a presentation to co-workers in your workplace to help them understand and promote safer and healthier work environments. It is recommended that you take the DSH Training Center course as a background for using One Hour Safety Presentation to train others at your workplace. Call 1-800-OHIOBWC, option 2, 2, for class dates and locations.

The One Hour Safety Presentation contains:
- Transparency Masters from which films can be made to use on an overhead projector,
- Instructor Notes which gives the instructor suggestions and script notations to use during the presentation, and
- Student Handouts which can be copied for those attending the presentation.

Materials are included for a one-hour presentation on each of these topics:
- Accident Analysis
- Bloodborne Pathogens
- Effective Safety Teams
- Enhancing Safety through a Drug-Free Workplace
- Ergonomics Basic Principles
- Ergonomics Developing an Effective Process
- Hazard Communication
- Lockout/Tagout and Safety-related Work Practices
- Machine Guarding Basics
- Measuring Safety Performance
- Noise & Hearing Conservation
- Personal Protective Equipment
- Powered Industrial Trucks Training Program
- Respiratory Protection
- Safety and Ergonomics for Extended Care Facilities
- Violence in the Workplace
- Wellness in the Workplace

Applications used:
1) Text documents (ending in .txt) can be opened with any word processing program.
2) Microsoft PowerPoint slides (ending in .ppt) can be opened with the Microsoft PowerPoint program. If you do not have PowerPoint and you do have Windows 95, 98, 2000 or Windows NT operating system, you can view the PowerPoint slides by downloading a free PowerPoint Viewer from the following website:
3) Adobe Reader document (ending in .pdf) contains the One Hour Safety Presentation in read-only format. It can be opened when you download Adobe Reader, which is available free of charge at the following website:
   http://www.adobe.com/products/acrobat/readstep2.html

If you have comments or questions about these materials for One Hour Safety Presentation, please e-mail us: Safety@bwc.state.oh.us or call us at the number above.
Transparency Masters
Ergonomics
A Balance for Optimization

Job Demands

Worker Capabilities
Ergonomics

Win/Win

Higher Production
Higher Quality
Compliance
Lower Compensation Costs

Careers/Employment
Longevity
Safe Working Conditions
Quality of life
Morale
Acute Vs. Cumulative Disorders

- **Acute:**
  - Result from a one time event

- **Cumulative:**
  - Result from repeated wear and tear; however, a specific event may have been “the last straw” upon a previously weakened system and thus given the appearance that the problem is acute rather than chronic. (Stephen Konz. “Work Design; Industrial Ergonomics”, Third edition. 1990)
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- Tenosynovitis
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- Carpal Tunnel Syndrome
Two Kinds of Back Injuries

MUSCULAR

SPINAL
Risk Factors

- Repetition
- Forceful Exertion
- Direct Mechanical Pressure
- Static Posture
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- Workstation Design
- Tool Design
- Process Modification
- Mechanical Assist
- Education

Administrative Controls
- Training
- Job Rotation
- Pacing
- Policy
- Job Enlargement

Band Aid Solutions ?!
- Splints
- Braces
Design Strategies - Hand Tool Design

Power Tools Tips & Controls

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Ergonomics

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Instructor Notes
Ergonomics
WHAT IS ERGONOMICS?
There are many definitions of ergonomics:
The study of the laws of work.
Fitting the task to the worker rather than forcing him/her to adapt to the working environment.
Designing the workplace to prevent occupational injury and illness.
The process of identifying and preventing work related musculoskeletal disorders.
Working definition:
The process of balancing job demands worker capabilities.
The application of ergonomic principles is a win-win scenario for both management and labor.

**LABOR BENEFITS**

**Career Longevity**
You can control your career destiny.

**Safe Working Conditions**
Safe working conditions allows everyone to work with minimum fatigue. This in-turn will give you more energy for other activities. Minimizing pain on the job allows a worker to focus on the tasks of the job.

**Quality of Life**
Ergonomics can provide long-term benefits. You should retire from work able to enjoy your hobbies and activities pain-free for the rest of your life.

**Morale**
Ergonomics can help make your job less stressful so that you can concentrate on other things rather than your discomfort. Employees' morale may also be uplifted if they “see” that the company does care about how the workers are feeling while performing a job.

**MANAGEMENT BENEFITS**

**Production**
When ergonomic principles are properly applied, many obstacles to efficient production are removed. It has been shown that production can be positively impacted when ergonomics is applied.
Some examples of production benefits of proper ergonomically designed jobs are:
Less fatigue
Elimination of bottlenecks
Reduction of bottlenecks
Increased throughput
Optimization of cycle time
Help in meeting deadlines
Well designed jobs
Increase in profitability & competitiveness

**Quality**
As mentioned earlier, when an employee has an ache or pain, his/her mind is not on the task at hand. Removing the causes of those pains will mean greater focus on the job, resulting in higher quality. This is true for all jobs where quality of the product or service is important.

Some examples of quality benefits of proper ergonomically designed jobs are:
Less scrap and re-work
Increased efficiency
Reduction of rushing and shortcuts
Less fatigue
Improved customer satisfaction
Better accuracy
Acute Vs. Cumulative Disorders

- Acute:
  - Result from a one time event
- Cumulative:
  - Result from repeated wear and tear; however, a specific event may have been “the last straw” upon a previously weakened system and thus given the appearance that the problem is acute rather than chronic. {Stephen Konz. “Work Design; Industrial Ergonomics”, Third edition. 1990}

ACUTE VERSUS CUMULATIVE INJURIES

Acute Injuries are the type of injuries that traditional safety deals with preventing. These injuries result from a single event that has a clear cause-effect relationship.

Example: If a person cuts his/her finger, it is very simple to determine the cause. The individual usually knows:
what cut the finger;
what they were doing when they were cut;
what they were doing just before the injury occurred;
who was around them at the time of the injury, and so forth.

Cumulative Injuries result from multiple events over a period of time. However, a specific event may have been “the last straw” for the previously weakened system, thus giving the appearance that the problem is acute rather than chronic.


Example: You probably know someone that has stepped off of a curb, hopped out of a truck, or picked up a small item from the floor and had shooting, debilitating pain in their back. At first glance this may seem like an acute injury. However, the act of picking a small bolt up off of the floor is not a dangerous act. And, it is obvious (since we all do similar activities daily) that it is not the sole cause of this injury. This action, that was associated with the pain, is simply that “last straw” that “broke their back”. There were probably thousands of insults and injuries to this back before it reached the injury point. This is a classic example of a back injury that could be classified as a cumulative trauma disorder.
Some Common Upper Extremity CTD’s

- Tendinitis
- Tenosynovitis
- Trigger Finger
- Epicondylitis
- Thoracic Outlet Syndrome
- Carpal Tunnel Syndrome

**Common Cumulative Trauma Disorders**

Tendinitis: a form of tendon inflammation when muscle/tendon unit is repeatedly tensed.

Tenosynovitis: repetitive-induced tendon injury involving the synovial sheath; sheath produces excess synovial fluid

Trigger Finger: tendon sheath of finger sufficiently swollen to lock tendon in sheath

Epicondylitis: tendonitis effecting vulnerable unsheathed tendons of the elbow and shoulder

Carpal Tunnel Syndrome: compression of median nerve through the tunnel, sometimes resulting from tenosynovitis of finger tendons
Two Kinds of Back Injuries

BACK INJURIES

Work related back injuries fall into two primary categories:
1) Muscular injuries
2) Spinal injuries

Muscular injuries
Of the two we can recover most easily from muscle injuries. A pulled muscle, if the individual is injured while doing the normal duties of his or her job, is a warning that the back is not strong enough to do the work. Proper exercises should be obtained from a doctor, physical therapist, or occupational therapist that knows the individual’s back history and job duties.

Spinal injuries
The three main components of the spine are the vertebrae, spinal cord, and the discs. The weak links in this system are the discs.

There are two important factors which must be considered when dealing with the spine. First, the discs have no direct blood supply which means that all nutrients must be transmitted from the surface of the vertebra. Therefore, the discs actually take longer to heal than bones.

The second factor is that there are no nerve connections to the discs. This means that when the disc is injured you don’t know it. Because you are not aware of the injury, you do not make any changes and keep doing what you normally do, making the healing process even slower.

Since the discs and surrounding bone heal slowly, and are aggravated by sustained activity, scar tissue is formed. This scar tissue impedes the flow of nutrients to the disc, causing increased degeneration as time progresses.
Risk factors are those characteristics of a job that might contribute to the onset of aches/pains and/or injury. There are several CTD risk factors that may be present at a work area. The more risk factors that are present, the higher the risk of injury. Also, higher levels of individual risk factors increases the risk of injury.

The best way to reduce the risk of injury is to identify these risk factors and implement control measures which eliminate or reduce these risk factors.
Ergonomics

Worksite Analysis

Methods

• Task Analysis
• Checklists
• NIOSH Lifting Guides
• Video Taping / Observation
• Interviews
• Symptom Surveys

BWC / OSU Lifting Guidelines: BWC and The Ohio State University have partnered to develop lifting guidelines for healthy workers and workers with low back disability. The purpose of the guidelines is to aid in developing realistic transitional work programs for employees with low back disorders and to provide guidance on the design of lifting tasks to reduce the frequency and severity of initial and recurring back claims. The tool can be accessed online at http://www.ohiobwc.com/employer/programs/safety/Ergoliftguide.asp

There are many techniques for evaluating problem jobs and determining the causes of the problems. **Task Analysis** is an outline or set of instructions for sequenced actions to accomplish a task. **Checklists** are shorthand tools that help to collect and quantify risk factors. Checklists are rarely if ever valid pass/fail measurement devices. They are best used as comparative gauges.

**National Institute for Occupational Safety and Health (NIOSH) Lifting Model** – was developed as an evaluation tool to assist individuals in assessing lifting tasks. The outcome of the model is to determine a recommended weight limit (RWL) where a “normal” worker would not likely injure their back while performing the lifting task.

**Video taping** is a useful tool for ergonomic evaluations for many reasons:

• It allows a permanent record of the job to show before and after conditions.
• It allows multiple people to perform a task analysis without causing a major disruption.
• It allows much more thorough analysis of a task.
• It uncovers differences in technique.

**Interviews and Symptoms Surveys** involve asking the workers to suggest improvements and to report pain and/or discomfort associated with the job.
CONTROL STRATEGIES

Engineering Controls are permanent modifications to the working environment to reduce or eliminate a recognized ergonomic risk factor. Common types of engineering controls include:

- Workstation design
- Tool Design
- Process modification
- Mechanical Assistance devices

The most important consideration when making an engineering change to a job is to include the employees that will be using the modifications. They must:
- understand why the change is being made,
- feel as if they have had input into the change
- understand that the first modification is not perfect and that their input will be critical to making the project work.

Administrative Controls are managerial decisions that affect exposure to the risk factors but do not remove the actual hazards. Typical Administrative controls include:

- Training
- Job Rotation
- Pacing
- Policy
- Job Enlargement

Administrative controls can be put in place until an engineering solution can be developed.

Band-Aid Solutions (or ergonomic snake oil?) are things such as wrist splints. Wrist splints should not be used on the job unless the individual is under ongoing care and monitoring of a physician or physical therapist. Many products have had the term ERGONOMICS added to them by the marketing people. However, any tool or item can be used in a good or poor ergonomic fashion. What makes a job poorly designed, from an ergonomic standpoint, is not how a given item was designed, but how it works in conjunction with the task at hand.
Power Tools Tips & Controls

- Use tool balancers
- Reorient work
- Use angled tools
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- Use dyna-swivel
- Use adjustable workstations
- Use 3 or 4 finger triggers
- Handles should be 4”-5” long
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- Handle diameter 1.25”-2”
- Control exhaust exit point

Trigger Design

- Minimal 1” long to allow for activation by 2 fingers
- 3 to 4 finger triggers should only be used on suspended tools,
- Trigger should be activated by index or middle finger,
- Avoid thumb triggers on highly repetitive operations

Torque reduction strategies

- For a pistol grip tool use reaction torque limiting devices if the torque exceeds 24 in-lbs.
- For a straight or in-line deriver, use reaction a reaction torque exceeds 14 in-lbs.
- For right angle power tools with torque exceeding 42 in-lbs. Use an articulation arm, or some other positive means of reaction torque limiting devices.
**Ergonomics**

**Design Strategies - Back Issues**

- Minimize pushing/pulling
- Minimize load weights
- Slide objects
- Lower loads rather than lift
- Use gravity
- Avoid double handling
- Use suitable containers
- Provide comfortable hand holds
- Remove constraints/obstacles
- Avoid placing loads on the floor

**Back Protecting Strategies:**

Bending at the waist should be avoided. Objects to be lifted should be located between knuckle and shoulder levels. Avoid placing loads on the floor.

Reach distances should be minimized. Reaching to the other side of a pallet places 10 times the compression on the spine as lifting close to the body!

Twisting should be eliminated. Twisting, while lifting, stresses the spine, as well as requiring the least capable muscles in the torso to do most of the work.

High speed or acceleration/deceleration should be avoided. The faster the object is moving, the greater the effective weight of the object.

Minimize pushing/pulling – if one must be done, pushing allows a person to get in better alignment to use both hands to exert the force, allows entire body weight to be used more effectively, and improves stability in case of slipping

Minimize load weights
Slide objects
Lower loads rather than lift
Use gravity
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Remove constraints/obstacles
Ergonomics Consultants analyze the physical relationship between the worker and the workplace. They formulate solutions for problems involving manual materials handling, cumulative trauma disorders, video display terminals, workplace and workspace design, adverse environmental conditions, shift work, and occupational stress, and provide consultation to reduce low-back injuries in the workplace. BWC consultants are available, at no additional fee, to help Ohio employers.

The BWC Library provides free information services on the topics of occupational safety and health, workers’ compensation, and rehabilitation. Library users do not have to visit the library; most phone, fax, or e-mail their requests for a quick response. Our experienced and knowledgeable staff provides personalized, objective research services and in-depth answers.

The Video Library is a lending library of occupational safety and health videotapes. It has an extensive collection of 500 titles. There is no direct charge for borrowing tapes from the Video Library. Users may view or preview tapes on-site.

The BWC Division of Safety & Hygiene Training Center is an adult continuing education facility specializing in occupational safety and health. Through seminars and workshops, the Training Center provides students with the knowledge, tools and skills they need to prevent occupational injuries and illnesses in the workplace. More than 30 subjects are offered addressing:

- industrial safety,
- construction safety,
- industrial hygiene,
- ergonomics and
- safety management.

For more information:
Call 1-800-OHIOBWC
Or visit www.ohiobwc.com
Student Handouts
Ergonomics

A Balance for Optimization

Win/Win

- Higher Production
- Higher Quality
- Compliance
- Lower Compensation Costs

Careers/Employment
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- Tool Design
- Process Modification
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- Education

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- Pacing
- Policy
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