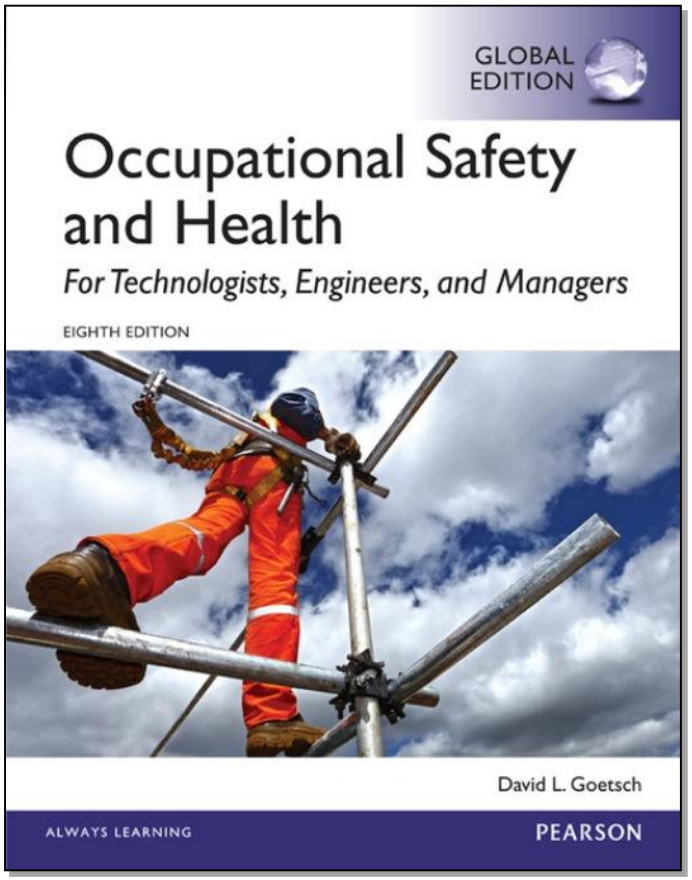
Occupational Safety and Health

for Technologists, Engineers, and Managers

EIGHTH EDITION



CHAPTER 10

Ergonomic Hazards: Musculoskeletal Disorders (MSDs) and Cumulative Trauma Disorders (CTDs)

Introduction

- Workplace development in the Western world is characterized by jobs & technologies designed to improve processes and productivity.
  - With little or no concern was given to the impact of the job process or technology on workers.
  - Work processes and machines have sometimes been unnecessarily dangerous.

Introduction

- Workplace development in the Western world is characterized by jobs & technologies designed to improve processes and productivity.
  - New technologies have sometimes failed to live up to expectations.

Introduction

- The advent of the science of ergonomics is making the workplace more physically friendly.
  - Making the workplace a safer and healthier place.

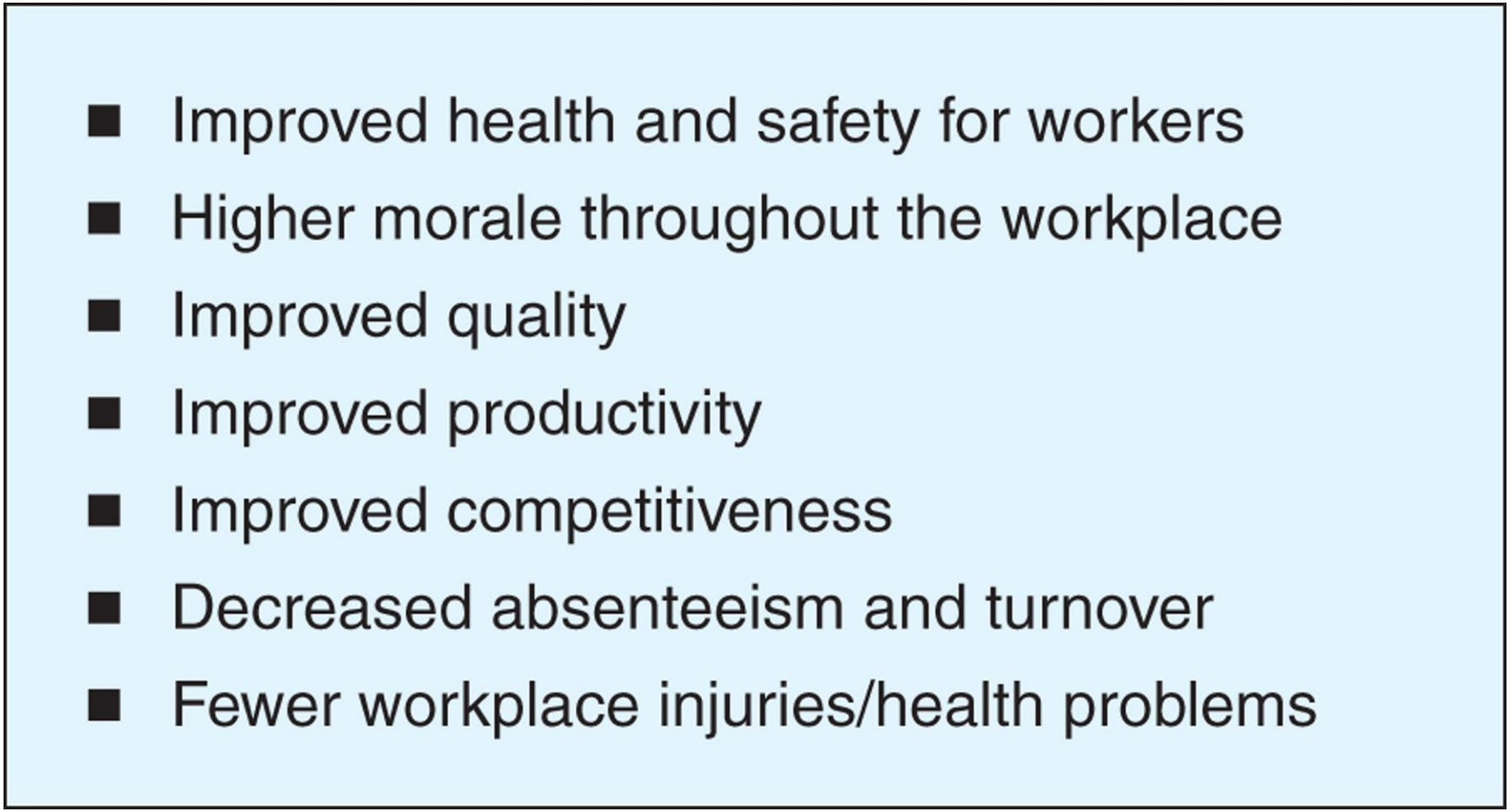
Ergonomics Defined

- Ergonomics is defined as:
  - *…a multidisciplinary science that seeks to conform the workplace and all of its physiological aspects to the worker.*
- Ergonomics involves the following:
  - *Using special design and evaluation techniques to make tasks, objects, and environments more compatible with human abilities and limitations.*

Ergonomics Defined

- Ergonomics involves the following:
  - *Seeking to improve productivity and quality by reducing workplace stressors, reducing the risk of injuries and illnesses, and increasing efficiency.*

FIGURE 10–1 **Benefits of ergonomics.**



Human Factors and Ergonomic Hazards

- *What is meant by the term human factors?*
  - A profession to help ensure that equipment & systems are safe & easy to operate by human beings.
- A human factors researcher gathers and analyzes data on human beings,
  - How they work, their size, capabilities & limitations

Human Factors and Ergonomic Hazards

- A human factors engineer works with designers.
  - To incorporate data into designs to make sure people can operate and maintain the product or system.
- Human factors experts are trained in:
  - Psychology, anthropology, engineering, biology, medicine, education, and physiology.

Human Factors in Action

- **Predesign analysis** - Human factors professionals conduct research to answer such questions as:
  - What is the best way for humans to interact with computers?
  - What factors contribute to fatigue and stress in an office environment?
  - How can designers overcome these factors?

Human Factors in Action

- **Preliminary design** - Study of machine and human capabilities to determine which tasks should be undertaken manually and which should be automated.

Human Factors in Action

- **Detail design and development** - defining the environment required for operator safety, enhanced operator performance, and the reduction or prevention of operator stress and fatigue.

Human Factors in Action

- **Test and evaluation -** In this stage, human factors professionals test actual humans in using the prototype equipment or system.

Human Factors and Safety

- The science of human factors can help reduce both product and workplace hazards…
  - **Hazard elimination by design** - Intelligent design can reduce human errors by providing controls that are simple to understand and operate

Human Factors and Safety

- The science of human factors can help reduce both product and workplace hazards…
  - **Provision & location of safety devices -** Design/location of safety devices such as emergency cutoff switches can reduce human error on the job, correspondingly reducing the chances of an accident.

Human Factors and Safety

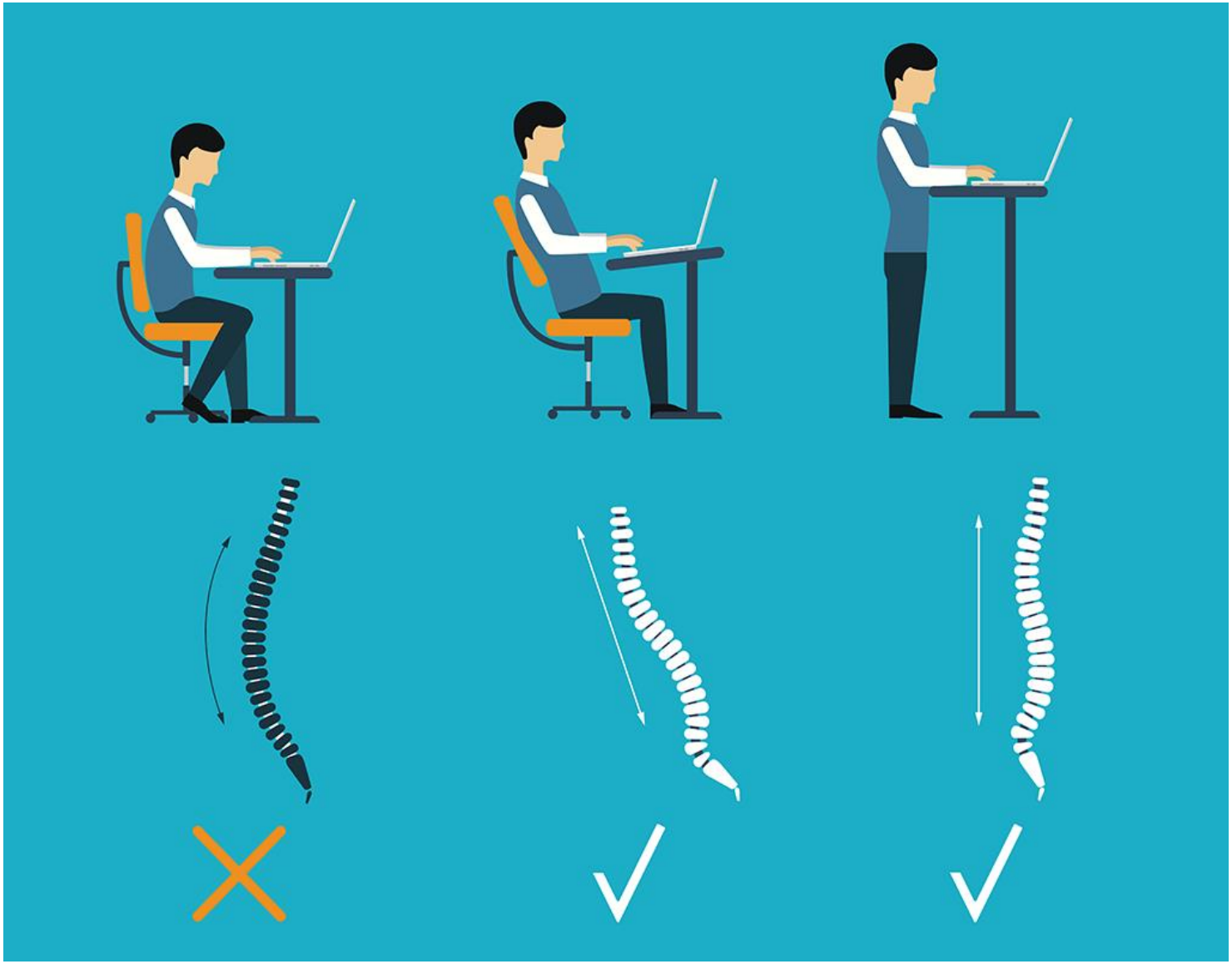
- The science of human factors can help reduce both product and workplace hazards…
  - **Provision of warning devices -** Color, location & wording of warning devices; pitch & volume of warning signals; design of caution markings on gauges and video displays are important factors in reducing human error.

Human Factors and Safety

- The science of human factors can help reduce both product and workplace hazards…
  - **Establishment of procedures/provision of training** - When hazards cannot be realistically designed out of a system, administrative procedures for hazard reduction must be established, and training relating to those procedures must be provided.

Factors Associated with Physical Stress

- Eight variables can influence the amount of physical stress experienced on the job are as follows:
  - Sitting versus standing.
  - Stationary versus moveable/mobile.
  - Large demand for strength/power vs. small demand for strength/power.



2021 WORKSTATION ERGONOMICS

WRONG POSTURE

- ✗ Leaning too far forward
- ✗ Not using back rest
- ✗ Strained wrist angle
- ✗ No armrests

HEALTHY POSTURE

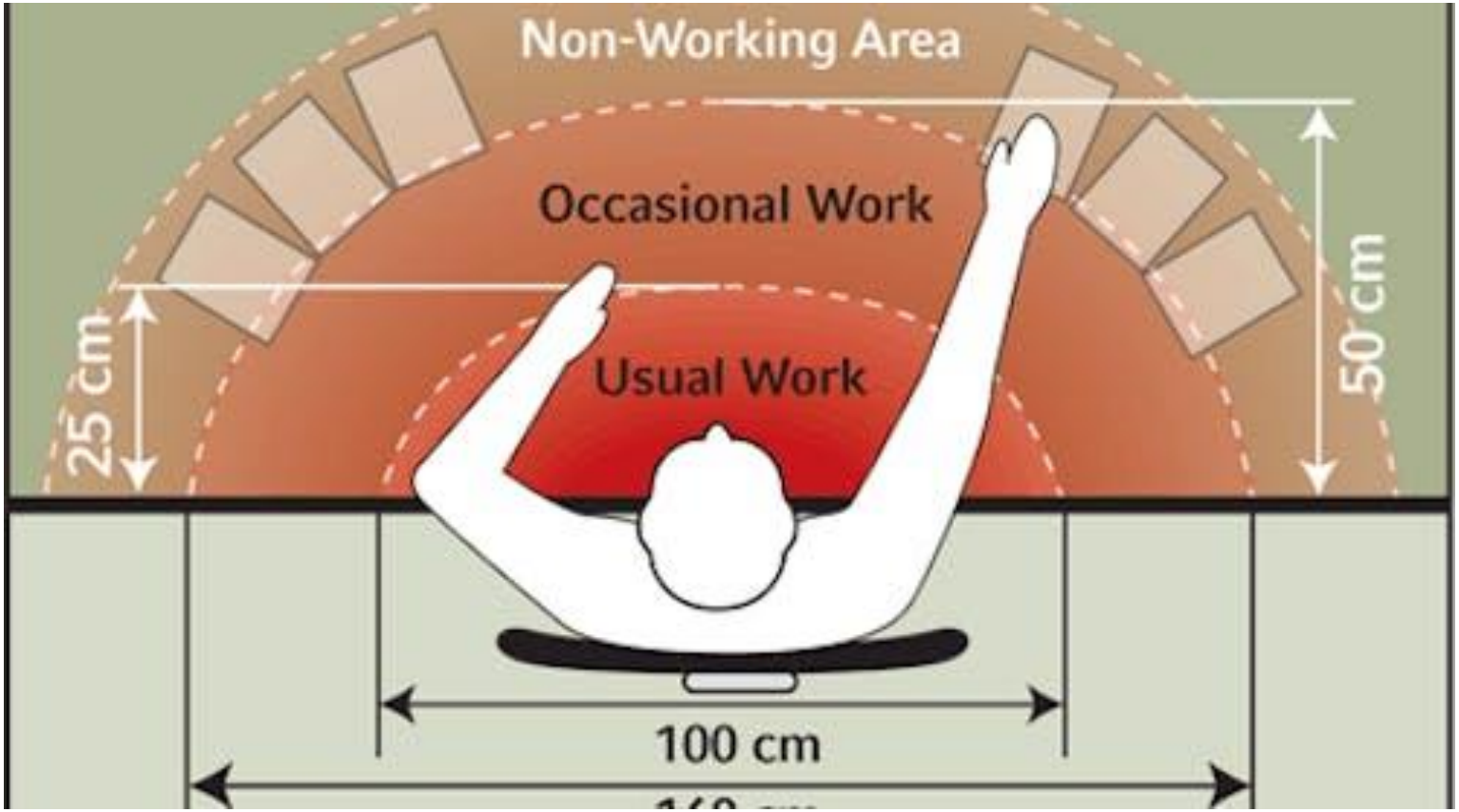
- ✓ Eyes 18-14” from screen
- ✓ Proper chair support
- ✓ Relaxed wrist angle
- ✓ Armrests support elbows & wrist height

Source: Ergonomics Health Association
Creating Safer Workplaces
Attribution: vecteezy.com

Reported by: www.rhymebiz.com Rhyme

Factors Associated with Physical Stress

- Eight variables can influence the amount of physical stress experienced on the job are as follows:
  - Good vertical work area vs. bad vertical work area
  - Good horizontal work area vs. bad horizontal work area.
  - Nonrepetitive motion vs. repetitive motion



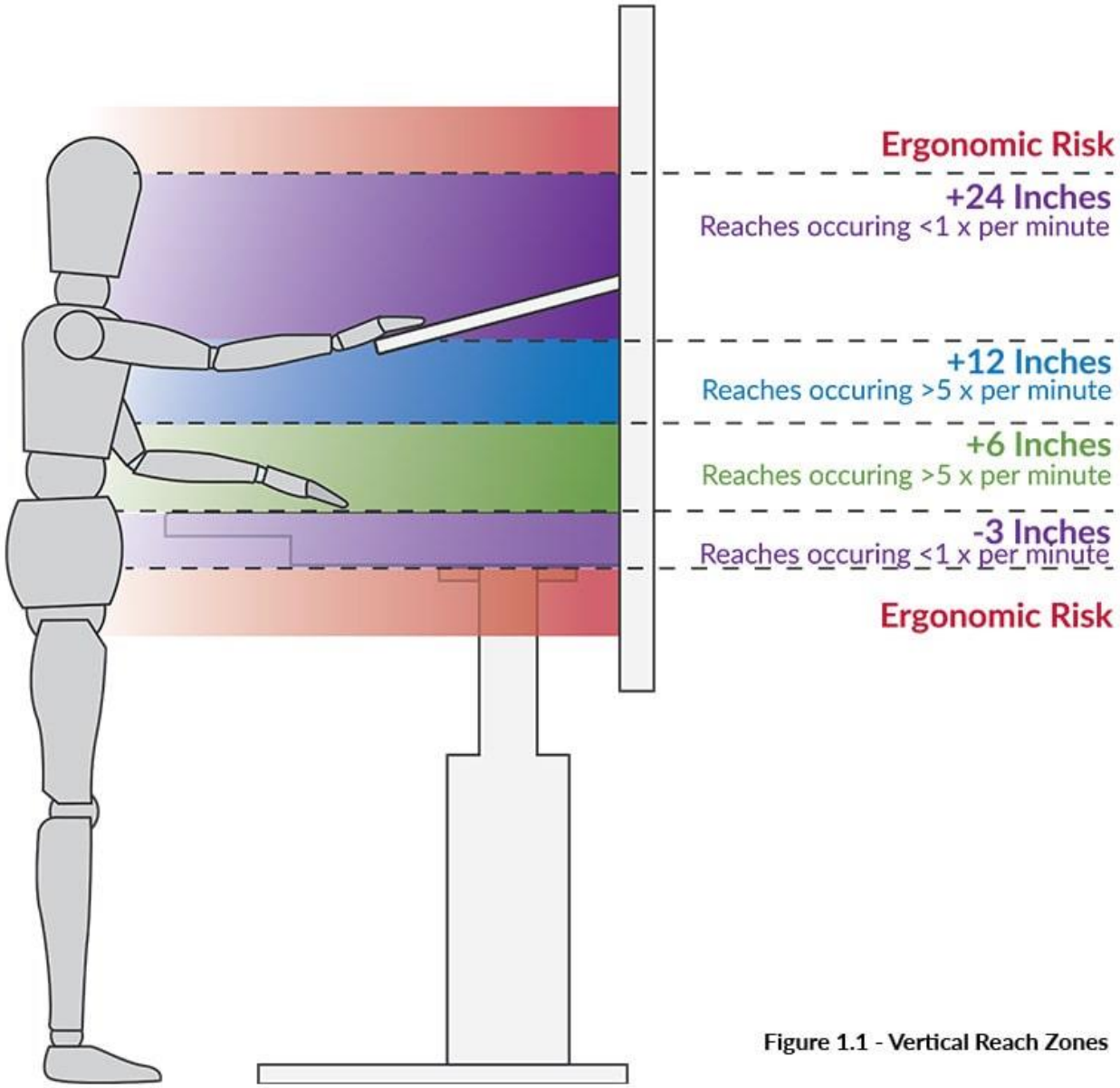


Figure 1.1 - Vertical Reach Zones

Nonrepetitive versus Repetitive Motion

Repetitive motion jobs involve short-cycle motion that is repeated continually.

Nonrepetitive jobs involve a variety of tasks that are not, or only infrequently, repeated.

Repetition can lead to monotony and boredom. When this happens, the potential for physical stress increases.

Factors Associated with Physical Stress

- Eight variables can influence the amount of physical stress experienced on the job are as follows:
  - Low surface versus high surface contact
  - No negative environmental factors vs. negative environmental factors

Low versus High Surface Contact

Surface stress can result from contact with hard surfaces such as tools, machines, and equipment.

High-surface-contact jobs tend to be more stressful in a physical sense than are low-surface-contact jobs.

Absence versus Presence of Negative Environmental Factors

Generally, the more **environmental factors** with which a worker has to contend on the job, the more stressful is the job. For example, personal protective equipment, although conducive to reducing environmental hazards, can increase the amount of physical stress associated with the job.

Ergonomics: A Political Football

- OSHA established voluntary ergonomics guidelines in 1989, and organized labor began its campaign to have the guidelines made mandatory.
  - Just before leaving office, President Clinton signed an executive order putting proposed standards in place.
    - Congress used the Congressional Review Act (CRA) to overturn former President Clinton's executive order.

Ergonomics: A Political Football

- OSHA continues to develop voluntary guidelines beyond those that apply to industry in general for businesses in specific industrial classifications.
- OSHA has begun to claim it will use its general duty clause to enforce ergonomic safety.
- You can visit the fallowing website for detailed information about ergonomics: https://www.osha.gov/ergonomics

OSHA Voluntary Ergonomics Guidelines

- OSHA ergonomics guidelines are designed to give employers information & guidance needed to meet OSH Act obligations regarding ergonomics.
  - OSHA has guidelines specifically for meatpacking, ship-yards, poultry processing, nursing homes & retail stores.

OSHA Voluntary Ergonomics Guidelines

- Meatpacking & poultry processing were singled out because of the high incidence of cumulative trauma disorders (CTDs) associated with these industries.
  - Injuries that result from an accumulation of repetitive motion stress.

OSHA Voluntary Ergonomics Guidelines

- OSHA's current plan for reducing ergonomic hazards in the workplace has four elements:
  - Voluntary guidelines for specific industries.
  - Enforcement of the guidelines under the general duty clause of the OSH Act 5(a)(1).

OSHA Voluntary Ergonomics Guidelines

- OSHA's current plan for reducing ergonomic hazards in the workplace has four elements:
  - Compliance assistance to help employers reduce ergonomic hazards.
  - Research into ergonomic issues to help identify gaps in the body of knowledge surrounding this topic.

Repeal of OSHA's Ergonomic Program Standard

- On November 14, 2000 OSHA issued a final Ergonomic Program Standard (29 CFR 1901 Subpart W). The final rule became effective on January 16, 2001. However, on March 6, 2001 the United States Senate passed a resolution of disapproval (S.J.Res. 6) of the Ergonomic Program Standard under the Congressional Review Act.

Repeal of OSHA's Ergonomic Program Standard

- The House of Representatives then passed S.J. Res. 6 on March 7, 2001. President George W. Bush signed the resolution into law as Public Law 107-5 on March 20, 2001. At this point, OSHA removed the Ergonomic Program Standard from the Code of Federal Regulations. OSHA's Voluntary Ergonomic Guidelines still apply.

Enforcement by OSHA

- OSHA criteria for applying the general duty clause:
  - *Is there currently an ergonomic hazard causing injuries?*
  - *Does the employer in question know about the hazard (or should the employer know)?*

Enforcement by OSHA

- OSHA criteria for applying the general duty clause:
  - *Are the injuries caused by the ergonomic hazard resulting in serious physical harm?*
  - *Are there feasible alternatives available to the employer for reducing or minimizing the hazard?*

Application of the Voluntary Guidelines

- OSHA ergonomics guidelines are geared toward manufacturing/materials handling in the general industry sector—more than 1.5 million employees nationwide.
  - They do not apply to construction, maritime operations, agriculture, or employers that operate a railroad,

Proposed Requirements of the Guidelines

- Organizations in the general industry classifications of manufacturing & manual material handling are asked to implement a "basic ergonomics program."
  - Assigning responsibility for ergonomics to one individual and informing employees about the risks of MSD-related injuries, symptoms & why early reporting is important.

Proposed Requirements of the Guidelines

- Organizations in the general industry classifications of manufacturing & manual material handling are asked to implement a "basic ergonomics program."
  - It also requires employers to establish a system employees can use to report symptoms of MSD injuries.

Proposed Requirements of the Guidelines

- The so-called full program consists of:
  - Management leadership and employee participation.
  - Training, Record keeping, Job hazard analysis & control.
  - Work restriction protection, MSD management, Program evaluation.

Worksite Ergonomics Analysis Program

- Although complex analyses are best performed by a professional ergonomist, this program can be used to conduct a worksite analysis & identify stressors.

Worksite Ergonomics Analysis Program

- The discussion of the recommended program for worksite analysis is divided into four main parts:
  - Gathering information from available sources.
  - Conducting baseline screening surveys to determine which jobs need closer analysis.

Worksite Ergonomics Analysis Program

- The discussion of the recommended program for worksite analysis is divided into four main parts:
  - Performing ergonomic job hazard analyses of those workstations with identified risk factors.
  - After implementing control measures, conducting periodic surveys and follow-up studies to evaluate changes.

Worksite Ergonomics Analysis Program

- The essential first step in worksite analysis is records analysis & tracking to develop information to identify ergonomic hazards in the workplace.
- Incidence rates for upper extremity disorders and/or back injuries should be calculated.

Worksite Ergonomics Analysis Program

- Detailed baseline screening surveys identify jobs that put employees at risk of developing CTDs.
  - If the job places employees at risk, an effective program will then require the ergonomic job hazard analysis.

Worksite Ergonomics Analysis Program

- Detailed baseline screening surveys identify jobs that put employees at risk of developing CTDs.
  - The survey is performed with a checklist of items like posture, materials handling, and upper extremity factors.
    - Tailored to specific needs/conditions of the workplace.

Worksite Ergonomics Analysis Program

- Identification of ergonomic hazards is based on ergonomic risk factors.
  - Conditions of a job process, workstation, or work method that contribute to the risk of developing CTDs.
- The combined effect of several risk factors in the development of CTDs is sometimes referred to as *multiple causation*.

CTD Risk Factors

- Some risk factors for CTDs of the upper extremities:
  - Repetitive and/or prolonged activities.
  - Forceful exertions, usually with hands.
  - Prolonged static postures.
  - Awkward postures of the upper body.
  - Continued physical contact with work surfaces.

CTD Risk Factors

- Some risk factors for CTDs of the upper extremities:
  - Excessive vibration from power tools.
  - Cold temperatures.
  - Inappropriate or inadequate tool design.
  - High wrist acceleration.
  - Fatigue (inadequate recovery time).
  - Use of gloves.

Back Disorder Risk Factors

- Risk factors for back disorders include:
  - Bad body mechanics such as continued bending or lifting from below the knees or above the shoulders, and twisting at the waist, especially while lifting.
  - Lifting or moving objects of excessive weight or asymmetric size
  - Prolonged sitting, especially with poor posture.

Back Disorder Risk Factors

- Risk factors for back disorders include:
  - Lack of adjustable chairs, footrests, body supports, and work surfaces at workstations.
  - Poor grips on handles.
  - Slippery footing.

Ergonomic Job Hazard Analyses

- As an essential third step in the worksite analysis, an effective ergonomics program requires a job hazard analysis for each job so identified.
  - Routinely performed by a qualified safety & health professional, preferably an ergonomist, for jobs that put workers at risk of developing CTDs.

Workstation Analysis

- For upper extremities, measures of repetitiveness:
  - Total hand manipulations per cycle, cycle time & total manipulations or cycles per work shift.
- Force measurements may be noted as an estimated average effort and a peak force.
  - Light, moderate, or heavy.

Workstation Analysis

- Tools should be checked for excessive vibration.
- Hand, arm, and shoulder postures and movements should be assessed for levels of risk.
- For manual materials handling, the maximum weight-lifting values should be calculated.

Workstation Analysis

- Slow-motion videotape or equivalent visual records of workers performing their routine job tasks should be analyzed to determine the demands of the task on the worker and how each worker actually performs each task.

Periodic Ergonomic Surveys

- Periodic surveys should be conducted to identify previously unnoticed factors/failures or deficiencies in work practices or engineering controls.
  - And should include feedback, follow-up & trend analysis.

Feedback and Follow-Up

- A reliable system should be provided for employees to notify management about conditions that appear to be hazardous and to utilize their insight and experience to determine work practice and engineering controls.

Trend Analysis

- Trends of injuries and illnesses related to actual or potential CTDs should be calculated, using several years of data where possible.
  - For several departments, process units, job titles, or workstations.

Trend Analysis

- These trends may also be used to determine…
  - Which work positions are most hazardous and need to be analyzed by the qualified person.
  - Determine the priority of screening surveys and/or ergonomic hazard analyses.

Hazard Prevention and Control

- Engineering solutions, where feasible, are the preferred method for hazard prevention & control.
  - **The focus of an ergonomics program is to make the job fit the person— not to make the person fit the job.**

Hazard Prevention and Control

- A program with this goal requires research into currently available controls and technology.
  - It should also include provisions for utilizing new technologies when available, and for in-house research and testing.

Hazard Prevention and Control

- Workstations should be designed to accommodate the persons who actually use them.
  - It is not sufficient to design for the average/typical worker.

Hazard Prevention and Control

- Work method analysis should static postures and repetition rates, supplemented by addressing force levels and the hand and arm postures involved.
  - Tasks should be altered to reduce these and the other stresses associated with CTDs.

Hazard Prevention and Control

- Tools should be selected and designed to minimize the risks of upper extremity CTDs and back injuries.
  - A variety of sizes, designed to be used by either hand or providing tools for both left- and right-handed workers.

Medical Management Program

- An effective medical management program for CTDs is essential to the success of an ergonomic program in industries with a high incidence of CTDs.
  - Medical management of CTDs is a developing field, and health care providers should monitor developments.

Medical Management Program

- In an effective ergonomics program, health care providers should be part of the ergonomics team interacting and exchanging information routinely to prevent and treat CTDs properly.

Medical Management Program

- Appropriately trained health care providers should be available at all times and on an ongoing basis as part of the ergonomics program.
- Health care providers should conduct periodic, systematic workplace walk-throughs to remain knowledgeable of operations and work practices.

Medical Management Program

- A standardized measurement should be developed to determine the extent of work-related disorder symptoms in each area of the plant.
- Conduct an annual symptoms survey to measure employee awareness of work-related disorders and to report location/frequency/duration of discomfort.

Medical Management Program

- The ergonomist or qualified person should analyze physical procedures used in each job, including lifting requirements, postures, hand grips, and frequency of repetitive motion.
  - To develop a list of jobs with the lowest ergonomic risk.
    - This assists health care providers in recommending assignments to light- or restricted-duty jobs.

Medical Management Program

- The ergonomist or qualified person should analyze physical procedures used in each job, including lifting requirements, postures, hand grips, and frequency of repetitive motion.
  - Health care providers should likewise develop a list of known high-risk jobs.
- Supervisors should periodically review and update the lists.

Medical Management Program

- A baseline health surveillance establishes a base against which changes in health care status can be evaluated, not prevent people from performing work.
- New/transferred employees should have a four- to six-week break-in period to condition their muscle-tendon groups prior to working at full capacity.

Medical Management Program

- Periodic health surveillance—every two to three years—should be conducted on workers assigned to positions involving exposure of a particular body part to ergonomic stress.

Medical Management Program

- Health care providers should participate in the training and education of all employees, including supervisors & plant management personnel.
  - On different types of CTDs & means of prevention, causes, early symptoms, and treatment of CTDs.

Medical Management Program

- Employees should be encouraged by health care providers and supervisors to report early signs and symptoms of CTDs to the in-plant health facility.

Medical Management Program

- Health care providers should use written protocols for health surveillance, and evaluation, treatment, & follow-up of workers with signs/symptoms of CTDs.
  - Qualified health care providers should prepare protocols.

Medical Management Program

- A good medical management program that seeks to identify & treat CTDs is important.
  - CTDs are recognized and treated appropriately early in their development, a more serious condition can likely be prevented.

Medical Management Program

- The OSH Act & record-keeping regulations provide specific recording requirements that comprise the framework of the occupational safety & health recording system.
  - Health care providers should be aware of record-keeping requirements & participate in fulfilling them.

Medical Management Program

- Health care providers should periodically review health care facility sign-in logs, OSHA Form 300, and individual employee medical records to monitor trends for CTDs in the plant.
  - This ongoing analysis should be made in addition to the symptoms survey to monitor trends and substantiate the information obtained in the annual symptoms survey.

Training and Education

- Training & education allow managers, supervisors, and employees to understand the hazards associated with a job or process, their prevention and control, and their medical consequences.

Training and Education

- A training program—designed & implemented by qualified persons—should include all affected employees, engineers & maintenance personnel, supervisors, and health care providers.
- The program should also include a means for adequately evaluating its effectiveness.

Common Indicators of Problems

- Accident reports, record-keeping documents, first-aid logs, insurance forms & other available records of illnesses or injuries, can identify trends.

Common Indicators of Problems

- Observing the workplace and people at work can help determine the amount of exposure that employees have to these factors associated with CTDs & potential for ergonomics-related problems.

Common Indicators of Problems

- Musculoskeletal injuries increase significantly when the job involves lifting large objects or bulky objects, lifting objects from the floor, and lifting frequently.
  - When such conditions exist, the company has ergonomic problems.

Common Indicators of Problems

- People uncomfortable to the point of physical stress are more likely to miss work.
  - Or leave for less stressful conditions.
- A high incidence of employee complaints can indicate the presence of ergonomic problems.
  - Also high absentee rates and high turnover rates.

Common Indicators of Problems

- Presence of many employee workplace adaptations, particularly those intended to decrease physical stress, can indicate the presence of ergonomic problems.
  - Added padding, modified personal protective equipment, brought in extra lighting, or other modifications.

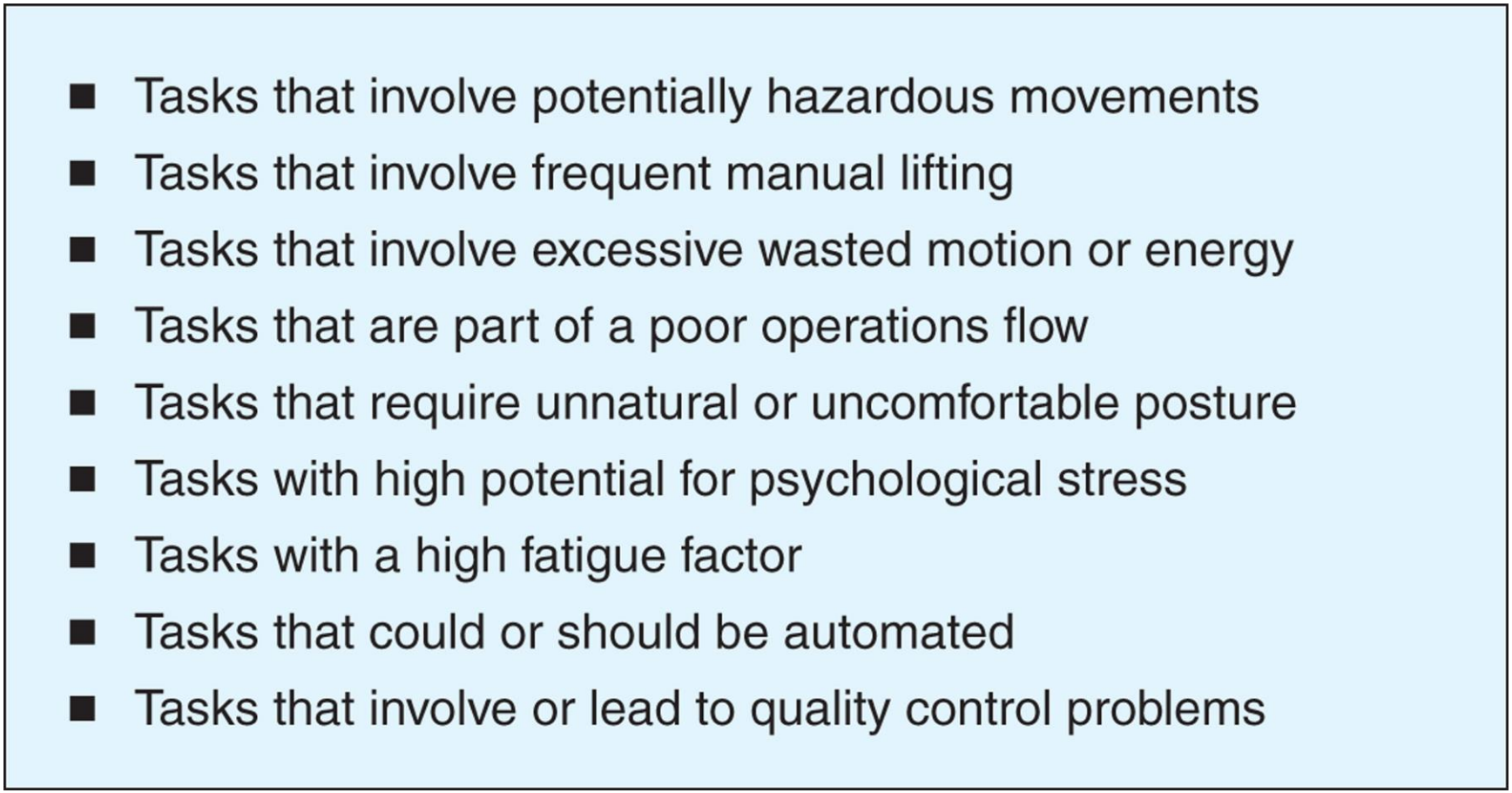
Common Indicators of Problems

- Poor quality, while not necessarily caused by ergonomic problems, can be the result of such problems.
  - It is at least an indicator that there may be ergonomic problems.

Identifying Ergonomic Problems

- A task analysis of the job in question can identify specific ergonomic problems.

FIGURE 10–3 Problems that can be pinpointed by a task analysis.



Identifying Ergonomic Problems

- General observation of a worker or workers performing the task(s) in question can be an effective task analysis technique.
- Questionnaires and interviews can be used for identifying ergonomic problems.

Identifying Ergonomic Problems

- Videotaping is silent, not intrusive, and can enhance the observer's analysis capabilities significantly.
  - Photography can also enhance analysis capabilities.

Identifying Ergonomic Problems

- An accurate sketch of a workstation or a drawing showing workflow can help identify problems.
- Measurements can help identify specific ergonomic problems.

Identifying Ergonomic Problems

- Aging workers present special challenges, and adaptations must be individualized, and should take aging factors into account.
  - As nearly 30% of the workforce is 45 years of age or older, organizations must be prepared to adapt to employees whose physical needs are different from those of their younger counterparts.

Identifying Ergonomic Problems

- Aging workers present special challenges, and adaptations must be individualized, and should take aging factors into account.
  - Nerve conduction velocity, hand-grip strength, muscle mass, range of motion & flexibility all begin to diminish about age 45.

Ergonomic Problem-Solving Strategies

- Back, neck, shoulder & lower leg pain are often associated with seated repetitive work on light parts.
  - It may be necessary to modify the job & the workstation.
- Rotate workers between one or more different jobs.

Ergonomic Problem-Solving Strategies

- Adjust height of the work surface and/or position.
- Use adjustable chairs with hand, wrist, or arm supports.
- Ensure sufficient legroom (height, width, and depth).
- Use ergonomic devices to adjust height & angle of work.

Ergonomic Problem-Solving Strategies

- Seated work with larger parts involves interacting with objects that may be too large to manipulate manually, associated with assembly & welding jobs.
  - Problems are typically related to posture, illumination, reach, and lifting.

Ergonomic Problem-Solving Strategies

- Use technology to lift & position the work for easy access that does not require bending, twisting & reaching.
- Use supplemental lighting.
- Use adjustable chairs/work surfaces.

Ergonomic Problem-Solving Strategies

- Seated control work involves sitting in one location and using wheels, levers, knobs, handles, and buttons to control a process, system, or equipment.
  - Use an adjustable swivel chair with inflatable back and seat support, and keep both feet on the floor.
  - Provide comfortable/convenient locations for controls.

Ergonomic Problem-Solving Strategies

- Seated control work involves sitting in one location and using wheels, levers, knobs, handles, and buttons to control a process, system, or equipment.
  - Sit with a straight back & shift positions frequently.
  - Use control devices that do not require more than five newtons (1.1 lbs); hand levers, 20 newtons (4.5 lbs).

Ergonomic Problem-Solving Strategies

- Seated control work involves sitting in one location and using wheels, levers, knobs, handles, and buttons to control a process, system, or equipment.
  - Position the control seat so a clear line of sight exists between the work and the person controlling it.

Ergonomic Problem-Solving Strategies

- Seated control work involves sitting in one location and using wheels, levers, knobs, handles, and buttons to control a process, system, or equipment.
  - Get up and walk around on a regular basis.
  - Provide a ladder if a workstation is over 14" above ground.

Ergonomic Problem-Solving Strategies

- Most jobs performed while standing do not involve a great deal of repetitive motion, but do involve handling medium to heavy materials.
  - Physical stress includes leg, arm, and back strains.
    - Occasionally, side strains occur when bending/twisting.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Adjust machines/work surfaces for height/position.
  - Make sure there is a recess at the bottom for feet, to allow operators to stand close to the machine without bending.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Machines with easily accessible controls, within a comfortable reach zone for operators.
  - Ample free space around machines for moving material in & out, and for ease of movement in servicing machines.

Ergonomic Problem-Solving Strategies

- Standing for heavy lifting and carrying involves heavy lifting and moving material while standing.
  - Lifting and moving may be a relatively small part of the job, but are required somewhat regularly.

Ergonomic Problem-Solving Strategies

- Physical stress commonly associated with this work is back/muscle strains resulting from improper lifting.
  - Stairs increase the physical stress of carrying & potential for injury; falls can also be a problem.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions, when standing for heavy lifting and carrying :
  - Eliminate manual lifting to the extent possible using various lifting and hoisting technologies.
  - Where manual lifting is necessary, train workers in proper lifting techniques.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions, when standing for heavy lifting and carrying :
  - Provide sufficient room around all objects to allow lifting without twisting.
  - Supply the appropriate personal protection equipment such as sure-grip shoes and gloves.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions, when standing for heavy lifting and carrying :
  - Keep floors around materials to be lifted clean & dry.
  - Do not allow manual carrying of heavy objects upstairs.

Ergonomic Problem-Solving Strategies

- Work with hands above chest height can be done in either a standing or sitting position, and may or may not involve material handling.
  - Physical stress associated with this type of work includes neck, upper body, and heart strain.
    - Prolonged work with arms above shoulder level requires the heart to work harder to pump blood to elevated areas.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Eliminate manual lifting to the extent possible by raising the work floor using lifts and various other technologies.
  - Extension arms/poles when the work floor can't be raised.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Machines controls should be easily accessible below the horizontal plane of a worker's shoulders.

Ergonomic Problem-Solving Strategies

- Hand tools introduce a variety of potential hazards indigenous to their use.
  - Most commonly carpal tunnel syndrome (CTS), and muscle strains of the lower arm, hands, and wrist.

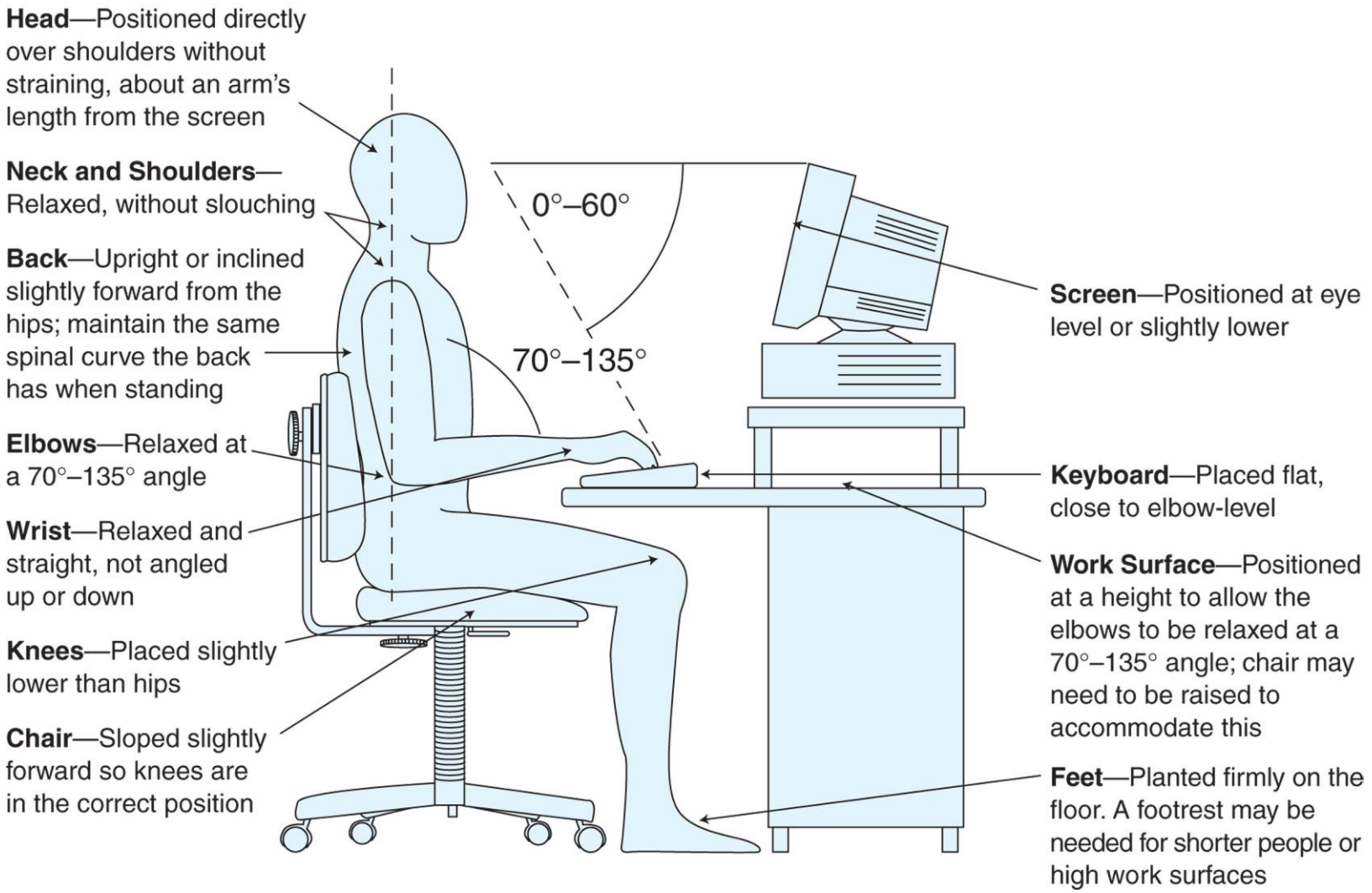
Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Tools designed to keep hands in the rest position.
  - Select tools with thick, rather than thin, handles, enhanced gripping surfaces, such as knurling, filing, etc.

Ergonomic Problem-Solving Strategies

- Ergonomic strategies for improving work conditions:
  - Eliminate twisting by selecting tools designed so the direction of movement or function is the same as the direction in which force is applied or by using technology.
  - Select tools with handles made of hard, nonpermeable materials that will not absorb toxic liquids harmful to skin.

FIGURE 10–7 Ergonomics of VDTs. The left of the diagram highlights optimal postures and positions for the computer user.



Economics of Ergonomics

- A number of factors inhibit hard research into the economics of ergonomics.
  - Record-keeping systems in industry are not sufficient to support such studies.
  - Industry does not track injuries and illnesses in ways that provide the controls necessary for true hard research.

Economics of Ergonomics

- A number of factors inhibit hard research into the economics of ergonomics.
  - There are no control groups against which to compare groups of injured workers.

Economics of Ergonomics

- A number of factors inhibit hard research into the economics of ergonomics.
  - It is difficult & often impossible to determine improvements attributed directly to specific strategies, and those attributed to other factors.
  - Hard research studies requires time and money.

Cumulative Trauma Disorders (CTDS)

- Frequent and, for some, constant computer use has led to an explosion of injuries that until now were seen mostly in the meatpacking industry.
  - Collectively, these injuries are known as CTDs.

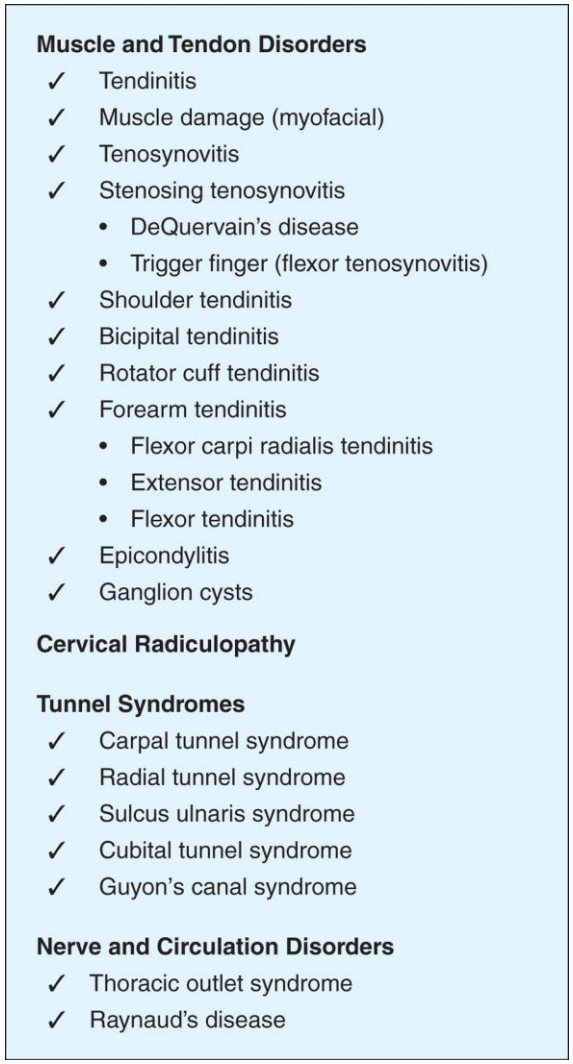
Cumulative Trauma Disorders (CTDS)

- CTD is an umbrella term covering injuries caused by forceful or awkward movements, repeated frequently over time.
  - CTDs occur to the muscles, nerves, and tendons of the hands, arms, shoulders, and neck.

Cumulative Trauma Disorders (CTDS)

- Overworking a tendon can cause small tears in it, which inflame and cause intense pain.
  - Known as *tendinitis*.
- Other forms of CTDs are shown below.

FIGURE 10–8 CTD checklist—types of injury by classification.



Muscle and Tendon Disorders

- ✓ Tendinitis
- ✓ Muscle damage (myofacial)
- ✓ Tenosynovitis
- ✓ Stenosing tenosynovitis
  - DeQuervain's disease
  - Trigger finger (flexor tenosynovitis)
- ✓ Shoulder tendinitis
- ✓ Bicipital tendinitis
- ✓ Rotator cuff tendinitis
- ✓ Forearm tendinitis
  - Flexor carpi radialis tendinitis
  - Extensor tendinitis
  - Flexor tendinitis
- ✓ Epicondylitis
- ✓ Ganglion cysts

Cervical Radiculopathy

Tunnel Syndromes

- ✓ Carpal tunnel syndrome
- ✓ Radial tunnel syndrome
- ✓ Sulcus ulnaris syndrome
- ✓ Cubital tunnel syndrome
- ✓ Guyon's canal syndrome

Nerve and Circulation Disorders

- ✓ Thoracic outlet syndrome
- ✓ Raynaud's disease

Cumulative Trauma Disorders (CTDs)

- The best way to prevent CTDs is proper work design, which also helps make employees aware of the hazards that can cause it.
  - Poor posture at the workstation.
  - Inappropriate positioning of the hands & arms
  - Heavy hand on a keyboard or mouse.

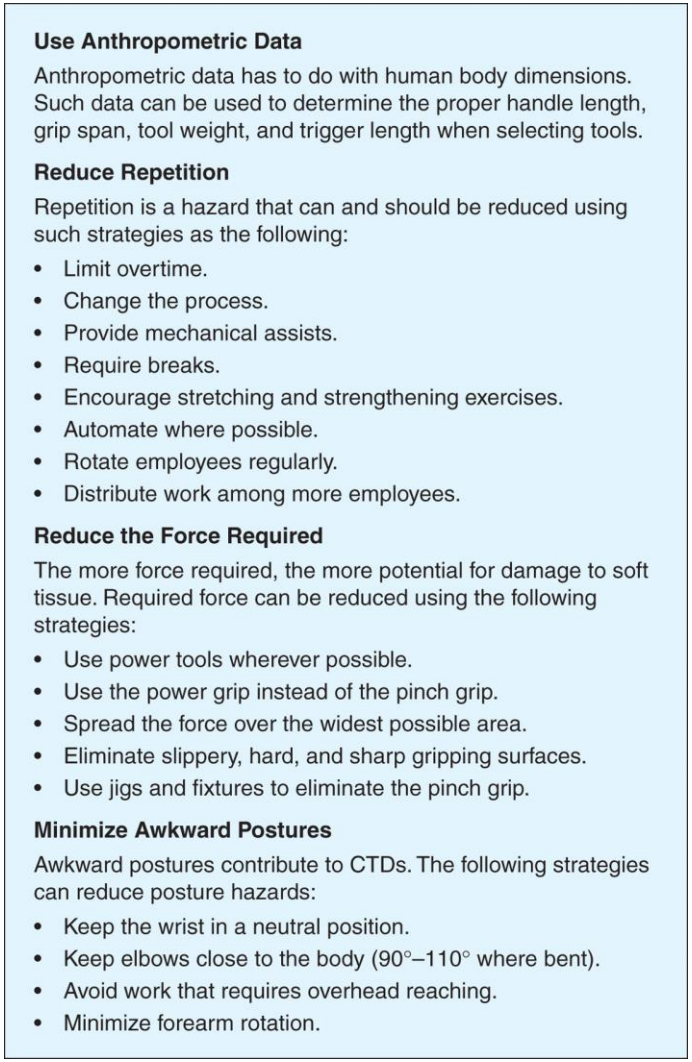
Cumulative Trauma Disorders (CTDs)

- Preventive strategies that can be applied:
  - Teach employees the warning signs.
  - Teach employees how to stretch.
  - Teach employees to start slowly.
  - Teach employees to limber up, then begin slowly and increase their pace gradually.

Cumulative Trauma Disorders (CTDs)

- Preventive strategies that can be applied:
  - Teach employees to position their hands properly without using wrist splints.
  - Exercise regularly.
  - Select tools wisely.
- Good job design & proper tool selection together are the best strategy.

FIGURE 10–9 Checklist for safe selection and use of hand tools.



Use Anthropometric Data

Anthropometric data has to do with human body dimensions. Such data can be used to determine the proper handle length, grip span, tool weight, and trigger length when selecting tools.

Reduce Repetition

Repetition is a hazard that can and should be reduced using such strategies as the following:

- Limit overtime.
- Change the process.
- Provide mechanical assists.
- Require breaks.
- Encourage stretching and strengthening exercises.
- Automate where possible.
- Rotate employees regularly.
- Distribute work among more employees.

Reduce the Force Required

The more force required, the more potential for damage to soft tissue. Required force can be reduced using the following strategies:

- Use power tools wherever possible.
- Use the power grip instead of the pinch grip.
- Spread the force over the widest possible area.
- Eliminate slippery, hard, and sharp gripping surfaces.
- Use jigs and fixtures to eliminate the pinch grip.

Minimize Awkward Postures

Awkward postures contribute to CTDs. The following strategies can reduce posture hazards:

- Keep the wrist in a neutral position.
- Keep elbows close to the body (90°–110° where bent).
- Avoid work that requires overhead reaching.
- Minimize forearm rotation.

Participatory Ergonomics

- Participatory ergonomic (PE) is the involvement of people at work in planning for and controlling the ergonomic aspects of their work environment.
  - They must first be equipped with prerequisite knowledge.

Participatory Ergonomics

- Participatory ergonomics combines the best of two worlds: outside expertise and inside experience.
  - The most common approach is to form a PE team.
- The goal of the PE team is to design ergonomic interventions that are tailored specifically to the workplace in question.

- **https://www.youtube.com/watch?v=1sb548iiuPY**
- https://www.youtube.com/watch?v=_Wkq_hXEZeM
- https://www.youtube.com/watch?v=bplcx2vsZOY
- https://www.youtube.com/watch?v=ov4WsLZYCYc
- https://www.youtube.com/watch?v=OXC1eBxLhPA
- https://www.youtube.com/watch?v=lX6kUjQzrDo
- https://www.youtube.com/watch?v=nmJok2GYQ3I
- https://www.youtube.com/watch?v=K88q_oEwRS8
- https://www.youtube.com/watch?v=n-iAK4vusqk
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