*WorkWell and ErgoSystems Present:*

# Ergonomics Analysis for Health Care Professionals

## Manufacturing and Office Work Environments

*WorkWell Systems, Inc.*
*ErgoSystems Consulting Group, Inc.*
*Version 01162012*

# Ergonomics Analysis
## For Health Care Professionals

## Manufacturing and Office Work Environments

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## COURSE PRESENTERS AND DEVELOPER

### Deirdre "Dee" Daley, PT, DPT, MS, HPE

Dr. Daley is a physical therapist and faculty member who also assists with injury prevention and rehabilitation program development and implementation at WorkWell Systems. Ms. Daley's 20 year background in clinical and onsite orthopedics combined with a focus on adult learning and evidence-based medicine bring together prevention principles, rehabilitation practices, and return to work philosophies to enhance worker, employer and provider capabilities in the area of occupational health and injury management.

Prior to joining WorkWell, Dee was instrumental in the development of occupational health modules and provider training for a national rehabilitation company, in addition to clinic and onsite physical therapy practice with several North Carolina businesses. Ms. Daley serves as education chair of the OHSIG (the Occupational Health Special Interest Group of the Orthopedic Section of the APTA) and has been active in several board positions in the North Carolina Physical Therapy Association (NCPTA). She has presented information on work rehabilitation, adult learning and continuing competency for physical therapists and multidisciplinary groups.

Ms. Daley is a graduate of Quinnipiac University with a degree in Physical Therapy. She later earned a Masters of Science degree in Health Occupation Education at North Carolina State University, and most recently a Doctorate of Physical Therapy from UNC-Chapel Hill.

### Steve McKenney, PT

In his role as Occupational Health Specialist, Steve provides clinical support, report critiquing, and consultation services to therapists trained in WorkWell programs. Steve also serves as an Isernhagen faculty member. As a faculty member, he is responsible for training Isernhagen providers in the WorkWell programs including Functional Capacity Evaluation, Functional Job Analysis, Prework Screening, and Work Rehabilitation. Steve was instrumental in the development of the Advanced FCE training course and is one of the primary faculty members providing this advanced level training for WorkWell therapists.

Steve has more than 20 years of experience as a physical therapist, with a concentration in industrial rehabilitation for 19 years. His clinical experience includes directing work rehabilitation departments, providing ergonomic consultation to employers, and managing his own work injury consulting company. Steve also taught at the University of North Dakota, School of Medicine, Department of Physical Therapy. Steve is a member of the American Physical Therapy Association's Orthopedic Section.

### Mark A. Anderson, MA, PT, CPE

Mark A. Anderson is the president and founder of Minneapolis, Minnesota based ErgoSystems Consulting Group, Inc. Anderson is a certified professional ergonomist by the Board of Certification in Professional Ergonomics (www.bcpe.com). His background also includes licensure as a physical therapist. He has consulted in ergonomics for over 20 years.

Anderson has developed and implemented ergonomics strategies for a wide range of companies and organizations. (Including Emerson Process Management, Tescom, Tennant Company, General Electric, Alliant Techsystems, Quaker Oats, Pepsi-Cola, General Mills, Fingerhut, Panama Canal Commission, United States Navy and Marine Corps, United States Customs Service and state and local governments.)

Anderson has worked with manufacturing and engineering design firms to integrate ergonomics principles into the design and manufacture process. Adding the elements of ergonomics as part of the design equation enhances the effectiveness of the overall process and final outcome.

He has written a number of publications and spoken nationally and internationally on ergonomics. He has been active in the Upper Midwest Chapter of the Human Factors and Ergonomics Society serving as the secretary and past co-program chair.

# Table of Contents (refer to end of manual for expanded Table of Contents)

## WELCOME

### Introduction

QUESTION: What advantages do Health Care Professionals (HCP) gain by acquiring new or enhancing existing skills in ergonomics principles and applications?

ANSWER: Check ☑ those that apply and add your own unique advantages:

❑ **Focusing a patient's treatment plan** through an ergonomics analysis of a patient's work and/or home demands.

❑ **Identifying potential job modifications** to assist a patient in the return to work (or other activity) process.

❑ **Preventing potential injuries** to employees and others through proactive ergonomics analysis and intervention.

❑ **Enhancing a company's bottom line** through ergonomics related improvements in quality and productivity that also complement health and safety.

❑ (OTHER) _____

❑ (OTHER) _____

## SETTING THE STAGE

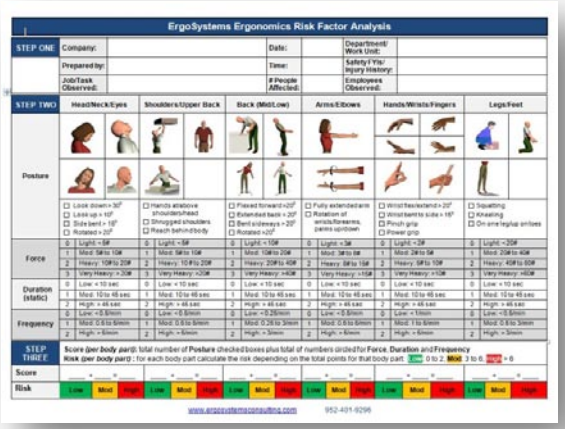
### Course Content and Objectives

***Ergonomics Analysis for Health Care Professionals*** offers a framework to help Physical Therapists, Occupational Therapists, Occupational Health Nurses, Physicians and other health care professionals perform ergonomics analyses and generate reasonable and feasible recommendations. Course content includes specific information in Manufacturing and Office work environments.

#### *Ergonomics Analysis Process*

You will learn how to use an ergonomics process to identify ergonomics risk factors ranks them in terms of risk and develop reasonable and feasible recommendations to improve health, safety and productivity.

The ergonomics analysis process is based on a fundamental knowledge of ergonomics principles and applications. Through interactive lecture and a strong emphasis on case studies, the course presents a systematic approach to ergonomics analysis.



### *Ergonomics Principles and Foundations*

We will define a set of **Ergonomics Principles and Foundations.** The principles can be applied to any ergonomics analysis. The foundations provide objective rationale to support the principles.

### *Ergonomics Analysis and Problem Solving*

Next, we delve into **ergonomics analysis and problem solving** with a look at problem solving principles and the components of an ergonomics 'Tool Box'. The Tool Box includes a list of recommended equipment, materials and forms to conduct and document the analysis.

### *Ergonomics Case Studies*

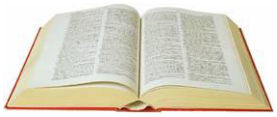
To pull the concepts together a series of cases studies are included for **hands-on practice and feedback**.

### *Resources*

Also included is a list of ergonomics related resources and references.

## FIRST OF ALL . . . WHAT IS ERGONOMICS?

### Definition of Ergonomics



The word '***ergonomics'*** was coined by a Polish scholar in 1857. In Greek 'ergon' means work and 'nomos' means the laws or study of. So, ergonomics is literally the ***"the laws or study of work."***

#### *Ergonomics – What is the Goal?*

We all would agree that the goal of ergonomics is to improve the health, safety and productivity of activities – whether at home or at work. We would also agree that aspects of physical and mental stress contribute to the factors of health, safety and productivity.

Is the goal of ergonomics to . . .

ELIMINATE physical and mental stress?

**Eliminate physical stress** . . . what is the outcome? We are aware that if physical stress is eliminated (bed rest, for example) the result is disastrous. (If you don't use it . . . you will lose it!) And of course we also realize that excessive physical stress without time for adequate recovery is equally problematic.

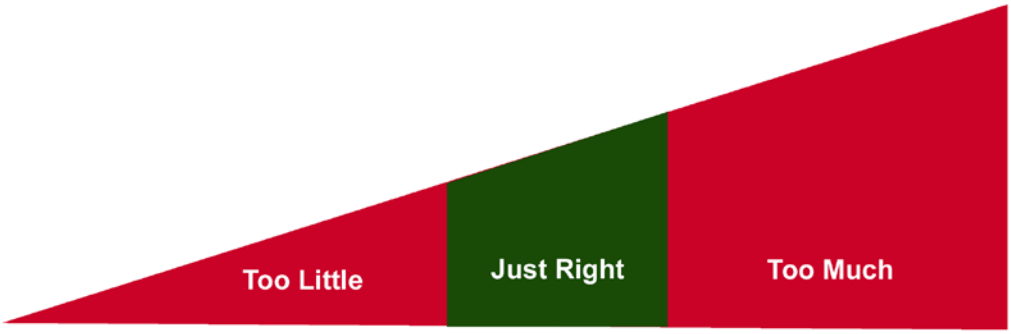
**Eliminate mental stress** . . . what is the outcome? As it turns out . . . not much! We recognize that some mental stress acts as a motivator. However, we also know that too much mental stress results in decompensation and dysfunction.

How about if we replace the word **ELIMINATE** with **OPTIMIZE**.

OPTIMIZE physical stress

OPTIMIZE mental stress

A completely different connotation is appreciated. Think of it as the '***Just Right Continuum***'; a certain window of optimization is apparent.




**The "Just Right" Continuum**

Here is a critical question . . .

Is the 'JUST RIGHT' window the same for each person?

Or is it true that what may be **TOO MUCH** for one individual is **JUST RIGHT** and very acceptable for another?

And how about . . .

Do other factors influence the 'JUST RIGHT' window?

Factors like the time of the day, fatigue, work station design, tools and equipment, training, environmental conditions, supervision - this list can go on and on - also impact the **JUST RIGHT** window.

The true challenge of ergonomics analysis is to recognize the influence of individual variation **AND** figure out how best to deal with them to optimize performance.

### *What is ergonomics and how can it make a difference?*

## *Ergonomics and Gravity*

Ergonomics is like throwing a ball into the air.

What happens?

Correct!

The ball comes back down.

Why?

Gravity works!

In fact, if it didn't come back down, we would be quite surprised! As we understand the laws of gravity, when we stand on the face of the earth and throw a ball into the air, it will come back down. In other words the . . .

CIRCUMSTANCES DICTATE THE REPONSE.

Now, imagine we **DON'T** want the ball to come back down. What do we need to do? How about throw the ball up and just tell it to stay in the air . . .

BALL - STAY UP!!

Everyone will agree this is **LUDRICOUS**. You can't get a ball to stay in the air just by telling it to.

Rather you need to change something . . . attach Velcro to it, throw it into a net, attach it to a string, launch yourself into outer space . . . you get the picture!

How does this relate to what ergonomics is all about?

### *Circumstances predict the response!*

Well, rather than throw a ball into the air, let's say you bend over to assemble a component at a low level.

The body position most likely used is to just bend over at the waist.

From a health and safety, as well as productivity standpoint, we recognize this work position can cause problems. But unfortunately, it is a commonly observed work position.

How about this for a solution - whenever we see someone in this poor position we tactfully tap them on the shoulder and say,

'When you are in that bad position, be really, really, really careful you don't hurt yourself!'

That makes about as much sense as telling the ball to, **'Just stay in the air!'**

A much better solution is to. . .

CHANGE THE CIRCUMSTANCES TO CHANGE THE RESPONSE!

We could reposition either the assembler or the work – for example use a rolling stool.

What are some other options?

_____

_____

_____

_____

Given a certain set of circumstances, we will typically respond in a predictable way.

If we want to change the RESPONSE
We need to change the CIRCUMSTANCES!

ERGONOMICS . . .
The optimization of all aspects of job performance - *safety, quality and productivity* - accomplished through the appropriate *design and use* of work stations, work processes and the overall organization of work.

***Why does Ergonomics Work?***

Ergonomics works because it:

- Strategies to identify and solve problems.
- Design based; it addresses the true root cause not just the symptoms.
- Cost-effective; incorporates an incremental approach.
- Makes use of the best ergonomists in the world . . . people who actually do the work!

## Systems Design

The essence of ergonomics is design. Design of work stations, work processes, work environment and work culture dictates the level of safety and productivity. For example, effort may be wasted because of:

- Poor positioning of tools, equipment and parts.
- Poor design or maintenance of tools.
- Haphazardly thought out work processes.
- Poor work environments due to poor ventilation and lighting.
- Non-responsive management systems and work culture.

You can effectively deal with these problems and other problems by using ergonomics. A systems design approach provides a solid foundation.

### *A little mind reading!*

To get a handle on the concept of systems design . . . get out your crystal ball and try this example.

| STEP | ACTIVITY | RESULT |
|---|---|---|
| **One:** | Choose a number between one and nine. | |
| **Two:** | Multiply that number by nine. | |
| **Three:** | Add together the digits of the result of Step Two. | |
| **Four:** | Subtract five from the result of Step Three. | |
| **Five:** | Choose the letter of the alphabet that corresponds to the result of Step Four, e.g., A=1, B=2, C3, etc. | |
| **Six:** | Choose a country that begins with that letter. | |
| **Seven:** | Choose an animal that begins with the last letter of that country. | |
| **Eight:** | Choose a color that begins with the last letter of the animal. | |

**This is a good design of a system; let's discuss why.**

### *Systems Design: Principles*

The Human Factors Design Handbook defines a system as:

**A system is a mission-oriented grouping of elements into an integrated, functional whole.**
**The system typically includes a facility, equipment, furnishings, and fixtures and involves a variety of people who use, operate, or maintain it.**
**The system must perform a mission or function and must work in an environment.**

### Country-Animal-Color

The ***Country-Animal-Color*** exercise you just completed yields a consistent response for a majority of people based on a set of principles that make up a system. (Or, if you choose to – you can believe it really is possible to read minds!)

A set of general principles of the Systems Design approach includes:

- The system is adapted to the human
- The system facilitates the highest level of performance to which the operator is capable
- The system optimizes physical and mental stress imposed on the operator
- The system provides personal satisfaction for the user in terms of use
- The system and its components function to serve the human
- The system recognizes individual variation in human capabilities and limitations
- The design of the system influences human behavior either positively or adversely
- A system, by definition, does not exist in isolation

Human Factors Design Handbook, 2nd Edition
Woodson, Tillman and Tillman
McGraw-Hill, Inc., New York, NY, 1992

### *Systems Design: Foundations*

The study of systems design encompasses many fields. For our purposes, we will examine several that have direct influence on ergonomics. Each of them is a full-fledged discipline. As we introduce the ergonomics principles we will discuss:

- Epidemiology
- Work Physiology
- Engineering Psychology
- Anthropometry
- Occupational Biomechanics

## ERGONOMICS PRINCIPLES AND FOUNDATIONS

Based on our discussion we will develop a general set of **Ergonomics Principles**. Here is a summary of the **Ergonomics Principles** and associated **Risk Level Index**.

### Ergonomics Principles

**PROCESS** – Promote effective work processes

**POSITION/SUPPORT** – Promote neutral body and limb position/support

**MOVEMENT** – Promote regular physical movement

**MATERIAL HANDLING** – Control manual material handling

**REACH** – Promote work in reach zone

**WORKSTATION/TOOLS/EQUIPMENT** – Provide correct workstation, tools and equipment

**TRAINING** – Provide competency based training

**ENVIRONMENT** – Control exposure to work environment

**HEALTH/WELLNESS** – Promote personal health and wellness

**FEEDBACK** – Provide on-going feedback for continuous improvement

### Risk Level Index

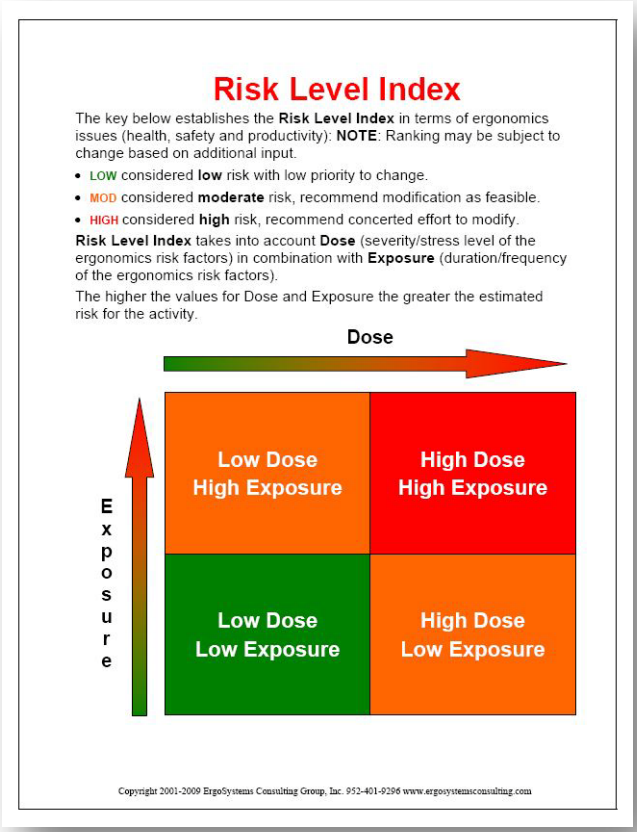
The **Risk Level Index** ranks risk in terms of ergonomics issues (health, safety and productivity).

The Risk Level Index takes into account:

- ***Dose*** - physical stress level of the ergonomics risk factors
- ***Exposure*** - how long/how often exposed to the ergonomics risk factors

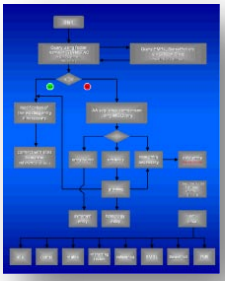
The higher the values for Dose and Exposure the greater the estimated risk.

- **LOW** considered **low** risk with low priority to change.
- **MOD** considered **moderate** risk, recommend modification as feasible.
- **HIGH** considered **high** risk, recommend concerted effort to modify.



# Promote Effective Work Processes

## Introduction



The overarching principle of ergonomics focuses on promoting the effectiveness of the work process itself. This principle is a wide ranging one that addresses the work process in total.

The goal is to take a step back and really examine why something is done as it is. If the answer is . . .

"Because it has always been done that way!"

It may be worth the effort to take a fresh look. Is there a better way to get it done?

What we see day after day becomes commonplace to use. We simply don't pay attention anymore. We can't see the forest because of the trees.

Recall we defined ergonomics as:

**The optimization of all aspects of job performance - *safety, quality and productivity* - accomplished through the appropriate *design and use* of work stations, work processes and the overall organization of work.**

By optimizing job performance, we have a dramatic impact on the effectiveness of the work. While buzz words come and go:

- Lean Manufacturing
- Continuous Process Improvement
- Value Stream Mapping
- Kaizen Events
- Six Sigma
- 5S+1

In one way or another, these types of strategies encompass the goal of promoting effective work. This is what Ergonomics is all about. Ergonomics is now recognized as an essential component and business tool in organizations across the country and the world.

## Work Process

The work process principle really includes all of the ergonomics factors we will discuss and integrates them into the whole picture of a successful workplace.

### *Look at the whole picture*

Looking at the entire picture is an essential part of the ergonomics analysis and modification. The goal is to:

- Design work to take into account basic predictable human behavior.
- Provide an adequate level of job complexity and challenge.
- Involve the worker in the design process.
- Implement engineering, work practice and administrative control as appropriate.

### *Management/Supervision*

Management and supervision issues are included in the work process component. Without appropriate management of the work place ergonomics interventions will not be effective. These factors include:

- Labor/management relationships
- Supervision given and received
- Peer interaction
- Corporate philosophies and management style

In other words all of those tangible and intangible factors which make up the "culture" of the organization.

As noted, management's commitment to, involvement in and facilitation of the ergonomics process is critical to its success. Significant evidence suggests that a management team who sends the message "we care" has major impact on controlling workplace injuries and illnesses and enhancing productivity and quality.

### *Establish clear performance goals and objectives*

Establish a clear mandate for a safe and productive work environment.

- Provide adequate employee reporting system with supervision.
- Develop effective relationships in all aspects of the organization.
- Ensure adequate training and re-fresher training.

### *Work Force*

The ***Work Force*** is a critical component. The essence of ergonomics focuses on enhancing the health, safety and productivity of the work force.

### Work Force Demographics

When ergonomics is used at the organizational level, it is to develop a description of the individual worker and/or workforce: age, fitness level, training and experience levels, gender breakdown, body stature, hand dominance and so on.

Ergonomics findings and recommendations are greatly influenced by these factors.

#### *Age*

Physiological changes occur as a matter of aging:

- Strength and flexibility may significantly decrease.
- Aerobic capacity and endurance decrease.
- Visual acuity may deteriorate.
- Reflexes and hand-eye coordination may deteriorate.

Changes also take place in psychosocial aspects. With age, work experience associated with work expertise is enhanced. Experienced workers bring a valuable factor to the workplace.

### *Gender*

Knowledge of the gender breakdown is often required to implement successful ergonomics interventions. This is important to know in terms of proper:

- Fit and use of work stations, tools, equipment and clothing. For example small hand size vs. large hand size in relation to tool handle size.
- Match between physical demands of the job and functional capacity levels of the worker.

### *Stature and Morphology*

Anthropometry - the study of the size and shape of the body plays an important role. Assessing the stature and morphology numerical ranges of the workforce is necessary to provide for adequate design and use of the workplace.

- In other words . . . How tall? How short? How big? How small?
- We will discuss anthropometry in greater detail later.

### *Hand Dominance*

Approximately 90% of the general population is right-hand dominant. As a result, most work stations, tools and equipment are designed and set up to accommodate right hand dominance use.

This often presents complications for the remaining 10% of the workforce. Of course, there are those lucky few who are ambidextrous!

### *Fitness level*

#### ***Job Match***

Every athlete recognizes the extreme importance of suitable physical fitness levels to perform at competitive levels. Fitness levels also have significant influence in the business and industrial environment.

- Does the worker or workforce in general demonstrate the physical fitness and functional reserve needed to safely and effectively perform the job demands?

#### ***Health and Wellness***

While more difficult to measure, general health and wellness of the worker has influence on ergonomics issues.

Good health is the essential requisite if the body's systems are able to repair themselves in response to the everyday stresses of life including work and home activities.

### *Training*

Appropriate work station design is only part of the issue. The very best ergonomics design can be rendered worthless if the worker is poorly trained in its use. Training may be considered to have two primary parts.

***Technical***

- Has the worker been adequately trained in the work process?
- Can the worker properly demonstrate the technical aspects of the job process and work demands?

***Safety***

- Has the workforce been adequately trained in the safe performance of the job tasks?
- Has the workforce been adequately trained in methods (work station setup, tool use, breaks, stretching, and warm-up activities, etc.) to control job fatigue?

### *Work Experience*

An experienced, well-seasoned workforce is a valuable resource. We need to examine the workforce in terms of level and scope of experience.

***Level***

- What is the general work experience level of the workforce or worker?
- Is the level of experience considered a significant factor in performing the job task?

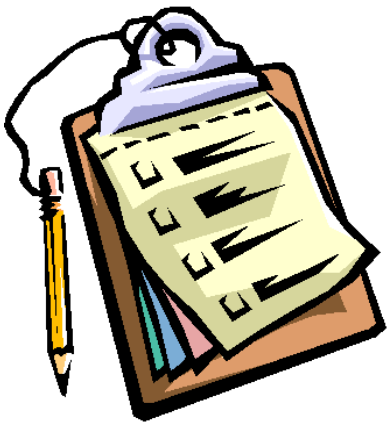
***Scope***

- What is the scope of experience of the workforce or worker?
- Are they cross-trained in other job demands; are they able to deal with emergency situations, etc.?
- Is the scope of experience of the workforce or worker considered a significant issue?

### ***Effective Work Process Metrics***

One of the important components of the ergonomics process is to establish a picture of the present state of affairs.

Part of this is an examination of the company's record of injury/illness reports, productivity reports, quality reports, etc.



This information can:

- Establish an injury and illness baseline against which future interventions can be measured
- Provide guidance for allocation of resources
- Compare a particular company to industry wide statistics
- Provide for work force input to enhance communication

Typically, this can be a reactive records review and/or proactive data collection.

## Reactive Records Review

One way to think of a reactive records review is the 'iceberg' analogy. Ten percent of the iceberg floats above the surface and is visible. This equates to the reactive records review that includes OSHA logs, medical records, productivity records, insurance records and payroll records.

## Proactive Data Collection

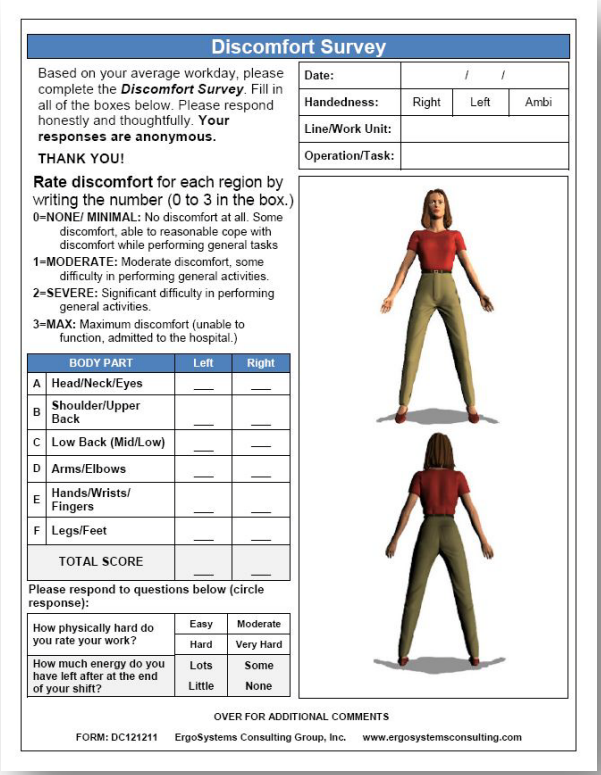
Proactive data collection provides a means of evaluating the ninety percent of the iceberg still below the surface.

Rather than evaluating what has happened in the past, we attempt to glean information from what workers are currently feeling and experiencing. The advantages of doing a proactive data collection and analysis include:

- Identification of hazards prior to an incident
- Revelation of gaps in the record keeping process
- Identification of pre-clinical cases
- Indication of the number of workers affected within a particular department to aid in prioritization of resources

We will introduce the ***Discomfort Survey*** during the Analysis section in the course to directly obtain input from the workforce.

So whatever strategies you currently apply, ergonomics can help them be even more successful. All of the ergonomics principles directly relate to factors to optimize job performance.



**Discomfort Survey**

Based on your average workday, please complete the ***Discomfort Survey***. Fill in all of the boxes below. Please respond honestly and thoughtfully. **Your responses are anonymous.**

**THANK YOU!**

| | | | |
|---|---|---|---|
| **Date:** | / / | | |
| **Handedness:** | Right | Left | Ambi |
| **Line/Work Unit:** | | | |
| **Operation/Task:** | | | |

**Rate discomfort** for each region by writing the number (0 to 3 in the box.)

**0=NONE/ MINIMAL:** No discomfort at all. Some discomfort, able to reasonable cope with discomfort while performing general tasks

**1=MODERATE:** Moderate discomfort, some difficulty in performing general activities.

**2=SEVERE:** Significant difficulty in performing general activities.

**3=MAX:** Maximum discomfort (unable to function, admitted to the hospital.)

| | BODY PART | Left | Right |
|---|---|---|---|
| A | Head/Neck/Eyes | ___ | ___ |
| B | Shoulder/Upper Back | ___ | ___ |
| C | Low Back (Mid/Low) | ___ | ___ |
| D | Arms/Elbows | ___ | ___ |
| E | Hands/Wrists/ Fingers | ___ | ___ |
| F | Legs/Feet | ___ | ___ |
| | TOTAL SCORE | ___ | ___ |

**Please respond to questions below (circle response):**

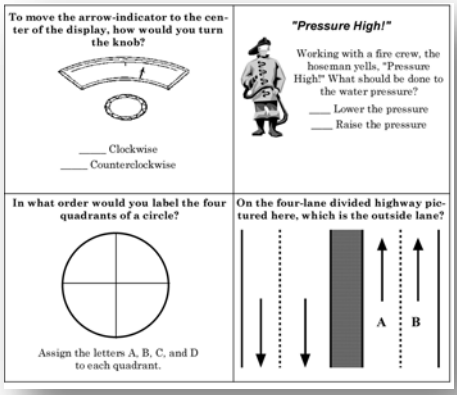
| | | |
|---|---|---|
| How physically hard do you rate your work? | Easy | Moderate |
| | Hard | Very Hard |
| How much energy do you have left after at the end of your shift? | Lots | Some |
| | Little | None |

OVER FOR ADDITIONAL COMMENTS

FORM: DC121211 ErgoSystems Consulting Group, Inc. www.ergosystemsconsulting.com

## *Designing Effective Work Processes*

### Population Stereotypes




The practice of ergonomics has sometimes been described as the application of common sense to the situation. "Common sense" is an interesting concept.

This implies that we all have the same "sense in common".

Here is an exercise that may shed some light on the validity of the 'in-common' common sense hypothesis. Population stereotypes , as you have just discovered, indicates we do not have the same "common sense." Our view of the world is greatly shaped by our experiences. Falling back on the, **"Well, it is just common sense!"** will not provide the desired consistent and reliable result we are striving to achieve.

### Design Conventions and Human Behavior

Engineering psychology involves designing systems with information processing capabilities and limitations in mind. Once again, optimizing performance is the objective. A crucial aspect of a good systems design involves understanding and applying design conventions and human behavior.

#### *Overload/Underload*

As technologies become more complex, systems may overload human information processing capabilities.

- For example, a typical telephone number with the area code is 10 digits long; too long for most people to remember it long enough to dial it.
- Fighter jet pilots have been known to actually shut down some of their displays to control the amount of information they receive.

Can a job be too boring? A job that lacks reasonable challenge results in problems. Workers are not challenged to stay on task and minds tend to drift with potentially very serious consequences.

#### *Previous Experience*

Accurate information processing is also predicated on future expectations based on previous experiences.

For instance, it does absolutely no good to pound on the center of the steering wheel of a 1983 Ford LTD station wagon to warn the driver of the car that is about to back into you. (Depressing the turn signal stalk activates the horn **NOT** pushing on the steering wheel.)

Based on an understanding of behavior it is possible to design a tool, work station, work process, and work environment in a manner that enhances performance.

## Effective Work Process Design Principles

Donald Norman, in ***The Psychology of Everyday Things***, (Basic Books, Inc. New York, 1998) outlines relevant basic principles of design in a practical manner:

### *Design for good visibility*

Make it visually apparent what the control on a piece of equipment does.

**Application example:**

*Many people never learn how to program their DVD players or fully use the features of their telephones. The controls, by themselves, are not visually apparent.*

### *Apply the principles of mapping*

Make clear the relationship between two things - between controls, their movements, and the results in the real world. Make use of physical analogies and cultural standards.

- To steer a car to the right, turn the wheel to the right.
- An indicator moving up means an increase in volume.
- An indicator moving from left to right means an increase in volume.
- Push a light switch up to turn on the light. (Is this always true?)

**Application example:**

*Ever been in someone's kitchen and turned on the wrong stove burner? The relationship between the actual burner location and the control knobs wasn't properly mapped. Be honest now, ever happen with your own stove!*

### *Provide feedback*

Return information to the user regarding the outcome of user actions. The problem becomes even more significant when more features are available but less feedback is provided.

**Application example:**

*Without adequate feedback, how do you really know you have correctly programmed your alarm clock? Or entered correct number in your cell phone? Or entered the correct code into the ATM?*

## Effective Work Process Design Principles – Synopsis

### *Design Conventions*

- Avoid operator overload (as well as underload)
- Previous experience influences future performance

### *Design Principles*

- Visibility – design for good visibility for operation
- Mapping – make sure the relationship is clear
- Feedback – provide to user regarding outcome

## ***Work Process Design Checklist***

Use the ***Work Process Design Checklist*** as needed for the ergonomics analysis process.

# Work Process Design Checklist

**"YES" response indicates potential problem area that should receive further investigation.**

| | | | |
|---|---|---|---|
| **Is the task complex?** | | | |
| 1. Does worker have to evaluate data before taking action? | YES | NO | NA |
| 2. Must operator sense and respond to information signals occurring simultaneously from different machines without sufficient time to do so? | YES | NO | NA |
| 3. Must operator process information at rate that might exceed capability? | YES | NO | NA |
| 4. Is job so complex it takes a long time to train workers? | YES | NO | NA |
| 5. Does task require a great deal of accuracy? | YES | NO | NA |
| 6. Does work situation require monitoring several machines? | YES | NO | NA |
| **Is the task monotonous?** | | | |
| 7. Does the worker repeat same task without change for entire shift? | YES | NO | NA |
| 8. Does the worker lose track of task at hand because it is overly monotonous? | YES | NO | NA |
| **Design and Use Standards** | | | |
| 9. Are controls standardized on similar equipment? | YES | NO | NA |
| 10. Does design of any instrument increase reading errors? (Dials and instruments difficult to read quickly and accurately) | YES | NO | NA |
| 11. Are controls difficult to reach and operate? | YES | NO | NA |
| 12. When all readings are correct, do pointers in a group of dials point in different directions? | YES | NO | NA |
| 13. Are dials grouped inconveniently? | YES | NO | NA |
| 14. Is dial too complex for level of information required? | YES | NO | NA |
| 15. Is it difficult to see immediately how a control is set? | YES | NO | NA |
| 16. Does reading instruments require a lot of head or body movement? | YES | NO | NA |
| 17. Does worker's hand obstruct dial when operating controls? | YES | NO | NA |
| 18. Is there a need to tell difference between parts by touch? | YES | NO | NA |
| 19. Is it difficult to recognize controls and tools by touch and/or position? | YES | NO | NA |
| 20. Does the task require fine visual judgments? (Includes need to detect small defects, judging distances accurately) | YES | NO | NA |
| 21. Are controls, instruments and equipment placed where they are difficult to see? | YES | NO | NA |
| 22. Are warning lights located out of center of field of vision? | YES | NO | NA |
| **Training (Technical and Safety)** | | | |
| 23. Is the workforce inadequately trained in the technical aspects of the job process and demands? | YES | NO | NA |
| Is the workforce inadequately trained in the safe performance of the job tasks? | YES | NO | NA |
| Is the workforce inadequately trained in methods (breaks, stretching, and warm-up activities) to control job fatigue | YES | NO | NA |

## Promote Neutral Position and Support

The next principle is to position and support the body and limbs in neutral.

### *Neutral Position*

One way to think about the neutral position is to consider what really is the foundation of the body?

Is it the feet? Consider if you sprain an ankle . . . by using a pair of crutches you can still get around.

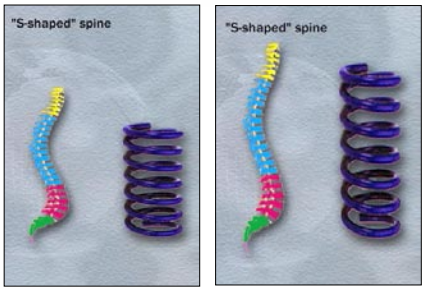
On the other hand what if you "sprain" your back? You might know someone who's been in this condition – they have a significant problem even getting out of bed to get to the bathroom.

The foundation or core of the body truly is the spine and pelvis. This directly relates to the position of the body in general and to posture in specific. With the spine and pelvis in a good position, this allows us to make good use of our legs and arms.

### Spine neutral position

What is the neutral spine position?

A neutral spine is in an S-shape: inward curves in the low back and neck; outward curve in the midback.




The advantage is that the spring like shape is able to better deal with compression and shear stresses in the spine.

Benefits:

- Decreased biomechanical strain
- Increased respiratory function
- Improved range of motion

### Arm/hand neutral position

What is neutral for the arms and hands? Neutral is the midrange of joint position. For the arms/hands this is with the shoulders relaxed, elbows at the sides flexed to about 90 degrees and the hands positioned with the thumbs pointing up.

Can you position yourself 100% of your time in neutral?

Of course, the answer is **NO**!

But how about 15%? In many situations, it is very feasible to significantly improve the situation to increase neutral position and

support by about 15%.

15% more time in neutral with good support can significantly decrease the level of stress into the body's tissue, enhance performance and increase comfort levels.

We encourage you to become a charter member of the 15% Club!

### *Support for Body Weight and Limbs in the Neutral Position*

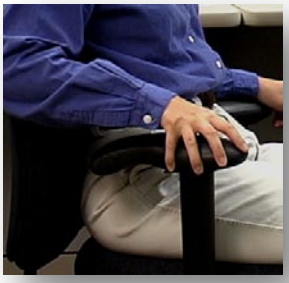
#### Seated

With the body and limbs positioned in neutral, the second part of the principle is to provide suitable support for the weight of the body and limbs.

Inadequate and improper seated support creates problems. People sit on their legs on the chair. They cross their legs for extended times.

Compression of the soft tissues occurs with a decrease in blood flow and circulation. Proper seated support is critical.

In fact, even well supported seated posture becomes uncomfortable quite quickly. How long do you sit in one position before your body gives you a signal to move?



#### Limbs

Proper support for the limbs (for example, chair armrests) removes the strain of weight bearing and also unloads the neck, shoulders and back.

Hold your arms half way out in front of you. How long can you do it before you experience discomfort and fatigue?

#### Standing

Unsupported standing for extended periods is not desired.

Joint compression occurs, actually decreasing the amount of joint space and not allowing adequate joint lubrication. Fluid tends to pool in the lower extremities.

The bottom line . . . it is tiring!

In fact as individuals, we try very hard to eliminate sustained unsupported standing.

Look at people standing in a line. What do you see them do to obtain relief?

## Promote Dynamic Physical Movement

This ergonomics principle promotes dynamic physical movement in the workplace on an on-going basis.

### *Stand or Walk?*

Most people have carried a backpack at some point. Picture this scenario - you are with a group of friends going for an extended hike; your backpack weighs 50# and you have put it on your shoulders.

What would you rather do: stand in one place for the next 20 minutes OR take that same backpack and start to walk for a few miles?

To a person, everyone agrees that it is much better to walk – not to stand. We intuitively know that movement is superior to maintaining one position. In other words, we need to move to be comfortable.

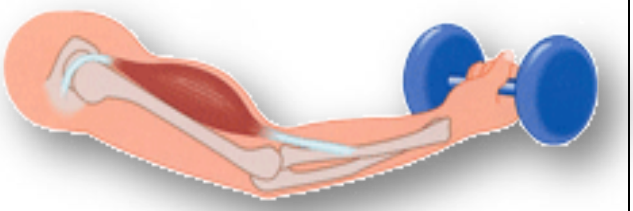
That is what this ergonomics principle is all about and there are sound physiological reasons why this is the case.

### *Metabolism (Work Physiology)*

To accomplish work, the body is able to take in nutrients, convert them into chemical energy and then ultimately into mechanical energy (e.g., muscular contraction) and heat. This is called metabolism.

Glucose and oxygen are stored in relatively small amounts within the muscle tissue. Consequently, to sustain performance continuous flow of oxygen and energy-rich blood into the tissue in addition to removal of metabolic waste products is required.

### Static Muscle Contraction



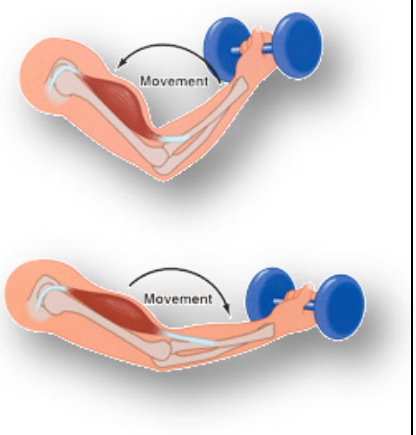
Type of muscular effort has been shown to have a profound impact on blood flow.

Static muscle contractions (the muscle shortens but no joint movement occurs) results in blood vessel compression due to internal muscle pressure.

At contraction levels of 60% and greater of the maximum voluntary contraction of the muscle, blood flow ceases.

The muscle depends on the quite limited initial reserves stored internally. Waste products accumulate and only short duration contractions are possible.

### Dynamic Muscle Contraction




On the other hand, dynamic muscle contractions are the alternating contracting and relaxing of muscle groups to perform tasks.

In terms of enhancing performance and controlling fatigue, dynamic muscle contractions are a significant improvement over static muscle contractions.

Dynamic muscle activity promotes blood and fluid flow by acting as a pump to increase oxygen and nutrition to the working muscles and helps to remove the waste products of metabolism.

### Position—Sustained/Awkward

Metabolic fatigue also occurs as the result of sustained position.
Blood flow—both volume and rate of flow—decreases. Pooling of fluid in the extremities occurs.

The body's tissues require ongoing nutrition even at low or minimal activity levels. The position of the body when sedentary has impact. Sustained awkward positions result in:

- Muscular contractions to maintain the position.
- Potential decrease in blood flow due to internal impingement or external contact stress.

### *Metabolic/Work Physiology Synopsis*

### Movement/activity

- Promote dynamic not static muscle contractions
- Build-in adequate physical recovery times
- Incorporate movement into the work process

### Position and support

- Design for neutral positions
- Design for body/limb support at work stations

## Control Manual Material Handling

### *How Much Can a Person Lift?*

The next ergonomics principle details the specifics regarding manual material handling capabilities of individuals.

How much can a person lift in a safe and effective way? What are the factors involving the manual handling that need to be considered? These questions have been studied extensively over the past 30 years.

### *Occupational Biomechanics*

## NIOSH Work Practices Guide for Manual Lifting

The NIOSH Work Practices Guide for Manual Lifting was initially introduced in 1981. Industry and government representatives recognized that manual material handling was a significant problem in industry and felt guidance in controlling how much weight could be safely lifted was needed.

A lifting equation was derived from four primary bodies of knowledge: epidemiology, biomechanics, psychophysics, and physiology. The equation consisted of a series of multipliers derived from a number of parameters that described the lift.

The original equation was modified in 1991 (and published in 1993) to compensate for two factors that were not accounted for in the original equation is far- hand-to-container coupling and asymmetry of the lift. Some of the original factors were modified as well.

The present equation allows calculation of a **Recommended Weight Limit (RWL)** and the **Lifting Index (LI)**.

The RWL is the recommended weight of the load that nearly all healthy workers could lift over a period of time (up to eight hours) without an increased risk of developing lifting related low back pain or injury, given all other task parameters remain unchanged.

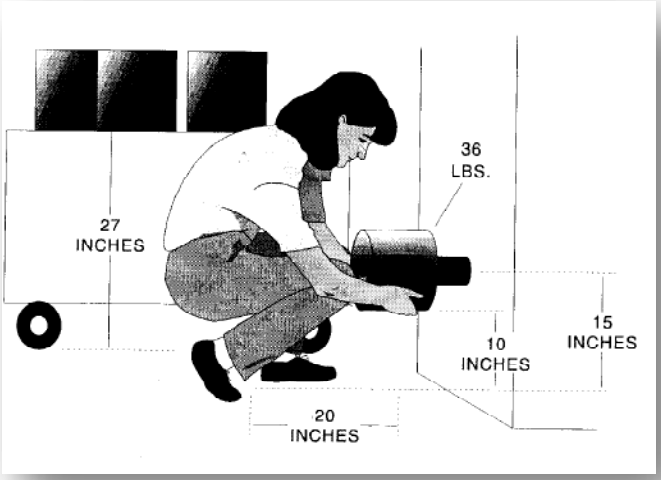
The LI is a relative estimate of the physical stress associated with a manual lifting job. As the magnitude of the LI increases, the level of the risk for a given worker increases, and a greater percentage of the workforce is likely to be at risk for developing lifting-related low back pain.

From the NIOSH perspective, it is ***likely that lifting tasks with a LI > 1.0 pose an increased risk for lifting-related low back pain and injury*** for some fraction of the workforce. NIOSH considers that the goal should be to design all lifting jobs to achieve a Lifting Index ( LI) of 1.0 or less.

$$\textbf{Lifting Index} = \frac{\textbf{Load Weight}}{\textbf{Recommended Weight Limit}}$$

With the ideal parameters in place, the RWL is 51#.

*Example: Loading Supply Rolls*



## JOB ANALYSIS WORKSHEET

DEPARTMENT: Shipping
JOB TITLE: Packager
ANALYST'S NAME:
DATE:

JOB DESCRIPTION: Loading paper supply rolls
Example 2

### STEP 1. Measure and record task variables

| Object Weight (lbs) | | Hand Location (in) | | | | Vertical Distance (in) | Asymmetric Angle (degrees) | | Frequency Rate lifts/min | Duration (HRS) | Object Coupling |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Origin | | Dest | | | Origin | Destination | | | |
| L (AVG.) | L (Max.) | H | V | H | V | D | A | A | F | | C |
| 35 | 35 | 15 | 27 | 20 | 10 | 17 | 0 | 0 | <.2 | <1 | Poor |

### STEP 2. Determine the multipliers and compute the RWL's

RWL = LC x HM x VM x DM x AM x FM x CM

ORIGIN RWL = 51 x .67 x .98 x .93 x 1.0 x 1.0 x .90 = 28.0 Lbs

DESTINATION RWL = 51 x .50 x .85 x .93 x 1.0 x 1.0 x .90 = 18.1 Lbs

### STEP 3. Compute the LIFTING INDEX

ORIGIN LIFTING INDEX = OBJECT WEIGHT (L) / RWL = 35 / 28.0 = 1.3

DESTINATION LIFTING INDEX = OBJECT WEIGHT (L) / RWL = 35 / 18.1 = 1.9

## Hazard Assessment

The weight to be lifted (35 lbs.) is greater than the RWL at both the origin and destination of the lift (28.0 lbs. and 18 lbs., respectively). The LI at the origin is 35 lbs./28.0 lbs. or 1.3, and the LI at the destination is 35 lbs./18.l lbs. or 1.9. These values indicate that this job is only slightly stressful at the origin, but moderately stressful at the destination of the lift.

## Redesign Suggestion

The first choice for reducing the risk of injury for workers performing this task would be to adapt the cart so that the paper rolls could be easily pushed into position on the machine, without manually lifting them.

If the cart cannot be modified, then the results of the equation may be used to suggest task modifications. The worksheet indicates that the multipliers with the smallest magnitude (i.e., those providing the greatest penalties) are .50 for the HM at the destination, .67 for the HM at the origin, .85 for the VM at the destination, and .90 for the CM value. The following job modifications are suggested:

1. Bring the load closer to the worker by making the roll smaller so that the roll can be lifted from between the worker's legs. This will decrease the H value, which in turn will increase the HM value.
2. Raise the height of the destination to increase the VM.
3. Improve the coupling to increase the CM

If the size of the roll cannot be reduced, then the vertical height (V) of the destination should be increased. If V was increased to about 30 inches, then VM would be increased from .85 to 1.0; the H value would be decreased from 20 inches to 15 inches, which would increase VM from .50 to .67; the DM would be increased from 0.93 to 1.0.

Thus, the final RWL would be increased from 18.1 lbs. to 30.8 lbs., and the LI at the destination would decrease from 1.9 to 1.1.

In some cases, redesign may not be feasible. In these cases, use of a mechanical lift may be more suitable. As an interim control strategy, two or more workers may be assigned to lift the supply roll.

### Comments

The horizontal distance (H) is a significant factor that may be difficult to reduce because the size of the paper rolls may be fixed. Moreover, redesign of the machine may not be practical.

Therefore, elimination of the manual lifting component of the job may be more appropriate than job redesign.

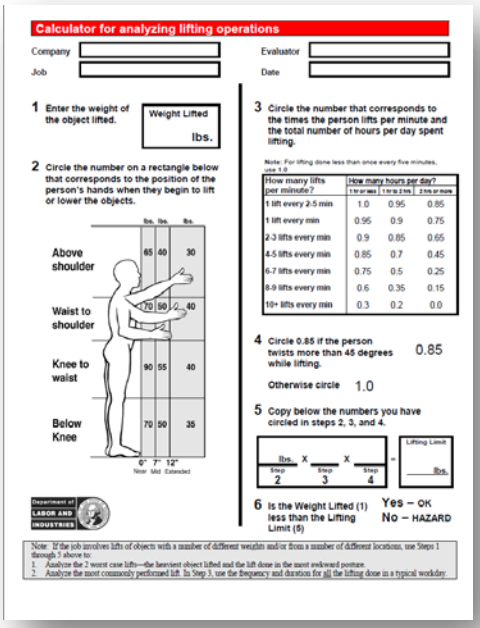
### *Lifting Calculator (State of Washington Department of Labor and Industries)*

The State of Washington Department of Labor and Industries developed a simplified version of the NIOSH Work Practices Guide for Manual Lifting.

It is easy to use and provides valuable information.

An on-line, interactive version is also available at:

http://www.lni.wa.gov/Safety/Topics/Ergonomics/ServicesResources/Tools/default.asp




### Occupational Biomechanics Principles

- Eliminate (as feasible) manual handling
- Make use of mechanical handling equipment (forklifts, powered lifts, etc.)
- Reduce physical stress of manual handling
- Make use of manual handing equipment (carts, two-wheelers, etc.)

### *Manual Material Handling Checklist*

Use the ***Manual Material Handling Checklist*** as needed for the ergonomics analysis process.

# Manual Material Handling Checklist

**"NO" response indicates potential problem area that should receive further investigation.**

| | | | |
|---|---|---|---|
| 1. Are the weights of loads to be lifted judged acceptable by the workforce? | YES | NO | NA |
| 2. Are materials moved over minimum distances? | YES | NO | NA |
| 3. Is the distance between the object load and the body minimized? | YES | NO | NA |
| 4. Are walking surfaces: | | | |
| • Level? | YES | NO | NA |
| • Wide enough? | YES | NO | NA |
| • Clean and dry? | YES | NO | NA |
| 5. Are objects: | | | |
| • Easy to grasp? | YES | NO | NA |
| • Stable? | YES | NO | NA |
| • Able to be held without slipping? | YES | NO | NA |
| 6. Are there handholds on objects? | YES | NO | NA |
| 7. When required, do gloves fit properly? | YES | NO | NA |
| 8. Is the proper footwear worn? | YES | NO | NA |
| 9. Is there enough room to maneuver? | YES | NO | NA |
| 10. Are mechanical handling aids (powered or manual) used whenever possible? | YES | NO | NA |
| 11. Are working surfaces adjustable to the best handling heights? | YES | NO | NA |
| 12. Does material handling avoid: | | | |
| • Movements below knuckle height and above shoulder height? | YES | NO | NA |
| • Static muscle loading? | YES | NO | NA |
| • Sudden movements during handling? | YES | NO | NA |
| • Twisting at the waist? | YES | NO | NA |
| • Extended reaching? | YES | NO | NA |
| 13. Is help available for heavy or awkward lifts? | YES | NO | NA |
| 14. Are high rates of repetition avoided by: | | | |
| • Job rotation? | YES | NO | NA |
| • Self-pacing? | YES | NO | NA |
| • Sufficient pauses? | YES | NO | NA |
| 15. Are pushing or pulling forces reduced or eliminated? | YES | NO | NA |
| 16. Does the employee have an unobstructed view of handling the task? | YES | NO | NA |
| 17. Is there a preventive maintenance program for equipment? | YES | NO | NA |
| 18. Are workers trained in correct handling and lifting procedures? | YES | NO | NA |

## Promote Work in Reach Zone

### *Hand Use*

#### How much do you use your hands every day?

More than half the day? How about more than 75% of the day? Well in fact, most people will say they use their hands at least 99.9% of the day!

#### Where do we tend to use our hands?

For example does anybody work behind their back? Pretty hard to see what you're doing!

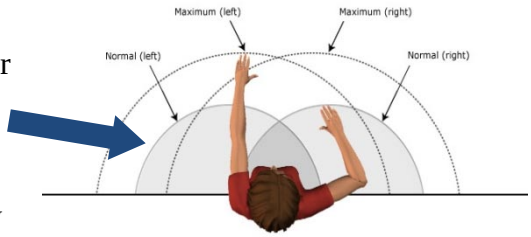
Because in most cases we need to see what we are doing we tend to use our hands in front of and to the sides of our body. We can define two reach zones:

- Comfort Reach Zone
- Functional Reach Zone

#### Comfort Reach Zone

Think of the comfort reach zone as that area in front and to the side where you'd like to use your hands when you're doing precise hand activity.

Your forearm length will determine the dimensions of the Comfort Reach Zone. To get a feel for this, position your elbows at your sides with your elbows bent at about 90°, swing your hands from side to side.



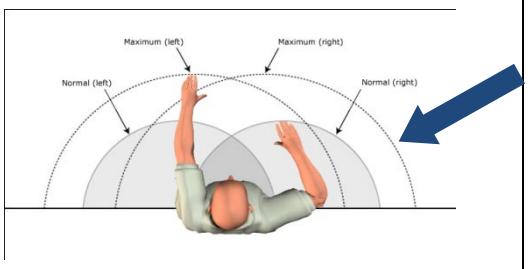

The height of this reach zone will be about three or 4 inches above and below your elbow level. This is your ***Comfort Reach Zone.***

Typical activities in the Comfort Reach Zone will include keyboard and mouse use along with handwriting. This also includes precision assembly in a manufacturing environment where you may exert a minimal downward force.

#### Functional Reach Zone

Think of the Functional Reach Zone as that area in front and to the side were you be able to comfortably reach to obtain parts and materials.

Your arm length determines the dimensions of the Functional Reach Zone. An easy way to get a feel for this is to reach your arms out in front of your body with your elbows straight. From your shoulder to the middle of your hand is your forward functional reach.




Now swing your arms out to the side about 45° from the midline of your body. This is the side-to-side functional reach.

Drop your hands so they are relaxed at your sides. This is called knuckle height and is the bottom zone of the functional reach.

Finally, with your arms extended raise them so they are about shoulder level. This is the upper zone of the functional reach.

Stature and arm's length determine the reach zones. Determine the individual reach zones and set up the work station to promote reaches in the appropriate zones.

Reach zone is really of function of lever arms. The longer the lever arm, the greater the force that is imposed on the body. How long can you hold 10 pounds at arm's length compared to the exact same 10 pounds held close to your body?

### *Anthropometry*

How can we determine how far a person can reach? Well we could actually go measure the individual to determine what their capability is. And sometimes in ergonomics, this is exactly what we will do.

Another strategy is to use anthropometry. For example, an engineer is designing a work station used by many different people. Countless design decisions have to be made. How high, how wide, how big, how long, will it fit, etc.? Anthropometry can help. The word 'anthropometry' is derived from two Greek words:

- anthrōpos, (human being)
- metry (measuring)

### Size and Shape

Anthropometry is the study of the physical dimensions—size, shape and weight—of the human body. Anthropometric principles are applied across the full spectrum of the practice of ergonomics:

- Design standards
- Machine guards
- Reaches/heights
- Handle configuration
- General work station design
- Development of biomechanical models

### Data Tables

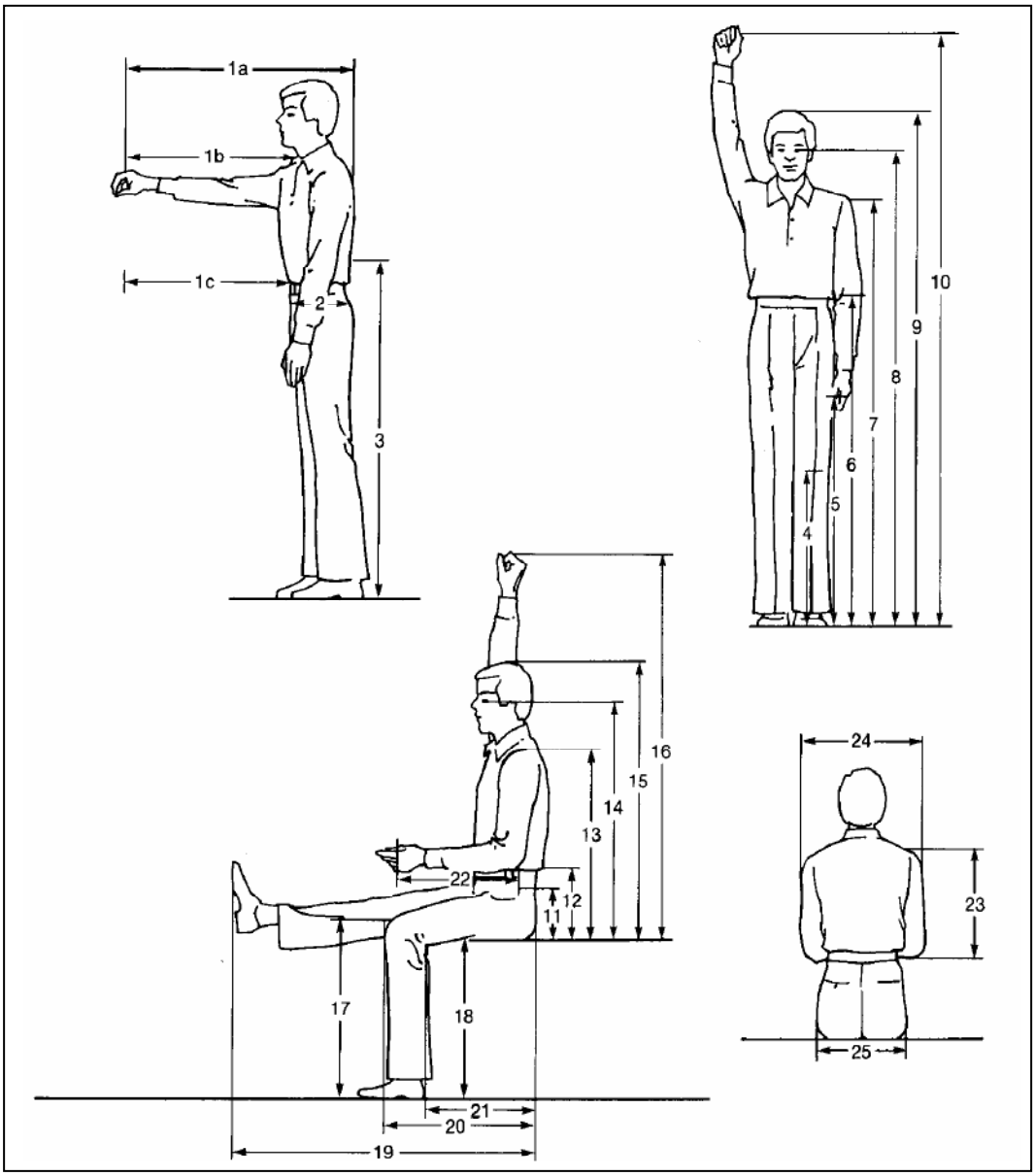
The basis for anthropometry is the careful measurement of the length, volume and weight of body part segments. From this, measurement tables have been generated that calculate a number of factors among others:

- Segment length
- Segment mass
- Center of mass location

The outcome is a set of statistical data that describes the human size and form. Often the data is described in terms of the mean and standard deviations. $5^{th}$, $50^{th}$ and $95^{th}$ percentiles are also calculated.

Examine the tables over the next pages to get a feel for what type of information is available.

# Anthropometry Data Table

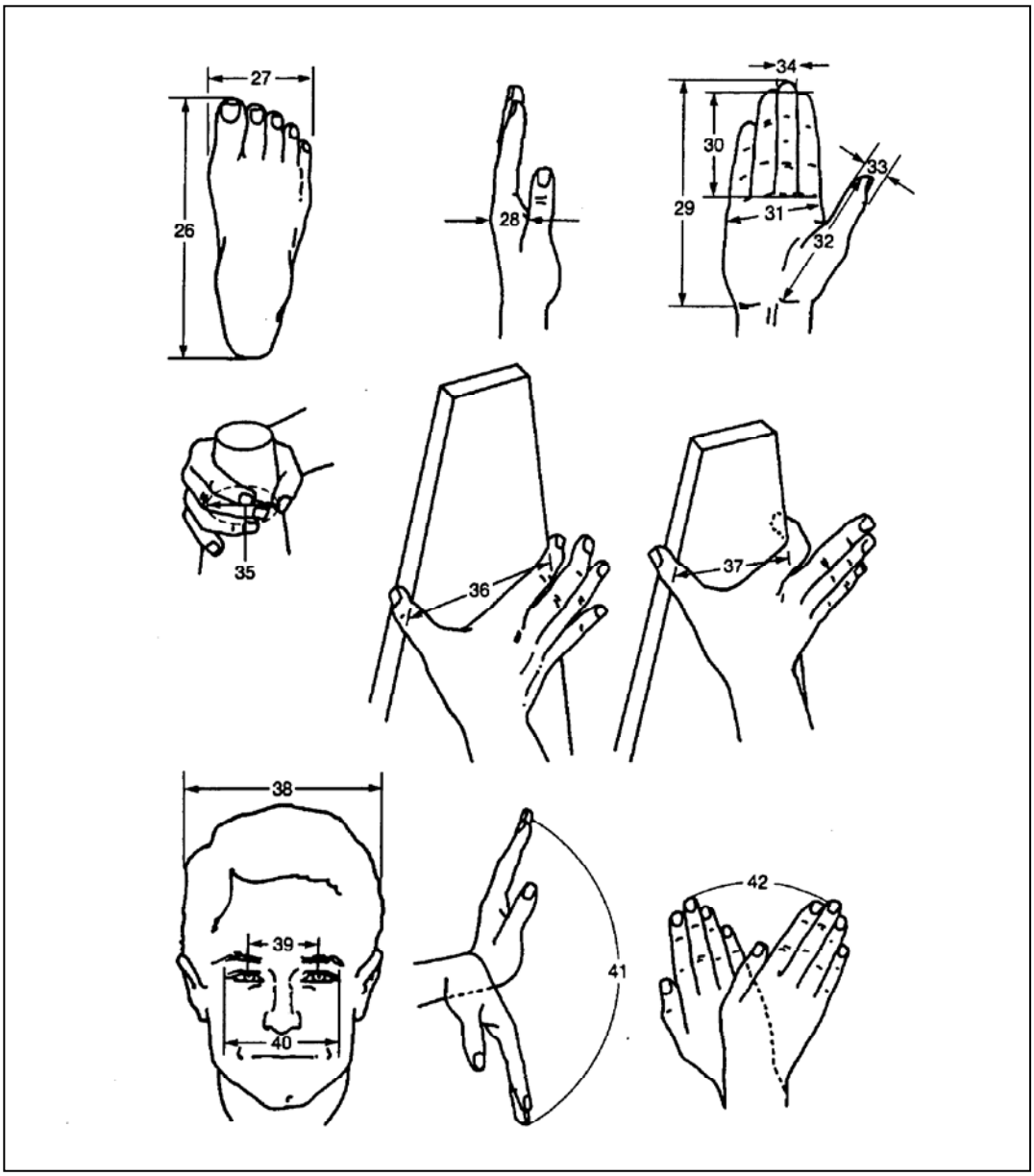


## Anthropometry Data Tables

Column 1 shows the measures and corresponding numbers from the body diagrams. Columns 2-7 provide the 5th, 50th and 95th percentiles respectively for males and females. Columns 8-10 show equivalent data for a 50/50 mix of males and females. All measures in inches. Data taken primarily from U.S. military personnel with sample size of several thousand.

| | Males | | | Females | | | 50/50 Males/Females | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5th | 50th | 95th | 5th | 50th | 95th | 5th | 50th | 95th |
| **STANDING** | | | | | | | | | |
| 1. Forward Functional Reach | | | | | | | | | |
| a. Includes body depth at shoulder | 28.7 | 32.5 | 36.3 | 26.2 | 29.2 | 32.2 | 27.2 | 30.7 | 35 |
| b. Acromial Process to Functional Pitch | 23.5 | 26.9 | 30.3 | 22.0 | 24.6 | 27.2 | 22.6 | 25.6 | 29.3 |
| c. Abdominal Extension to Functional Pitch | 17.4 | 24.4 | 31.4 | 18.6 | 23.8 | 29.0 | 19.1 | 24.1 | 29.3 |
| 2. Abdominal Extension Depth | 7.5 | 9.1 | 10.7 | 6.6 | 8.2 | 9.8 | 7.1 | 8.7 | 10.2 |
| 3. Waist Height | 37.7 | 41.9 | 46.1 | 36.0 | 40.0 | 44.0 | 37.4 | 40.9 | 44.7 |
| 4. Tibial Height | 15.7 | 17.9 | 20.1 | 14.7 | 16.5 | 18.3 | 15.3 | 17.2 | 19.4 |
| 5. Knuckle Height | 26.5 | 29.7 | 32.9 | 24.8 | 28.0 | 31.2 | 25.9 | 28.8 | 31.9 |
| 6. Elbow Height | 39.9 | 43.5 | 47.1 | 37.6 | 40.4 | 43.2 | 38.0 | 42.0 | 45.8 |
| 7. Shoulder Height | 51.8 | 56.6 | 61.4 | 46.5 | 51.9 | 57.3 | 48.4 | 54.4 | 59.7 |
| 8. Eye height | 59.9 | 64.7 | 69.5 | 55.2 | 59.6 | 64.0 | 56.8 | 62.1 | 67.8 |
| 9. Stature | 63.5 | 68.7 | 73.9 | 59.0 | 63.8 | 68.6 | 60.8 | 66.2 | 72 |
| 10. Functional Overhead Reach | 75.9 | 82.5 | 89.1 | 71.6 | 78.4 | 85.2 | 74.0 | 80.5 | 86.9 |
| **SEATED** | | | | | | | | | |
| 11. Thigh Clearance Height | 4.6 | 5.8 | 7.0 | 3.9 | 4.9 | 5.9 | 4.3 | 5.3 | 6.5 |
| 12. Elbow Rest Height | 6.9 | 9.5 | 12.1 | 6.7 | 9.1 | 11.5 | 7.3 | 9.3 | 11.4 |
| 13. Midshoulder Height | 22.1 | 24.5 | 26.9 | 20.8 | 22.8 | 24.8 | 21.4 | 23.6 | 26.1 |
| 14. Eye Height | 28.2 | 31.0 | 33.8 | 26.6 | 29.0 | 31.4 | 27.4 | 29.9 | 32.8 |
| 15. Sitting Height, Normal | 31.1 | 34.1 | 37.1 | 29.0 | 32.2 | 35.4 | 32.0 | 34.6 | 37.4 |
| 16. Functional Overhead Reach | 44.0 | 50.6 | 57.2 | 42.0 | 47.2 | 52.4 | 43.6 | 48.7 | 54.8 |
| 17. Knee Height | 19.1 | 21.3 | 23.5 | 18.1 | 20.1 | 22.1 | 18.7 | 20.7 | 22.7 |
| 18. Popliteal Height | 15.2 | 17.2 | 19.2 | 14.8 | 16.2 | 17.6 | 15.1 | 16.6 | 18.4 |
| 19. Leg Length | 37.6 | 41.4 | 45.2 | 36.2 | 39.6 | 43.0 | 37.3 | 40.5 | 43.9 |
| 20. Upper-Leg Length | 21.2 | 23.4 | 25.6 | 20.6 | 22.6 | 24.6 | 21.1 | 23.0 | 24.9 |
| 21. Buttocks-to-Popliteal Height | 17.2 | 19.2 | 21.2 | 16.5 | 18.9 | 21.3 | 17.2 | 19.1 | 20.9 |
| 22. Elbow-to-Popliteal Height | 12.4 | 14.2 | 16.0 | 10.5 | 12.7 | 14.9 | 12.6 | 14.5 | 16.2 |
| 23. Upper-Arm Length | 13.1 | 14.5 | 15.9 | 12.6 | 13.4 | 14.2 | 12.9 | 13.8 | 15.5 |
| 24. Shoulder Breadth | 16.3 | 17.9 | 19.5 | 13.8 | 15.4 | 17.0 | 14.3 | 16.7 | 18.8 |
| 25. Hip Breadth | 12.2 | 14.0 | 15.8 | 13.0 | 15.0 | 17.0 | 12.8 | 14.5 | 16.3 |

Data tables excerpted from: Human Factors Section, Eastman Kodak Company, *Ergonomic Design for People at Work*, Van Nostrand Reinhold, 1983.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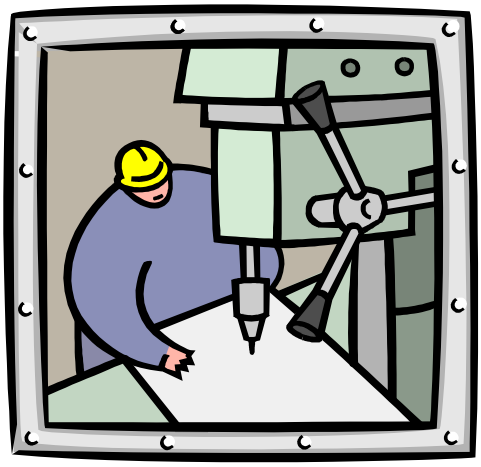
# Anthropometry Data Tables

| | Males | | | Females | | | 50/50 Males/Females | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5th | 50th | 95th | 5th | 50th | 95th | 5th | 50th | 95th |
| **FOOT** | | | | | | | | | |
| 26. Foot Length | 9.5 | 10.5 | 11.5 | 8.7 | 9.5 | 10.3 | 8.9 | 10.0 | 11.2 |
| 27. Foot Breadth | 3.5 | 3.9 | 4.3 | 3.1 | 3.5 | 3.9 | 3.2 | 3.7 | 4.2 |
| **HAND** | | | | | | | | | |
| 28. Hand Thickness, Metacarpal III | 1.1 | 1.3 | 1.5 | 0.9 | 1.1 | 1.3 | 1.0 | 1.2 | 1.4 |
| 29. Hand Length | 6.7 | 7.5 | 8.3 | 6.4 | 7.2 | 8.0 | 6.7 | 7.4 | 8.0 |
| 30. Digit Two Length | 2.4 | 3.0 | 3.6 | 2.1 | 2.7 | 3.3 | 2.3 | 2.8 | 3.3 |
| 31. Hand Breadth | 3.0 | 3.4 | 3.8 | 2.6 | 3.0 | 3.4 | 2.8 | 3.2 | 3.6 |
| 32. Digit One Length | 4.2 | 5.0 | 5.8 | 3.6 | 4.4 | 5.2 | 3.8 | 4.7 | 5.6 |
| 33. Breadth of Digit One Interphalangeal Joint | 0.8 | 0.9 | 1.0 | 0.7 | 0.8 | 0.9 | 0.7 | 0.8 | 1.0 |
| 34. Breadth of Digit Three Interphalangeal Joint | 0.6 | 0.7 | 0.8 | 0.5 | 0.6 | 0.7 | 0.6 | 0.7 | 0.8 |
| 35. Grip Breadth, Inside Diameter | 1.5 | 1.9 | 2.3 | 1.5 | 1.7 | 1.9 | 1.5 | 1.8 | 2.2 |
| 36. Hand Spread, Digit One to Two, 1st Phalangeal Joint | 3.1 | 4.9 | 6.7 | 2.5 | 3.9 | 5.3 | 3.0 | 4.3 | 6.1 |
| 37. Hand Spread, Digit One to Two, 2nd Phalangeal Joint | 2.7 | 4.1 | 5.5 | 1.8 | 3.2 | 4.6 | 2.3 | 3.6 | 5.0 |
| **HEAD** | | | | | | | | | |
| 38. Head Breadth | 5.6 | 6.0 | 6.4 | 5.3 | 5.7 | 6.1 | 5.4 | 5.9 | 6.3 |
| 39. Interpupillary Breadth | 2.0 | 2.4 | 2.8 | 1.9 | 2.3 | 2.7 | 2.1 | 2.4 | 2.6 |
| 40. Biocular Breadth | 3.2 | 3.6 | 4.0 | 3.2 | 3.6 | 4.0 | 3.3 | 3.6 | 3.9 |
| **OTHER MEASUREMENTS** | | | | | | | | | |
| 41. Flexion-Extension, Range of Motion of Wrist Degrees | 96.0 | 134.0 | 172.0 | 111.0 | 141.0 | 171.0 | 108.0 | 138.0 | 166.0 |
| 42. Ulnar-Radial Range of Motion of Wrist Degrees | 34.0 | 60.0 | 86.0 | 39.0 | 67.0 | 95.0 | 41.0 | 63.0 | 87.0 |
| 43. Weight, in pounds | 117.0 | 183.4 | 249.8 | 84.9 | 146.3 | 207.7 | 105.3 | 164.1 | 226.8 |

**Note: All values may be affected by clothing and posture.**

Data tables excerpted from: Human Factors Section, Eastman Kodak Company, *Ergonomic Design for People at Work*, Van Nostrand Reinhold, 1983.

## Work station Height

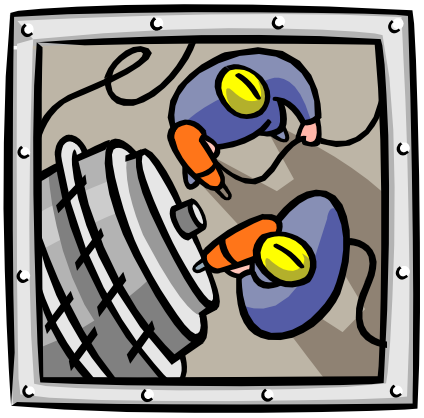


Returning to the engineer designing the work station, let's address the question of how high the work station should be. We could look for the tallest person and make sure the height accommodates that person. But, examining the tables we find that only a very few people are actually that height.

We could look for the average height individual in the data set. The 50th percentile height indicates half of the population is shorter and half is taller. But then this would accommodate only half of the population. The 95th percentile height would allow the taller person to fit. **Generally, it's considered easier to raise the shorter person to a higher level than lower the taller person.**

In practical use, we also have to consider the type of work being performed - handwork, precision or forceful - as well as the size and shape of the material.

## Work station Reach



Let's examine the other end of the continuum. A work station is being designed including the layout of parts and materials. How far away, at maximum, should the supplies be placed and still achieve a reasonable reach?

In a fixed work station design we need to look at the reach envelope of the smallest individual. The adopted convention is to design for the 5th percentile woman.

In reality, the best bet is to build in reach flexibility to accommodate both ends of the reach envelope. A 95th percentile man feels quite cramped at the 5th percentile woman's reach.

So, by applying the principles of anthropometry as part of the overall systems design, objectives of enhancing human performance by controlling fatigue can be met.

## Anthropometry Principles

- Design to allow the tall person to fit
- Design to allow the short person to reach

## Provide Correct Workstations, Tools and Equipment

Providing the correct tools, equipment and facilities is a critical ergonomics principle. Safer, faster and more productive are the tangible results.

The correct workstation, tools and equipment can make the difference between getting the job done or not at all. And even worse, the wrong tool can result an injury to the use.

### *Work Station*

The general design and set-up of the work station is an important factor. We will examine a number of factors to adequately assess the work station.

### Stationary/Mobile

- Is the work station stationary - used primarily in one position? (See below for adjustability features.)
- Is the work station mobile - taken from job site to job site? If so, how is it transported?

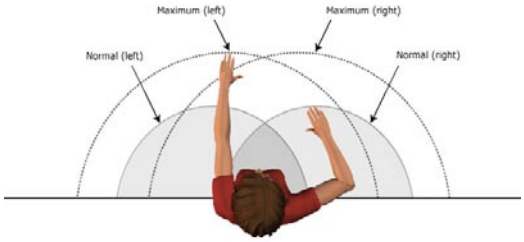
### *Adjustability features*

Can the work station be adjusted to accommodate the needs of different workers and work processes?

***Work height***

- Does the height of the work surface permit a comfortable view of the job being done?
- Is the height of the work surface adjustable?
- Does the height of the work surface permit satisfactory arm posture? (Correct hand height depends on type of work performed and object worked on.)

***Work reach envelope***




- Can the worker keep horizontal stretches within the range of normal arm reach?
- Refer to the anthropometric data tables for additional details.

***Chair/stool***

- If a chair/stool is provided, is its design satisfactory? (Adequate back support, vertical adjustability, etc.)

***Equipment controls***

- Can equipment controls and machinery be adjusted to accommodate the needs of different operators?

***Worker movement***

- Is it possible for the worker to alternate sitting and standing when performing the task?

***Space and clearance***

- If containers are used, are they placed conveniently?
- Is there adequate space at the work station to perform the work comfortably?
- Does the positioning of equipment controls and work surface make it possible to maintain a comfortable posture?
- Is the workplace accessible to material handling equipment?
- Is clearance space in the workplace adequate for maintenance tasks?

## Tools

### *Manual to Power*

A switch from manual hand tools to power tools can reduce force levels. Power tools create their own set of issues, including vibration and torque reaction force.

### *Torque reaction forces*

Torque reaction occurs when a fastener reaches the end of its travel, transferring the torque to the tool and operator. Employ clutches and torque reaction bars to reduce torque reaction forces.

Newer tools make use of pulse rather than impact technology. These tools significantly reduce power grip force requirements.

### *Handle size*

- Handle size should be monitored to provide optimum power grasps.
- Trigger configuration should spread the required triggering force over a large area, rather than concentrated in a smaller area.

### *Preventive Maintenance*

Preventive maintenance, based on manufacturer specifications, is critical to ensure proper operation of the tool. Sharp bits, blades, and un-clogged abrasives significantly reduce the force required to use manual or power tools.

## Machinery/Equipment

Part of the work station is the machinery/equipment used in the operation. Look for a number of factors.

*Foot pedals*

- Are foot/knee control pedals used?
- Does the operator have to operate foot/knee pedals while standing?
- To operate foot pedals or knee switches, must the worker assume an unnatural or uncomfortable posture?
- Are pedals limited to two?
- Are pedals too small to allow the operator to alter the position of the foot/knee?
- Are pedals triggered at a high repetition rate?

*Hand controls*

- Are hand controls used?
- Placed to allow neutral hand/arm/body position?
- Difficult (require excessive force) to operate?
- Designed (shape and configuration) to take into account the amount and types of force required for operation?

## Personal Protective Equipment (PPE)

Personal protective equipment is an essential complement to an effective ergonomics process.

*Mandatory*

- Are there conditions that require personal protective clothing or equipment?
- What conditions exist?
- What PPE is used?

*Monitoring and Enforcement*

- How is PPE use monitored?
- Are PPE policies enforced?

## Physical Demands

*Metabolic Load*

- Does the job involve peak loads of muscular effort?
- How often do peak loads occur and

how long do they last?

- Are there signs of unacceptable fatigue on the worker's part? (i.e. profuse sweating, red flushed face, heavy and labored breathing, poor coordination, etc.)
- Is there frequent daily stair or ladder climbing?
- Is recovery time figured into the work process?

### *Force - Component Fit*

A poor fit of components during an assembly process may force an assembler to "bang in" the component using the hand or other body part as a hammer. Coordinated effort with the vendor, in house or off site, can ensure the needed fit quality.

The type of fastener used may be at issue. Options include use of riveting, spot welding, and use of specialized fastening systems rather than slotted fasteners.

### *Force - Lift/Push/Pull*

Manual material handling is commonly seen in many diverse settings, not just in warehouses. OSHA has identified the stresses associated with manual material handling as one of the major factors to examine and alleviate.

Force levels are a function of the weight of the tools, containers, boxes, parts, carts, etc. Whether lifted, carried, pushed, or pulled, the force required to move or manipulate the object directly creates stress on the body.

*Questions*

- Do workers have to lift objects, boxes, parts, materials?
- Does the task require:
  - Strenuous one-hand lifting?
  - Strenuous two-hand lifting?
  - Lifting over too great a vertical distance (near floor or above shoulders)?
  - Lifting at too great a horizontal distance?
  - Difficult-to-grasp items?
- Does the job require handling of oversized objects?
- Does the job require two-person lifting?
- Is help for heavy lifting or exerting force unavailable?
- Do workers have to push or pull objects?
- Does the task require:
  - Large breakaway forces to get the object started?
  - Pushing or pulling hand trucks or carts up or down inclines or ramps?
- Does the job lack material handling aids such as air hoists or scissors tables?

*Force Intervention strategies*

Intervention strategies to control force levels related to the weight of the load include:

- Design job to reduce static muscle loading. (Provide jigs, fixtures, clamps, spot welds, etc. to hold work object.)
- Workers learn how to better control static muscle loading. (Body mechanics, stretching, etc.)
- Make use of mechanical devices, hoists, lifts, etc. to eliminate manual lifting.
- Slide rather than lifting the weight.
- Eliminate the effect of gravity by counterbalancing the weight, a method commonly used with tools.
- Remove physical barriers, thereby reducing the horizontal distance (long lever arm).
- Relocate storage heights with heavier objects stored between mid- thigh and waist height.
- Work with vendors to provide material either in smaller unit weights (e.g., 50 pounds, rather than 100 pounds) or in bulk that requires handling with mechanical means.
- Provide adjustable height surfaces (e.g., scissors tables) to maintain desired height of material.
- Reposition the worker to provide greater mechanical advantage; e.g., use body weight rather than musculoskeletal strength.
- Reposition the work material; e.g., bring parts and tools within reach envelope; place bin on a bin tipper or provide side drop-down bins

The safest lift of all is the one that does not occur. Whenever possible slide objects rather than lift them. Friction between the surface and object may be a problem. Friction can by decreased by:

- Line storage shelves with decreased friction liners (e.g., Teflon sheets).
- Spray-on products will reduce friction (may cause a toxic substance problem.)
- Use roller conveyor systems to transport materials.

Maintain the quality of floor conditions to eliminate cracks and general deterioration.

Use appropriate type and size of casters or wheels as original equipment or retrofit, depending on floor type.

### *Force - Workflow and Rate*

The factors of workflow and rate contribute to the effect of force on the musculoskeletal system. The duty cycle of the job demand determines the force dose-exposure.

Reducing either the dose (level of force) or the exposure (duration of the force) is desirable. Reduce exposure through administrative controls including job rotation and job enlargement.

### *Force - Grip*

Whether using tools or handling boxes, grip has a major influence on controlling force levels. A power grip makes use of larger, more powerful muscles than does a pinch grasp.

Typically, a maximal pinch is only 20% of maximal power grasp. Adjusting coupling can facilitate the use of power grips.

Grip spans of 1 1/2 to 2 inches are ideal. Spans greater or less result in less than desirable mechanical advantage.

***Questions:***

Is a power grip used?

- For what purpose is the grip used?
- Do workers have to exert high levels of power grip force to perform tasks?

Is a pinch grip used?

- For what purpose is the grip used?
- Do workers have to exert high levels of pinch grip force to perform tasks?
- Can a change to a power grip be made?
- Can the grip be eliminated or reduced?

***Coefficient of Friction***

The coefficient of friction can have a major impact on controlling grip force levels. Friction between the hand and object can be increased by:

- Use rubberized coating on the object; e.g., tool handle.
- Clean the object of lubricants.
- Provide appropriate non-slip gloves.
- Maintain normal skin moisture; dry skin has about 2/3s the coefficient of friction compared to moist skin.

### *Glove use*


Gloves are commonly seen in work environments. The type and fit of the glove should reflect the purpose of the glove. Determine if the glove is truly necessary.

Generally, a gloved hand is able to produce a maximum of 25% to 30% less force than an ungloved hand. A ***"one size fits all"*** policy does not work.

Gloves that are too small increase the force required to overcome the resistance of the glove. Gloves that are too large hinder dexterity due to sloppiness of fit.

## Position

The goal is to have the body in a neutral posture as much as possible. Evaluate jobs or activities that tend to force the worker out of ergonomic neutral positions and/or result in awkward or sustained positions.

### *Prolonged or repeated non-neutral spinal positions*

Non-neutral spinal positions include bending the head, neck, and trunk forward, backward or to the side, with or without twisting.

### *Wrist deviations greater than 15 degrees from neutral*

You can demonstrate the neutral position at the wrist by making a tight fist. This results in approximately 10-15 degrees in extension in most people, and is the position of power for the wrist. This posture enables maximum force production while maintaining space within the carpal tunnel.

As the wrist moves away from this power position, the finger flexor tendons increase their contact against the carpal ligament or bones of the wrist. This increased contact may result in inflammation, and the pressure within the carpal tunnel may increase.

### *Forearm rotation*

When the forearm is rotated toward the extremes of supination (palm up) and pronation (palm down), in combination with deviations of the wrist from the power position, there is a great degree of stress at the origin of the forearm muscles.

*Elbows sustained above mid-chest height*

Elbows positioned above mid-chest height place additional stress on the shoulder when prolonged muscle contractions are required. In addition to inefficient use of energy, these positions also tend to cause a reduction in blood flow to the tendons in the shoulder.

*Reaching frequently behind the body or above the shoulders*

Arm positions behind the body or above the shoulders tend to increase pressure within the shoulder joint while stretching many of the shoulder tendons and muscles.

**Modifying Work Positions**

*Standing work position*

Standing positions are more appropriate than sitting positions if:

Frequent or relatively heavy lifting is required.

Significant downward forces are required.

*Seated work position*

Use seated work stations when light assembly or precision work is performed.

### *Sit/Stand work positions*

In some cases, sit/stand work stations may provide a viable option. These provide for postural variability.

### *Adjustable height work stations*

Adding adjustable height work stations and lift tables to a work area allows for increased postural variety for workers but also allows accommodation for variation in body stature between workers.

### *Turntables*

Use turntables to bring parts closer to the worker, reducing the need for sustained or extreme forward reaching.

These are particularly helpful when the worker needs to access the other side of the pallet.

### *Movement*

Even relatively well-designed ergonomic work stations require individuals to work in one posture. Evaluation of the work place should include an assessment of how often individuals have the opportunity to move out of sustained postures to perform other movements or tasks.

### *Tool use and postures*

Frequently workers use tools specifically designed for another purpose. This is often found when using pistol grip and in-line tools.

***In-line grip***

An in-line power tool is used when there is need for a vertical drive that occurs between the waist and elbow height.

***Pistol grip***

Use pistol grip tools on horizontal surfaces at waist height or for vertical surfaces between elbow and shoulder height.

***Ergonomically designed tools***

In the past decade, tool manufacturers have made major strides in the design of ergonomically approved tools. Such tools include bent handle pliers, ergonomic knives, reduced vibration power tools, etc.

*Rapid machine pacing in an assembly task*

Production workers performing machine-paced tasks are frequently required to maintain a work rate greater than they can perform comfortably.

In many cases, workers work ahead to create a buffer, for fear that they may fall behind.

Other workers find themselves working behind the line because they cannot keep pace.

Both situations require individuals to work in positions other than directly in front of them, promoting awkward postures.

*Reach envelope*

Examine the work station layout regarding placement of tools, parts, or materials to promote a reasonable reach envelope. A desirable reach envelope is laid out horizontally within a 45° arc from midline to each side of the body.

The amount of forward reach is also considered, recognizing that items stored above or below shoulder height need to be closer to the worker than those stored at shoulder height.

*Storage locations*

Place the most frequently used materials, tools and controls at optimal positions within the reach envelope.

Incline the work station and/or use rotating jigs and turntables to bring parts or materials close to the person when required.

## Repetition

Repetition rates can be difficult to reduce due to production standards. However, the associated stresses can be controlled in a number of ways.

*Mechanical Aids*

Reduce repetition rates through the use of mechanical aids:

- Introducing power tools in the work place may reduce duration of forceful contractions and awkward and sustained positions.

- Mechanical aids can also automate all or parts of a work process.
- The operator's exposure to the stresses associated with high repetition is reduced without reducing the output.

### *Worker Rotation*

A feasible alternative to reducing repetition rates is the use of worker rotation. Worker rotation reduces overall exposure of workers to particular types of repetition.

Analyze work methods when you implement worker rotation system; the required motions for each body part should be identified.

After determining that designs are acceptable or that redesign is not feasible, workers should be cross-trained to perform each job within a rotation schedule.

In addition to involving the workers in identifying a successful rotation strategy, it is also important to ensure that jobs into which workers rotate involve significantly different physical job demands.

**In some cases, job rotation schemes rotate individuals through different jobs, but the actual physical demands are very similar from position to position. This is not a beneficial use of worker rotation.**

***Repetition - Pacing***

- Is the work pace rapid?
- Is the work pace under the worker's control?
- Is the pace of material handling determined by a machine? (Feeding machines, conveyors, etc.)

***Repetition - Manual Handling***

- Are workers frequently required to lift and carry heavy weights?
- Does the task require the worker to repeat the same movement pattern at a high rate of speed?

***Repetition - Arm/Hand***

- Does the task require the worker to repeat the same movement pattern at a high rate of speed?
- Does the task require the continuous use (or nearly so) of both hands and both feet in order to operate controls or manipulate the work object?

***Repetition - Tool Use***

- Does the job involve the frequent use or manipulation of tools?
- Are power tools in use?
- Are manual tools in use?
- In some cases, rivets, welding, or adhesives may replace the need for screw fasteners.

## Whole Body Vibration

*Whole body vibration*

Truck and forklift drivers frequently encounter whole body vibration. Vibration of this type is suspected of weakening and disrupting soft tissue structures such as tendons and ligaments.

*Questions:*

- Is the body as a whole subjected to vibration?
- Is the level of vibration high enough to have adverse effects on the worker?

## Segmental Vibration

Segmental vibration is typically found in tasks that require the use of abrasive wheels, grinders, lathes, and power hand tools. Vibration from these sources has been shown to decrease sensitivity in the hand, resulting in an unnecessary increase in local muscle contractions.

*Associated with other factors*

- As with force, posture, repetition, and contact stress, vibration is frequently associated with other risk factors.
- Assess the duration of the exposure, the exposure patterns during the shift, and the force levels and postures assumed during the vibration exposure.

*Fastener types*

Fastener types used with various power drivers and nut runners may also play a role in vibration exposure. Certain fasteners, because of the manner by which they engage the power tool, may drive more easily resulting in reduced exposure to vibration, sustained or high force levels, poor postures and contact stresses.

- Hex head screws drive faster and with less effort than Phillips screws and Phillips screws less so than slotted screws.
- In some cases, rivets, welding, or adhesives may replace the need for screw fasteners.

*Questions*

- Is there tool vibration?
- Is the level of vibration high enough to have adverse effects on the worker?

*Control vibration*

*Source control*

When possible try to control vibration at the source. This is important whether the vibration is segmental or whole body in nature.

- Maintain and balance power tools on a regular basis.
- Evaluate the floor quality.
- Repair work, or even replacing vehicle seats, may be necessary to reduce exposure to whole body vibration.

*Path control*

In many situations, it may not be possible to control vibrations at the source. In this situation, obstruct and dampen the path of the vibration.

- Vibration attenuation covers that attach directly to the tools.
- Wear gloves with padded palms.
- When you add these coverings, be aware the effective handle diameter increases and tool control and grip strength may be adversely affected.
- Increasing the speed (RPM) at which the tool turns, frequently helps to reduce the amplitude of the vibration.
- Quick-cutting abrasives in grinding and sanding operations.

## Contact Stress - Sharp edge

When you evaluate the type and severity of contact stress, look for any part of the body that is in contact with a sharp edge.

- Examine tool handle size and shape for prominences that promote increased pressure over any point of the grasping surface of the hand.
- Evaluate tools regarding the amount of localized pressure tools produce in the palm of the hand.
- Finger contours on handles or triggering devices of tools may also produce unnecessary stress on the digits.
- Examine the size and shape of any machine guards for potential contact stress. Identify and correct sharp edges or sustained pressure on the guard.

*Control strategies - round edges*

- Round work surface edges that come in contact with the worker.
- Tool handles and trigger switches should have rounded contours.
- Avoid the use of tools that require continuous or intermittent pressure on the fingers, palm, base of the wrist, forearm, and elbow.
- When possible, use self-opening tools such as pliers and scissors that are spring loaded. This reduces contact stresses required to open the tool.
- When contact stress itself cannot be avoided, the goal is to distribute the pressure over as large an area as possible by increasing the contact surface area.

*Questions:*

- Is the worker in contact with sharp edges in the work place (machine guards, tool handles, desk edges, etc.)?

*Use of the hands for pounding*

Nerve and soft tissue trauma may occur when the hands are used as hammers. Using the hands in this manner increases the likelihood of local inflammation that may cause unnecessary scarring.

Eventually reduction in blood flow to the nerves and other soft tissues may occur. Inappropriate techniques and work processes are frequently the culprit regarding contact stresses.

Encourage workers to be aware of potential problem areas such as pressure over vulnerable areas of the body where nerves and blood vessels are close to the surface.

Hands are NOT hammers!

## Contact Stress – Sitting and Standing

Two areas of the body that are frequently not evaluated for contact stress are the feet of people who stand all day, and the buttocks and thighs of those who sit all day.

Evaluate chairs by observing pressure at the front of the seat pan and the position of the backrest. Evaluate the potential for pressure behind the knee or at the back of the thigh caused by the edge of the seat pan.

Floor surfaces can affect the comfort of workers who are required to stand for a large percentage of the day. This is a problem particularly when there is limited potential for movement.

Concrete, steel grates, uneven or vibrating floor surfaces may increase foot, leg or spinal fatigue and discomfort and can affect concentration and product quality. Anti-fatigue mats or shock absorbing shoe inserts can improve comfort levels.

*Questions:*

***Contact Stress - Hard surface***

- Must the worker stand on a hard surface for 45 percent or more of the work shift?
- Is the texture of the work surface comfortable, taking into account hardness, elasticity, color and smoothness?

## Mental Demands

The mental demands of work can be just as demanding and stressful as the physical demands. They require a thoughtful examination.

*Is the task complex?*

- Does the worker have to evaluate data before taking action?
- Must the operator sense and respond to information signals occurring simultaneously from different machines without sufficient time to do so?
- Must the operator process information at a rate, which might exceed his or her capability?
- Is the job so complex it takes a long time to train workers?
- Does the task require a great deal of accuracy?
- Does this work situation require monitoring several machines?

*Is the tack monotonous?*

- Does the worker repeat the same task without change for the entire shift?
- Does the worker lose track of the task at hand because it is overly monotonous?

*Design and Use Standards*

- Are controls standardized on similar equipment?
- Does the design of any instrument increase reading errors?

## Perceptual Demands

Our ability to properly perceive our environment exerts a major influence on our interaction with it.

Issues like illumination, auditory, touch and visual acuity fall into the realm of perceptual demand.

*Illumination*

Evaluate the quantity and quality of light. In many cases, today's office buildings have illumination levels approximately 25 to 30 per cent greater than desirable. Decreasing the amount of general overhead light and bringing in specific task lighting is effectively in selected areas.

Also, consider the overall quality and level of the light in relation to the color and reflectivity of the walls, floors, and ceilings. Glare is a commonly observed

problem in office environments where it is apparent on video display terminals (VDT) screens.

Under-illumination facilitates forward bending of the trunk and head as individuals attempt to get closer to the material they are viewing. Task lighting can be effective to focus illumination where desired and at the same time control glare.

***Illumination - General***

- Is special lighting necessary to perform the job?
- Is the general work area including egress/ingress poorly lit?

***Illumination - Task***

- Is lighting inadequate for the job?
- Are controls, instruments and equipment poorly lit?
- Is the illumination not satisfactory for the task?

***Illumination - Contrast***

- Is contrast poor between the workspace and its surroundings?
- Is the workplace so poorly lit that there are great differences between brightness levels in panels, dials and surroundings?

***Illumination - Glare***

- Is glare present in the workplace?
- What is the source of the glare?
- Is glare from displays a problem?

*Auditory*

- Does the noise level prevent or impair verbal communication?
- Are there auditory signals?
- Are some auditory signals hard to hear in general?
- Are auditory signals difficult to distinguish from one another?

*Touch*

- Is there a need to tell the difference between parts by touch?
- Is it difficult to recognize controls and tools by touch and/or position?

*Visual Acuity*

- Does the task require fine visual judgments? (This includes the need to detect small defects, judging distances accurately, etc.)
- Are dials and instruments difficult to read quickly and accurately?
- Are controls, instruments and equipment placed where they are difficult to see? (At a bad angle, too high, too low.)
- If warning lights are present, are they located out of the center of the field of vision?
- Are dials grouped inconveniently?

*Preventive Maintenance*

Preventive maintenance of tools, equipment, work stations and the facility itself have a major impact on the workforce.

***Regular schedule***

- Is there a regular maintenance schedule?

***Ease of maintenance***

- Is the equipment designed or placed in such a way that cleaning and maintenance activities are difficult?
- Are containers designed for easy maintenance and repair?
- Does the design of the equipment allow for easy access for maintenance and repair?
- Are floors uneven?

*Housekeeping*

***General***

- Is the workplace floor clear of clutter and obstructions, which could create the risk of slips, trips or falls?
- Are floors slippery?

***Work station***

- Does there seem to be too much clutter in the work station?
- Is housekeeping at the work station poor?

## *Work Station, Tools and Equipment Checklists*

### Work Station

The general design and set-up of the work station is an important factor. Use the ***Workstation Checklist*** as needed for the ergonomics analysis process.

### Tools

How much money do professional carpenters spend on tools? In fact they may have one tool that does just one job! Why is it worth the investment? That specific tool makes the job go faster and easier with less chance of injury.

Refer to the ***Tool Checklist*** for additional information.

### Equipment

Part of the work station is the machinery/equipment used in the operation. Look for a number of factors including foot pedals, hand controls, whole body vibration, maintenance, etc. Refer to the ***Equipment Checklist*** for additional information.

# Workstation Checklist

**"NO" response indicates potential problem areas that should receive further investigation.**

| | | | |
|---|---|---|---|
| Does the work space allow for full range of movement within the workstation? | YES | NO | NA |
| Is the height of the work surface adjustable? | YES | NO | NA |
| Can the work surface be tilted or angled to provide a comfortable view of the job being done? | YES | NO | NA |
| **Is the workstation designed to reduce or eliminate:** | | | |
| • Bending or twisting at the wrist? | YES | NO | NA |
| • Reaching above the shoulder? | YES | NO | NA |
| • Static muscle loading? | YES | NO | NA |
| • Full extension of the arms? | YES | NO | NA |
| • Raised elbows? | YES | NO | NA |
| Are the workers able to vary posture? | YES | NO | NA |
| Are the hands and arms free from sharp edges on work surfaces? | YES | NO | NA |
| Is an armrest provided where needed? | YES | NO | NA |
| Is a footrest provided where needed? | YES | NO | NA |
| Is the floor surface free of obstacles and flat? | YES | NO | NA |
| Are cushioned floor mats provided for employees required to stand for long periods? | YES | NO | NA |
| If a chair/stool is provided, is its design and adjustability satisfactory and suited to the task? (Back support, vertical adjustability, etc.) | YES | NO | NA |
| Are all task elements visible from comfortable positions (seated or standing)? | YES | NO | NA |
| Is there a preventive maintenance program for mechanical aids, tools, and other equipment? | YES | NO | NA |
| Is the worker able to work within the comfort and functional reach zones? | YES | NO | NA |
| Is it possible for the worker to alternate sitting and standing when performing the task? | YES | NO | NA |
| Is there adequate space at the workstation to perform the work effectively and comfortably? | YES | NO | NA |
| Can position of tools/equipment and controls be adjusted to suit the worker? | YES | NO | NA |
| If parts and materials containers/bins/tubs/carts are used, are they conveniently placed? | YES | NO | NA |
| Are mechanical aids and mechanical handling equipment available? | YES | NO | NA |
| Is the workstation accessible to material handling equipment? | YES | NO | NA |
| Is clearance space in the workplace adequate for maintenance tasks? | YES | NO | NA |

# Tool Checklist

**"NO" response indicates potential problem areas that should receive further investigation.**

| | | | |
|---|---|---|---|
| Are power tools used and acceptable? (If not acceptable what problems with power tools are noted?) | YES | NO | NA |
| Are manual tools used and acceptable? (If not acceptable what problems with power tools are noted?) | YES | NO | NA |
| **Are tools selected to limit or minimize:** | | | |
| • Exposure to excessive vibration? | YES | NO | NA |
| • Use of excessive force? | YES | NO | NA |
| • Bending or twisting the wrist? | YES | NO | NA |
| • Finger pinch grip? | YES | NO | NA |
| • Problems associated with trigger finger? | YES | NO | NA |
| Are tools powered where necessary and feasible? | YES | NO | NA |
| Are tools evenly balanced? | YES | NO | NA |
| Are heavy tools suspended or counterbalanced in ways to facilitate use? | YES | NO | NA |
| Does the tool allow adequate visibility of the work? | YES | NO | NA |
| Does the tool grip/handle prevent slipping during use? | YES | NO | NA |
| Are tools equipped with handles of textured, non-conductive material? | YES | NO | NA |
| Are different handle sizes available to fit a wide range of hand sizes? | YES | NO | NA |
| Is the tool handle designed not to dig into the palm of the hand? | YES | NO | NA |
| Can the tool be used safely with gloves? | YES | NO | NA |
| Can the tool be used by either hand? | YES | NO | NA |
| Is there a preventive maintenance program to keep tools operating as designed? | YES | NO | NA |
| **Have employees been trained:** | | | |
| • In the proper use of tools? | YES | NO | NA |
| • When and how to report problems with tools? | YES | NO | NA |
| • In proper tool maintenance? | YES | NO | NA |

# Equipment Checklist

**"YES" response indicates potential problem areas that should receive further investigation.**

| | | | |
|---|---|---|---|
| **Foot/knee control pedals** | | | |
| Does the operator have to operate foot/knee pedals while standing? | YES | NO | NA |
| To operate foot pedals or knee switches, must the worker assume an unnatural or uncomfortable posture? | YES | NO | NA |
| Are pedals too small to allow the operator to alter the position of the foot/knee? | YES | NO | NA |
| Are pedals triggered at a high repetition rate? | YES | NO | NA |
| **Hand controls** | | | |
| Hand controls placed to **not** allow neutral hand/arm/body position? | YES | NO | NA |
| Hand controls difficult (require excessive force) to operate? | YES | NO | NA |
| Hand controls not properly designed to take into account amount and types of force required for operation? | YES | NO | NA |
| Do workers have to exert high levels of power grip force to operate equipment? | YES | NO | NA |
| Do workers have to exert high levels of pinch grip force to operate equipment? | YES | NO | NA |
| **Position - Sustained/Awkward** | | | |
| To operate equipment, must worker maintain same body posture (either sitting or standing) all or most of the time? | YES | NO | NA |
| Is the pace of material handling determined by the equipment? (Feeding machines, conveyors, etc.) | YES | NO | NA |
| Does equipment operation require worker to repeat same movement pattern of arm/hand at a high rate of speed? | YES | NO | NA |
| Does equipment operation require continuous use (or nearly so) of both hands and both feet in order to operate controls or manipulate work object? | YES | NO | NA |
| **Vibration - Whole body** | | | |
| Is the body as a whole subjected to vibration from exposure to or operation of the equipment? | YES | NO | NA |
| **Equipment Preventive Maintenance** | | | |
| Is there **not** a regular maintenance schedule? | YES | NO | NA |
| Is the equipment designed or placed in such a way that cleaning and maintenance activities are **not** facilitated? | YES | NO | NA |

## Provide Competency Based Training

This ergonomics principle indicates that adequate workforce training is a critical part of the ergonomics process.

### *Results not Achieved?*

A company spends thousands of dollars on tools, equipment and facility that are ergonomically designed but they don't achieve the desired results. What happened?

In many situations the problem is that the workforce doesn't know how to make the most of the tool or equipment or furniture. Two sides of the coin emerge: you need to have the correct item AND you need to know how to use it properly. For the workforce to really get the benefits of ergonomics they need to be able to demonstrate competency in the setup and use of the tool or equipment.

To give you an example. A company purchased new fully featured ergonomics office chairs. They were delivered and put into use. A short while later during an ergonomics audit it was determined that no one had adjusted the chairs for their specific needs. They hadn't received any instruction in how to use the chairs - they just sat down and went to work. In fact a number of individuals reported they actually felt intimidated by the chair and all of its "bells and whistles"!

If you want to improve your golf game (or some other physical skill) what do you need to do? Right, you need to correctly practice the new technique to acquire the skill level to advance.

In the same way, ergonomics is all about learning new skills; provide training sessions that involve a hands-on approach. Over time, with proper feedback and practice, the desired result will be accomplished.

## Control Exposure to Work Environment

Controlling exposure to the work environment includes light, noise, temperature and ventilation is the next principle.

(What do you think, can we set the thermostat at a level that everyone will agree to? The goal is to shoot for the middle and let individuals use personal controls based on their needs.)

**Environment**

*Cold*

Cold environments, tools, or pneumatic tool exhaust may bring about a reduction in tissue sensitivity, manual dexterity, and grip strength.

When sensitivity decreases the amount of force exerted to perform a task increases. This requires the individual to perform more work than necessary.

Adequate personal protective equipment and appropriate worker rotation (in and out of cold environment) are also effective.

Directing tool exhaust away from the user is important for maintaining tissue sensitivity.

*Heat*

Hot environments result in an increase in metabolic demand. Heat may also affect an individual's ability to grasp tools and parts and to manipulate controls due to the effect of perspiration on grasp.

When perspiration increases, friction between the hand and the tool decreases. Higher force levels are again required to maintain the integrity of the grasp.

Hot and humid environments may also result in the fogging of eye protection, again complicating effective task completion.

Adequate ventilation and clothing as well as worker rotation are effective.

*Air*

***Temperature***

- Is the air temperature too cold? Too hot?
- Is it too humid in the workplace?
- Are radiant heat sources placed near any work stations?
- Are there rapid changes in temperature in the work environment?

***Quality***

- Is there so much air contaminant in the process that it settles on displays, making them difficult to see?
- Are suspended dust, mists and other particulates present in the air?

***Flow***

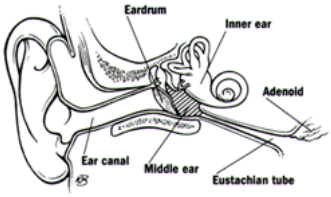
- Is air circulation too low?
- Is there too much air movement?
- Are workers exposed to rapid environmental changes?

***Humidity***

- Is the humidity frequently uncomfortable enough to interfere with the job?
- Are there wet locations that may produce shock hazards for work with electrically powered equipment?

**Noise**

Noise is any unwanted sound. One person's music may be another person's noise. Potentially damaging noise is frequently encountered in work environments.




Noise has basic components of frequency, level, and duration. Frequency, or pitch, is measured in Hertz (Hz), or cycles per second; the higher the frequency, the higher the pitch. The range of human hearing is 20 Hz to 20 kHz. Noise is measured in decibels (dB) and is perceived as loudness.

For example:

- 60 dB - social conversation.
- 80 dB - conversing in loud noise less than one foot away.

- 105 dB - jet engine.
- 150 dB - reduced visual acuity, chest wall vibration, "gagging" sensation.

Sounds may have a very short duration, such as the crack of a rifle, or a long duration, such as the engine of an industrial generator.

High noise levels can drastically impede effective communication in the workplace. Concentration is affected, negatively influencing productivity. Noise has also been blamed for excessive fatigue.

*Noise Abatement*

Because noise is essentially another form of vibration, intervention strategies are similar to those for the control of vibration.

Controlling noise at its source is always the best possible solution. For example, replacing noisy dot matrix printers with laser printers can be effective in office environments.

If it is not possible to control the source of the noise, changing its path can also control it. Use acoustical sound barriers, enclosures, and sound absorbing tiles and carpet.

*Noise - Questions*

- Is there so much process noise that hearing loss could occur?
- Is there so much noise that it interferes with speech or audible signals of various kinds?
- Are there noise levels that interfere with conversation or performing the job?
- Is the noise level high enough to cause hearing loss?

Use the ***Environment Checklist*** as needed for the ergonomics analysis process.

# Environment Checklist

**"YES" response indicates potential problem area that should receive further investigation.**

| | | | |
|---|---|---|---|
| **Illumination** | | | |
| Is special lighting necessary to perform the job? | YES | NO | NA |
| Is the general work area including egress/ingress poorly lit? | YES | NO | NA |
| Is lighting inadequate for the job tasks? | YES | NO | NA |
| Are controls, instruments and equipment poorly lit? | YES | NO | NA |
| Is the illumination not satisfactory for task? | YES | NO | NA |
| Is contrast poor between workspace and surroundings? | YES | NO | NA |
| Is workplace so poorly lit that there are great differences between brightness levels in panels, dials and surroundings? | YES | NO | NA |
| Is glare present in workplace? (What is source of the glare?) | YES | NO | NA |
| Is glare from displays a problem? | YES | NO | NA |
| **Auditory/Noise** | | | |
| Does the noise exposure require a hearing conversation program? | YES | NO | NA |
| Does noise level prevent or impair verbal communication? | YES | NO | NA |
| Are there auditory signals? | YES | NO | NA |
| Are some auditory signals hard to hear in general? | YES | NO | NA |
| **Air (Temperature, Quality, Flow, Humidity)** | | | |
| Is the air temperature too cold? | YES | NO | NA |
| Is the air temperature too hot? | YES | NO | NA |
| Is it too humid in workplace? | YES | NO | NA |
| Are radiant heat sources placed near any workstations? | YES | NO | NA |
| Are there rapid changes in temperature in work environment? | YES | NO | NA |
| Is there so much air contaminant in the process that it settles on displays, making them difficult to see? | YES | NO | NA |
| Are suspended dust, mists and other particulates present in the air? | YES | NO | NA |
| Is air circulation too low? | YES | NO | NA |
| Is there too much air movement? | YES | NO | NA |
| Are workers exposed to rapid environmental changes? | YES | NO | NA |
| Is the humidity frequently uncomfortable enough to interfere with the job? | YES | NO | NA |
| Are there wet locations that may produce shock hazards for work with electrically powered equipment? | YES | NO | NA |

## Promote Health and Wellness!

### *What is the most important tool we all own?*

This principle directly addresses our need to maintain the most important tool we have . . . our minds and our bodies; in other words our physical and mental health.

The goal is to provide a workplace where regular health and wellness concepts and practices are built into the course of doing business. Health and wellness factors include:

- Diet and nutrition
- Body weight control
- Stress management
- Smoking cessation
- Blood pressure control
- Fluid intake - don't get dehydrated
- Adequate rest/sleep

For example: movement helps to control fatigue by relieving awkward and sustained positions and promoting circulation to the body's tissues.

Who has dogs or cats at home? When they first get up from a little nap what is the first thing they do? We have an instinctive need to move . . . we just need to pay attention to it.

## Provide On-going Feedback and Follow-up

The last ergonomics principle is to provide on-going feedback and follow-up regarding the ergonomics analyses and processes.

### *100% Correct the First Time?*

In your experience does any new process work 100% correctly out of the gate? Even with the best up-front planning there will be unintended consequences, something will vary from the plan. This is why providing on-going feedback as part of the follow-up process is so critical.

Schedule formal follow-up sessions at regularly intervals; for example one week post-implementation and then one month, six months and one year. Document the outcome of the follow-up, very importantly alleviate the issues identified in a timely manner and publicize the lessons learned.

### *Continuous Process Improvement and Ergonomics*

Applying ergonomics principles to the overall continuous process improvement effort is integral to the success of the process.

Ergonomics, when focused on optimizing performance –enhancing safety and quality and productivity – is made stronger when on-going feedback and follow-up is performed.

# Ergonomics Principles

**PROCESS** – Promote effective work processes

**POSITION/SUPPORT** – Promote neutral body and limb position/support

**MOVEMENT** – Promote regular physical movement

**MATERIAL HANDLING** – Control manual material handling

**REACH** – Promote work in reach zone

**WORKSTATION/TOOLS/EQUIPMENT** – Provide correct workstation, tools and equipment

**TRAINING** – Provide competency based training

**ENVIRONMENT** – Control exposure to work environment

**HEALTH/WELLNESS** – Promote personal health and wellness

**FEEDBACK** – Provide on-going feedback for continuous improvement

## ERGONOMICS PROBLEM SOLVING PRINCIPLES

### If you like to solve problems, ergonomics is for you!

Identifying and solving problems is at the core of the ergonomics process. Here are a few important caveats to problem solving.

### Caveats

#### *Design dictates performance*

Recall the toolbox on the floor scenario. Placing a toolbox on a floor promotes poor technique to remove the tools. Body mechanics training may be ineffective in promoting proper technique. The successful response involves repositioning the toolbox to waist height to promote the desired technique. You can apply this concept in any workplace for any ergonomics problem.

#### *Understand and make productive use of human behavior*

The study of human behavior is a most fascinating and frustrating field of study. There are reasons why we do what we do; sometimes we just cannot figure out what they are! It is possible, however, to understand human behavior at some level, and to use this knowledge in a productive way. If we offer a solution that is contrary to the nature of human behavior, the solution will not be effective.

#### *Do not fix without adequate analysis!*

Many novice analysts (and sometimes some experienced ones) cause themselves and others problems because they try to "fix stuff" without knowing why or what or when or who. Perform an adequate analysis before offering recommendations.

#### *Always ask why!*

Sometimes when we look at work, all we see is what is in front of us. It is imperative that we look both up and down stream to see the context of a single work station or job demand within the overall production scheme.

#### *Don’t generalize from a sample of one!*

A common error made is to make the assumption that just because it makes sense to mo or works for a particular individual it will also work for the entire population.

Be careful not to fall into the trap of population stereotypes. Recognize the diversity that exists in the user population and design to take this into account.

#### *Scope of Influence*

Know the scope of influence of the situation and the worker and not exceed the worker's scope of influence. If we offer a solution that is beyond the scope of influence of the individual, department, or organization, the solution will not work.

### *Overcome resistance to change*

Most people do not like change. If we try to introduce change we have to do it in a very careful way, otherwise the solution will not work. How is change accomplished?

### Creating positive change

Creating positive change is truly the core of any successful ergonomics process. Work through this exercise. Pull from your own experiences with change.

| Why do people resist change? | How to facilitate change! |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| Resist Change | Facilitate Positive Change |
|---|---|
| Fear of change! | Knowledge and training |
| Habit! | Practice correct behaviors |
| Do not recognize need for change! | Knowledge and education |
| Do not know how to accomplish change! | Education, training and practice |
| Was not their idea! | Emphasize inclusion – not exclusion |
| The change is forced on them! | Input from group with their involvement |
| No one else is changing! | Group involvement |

## Ergonomics Analysis Tool Box

Your job performance analysis toolbox will have several trays.

### *Personal Protective Equipment*

Ensure that you have the proper personal protective equipment and attire to conduct the analysis. At a minimum, you may need eye, foot, clothing, head, and hearing protection.

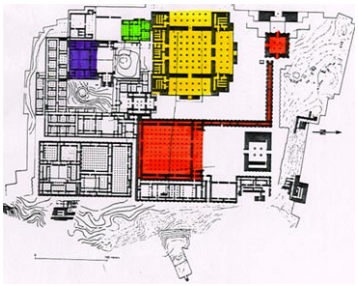
Dress at the proper level based on the worker's level of attire. For example, do not show up in a suit, white shirt, and tie on an assembly production floor, just as jeans, steel toe boots, and a work shirt may not be appropriate for a boardroom.

### *Measurement Devices*

To take measurements of the workplace, you'll need a stopwatch, tape measure, force gauge, and photographic equipment (video camera, 35-mm camera, etc.)

A NOTE OF CAUTION: always have prior authorization to bring any photographic or videographic equipment on premises, and know how to handle sensitive proprietary data.

### *Background Materials*



Identify the proper background materials to have available. This could include job descriptions, sketch of the floor plan or layout, organizational chart, check lists, clipboard or notepad, Dictaphone, etc.

### *Set of Objectives*

The most important tray in your toolbox is the set of objectives you bring to the job.

What are the outcome objectives?

Make sure you bring an "open mind."

Do not hesitate to ask questions.

The most important thing you bring to the work place is a new and fresh look at the situation. What has become common place to those in the workplace may be brand new to you. Take advantage of this opportunity.

## Why use Video?

If a picture is worth 1,000 words, a moving picture (video) must be worth at least 5,000 words.

- Using video is one of the best ways to document an ergonomics analysis.
- You can study the video over and over again at a later date.

You can show the video to other interested parties for their input.

### *Video "Secrets"*

Because you don't want to be accused of making home videos, follow these guidelines.

- Use enough light. Low light causes grainy videotape that is hard to analyze.
- Plan your video sequence. Think ahead to know what shots you want.
- Use a tripod as much as you can. You will get much better quality video.
- If you have to use a handheld technique, build a bridge with your arm against your body for stability.
- Use the zoom sparingly. Zooming in and out in and out will drive your audience wild.
- Always have a backup power supply; either additional battery packs or is able to run off of wall current with the AC adapter.
- After videoing a few seconds, check to make sure the camcorder is working correctly.
- Use manual focus (if available) to stop the auto focus from searching.
- Pan (move from side to side) the camera about three times more slowly than what your eye can track.

- In a loud environment, use a separate microphone to pick up interviews.
- Be aware of your surroundings; don't walk into equipment, people, etc.

### *Videotaping Sequence*

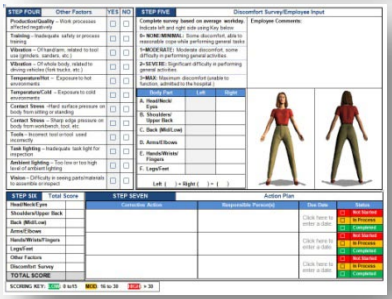
- Document the name of the job with a brief description
- Inform any people being videotaped of your purposes.
- Record the date and time
- Say the name of the job or task description on the audio portion of the tape at the beginning of each task.
- In the viewfinder, frame an overview of the job to "set the stage."
- Capture 5 to 6 cycles of repetitive tasks.
- Video as many different workers as you need to get an accurate portrayal of the job.
- Reposition the camera to get back, side and diagonal views. If possible, get an overhead view.
- Get close up views of each of the separate job tasks and identified issues
- If needed video the tasks immediately before and after the task being reviewed – this may also lend additional insight.

## ERGONOMICS CASE STUDY

### Perform Ergonomics Analysis

You will be asked to perform an actual ergonomics analysis and present your findings to the class. Please read the following pages to familiarize yourself with this assignment. You will be given approximately 15 to 20 minutes for your ergonomics presentations, so please keep the scope of your analysis focused.

Effective problem solving is a skill set like any other. Initially, a discrete series of follow-along-steps will help to guide the process. Later, with gained expertise, a more holistic approach can be adapted.

### Ergonomics Analysis Process

Two worksheets are available.

The first is the ***ErgoRED Quick Screen*** – this allows for a very quick examination of the job task to identify if risk factors are evident.

The second is the ***Ergonomics Risk Factor Analysis*** – this provides a detailed examination of the risk factors, garners input from the workers with the Discomfort Survey, scores the level of risk and outlines the Corrective Action Plan.

The following steps describe use of the ***Ergonomics Risk Factor Analysis*** worksheet**.**

#### *Step 1: Gather and document BACKGROUND INFORMATION.*

Fill in the background information:

- Job/Task
- Area/Dept.
- Date
- Time
- Analyzed by
- Name (optional)

#### *Step 2: Identify Posture, Force, Duration and Frequency issues*

Observe the job. If it makes sense try the job yourself. Once you have a handle on the job, briefly describe the job/task as concisely as you can.

Complete the worksheet for each category making use of the rating scale.

**Comments**

- Compare experienced faster and injury-free workers with those who are inexperienced, fatigued, uncomfortable, or complaining of pain or injury.
- Determine if there are differences in work technique among these groups.
- If repetitive, note cycle time, capture a minimum of 5 cycles.
- Sketch the work area, if needed.
- Obtain weights and measures as needed.

### *Step 3: Score Posture, Force, Duration and Frequency issues*

Calculate the score per body part.

### *Step 4: Identity any other factors*

Determine if other factors are pertinent.

### *Step 5: Worker discomfort survey and input*

Interview the person or persons performing the job to gain their insight and perspective. (Involve all people who can provide input; you absolutely have to involve the operator/worker. After all, who is the very best ergonomist?)

Document any discomfort they report. Have each individual complete a separate Discomfort Survey Form. Compile the average scores on the main form.

### *Step 6: Calculate final score*

Tally the scores in Steps 3, 4 and 5 to determine the final TOTAL score.

### *Step 7: Generate Recommendations and Action Plan*

Brainstorm on specific interventions. Be careful you don't recommend wholesale change. A "minimalist" approach may be much more palatable.

Document the recommended Corrective Actions, Responsible Person(s), Due Date and Status.

## Perform Cost Analysis

In this day of downsizing and budget cuts it's easy for any organization to be penny wise and pound foolish. We all know that management is under a great deal of pressure to cut costs and save money where ever possible.

We also know that many jobs and tasks we perform are not designed safely or efficiently and must be improved. We must be able to justify our requests for ergonomic improvements in terms that management can understand. That's right - dollars and cents.

Here is a simple formula that can be used to decide how to intervene. It is useful to justify the ergonomics intervention either when significant resources are involved or when little or no resources are required. This formula will help prioritize your ergonomics project list.

ROI = Total Estimated Benefit/Total Cost of Intervention

Return of investment (ROI) is the primary calculation in this formula. It requires the following information.

*Costs of Intervention:*

- Material/Hardware Costs
- Labor cost for installation
- Training costs
- Any other cost related to the intervention

*Benefits of Intervention:*

- Reduced labor costs
- Productivity gains
- Lower injury/illness costs

*Indirect Benefits:*

- Quality improvements
- Reduced scrap/rework
- Improved morale
- Improved idea sharing and problem solving
- Improved team work/owner-ship
- Reduced absenteeism

For the inexpensive fixes you don't need to spend a great deal of time gathering data and calculating your ROI. For more expensive and important projects this time will be well worth it.

*ROI Worksheets*

Cornell University Ergonomics has produced worksheets to assist in calculating ROI: 1.) if actual cost data is available, 2.) if estimated cost data is used, and 3.) if no cost data is used. Please refer to the worksheets for additional details

Even the most reluctant manager will make the right decision when the ROI is high and the payback period is relatively short.

### Implement Solutions

The goal is to accomplish controlled measurable change. If you change too many variables all at once you run the risk of not being able to recognize what did and did not work. Apply the principles but be careful of generalizations. In all likelihood, the "normal" person does not exist.

The modification itself is not the issue; the acceptance and integration of the modification is the issue. Introducing the job modification into the work place only begins the process.

### *Follow-up: Evaluate outcome and make needed changes.*

Proper outcomes evaluation continues the process. On-going measures are compared to the initial performance measures.

- Compare at set intervals (1, 3, 9, and 12-month intervals).
- Determine changes in performance measures
- Detail lessons learned to modify the interventions.
- Reevaluate and repeat the analysis steps.

## ERGONOMICS – A POTENT TOOL!

Ergonomics is a potent tool!

When the principles of ergonomics are applied the outcome is demonstrated improvements in quality, productivity, health and safety.

# Office Ergonomics for Health Care Professionals

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## OFFICE ERGONOMICS FOR HEALTH CARE PROFESSIONALS

### Welcome!

***Office Ergonomics for Health Care Professionals*** offers a framework to help Physical Therapists, Occupational Therapists, Occupational Health Nurses, Physicians and other health care professionals perform office ergonomics analyses and generate reasonable and feasible recommendations.

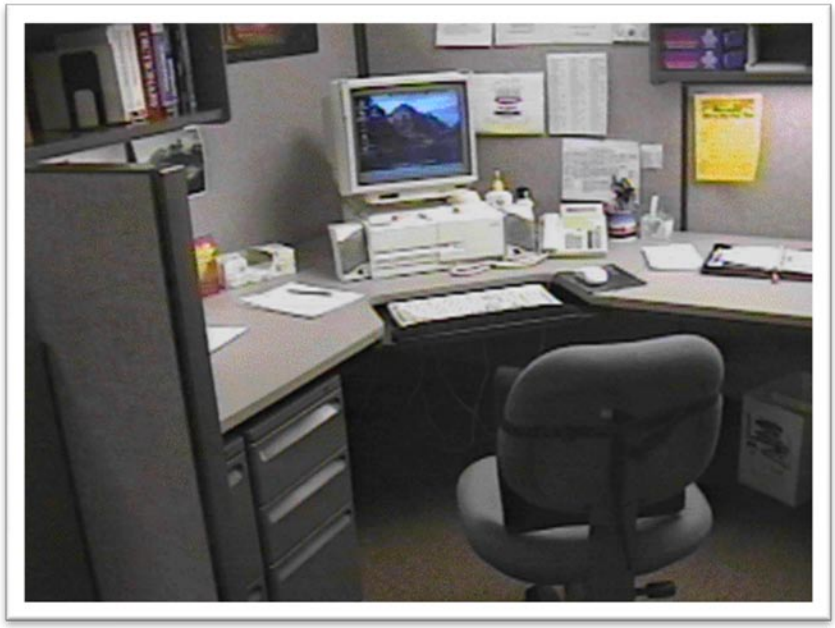
### Objectives

- Discover what Office Ergonomics is all about
- Identify components that make up successful office workspace
- Learn how to analyze and setup office workplace
- Acquire confidence in using system through practice

### It's all about relationships!

The relationships we form are a very important part of life. In the context of office ergonomics, relationships between the user, chair, workstation and equipment are also critical.

For example, what do you see as potential problems in this example? *(Look closely – some may not be very obvious)*



1. _____
2. _____
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8. _____
9. _____
10. _____

More than likely you discovered a number of things. One is that you already know a good deal about office ergonomics! Another is that you really can't tell a whole lot until you see the workspace in use!

## Where do we use computers?

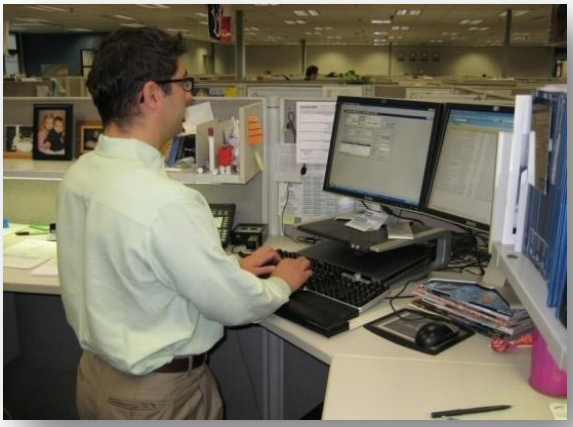
In many ways there seems to be a love-hate relationship with computers.

Think for a moment about how important computer use has become in our world. Computer use is an integral and pervasive part of our society.

Where do we use computers . . .

***EVERYWHERE***!

Let's build an office!



## Typical office components

From the ergonomics perspective, our next goal is to apply the ergonomics foundations and principles we have been discussing.

Earlier we alluded to the components that make up the typical office, let's spend a minute and outline them in some detail.

They include:

- User population profile
- User – Single/Multi
- Tasks – Single/Multi
- Floor space
- Chair
- Worksurface
- Floor surface
- Computer
- Telephone
- Office equipment
- Storage
- Conference tables/chairs
- Light
- Noise
- Temperature

### *User population profile*

An important step is to accurately define the user population. Specific points of information include:

- Age range
- Gender
- Stature
- Vision
- Physical fitness levels
- Hand dominance
- Work experience (level and scope)
- Training (technical and safety)
- Other

We may find we have a very homogenous group or one that is quite diverse. The user population may be one individual or it could number in the thousands. In any case we need to define it.

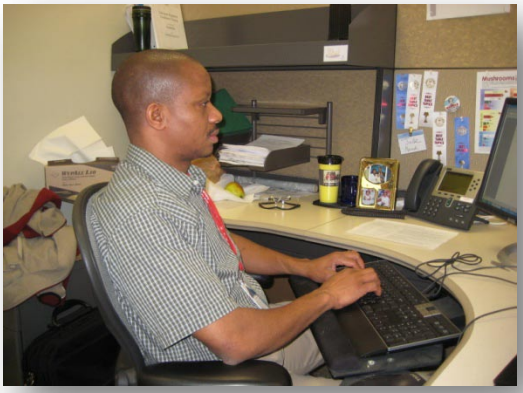
For example, we need to understand the makeup of the user population including stature, reach and other anthropometric data along with any other special needs a particular individual may have.

Inadequately defining the user population impedes the design of new workstations and the analysis of existing ones. Defining the user profile lays the foundation for the remainder of the process.

### *User –Single/Multi*

In terms of the workstation it is critical to be aware if a single person will primarily use the workstation or if two or more individuals will share it on a regular basis. We also need to determine how often the change over occurs. We need to determine if the workstation is a ***single user*** or ***multi user*** workstation.

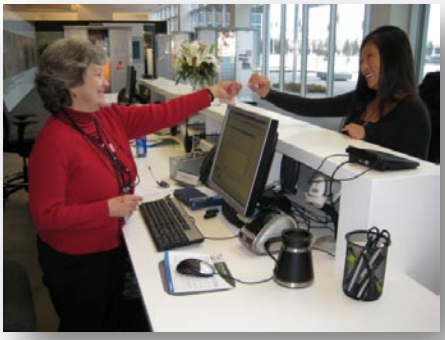
#### Single user



By definition the workstation is designated for use by one individual only. For the single-user workstation we are less influenced by the need for adjustability of the workstation itself. For example, once we determine the proper height of the worksurface it can be fixed at this height with little or no need for adjustability.

For instance, a fixed height or adjustable/fixed worksurface (i.e. worksurface can be height adjusted but once adjusted is not readily changed; e.g. wall panel mounted worksurfaces) makes for a viable workstation.

#### Multi user



On the other hand multi-user workstations (e.g. reception counters) by definition require a significantly greater degree of adjustability.

To make the workstation effective, it is critical that the changeover from one user to the next be accomplished quickly and easily.

An adjustable/adjustable worksurface is desired. In this case, either through a spring balanced manual system or a powered system, the height of the worksurface can be readjusted within seconds.

### *Tasks: Single-task or Multitask*

Specific tasks performed in the office workstation will help to determine the office workstation configuration and setup. Typically, we can categorize job demands as ***single task*** or ***multitask***.

#### Single-task

An office workstation designated as single-task is defined as one where the majority of the work time is spent accomplishing a specific, focused task.

For example, a customer service representative may spend a majority of the day on the computer and telephone performing computer lookup activities. Physically the job demands are concentrated in a single area.

The efficient set up of the single-task workstation is critical because the user tends to maintain a sustained position to perform their activities. Other examples of single-task workstations are data entry and CADCAM.

### Multi-task

In the workstation designated as multi-task, a number of different tasks need to be accomplished. For example, the user may spend some of the day at the computer, on the telephone, at a writing workstation, attending meetings and so on.

Physically, the job demands may be spread across several areas if the work space is available to accomplish this. However in many situations the space is not available and the user tries to multitask in a confined workstation.

The efficient set up of the multi-task workstation either provides for separate workstations for separate tasks or makes it extremely easy for the user in the same workstation area to shift from one task to the next.

Other examples of multi-task workstations include supervisory positions, technicians, etc.

### Specific task (percentage breakdown)

Part of our assessment will include identifying the percentage breakdown that specific tasks are performed to accomplish the overall job demands. We will ask the user to estimate the percentage based on an average week or month, recognizing that extreme variations can occur from day-to-day.

| Activity | % | **Note:** the total may not necessarily equal 100%; it is possible to perform two or more activities at one time – computer and telephone use at the same time for example. |
|---|---|---|
| Computer | | |
| Telephone | | |
| Handwriting | | |
| Reading | | |
| Meetings | | |
| Miscellaneous | | |

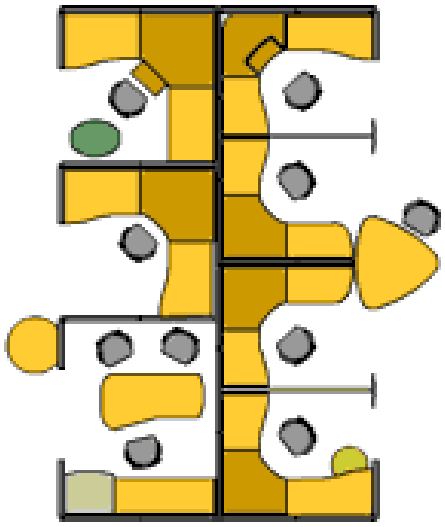
### *Floor space*

In the ideal world, the dimensions of the office workstation are determined exclusively by the job tasks.

For example, in some very focused single-task workstations 48 square feet may be sufficient. In other cases, a multitask workstation may require 120 square feet or even more to effectively accomplish the job tasks.

However, as we all recognize we do not live in the ideal world. Floor space may be determined by a host of factors not relative to job task.

This does not negate the need to perform an effective job analysis to make recommendations but does cause us in many cases to be quite creative!



### *Office Ergonomics Workstation Evaluation Worksheet*

| Demographics | | Work Activity | % | Reason |
|---|---|---|---|---|
| **Evaluated by** | | **Computer** | | New employee<br>New workstation<br>Medical issue<br>Equipment/furniture issue<br>Other (comment below) |
| **Eval Date** | | **Telephone** | | |
| **Last Name** | | **Handwriting** | | |
| **First Name** | | **10 key** | | |
| **Job Title** | | **Read-hard copy** | | |
| **Dept** | | **Meetings** | | |
| **Location** | | **Other** | | |
| **Stature (shoeless)** | | **Work Activity Comments** | | **Other Information** |
| **Heel height** | | | | |
| **Handedness** | Right/Left/Ambidextrous | | | |
| **Job demands** | Sedentary/Manual | | | |
| **Work hours** | Full/Part time | | | |
| **User** | Single/Multi | | | |
| **Vision** | No correction//Reading/Distance/ Bi/trifocal/Computer/Contacts | | | |

## *Chair*

### Objectives of chair

- Support body and limbs to provide relief from weight bearing.
- Provide a stable base or platform for the body and limbs.
- Position the user at the correct height and reach relationship to the worksurface and tasks at hand.
- Allow for easy change in position/movement of the user.

### Types of seating systems

A number of seating systems are available in the office workplace and include office chairs, stools, lean platforms and other miscellaneous seating.



Without question the traditional office task chair is the most commonly used seating system in the office workstation.

### Chair criteria

In the office environment, the type, use and efficiency of the chair are critical elements. The acceptable chair criteria is determined by the type of job activities performed, the size and shape of the user and the duration of time spent in the chair. These criteria are typically considered necessary for an adequate office task chair (Note: First we will discuss the chair's feature and then will go through chair feature adjustment based on the user's specific needs.):

*Legs*

Minimum 5-point support system for the chair legs. This is specifically intended to reduce the likelihood of inadvertently tipping over the chair.

*Casters*

Appropriate casters for the floor surface – hard caster on a soft surface such as carpet, soft caster on a hard surface such as tile.

### *Seatpan*

Height, tilt and tension adjustability needs to be suited for the individual user's body segment length and size.

- If the height of the seatpan is not fixed, the type of mechanism to raise or lower the seatpan could be spin up/down but in a modern chair will be a gas pneumatic cylinder.
- A seatpan slide is also a recommended feature. This allows for the apparent depth of the seatpan to be changed to fit the user.
- The seat pan height and angle establishes the relationship between you, your work surface and the floor
- The seat pan tension allows you to adjust the seat so that you are stable in your chair. The seat pan tension provides a balance between adequate support and movement in the chair.

### *Back support*

Adjustable back support height and angle needs to be suited for the individual user's body segment length and size.

- The back support angle and height influence the angle between your upper and lower body as well as your relationship to your work surface.
- The back support angle allows you to adjust the lumbar support built into the back support so that it can comfortably support your upper body weight.

### *Cushion*

Suitable cushion - in terms of foam density, wearability and breathability, type of material (fabric or rubberized) - for the seatpan and back support should be in the chair. A number of chairs have introduced web or mesh fabrics in place of the traditional cushion.

### *Armrests*

Armrests may be used to support the weight of the arms and upper body. If used, the armrests need to be adjustable in height, lateral position and axial rotation. (Non-adjustable armrests on office task chairs are essentially non-functional.)

- The armrest adjustments allow you to position the armrests where they will provide adequate support for your arms and shoulders in neutral postures.

### *Adjustment levers/knobs/controls*

Adjustment levers/knobs/controls for the chair should generally be within easy reach of the user when seated in the chair. The levers should be easy to manipulate and not be so complicated that they discourage use.

*Cervical support*

Additional modifications are possible for chairs. In some situations the user may require cervical and head support in addition to mid and low back support.

*Exercise ball chairs*

Therapeutically, exercise balls have been used in clinical settings as treatment modalities to improve spinal stability. Over the past several years, the use of exercise balls in the workplace in place of or in addition to task chairs has taken place. At this point, primarily only anecdotal evidence exists to support the full-time use of them. Most ergonomists continue to advocate for properly sized and properly adjusted office task chairs rather than the use of ball chairs.

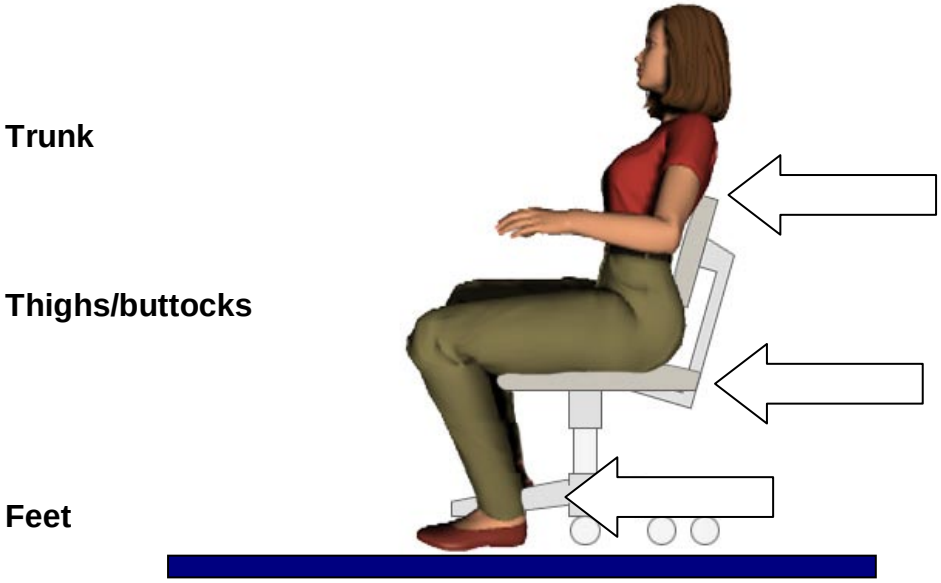
*Micro-breaks*

Recalling that frequent and regular body movement is one of the ergonomics principles the 30/30 Rule of Physical Movement (physically active micro-breaks 30 seconds in length taken about every 30 minutes) is supported by research to reduce tissue compression and joint stiffness, enhance circulation and overall improve comfort levels.

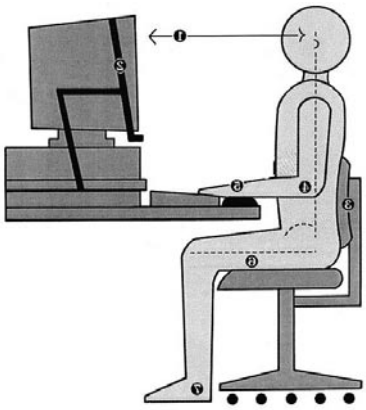
## Art of sitting

The body is not designed to sit - particularly for long periods of time. Studies have determined that even when seated in well-supported postures, individuals want to move to gain relief within a few minutes. Let's cover the art of sitting.

*Three point contact*



*90/90 seated posture?*



You probably have seen illustrations of an office workstation where the person is seated at the chair with their hips and knees at 90 degrees.

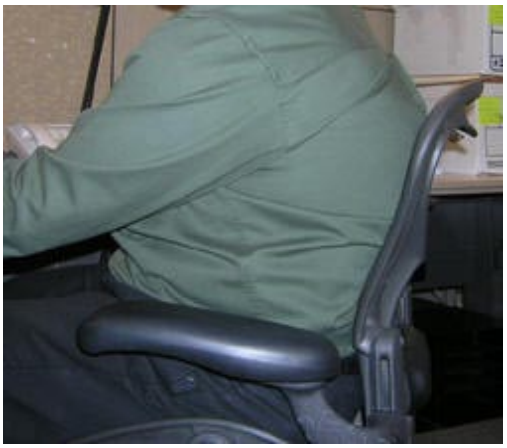
In all practicality very few people actually sit this way.

A much more commonly accepted seated posture is 105 to 110 degrees at the hips and knees. Let's take a look at how people sit.

## Sitting styles

Sitting styles can be quite varied from person to person. Let's look at some potentially problematic sitting styles:

**Percher**



**Sloucher**

**Sit crossed leg**

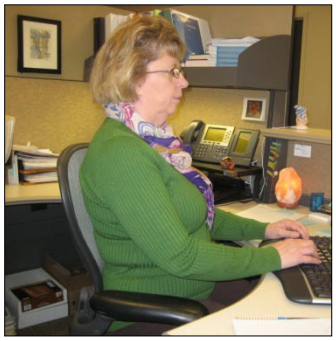
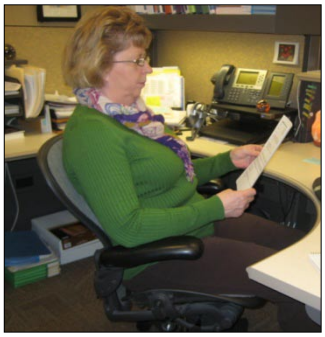
**Sit on leg**

The particular sitting style observed needs to be assessed to determine why it is being used. It may be a habit that has been developed over time; it may be in response to a poor workstation setup or a combination of both.

What drives the problem is the frequency and duration of the seated position. If the individual only occasionally sits in an undesirable position it may not be a concern; however if that is their habitual manner of sitting it could lead to problems.

## Functional seated positions

A general guideline in the art of sitting is to provide for different acceptable seated postures that a person can rotate throughout the day on a regular basis. They can include:

| | | |
|---|---|---|
|  |  |  |
| **Upright Keyboard Position** | **Semi-reclined Conversation Position** | **Standing*** |

(* We recognize this is not a seated posture but it makes the point that an individual needs to get out of the chair and either stand or walk around the work place on a regular basis.)

## Adjustment anxiety

Chairs can be pretty expensive. They can have all kinds of bells and whistles. So, let's see what this baby will do! It seems that the answer is nothing until we do something to the chair.

Sometimes we overemphasize what a chair can do, and forget to emphasize what it is we need to do to make it work. The truth is that a chair is only as good as what we choose to do with it.

Some people have never adjusted their chair? They just sit down and go to work. The bottom line is people need to be able to adjust their chair to fit them as well as throughout the day to provide the body with a break.

### *Chair solutions*

#### Manual

Look for the chair manual for specific information about the chair or to talk to someone who handles chairs in the work area. Better yet, just start playing with the adjustments. Most people learn best by the "hands-on" approach anyway.

#### Position and support body in neutral

Here is a series of steps along with tips and techniques when adjusting chairs:

- Adjust the seat pan/back support tension to hold body in a solid neutral position.
- Adjust the pan seat height to get feet on the floor with even pressure on hips and thighs.
- If feet do not touch the floor adjust the seat pan height to get feet on the floor with even pressure on hips and thighs – if still not possible to get the seatpan low enough a footrest will be needed. Another option is replace the chair with one that will go low enough.
- Adjust the height and angle of the back support to fill in the low back curve.
- Add a back cushion to provide better support for spine – *although many times this means the chair does not fit right and a replacement chair may need to be considered.*
- If needed, add a seat cushion to elevate the user to a more appropriate height – *although many times this means the chair does not fit right and a replacement chair may need to be considered.*
- If the back of knees run into the front of the chair see if a back cushion to move the body forward on the chair and still have adequate back support, will work. Firmly fix the cushion to the chair, one way to do this is with Velcro tape. A*lthough many times this means the chair does not fit right and a replacement chair may need to be considered.*
- For the case where hips and thighs don't fit on the seat - the seat pan is too short or too narrow; see if you can find a chair that better fits.
- If the armrests are adjustable, see if they can be adjusted to provide neutral support for .the arms based on particular job tasks.
- Build up the armrests by putting pads on them if more height is needed.
- If you identify maintenance problems with the chair make sure you contact the appropriate people in your organization to get them taken care of.

Remember, no matter how perfectly you can adjust your chair to fit you; it still comes down to the fact that you need to move on a regular basis to keep your body healthy and safe.

| Chair | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| **Chair ID** | | No<br>Yes | ❑ Chair fit/adjustment OK<br>❑ Chair not properly adjusted<br>❑ Back support not OK<br>❑ Armrests not OK<br>❑ Chair too small<br>❑ Chair too large<br>❑ Maintenance issue (comment)<br>❑ Other (comment) | ❑ None<br>❑ Chair adjusted with instructions provided<br>❑ Replace chair - refer to Recommended Specifications<br>❑ Repair chair (comment)<br>❑ Other (comment) |
| **Legs** | 4 / 5 / 6 | | | |
| **Casters** | Carpet/Hard surface | | | |
| **Seatpan** | Ht/Tilt/Tension/Slide | | | |
| **Back** | Ht/Angle | | | |
| **Armrest** | Ht/Side/Rotate | | | |
| **Fit** | OK No/Yes | | | |
| **Maint Issue** | No/Yes | | | |

## *Worksurface*

### Worksurface objectives

The objectives of the worksurface include:

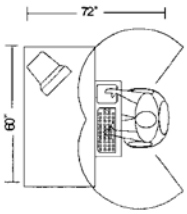
- Provide functional workspace (depth, width)
- Support and position equipment
- Provide access to work materials
- Achieve the desired relationship match between user/work

### Types of workstation layouts

Three types of workstation layouts are typically recognized.

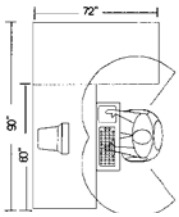
*Straight line (desk/table)*

The **straight in-line** configuration is suited for single task activities with minimal reach requirements for other office equipment and materials.



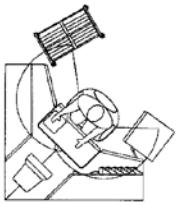

*L-shape (two work surfaces)*

The **L-shaped** configuration is suited for single to multitask activities that require two or more separate workspaces. For example, one workspace may be used as the computer workstation and another as a writing or collating workstation.




*Corner/Cockpit (middle with two side pieces)*

The **corner/cockpit** configuration is well suited for multitask activities in the same workspace with significant requirements to frequently reach other office equipment and materials.



## Worksurface adjustability (height and angle)

Height and angle adjustability of the worksurface can be a critical component. In general terms, three different types of worksurface adjustability are recognized:

### *Fixed*

We admit by definition ***fixed*** means nonadjustable, but we need to include it in our discussion. An example is the traditional desk at a fixed worksurface height of 29 inches. There are literally millions of these types of worksurface in workstations. In this case ***fixed*** means that they are not designed to be changed in height or angle.

We should note that it is generally possible to raise a fixed height worksurface on supports but also generally very difficult to lower it. (Although we have been known to actually cut off legs off traditional desks!)

### *Fixed/adjustable*

An example of a ***fixed/adjustable*** worksurface is a wall panel mounted systems where the worksurface is hanging on the wall panel or a worksurface on legs where the height can be adjusted by loosening screws and sliding sleeves up or down in the legs.

These worksurfaces are termed ***fixed/adjustable*** because they can be adjusted within a given range but once adjusted they are fixed in that position and not readily moved.

### *Adjustable/adjustable*

Adjustable/adjustable indicates that the user – as needed throughout the day - can readily and easily adjust the worksurface.

Examples of these worksurfaces are sit/stand workstations that are controlled by mechanical springs or powered mechanisms.

## Other Considerations

Other considerations for the worksurface include:

- Eliminate a sharp edge by specifying a rounded or radius edge of the worksurface
- Reduce glare by providing a non-glare surface of the worksurface
- Enhance durability through proper construction and use of materials.

## Worksurface solutions

### *Wrong desk height*

Here are some possible solutions if the issue is the wrong desk height in relation to the position at desk:

- If work height is adjustable, adjust it. For example modular work surfaces that can be adjusted on the wall panels or a stand-alone desk that can be adjusted.
- A simple option is to raise the height of the work surface by putting it up on a couple of blocks. (Just make sure that the desk or work surface is solidly placed on the blocks and won't fall off.) It may be advisable to get maintenance or someone else to help do it safely.
- An option is to adjust chair height. Once again, make sure the feet are supported either on the floor or with a footrest.
- Add a height adjustable keyboard tray mounted underneath the work surface.

### *Not enough layout space*

Occasionally, or possibly quite frequently, there is not enough space on the worksurface to lay out materials. Now, one option is to get a bigger desk, and a bigger office.

Assuming that this is probably not a realistic option, we may need to be a bit more creative.

- Try a little house cleaning and see if this frees up more available space on the desk.
- Look around to see if there are other worksurfaces available for use, for example a file cabinet at a standing height to review documents or perform other work. If there is available space, see if any more worksurface can be added to the workstation. This can be a small worktable.
- If it doesn't need to be readily available, relocate some of the equipment on the desk to see if it provides more space.
- Make use of any pullout drawers already in the desk.
- A computer monitor stand can be added to provide more clearance on the desk.

### *Sit/Stand Workstations*

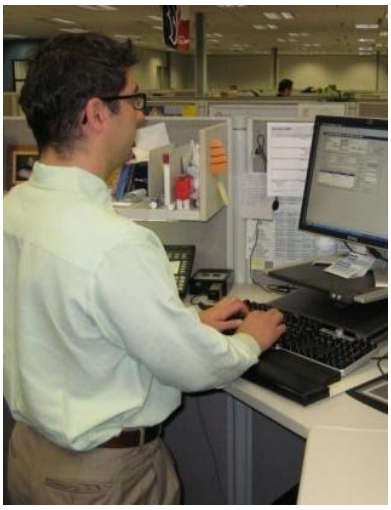
Sit/stand workstations are becoming more and more prevalent in offices these days. Office jobs are very sedentary in nature with resulting negative impact on general health and wellness.

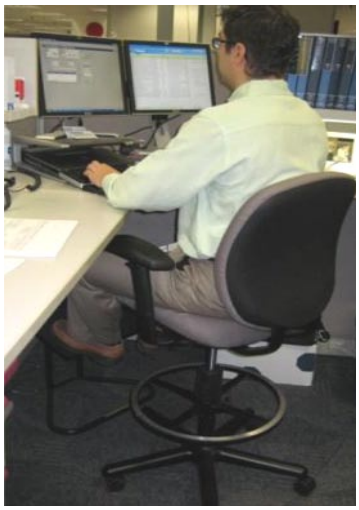
Several options exist for creating sit/stand workstation that range all the way from makeshift ones created by putting boxes on the desk to full fledged powered sit/stand workstations and other options in between. The same setup principles for office ergonomics in general remain in effect: neutral body position and support, reach zones, control exposure to sutained postions by promoting movement throughout the day, etc. Here are some ways to create a viable sit/stand workstation.

*Fixed worksurface at standing height*

The correct height of the worksurface when the user is standing at it is determined.

A stool and footrest are provided to allow for an elevated seated position.



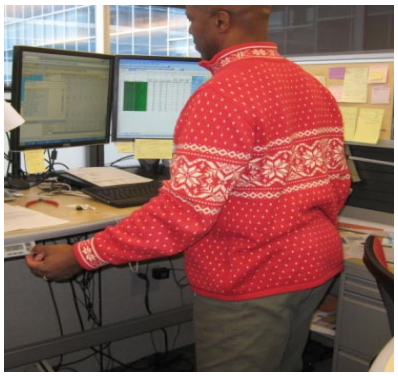


*Portable system placed on desk*

Portable desktop systems are now available to be placed on the worksurface. The system can be height adjusted to alternate between a seated and standing position.

*Sit/Stand workstation*

The entire workstation is height adjustable allowing for seated and standing height work positions.

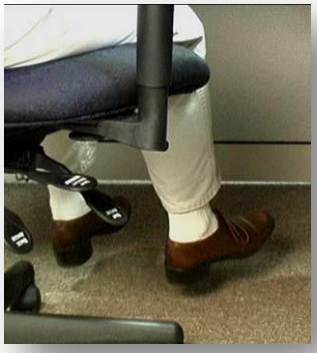


| Worksurface | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Config | Straight/Corner/ L-shape/U-shape | No<br>Yes | ❑ Worksurface is appropriate<br>❑ Worksurface is too low<br>❑ Worksurface is too high<br>❑ Worksurface does not have enough work area.<br>❑ Other (comment) | ❑ None.<br>❑ Lower worksurface - see Recommended Specifications<br>❑ Raise worksurface - See Recommended Specifications.<br>❑ Reorganize to provide additional worksurface area.<br>❑ Other (comment) |
| Type | Fixed/Adjust | | | |
| Height | Sit/Stand: ( “) | | | |

### *Foot support/clearance*

#### Foot support

In the ideal world the best foot support when seated in the chair is the floor. However, based on work at a fixed height worksurface where the chair needs to be adjusted upwardly or work at a standing height workbench where a stool is used, a foot support will be needed.



#### Clearance

A real common issue is not enough access or clearance under the worksurface. For example file drawers that are in the way or boxes piled under the desk.

Survey the work area and determine what is blocking access. For example it may be a pencil drawer that needs to be removed to make that space accessible for the legs.

Determine what is really needed in the immediate work area. Move what is not needed to some other storage position or get rid of it.

Use vertical files or other stands to get materials off the worksurface. Use secondary shelf or other platform on the worksurface to free up primary worksurface.

| Foot support/clearance | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| **Feet** | Dangling/Supported/ Clearance | No<br>Yes | ❑ Foot support is appropriate<br>❑ Feet dangling – not supported<br>❑ Inadequate foot/knee clearance<br>❑ Other (comment) | ❑ None.<br>❑ Add footrest<br>❑ Lower worksurface - see Recommended Specifications<br>❑ Raise worksurface - See Recommended Specifications.<br>❑ Remove foot/knee obstruction (comment).<br>❑ Other (comment) |
| **Footrest** | No/Yes | | | |

### *Sharp edges*

It is a problem if sharp edges in contact with the wrists and forearms.

Make sure that you are at the proper work height in relation to the worksurface edge. Simply getting at the proper work height may change the contact point of your desk and distribute the pressure more evenly.

Another option is to pad the sharp edge. This may be as home grown as a small washcloth or dishtowel folded up or a commercially available edge added to the worksurface edge itself.

### *Work organization*

Organize work in a way that allows work goals to be achieved as efficiently as possible. This takes into account all aspects that make up the workspace including your chair, desk, computer, telephone and other materials used through the day. This also includes the organization and structure of tasks and activities performed throughout the workday.

### Work organization solutions

Unorganized desk, huh? Well, the simple solution for the problem of an unorganized desk is pretty clear. Organize it! Ha, if it were that simple our desks and our lives would be much more organized. Keeping this in mind, here are some tips that might help.

Space in most companies is a premium, but try to store infrequently used items outside of the immediate work environment. You may need to be a bit creative!

Things can get cluttered even in the electronic world. Purge unneeded items. How many files do you have in your computer that you never or rarely use, but that make it hard to find the files you need to access frequently. Back up these files and get them out of your hair.

You might try something that we try to get our kids to do, and that is to clean up their rooms at the end of each day. You know how stressed out you can get when you open the door and see total chaos…and we don't even have to work there. This same emotion can greet you in the morning if you walk in to your work area and the first thing you have to deal with is clutter.

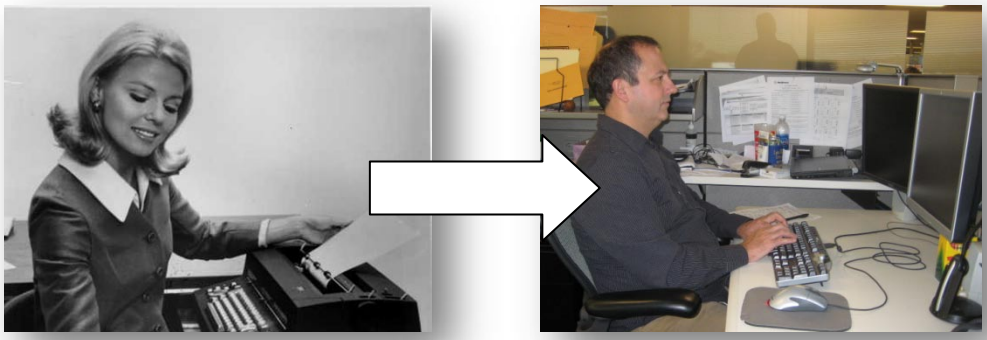
## Floor surface

The floor surface of the workstation is important to consider in terms of providing ease of rolling the chair on the floor surface, a nonskid surface to prevent slips and follows and a non glare surface to reduce overall glare in the workstation.

## *Computer equipment*

The next step is to properly position the computer equipment (keyboard, pointing device, monitor, CPU, hard copy holder, etc.)

### Keyboard



To put this into perspective, let's take a brief look at the differences between modern keyboards and old-style typewriters. In the "olden days" you had to actually insert paper, hit the shift bar and physically stop what you were doing to correct mistakes.

Not only that, but you also couldn't go too fast or the keys would stick together. In essence, the task had built in breaks that kept it from becoming too much of a problem.

Now it is possible with a modern keyboard to come in at 7 in the morning, start keying as fast as you can, never take a break, and keep this up until 5 o'clock without a break.

Because we have lost a lot of the natural breaks and position changes that were associated with the old style typewriter we have to actively make good choices during our day.

*Keyboard types*

Keyboards come in a variety of configurations. While intuition may indicate that keyboard configuration influences hand/arm position and consequently physical stressors, studies have indicated that proper position of the keyboard in relation to the user (height and reach) has been shown to be more important than the

configuration. Personal preference and specific issues also can drive the type of keyboard used.

Straight line

Curved

Articulated

### *Keyboard solutions*

### Neutral positioning

If your keyboard position does not allow neutral hand/arm/shoulder/ neck and upper back positioning, remember your goal is to work in as neutral a position as feasible. Identify your particular keyboarding style or technique.

This may be the:

*Free float piano playing style*

*Use of the worksurface for forearm support*

Now, based on your technique, you need to obtain correct height, reach and angle of the keyboard so that you are able to work in neutral.

If you can, adjust the keyboard height and position, either by adjusting the worksurface height itself or through the use of a keyboard tray. If you cannot adjust your keyboard height, you will need to position your chair height to place your hands in neutral posture in relation to the keyboard. This may require support for your feet if they no longer touch the floor.

NOTE: A wrist rest can be a good addition to a keyboard. Remember that it is called a wrist ‘rest’ not wrist ‘anchor’. In other words it should provide some weight-bearing supports for your arms, as you need rest. You should NOT anchor

your wrists to the rest and then move your hands and fingers side to side out of a neutral wrist position.

### Poor Technique

If you have really bad technique, you may want to consider investing in one of the computer training programs that teach improved technique.

### Take a break

One of the biggest problems with the modern computer is that it does not cue you to take a break. There are a number of human movements, such as reaching your arms over your head, arching your back or rotating your neck, that are normal human movements, but are not a normal part of your day. The computer workstation is notorious for discouraging much movement. For that reason people need to recognize the need for adding stretching to your day.

Create some type of system to key you or remind you to stop and stretch. Or change positions. Or work on a different activity that does not involve use of the keyboard. This could be:

- A little post it note put on your computer monitor
- Software is also available to load on your system or network that reminds you to stretch
- Team up with someone else in the office to remind each other to stretch and change positions.
- Take advantage of natural breaks between activities. And if it makes sense, create breaks at regular intervals to give your body a chance to move and stretch.

| Keyboard Tray | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Tray | No/Yes | No<br>Yes | ❑ Keyboard tray appropriate<br>❑ Keyboard tray limits reach access to worksurface<br>❑ Keyboard tray type does not allow neutral arm/hand position<br>❑ Keyboard tray location does not allow neutral hand/arm position<br>❑ Other (comment) | ❑ None<br>❑ Adjusted keyboard tray position and provided user instruction<br>❑ Remove tray - place keyboard directly on worksurface<br>❑ Other (comment) |
| Ht adjust | No/Yes | | | |
| Angle adjust | No/Yes | | | |
| Size fits | Keyboard only<br>Keyboard-mouse | | | |
| | | | | |

| Keyboard | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Type | Straight/Curved/ Articulated/Other | No<br>Yes | ❑ Keyboard type and location appropriate<br>❑ Keyboard type does not allow neutral arm/hand position<br>❑ Keyboard location does not allow neutral hand/arm position<br>❑ No wrist rest in use for support<br>❑ Other (comment) | ❑ None<br>❑ Adjusted keyboard position and provided user instruction<br>❑ Replace keyboard - see comments<br>❑ Add gel keyboard wrist rest<br>❑ Other (comment) |
| Location | Work surface/Tray | | | |
| Shortcuts | Used: No/Yes | | | |
| Maint | No/Yes | | | |
| | | | | |

## *Mouse*

No . . . not that kind of mouse!

The type of mouse we are talking about is one of a number of different types of pointing devices used to navigate through software programs.

In all practicality the best way to use a mouse is to use it as little as possible. In other words make full use of keyboard shortcuts as possible for navigation purposes. (Dual control – mouse and/or keyboard – are often incorporated as part of the software.)

Emphasis on use of the keyboard limits the amount of time spent reaching to the mouse and also has a positive impact on productivity.

### Pointing device solutions

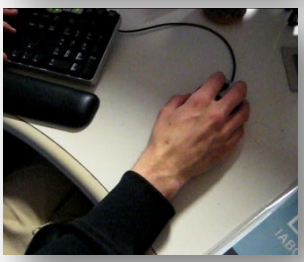
#### *Neutral positions*

The pointing device should be positioned so it is in the same plane as the keyboard. Here are some simple solutions to make it easier to work with your mouse. If your mouse position does not allow neutral hand/arm/shoulder/neck and upper back positioning, remember your goal is to work in as neutral a position as feasible. Identify your particular mousing style or technique. This may one of the following.

- Free float piano playing style
- Use of the worksurface for forearm support

Based on your technique, adjust your position to get the correct height, reach and angle of the mouse so that you are able to work in neutral. If you can, adjust mouse height and position (either by adjusting the worksurface height itself or through the use of a mouse tray)

Based on proper chair position, position the mouse so that shoulder/hands/wrists are in neutral. If you cannot adjust mouse height and position, position the chair height to place your hands at the proper height and position in relation to the mouse. This may require support for your feet if they no longer touch the floor.



### *Mouse wrist rests*

While wrist rests for keyboard use (if used correctly) are often a good idea in most case use of wrist rest for mouse use is not. The wrist rest tends to “anchor” the wrist with excessive deviation of the hand side-to-side.

Generally recommended use of the mouse is to allow straight in access allowing the forearm, wrist and hand moving as unit to manipulate the mouse. Think of the mouse as an extension of the arm NOT just an extension of the wrist.

### Variety of pointing devices

There is no doubt that the traditional mouse is by far the most commonly used pointing device. When properly positioned and setup it works well. However, there are a wide variety of pointing devices available with different shapes and styles that include touchpads, rollerballs, joysticks, pens and so on. Multiple buttons can be programmed to minimize keying. There are some even specifically designed for lefties. Workers should try different models and choose one that suits their needs.

The type of pointing device that works the best is based on the setup of the workstation, the job task and the personal preference of the user. With many mouse designs available here are general suggestions for selection:

**Size -** The mouse should fit into the hand and the fingers should be able to curl around it comfortably.

**Shape -** Find a mouse that reduces the need to place the heel of your hand on the desk. Some mice are larger, especially at the rear, and can support your entire hand.

**Buttons -** The location of the buttons is important. They should not be cramped nor too spread out. The pressure needed to click the buttons should not be so great that it tires the fingers but neither should it be so sensitive that it is too easy to activate the buttons

**Scroll wheel** – allows for easy scrolling within a document.

**Don't squeeze** the mouse. Hold it loosely in your hand and relax your grip. A tight grip will not help to position the pointer any more accurately or quickly.

**Program** your mouse to manipulate the speed at which the cursor moves or the sensitivity of the buttons.

**Wireless -** a number of pointing devices are wireless, which increases the flexibility of where it can be positioned.

**Optical** – rather than a mechanical ball that rolls on a surface an optical mouse depends on a laser to detect movement.

A button that is too sensitive can force you to keep your fingers slightly elevated off the buttons and for some people this can lead to eventual fatigue and discomfort in the muscles and tendons of the forearm.

If your mouse is sticking, you may need to clean it. Your owner's manual will instruct you how to do this without causing any damage to the mouse.

### Mouse Pros and Cons

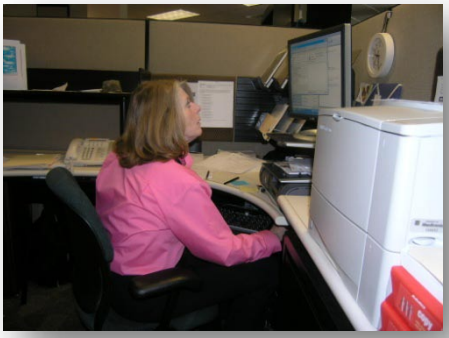
Pros and cons for each type of pointing device are outlined in the table below.

| Pointing Device | Pros | Cons |
|---|---|---|
| **Shell mouse**  | Relatively easy to learn how to use.<br>Installed base is huge with most computer users first exposed to traditional mouse.<br>Inexpensive. | Promotes "skating" of the mouse with subsequent out of neutral hand/wrist/arm/shoulder positions.<br>Hand size is important to consider matching the correct size shell with hand size.<br>Often poorly positioned in relation to user and keyboard. |
| **Roller ball/Track ball**  | Can provide a stable platform for the hand that eliminates 'skating' of the traditional mouse.<br>May be very effective in controlling wrist and elbow problems.<br>Available in a variety of configurations with ball controlled by either the thumb or fingers or in some cases eith<br><br>er. | Acceptance curve is quite steep. Minimum of one week trial basis to determine benefit is recommended.<br>Some users never accept it.<br>Hand size is important to consider matching the correct size shell with hand size.<br>Typically more expensive than a traditional mouse. |
| **Touch pad**  | Provides an alternative to the traditional and roller ball styles. | Learning curve may be quite steep for some users.<br>Typically more expensive than a traditional mouse. |

| | | |
|---|---|---|
| **Pen/Tablet**  | Often used by graphics designers who require the ability to 'draw' on the tablet. | Can be cumbersome for some users.<br>Typically more expensive than a traditional mouse. |
| **Joystick**  | Designed to place the hand in neutral position during use. | Limited acceptance to date.<br>If frequent reach to the keyboard is part of the job task may result in excessive hand/arm movement. |
| **Vertical**  | Designed to place the hand in neutral position during use. | If frequent reach to the keyboard is part of the job task may result in excessive hand/arm movement. |

| Mouse | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| **Type** | **Shell/Rollerball/ Vertical/ Joystick/ Touchpad/Other** | **No**<br>**Yes** | ❑ Mouse type and location appropriate<br>❑ Mouse type does not allow neutral arm/hand position<br>❑ Mouse location does not allow neutral hand/arm position<br>❑ Mouse wrist rest in the way<br>❑ Other (comment) | ❑ None<br>❑ Adjusted mouse position and provided user instruction<br>❑ Replace mouse - see comments<br>❑ Remove mouse wrist rest<br>❑ Other (comment) |
| **Location** | **Work surface/Tray** | | | |
| **Scroll** | **No/Yes** | | | |
| **Maint** | **No/Yes** | | | |
| | | | | |

### *Computer (CPU, computer case, hard drive)*



Many people tend to put the computer underneath the monitor. In some cases this may be appropriate but in a lot of cases, it's not – it may position the monitor at too high a level. When you decide where to position your computer think about your particular needs.

Do you need to keep the computer close in terms of the on-off switch and access to the disk drives on the computer? In that case you may want to position the computer on your worksurface or maybe on the floor on a computer stand with easy reach. On the other hand, if it really doesn't make much difference then position it so it is out of your way.

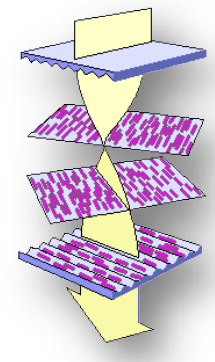
Remember that the computer does generate heat and has vents on the case. Make sure you don't block ventilation around the computer – this could result in overheating problems.

| Computer | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Type | Desktop/Laptop | No<br>Yes | ❑ Computer type and location are appropriate<br>❑ Computer in the way<br>❑ Other (comment) | ❑ None<br>❑ Reposition computer out of way<br>❑ Other (comment) |
| Location | Work surface/Floor | | | |

### *Monitor*

Things have changed dramatically from the days when we used to spend our day reading/writing reports on paper. Now, for most of us, everything we need access to can be viewed through the monitor on our desks. While this has made our lives a bit easier, the demands of looking at a monitor all day long can create some problems if not used appropriately.

Ever watch people when they are sitting looking at their monitors. It's almost like the monitor is a vacuum cleaner. They turn it on and it sucks their head right in!



## LCD Monitors

Having an adequate monitor is critical to success of the computer user. At this point in time one primary monitor type is in place - the flat panel **liquid crystal display (LCD).**

### *Physical Size*

One of the biggest advantages of LCD monitors is that they are compact and lightweight. An LCD monitor is based upon a very thin screen as opposed to the bulky tube of a CRT monitor.

This means that not only do they take up less desktop space; they can also be used in many places where a larger CRT monitor can not fit.

### *Resolution*

An important issue with LCD monitors is resolution. Resolution is the number of pixels (picture elements) displayed. CRT monitors are usually capable of running multiple resolutions. LCD monitors, however, will usually work well in only one resolution. Other resolutions can be sometimes be displayed, but either the image may not be full-screen or the image quality may be poor. Smaller LCD monitors up to 12" are normally capable of 640 x 480 or 800 x 600 resolution, and most LCD monitors 14" and above are normally cable of 1024 x 768 resolution or higher.

Typically the LCD resolution should be set at the highest resolution possible. This will make images appear smaller on the screen, creating a potential of visual issues. Options to increase viewing size are to set the DPI of the monitor to 120 rather than the default 96 DPI. Also view size can be increased or decreased by using the keyboard shortcut CTRL + mouse scroll wheel. Another keyboard shortcut is CTRL + (+ or -).

### *Brightness*

LCD monitors are backlit and have different levels of brightness. The brightness rating for an LCD monitor is commonly referred to as 'nits', and commonly range from 70 to 250 nits. The higher the nits, the brighter the display.

### *Viewing Angle*

Another issue with the LCD monitor is the viewing angle; an LCD monitor has a much smaller viewing angle, needing to be viewed more directly from the front. From the side, the image on an LCD screen can seem to disappear, or invert colors.

## Monitor solutions

### *Alignment*

When you think about the alignment of your monitor in relation to your body position, the first thing to recognize is the importance of directly facing your primary work task.

If you are doing primarily data creation or manipulation, it makes sense to have your monitor directly in front of you.

If, on the other hand you are doing primarily data entry and your main focus is on paper documents, you would want your monitor slightly off to the side and utilize a copy stand to place your paper documents directly in front of you.

### *Glare*

Ways to control glare are to position the monitor so that a light source is not behind you or at an angle that can be reflected by the monitor.

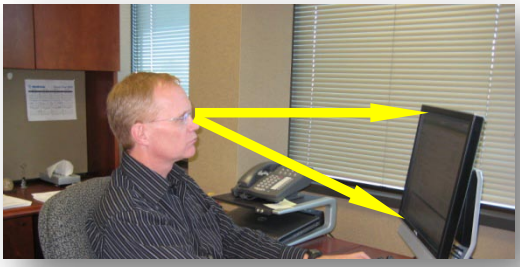
Ideally the light should be overhead, or perpendicular to the monitor. If an overhead light is a bit behind you and can be seen in the monitor, you may want to place a glare hood on top of your monitor to shield it from the light.

A glare screen added to the monitor will also control glare. In this case you truly get what you pay for. An inexpensive glare screen is generally just wire mesh; it will cut the glare but also will make it harder to read the text on the screen. Look for a good quality optical glass glare screen. (Also privacy screens are available that limit viewing of the screen from the side as well as control glare.)

You don't want to have a light source such as window directly behind the monitor. Your eyes try to adjust to the level of light coming in, and your eyes have trouble adjusting to the light coming in from outside and the light generated from your monitor. If you can't place the monitor perpendicular to the light source, close the shades when working on the computer.

Adjust the monitor screen brightness and contrast based on your perception of the overall quantity and quality of light in the workstation and the need to see what's on your monitor clearly and comfortably

### *Height*



A general guideline for the height of the monitor screen is to position it so that it is at eye level or slightly lower.

Trying to look at a screen higher than eye-level is uncomfortable because it forces you to open your eyes wider than usual causing discomfort as well as a tendency for your eyes to become drier.

Also with a monitor that's too high, your tendency will be to tip your head back putting an additional strain into your neck and shoulders.

Remember that it's all about relationships. Make sure you have set your chair at the correct height and that you are in your typical seated posture as a guide to position the height of your monitor screen.

***Lower monitor***

Most monitor are on adjustable height stands or arms that can be adjusted. If not on an arm if the monitor is too high, you may try either tipping the monitor

forward a bit which in effect lowers the viewing area, or raise your chair slightly (as long as this doesn't affect your ability to have adequate foot support.).

Remember, as a final option you may need to consider actually lowering the surface that the monitor is on. This is particularly true as monitors of larger size are more commonly in use. Recall this will influence the relationships you have established between yourself and your workstation. For example you may need to re-examine your chair height keyboard location and so on.

***Raise monitor***

There are a number of methods for raising your monitor including monitor stands.

There are a variety of types including those that come in 1" increments, stands that have a space to put your keyboard when not in use, and monitor arms that actually suspend your monitor above your desk and allow you to place it in an infinite number of positions.

A simple and effective solution for raising your monitor, is to place it on an old phone book or other material that places it at the desired height

*Distance*

Here's a general guideline for monitor screen distance: get the screen as far away from you as you can and still be able to read it clearly with good posture. Either move the monitor closer or increase the character size.

To demonstrate this, focus on a finger at arm's reach, slowly bring your finger toward your nose maintaining focus and notice the increase in stress in eyestrain the closer your finger gets to your eyes. The same thing will be true the closer your monitor gets to your eyes.

***Accommodation***

Accommodation is when the lens capsule in your eye changes shape to focus on a close object. The eyes have a default accommodation distance, called the resting point of accommodation (RPA). That is the distance at which the eyes focus when there is nothing to focus on.

In total darkness our eyes are set to focus at a particular distance, so that if the lights were turned on, an object at that distance would be in clear focus. The RPA averages 30 inches for younger people and gets farther away with age.

***Convergence***

Convergence is when the eyes turn inward toward the nose when we view close objects. Convergence allows the image of the objects to be projected to the same relative place on each retina. Without accurate convergence, we see double images. The closer the objects, the greater the strain on the muscles that converge the eyes. Recent studies have shown the stress of convergence contributes more to visual discomfort than the stress of accommodation. (The visual system also has a resting point of vergence (RPV). It is similar to the resting point of

accommodation, but it's the distance at which the eyes are set to converge when there is no object to converge on.)

### *How close is too close?*

It is difficult to set an exact limit for a minimum viewing distance. If sustained viewing closer than the resting point of vergence contributes to eyestrain, perhaps we should say that eye-screen distance should not be closer than the resting point of vergence. (On average, about 45 inches away at horizontal eye level and 35 inches away with a 30-degree downward gaze angle.)

### *How far is too far?*

The reality is that there is no limit, based on visual fatigue considerations, to maximum viewing distance at computer workstations. From what we know about visual strain, farther viewing distances are better, at least up to the RPV. For example, if the RPV is 35 inches, an eye-to-screen distance of 25 inches is preferred to 20 inches. Thirty-five inches is better than 25 inches. Viewing distances beyond 35 inches (the RPV in this case) should neither increase nor decrease eyestrain.

## Adjustments

Bringing your monitor closer is generally as simple as sliding the screen towards your body. Moving it farther is generally a bit more complicated if simply sliding it farther away isn’t an option.

First, figure out why you can’t get your monitor farther away. It may be that you can reorganize what’s on your worksurface and get the monitor farther away.

If it’s not possible to reorganize your worksurface, consider reconfiguring how you place your monitor on the desk. For example you might be able to place the monitor more in a corner of the worksurface to gain greater distance.

Another option you may have is to add a keyboard tray to the existing worksurface; this will let you to sit more comfortably at a greater distance from the monitor. Remember also that a keyboard tray will push you farther away from the rest of your worksurface and may put some items out of a comfortable reach.

If you have a freestanding desk that is backed up to a wall, another option is to actually pull the desk a few inches away from the wall and slightly overhang the base of the monitor off the worksurface. If you do this, make very sure that the monitor will not fall off the worksurface.

At a minimum, when you’re not doing a great deal of keyboard data entry but are primarily reviewing documents on your monitor, simply push your chair farther back from your worksurface to give your eyes a bit of a break

### *Clean screens*

Dirty monitor screens are a lot like dirty eyeglasses, it isn’t until you clean them that you realize they needed to be cleaned.

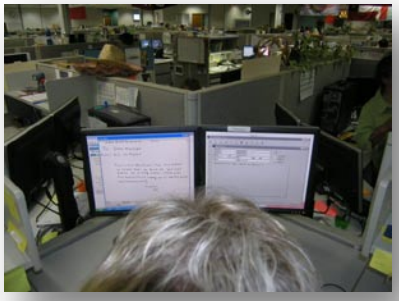
On a regular basis get into the habit of cleaning your monitor screen. There are a variety of sprays/cloths that are commercially available that are made specifically to safely clean the monitor screen.

### *Dual Monitors*

More and more use of dual monitors is coming into play. The second monitor provides for open programs to be viewed concurrently and comparison between two documents is much easier. Typically the monitors are positioned as Primary/Primary or Primary/Secondary setups. Also maintain a consistent viewing distance to the monitors by positioning the monitors in an array fashion as opposed to a straight-line manner.

### *Primary/Primary*

In a Primary/Primary setup both monitors are viewed about 50% of the time each. The monitors should be positioned so they are centered on the user.



### *Primary/Secondary*

In the Primary/Secondary setup one monitor is viewed most of the time with the second monitor viewed only occasionally.

The primary monitor should be positioned directly in front of user and the secondary monitor positioned off to the side directly next to the primary monitor.

### Eye Examinations

If you do a lot of computer work you want to make sure you have periodic eye examinations. When you do so make sure you tell the examiner the amount and type of computer work you do. You may even think about taking a measurement of the distance from your eyes to the screen and take that into the person performing the examination. This will allow them to have information needed to provide a proper prescription for computer glasses.)


### *Presbyopia*

During middle age, usually beginning in the 40s, people experience blurred vision at near points, such as when reading, sewing, or working at the computer. There's no getting around it — this happens to everyone at some point in their life, even if they never had a vision problem before.

When people develop presbyopia, they find they need to hold books, magazines, newspapers, menus and other reading materials at arm's length in order to focus properly. When they perform near work, they may have headaches or eyestrain, or feel fatigued.

Presbyopia is caused by an age-related process, rather than the way light is refracted, or bent, by the eye. Presbyopia is caused by a slow loss of flexibility within the lens inside the eye.

Glasses with bifocal or progressive addition lenses (PALs) are the most common correction for presbyopia. Bifocal means two points of focus: the main part of the spectacle lens contains a prescription for nearsightedness or farsightedness, while the lower portion of the lens holds the stronger near prescription for close work. Progressive addition lenses are similar to bifocal lenses, but they offer a more gradual visual transition between the two prescriptions.

Always be aware that bifocals may result in awkward head and neck position when viewing a computer screen. Options are to reposition the monitor to a lower level, trifocals where the middle of the lens is set for monitor viewing and separate computer glasses used only when at the computer.

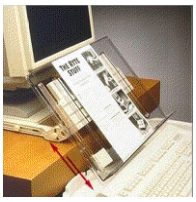
Reading glasses are another choice. They may be worn just while doing close work, and may even be prescribed to wear over top of contact lenses (usually worn for distance correction). These glasses may be purchased over-the-counter at a retail store, or higher-quality versions may be prescribed by your eye care practitioner.

There are contact lenses for presbyopes, called multifocal lenses. Multifocal contact lenses in gas permeable or soft lens materials are available.

Another type of contact lens correction for presbyopia is monovision, in which one eye wears a distance prescription, and the other wears a prescription for near vision. The brain learns to favor one eye or the other for different tasks. But while some people are delighted with this solution, others complain of dizziness or nausea, or miss the depth perception they once had.

| Monitor | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Type | CRT/LCD | No<br>Yes | ❑ Monitor type and location appropriate<br>❑ Monitor too low<br>❑ Monitor too high<br>❑ Monitor too close<br>❑ Monitor too far away<br>❑ Monitor resolution not appropriate.<br>❑ Other (comment) | ❑ None<br>❑ Adjusted monitor position and provided user instruction<br>❑ Adjusted monitor resolution and provided user instruction<br>❑ Add monitor riser (comment)<br>❑ Other (comment) |
| Number | Single/Dual/More | | | |
| Adjustable Stand | No/Yes | | | |
| Resolution | OK No/Yes | | | |
| Position | OK No/Yes | | | |
| | | | | |

### *Document holder*



If material is read from hard copy, the hard copy should be placed on a document or hard copy holder. This can be placed either directly in front of the user between the monitor and keyboard if enough room is available or can be placed on a hard copy stand placed adjacent to the monitor.

It is not essential that the document be the exact same distance from the user. In fact many times if you try to put a holder right next to the monitor you put it out of the desired reach zone.

| Document holder | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Holder | No/Yes | No<br>Yes | ❑ No document holder in use - not needed<br>❑ No document holder in use - awkward head/neck position<br>❑ Other (comment) | None<br>❑ Add landscape holder between keyboard and monitor<br>❑ Add landscape holder off to side of monitor<br>❑ Add portrait holder between keyboard and monitor<br>❑ Add portrait holder off to side of monitor<br>❑ Other (comment) |
| Type | Portrait/Landscape | | | |
| Location | Side/Front | | | |

### *Laptops*

Design of laptops violates a basic ergonomic requirement for a computer, namely that the keyboard and screen are separated. The reason is simple - with a fixed design, if the keyboard is in an n optimal position for the user, the screen isn't and if the screen is optimal the keyboard isn't.

This means that you need to pay special attention to how you use your laptop because it can cause you problems.

#### Laptop User Type

Are you an **occasional user** who works on your laptop for short periods of time or are you a **full-time user** with the laptop as your main computer? Occasional users will have less risk of problems than full-time users. All users should pay some attention to how they use their laptop, but full-time users may have more problems.

### Occasional Users

Because large muscles control the neck/head position, you are better off sacrificing neck posture rather than wrist posture. For occasional use:

- Find a chair that is comfortable and that you can sit back in.
- Position your laptop in your lap or table for the most neutral wrist posture that you can achieve.
- Angle laptop screen so that you can see this with the least amount of neck deviation.

### Full-time Users

If you use your laptop at work as your main computer you should:

- Use a separate keyboard and mouse. You should be able e to connect a keyboard and mouse directly to the back of the laptop or to a docking station. A port replicator is used.
- Position this on your desk/worksurface in front of you so that you can see the screen without bending your neck. This may require that you elevate the laptop off the desk surface using a stable support surface, such as a computer monitor pedestal.
- Follow the postural guidelines for working at a computer workstation.

### Laptop weight

If you frequently transport your laptop think about the weight of the system. Many lightweight portables can become as heavy as regular laptops when you add the weight of all of the components together. If your laptop and components weighs 10 lbs or more then you should certainly consider using a carry-on bag that you can pull along. If you want a smaller bag and can comfortably carry your laptop consider a good shoulder bag or wheeled case.

## *Telephone*

### Frequency and duration

There is no doubt that the telephone is an essential part of our offices. Think for a moment about how much time you spend on the telephone and how important is it for you to have a proper telephone set up? If you make only a few calls a day, it really doesn't have much of an impact.

On the other hand, if you spend hours on the phone every day or if you make frequent short calls here are some things to consider. The position of your head/shoulder/hand can be an issue with telephone use. If you use a telephone handset how do you hold it? Do you hold the handset between your ear and shoulder forcing you to crane your neck?

### Headsets

To improve head/shoulder/hand position, more and more people who use a telephone on a frequent and regular basis are switching to

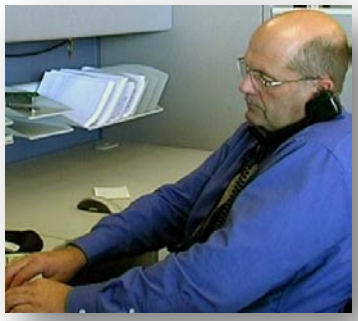
headsets. This frees up both your neck and your hands and allows a good neutral position.

Several different types of headsets are available and you'll want to find one that works the best for you. Over-the-head and over-the- ear versions are available either in wired or wireless formats.

It does take a little while to get used to headsets, so give it some time.

Think about where you want to store your headset when you're not using it. Sometimes a small hook on the wall or on your computer monitor for example, can be a good storage place. This keeps it off your worksurface and also keeps it in ready reach.

### Cradle



You could add a phone cradle onto your telephone handset. This does help to put your head and neck in a better position but it still requires you to maintain tension in your neck and shoulder to position the telephone handset. Our recommendation is to not use phone cradles on a regular basis. A headset is a much better solution in most cases.

### Sound quality

Poor sound quality and low-volume are problems in the effective use of your telephone. If you identify either the sound quality or volume as an issue see if there are any adjustments you can make to improve it. If not you may want to consider replacing or exchanging your telephone handset or headset.

| Telephone | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| Type | Handset/Headset/ Speaker | No<br>Yes | ❑ Telephone type and location appropriate<br>❑ Telephone located in awkward position<br>❑ Awkward head/neck position with handset use<br>❑ Other (comment) | ❑ None<br>❑ Add headset to allow for hands-free operation<br>❑ Reposition telephone to left side worksurface<br>❑ Reposition telephone to right side worksurface<br>❑ Other (comment) |
| Location | Left/Right | | | |

### *Handwriting/Reading*

Despite the leaps and bounds of technology we still find ourselves using the good old pen and paper as a tool for communication. The way we choose to do the

simple task of writing, or even reading, ca n have a huge influence on the condition of our hands and wrists, neck, shoulders and eyes.

### Inclined

To correct working on a horizontal surface think about the old-style school desk. It actually had a tilted worksurface to position the writing and reading materials that encouraged the student to stay in a more upright position.

Think about how you might put your material in a more in a tilted position.

You might use a document stand or podium. Think about where you need to place the stand or podium. If you're using it when at your computer you might place it either in front of you between the keyboard and monitor if there is enough room, or you might position it slightly off to the side.

### Gripping

Is it really true, that the harder you squeeze the more ink or lead will come out? Lighten up your grip/use a soft grip that slides onto your pen/pencil or use one of the newer "ergonomic" grips designed to fit your hand. The larger the grip the more you can use the larger muscles of your hands. The smaller the grip the more we tend to use the smaller muscles which fatigue more rapidly.

We all have our favorite pen. However it makes sense to have a variety of different types and sizes of pens and pencils sleeping trade-off throughout the day and give your hand a break.

Remember that whenever you try something new, it takes a while to get used to it; our bodies sometimes have a difficult time with good changes. So if it makes sense but feels strange give it a little time.

### *Lighting*

While monitors are designed to work with less light, to read text on a page you need to have more light that helps the text "jump" off the page.

If you work with both paper documents and a computer, keep the light appropriate for the computer monitor and use a task light that is a small lamp that points directly at your paper documents.

### *Office equipment*

Make use of the principles we have discussed to place the office equipment.

Includes:

- Calculator
- Printer
- Fax
- Writing utensils
- Scissors
- Paper clips
- Stapler
- Storage
- Etc

It's amazing sometimes how much stuff we can accumulate in our offices. So what we store on our desktops, some would put in our file cabinets and sometimes on shelves and in overhead cabinets.

The old adage, "a place for everything and everything in its place" makes good sense.

On a regular basis make sure that you can easily place and remove any of your office equipment and materials from their storage locations in file cabinets, drawers, shelves and cabinets.

Understand and make use of the reach zones.

***Storage***

**Primary- desktop, shelf, file**

- Commonly/frequently accessed from seating system
- Within easy reach
- Within accepted reach zone

**Secondary - desktop, shelf, file**

- Occasionally accessed
- Located in the "gray" or danger zone (able to reach to the location by over-extending)
- Require light weight and low frequency of access to limit stress
- Best bet: move into primary or tertiary


**Tertiary – shelf, file**

- Occasionally accessed
- Requires getting out of chair to reach

### *File cabinet types*

If you try to put 50 files in a file cabinet that holds 30 you're going to have problems trying to get them in and out. This creates a great deal of unnecessary additional work as well as the potential for musculoskeletal disorders. (And not to mention the frustration that goes along with.)

Make good use of the different types available:

- Vertical
- Lateral
- Rolling

| Storage | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| **Desktop** | OK No/Yes | No<br>Yes | ❑ Adequate desktop and file storage<br>❑ Limited desktop storage<br>❑ Limited file storage<br>❑ Other (comment) | ❑ None<br>❑ Housecleaning to provide additional desktop storage<br>❑ Housecleaning to provide additional file storage<br>❑ Add additional file storage<br>❑ Other (comment) |
| **File** | OK No/Yes | | | |

### *Conference rooms*

We need to take into account not only the information that is being delivered but is our audience capable of receiving and using the information in an effective way? One issue of meetings is the lack of physical movement: Long meetings without adequate movement can lead to fatigue, discomfort and a non-productive meeting. Ineffective workstation setup (often just a conference table with poor chairs) is an issue with meetings.

For example meetings held at a standard conference table could make you perform your work outside of the neutral postures. It is tough to be in one position for long periods of time. Look for as many opportunities as possible to move as part of your meeting.

You probably have heard that people think better on their feet. It has to do with improving oxygen flow. If your company wants people to think better during a meeting, consider doing a bit of standing mixed in with sitting.

If you get uncomfortable in long meetings bring in a small footrest or back cushion if you can't adjust the chair or worksurface.

### *Light*

Lighting is a big issue. When you think about light in the office, think about two things: general light that allows you to se e in the office and task light that is specifically focused on the work itself.

General light in the office may be an issue: either too much or not enough.

### Too much

For general light that may be too much, one option may be to turn out some of the overhead fluorescent lights. Before you do this on your own, contact your building facilities staff to make sure how to do it safely.

Also in some cases, turning out one fluorescent bulb in a set may cause the other bulbs to flicker

### Too little

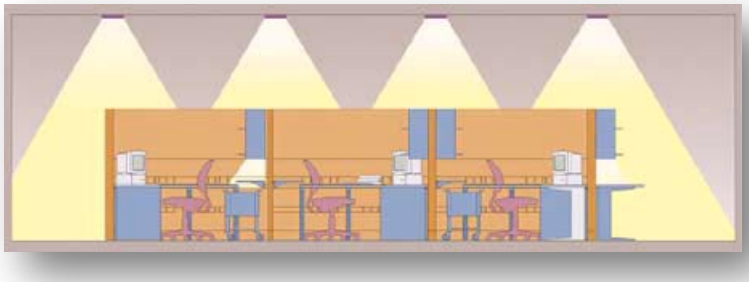
If you simply don't have enough general light for safety purposes, additional overhead lights may be added or another effective way is to add indirect lights, which bounce the light off of the ceiling and walls. Again contact your building facilities staff for the best solution.

Task lights are a great way to add additional light where you need it. They come in a variety of configurations and wattage. For example you may use a desktop lamp to provide additional light on your document holder. You may have a bulletin board where you post information; a task light can be attached to a wall panel or other surface and be pointed at the bulletin board to provide proper illumination.

Remember that how you position the task light is important, for example don't point it directly at your computer screen because you will create glare. Also make sure it is not in your direct line of vision and pointed at you because this also this will create a problem.

### Lighting design

Lighting design within an office setting can get quite complicated and detailed. The recommendation is to work with lighting designers to tackle large jobs.



| Illumination | | Issue | Comment | Recommendation |
|---|---|---|---|---|
| **Overhead** | OK<br>No/Yes | No<br>Yes | ❑ Ambient and task lighting appropriate<br>❑ Ambient light level too high<br>❑ Ambient light level too low<br>❑ Task lighting too high.<br>❑ Task lighting too low<br>❑ Other (comment) | ❑ None<br>❑ Lower ambient light level<br>❑ Raise ambient light level<br>❑ Add desktop task light<br>❑ Decrease desktop task light<br>❑ Other (comment) |
| **Task** | OK<br>No/Yes | | | |
| | | | | |

### *Noise*

An office can be a noisy place. People conversing, printers printing, telephones ringing, fax machines connecting, it all adds up. And your brain is trying to determine what are the relevant and important noises separate from all of the background noise. Noise can be a contributing factor to fatigue and general stress in the office environment. Too much noise or interestingly enough too little noise can interfere with communication and concentration. Even the type of noise is a factor. For example when a work environment is too quiet it becomes a problem because every sound becomes a distraction.

#### Noise source

The first step in solving too much noise is to figure out where the noise is coming from. Is it coming from the mouth of the person next to you (which may be an issue that needs to be handled tactfully) or is it coming from some other source like noisy office equipment (telephones, printers, and so on) or building noises (fans and elevators.

#### Noise control

A very reasonable first step is to find out what other people in the area are experiencing and whether or not this a problem for them? If so you can work together as a group to come up with solutions.

For example this could include limiting the volume and length of conversations in the areas where more quiet is needed. Make good use of more public areas or even conference rooms for louder or more extensive conversations.

For equipment noises, it may be possible to move the equipment where it is not as much of a noise distraction.

Sound engineers actually try to create what is called white noise in office environments. This is background noise that masks other noises. At a personal level you can create some of your own white noise by running a small fan in the office or checkout what's available for CDs or audiotapes that create background noise. Just make sure that what you add is also acceptable to your work neighbors.

### *Temperature*

Air temperature in the office environment is a very personal issue. We all have individual thermostats that vary from person to person.

It is not possible to have one temperature be totally accepted by every person in the office. The temperature in the office may be too hot or too cold based on particular preference. This can make it uncomfortable and affect work in a negative way.

### Survey

The first step to improving your comfort related to temperature is a general survey of your co-workers. It may be that everyone is too cold or too hot. In this case you may need to talk with your building's facilities staff to see if changes can be made.

### *Controls*

If sunlight coming through a window, even in the wintertime, provides too much radiant heat you may want to have a window shade that you can control.

Other controls that may work for you are to have a sweater available to put on if you are too cool or a personal fan you can use for a little more ventilation.

## Recommended Specifications

Once the assessment has been performed generate the Recommended Specifications. Refer to the notes below for details needed to take the measurements.

| Recommended Specifications (inches) | | | | | |
|---|---|---|---|---|---|
| **Seating System** | | **Worksurface Height** | | **Computer** | |
| Seatpan height: | | Writing/reading desk | | Keyboard height: | |
| Seatpan depth: | | | | Mouse height: | |
| Seatpan width: | | | | Monitor height: | |
| Armrest height: | | | | Monitor distance: | |
| Armrest width: | | | | | |

## NOTES

**Seatpan height** is measured as the distance from the floor to the seatpan (at the side of the seatpan) with the user in the chair. Seatpan height is **Seatpan depth** is measured as the distance from the back support to the front of the seatpan and allows for 1.5 to 2” of space between the back of the knee and front of the seatpan.

**Seatpan width** is measured as the distance side-to-side of the seatpan and allows for 1.5 to 2” of space between the thigh and side of the seatpan.

**Armrest height** is measured as the distance from the top of the armrest to the floor.

**Armrest width** is measured as the distance between the outside edges of the armrest.

**Worksurface height** (writing/reading desk) is measured as the distance from the floor to the top surface of the worksurface.

**Keyboard height** is the distance from the floor to the top surface of the platform that the keyboard rests on. (It is not to the top of the keyboard.)

**Mouse height** is the distance from the floor to the top surface of the platform that the mouse rests on. (It is not to the top of the mouse.)

**Monitor height** is height from the floor to the top of the monitor screen (not the top of the monitor bezel.)

**Monitor distance** is from the eye position (bridge of the nose between the eyes) to the screen.

| Follow-up |
|---|
| Date: (  /  /  ) |
| Date: (  /  /  ) |
| Date: (  /  /  ) |

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*Ergonomics*, Taylor and Francis.

*Human Factors*, Human Factors and Ergonomics Society.

(Reference www.ergoweb.com for a very complete list of ergonomics related journals)

Professional Organizations

American Industrial Hygiene Association

2700 Prosperity Avenue, #250

Fairfax, VA 22031

(703) 849-8888

American Society of Safety Engineers
1800 E. Oakton St.
Des Plaines, IL 60018-2187
(847) 699-2929

Human Factors and Ergonomics Society
PO Box 1369
Santa Monica, CA 90406-1369
(310) 394-1811

International Ergonomics Association
Secretary General IEA
Pieter Rookmaaker
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+31 30 2399455

National Safety Council
444 North Michigan Avenue
Chicago, IL 60611
(800) 621-7619

## Web Sites

Many, many, many web sites have ergonomics related content. Here are a couple of the better ones:

www.ergoweb.com
www.osha.gov

## EXPANDED TABLE OF CONTENTS