



**WorkWell and  
ErgoSystems Present**

**ERGONOMICS ON-DEMAND!**  
*Ergonomics for Health Care and Safety Professionals*

# Introduction to Ergonomics

*Presented by Mark Anderson, PT, CPE*

Developed by:

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

Certified Professional Ergonomist

Physical Therapist

ErgoSystems Consulting, LLC.

7421 West Shoreline Drive

Waconia, MN 55387

Voice: 952-401-9296

[Mark.Anderson@ergosystemsconsulting.com](mailto:Mark.Anderson@ergosystemsconsulting.com)

[www.ergosystemsconsulting.com](http://www.ergosystemsconsulting.com)

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## INTRODUCTION TO ERGONOMICS TRACK

### Welcome!



Hi everyone, welcome to the *Introduction to Ergonomics Track* of **ERGONOMICS ON-DEMAND!**

I'm Certified Professional Ergonomist and Physical Therapist, Mark Anderson. I have had the opportunity to work in ergonomics over the past 30 years in a wide variety of work environments ranging from manufacturing plants to offices to warehouse distribution centers and many things in-between.

I have been flown by Black Hawk helicopter into the Arizona/Mexico border working with a team to document the physical demands of Customs and Border Protection officers.

I have been lowered 70 feet below the city streets of St. Paul, MN to better understand the ergonomics of the Public Works crews who were cleaning out the storm drainage systems.

I think that is what I like the most about ergonomics; you never quite know what is next on your agenda! I appreciate the opportunity to share my ergonomics experience with you.

I'm reasonably sure the word, 'ergonomics' is not new to you. At this point it seems the word has entered the lexicon of common usage. This was not always the case.

When I first started practicing ergonomics in the 1980's, I recall traveling by airplane to work on a project and the passenger next to me asked what I did for a living. I responded, "***I work in ergonomics.***"

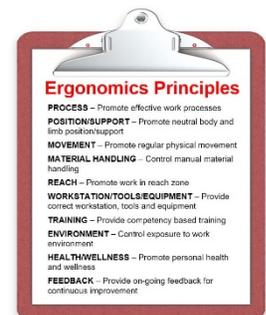
His next question to me was, "***How is the corn crop looking this year?***" I had a puzzled look on my face until I realized he thought I worked in Agronomics which of course is the branch of economics dealing with the distribution, management, and productivity of land. His question made sense to me then!

We then went on to have a nice conversation about ergonomics, corn and probably a few other topics as well!

At any rate, from the consumer's perspective, ergonomics has now found a niche in the marketing of consumer products. Chairs, toothbrush handles, keyboards, tools, you name it. The product (fill in the blank) is touted as having an 'ergonomic benefit'. Ergonomics has become a common word! For the next week, listen to how many times you hear the word, 'ergonomics' in advertising. I think you might be astounded!

However, just because a product is marketed as 'ergonomic', does that really mean it is better? The old adage, "***Let the buyer beware!***" has significant impact here. In the *Introduction to Ergonomics Track*, we'll delve into what ergonomics is really all about. We'll layout the *Foundations of Ergonomics* (Epidemiology, Work Physiology, Engineering Psychology, Anthropometry and Occupational Biomechanics) and integrate them into a set of ten practical *Ergonomics Principles*.

With the Ergonomics Foundations and Principles well in hand, you'll have the groundwork for the other tracks in the **ERGONOMICS ON-DEMAND** series. Let's get started!



## 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.

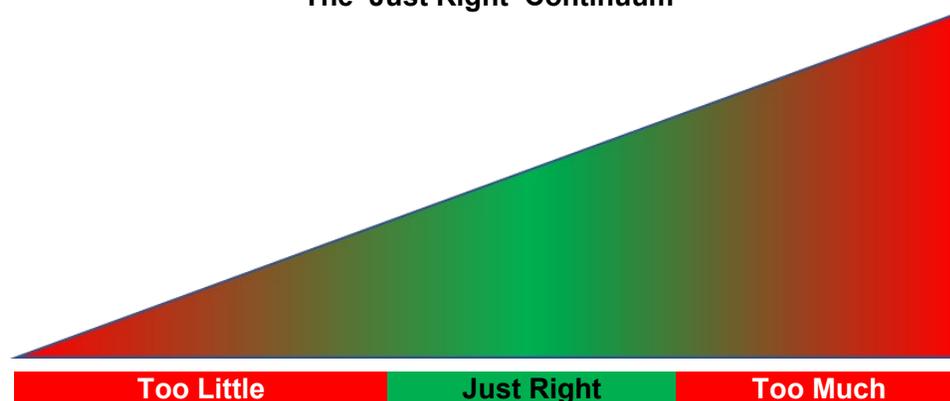
### Just Right Continuum

How about if we replace the word '**ELIMINATE**' with the word '**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



### Critical Question

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?

Do other factors influence the ‘**JUST RIGHT**’ window? Factors like the time of the day, fatigue, workstation 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 and intervention is to recognize the influence of individual performance variation **AND** figure out how best to deal with these variations to optimize performance. We’ll discuss this in more detail when we take a closer look at ergonomics interventions.

### How is Ergonomics Defined?

As we discussed, at this point in the evolution of the science of ergonomics, most people have heard the word, ‘Ergonomics’ and have a sense of how it is used.

Did you know you can even enjoy ergonomically designed corn chips?

Yep, *Scoops™* are designed to not break when you dip! Which is a good thing, otherwise the next person has to figure out how to get the broken chip out of the salsa bowl!



You probably have heard some definitions of ergonomics:

- “Working Smarter; Not Harder!”
- “Fit the Job to the Person; Don’t Force the Person to Fit the Job!”

These are reasonable concepts. In our context, we are going to go after it with a little different twist.

### 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 Predict the Response!**

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 **ridiculous!** You can’t get a ball to stay in the air just by telling it to. (Unless you are a magician and they really can’t do it either!)

How do we get the ball to stay in the air? We 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!

We need to change the circumstances to change the response!

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 need to assemble a component at a knee-high 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. Next time you are in a workplace, pay attention to how many times you observe the knee-straight, back-bent 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!”***

I think we need a different strategy.

**QUESTION**

Look at the person in this example working with the knee-straight, back-bent posture; what is driving force behind that bent over posture? What set of circumstances are in place?

**ANSWER**

Is it fair to say, the setup of the workstation with the assembly task occurring at about knee level is the driving factor?

What can be done to improve the setup?

We need to . . .

***‘Change the Circumstances to Change the Response!’***

How should we change the circumstances?

Intuitively, I think you recognize the recommended body position. You would like them to be more upright in some way. We call this the Neutral Position. We’ll get into the details a little later.

**Brainstorm Ideas**

Brainstorm on some potential options to change the circumstance to change the response.

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_



What did you come up with?

### **Option One**

One option would be to put the assembly on a lift the assembler can control and literally raise the work height. Now, as it turns out what he is working on is a large, heavy street sweeper. But with enough resources (money and time) that could be an option.

### **Option Two**

Another option would be to reposition the assembler. We could cut a hole into the floor and have the assembler work from the lower level.

Now, before you think I have taken a step off the deep end, have you ever seen the workstations at the quick oil change places. They actually have a pit they work in and position the vehicle to gain access to the underneath of the vehicle.



Once again, some pretty significant resources would be required. But it is possible in the right situation.

### **Option Three**

How else could we reposition the assembler? How about a rolling stool?

Honestly, that is what was done in this situation. The assembler is now seated on a rolling mechanic's stool. Posture is dramatically improved.



What we understand, based on Engineering Psychology Principles (more about this a little later), is given a certain set of circumstances, we will generally respond in a fairly predictable way. Now we know this is not 100% the case and we will talk about this when we discuss what are called Population Stereotypes in the Engineering Psychology section.



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

## **Systems Design**

The essence of ergonomics is design. Design of workstations, work processes, work environment and work culture dictates the level of workplace 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.

We 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 ergonomics systems design . . . get out your crystal ball and try this example. I will attempt to read your minds!

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, C=3, 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.	

**Poll – Mind Reading**

Did you come up with an Orange Kangaroo from Denmark?

A majority of people generally will! This is an example of a well-designed system; let's discuss why.

**Systems Design: Principles**

The Human Factors Design Handbook defines a system as:

- Mission-oriented grouping of elements into an integrated, functional whole
- It includes the facility, equipment, furnishings and fixtures
- It involves a variety of people who use, operate and maintain it
- It must perform a mission or function and must work in an environment

**Country-Animal-Color**

The *Country-Animal-Color* (Orange Kangaroo from Denmark) exercise you just completed yields a consistent response for a majority of people based on a set of principles that make up a system.

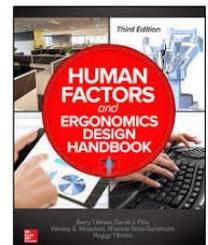
Or, if you choose to – you can believe it really is possible to read minds! Or you can use the Principle of Nines! Google it.

As a hint you all should have come up with the letter, ‘D’ in Step Five. If you didn’t, you may want to review your work!



The *Human Factors Design Handbook* lists a set of general principles of the Systems Design approach:

- 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, 3rd Edition  
Woodson, Tillman and Tillman  
McGraw-Hill, Inc., New York, NY, 2016

### Ergonomics Defined:

With this concept in mind here is our definition of ergonomics:

**Optimizing all aspects of job performance - *safety, quality and productivity* - accomplished through the appropriate *DESIGN AND USE* of work processes, workstations, tools and equipment and the overall organization of work.**

### 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 ten ergonomics principles we will discuss:

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



### Why does Ergonomics Work?

But first, here is a question for you, “*Why does ergonomics work?*” Well, in my experience it works because:

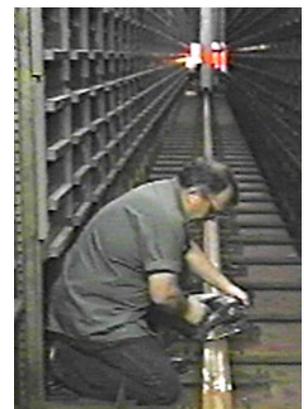
- Ergonomics employs strategies to identify and solve problems.
- Ergonomics is design based; it addresses the true root cause not just the symptoms.
- Ergonomics is cost-effective, it incorporates an incremental approach to the mitigation of identified issues.

These are all valid reasons. I have come to recognize one more crucial element to making sure ergonomics is effective.

Let me give you an example. Some years ago, I was working with a military installation with a large warehouse.

Look at the picture, in the background you can almost make out what is called a Cherry-Picker, essentially a lift used by a Picker to place and remove materials stored in the racking system. The Cherry-Picker runs on a mono-rail that is readily seen in the foreground. You also will see a maintenance technician on his hands and knees with a tool in his hands.

As it turns out the tool he is using is a hand-held belt sander. He is performing routine maintenance on the mono-rail. What do you think about the ergonomics of the work set-up? Can you envision any safety and productivity issues? Picture yourself doing the job.



Everyone who performed this task reported musculoskeletal issues. What body parts do you think were at issue? How about the knees, hips, back, shoulders, arms and hands? In fact, it is easier to list the body parts not affected!

You may be aware an automated system is available that attaches to the Cherry-Picker and performs the maintenance on an on-going basis. You probably also may be aware these systems are not cheap and require a significant capital expenditure. Even when approved, it will take some time to implement.

Our immediate objective was to figure out something that could be implemented within a maximum \$500 budget and within a two-week time-frame.

Any ideas?

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

You might have proposed knee pads, a rolling stool to sit on, padded gloves, taking more frequent breaks and perhaps some other ideas.

Recall I noted in my experience, ergonomics works because it:

- Employs strategies to identify and solve problems.
- Addresses the true root cause, not just the symptoms.
- Incorporates an incremental cost-effective approach.

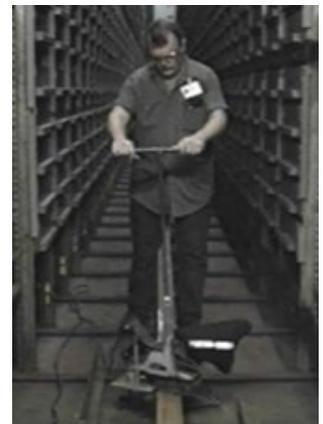
And then I mentioned one more crucial element to make sure ergonomics is effective. What is that element?

Well, working within our criteria of a maximum \$500 budget and a two week timeframe, the existing sander was modified by fabricating an adjustable height handle with a trigger and a roller system so it could be maneuvered on the mono-rail from a standing position. It was called a 'sander-on-a-stick'. Catchy name, huh? Honestly, an incredible difference was noted!

So, what is the last crucial element? Now, whose idea do you think this was? You probably have guessed it already; it came from the people doing the job! They knew the issues and had some sound ideas for improvement. They just needed affirmation and a little assistance.

In my experience the best people to practice ergonomics are the people who actually do the work. As health and safety professionals, we certainly bring our expertise to the table and when combined with the expertise of the worker and others in the organization, significant improvements are possible.

Who makes the best ergonomists in the world . . . people who actually do the work!



## Ergonomics Principles and Foundations

Let's get into the details of the ten *Ergonomics Principles* and integrate the *Ergonomics Foundations*.

Here is a summary of the principles:

1. **PROCESS** – Promote effective work processes
2. **POSITION/SUPPORT** – Promote neutral body and limb position/support
3. **MOVEMENT** – Promote regular physical movement
4. **MATERIAL HANDLING** – Control manual material handling
5. **REACH** – Promote work in the reach zone
6. **WORKSTATION/TOOLS/EQUIPMENT** – Provide correct workstations, tools and equipment
7. **TRAINING** – Provide competency-based training
8. **ENVIRONMENT** – Control exposure to work environment
9. **HEALTH/WELLNESS** – Promote personal health and wellness
10. **FEEDBACK** – Provide on-going feedback for continuous improvement

### Promote Effective Work Processes

#### Introduction

Promoting the effectiveness of the work process is the overarching principle of ergonomics. This ergonomics principle is the 'center cog' about which the other ergonomics principles interlock and rotate.

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

***“Because it has always been done that way!”***

Has it become commonplace? We don't pay attention anymore!

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.

Here is a personal example. We lived at the same house for about 25 years. I drove home literally thousands of times in those 25 years. To be very honest I recall a time or two after a very busy, tiring day, I pulled into the driveway and had the thought, ***“Did I stop back there at the stop sign at the intersection to turn onto our street?”***

I truly did not remember. I had done it so many times I was on “mental cruise”. As far as my mind was concerned, I was home already; I simply had not gotten the rest of me home yet!

What is the big deal? Well, you might be aware a majority of motor vehicle accidents happen close to home. Now part of that is because we do drive more often close to home, but a large reason is because it has become common place; we simply don't pay attention anymore!

This same effect has been demonstrated in the workplace. Workers don't pay attention and bad things can happen. One of the great advantages we bring to the workplace is a fresh set of eyes. We can ask the question, ***“Why is it being done that way?”*** We can help to identify better ways to get it done.

#### Work Process

Recall we defined ergonomics as:



**Optimizing all aspects of job performance - *safety, quality and productivity* - accomplished through the appropriate *DESIGN AND USE* of work processes, workstations, tools and equipment and the overall organization of work.**

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

- Lean Manufacturing
- Continuous Process Improvement
- Value Stream Mapping
- Kaizen Events
- Six Sigma
- 5S+1 and 6S

In one way or another, these types of strategies encompass the goal of promoting effective work processes. 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. 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 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 controls as appropriate.



### **Management/Supervision**

Management and supervision issues are included in the work process component. Without appropriate management of the workplace, ergonomics interventions will not be effective.

Check out more information about management and supervision issues in the manual.

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.

How is that message sent?

- Establish clear ergonomics performance goals and objectives.
- Establish a clear mandate for a safe and productive work environment.
- Provide adequate employee reporting systems with supervision.
- Develop effective relationships in all aspects of the organization.
- Ensure adequate training and re-fresher training.

### **Work Force**

The *Work Force*, the people performing the jobs, is the 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 can be greatly influenced by these factors. Let's take a closer look at them.

### **Age**

Physiological changes occur as a matter of aging:

- Strength and flexibility may significantly decrease.
- Aerobic capacity and endurance decreases.
- 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. They have what is sometimes called, 'Institutional Memory'.

### **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.
- Appropriate match between physical demands of the job and the 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 as we take a look at using anthropometry in the ergonomics analysis and design tracks.



### **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! Workstation, tool and equipment design should take into account hand dominance factors.



### **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 workstation 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 and can demonstrate the technical aspects of the work process?

##### **Safety**

- Has the workforce been adequately trained in methods (workstation setup, tool use, breaks, stretching, and warm-up activities, etc.) to work safely and 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 work 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. The field of Epidemiology can help us accomplish this. The Centers for Disease Control and Prevention defines Epidemiology.

*“Epidemiology is the study (scientific, systematic and data-driven) of the distribution (frequency and pattern) and determinants (causes and risk factors) of health-related states and events (not just diseases) in specified populations and the application of this study to the control of health problems.”*

*Centers for Disease Control and Prevention  
Principles of Epidemiology in Public Health Practice, Third Edition  
An Introduction to Applied Epidemiology and Biostatistics*

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

Typically, this includes a reactive records review and 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. This is historical data that is used to calculate incidence and severity rates and other pertinent information.

Please refer to other resources for a more extensive discussion. In the United States, OSHA (Occupational Safety and Health Administration) and in Canada, the Canadian Centre for Occupational Health and Safety are good resources.

Other countries will have similar agencies or administrations.

### 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

### Discomfort Survey

Use of a *Discomfort Survey* is one method to directly obtain input from the workforce. We have included one for you to use.

The *Discomfort Survey* may be administered to an individual for whom you are doing a specific ergonomics assessment, or it may be administered to an entire group to gain their overall perspective.

A few caveats for using surveys like this include:



Discomfort Survey		Age	Sex	Job Title
<p>Instructions: This survey is designed to help you identify areas of discomfort in your workplace. It is a self-administered survey. Please answer the questions to the best of your ability. The survey is confidential and your responses will not be shared with anyone else.</p> <p>Rate your discomfort level for each question (1 = No Discomfort, 2 = Mild Discomfort, 3 = Moderate Discomfort, 4 = Severe Discomfort).</p>				
1. How often do you experience discomfort in your neck/shoulder area?	1	2	3	4
2. How often do you experience discomfort in your back?	1	2	3	4
3. How often do you experience discomfort in your wrists/hands?	1	2	3	4
4. How often do you experience discomfort in your legs/feet?	1	2	3	4
5. How often do you experience discomfort in your eyes?	1	2	3	4
6. How often do you experience discomfort in your ears?	1	2	3	4
7. How often do you experience discomfort in your head?	1	2	3	4
8. How often do you experience discomfort in your arms?	1	2	3	4
9. How often do you experience discomfort in your chest?	1	2	3	4
10. How often do you experience discomfort in your stomach?	1	2	3	4
11. How often do you experience discomfort in your hips?	1	2	3	4
12. How often do you experience discomfort in your ankles?	1	2	3	4
13. How often do you experience discomfort in your fingers?	1	2	3	4
14. How often do you experience discomfort in your toes?	1	2	3	4
15. How often do you experience discomfort in your throat?	1	2	3	4
16. How often do you experience discomfort in your mouth?	1	2	3	4
17. How often do you experience discomfort in your nose?	1	2	3	4
18. How often do you experience discomfort in your skin?	1	2	3	4
19. How often do you experience discomfort in your hair?	1	2	3	4
20. How often do you experience discomfort in your overall health?	1	2	3	4

- DO NOT administer a survey to an individual or group without the express authorization of the appropriate company representatives.
- If the survey is administered to a group, determine up-front how the information will be collected, disseminated and acted upon.
- Group surveys will reveal and publicize issues; if the data is collected and little if any positive actions are taken as a result, the outcome may not be favorable.
- The information obtained is subjective in nature. Comments will, of course, be influenced by the respondent’s perception of the job demands.
- Survey responses need to be correlated with the more objective findings of the ergonomics analysis.
- Discrepancies between the survey and the analysis results will certainly occur and typically will be minor; if major discrepancies emerge, you will want to work with appropriate company representatives to understand and resolve them.

Surveys can be valuable tools if used appropriately.

**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 we all have the same ‘sense in common’. To test this, we can apply the concept of Population Stereotypes in the field of Engineering Psychology. Here is an exercise that may shed some light on the validity of the ‘in-common’ common sense hypothesis.

**Turn Knob**

To move the arrow indicator to the center of the display how would YOU turn the knob?

- Clockwise
- Counter-clockwise



About 95% of respondents will answer “Counter-clockwise”. This makes sense to them. You turn the knob counter-clockwise and the arrow will move to the left.

*Unless you understand the knob is actually controlling a pressure valve. The display represents the pressure in the system (less pressure to the left on the display) and you need to turn the knob clockwise to close the valve and thereby reduce the pressure.*

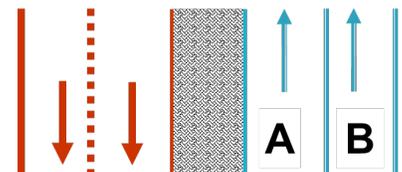
All right, so about 95% common sense!

But what about that last 5%. Could bad things happen with even 5% ambiguity?

**Passing Lane**

On the four lane divided highway pictured here, which is the outside lane, A or B?

- Lane A
- Lane B



Some people will say “B” because that lane is physically to the outside.

However, some people will say “A” because what they learned in Driver’s Training is the “outside lane” is the passing lane and “A” is the passing lane.

Now, if you are a Department of Transportation supervisor and tell your crew to, **“Go to I-94 and cone off the outside lane between mile markers 23 and 24.”**; you better make sure you all agree on what is the outside lane.

### **“Pressure High”**

Working with a fire crew, the “hoseman” (person controlling the business end of the hose) yells back to the person controlling the water pressure (at the hydrant or the pumper), **“PRESSURE HIGH!”**



What should be done to the water pressure?

- Lower the Pressure
- Raise the Pressure

Working with different fire crews we have observed both answers to be true.

- Some people look at this as a “Present State”. Pressure High means the pressure is too high and they want it lowered.
- Some people look at this as an “Action Command”. Pressure High means the pressure is too low and they want more pressure.

Obviously, you can see where this could be a big problem if there is lack of uniformity and consistency in the command.

Population stereotypes, as you have just discovered, indicate that while we do share some common perceptions, we do not all have the same exact same “common sense.” Our view of the world is 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. We need to go beyond ‘common sense’.

### **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.

People who make up the workforce will have different levels of information processing capabilities. We need to work to understand the worker’s perspective in terms of information overload and underload. Design systems need to take into account information human processing capabilities and limitations.

### **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 center of the steering wheel. I know this from personal experience!



### **Effective Work Process Design Principles**

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.

Donald Norman, in *The Design of Everyday Things*, (Basic Books, Inc. New York, 2013) outlines relevant basic principles of design in a practical manner: design for good visibility of the operation, ensure the mapping relationship is clear and provide appropriate feedback to the user regarding the outcome of the action.

### **Design for good visibility**

Design for good visibility. Make it visually apparent what the control on a piece of equipment does. The input should be reflected in a tangible output. The control may be buried deep in a menu selection.



### **Application example:**

For example, many people never fully use the full features of their cell phones or computer software. The controls, by themselves, may not be visually apparent.

### **Apply the principles of mapping**

Make clear the relationship between 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 typically means an increase in whatever.
- An indicator moving from left to right means an increase in whatever.
- Pushing a light switch up to turn on the light. (Is this always true?) How about three way light switches?



### **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**

Provide feedback by returning information to the user regarding the outcome of the user's 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 the correct number in your cell phone?



## **Effective Work Process Design Principles – Synopsis**

Here is a synopsis of the effective works process design conventions and principles.

### ***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 the user regarding outcome

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

Check out the *Ergonomics Design Track* for the *Work Process Design Checklist*.

## Promote Neutral Position and Support

Position and support of the body and limbs in the neutral position is the next ergonomics principle.

### 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 a person sprains an ankle . . . by using a pair of crutches they can still get around.

On the other hand, what if a person “sprains” their back? You 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, good use of the legs and arms is possible.

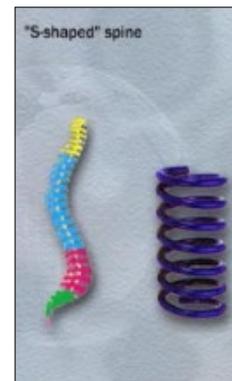


### Spine neutral position

What is the neutral spine position?

Viewed from the side, 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.



### Neutral Spine Posture/Function Demonstration

You can try out a demonstration for yourself to get a sense of the functionality of the neutral position.

### Slumped Position

First, stand up with your arms at your sides. From this standing position let your body slump. Your head will come forward, your shoulders will round, your spine will go from the S-Shape curve to a C-Shape. You will be slumped. So, this is the opposite of the neutral position. And what is the big deal? What is the relationship between function and posture?

### Forward Reach

From this slumped posture reach your hands out in front of you as if you were working at a workbench at some reach from your body. You just got a signal from your body. Was it a good signal or a bad one. You felt more stress into your arms, shoulders and particularly in your back!

### Deep Breath

Still slumped return your hands to your sides. From this slumped position take as deep a breath as you can. What did you find out? It was tough wasn't it. You couldn't get your rib cage to expand to create the negative pressure in your thorax to get a real deep breath. Let me ask you an obvious question and feel free to give me the obvious answer. ***“How important is breathing?”***

Pretty important is the obvious answer. Now, it is true working from a slumped position won't stop you from breathing, but pulmonary studies have shown a 20 to 25% decrease in pulmonary function when comparing slumped to neutral posture.

### Arms Overhead

Ok, one more example. Still in your slumped position, reach your hands as far as you can overhead. You definitely feel the decrease in range of motion of your shoulders. Next, relax your arms to your sides.

### Puppet on a String!

What is the neutral position? Well, from your slumped position reach your hand to the top of your head and imagine you are a puppet on a string and the puppeteer is pulling straight-up from the top of your head. Assume the position as if you were hanging from the very top of your head. This is the **upright neutral position**. Your head is balanced over your shoulders, over your low back, over your hips, knees and ankles.

From this neutral position repeat the three demonstrations.

- Reach your hands forward. You feel less stress, don't you!
- Take a deep breath. You can actually get one now!
- Reach as far as you can overhead. Quite impressive!

### Significant Benefit

You have just shown yourself the significant, functional benefits of promoting the neutral spine position.

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

Neutral position is a big deal in ergonomics!

### Limb joint neutral position

What is neutral for the joints of the arms and hands, the hips, knees and ankles?

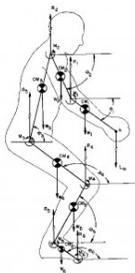
Neutral is the midrange of joint position. For the arms/hands this is with the shoulders relaxed, elbows at the sides flexed to about 90 degrees and the hands positioned with the thumbs pointing up.

Let's establish a more in-depth look at neutral and mid-range of joint position.



### Occupational Biomechanics basis for neutral position

One of the building blocks of Ergonomics is Occupational Biomechanics.



***“Biomechanics is the study of the physical structure of living organisms. As related to workplace ergonomics, the human body is viewed as a system of levers. At the simplest level, by knowing the weight of a held object and the distance from a joint, the load on that joint can easily be calculated.”***

Dan MacLeod  
Ergoweb Learning Center  
<https://ergoweb.com/biomechanics/>

A significant amount of research has been accomplished over the past 30 to 40 years that addresses the loads on the body's joints.

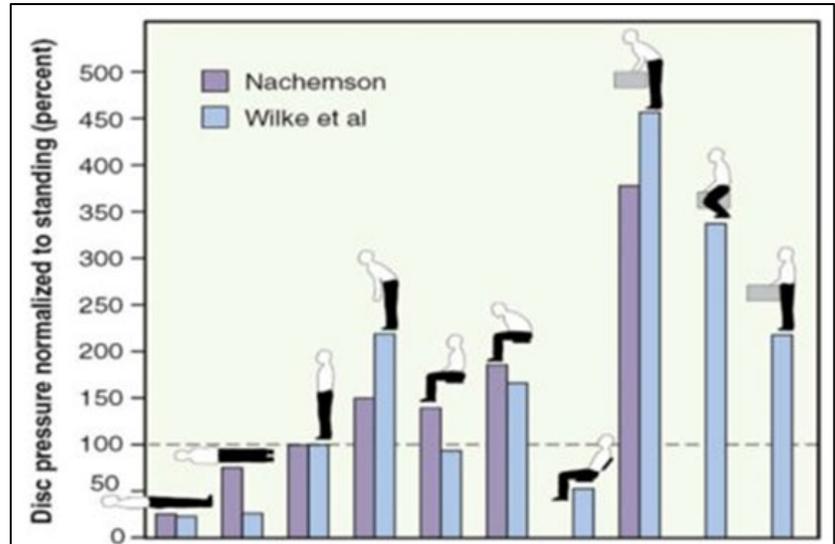
**Spine**

Specific to the spine, the combination of two adjacent vertebra, the intervertebral disc, facet joints and the associated ligaments make up the functional spine unit.

In the 1970's what have become classic research studies in the investigation of postural influences on in vitro lumbar intervertebral disc pressures were conducted by Alf Nachemson, MD, PhD and colleagues. Results revealed increased discal pressures in out-of-neutral spine configurations.

With in-vitro lumbar intervertebral disc pressures normalized to 100% when in a neutral upright standing position, pressures in various postures were measured.

For example, a straight-leg/back-bent posture of 30° forward bend resulted in about 225% increase, seated slumped posture to about a 200% increase and lifting about a 30 lbs box from a 30° flexed forward posture of the low back position of almost a 500% increase!



*Disc Pressure Measurements*  
Nachemson, AL  
*Spine*, 31 Dec 1980, 6(1):93-97

*New In Vivo Measurements of Pressures in the Intervertebral Disc in Daily Life*  
Hans-Joachim Wilke, PhD,\* Peter Neef, MD,† Marco Caimi, MD,‡  
Thomas Hoogland, MD,§ and Lutz E. Claes, PhD\*  
*Spine*, Volume 24, Number 8, pp 755-762  
©1999, Lippincott Williams & Wilkins, Inc.

**Limbs**

We have defined neutral position for the shoulders, arms, wrists and hands and the hips, knees and ankles as the midrange of joint position. From a functional perspective consider the elbow joint in terms of flexion and extension.



**Question** – At what angle of flexion is the elbow most functional? In other words, able to generate the greatest muscular force?

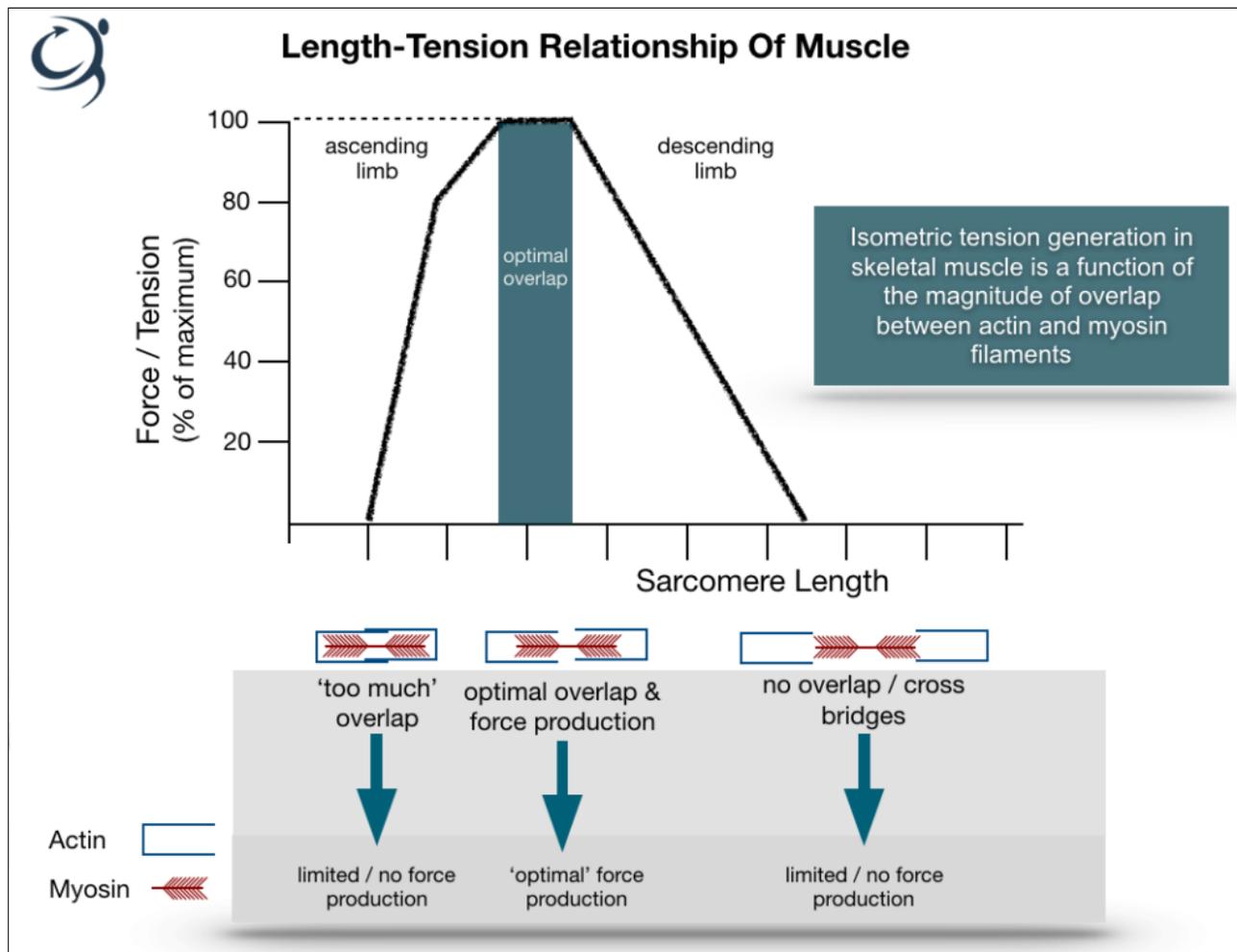
**Answer** – Fully flexed or fully extended?

Based on strength testing, the answer is about at about 90 degrees of flexion.

A fundamental functional property of skeletal muscle is the **length tension relationship** defined as the relationship between muscle length and the force the muscle can produce at that length.

A bit into the weeds here. From a physiological perspective it has to do with the overlap of the contractile proteins (actin and myosin). As a joint is flexed or extended through its range, the overlap of the actin and myosin contractile proteins changes.

This affects the potential for the development of cross-bridges and muscle force production. At about resting length (mid-range of joint position) the highest muscle force production is observed.



<https://getbacktosport.com/latest-news/strength-and-conditioning-for-rehabilitation/>

### 15 % Neutral Position Club

Realistically speaking can a person really position themselves 100% of the time in neutral positions? Of course, the answer is **NO!**

But how about 15% more time? 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 membership in 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?

Answer. Studies have shown about 20 to 30 minutes!

### 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.

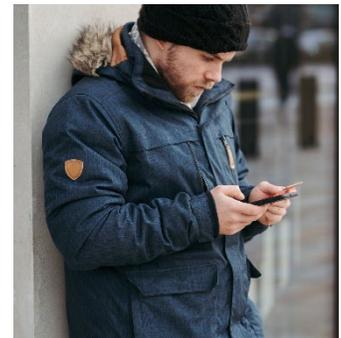
Joint compression occurs, actually decreasing the amount of joint space and not allowing adequate joint lubrication. Fluid tends to pool in the lower extremities.

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? They look for something to lean against.

### Bottom Line

The *Neutral Position and Support Ergonomics Principle* is a very large part of the ergonomics analysis and intervention process. We build on this paramount principle in the other **ERGONOMICS ON-DEMAND!** Tracks.



## Promote Dynamic Physical Movement

Promotion of *Dynamic Physical Movement* in the workplace on an on-going basis is the next ergonomics principle.

### 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 30 lbs. 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. I have never had a single person say, *“I would love to just stand around for 20 minutes with a 30 lb. pack!”*

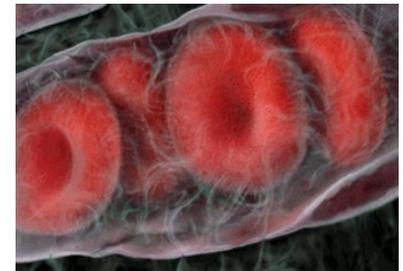
We intuitively know that movement is superior to maintaining one position. In other words, we need to move to be comfortable.

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 and is an important component of Work Physiology.

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

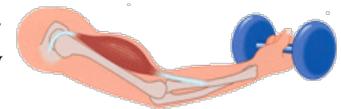
Type of muscular effort has been shown to have a profound impact on blood flow.

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 isometric contraction (MVIC) 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.

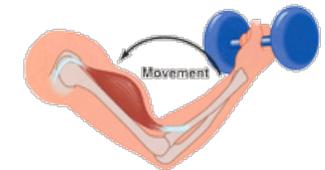


### Dynamic Muscle Contraction

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**

A summary of metabolic and work physiology principles includes.

**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 workstations

In the other *ERGONOMICS ON-DEMAND!* Tracks we will get into the details of how the set-up and use of workstations, tools and equipment whether in the office or manufacturing work environments are influenced by work physiology.

## Control Manual Material Handling

### How Much Can a Person Lift?

The next ergonomics principle asks the question,

***“How much can a person safely and effectively lift?”***

Why is this of concern? Lifting objects or manually handling materials has been shown to put workers at risk for back injuries. More than 111,000 such injuries requiring days away from work were recorded in 2019, according to Injury Facts, an online database created by the National Safety Council.

<https://injuryfacts.nsc.org/work/work-overview/top-work-related-injury-causes/>

What are the factors involving manual handling that need to be considered? What can be done to control manual material handling?

These questions have been studied extensively over the past 40 to 50 years in the scientific and ergonomics community.

### Occupational Biomechanics

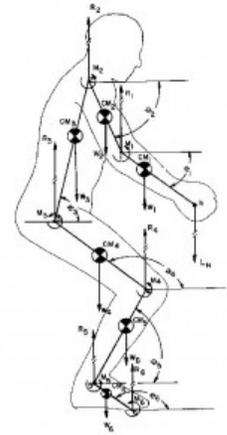
As one of the foundations of ergonomics, Occupational Biomechanics can help us answer some of these questions about safe and effective lifting.

***“Biomechanics is the study of the physical structure of living organisms. As related to workplace ergonomics, the human body is viewed as a system of levers. At the simplest level, by knowing the weight of a held object and the distance from a joint, the load on that joint can easily be calculated.”***

Dan MacLeod

Ergoweb Learning Center

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### All about lever arms

A simple example of lever arms in action is to compare the load on the body when holding a 10 lb. load at arm's length versus held as close as possible to the body.

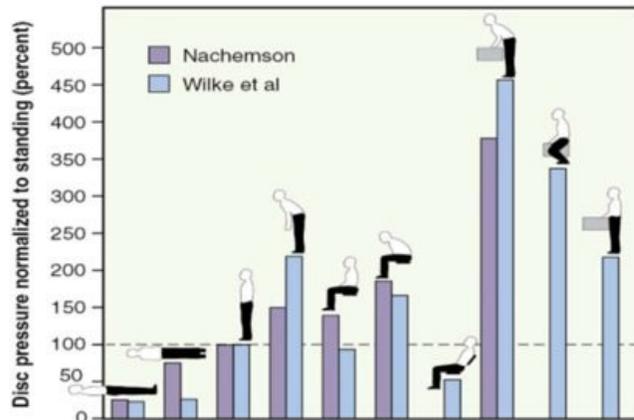
Everyone has done something like this and immediately recognizes you want to hold the load as close as possible to you to lessen the load! We intuitively know the goal is to reduce the lever arm length to reduce the stress into the body.



### Intervertebral disc pressures

In the 1970's, what have become classic research studies in the investigation of postural influences on in vitro lumbar intervertebral disc pressures were conducted by Alf Nachemson, MD, PhD and colleagues. Results revealed increased discal pressures based on lever arm lengths in the spinal column.

With in-vitro lumbar intervertebral disc pressures normalized to 100% when in a neutral upright standing position, discal pressures with lifting about a 30 lb. box from a 30° flexed forward posture of the low back position were almost 500%! Holding the same box in an upright posture as close to the body as possible resulted in about half that of about 225%. Decreasing the lever arm distance makes a huge difference.



*Disc Pressure Measurements*

*Nachemson, AL*

*Spine, 31 Dec 1980, 6(1):93-97*

*New In Vivo Measurements of Pressures in the Intervertebral Disc in Daily Life*

*Hans-Joachim Wilke, PhD,\* Peter Neef, MD,† Marco Caimi, MD,‡ Thomas Hoogland, MD,§ and Lutz E. Claes, PhD\**

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**Increase lever arm length**

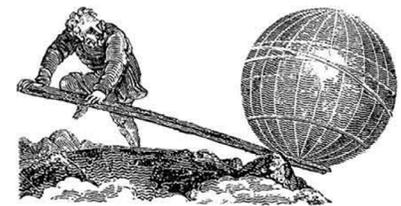
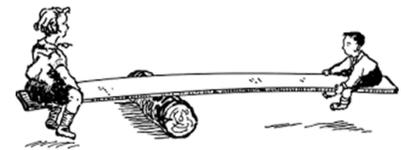
In ergonomics sometimes we want the opposite, we want to increase the lever arm length. We want to use leverage to our advantage.

This is how the small kid on the teeter totter can ‘outweigh’, so to speak, the larger kid on the playground.

Famously, Archimedes said,

*“Give me a lever long enough and a fulcrum on which to place it, and I shall move the world.”*

We’ll discuss application details in the *Ergonomics Manufacturing Track*. For now, let’s focus on manual material handling.



**Lifting Factors and Lifting Calculators**

If we were going to come up with a mathematical formula to predict how much a person can safely lift what factors would need to go into our equation?

Well not surprisingly, lifting formulas have been in existence for several decades. NIOSH (National Institute for Occupational Safety and Health) first published the *NIOSH Work Practices Guide for Manual Lifting* in 1981.

Check out the *Guide* at: <https://www.cdc.gov/niosh/docs/2007-131/default.html>.

The States of Washington and Oregon Departments of Labor and Industries developed a simplified version of the NIOSH Work Practices Guide for Manual Lifting.

We’ll get into the details of lifting calculators with application examples in the *Ergonomics Manual Material Handling Track*. Also take a look at the *Manual Material Handling Checklist* as needed for the general ergonomics analysis process in the *Ergonomics Design Guidelines Track*.

## Promote Work in Reach Zone

### Hand Use

Here is a question for you. *“How much do we use our 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 99.9% of the day!

All right then, 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.

Based on hand use, our next ergonomics principle is to *Promote Work in the Reach Zone*. From an ergonomics perspective we can define two reach zones:

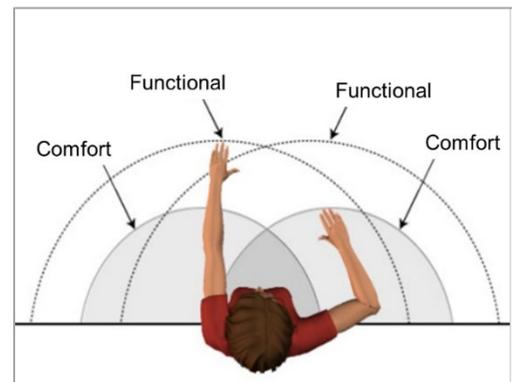
- Comfort Reach Zone
- Functional Reach Zone

### Comfort Reach Zone

Think of the comfort reach zone as that area in front and to the side where we'd like to use our hands when we're doing precise hand activity. 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 a minimal downward force is exerted.



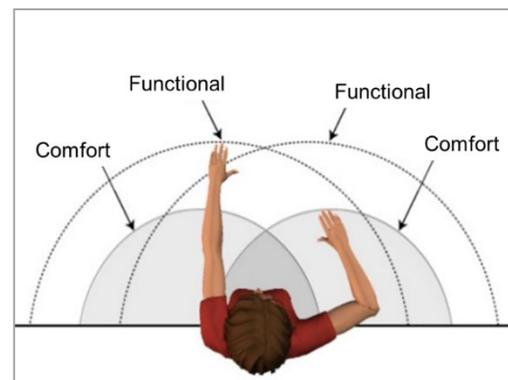
### Functional Reach Zone

Think of the Functional Reach Zone as that area in front and to the side where we'll be able to comfortably reach to obtain parts and materials.

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.



## 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 in injury to the user.

### What does Correct Mean?

In overview, a good way to assess if you have the correct workbench, tools and equipment is to apply the ergonomics principles. Can the job be performed:

- In neutral positions?
- With appropriate body and limb support?
- Within acceptable reach zones?
- While controlling manual handling?
- With adequate training?
- In a controlled environment?

If the answer to these questions is primarily **YES**, then more than likely it is correct.

If the answer is **NO**, then we need to understand why not and make appropriate changes.

Specific information about assessing and providing the correct workstations, tools and equipment is detailed in the *Manufacturing Ergonomics and Office Ergonomics Tracks*.



## Provide Competency Based Training

Providing competency based 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"!

### **Does practice make perfect?**

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

Vince Lombardi, the famous Green Bay Packers football coach said it well.

*Practice does not make perfect.*

*Only perfect practice makes perfect.*

He understood the need to practice correctly. If you don't, you will get really good at doing it incorrectly! That's why we stress **competency based training** approaches.

Ergonomics is all about learning new skills; we encourage 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 including light, noise, temperature and ventilation is the next ergonomics 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.

In ergonomics we are involved in how the work environment influences performance. Depending on your background and experience you may be well versed in analyzing work environment factors and offering recommendations. If not, make sure you tap into the expertise of other professionals as needed. Here are some basic concepts.



### **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**

Air temperature, quality, flow and humidity are important to consider.

#### **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?

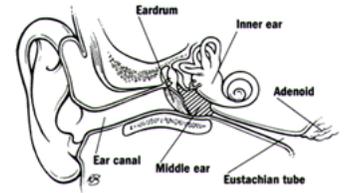
## Humidity

- 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 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?

Refer to the *Environment Checklist* in the *Ergonomics Design Guidelines Track* for more information.

## Promote Health and Wellness!

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

Here is a question for all of us.

***“What is the most important tool we all own?”***

Of course, the answer is.

***“The most important tool we all have is ourselves; our minds and our bodies; in other words, our physical and mental health.”***

As health and safety professionals we have valuable information and can play an important role in promoting health and wellness in the workplace.

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

Our 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



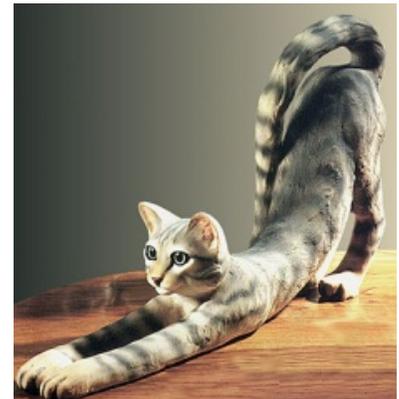
### ***Movement to control fatigue***

We recognize 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? They stretch!

We also have an instinctive need to move . . . we just need to pay attention to it. Promote movement in the workplace!

Health and wellness is an important ergonomics principle and fits well within our purview as health care and safety professionals.



## Provide On-going Feedback and Follow-up

### **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 IS A POTENT TOOL!***

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I have found ergonomics to be a potent tool! When the principles of ergonomics are applied the outcome is demonstrated improvements in quality, productivity, health and safety!

I hope the information has been helpful to you and sets the stage for the other tracks in ***ERGONOMICS ON-DEMAND!***

Thanks for your time and attention!

## ***ERGONOMICS ON-DEMAND! FOR HEALTH CARE AND SAFETY PROFESSIONALS***

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Focusing on office and manufacturing work environments, ***ERGONOMICS ON-DEMAND!*** provides a modular self-directed framework to assist you in integrating practical ergonomics applications into your practice.

Whether you are a Physical Therapist, Occupational Therapist, Certified Occupational Health Nurse, Physician, Kinesiologist other health care professional, Certified Safety Professional, Certified Industrial Hygienist or other safety professional, in ***ERGONOMICS ON-DEMAND!*** you will explore an ergonomics analysis process based on a fundamental knowledge of ergonomics principles and applications.

Through interactive self-directed lectures, a practical “Toolbox” full of information and an emphasis on short experiential case studies, ***ERGONOMICS ON-DEMAND!*** presents a systematic approach to ergonomics analysis.

### **Modular Format**

Modular in format, the course provides a series of **Ten Training Tracks** to allow you to customize your learning experience.

You can tailor and self-direct your learning experience.

## Introduction to Ergonomics Track

Depending on your background and ergonomics experience, you can start with the *Introduction to Ergonomics Track*, or you can jump to the other specific tracks.

In the *Introduction to Ergonomics Track*, we'll examine the definition of ergonomics within a *Systems Design* approach. We'll introduce ten *Ergonomics Principles*:

1. **Process** – promote effective work processes
2. **Position/support** – promote neutral body and limb position/support
3. **Movement** – promote regular physical movement
4. **Material handling** – control manual material handling
5. **Reach** – promote work in reach zone
6. **Workstation/tools/equipment** – provide correct workstation, tools and equipment
7. **Training** – provide competency based training
8. **Environment** – control exposure to work environment
9. **Health/wellness** – promote personal health and wellness
10. **Feedback** – provide on-going feedback for continuous improvement

We also integrate the foundations of ergonomics to provide the rationale for the ergonomics principles. Ergonomics foundations we cover include:

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

The *Ergonomics Foundations and Principles* content provides a solid background to perform ergonomics assessments in a wide variety of work environments.

## Work Office Ergonomics Track

If Office Ergonomics is your specific interest, the *Work Office Ergonomics Track* will take you through *General Office Ergonomics Guidelines* and provide hands-on case studies in performing office ergonomics analyses in the work office.

We go through a step-by-step office ergonomics assessment process including data collection, picture taking and report generation.

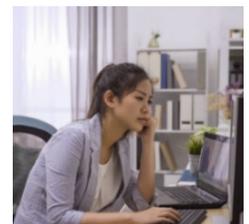
We also include a section importantly how to conduct virtual office ergonomics tele-assessments.



## Ergonomics Beyond the Traditional Office Track

With the recent increase in tele-commuting, the need for individuals to set-up a productive and safe home office is large and expected to continue to grow. Companies are appreciating that employees working at home can be very successful and some employees may never return to working full time in the work office.

In the *Ergonomics Beyond the Traditional Office Track*, we look at setting up a home office and mobile office wherever they may be. We continue to go 'beyond' by introducing *Universal Design (UD) Principles* to you to see how they improve use and access in both work and non-work environments. A few examples include curb cutouts and lever door handles.



## Manufacturing Ergonomics Track

If manufacturing ergonomics better suits your need, the *Manufacturing Ergonomics Track* provides *General Manufacturing Ergonomics Guidelines*.

You will be introduced to the *Ergonomics Risk Screen*, an easy-to-use assessment tool to objectively estimate ergonomics risk factors and generate potential interventions. In the *Ergonomics Risk Screen Track* we go through a detailed tutorial on using the ERS.



We use a variety of Case Studies throughout the Tracks to provide you practice in using the ergonomics principles and applications.

Oil Fill	Label Maker	Solder Station	Speaker Handling
			
Manhole Cover	Slag Removal	Work Positioner	CNC Reservoir
			

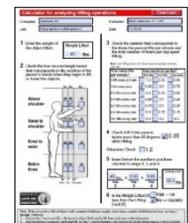
## Ergonomics Risk Screen Track

In the *Manufacturing Ergonomics Track* we introduced to the *Ergonomics Risk Screen (ERS)*, an easy-to-use assessment tool to objectively estimate ergonomics risk factors and generate potential interventions.

In the *Ergonomics Risk Screen Track* we go through a step-by-step detailed tutorial on using the ERS.

## Manual Material Handling Track

If Manual Material Handling is what you want to focus on, the *Manual Material Handling Track* references specific material handling guidelines and takes you through the easy-to-use LNI Lifting Calculator developed by the Washington State Department of Labor and Industries and Oregon OSHA based on the NIOSH Work Practices Guide for Manual Lifting.



## Ergonomics Anthropometry Track

How can we determine how far a person can reach or how high a workbench should be? 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. This is appropriate when the outcome is specific to a particular individual.

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.



In the *Ergonomics Anthropometry Track* we cover how to use anthropometric data bases as part of the foundation for ergonomics design.

### Ergonomics Design Guideline Track

The *Ergonomics Design Guideline Track* complements both the Office and Manufacturing Tracks by pulling together a series of *Ergonomics Design Specifications and Worksheets* to assist in making specific recommendations.

### Ergonomics Problem Solving Track

Ergonomics is all about problem solving! The *Ergonomics Problem Solving Track* details specific caveats to understand and make use of when applying ergonomics principles.

In the *Introduction to Ergonomics Track* we made the case that, “*Ergonomics is about changing the circumstances to change the result!*” Change being the operative word. We all know how difficult change can be for many! I’ll offer thoughts about facilitating change.

### Ergonomics Teams and Programs Track

Ergonomics, in my experience, is best realized as a collaborative process. As you work with ergonomics as part of your practice, you very likely will become part of the ergonomics team that includes the management team, the workforce, engineering, medical and facilities groups and other stakeholders. In the *Ergonomics Teams and Programs Track* we’ll cover working with teams and ergonomics programs.

### Bottom Line

Bottom line, *ERGONOMICS ON-DEMAND!* allows you to explore a wide variety of ergonomics related concepts and applications at your own pace while picking and choosing what you want to learn!

### Course Developer and Presenter

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

Mark Anderson, MA, PT, CPE is the president and founder of Minneapolis, Minnesota based, ErgoSystems Consulting, LLC. Anderson started working clinically as a Physical Therapist in Industrial Rehabilitation in the mid 1980’s; this led to his interest in ergonomics.

Since 1993, he has been certified by the Board of Certification in Professional Ergonomics as a Certified Professional Ergonomist ([www.bcpe.com](http://www.bcpe.com)).

Anderson is a graduate of the University of North Dakota Physical Therapy program and holds a Master of Arts degree in Physical Therapy from the University of Iowa. He has consulted in ergonomics for over 30 years.

Anderson has worked with WorkWell since 2005 developing the current Office and Manufacturing Ergonomics training courses. An experienced consultant and instructor, he has developed and implemented ergonomics consultation and training strategies for a wide range of companies, organizations and local, state and federal government agencies. (Including Emerson Process Management, Tescom, Tennant Company, General Electric, Alliant Techsystems, Boston Scientific Corporation, Quaker Oats, Pepsi-Cola, General Mills, Medtronic, Fingerhut, Panama Canal Commission, United States Navy and Marine Corps, United States Customs Service, Social Security Administration, USDA Animal and Plant Health Inspection Service and state and local governments.)



Anderson 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 past secretary and co-program chair.

## **Program Delivery**

### ***Logistics***

Materials, tests (if applicable) and course evaluations for online sessions are contained in the WorkWell Provider Learning Center. Materials are downloadable from the Learning Center portal, as part of the course content. Some materials are available in the File Repository Area of the course and others are downloadable files included as learning objects within the course itself.

## **Training Logistics**

### ***Disclosure***

WorkWell has some degree of financial and non-financial relationships with providers through our business model. WorkWell focuses sales of services on predominantly national companies and not on local corporations, contracting with provider groups instead of operating a brick and mortar operation business model.

While contracting with providers and facilities that employ clinicians trained by WorkWell allows WorkWell to have a basic understanding of quality of site service provision, there is no exclusivity requirement against sites participating in training from other vendors, nor any requirement to accept work on individual contract/s.

WorkWell also does contract with providers who have not been formally trained by WorkWell to meet basic service provision such as performance of standardized post offer testing, provided the testing protocol is strictly defined and the providers have skills, training or experience to complete the limited work scope (with a manual and training for consistency of performance).

WorkWell has a commercial interest in both delivering educational programs (to various healthcare and safety oriented individuals) and delivering prevention and work disability rehabilitation/management programs (generally to employers).

Clinics who foster local employer contracts and seek to expand the footprint of those contracts may negotiate with WorkWell to help leverage resources and/or partner to expand, grow and execute regional or national contracts.

There is not an implied or specific promise of additional contracting or business opportunities related to participant attending educational programs.

WorkWell offers FCE and work analysis equipment for sale to providers which meet designated safety standards/consultant measurement needs. Providers have the option to seek appropriate equipment described in the equipment list/s from any vendor.

### ***Non Discrimination***

WorkWell is committed to accessibility and non-discrimination in professional development activities.

WorkWell complies with laws and rules regarding discrimination relevant to learning activities and does not discriminate on the basis of race, color, national origin, religious affiliation, sex, gender, disability, military status, sexual orientation or age.

Participants who have special needs are encouraged to contact WorkWell so that reasonable efforts to accommodate these needs can be made.

### **Participation Attendance Policy**

Participation in the entire session is Mandatory. Registrants who arrive late or miss portions of the workshop will NOT be eligible for certificate or refund. WorkWell wants to ensure a suitable learning environment and conditions free from distraction to optimize participation. Faculty complete an attendance log at program initiation and completion.

### **Certificates of Completion**

Certificates of completion will only be provided to individuals who meet the course requirements and complete all training modules. Individuals who do not complete the training modules will not be eligible for certificates of completion.

### **Course Evaluation**

Each participant must complete the course evaluation in the WorkWell Provider Learning Center prior to receiving a certificate of completion.

### **Copyright**

Reminder - As part of your registration and accessing the course materials, you agreed “to adhere to the WWPC copyright policy which can be viewed at <http://www.workwell.com/general-course-information/>.

### **Record Retention**

Course records are kept in a secure, electronic location. Individual participant information and forms may only be disclosed to the participant or WorkWell personnel in the course of their duties. Information may be released to other designated individuals or entities with a written request submitted via mail or fax by the participant which includes the name and date of the relevant training, contact information of the participant, contact information for the intended recipient, and signature of the participant.

Participant may contact WorkWell via email ([michelle.anderson@workwellpc.com](mailto:michelle.anderson@workwellpc.com)), by mail (306 W. Michigan St. Suite 301, Duluth MN 55802), by fax (320-323-4495) or by phone (866-997-9675) to request records.

### **For Clinical Support, Questions and Inquiries**

P: (866) 997-9675

F: (320) 323-4423

E: [provider@workwellpc.com](mailto:provider@workwellpc.com)  
[www.workwell.com](http://www.workwell.com)

### **Complaints**

Complaints regarding any part of program sales, registration and course delivery should be directed toward WorkWell. All attempts will be made to resolve complaints in a timely and professional manner. Complaints will be forwarded to Dee Daley (Director of Clinical Practice) and Kristen Cederlind (Director, Clinical Services). Complaints may be submitted via the following methods:

Email: [dee.daley@workwellpc.com](mailto:dee.daley@workwellpc.com) or [kristen.cederlind@workwellpc.com](mailto:kristen.cederlind@workwellpc.com)

Phone: Toll Free 1-866-997-9675

Mail: 306 W. Michigan St. Suite 301, Duluth, MN 55802

## APPENDICES

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## State Publications

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## Journals (Selected)

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*Ergonomics*, Taylor and Francis.

*Human Factors*, Human Factors and Ergonomics Society.

(Reference [www.ergoweb.com](http://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

Board of Certification in Professional Ergonomics

2950 Newmarket Street

Ste 101 PMB 244

Bellingham WA 98226

Phone: 888.856.4685

Fax: 866.266.8003

E-Mail: [bcpehq@bcpe.org](mailto:bcpehq@bcpe.org)

Human Factors and Ergonomics Society

PO Box 1369

Santa Monica, CA 90406-1369

(310) 394-1811

International Ergonomics Association

Secretary General IEA

Pieter Rookmaaker

SEARBO/Ergonomics  
PO Box 2286  
3500 GG Utrecht  
The Netherlands  
+31 30 2399455  
National Safety Council  
444 North Michigan Avenue  
Chicago, IL 60611  
(800) 621-7619

## Glossary

**Anthropometry:** The measurement of the dimensions, and certain other physical characteristics such as weight and centers of gravity, of the human body as a whole or of its segments.

**Clearance dimensions:** The dimensions of a workspace required to provide appropriate space for body members to maneuver without interference from surrounding structures or equipment.

**Contact point or Pressure point:** A body site at which an item of workplace equipment or a tool exerts pressure on the tissues. Soft tissue sites are of most concern to ergonomics since the compression of the tissue can occlude blood vessels, irritate nerves and tendons, or damage the muscle tissue itself.

**Dynamic work:** Work activities involving movement and thus requiring the muscles to both contract and relax during the activity.

**Elbow height:** The anthropometric dimension referring to the height of the elbow above the floor when the arm is hanging relaxed at the side of the standing individual.

**Elbow rest height:** The anthropometric dimension referring to the elbow above the seat surface when the upper arm is hanging relaxed and the elbow is bent so that the forearm is parallel with the floor.

**Ergonomics:** The scientific study of the relationship between humans and their working environment.

**Extended reach radius:** The area that can be reached by extending the arm from the shoulder.

**Fixed work posture:** A work posture that does not permit the operator to freely change position so as to relieve postural stress. Fixed postures tend to statically load muscle groups since movement of the body segments and/or trunk is inhibited.

**Foot-candle:** A unit measure of illumination striking a surface. One foot-candle is equivalent to one lumen per square foot.

**Functional reach or “dynamic” reach:** An anthropometric dimension representing the arm reach capability when the body is allowed to bend and/or rotate at the shoulder and hips so as to extend the reach beyond that obtainable when the body is in a static or fixed posture.

**Normal reach radius:** The area that can be conveniently reached with a sweep of the forearm, with the upper arm hanging in a natural position vertically at the side. All materials, tools, controls, and containers should be arranged within the normal reach radius whenever possible.

**Normal work area:** The area in front of the worker which can be used for work with a normal expenditure of effort.

**Power grasp/grip:** A grasp in which the hand wraps around the handle being grasped. In the power grasp the thumb aligns the hand with the long axis of the forearm and the wrist assumes a slight ulnar deviation. The power grip provides more than five times the gripping strength of a precision grip.

**Precision grasp/grip:** A grasp in which the object is held by the force of the thumb vs. the first (or first and second) finger(s). It provides precise aim but has limited strength.

**Reach envelope:** The surface in space centered on the left/right midline plane of the body representing the reach capability of the population percentile of interest. The envelope may be described as a functional reach envelope.

**Viewing angle:** The angle, either vertical or horizontal, at which the worker views the task measured from the center line of the horizontal line of sight when the operator is looking straight ahead.