WorkWell Prevention and Care and ErgoSystems Present:

Manufacturing Ergonomics: Introduction for Health Care Professionals (Online)

Course developed by:
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Course Developer

Mark A. Anderson, MA, PT, CPE

Mark Anderson, MA, PT, CPE is the president and founder of Minneapolis, Minnesota based ErgoSystems Consulting Group, Inc. Anderson started working clinically in the Industrial Rehabilitation arena 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).

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.

Course Overview

Introduction to Manufacturing Ergonomics for Health Care Professionals is an online course designed to assist you and your team in integrating practical ergonomics into your practice. The program is appropriate for health providers wanting to learn the basics of ergonomics analysis where real results are important and the gap between medical and workplace philosophies can be bridged.

The program includes information on problem solving for injury prevention, for facilitating return to work planning for individuals following injury and improving communication with other stakeholder groups.

The ergonomics analysis process is based on a fundamental knowledge of ergonomics principles and applications. Through interactive lecture, a practical "Tool Box" and an emphasis on case studies, the course presents a systematic approach to ergonomics analysis. The 6 hours of education (5 hours of instruction delivered in 2 sessions and completion of self-paced short assignments following sessions) will include: a comprehensive manual, download materials discussed in training, and video clips of ergonomic projects taped before and after improvements. Participants will be expected to complete short experiential exercises using the "Tool Box" following each session.

Intended Audience

Licensed health professionals - Physical Therapist, Occupational Therapist, Physical Therapist Assistant, Occupational Therapist Assistant, Athletic Trainer, Physician, Physician Assistant, Chiropractor, Occupational Health Nurse. Certified/Registered Kinesiologist, Exercise Physiologist or Case Manager. Consideration of other health/safety personnel is based on space and background.

Program Delivery

Logistics

- Download link for materials in registration email and from Dashboard
- Overview of online delivery method and dashboard
- Attendance log
- Course schedule
- Break/s
- Telephones and use of mute

Schedule

Session 1 – 3.0 hours			
Content Areas	**Tools and Templates**	**Class Observation and Exercises**	**Professional Development**
Manufacturing (P 1 – 67 in Manual) • Ergonomics Risk Screen – Introduction • Ergonomics Defined • Ergonomics Principles • Systems Design • Posture • Work Process • Neutral Position • Materials Handling • Reach Zone • Anthropometry	• Ergonomics Risk Screen • Relative Risk Level • Discomfort Survey • Checklists- ✓ Manual Material ✓ Work Process • NIOSH Lifting Guide • LNI Lifting calculator • Anthropometry Data Base	• Oil Fill Case Study • Systems Design (mind reading) • Anthropometry Case Study • Speaker Handling Case Study	**Assignment** • Review Assignment Worksheets ✓ Session Test Questions ✓ LNI lift calculator for start/end height calculations and complete 2 problems ✓ Anthropometry Case Study (Workbench)
Session 2 – 3.0 hours			
Content Areas	**Tools and Templates**	**Class Observation and Exercises**	**Professional Development**
Manufacturing (P 68 – 112 in Manual) • Workstation • Tools • Equipment • Training • Work Environment • Health/Wellness • On-going Feedback • Problem Solving Principles • Behavior Change • ERS Tutorial • Tool Box	• Checklist ✓ Equipment ✓ Workstation ✓ Tools ✓ Environment • Tool Box • Ergonomics Risk Screen	• Solder Station Case Study • Slag Removal Case Study • Label Maker Case Study • Manhole Cover Case Study • Work Positioner Case Study • Why do people resist change? • How to accomplish change!	• Feedback on Session One Homework – 2 way • Common areas of clarification based on assignment • ERS Tutorial in detail • Review Assignment ✓ Session Test Questions ✓ CNC - score with risk tools using form introduced in class

(10 min. break approx. mid-way through class for both sessions - at faculty discretion)

Learning Objectives

At the end of the training, participants will be able to:

1. Analyze material handling ergonomics risk factors in 2 work tasks, quantifying risk using the LNI calculator for lift analysis consistent with homework completion criteria.
2. Analyze ergonomic risks in 2 manufacturing video cases, identifying at least 3 risk factors (such as specific posture, force, repetition, duration risks) that are relevant to each task.
3. Independently recommend a practical ergonomics solution that reduces a musculoskeletal risk in two different manufacturing scenarios.
4. Identify two strategies that facilitate positive change in ergonomics initiatives based on common barriers influencing stakeholder behavior.

Faculty

Kristen Cederlind, OTR/L

Kristen Cederlind, OTR/L joined the WorkWell team in 2013, first serving as a Manager of On-Site Services and more recently, assuming the role of Director of the WorkWell Quality Provider Network.

With over 25 years of experience as an Occupational Therapist, she has consulted with manufacturing employers across the country to develop customized On-Site therapy and wellness programs to improve employee health and safety, while collaborating with the rest of the On-Site team in service implementation, provider training, customer and provider relations and metrics reporting.

Her background includes program development and management of a hospital acute care and outpatient rehabilitation department. Her partnership with WorkWell began in 2003, when the hospital joined the WQP network and received training in FCE, FJA and PWS programs.

While working in the hospital setting, she championed ergonomics initiatives such as safe patient handling and office ergonomics and was able to utilize job analysis and prework screening skills both within the hospital and in her local community.

Kristen is a graduate of the University of Southern California and is a member of both the California and American Occupational Therapy Associations.

Deirdre “Dee” Daley, PT, DPT

Dee Daley, PT, DPT is a graduate of the University of North Carolina- Chapel Hill and Quinnipiac College physical therapy programs. Dee is currently employed by WorkWell in New Ipswich, NH as Director of Clinical Practice. Dee has been a member of the WorkWell faculty since 2003, and intermittently teaches as a guest lecturer for PT and PTA schools on topics related to Work Injury Prevention and Management. Dee also holds a degree in Health Professions Education from North Carolina State University.

In addition to clinical practice, Dee has been active in the New Hampshire and North Carolina Chapters of the American Physical Therapy Association (APTA) as President and other roles in the area of Education and Policy. In addition to helping develop training materials for WorkWell, she has coauthored several publications on the Role of PT in Occupational Health and Wellness, and Safety in Functional testing. She has also served as a member of the APTA as a working member of the Occupational Health Special Interest Group and Work Rehab Clinical Practice Guideline group.

Robin Peterson, PT

Robin Peterson PT is a graduate of the University of Minnesota Physical Therapy Program. Robin is currently employed by Regions Hospital in St. Paul MN as Physical Therapist and Supervisor. Robin has been a faculty member and consultant for WorkWell since 2008. Robin also holds a Bachelor of Arts degree in Distributive Sciences and Psychology from Gustavus Adolphus College in St. Peter MN.

In addition to clinical practice and consulting, Robin Peterson has been an active member in the MN chapter of the APTA since 1987 and has served as the physical therapy alternate member for the MN Medical Services Review Board with the Department of Labor and Industry since 2002. Robin Peterson is also a member of the National Association of Occupational Health Providers and Human Factor Society. She co-authored Smart Tracks patient management system, Volumes I and II.

Marc Yeager, PT, MPT

Marc Yeager, MPT, is a graduate of Loma Linda University, where he received a bachelor’s degree in Life Sciences and a Master of Physical Therapy degree in June 1993. Marc is the Managing Principal of Injury Prevention & Management Consulting.

Marc has been a member of the American Physical Therapy Association since 1994 and the Georgia Physical Therapy Association since 1997. He has been a faculty member for WorkWell Systems since 2006. He achieved the distinction of WorkWell Master Clinician in 2001 with certifications in Functional Capacity Evaluations, Functional Job Analysis, Return to Work Clinical Pathways, Functional and Office Ergonomics.

Marc founded Highland Park Physical Therapy in 2001, shortly before joining WorkWell Systems as an Occupational Health Specialist developing injury prevention and management programs, including Rapid Return to Work, Stress Factor Analysis, and supportive training materials, in addition to implementing internet-based injury prevention and management programs for industrial clients.

Marc has assisted in the development and implementation of on-site ergonomic programs for a Silicon Valley-based high-tech Fortune 100 Company and served as a member on their ergonomic safety committee as an external consultant. Early into his profession, Marc’s clinical experience included providing on-site physical therapy services for several companies in the Silicon Valley area of California. He has utilized that experience to help incorporate functionality into his client’s rehabilitation program and provides practical insight during the return-to-work decision process

All faculty are paid by WorkWell and have non-financial relationships with WorkWell. Non-financial relationships include a preference for WorkWell evaluation, prevention and work rehabilitation programs.

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 training 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.

Attendance Sheets

Participants should sign in and sign out using the WorkWell Attendance log (additional site attendance logs may also be required). Log in signatures will be completed prior to the first break and sign out will be completed following the final break to document attendance.

Certificates of Completion

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

Course Evaluation

A course evaluation must be completed by each participant, prior to issuing a certificate of completion or certificate of attendance. Course evaluations will be distributed electronically (or mailed in cases where the participant does not have an email).

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), by mail (11 E. Superior St. Suite 410, Duluth MN 55802), by fax (320-323-4495) or by phone (866-997-9675) to request records.

Important Contact Information

Clinical Help	Internet Tool Help	Referral Help
P: (866) 997-9675	P: (800) 535-6760	P: (866) 997-9675
F: (320) 323-4423	F: (320) 323-4393	F: (320) 323-4423
E: clinicalhelp@workwell.com	E: customercare@workwell.com	E: referralcenter@workwell.com

Other Questions and Inquiries

11 E. Superior St. Suite 410
Duluth, MN 55802
P: (866) 997-9675
F: (320) 323-4423
E: network@workwell.com
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, WQP Network). Complaints may be submitted via the following methods:

Email: dee.daley@workwellpc.com or kristen.cederlind@workwellpc.com

Phone: Toll Free 1-866-997-9675

Mail: 11 E. Superior St. Suite 410, Duluth, MN 55802

WELCOME

Introduction

Welcome to **Manufacturing Ergonomics: Introduction for Healthcare Professionals.**

Offering a framework to help Physical Therapists, Occupational Therapists, Occupational Health Nurses, Physicians and other health care professionals perform ergonomics analyses and generate reasonable and feasible recommendations, the course focuses specifically on manufacturing work environments.

Let's begin by learning more about you.

Poll – Practice Setting

Poll – Assessment Experience

Poll – Ergonomics Consultation

Health Care Professionals Advantages

QUESTION:

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

ANSWER:

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

- ❑ **Focusing a patient's treatment plan** through an ergonomics analysis of a patient's work and/or home demands.
- ❑ **Identifying potential job modifications** to assist a patient in the return to work (or other activity) process.
- ❑ **Preventing potential injuries** to employees and others through proactive ergonomics analysis and intervention.
- ❑ **Enhancing a company's bottom line** through ergonomics related improvements in quality and productivity that also complement health and safety.

- ❑ ____
- ❑ ____
- ❑ ____

SETTING THE STAGE

Systematic Approach

Through interactive lecture and a strong emphasis on case studies, the course presents a systematic approach to ergonomics analysis in the manufacturing work environment.

You'll learn how to use a step-by-step ergonomics analysis process to identify ergonomics risk factors and rank them in terms of relative risk.

This approach leads to the development of a set of reasonable and feasible recommendations intended to improve health, safety and productivity.

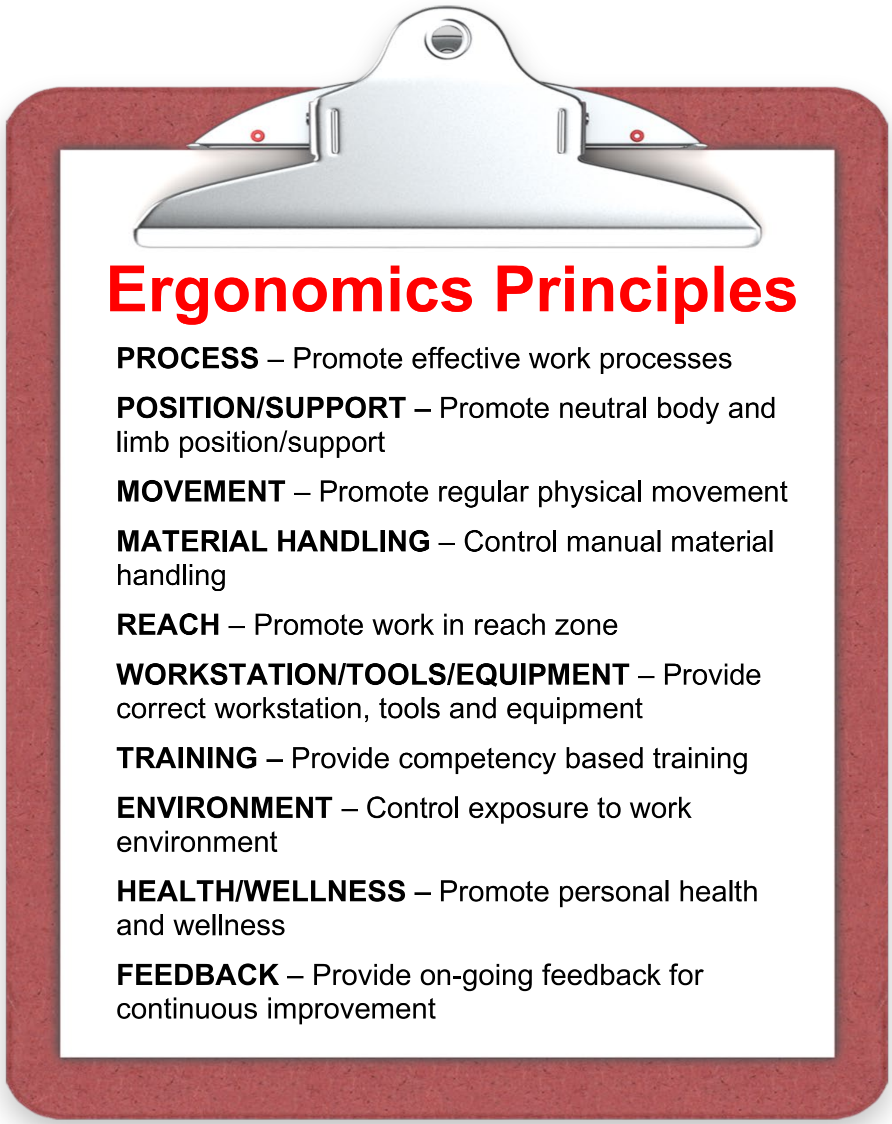
A fundamental knowledge of ergonomics principles and applications is the core of the ergonomics systematic analysis process.

Ergonomics Foundations

We'll define a set of Ergonomics Principles and provide objective **scientific foundations** for the ergonomics principles in the context of **Epidemiology, Work Physiology, Engineering Psychology, Anthropometry** and **Occupational Biomechanics**.

Ergonomics Principles

Here is an overview of the ten **Ergonomics Principles**, we'll get into the details a little later. As you will discover, the principles can be applied to any ergonomics analysis.



Ergonomics Analysis and Problem Solving

We'll delve into **ergonomics analysis and problem solving** with a look at problem solving principles and the components of the **Ergonomics Tool Box**.

The **Tool Box** includes a list of recommended equipment, materials and forms to conduct and document the ergonomics analysis.

References

Refer to the **Appendices** for a list of ergonomics related references and a glossary.

Introduction: Ergonomics Case Studies

To pull the concepts together, we'll work through of series of cases studies that provide **hands-on practice and feedback**.

Let's introduce the **Case Studies** to give you an idea of what we'll be working with.

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

Ergonomics Risk Screen

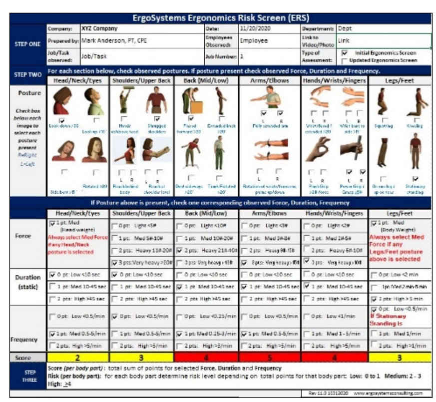
Introduction

ErgoSystems Ergonomics Risk Screen (ERS) Version 11.0 is an ergonomics risk factor screening tool developed by Mark Anderson, MA, PT, CPE.

The ERS is intended to provide an overview assessment of the relative risk of ergonomics related factors specific to the physical performance of repetitive job tasks.

The ERS makes use of an Excel spreadsheet for calculation purposes.

Primary ergonomics factors of **Posture, Force** and **Repetition (Duration and Frequency*)*** are documented examining the potential for increase in the relative risk of musculoskeletal disorders and the impact on quality and productivity.

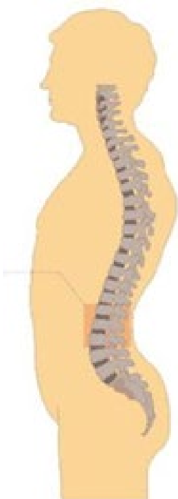


Other factors *(***Training, Workstation Design, Tool and Equipment Use, Environmental Factors, etc**.) are scored to help identify the root cause of the primary ergonomics risk factors.

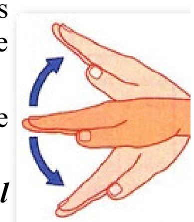
The ERS can quickly indicate that either the assessed job tasks are at low risk or have a potential greater relative risk.

It can also point toward recommendations for additional assessment and intervention.

ERS Scoring



In overview, the **ERS** is scored by first evaluating the position of various body parts in relation to the **Neutral Position** concept. Neutral Position, for the body as a whole, is with the head balanced over the shoulders, shoulders over the hips and hips over the knees and feet.



For each specific body joint, Neutral Position is defined at the mid-range of the joint's range of motion.

From biomechanical and physiological perspectives, the ***Neutral Position/Mid-range of Joint Position*** concept is recognized as advantageous in controlling stress into the body.

As part of the analysis, if out-of-neutral postures are observed, the extent of physical exposure of each body part to the posture is documented.

This includes a combination of:

- **Force** (typically expressed as pounds-force either imposed on the body or that the body has to generate)
- **Duration** (how long the out-of-neutral position is sustained)
- **Frequency** (how often the out-of-neutral position occurs)

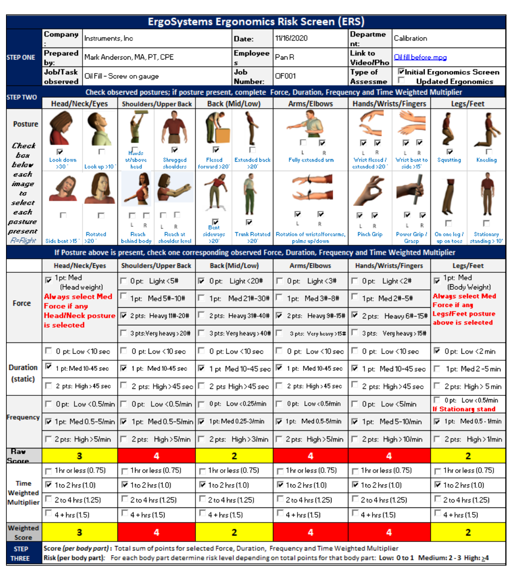
For scoring the number of points increases as the intensity of the ***Force***, ***Duration*** and ***Frequency*** increases. We'll discuss the concept of Relative Risk later, but for now recognize the ERS is numerically scored.

A score of 0 to 1 is considered ***Low Relative Risk*** (indicated by **GREEN**), a score of 2 to 3 is considered ***Medium Relative Risk*** (indicated by **YELLOW**) and 4 and higher is considered ***High Relative Risk*** (indicated by **RED**).

ERS Pre and Post Intervention

The ERS is often conducted pre and post ergonomics intervention to demonstrate the extent to which the intervention has been successful. What difference do you see?

ERS Pre Intervention



ERS Post Intervention

The ***Weighted Time Multiplier*** was also calculated based on the overall exposure.

Time Weighted Multiplier	☐ 1 hr or less (0.75)	☐ 1 hr or less (0.75)	☐ 1 hr or less (0.75)	☐ 1 hr or less (0.75)	☐ 1 hr or less (0.75)	☐ 1 hr or less (0.75)
	☑ 1 to 2 hrs (1.0)	☑ 1 to 2 hrs (1.0)	☑ 1 to 2 hrs (1.0)	☑ 1 to 2 hrs (1.0)	☑ 1 to 2 hrs (1.0)	☑ 1 to 2 hrs (1.0)
	☐ 2 to 4 hrs (1.25)	☐ 2 to 4 hrs (1.25)	☐ 2 to 4 hrs (1.25)	☐ 2 to 4 hrs (1.25)	☐ 2 to 4 hrs (1.25)	☐ 2 to 4 hrs (1.25)
	☐ 4 + hrs (1.5)	☐ 4 + hrs (1.5)	☐ 4 + hrs (1.5)	☐ 4 + hrs (1.5)	☐ 4 + hrs (1.5)	☐ 4 + hrs (1.5)
Weighted Score	**3**	**4**	**2**	**4**	**4**	**2**
STEP THREE	**Score *(per body part)*:** Total sum of points for selected Force, Duration, Frequency and Time Weighted Multiplier **Risk (per body part):** For each body part determine risk level depending on total points for that body part: **Low: 0 to 1 Medium: 2 - 3 High: ≥4**					

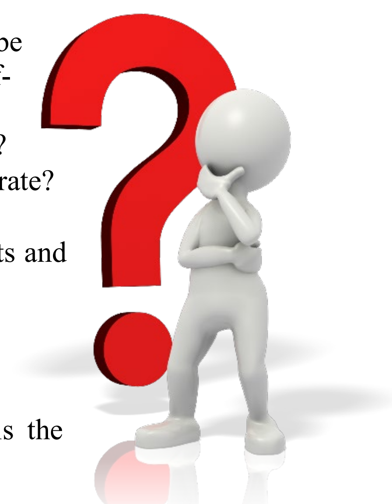
The ERS can be used as an ***Action Plan*** to document and track recommended ***Corrective Actions***.

STEP SIX Risk Areas Step Five		**Corrective Actions** **(Recommended for any Risk Area from STEP FIVE with a score >1)**	**Responsible Person**	**Due Date**	**Status**
1. Head/ Neck/Eyes	3	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically	Pam R, Mark A, Sue S	11/30/2020	Not Started
2. Shoulder / Upper Back	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
3. Back (Mid/ Low)	2	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020v	Not Started
4. Arms / Elbows	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
5. Hands/ Wrists/ Fingers	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
6. Legs/ Feet	2	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
7. Other Factors (Step 4)	8	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started

Relative Risk Level Index – Defined and Interpretation

How Much is TOO Much?

Ergonomics analysis and subsequent intervention recommendations revolve around answering some basic questions:



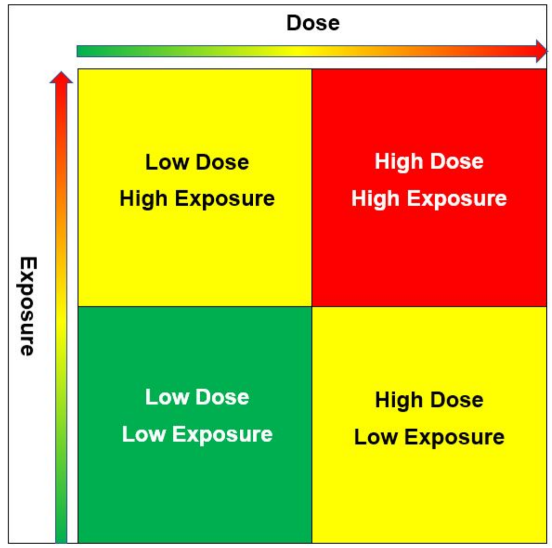
- How awkward do the body and joint positions have to be to cause a problem? (In other words, how far out-of-neutral?)
- How much weight is too much for a person to safely lift?
- How much force is too much for a person to safely generate?
- How many repetitions of a task are too many?
- How far is too far a person to functionally reach to parts and materials on a workbench.
- Should the workbench be at a seated height or
- a standing height?
- How high should the workbench be?
- How to determine if the tool and equipment in use is the correct tool and equipment
- The list can go on and on!

Essentially, we are talking about the factors that influence physical and mental performance.

We can sum many of the questions by simply asking, **'How much is TOO much?'**

Dose/Exposure

One way to address this is the Dose/Exposure concept.



Dose – is defined as the **level** of physical/mental stress of the ergonomics risk factors.

Exposure – is defined as **how long and how often** the exposure to the ergonomics risk factors is occurring.

We appreciate the higher the values for **Dose** and **Exposure**, the greater the estimated risk.

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

A combination of **Low Dose/Low Exposure** would be considered to have a lower relative risk.

A combination of **High Dose/High Exposure** would be considered to have higher relative risk.

However, it is very conceivable the job task could consist of a Low Dose (minimal force levels) combined with High Exposure (high frequency). The converse is also true; High Dose (high force levels) with Low Exposure (low level frequency).

As we discussed, for the **ERS*:***

- Score of 0 to 1 is considered **Low Relative Risk** (indicated by **GREEN**)
- Score of 2 to 3 is considered **Medium Relative Risk** (indicated by **YELLOW**)
- Score of 4 and higher is considered **High Relative Risk** (indicated by **RED**)

For **YELLOW** and **RED** scores, additional assessment and intervention is recommended. Research has demonstrated that **lowering the score through a combination of administrative, work process and engineering initiatives will generally lower the relative risk** of the ergonomics factors.

Medical Analogy

What does Relative Risk mean? Exceptions apply to every rule.

- Two individuals can do exactly the same job. Within a short time one person experiences significant musculoskeletal issues and the other person does the job for 30 years with no problems at all.
- We generally consider cigarette smoking to be detrimental to health. Greater risk of lung cancer is well documented. However, a person can start smoking at age 10 and live to be a hundred!

This truly demonstrates the incredible variation in individual tolerance levels

In this light, how should the ***Relative Risk Score*** be interpreted? Consider this medical analogy.

It is generally understood that a combined HDL and LDL blood cholesterol level of 200 milligrams per deciliter of blood (mg/dL) and lower is advantageous. Does this mean an individual with a **level of 320 will for sure die of heart disease**? Or an individual with a **level of 160 will never die of heart disease**?

For both questions the answer is ***NO***. However, which score would you rather have. The obvious answer is 160. While there are other factors, the relative risk of dying from heart disease is lower with a lower level of blood cholesterol.

So specific to the *ERS* scoring does a score of 0 to 1 mean there is **absolutely no risk** of suffering a musculoskeletal disorder and does a score of 4 and higher mean **absolutely for sure** that a musculoskeletal disorder will occur?

The answer to both questions is **NO**.

So, what is the answer to the question, **'How much is TOO much?'**

We may well say, **'It depends!'**

However, the Relative Risk scores simply indicate that the potential for experiencing issues is greater with a higher score.

From our perspective, through the application of ergonomics principles, we are attempting to lower the Relative Risk score and **broaden the range of individuals** who can safely and effectively perform the job task.

Example Case Study

At this point, recognizing we haven't yet delved into the details, we want to introduce an example of how to conduct an ERS. This will provide an overview and set the stage to get into the details later. Refer to the **Ergonomics Risk Screen Tutorial** for the step-by-step protocol.

Oil Fill ERS Case Study

Background Information

Instruments, Inc. is a company that manufactures calibration equipment. Part of the manufacturing process is to screw a gauge onto an oil fill canister.

This task had been identified as a problem in terms of discomfort and even injuries reported by the workforce.

An ergonomics assessment was conducted using the ERS process and recommendations for improvement were made.

To conduct the assessment video of the task was taken along with interview of the worker and measurements of the workstation and physical demands to perform the task.

Oil Fill Video

Let's take a look at the video. As you look at it, think about the Ergonomics Principles we outlined earlier to identify potential ergonomics issues and consider feasible and reasonable recommendations for improvement.

ERS Results

Pre Intervention ERS

Here are the results for the **Posture, Force, Duration** and **Time Weighted Multiplier**.

It is apparent we are seeing scores in the **Yellow** and **Red** range with particular issue with **Shoulders/Upper Back, Arms/Elbows** and **Hands/Wrists/Fingers**.

The **Time Weighted Multiplier** was scored at 1.0. The task is performed 1 to 2 hours/shift. Do the scores correlate with what you observed on the video?

ErgoSystems Ergonomics Risk Screen (ERS)

STEP ONE						
Company:	Instruments, Inc	Date:	11/16/2020	Department:	Calibration	
Prepared by:	Mark Anderson, MA, PT, CPE	Employees observed:	Pan R	Link to Video/Photo	Oil fill before.mpg	
Job/Task observed:	Oil Fill - Screw on gauge	Job Number:	OF001	Type of Assessment:	[x] Initial Ergonomics Screen [ ] Updated Ergonomics Screen	

STEP TWO — Check observed postures; if posture present, complete Force, Duration, Frequency and Time Weighted Multiplier

Posture (Check box below each image to select each posture present; R=Right L=Left)	Head/Neck/Eyes	Shoulders/Upper Back	Back (Mid/Low)	Arms/Elbows	Hands/Wrists/Fingers	Legs/Feet
	[x] Look down >30° [ ] Look up >10°	[ ] Hands at/above head [x] Shrugged shoulders	[x] Flexed forward >20° [ ] Extended back >20°	Fully extended arm L [ ] R [x]	Wrist flexed / extended >20° L [x] R [x] Wrist bent to side >15° L [x] R [x]	[x] Squatting [ ] Kneeling
	[ ] Side bent >15° [ ] Rotated >20	Reach behind body L [ ] R [ ] Reach at shoulder level L [ ] R [ ]	[x] Bent sideways >20° [x] Trunk Rotated >20°	Rotation of wrists/forearms, palms up/down L [x] R [x]	Pinch Grip L [x] R [x] Power Grip / Grasp L [x] R [x]	[ ] On one leg / up on toes [ ] Stationary standing > 10'

If Posture above is present, check one corresponding observed Force, Duration, Frequency and Time Weighted Multiplier

	Head/Neck/Eyes	Shoulders/Upper Back	Back (Mid/Low)	Arms/Elbows	Hands/Wrists/Fingers	Legs/Feet
Force	[x] 1 pt: Med (Head weight) Always select Med Force if any Head/Neck posture is selected	[ ] 0 pt: Light <5# [ ] 1 pt: Med 5#-10# [x] 2 pts: Heavy 11#-20# [ ] 3 pts: Very heavy >20#	[x] 0 pt: Light <20# [ ] 1 pt: Med 21#-30# [ ] 2 pts: Heavy 31#-40# [ ] 3 pts: Very heavy >40#	[ ] 0 pt: Light <3# [ ] 1 pt: Med 3#-8# [x] 2 pts: Heavy 9#-15# [ ] 3 pts: Very heavy >15#	[ ] 0 pt: Light <2# [ ] 1 pt: Med 2#-5# [x] 2 pts: Heavy 6#-15# [ ] 3 pts: Very heavy >15#	[x] 1 pt: Med (Body Weight) Always select Med Force if any Legs/Feet posture above is selected
Duration (static)	[ ] 0 pt: Low <10 sec [x] 1 pt: Med 10-45 sec [ ] 2 pts: High >45 sec	[ ] 0 pt: Low <10 sec [x] 1 pt: Med 10-45 sec [ ] 2 pts: High >45 sec	[ ] 0 pt: Low <10 sec [x] 1 pt Med 10-45 sec [ ] 2 pts High >45 sec	[ ] 0 pt: Low <10 sec [x] 1 pt: Med 10-45 sec [ ] 2 pts: High >45 sec	[ ] 0 pt: Low <10 sec [x] 1 pt: Med 10-45 sec [ ] 2 pts: High >45 sec	[x] 0 pt: Low <2 min [ ] 1 pt: Med 2 -5 min [ ] 2 pts: High > 5 min
Frequency	[ ] 0 pt: Low <0.5/min [x] 1 pt: Med 0.5-5/min [ ] 2 pts: High >5/min	[ ] 0 pt: Low <0.5/min [x] 1 pt: Med 0.5-5/min [ ] 2 pts: High >5/min	[ ] 0 pt: Low <0.25/min [x] 1 pt: Med 0.25-3/min [ ] 2 pts: High >3/min	[ ] 0 pt: Low <0.5/min [x] 1pt: Med 0.5-5/min [ ] 2 pts: High >5/min	[ ] 0 pt: Low <5/min [x] 1 pt: Med 5-10/min [ ] 2 pts: High >10/min	[ ] 0 pt: Low <0.5/min If Stationary stand [x] 1pt: Med 0.5 - 1/min [ ] 2 pts: High >1/min
Raw Score	3	4	2	4	4	2
Time Weighted Multiplier	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)	[ ] 1 hr or less (0.75) [x] 1 to 2 hrs (1.0) [ ] 2 to 4 hrs (1.25) [ ] 4 + hrs (1.5)
Weighted Score	3	4	2	4	4	2

STEP THREE
Score *(per body part)*: Total sum of points for selected Force, Duration, Frequency and Time Weighted Multiplier
Risk (per body part): For each body part determine risk level depending on total points for that body part: **Low: 0 to 1 Medium: 2 - 3 High: ≥4**

Here are the results for the **Other Factors.**

In the **Other Factors** section, we are documenting potential causal factors for the issues identified in the **Posture, Force and Duration** step.

We checked eight **Other Factors**:

- **Production/Quality** – Gauge was tightened with a wrench without definitive torque applied
- **Training** – Technique observed was not effective in reducing stress
- **Contact Stress** – Sharp, hard edge from the wrench and gauge itself
- **On feet (standing or walking) > 50% of shift** – Identified as an issue
- **Fixture/Jig** – Vise was used to stabilize the canister, ineffective use
- **Tools** – Fairly short wrench used to tighten the gauge
- **Workstation** – Questionable setup of the workstation
- **Worksurface height, too low** – Negative influence on posture

STEP FOUR	Other Factors - Check All that Apply (1 point each)			STEP FIVE (Scores from Steps 3 & 4)	SCORE
[x]	**Production/Quality** - Work Processes affected negatively			1. Head/Neck/Eyes	3
[x]	**Training** - Inadequate safety or process training			2. Shoulders/Upper Back	4
[ ]	**Vibration** - Of hand/arm, related to tool use (e.g. grinders, sanders, etc)	[ ]	**Vibration** - Of whole body, relating to driving vehicles (e.g. fork trucks)	3. Back (Mid/Low)	2
[ ]	**Hot Environment** exposure	[ ]	**Cold Environment** exposure	4. Arms/Elbows	4
[x]	**Contact Stress** - Sharp edge pressure on body from workbench,	[ ]	**Contact Stress** - Hard surface pressure on body from workbench, tool	5. Hands/Wrists/Fingers	4
Wrong or incorrectly used:		[x]	**On feet** (standing or walking)> 50% of shift	6. Legs/Feet	2
[ ]	Equipment [x] Fixture/Jig	[ ]	Controls [x] Tools	7. Other Factors (Step Four)	8
[x]	Workstation	[ ]	Chair [ ] Display	STEP FIVE RISK CATEGORIES	
[ ]	Foot support	[x]	Work surface height - too low/high	Corrective action recommended for each of the 1-7 risk factors with a rating > 1	LOW: 0 to <2
[ ]	**Ambient lighting too low**	[ ]	**Ambient lighting too high**		MED: >2 to <4
[ ]	**Task lighting** - Inadequate for precision assembly, inspection, etc.	[ ]	**Vision** - Visual acuity difficulty in seeing parts/materials to assemble or inspect		HIGH > 4
[ ]	**Foot Controls** - use of foot controls while standing		TOTAL STEP FOUR - OTHER 8		

With the assessment results in hand, the next step was to generate the recommended **Corrective Actions**.

Our goal is to recommend changes that will positively influence the factors we identified in the **Posture, Force and Duration** and **Other Factors** sections.

We collaborated with the worker, supervisor, health and safety manager and the engineer assigned to the area to come up with these straightforward recommendations:

- Reorient vise to position canister vertically
- Replace wrench with long handled torque wrench with proper technique (document the amount of torque required to effectively secure the gauge)
- Consider anti-fatigue mat or shoe in-soles (made on the Post Intervention ERS)

You will notice about the same recommendations were made for each body part. This is fairly common. We need to look at the integrated whole of the risk factors and recognize that one or more changes may have an impact across the board. This was certainly the case in this Case Study.

STEP SIX Risk Areas Step Five		Corrective Actions (Recommended for any Risk Area from STEP FIVE with a score >1)	Responsible Person	Due Date	Status
1. Head/ Neck/Eyes	3	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically	Pam R, Mark A, Sue S	11/30/2020	Not Started
2. Shoulder / Upper Back	4	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
3. Back (Mid/ Low)	2	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020v	Not Started
4. Arms / Elbows	4	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
5. Hands/ Wrists/ Fingers	4	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
6. Legs/ Feet	2	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
7. Other Factors (Step 4)	8	[ ] Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started

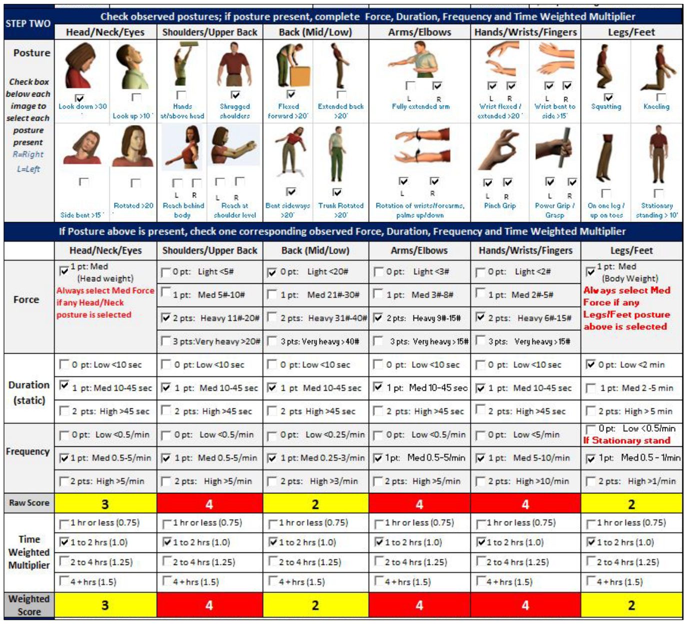
Post Intervention ERS

Let's look at the Post Intervention video clip.

Once the recommendations were implemented the ERS was repeated.

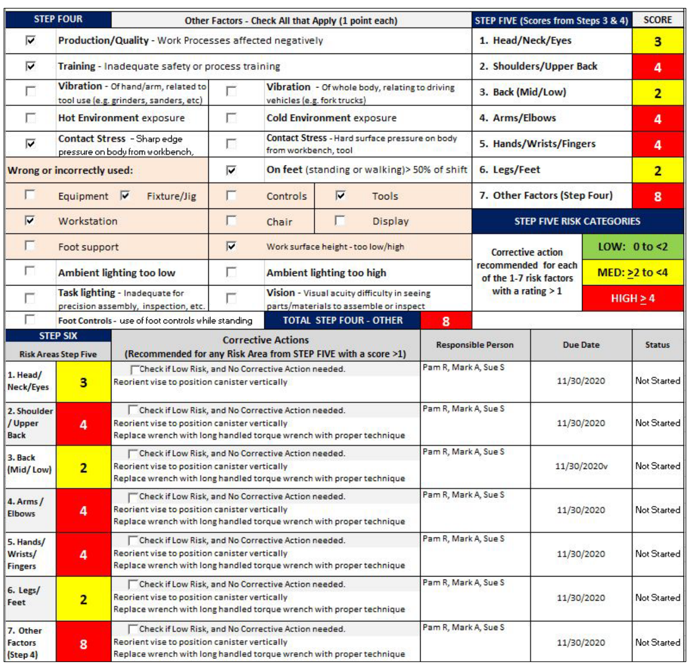
This Case Study (video clips and ERS worksheets) is part of your course materials.

Take at a look at the difference. Visually the distinctions are quite dramatic.



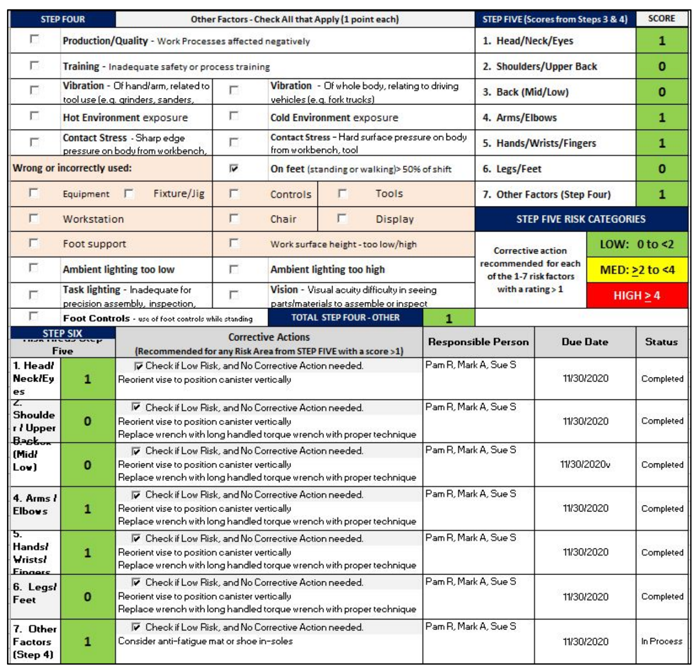
STEP TWO	Check observed postures; if posture present, complete Force, Duration, Frequency and Time Weighted Multiplier					
	Head/Neck/Eyes	Shoulders/Upper Back	Back (Mid/Low)	Arms/Elbows	Hands/Wrists/Fingers	Legs/Feet
Posture (Check box below each image to select each posture present, R=Right L=Left)	☑ Look down >30; Look up >10; Side bent >15; Rotated >20	Hands at/above head; ☑ Shrugged shoulders; Reach behind body (L R); Reach at shoulder level (L R)	☑ Flexed forward >20; Extended back >20; ☑ Bent sideways >20; ☑ Trunk Rotated >20	Fully extended arm (L ☑R); Rotation of wrists/forearms, palms up/down (☑L ☑R)	Wrist flexed / extended >20 (☑L ☑R); Wrist bent to side >15 (☑L ☑R); Pinch Grip (☑L ☑R); Power Grip / Grasp (☑L ☑R)	☑ Squatting; Kneeling; On one leg / up on toes; Stationary standing >10'
If Posture above is present, check one corresponding observed Force, Duration, Frequency and Time Weighted Multiplier						
Force	☑ 1 pt: Med (Head weight) Always select Med Force if any Head/Neck posture is selected	0 pt: Light <5#; 1 pt: Med 5#-10#; ☑ 2 pts: Heavy 11#-20#; 3 pts: Very heavy >20#	☑ 0 pt: Light <20#; 1 pt: Med 21#-30#; 2 pts: Heavy 31#-40#; 3 pts: Very heavy >40#	0 pt: Light <3#; 1 pt: Med 3#-8#; ☑ 2 pts: Heavy 9#-15#; 3 pts: Very heavy >15#	0 pt: Light <2#; 1 pt: Med 2#-5#; ☑ 2 pts: Heavy 6#-15#; 3 pts: Very heavy >15#	☑ 1 pt: Med (Body Weight) Always select Med Force if any Legs/Feet posture above is selected
Duration (static)	0 pt: Low <10 sec; ☑ 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <10 sec; ☑ 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <10 sec; ☑ 1 pt Med 10-45 sec; 2 pts High >45 sec	0 pt: Low <10 sec; ☑ 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <10 sec; ☑ 1 pt: Med 10-45 sec; 2 pts: High >45 sec	☑ 0 pt: Low <2 min; 1 pt: Med 2-5 min; 2 pts: High >5 min
Frequency	0 pt: Low <0.5/min; ☑ 1 pt: Med 0.5-5/min; 2 pts: High >5/min	0 pt: Low <0.5/min; ☑ 1 pt: Med 0.5-5/min; 2 pts: High >5/min	0 pt: Low <0.25/min; ☑ 1 pt: Med 0.25-3/min; 2 pts: High >3/min	0 pt: Low <0.5/min; ☑ 1 pt: Med 0.5-5/min; 2 pts: High >5/min	0 pt: Low <5/min; ☑ 1 pt: Med 5-10/min; 2 pts: High >10/min	0 pt: Low <0.5/min If Stationary stand; ☑ 1 pt: Med 0.5 - 1/min; 2 pts: High >1/min
Raw Score	3	4	2	4	4	2
Time Weighted Multiplier	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)
Weighted Score	3	4	2	4	4	2

STEP TWO	Check observed postures; if posture present, complete Force, Duration, Frequency and Time Weighted Multiplier					
	Head/Neck/Eyes	Shoulders/Upper Back	Back (Mid/Low)	Arms/Elbows	Hands/Wrists/Fingers	Legs/Feet
Posture (Check box below each image to select each posture present, R=Right)	☑ Look down >30; Look up >10; Side bent >15; Rotated >20	Hands at/above head; Shrugged shoulders; Reach behind body (L R); Reach at shoulder level (L R)	Flexed forward >20; Extended back >20; Bent sideways >20; Trunk Rotated >20	Fully extended arm (L R); Rotation of wrists/forearms, palms up/down (☑L ☑R)	Wrist flexed / extended >20 (☑L ☑R); Wrist bent to side >15 (☑L ☑R); Pinch Grip (☑L ☑R); Power Grip / Grasp (☑L ☑R)	Squatting; Kneeling; On one leg / up on toes; Stationary standing >10'
If Posture above is present, check one corresponding observed Force, Duration, Frequency and Time Weighted Multiplier						
Force	☑ 1 pt: Med (Head weight) Always select Med Force if any Head/Neck posture is selected	0 pt: Light <5#; 1 pt: Med 5#-10#; 2 pts: Heavy 11#-20#; 3 pts: Very heavy >20#	0 pt: Light <20#; 1 pt: Med 21#-30#; 2 pts: Heavy 31#-40#; 3 pts: Very heavy >40#	☑ 0 pt: Light <3#; 1 pt: Med 3#-8#; 2 pts: Heavy 9#-15#; 3 pts: Very heavy >15#	0 pt: Light <2#; ☑ 1 pt: Med 2#-5#; 2 pts: Heavy 6#-15#; 3 pts: Very heavy >15#	1 pt: Med (Body Weight) Always select Med Force if any Legs/Feet posture above is selected
Duration (static)	☑ 0 pt: Low <10 sec; 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <10 sec; 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <10 sec; 1 pt Med 10-45 sec; 2 pts High >45 sec	☑ 0 pt: Low <10 sec; 1 pt: Med 10-45 sec; 2 pts: High >45 sec	☑ 0 pt: Low <10 sec; 1 pt: Med 10-45 sec; 2 pts: High >45 sec	0 pt: Low <2 min; 1 pt: Med 2-5 min; 2 pts: High >5 min
Frequency	☑ 0 pt: Low <0.5/min; 1 pt: Med 0.5-5/min; 2 pts: High >5/min	0 pt: Low <0.5/min; 1 pt: Med 0.5-5/min; 2 pts: High >5/min	0 pt: Low <0.25/min; 1 pt: Med 0.25-3/min; 2 pts: High >3/min	0 pt: Low <0.5/min; ☑ 1 pt: Med 0.5-5/min; 2 pts: High >5/min	☑ 0 pt: Low <5/min; 1 pt: Med 5-10/min; 2 pts: High >10/min	0 pt: Low <0.5/min If Stationary stand; 1 pt: Med 0.5 - 1/min; 2 pts: High >1/min
Raw Score	1	0	0	1	1	0
Time Weighted Multiplier	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)	1 hr or less (0.75); ☑ 1 to 2 hrs (1.0); 2 to 4 hrs (1.25); 4+ hrs (1.5)
Weighted Score	1	0	0	1	1	0



STEP FOUR	Other Factors - Check All that Apply (1 point each)			STEP FIVE (Scores from Steps 3 & 4)	SCORE
☑	Production/Quality - Work Processes affected negatively			1. Head/Neck/Eyes	3
☑	Training - Inadequate safety or process training			2. Shoulders/Upper Back	4
☐	Vibration - Of hand/arm, related to tool use (e.g. grinders, sanders, etc)	☐	Vibration - Of whole body, relating to driving vehicles (e.g. fork trucks)	3. Back (Mid/Low)	2
☐	Hot Environment exposure	☐	Cold Environment exposure	4. Arms/Elbows	4
☑	Contact Stress - Sharp edge pressure on body from workbench,	☐	Contact Stress - Hard surface pressure on body from workbench, tool	5. Hands/Wrists/Fingers	4
Wrong or incorrectly used:		☑	On feet (standing or walking)> 50% of shift	6. Legs/Feet	2
☐	Equipment ☑ Fixture/Jig	☐	Controls ☑ Tools	7. Other Factors (Step Four)	8
☑	Workstation	☐	Chair ☐ Display	STEP FIVE RISK CATEGORIES	
☐	Foot support	☑	Work surface height - too low/high	Corrective action recommended for each of the 1-7 risk factors with a rating > 1	LOW: 0 to <2
☐	Ambient lighting too low	☐	Ambient lighting too high		MED: >2 to <4
☐	Task lighting - Inadequate for precision assembly, inspection, etc.	☐	Vision - Visual acuity difficulty in seeing parts/materials to assemble or inspect		HIGH > 4
☐	Foot Controls - use of foot controls while standing	TOTAL STEP FOUR - OTHER	8		

STEP SIX Risk Areas Step Five		Corrective Actions (Recommended for any Risk Area from STEP FIVE with a score >1)	Responsible Person	Due Date	Status
1. Head/ Neck/Eyes	3	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically	Pam R, Mark A, Sue S	11/30/2020	Not Started
2. Shoulder / Upper Back	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
3. Back (Mid/ Low)	2	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020v	Not Started
4. Arms / Elbows	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
5. Hands/ Wrists/ Fingers	4	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
6. Legs/ Feet	2	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started
7. Other Factors (Step 4)	8	☐ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Not Started



STEP FOUR	Other Factors - Check All that Apply (1 point each)			STEP FIVE (Scores from Steps 3 & 4)	SCORE
☐	Production/Quality - Work Processes affected negatively			1. Head/Neck/Eyes	1
☐	Training - Inadequate safety or process training			2. Shoulders/Upper Back	0
☐	Vibration - Of hand/arm, related to tool use (e.g. grinders, sanders,	☐	Vibration - Of whole body, relating to driving vehicles (e.g. fork trucks)	3. Back (Mid/Low)	0
☐	Hot Environment exposure	☐	Cold Environment exposure	4. Arms/Elbows	1
☐	Contact Stress - Sharp edge pressure on body from workbench,	☐	Contact Stress - Hard surface pressure on body from workbench, tool	5. Hands/Wrists/Fingers	1
Wrong or incorrectly used:		☑	On feet (standing or walking)> 50% of shift	6. Legs/Feet	0
☐	Equipment ☐ Fixture/Jig	☐	Controls ☐ Tools	7. Other Factors (Step Four)	1
☐	Workstation	☐	Chair ☐ Display	STEP FIVE RISK CATEGORIES	
☐	Foot support	☐	Work surface height - too low/high	Corrective action recommended for each of the 1-7 risk factors with a rating > 1	LOW: 0 to <2
☐	Ambient lighting too low	☐	Ambient lighting too high		MED: >2 to <4
☐	Task lighting - Inadequate for precision assembly, inspection,	☐	Vision - Visual acuity difficulty in seeing parts/materials to assemble or inspect		HIGH > 4
☐	Foot Controls - use of foot controls while standing	TOTAL STEP FOUR - OTHER	1		

STEP SIX Risk Areas Step Five		Corrective Actions (Recommended for any Risk Area from STEP FIVE with a score >1)	Responsible Person	Due Date	Status
1. Head/ Neck/Eyes	1	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically	Pam R, Mark A, Sue S	11/30/2020	Completed
2. Shoulder / Upper Back	0	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Completed
3. Back (Mid/ Low)	0	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020v	Completed
4. Arms / Elbows	1	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Completed
5. Hands/ Wrists/ Fingers	1	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Completed
6. Legs/ Feet	0	☑ Check if Low Risk, and No Corrective Action needed. Reorient vise to position canister vertically Replace wrench with long handled torque wrench with proper technique	Pam R, Mark A, Sue S	11/30/2020	Completed
7. Other Factors (Step 4)	1	☑ Check if Low Risk, and No Corrective Action needed. Consider anti-fatigue mat or shoe in-soles	Pam R, Mark A, Sue S	11/30/2020	In Process

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.

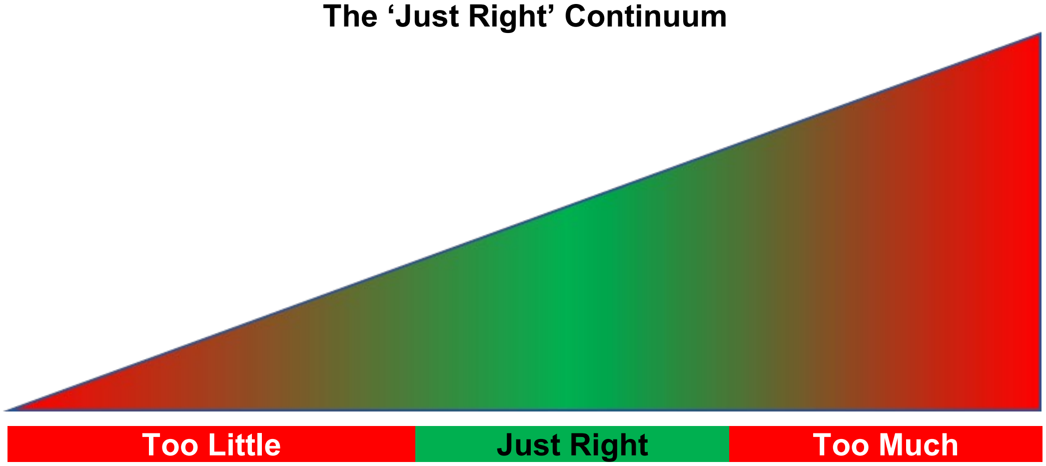
Just Right Continuum

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

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. Interestingly, ergonomics has found a niche in the marketing of virtually all tangible consumer products; from the toothbrush you use with dotted grips on the handle to the vacuum cleaner button that reels in the plug with a touch of your foot.

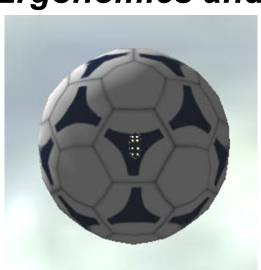
Did you know you can enjoy ergonomically designed corn chips? Yep, ***Scoops*** are designed to not break when you dip! Which is a good thing, otherwise the next person has to figure out how to get the broken chip out of the salsa bowl!

You probably have heard of a few 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!)

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

How does this relate to what ergonomics is all about?

Circumstances predict the response!

Well, rather than throw a ball into the air, let's say you need to assemble a component at a low level. The body position most likely used is to just bend over at the waist.

From a health and safety, as well as productivity standpoint, we recognize this work position can cause problems.

But unfortunately, it is a commonly observed work position. How about this for a solution - whenever we see someone in this poor position, we tactfully tap them on the shoulder and say,

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

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

We need a different strategy.

QUESTION

Looking at the person working with the bent over posture; what is driving force behind that bent over posture?

ANSWER

It is 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!

For example, we could reposition the worker: use a rolling stool.

What are some other options?

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

What we understand, based on Engineering Psychology Principles (more about this a little later), is given a certain set of circumstances, humans will typically respond in a fairly predictable way.

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

Systems Design

The essence of ergonomics is design. Design of work stations, work processes, work environment and work culture dictate the level of safety and productivity.

For example, effort may be wasted because of:

- Poor positioning of tools, equipment and parts.
- Poor design or maintenance of tools.

- Haphazardly thought out work processes.
- Poor work environments due to poor ventilation and lighting.

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 systems design . . . get out your crystal ball and try this example.

STEP	ACTIVITY	RESULT
One:	Choose a number between one and nine.	
Two:	Multiply that number by nine.	
Three:	Add together the digits of the result of Step Two.	
Four:	Subtract five from the result of Step Three.	
Five:	Choose the letter of the alphabet that corresponds to the result of Step Four, e.g., A=1, B=2, 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

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

Systems Design: Principles

The ***Human Factors Design Handbook*** defines a system as:

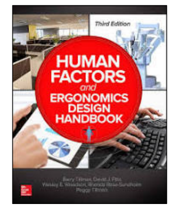
- **Mission-oriented grouping of elements into an integrated, functional whole**
- **Includes facility, equipment, furnishings and fixtures**
- **Involves variety of people who use, operate or maintain it**
- **Must perform mission or function and must work in an environment**

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.)

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

Systems Design: Foundations

The study of systems design encompasses many fields. For our purposes, we will examine several that have direct influence on ergonomics.

Each of them is a full-fledged discipline. As we introduce the ergonomics principles we will discuss:

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

Why does Ergonomics Work?

Ergonomics works because it:


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

Ergonomics Definition

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.

ERGONOMICS PRINCIPLES AND FOUNDATIONS

Ergonomics Principles

Let's get into the details of the ten **Ergonomics Principles**. Here is a summary:

PROCESS – Promote effective work processes

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

MOVEMENT – Promote regular physical movement

MATERIAL HANDLING – Control manual material handling

REACH – Promote work in reach zone

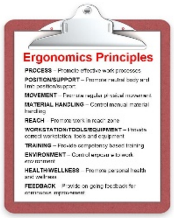
WORKSTATION/TOOLS/EQUIPMENT – Provide correct workstation, tools and equipment

TRAINING – Provide competency based training

ENVIRONMENT – Control exposure to work environment

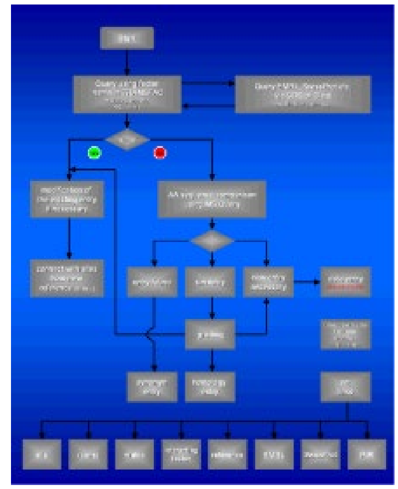
HEALTH/WELLNESS – Promote personal health and wellness

FEEDBACK – Provide on-going feedback for continuous improvement



Promote Effective Work Processes

Introduction



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

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

"Because it has always been done that way!"

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

What we see day after day becomes commonplace to use. We simply don't pay attention anymore.

We can't see the forest because of the trees.

Recall we defined ergonomics as:

> **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

Poll Continuous Improvement

Work Process

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

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

Look at the whole picture

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

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

Management/Supervision

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

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

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

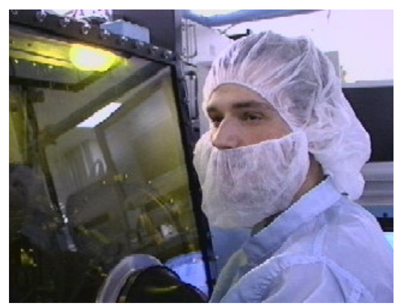
As noted, management's commitment to, involvement in and facilitation of the ergonomics process is critical to its success. Significant evidence suggests that a management team who sends the message "we care" has major impact on controlling workplace injuries and illnesses and enhancing productivity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

Establish clear performance goals and objectives

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

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

Work Force



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

Work Force Demographics

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

Ergonomics findings and recommendations are greatly influenced by these factors.

Age

Physiological changes occur as a matter of aging:

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

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

Gender

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

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

Stature and Morphology

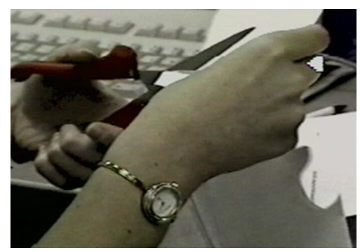
Anthropometry - the study of the size and shape of the body plays an important role.

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 sections.

Hand Dominance



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

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

Fitness level

Job Match

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

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

Health and Wellness

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

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

Training

Appropriate 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 the work process?
- Can the worker properly demonstrate the technical aspects of the job process and work demands?

Safety

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

Work Experience

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

Level

- What is the general work experience level of the workforce or worker?
- Is the level of 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.

> ***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:

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

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

Reactive Records Review

One way to think of a reactive records review is the 'iceberg' analogy. Ten percent of the iceberg floats above the surface and is visible.

This equates to the reactive records review that includes OSHA logs, medical records, productivity records, insurance records and payroll records.

Proactive Data Collection

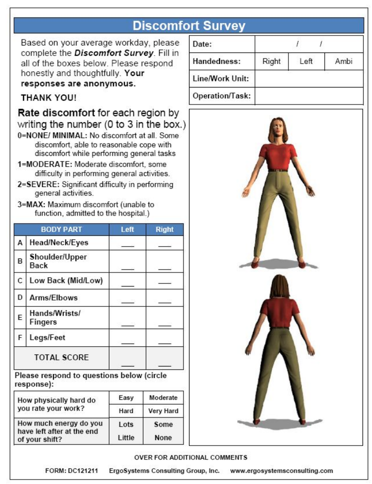
Proactive data collection provides a means of evaluating the ninety percent of the iceberg still below the surface.

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

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

Poll – 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.



Discomfort Survey

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

THANK YOU!

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

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

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

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

2=SEVERE: Significant difficulty in performing general activities.

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

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

Please respond to questions below (circle response):

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

OVER FOR ADDITIONAL COMMENTS

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

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:

- 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.

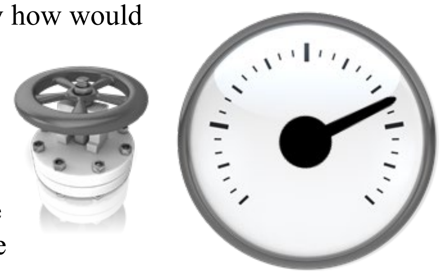
This implies that we all have the same "sense in common". We can apply the concepts of Engineering Psychology. Here is an exercise that may shed some light on the validity of the 'in-common' common sense hypothesis.

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.

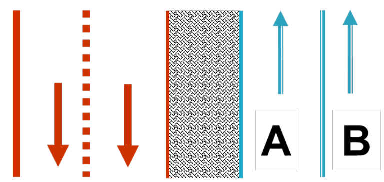
Unless, you understand the knob is actually controlling a pressure valve, the display represents the pressure in the system (less pressure to the left on the display) and you need to turn the knob clockwise to close the valve and thereby reduce the pressure.

All right, so about 95% common sense!

But what about that 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 Mile Marker 23 and cone off the outside lane between marker 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 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, indicates we do not have the same "common sense." Our view of the world is greatly shaped by our experiences. Falling back on the, **"Well, it is just common sense!"** will not provide the desired consistent and reliable result we are striving to achieve. 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. Work to understand the operator'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.)

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

Effective Work Process Design Principles

Donald Norman, in ***The 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

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:

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

Application example:

Ever been in someone's kitchen and turned on the wrong stove burner? The relationship between the actual burner location and the control knobs wasn't properly mapped.

Be honest now, ever happen with your own stove!

Provide feedback

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

Application example:

Without adequate feedback, how do you really know you have correctly programmed your alarm clock?

Or entered correct number in your cell phone?

Or entered the correct code into the ATM?

Effective Work Process Design Principles – Synopsis

Design Conventions

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

Design Principles

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

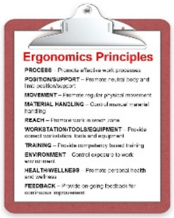
Work Process Design Checklist

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

Work Process Design Checklist

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

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



Promote Neutral Position and Support

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

Neutral Position

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

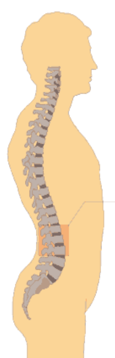
Is it the feet? Consider if a person sprains an ankle . . . by using a pair of crutches they can still get around.

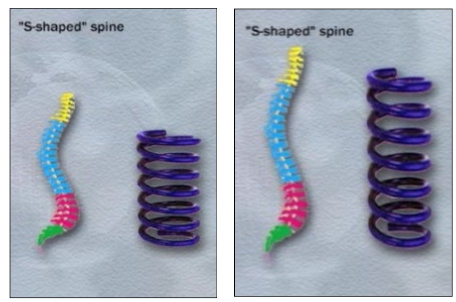
On the other hand, what if a person "sprains" their back? You know someone who's been in this condition – they have a significant problem even getting out of bed to get to the bathroom.

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, this allows us to make good use of our legs and arms.

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.

Benefits of promoting the neutral spine position are significant:

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

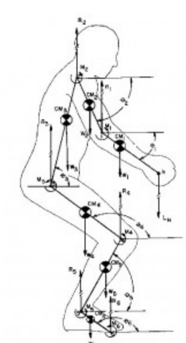
Limb joint neutral position

What is neutral for the arms and hands, the hips, knees and ankles.

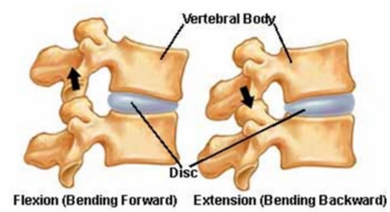
Neutral is the midrange of joint position. For the arms/hands this is with the shoulders relaxed, elbows at the sides flexed to about 90 degrees and the hands positioned with the thumbs pointing up.

Occupational Biomechanical 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/*

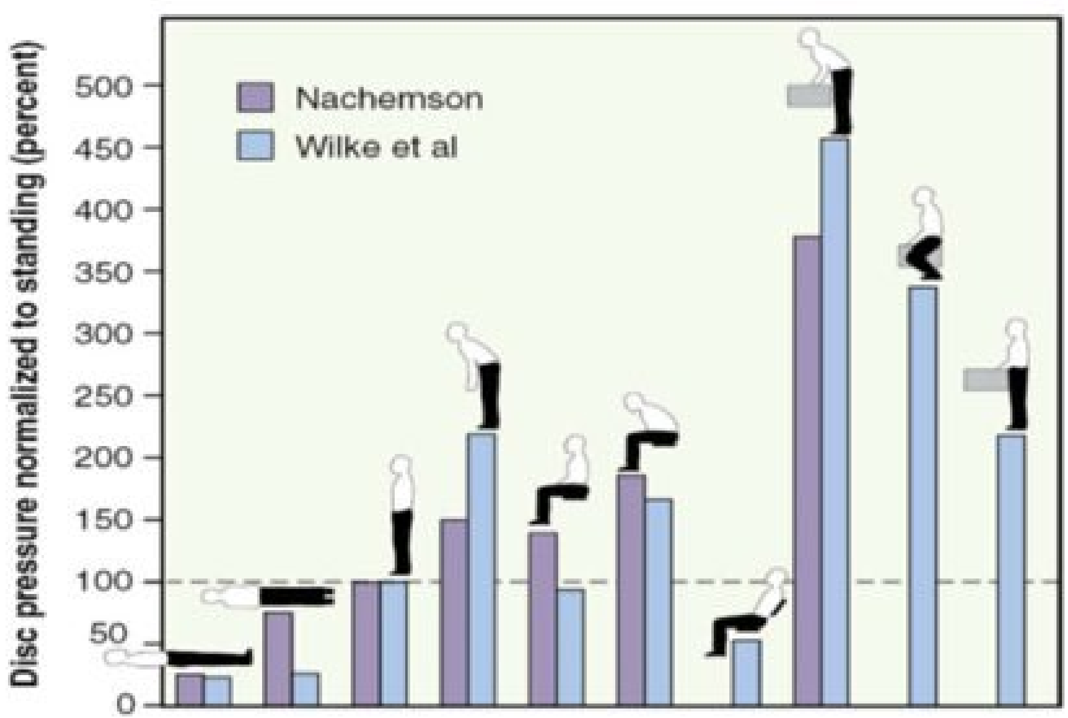


A significant amount of research has been accomplished over the past 30 years that addresses the loads on the body's joints.

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.



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.

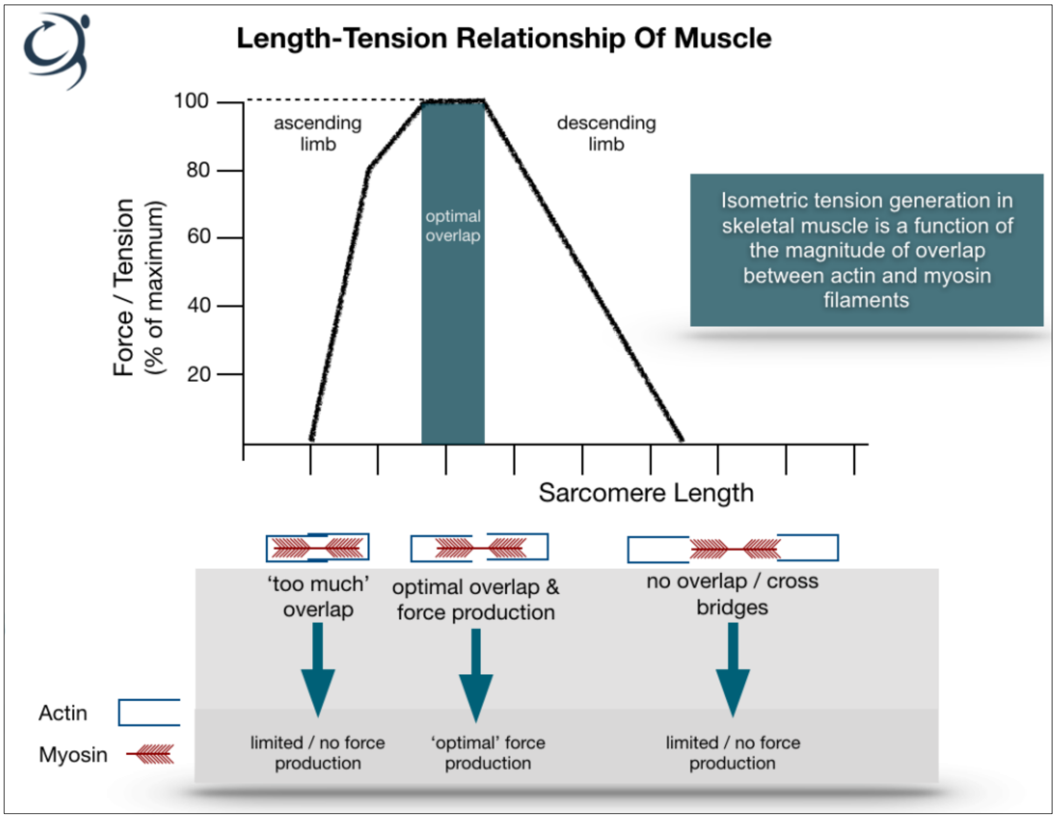
Question – At what angle of flexion is the elbow most functional? In other words, able to generate the greatest muscular force?

Answer – Fully flexed, 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-rehabillitation/

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?

Limbs

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

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

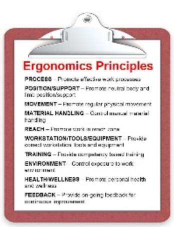
Standing

Unsupported standing for extended periods is not desired.

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

The bottom line . . . it is tiring!

In fact, as individuals, we try very hard to eliminate sustained unsupported standing. Look at people standing in a line. What do you see them do to obtain relief?



Promote Dynamic Physical Movement

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

Stand or Walk?

Most people have carried a backpack at some point. Picture this scenario - you are with a group of friends going for an extended hike; your backpack weighs 30# and you have put it on your shoulders.

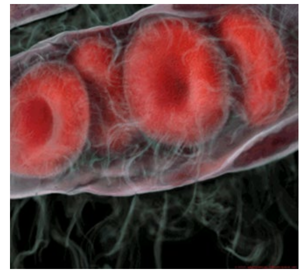
What would you rather do: stand in one place for the next 20 minutes OR take that same backpack and start to walk for a few miles?

To a person, everyone agrees that it is much better to walk – not to stand.

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

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

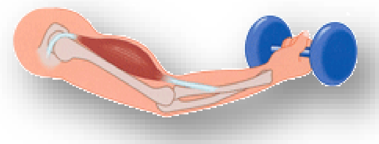
Metabolism (Work Physiology)



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

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

Static Muscle Contraction



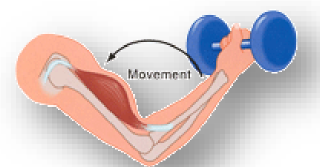
Type of muscular effort has been shown to have a profound impact on blood flow.

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

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

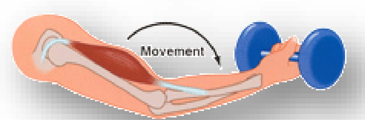
The muscle depends on the quite limited initial reserves stored internally. Waste products accumulate and only short duration contractions are possible.

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.

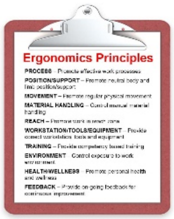
Metabolic/Work Physiology Synopsis

Movement/activity

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

Position and support

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



Control Manual Material Handling

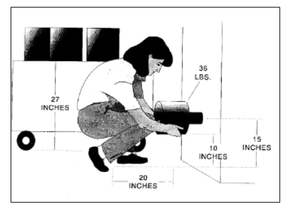
How Much Can a Person Lift?

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

How much can a person lift in a safe and effective way? What are the factors involving the manual handling that need to be considered? These questions have been studied extensively over the past 40 to 50 years.

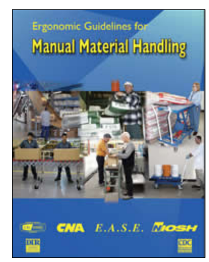
Occupational Biomechanics

Lifting Factors



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 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. Details are found in the Loading Supply Rolls example below.

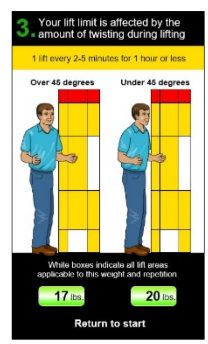


Check out the ***NIOSH Ergonomics Guidelines for Manual Material Handling*** at:

https://www.cdc.gov/niosh/docs/2007-131/default.html

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

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



Let's take a look at how it works and play around with the online version. Your homework assignment includes a case study making use of the LNI Lifting Calculator. This will help us understand the basic criteria that need to be addressed in the LNI Lifting Calculator.

It is easy to use and provides valuable information. Your materials include a fillable PDF version.

An on-line, interactive version is available at:
http://www.lni.wa.gov/Safety/Topics/Ergonomics/ServicesResources/Tools/default.asp

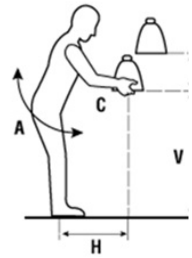
Poll – Formal Manual Material Handling Evaluation Tools

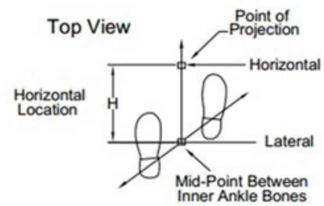
Manual Material Handling Basic Criteria

So, in overview essentially the formula considers basic criteria of the manual material handling event:

Actual Object Weight – Determine the actual weight of the object. If a range of weights is noted; for example, 30 to 40#, use the higher value in your calculations because it would be the "worst case".

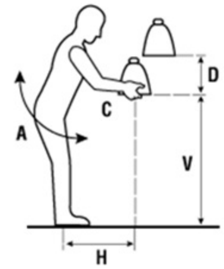
Horizontal Distance (H) - How far from the body is the object being handled? The farther away, the longer the lever arm and the more stress into the body.





Estimating Horizontal Distance (H) can be a little tricky. The horizontal location is determined by measuring the distance between the point projected on the floor directly below the mid-point of the hands grasping the object (center of mass), and the mid-point of a line between the inside ankle bones as pictured below. The ***LNI Lifting Calculator*** uses: 0”, 7” or 12”.

Vertical Position – At what level from the floor is the object being handled? The farther away from the Optimal Lifting Zone (about waist level) the more stress into the body.



The vertical location is measured from the floor (or standing surface) to the vertical mid-point between the hand grasps as defined by large middle knuckle of the hand.

You may need to determine two Vertical Position measurements (V is the origin position and V + D is the destination position) and perform two calculations.

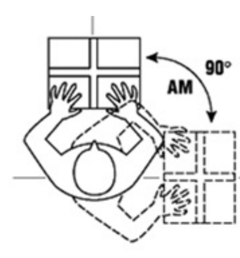
Frequency – How often is the object being handled? Once per shift is dramatically different than once per minute. From physiological fatigue standpoint frequency has a huge impact. Frequency is categorized as lifts per minute. Look at the ***LNI Lifting Calculator Worksheet*** below to see the categories.

Duration – How long throughout the shift is the handling occurring? Over the course of the shift is the manual handling occurring for an hour total or two or the entire shift? The longer duration is related to increased exposure to stress and results in lower weight limits.

Look at the ***LNI Lifting Calculator Worksheet*** below to see the relationship between the hours/day and the multiplier. For example, for one lift occurring every 2-5 minutes at a cumulative Duration of one hour or less in the shift, the multiplier is 1.0 and no impact on the calculation occurs.

On the other end of the spectrum for 10+ lifts occurring every minute at a cumulative Duration of two hours or more in the shift, the multiplier is 0.0 and essentially indicates this lift should not be performed. Then see the multiplier is on a sliding scale between these two points.

Spine Rotation *(Asymmetric Angle)* – Is there is spinal rotation occurring during the lift? Rotation of the spine with lifting has been determined to result in significant shear and compression force into the spine. Estimate spine rotation as the angle between the shoulders and hips from origin to destination.



For spine rotation more than 45 degrees the multiplier is 0.85.

Object size and grip – What shape and size is the object and how well can it be gripped? Smaller, well-balanced objects with handholds are easier to handle. The 1991 modified ***NIOSH Work Practices Guide for Manual Lifting*** added a hand-to-container coupling factor.

The **LNI Lifting Calculator** does not include a hand-to-container factor; if you identify this as an issue you will want to make note of this and perhaps decrease the recommended weight or recommend a change in object size or grasping.

LNI Lifting Calculator Worksheet

Calculator for analyzing lifting operations

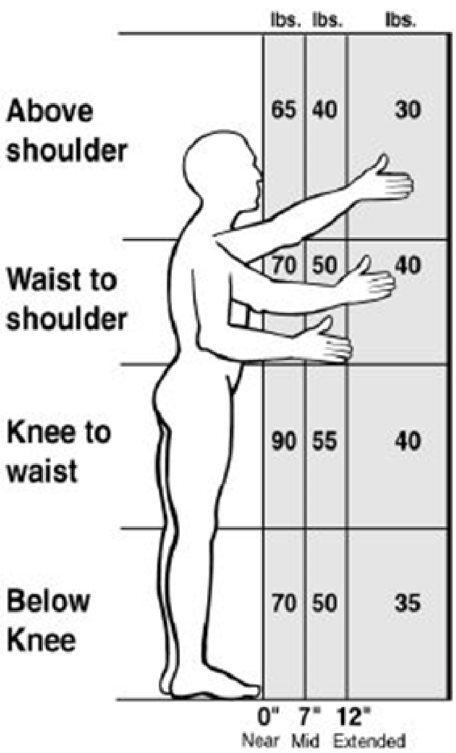
Company ______ Evaluator ______

Job ______ Date ______

1 Enter the weight of the object lifted.

Weight Lifted ______ lbs.

2 Circle the number on a rectangle below that corresponds to the position of the person's hands when they begin to lift or lower the objects.



3 Circle the number that corresponds to the times the person lifts per minute and the total number of hours per day spent lifting.

Note: For lifting done less than once every five minutes, use **1.0**

How many lifts per minute?	How many hours per day?		
	1 hr or less	1 hr to 2 hrs	2 hrs or more
1 lift every 2-5 min	1.0	0.95	0.85
1 lift every min	0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

4 Circle 0.85 if the person twists more than 45 degrees while lifting. 0.85

Otherwise circle 1.0

5 Copy below the numbers you have circled in steps 2, 3, and 4.

______ lbs. X ______ X ______ = Lifting Limit ______ lbs.

Step 2 — Step 3 — Step 4

6 Is the Weight Lifted (1) less than the Lifting Limit (5)

Yes – OK

No – HAZARD

Department of LABOR AND INDUSTRIES

Note: If the job involves lifts of objects with a number of different weights and/or from a number of different locations, use Steps 1 through 5 above to:

1. Analyze the 2 worst case lifts—the heaviest object lifted and the lift done in the most awkward posture.
2. Analyze the most commonly performed lift. In Step 3, use the frequency and duration for all the lifting done in a typical workday.

Manual Material Handling Case Study – Handle Speaker

Let' s work on a case study. Sound technicians at a company are responsible for setting up speaker systems on-site at various venues. Check out the video clip (***Speaker on Stand 45.mp4***). Here are the specifics:

- Speaker weight is 45#
- Speaker is lifted from the floor to place it on the top of a stand (about 5' off the ground)
- Duration is for one hour or less/day
- Frequency is 1 lift/min

We need to perform the calculation twice; first for the lift from the floor and second for the speaker placement on the stand.

Lift from Floor

Weight Lifted: 45#

Hand Position: Below knee at 7"

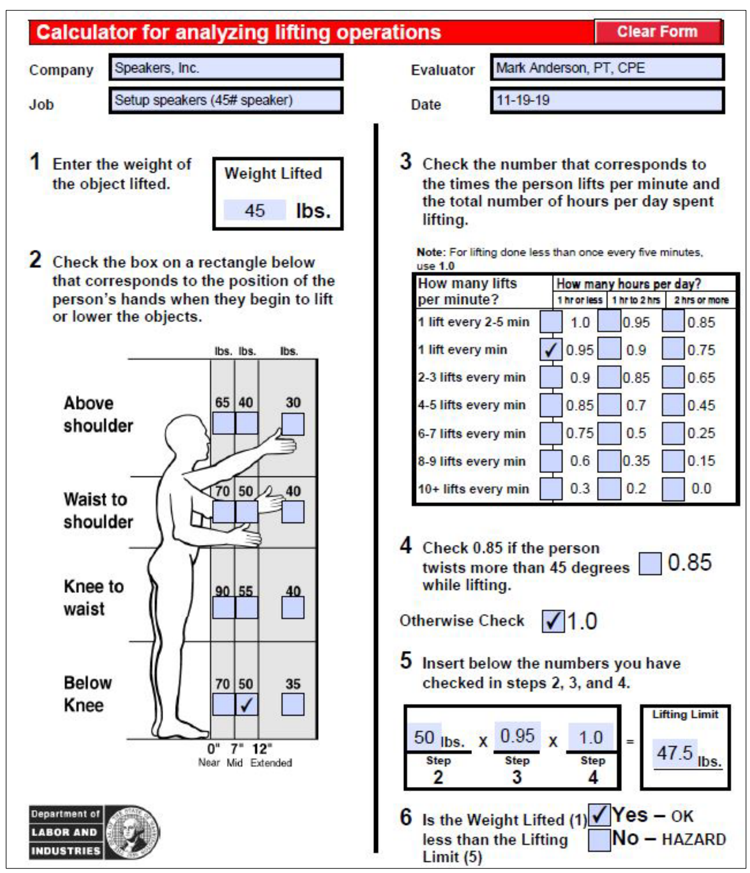
Lifts/min: 1

Hours/day: 1 hr or less

Twists: No

50# x 0.95 x 1.0 = 47.5#

Weight Lifted (45#) less than Lifting Limit (47.5#) YES – Ok



Calculator for analyzing lifting operations — Clear Form

Company: Speakers, Inc.
Job: Setup speakers (45# speaker)
Evaluator: Mark Anderson, PT, CPE
Date: 11-19-19

1 Enter the weight of the object lifted.
Weight Lifted: 45 lbs.

2 Check the box on a rectangle below that corresponds to the position of the person's hands when they begin to lift or lower the objects.

	0" Near (lbs.)	7" Mid (lbs.)	12" Extended (lbs.)
Above shoulder	65	40	30
Waist to shoulder	70	50	40
Knee to waist	90	55	40
Below Knee	70	50 ✓	35

3 Check the number that corresponds to the times the person lifts per minute and the total number of hours per day spent lifting.

Note: For lifting done less than once every five minutes, use 1.0

How many lifts per minute?	1 hr or less	1 hr to 2 hrs	2 hrs or more
1 lift every 2-5 min	1.0	0.95	0.85
1 lift every min	✓ 0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

4 Check 0.85 if the person twists more than 45 degrees while lifting. ☐ 0.85

Otherwise Check ✓ 1.0

5 Insert below the numbers you have checked in steps 2, 3, and 4.

50 lbs. (Step 2) x 0.95 (Step 3) x 1.0 (Step 4) = Lifting Limit 47.5 lbs.

6 Is the Weight Lifted (1) less than the Lifting Limit (5)
✓ Yes – OK
☐ No – HAZARD

Department of LABOR AND INDUSTRIES

Lift to Stand

Weight Lifted: 45#

Hand Position: Above shoulder knee at 7"

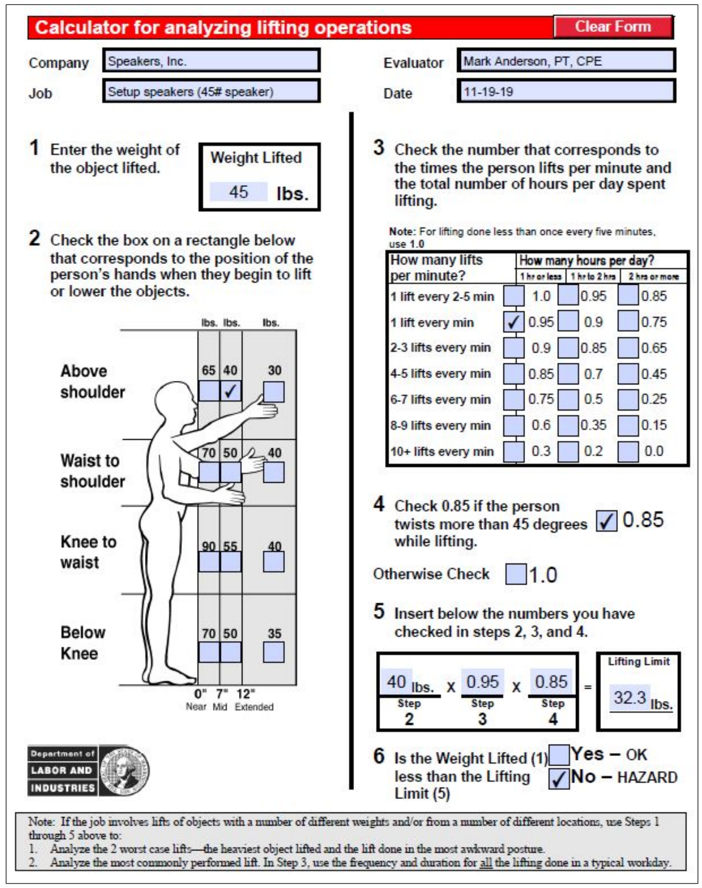
Lifts/min: 1

Hours/day: 1 hr or less

Twist: Yes

40# x 0.95 x 0.85 = 32.3#

Weight Lifted (45#) less than Lifting Limit (32.3#) NO – Hazard



Calculator for analyzing lifting operations — Clear Form

Company: Speakers, Inc. — Evaluator: Mark Anderson, PT, CPE

Job: Setup speakers (45# speaker) — Date: 11-19-19

1 Enter the weight of the object lifted. Weight Lifted: 45 lbs.

2 Check the box on a rectangle below that corresponds to the position of the person's hands when they begin to lift or lower the objects.

	0" Near (lbs.)	7" Mid (lbs.)	12" Extended (lbs.)
Above shoulder	65	40 ✓	30
Waist to shoulder	70	50	40
Knee to waist	90	55	40
Below Knee	70	50	35

3 Check the number that corresponds to the times the person lifts per minute and the total number of hours per day spent lifting.

Note: For lifting done less than once every five minutes, use 1.0

How many lifts per minute?	1 hr or less	1 hr to 2 hrs	2 hrs or more
1 lift every 2-5 min	1.0	0.95	0.85
1 lift every min	✓ 0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

4 Check 0.85 if the person twists more than 45 degrees while lifting. ✓ 0.85

Otherwise Check 1.0

5 Insert below the numbers you have checked in steps 2, 3, and 4.

40 lbs. (Step 2) x 0.95 (Step 3) x 0.85 (Step 4) = Lifting Limit 32.3 lbs.

6 Is the Weight Lifted (1) less than the Lifting Limit (5)? Yes – OK / ✓ No – HAZARD

Department of Labor and Industries

Note: If the job involves lifts of objects with a number of different weights and/or from a number of different locations, use Steps 1 through 5 above to:
1. Analyze the 2 worst case lifts—the heaviest object lifted and the lift done in the most awkward posture.
2. Analyze the most commonly performed lift. In Step 3, use the frequency and duration for all the lifting done in a typical workday.

Occupational Biomechanics Principles

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

Homework Assignment

Part of your homework assignment will be to analyze a lifting scenario using the LNI Lifting calculator.

Here are some tips:

- Review the ***basic criteria of the manual material handling*** event from above.
- If a range of weights is noted; for example, 30 to 40#, use the higher value in your calculations because it would be the "worst case".
- Carefully read the instructions to get all the details you need to complete the exercise.
- Use the ***LNI Lifting Calculator Worksheet Fillable PDF*** (from your training materials) for the assignment. You can certainly check out the on-line version we discussed; however, we would like to use the Worksheet to better understand how the calculator works.

Manual Material Handling Checklist

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

Manual Material Handling Checklist

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

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

NIOSH Work Practices Guide for Manual Lifting

We have provided an example below of how to use of the ***NIOSH Work Practices Guide for Manual Lifting*** that was initially introduced in 1981. Industry and government representatives recognized that manual material handling was a significant problem in industry and felt guidance in controlling how much weight could be safely lifted was needed.

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

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

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

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

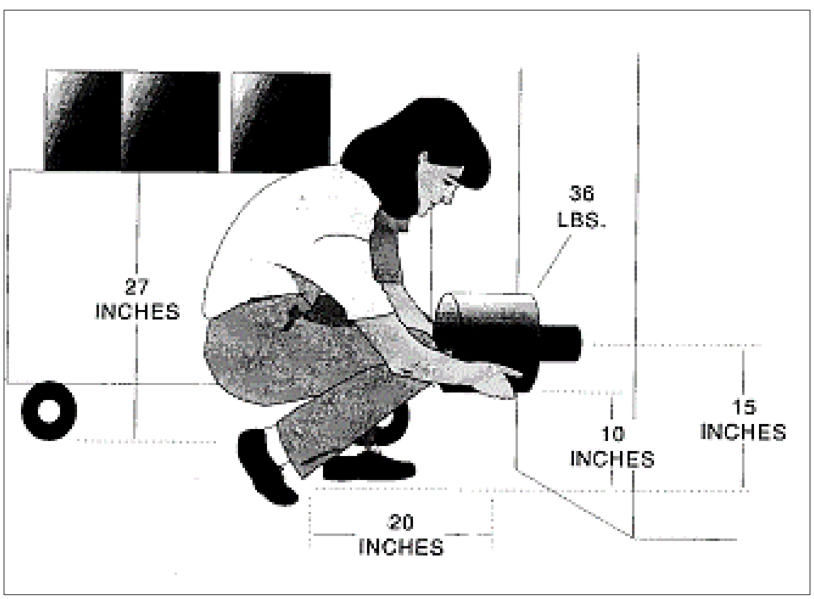
The **LI** is a relative estimate of the physical stress associated with a manual lifting job. As the magnitude of the LI increases, the level of the risk for a given worker increases, and a greater percentage of the workforce is likely to be at risk for developing lifting-related low back pain.

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

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

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

Example: Loading Supply Rolls (NIOSH Work Practices Guide for Manual Lifting)



JOB ANALYSIS WORKSHEET

DEPARTMENT Shipping
JOB TITLE Packager
ANALYST'S NAME
DATE

JOB DESCRIPTION Loading paper supply rolls

Example 2

STEP 1. Measure and record task variables

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

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

		LC		HM		VM		DM		AM		FM		CM		
ORIGIN	**RWL =**	51	×	.67	×	.98	×	.93	×	1.0	×	1.0	×	.90	=	28.0 **Lbs**
DESTINATION	**RWL =**	51	×	.50	×	.85	×	.93	×	1.0	×	1.0	×	.90	=	18.1 **Lbs**

STEP 3. Compute the LIFTING INDEX

ORIGIN LIFTING INDEX = $\frac{\text{OBJECT WEIGHT (L)}}{\text{RWL}} = \frac{35}{28.0} = 1.3$

DESTINATION LIFTING INDEX = $\frac{\text{OBJECT WEIGHT (L)}}{\text{RWL}} = \frac{35}{18.1} = 1.9$

Hazard Assessment Interpretation

The weight to be lifted (35 lbs.) is greater than the RWL at both the origin and destination of the lift (28.0 lbs. and 18 lbs., respectively). The LI at the origin is 35 lbs./28.0 lbs. or 1.3, and the LI at the destination is 35 lbs./18.1 lbs. or 1.9.

These values indicate that this job is only slightly stressful at the origin, but moderately stressful at the destination of the lift.

Redesign Suggestion

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

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

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

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

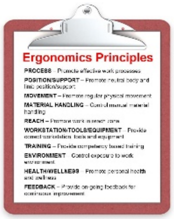
Thus, the final RWL would be increased from 18.1 lbs. to 30.8 lbs., and the LI at the destination would decrease from 1.9 to 1.1.

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

Comments

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

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



Promote Work in Reach Zone

Hand Use

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 at least 99.9% of the day!

Where do we tend to use our hands?

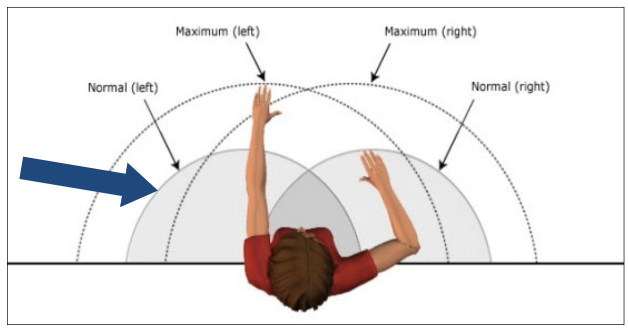
For example, does anybody work behind their back? Pretty hard to see what you're doing!

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

- Comfort Reach Zone
- Functional Reach Zone

Comfort Reach Zone

Think of the comfort reach zone as that area in front and to the side where you'd like to use 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.

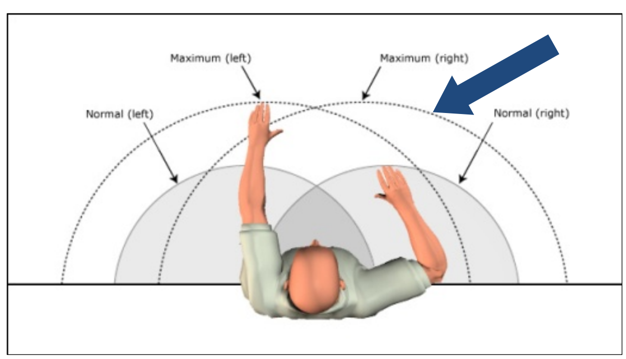
The height of this reach zone will be about three or 4 inches above and below your elbow level. This is your ***Comfort Reach Zone.***

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 will 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.

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

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

Anthropometry

How can we determine how far a person can reach 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. The word 'anthropometry' is derived from two Greek words:

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

Size and Shape

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

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

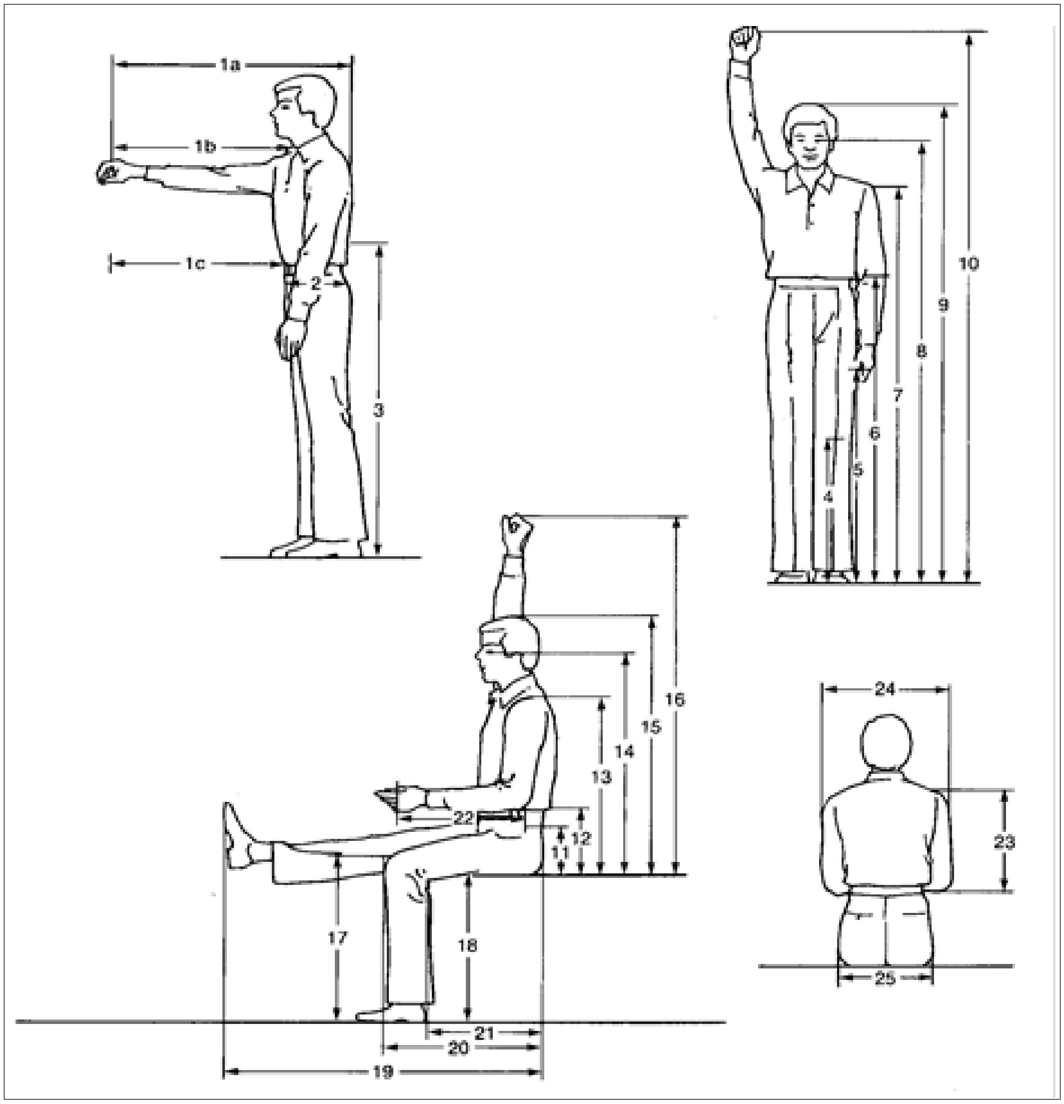
Data Tables

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

- Segment length
- Segment mass
- Center of mass location

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

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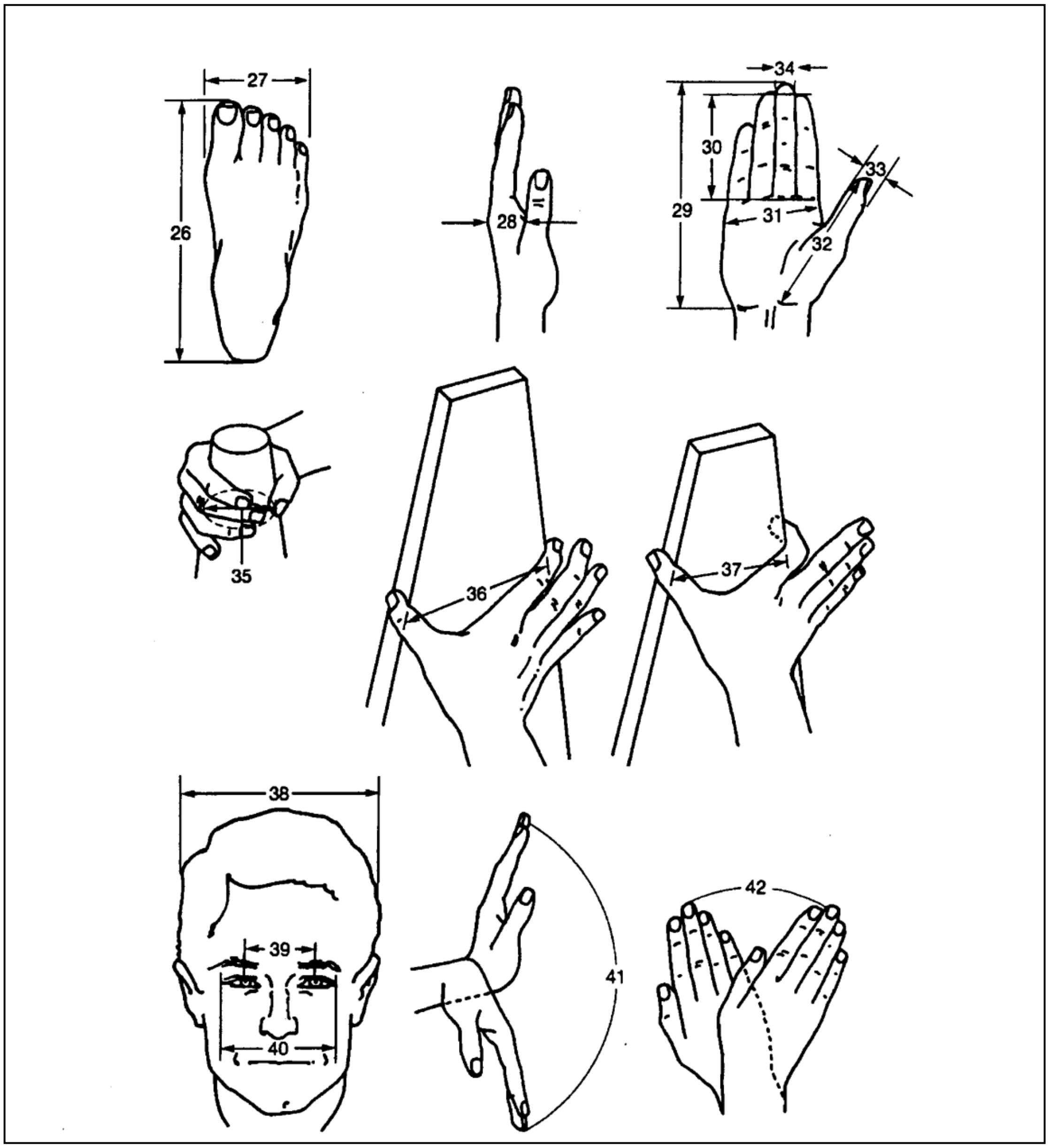
Anthropometry Data Tables

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

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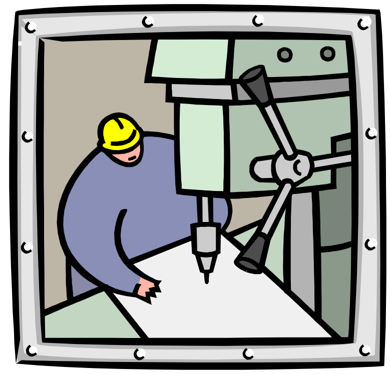
Anthropometry Data Tables

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

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

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

Work station Height

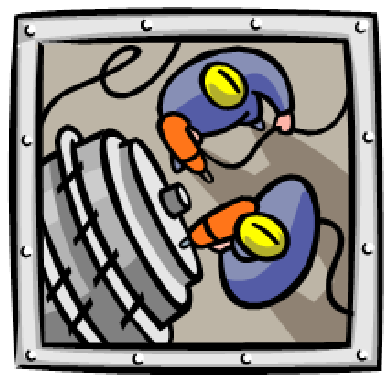


Returning to the engineer designing the work station, let's address the question of how high the work station should be. We could look for the tallest person and make sure the height accommodates that person. But, examining the tables we find that only a very few people are actually that height.

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

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

Work station Reach



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

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

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

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

Anthropometry Principles Summary

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

Design considerations

Ask any tall person trying to fit into an airplane seat or a short person trying to reach to a higher shelf and they will confirm the design considerations.

User Population

To make use of the data tables, the first design criterion is to define the user population. Is it predominately male or female? Northern European or Asian descent or, more than likely, a diverse combination?

The data base we use is primarily based on a Northern European data set. For a different population you may need to extrapolate the data.

For example, an Asian population will typically be of a shorter stature (about 3% or so.)

5th to 95th Percentile

General anthropometric guidelines promote design that attempts ***accommodation from the 5th percentile female to the 95th percentile male.*** Going through an example will illustrate how to access the data base and interpret the results.

Anthropometric Data Base (Excel Spreadsheet)

Let's introduce the ***Anthropometry Reference Data Base.xlsm***, (Excel spreadsheet found in your training materials)

Based on information from ***Ergonomic Design for People at Work, Vol 1, pp 299-310*** it was developed by Thomas E. Bernard, University of South Florida, College of Public Health, Tampa FL 33612-3805. It provides easy access to the data base.

A1 fx Anthropometric Measures -- Adult Population

Anthropometric Measures -- Adult Population

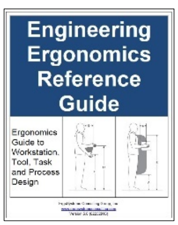
Job / Task Information -- Enter Useful Information in This Box -- See also comments in cells by placing curser over cells marked by red triangle in upper right corner.

Adult Population Mix (%)		Design Exclusion (%)
Men	Women	
0	100	5

in, lb — Find Values — Units: in, lb

If units are changed, push Find Values again.

Select Dimensions of Interest	Mean 50%ile	Limits (%ile) Minimum 5.0	Maximum 95.0	Range (%ile) Low 2.5	High 97.5
Frwd Func Reach - acromial process to pinch {1b}	24.6	22.4	26.8	22.0	27.3
Elbow-to-Fist Length {22}	13.7	12.2	15.2	11.9	15.5
Elbow Height - Stand {6}	40.4	37.3	43.5	36.7	44.1

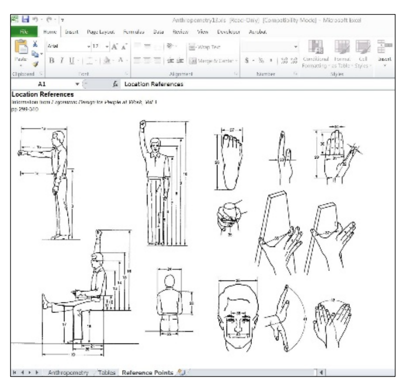


Anthropometric Case Study

A workbench is being designed for an assembly process. A diverse user population will perform light weight (up to 5#) repetitive assembly job tasks at elbow level from a standing position. ***Workbench height is the point of interest.*** Using anthropometric data, we can develop the design specifications for the workbench height.

Standing Workstation Guidelines and ***Standing Workstation Specifications*** are based on the anthropometric data and determined as follows.

Accessing the Anthropometric Data Base, in the ***Reference Points*** sheet in the Excel spreadsheet identify the metric of interest:



- ***Elbow height – Stand (6)*** (used to determine workbench height)

Select the ***Anthropometry*** sheet in the Excel spreadsheet. In the ***Select Dimensions of Interest*** pull down menu select:

- ***Elbow height – Stand (6)***

5th Percentile Female calculation:

- In the ***Adult Population Mix (%)*** input 0 for Men, Women 100 will be automatically input
- In the ***Design Exclusion (%)*** input 5, this will calculate 5th and 95th percentiles
- Click ***Find Values***

A1 | fx | Anthropometric Measures -- Adult Population

Anthropometric Measures -- Adult Population

Job / Task Information -- Enter Useful Information in This Box -- See also comments in cells by placing curser over cells marked by red triangle in upper right corner.

Adult Population Mix (%) Men	Adult Population Mix (%) Women	Design Exclusion (%)
0	100	5

in, lb | Find Values

If units are changed, push Find Values again.

Units: in, lb

Select Dimensions of Interest	Mean 50%ile	Limits (%ile) Minimum 5.0	Limits (%ile) Maximum 95.0	Range (%ile) Low 2.5	Range (%ile) High 97.5
Frwd Func Reach - acromial process to pinch {1b}	24.6	22.4	26.8	22.0	27.3
Elbow-to-Fist Length {22}	13.7	12.2	15.2	11.9	15.5
Elbow Height - Stand {6}	40.4	37.3	43.5	36.7	44.1

95th Percentile Male calculation:

- In the ***Adult Population Mix (%)*** input 100 for Men, Women 0 will be automatically input.
- In the ***Design Exclusion (%)*** input 5, this will calculate 5th and 95th percentiles
- Click ***Find Values***

A1 | fx | Anthropometric Measures -- Adult Population

Anthropometric Measures -- Adult Population

Job / Task Information -- Enter Useful Information in This Box -- See also comments in cells by placing curser over cells marked by red triangle in upper right corner.

Adult Population Mix (%) Men	Adult Population Mix (%) Women	Design Exclusion (%)
100	0	5

in, lb | Find Values

If units are changed, push Find Values again.

Units: in, lb

Select Dimensions of Interest	Mean 50%ile	Limits (%ile) Minimum 5.0	Limits (%ile) Maximum 95.0	Range (%ile) Low 2.5	Range (%ile) High 97.5
Frwd Func Reach - acromial process to pinch {1b}	25.1	22.4	27.9	21.8	28.5
Elbow-to-Fist Length {22}	15.2	13.8	16.5	13.5	16.8
Elbow Height - Stand {6}	43.5	40.6	46.5	40.1	47.0

Interpretation

For the 5th percentile female and the 95th percentile male, we now have determined standing elbow height (*Elbow height – Stand (6)).*

Workbench Height – Adjustable

So, with the 5th percentile female standing elbow height at 37.3" and the 95th percentile male at 46.5" we can specify the recommended range of adjustment of the workbench. Ideally the workbench will be **height adjustable and controlled by the user in the range of 36" to 48"** (1" buffer added to minimum and maximum height).

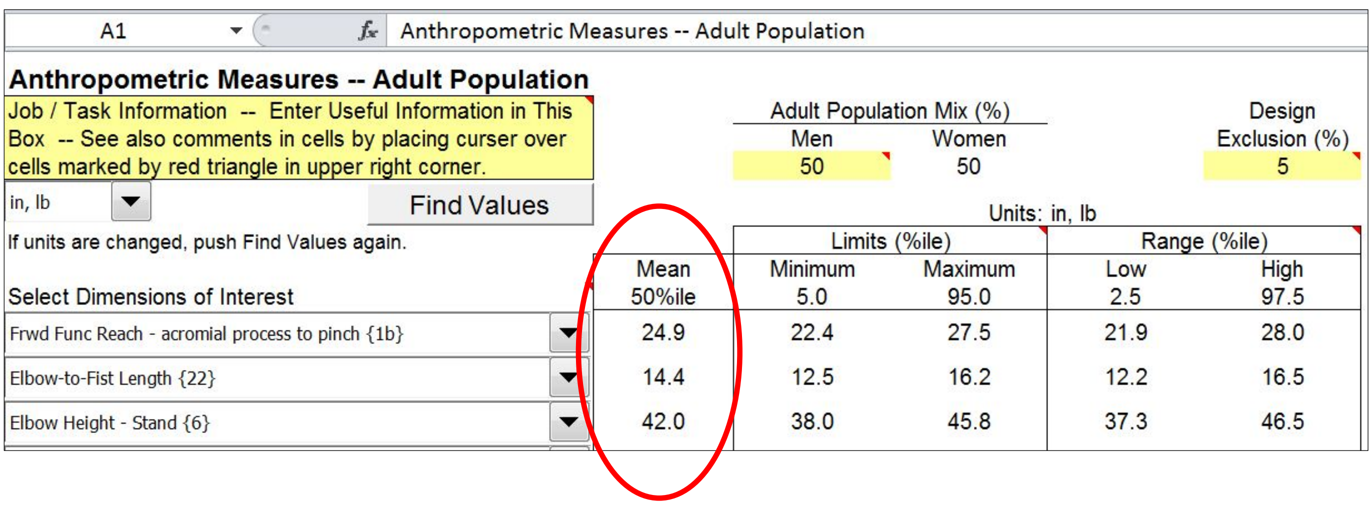
See the Caveats below for additional information.

Workbench Height - Fixed

If a height adjustable workbench is not an option, we have to consider what will be the most beneficial fixed height for all operators. We would like the operator to maintain a neutral upright body position as possible and operate within their power zone to handle tools, parts and materials. Here are some considerations:

- If the work bench height is set for the shorter individual at 37", this will force the taller individual to bend at the waist to position their hands at the workbench. This places their hands lower than their recommended power zone and increases biomechanical stress into the spine and shoulders.
- If the work bench height is set for the taller individual at 47", this will force the shorter individual to reach their hands up to the work bench. This places their hands higher than their recommended power zone and increases biomechanical and physiological stress into the shoulders and arms.

One option is to calculate the values for a mixed population of men and women. We can manipulate the *Adult Population Mix (%)* to consist of 50% men and 50% women.



A1 | Anthropometric Measures -- Adult Population

Anthropometric Measures -- Adult Population

Job / Task Information -- Enter Useful Information in This Box -- See also comments in cells by placing curser over cells marked by red triangle in upper right corner.

Adult Population Mix (%)		Design Exclusion (%)
Men	Women	
50	50	5

in, lb — Find Values

If units are changed, push Find Values again.

Units: in, lb

Select Dimensions of Interest	Mean 50%ile	Limits (%ile) Minimum 5.0	Maximum 95.0	Range (%ile) Low 2.5	High 97.5
Frwd Func Reach - acromial process to pinch {1b}	24.9	22.4	27.5	21.9	28.0
Elbow-to-Fist Length {22}	14.4	12.5	16.2	12.2	16.5
Elbow Height - Stand {6}	42.0	38.0	45.8	37.3	46.5

The ***Elbow Height – Stand 50th*** percentile for the mixed group would indicate a 42" workbench height:

- Some shorter individuals would be working in the top end of their power zone range.
- Some taller individuals would be working in the bottom end of their power zone range.

So, for a 50/50 Adult Population Mix, a 42" fixed workbench height could be a reasonable compromise.

We can also provide a foot platform for the shorter workers. Maximum recommended height of a single step foot platform is 6".

For a fixed height workbench at 42", a 6" foot platform would be comparable to a 5th percentile female working at workbench height of 36".

Honestly, we try to avoid the use of foot platforms based on issues of inadvertently stepping off the platform, need to move the platform in and out of position, etc.; but it can be a viable option when no alternative to a fixed height workbench exists.

Caveats

Higher Manual Handling Force Levels:

The case study was based on light weight (up to 5#) assembly activities. If higher force levels are required (> 5#) to manually lift parts/materials we have to be concerned about requiring shorter individuals to exert force in the upper part or even outside of their power zone, thereby compromising the arms and shoulders. We may need to ***lower the fixed workbench height or reconsider the need for a height adjustable workbench.***

Higher Downward Force Levels:

If a higher downward force is needed (e.g. using a torque wrench, pushing down on a part to get it to seat properly, etc.) ***the recommended workbench height would be 3 to 5" lower than elbow height*** and we would need to modify our interpretation accordingly; fixed height at 37" and adjustable height range of 32" to 44".

Task	Adjustable Height Workbench	Fixed Height Workbench
Precision	40" to 52"	45"
Light assembly	36" to 48"	42"
Heavy assembly	**32" to 44"**	**37"**

Precision Activities:

The case study was based on general assembly activities, not those that require a high level of precise hand and eye coordination.

For these situations, we need to position the parts/materials at a high enough level to limit excessive tilting the head down to see the activity.

We also may want to consider supporting the weight of the arms to unload the neck and shoulders.

In this case ***the recommended workbench height would be 3 to 5" higher than elbow height*** and we would need to modify our interpretation accordingly; fixed height at 45" and adjustable height range of 40" to 52".

Task	Adjustable Height Workbench	Fixed Height Workbench
Precision	**40" to 52"**	**45"**
Light assembly	36" to 48"	42"
Heavy assembly	32" to 44"	37"

NOTE: in all cases the actual size/placement of the object on the workbench needs to be considered. We recognize that "hand work height" is the determining factor; this may be different from the actual workbench height. For example, the object may have 6" of height and the hands may actually be placed 6" above the workbench height to accomplish the task.

Session One Homework Prep

Completion Requirements

To meet the completion requirements of this course (and get Continuing Education or Professional Development credit), you will need to attend both webinar sessions, complete several learning exercises and complete course evaluations for each of the 2 online sessions.

Please complete the ***Worksheets*** in this binder following this session and then submit the requested information from your homework by completing the **Session 1 Homework Test** in the CONTENT section of this course in the WorkWell Provider Learning Center.

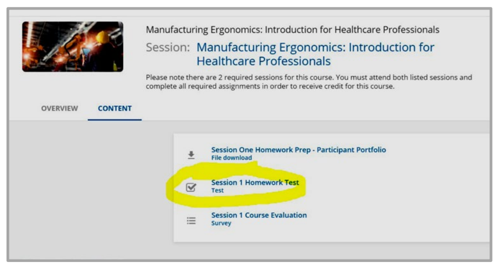
PLEASE CAREFULLY READ AND COMPLETE THE ENTIRE WORKSHEET PRIOR TO COMPLETING THE TEST IN WWW.WORKWELLPROVIDERTRAINING.COM.

Reporting Test Answers

When you have completed the worksheets and have about 15-20 minutes to enter the information, log in to http://www.workwellprovidertraining.com/ and complete the **Session 1 Homework Test**.

If you score below 80%, you may retake the test to achieve a passing score.

The test, along with the **Session 1 Course Evaluation** must be completed before attending Session 2 of the webinar. **If you have any questions, or need any clinical assistance, please email provider@workwellpc.com.**

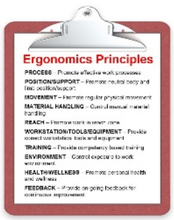


Worksheets include:

- Test questions included in Session 1 Homework Test
- LNI Lift Calculator Worksheet
  - o Exercise One: Low Lift
  - o Exercise Two: Pallet Top Lift
- Anthropometry Sit/Stand Workbench
  - o Exercise: Sit/Stand Workbench

The Worksheets are pdf-fillable forms. If you fill them out electronically, please save and print a copy of your pdf binder to reference as you complete the Session 1 Homework Test in www.workwellprovidertraining.com.

You will want to use the "save as" function and give your document a name.



Case Study – Solder Station

Repetitive hand soldering is what takes place at the Solder Station. Working with the engineer and technician of the area let's see what they came up with (with a little ergonomics guidance and encouragement).

Poll – Session One Homework

Provide Correct Workstations, Tools and Equipment

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

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

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.

Work Station

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

Stationary/Mobile

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

Adjustability features

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

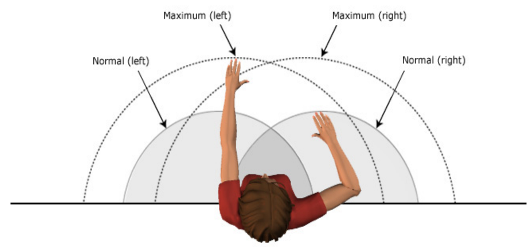
Work height

- Does the height of the work surface permit a comfortable view of the job being done?
- Is the height of the work surface adjustable?

- Does the height of the work surface permit satisfactory arm posture? (Correct hand height depends on type of work performed and object worked on.)

Work reach envelope

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



Chair/stool

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

Equipment controls

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

Worker movement

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

Space and clearance

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

Tools

Manual to Power

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

Torque reaction forces

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

Employ clutches and torque reaction bars to reduce torque reaction forces.

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

Handle size

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

Preventive Maintenance

Preventive maintenance, based on manufacturer specifications, is critical to ensure proper operation of the tool.

Sharp bits, blades, and un-clogged abrasives significantly reduce the force required to use manual or power tools.

Machinery/Equipment

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

Foot pedals

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

Hand controls

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

Personal Protective Equipment (PPE)

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

Mandatory

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

Monitoring and Enforcement

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

Physical Demands

Metabolic Load

- Does the job involve peak loads of muscular effort?

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

Force - Component Fit

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

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

Force - Lift/Push/Pull

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

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

Questions

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

Force – Lift/Push/Pull Intervention strategies

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

- Design job to reduce static muscle loading. (Provide jigs, fixtures, clamps, spot welds, etc. to hold work object.)
- Workers learn how to better control static muscle loading. (Body mechanics, stretching, etc.)
- Make use of mechanical devices, hoists, lifts, etc. to eliminate manual lifting.
- Slide rather than lifting the weight.

- Eliminate the effect of gravity by counterbalancing the weight, a method commonly used with tools.
- Remove physical barriers, thereby reducing the horizontal distance (long lever arm).
- Relocate storage heights with heavier objects stored between mid- thigh and waist height.
- Work with vendors to provide material either in smaller unit weights (e.g., 50 pounds, rather than 100 pounds) or in bulk that requires handling with mechanical means.
- Provide adjustable height surfaces (e.g., scissors tables) to maintain desired height of material.
- Reposition the worker to provide greater mechanical advantage; e.g., use body weight rather than musculoskeletal strength.
- Reposition the work material; e.g., bring parts and tools within reach envelope; place bin on a bin tipper or provide side drop-down bins

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

- Line storage shelves with decreased friction liners (e.g., Teflon sheets).
- Spray-on products will reduce friction (may cause a toxic substance problem.)
- Use roller conveyor systems to transport materials.
- Maintain the quality of floor conditions to eliminate cracks and general deterioration.
- Use appropriate type and size of casters or wheels as original equipment or retrofit, depending on floor type.

Force - Workflow and Rate

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

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

Force - Grip

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

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

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

Questions:

Is a power grip used?

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

Is a pinch grip used?

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

Coefficient of Friction

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

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

Glove use

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

Generally, a gloved hand is able to produce a maximum of 25% to 30% less force than an ungloved hand. A ***"one size fits all"*** policy does not work. Gloves that are too small increase the force required to overcome the resistance of the glove. Gloves that are too large hinder dexterity due to sloppiness of fit.

Position

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

Prolonged or repeated non-neutral spinal positions

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

Focus on why we see the out-of-neutral spine positions. What is driving them and what can be done to mediate them.

Wrist deviations greater than 15 degrees from neutral

You can demonstrate the neutral position at the wrist by making a tight fist. This results in approximately 5 degrees of extension in most people and is the position of power for the wrist. As the wrist moves away from this power position, the finger flexor tendons increase their contact against the carpal ligament or bones of the wrist. This increased contact may result in inflammation, and the pressure within the carpal tunnel may increase.

Forearm rotation

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

By the ways, those cookies tasted quite good!

Elbows sustained above mid-chest height

Elbows positioned above mid-chest height place additional stress on the shoulder when prolonged muscle contractions are required.

In addition to inefficient use of energy, these positions also tend to cause a reduction in blood flow to the tendons in the shoulder. Called, “elbows up”, this position is a good indicator of a mismatch between worker and work height.

Reaching frequently behind the body or above the shoulders

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

Acceptable ergonomics workstation should work to eliminate reaching behind the body.

Optimizing Work Positions

Standing work position

When does it make sense to stand at a workbench?

Standing positions are more appropriate than sitting positions if:

- Frequent or relatively heavy lifting is required.
- Significant downward forces are required.

Workbenches may be modified in any number of ways. In this example look for the 2x4 approach (wooden blocks placed under the bench legs). Of course, ensure the workbench remains stable.

Seated work position

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

The concept from a functional perspective is termed, “Proximal stability for distal precision.”

In other words, a stable core of the body supported by the seating systems provides for greater control and dexterity of the head and hands when precision assembly work is accomplished.

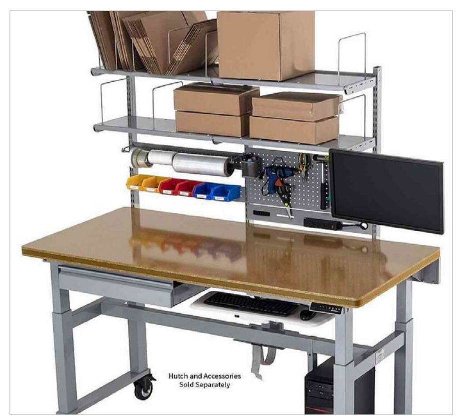
Sit/Stand work positions

In some cases, sit/stand work stations may provide a viable option. These provide for postural variability with an option to switch between seated and standing positions.

Lean platforms can be incorporated to provide for weight bearing relief of the major weight bearing joints and still allow for a standing height work position.

The worker needs to establish the correct relationship between themselves and the workbench.

Adjustable height work stations



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

More and more workstations are making use of height adjustability between seated positions with the feet on the floor and standing.

Powered options (electric-hydraulic) are the way to go to make it easy to make the switch; with hand crank models limited use has been observed.

Turntables

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

They work well in manufacturing workplaces to allow work within the recommended Comfort Reach Zone.

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

Movement

Even relatively well-designed ergonomic work stations require individuals to work in one posture.

Evaluation of the work place should include an assessment of how often individuals have the opportunity to move out of sustained postures to perform other movements or tasks.

As human beings we have an instinctive need to physically move on a regular and consistent basis.

Tool use and postures

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

In-line grip

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

Pistol grip

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

Ergonomically designed tools

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

Rapid machine pacing in an assembly task

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

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

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

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

Reach envelope

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

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

Storage locations

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

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

Repetition

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

Mechanical Aids

Reduce repetition rates through the use of mechanical aids:

- Introducing power tools in the work place may reduce duration of forceful contractions and awkward and sustained positions.
- Mechanical aids can also automate all or parts of a work process.
- The operator's exposure to the stresses associated with high repetition is reduced without reducing the output.

Worker Rotation

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

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

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

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

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

Repetition - Pacing

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

Repetition - Manual Handling

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

Repetition - Arm/Hand

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

Repetition - Tool Use

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

Vibration

Whole body vibration

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

Questions:

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

Segmental Vibration

Segmental vibration is typically found in tasks that require the use of abrasive wheels, grinders, lathes, and power hand tools.

Vibration from these sources has been shown to decrease sensitivity in the hand, resulting in an unnecessary increase in local muscle contractions.

Associated with other factors

As with force, posture, repetition, and contact stress, vibration is frequently associated with other risk factors.

Assess the duration of the exposure, the exposure patterns during the shift, and the force levels and postures assumed during the vibration exposure.

Fastener types

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

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

Questions

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

Control vibration

Source control

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

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

Path control

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

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

Case Study – Slag Removal

Slag removal is a hand intensive process where carbon slag that builds up inside a canister as result of a manufacturing process needs to be removed so the canister can be put back into service.

Let's take a look at how the process had been accomplished, brain storm on some potential modifications and then take a look what changes were made.

Contact Stress - Sharp edge

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

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

Control strategies - round edges

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

Questions:

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

Use of the hands for pounding

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

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

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

Hands are NOT HAMMERS!

Contact Stress – Sitting and Standing

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

Evaluate chairs by observing pressure at the front of the seat pan and the position of the backrest.

Evaluate the potential for pressure behind the knee or at the back of the thigh caused by the edge of the seat pan.

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

Concrete, steel grates, uneven or vibrating floor surfaces may increase foot, leg or spinal fatigue and discomfort and can affect concentration and product quality.

Anti-fatigue mats or shock absorbing shoe inserts can improve comfort levels.

Questions:

Contact Stress - Hard surface

- Must the worker stand on a hard surface for 50 percent or more of the work shift?
- Is the texture of the work surface comfortable, taking into account hardness, elasticity, color and smoothness?

Mental Demands

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

Is the task complex?

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

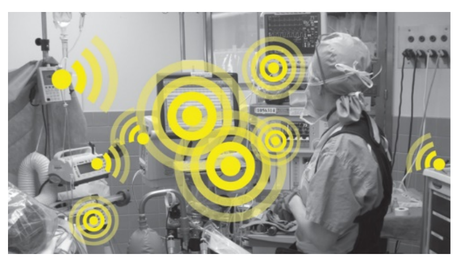
Is the task monotonous?

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

Design and Use Standards

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

Perceptual Demands



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

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

Illumination

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

Also, consider the overall quality and level of the light in relation to the color and reflectivity of the walls, floors, and ceilings. Glare is a commonly observed problem in office environments where it is apparent on video displays.

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

Illumination - General

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

Illumination - Task

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

Illumination - Contrast

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

Illumination - Glare

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

Auditory

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

Touch

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

Visual Acuity

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

Preventive Maintenance

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

Regular schedule

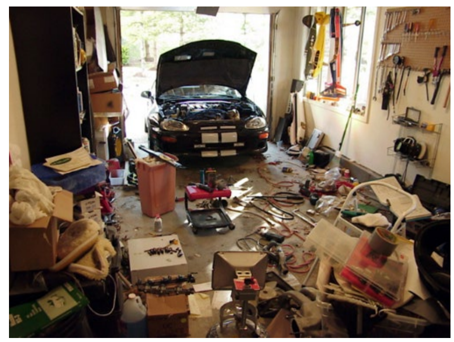
- Is there a regular maintenance schedule?

Ease of maintenance

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

Housekeeping

General



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

Work station

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

Workstation, Tools and Equipment Checklists

Work Station

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

Tools

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

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

Equipment

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

Workstation Checklist

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

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

Tool Checklist

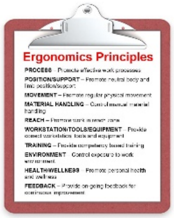
"NO" response indicates potential problem areas that should receive further investigation.

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

Equipment Checklist

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

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



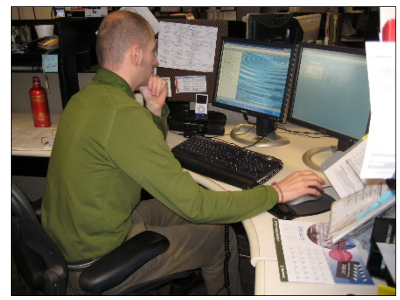
Provide Competency Based Training

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

Results not Achieved?

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

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

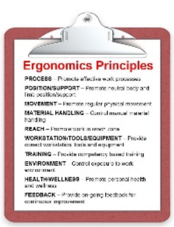


To give you an example. A company purchased new fully featured ergonomics office chairs. They were delivered and put into use. A short while later during an ergonomics audit it was determined that no one had adjusted the chairs for their specific needs.

They hadn't received any instruction in how to use the chairs - they just sat down and went to work. In fact, a number of individuals reported they actually felt intimidated by the chair and all of its "bells and whistles"!

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

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



Control Exposure to Work Environment

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

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

Environment

Cold

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

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

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

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

Heat

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

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

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

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

Air

Temperature

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

Quality

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

Flow

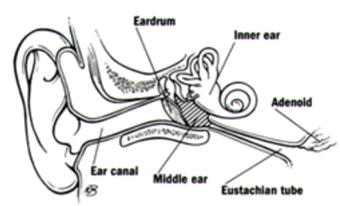
- Is air circulation too low?
- Is there too much air movement?
- Are workers exposed to rapid environmental changes?

Humidity

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

Noise

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



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

For example:

- 60 dB - social conversation.
- 80 dB - conversing in loud noise less than one foot away.
- 105 dB - jet engine.
- 150 dB - reduced visual acuity, chest wall vibration, "gagging" sensation.

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

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

Noise Abatement

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

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

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

Noise - Questions

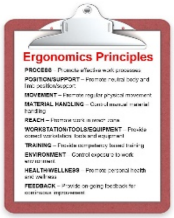
- Is there so much process noise that hearing loss could occur?
- Is there so much noise that it interferes with speech or audible signals of various kinds?
- Are there noise levels that interfere with conversation or performing the job?
- Is the noise level high enough to cause hearing loss?

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

Environment Checklist

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

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



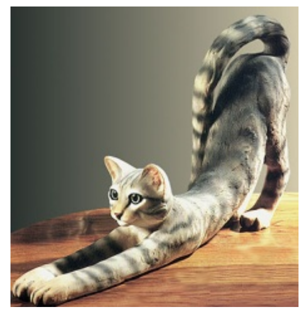
Promote Health and Wellness!

What is the most important tool we all own?

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

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

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

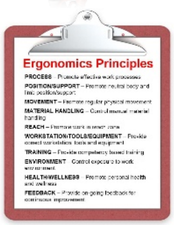


For example: movement helps to control fatigue by relieving awkward and sustained positions and promoting circulation to the body's tissues.

Who has dogs or cats at home? When they first get up from a little nap what is the first thing they do?

We have an instinctive need to move . . . we just need to pay attention to it.

Poll – Health and Wellness



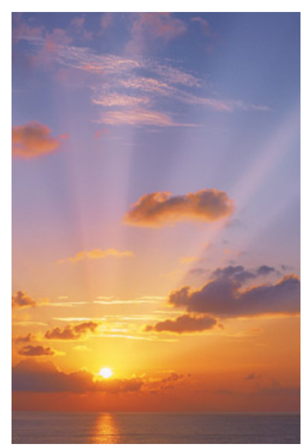
Provide On-going Feedback and Follow-up

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

100% Correct the First Time?

In your experience does any new process work 100% correctly out of the gate?

Even with the best up-front planning there will be unintended consequences, something will vary from the plan. This is why providing on-going feedback as part of the follow-up process is so critical.



Schedule formal follow-up sessions at regularly intervals; for example, one week post-implementation and then one month, six months and one year.

Document the outcome of the follow-up, very importantly alleviate the issues identified in a timely manner and publicize the lessons learned.

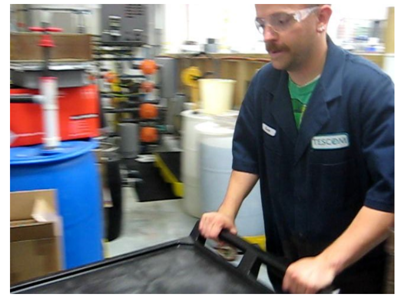
Continuous Process Improvement and Ergonomics

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

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

Ergonomics Problem Solving Principles

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



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

Caveats

Design dictates performance

Placing a toolbox on a floor promotes poor technique to remove the tools. Body mechanics training may be ineffective in promoting proper technique.

The successful response involves repositioning the toolbox to waist height to promote the desired technique. You can apply this concept in any workplace for any ergonomics problem.

Understand and make productive use of human behavior

The study of human behavior is a most fascinating and frustrating field of study. There are reasons why we do what we do; sometimes we just cannot figure out what they are! It is possible, however, to understand human behavior at some level, and to use this knowledge in a productive way.

If we offer a solution that is contrary to the nature of human behavior, the solution will not be effective.

Do not fix without adequate analysis!

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

Perform an adequate analysis before offering recommendations.

Always ask why!

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

Don't generalize from a sample of one!

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

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

Scope of Influence

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

Overcome resistance to change

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

Creating positive change

In your experience have you found that people in general like change, they embrace change?

Or for many people do they hate change. It seems that change is difficult for many people.

Recall what we want to accomplish with ergonomics.

We need to CHANGE the circumstances to CHANGE the response!

Creating positive change is truly the core of any successful ergonomics process. Work through this exercise. Pull from your own experiences with change. Consider why people resist change and what can be done to facilitate change.

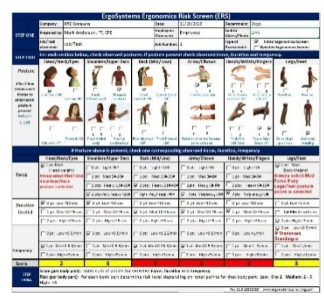
Poll – Why do people resist change?

Why do people resist change?	How to facilitate change!

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

ERGONOMICS RISK SCREEN – TUTORIAL

Overview



ErgoSystems Ergonomics Risk Screen (ERS) is a posture based assessment protocol intended to provide an overview assessment of the relative risk of ergonomics related factors in the physical performance of specific repetitive job tasks. The ERS makes use of an Excel spreadsheet for documentation and calculation purposes.

Primary ergonomics factors of **Posture, Force** and **Repetition (Duration and Frequency)** are scored along with other factors (**Training, Workstation Design, Tool and Equipment Use, Environmental Factors, etc**.) that are scored to help identify the root cause of the primary ergonomics risk factors.

The ERS is numerically scored. A score of 0 to 1 is considered ***Low Relative Risk*** (indicated by GREEN), a score of 2 to 3 is considered ***Medium Relative Risk*** (indicated by YELLOW) and 4 and higher is considered ***High Relative Risk*** (indicated by RED).

A ***Weighted Time on Task*** modifier is also calculated based on overall exposure.

The ERS can be used as an ***Action Plan*** to document and track recommended ***Corrective Actions***.

Step One – Identify the ERSs to be Conducted

ERS Breakdown Determination

A basic question is:

'For a specific job task how many different ERSs do you need to conduct to capture the needed information?'

The basic answer is:

'The job tasks assessed with the ERS need to be discrete enough to provide a focused examination of the physical demands of the job tasks.'

For example, let's say the assembly process has five separate steps. Each step involves quite different physical demands. If you attempt to use one ERS to capture all five steps it will not have the depth of task specificity necessary to drill down to the level needed. There is simply just too much going on in a broad manner.

In our example, you will probably end up with five ERSs. An exception to this is if you identify some steps are essentially the same in terms of physical demand (including exposure) you can group these steps together in an amalgamated ERS.

Develop Task Inventory

As you plan for the ERS process develop the ***Task Inventory***. This is a list of the separate ERSs you will need to conduct. Typically, you will work with the company representative (Safety Manager, Supervisor, Health Professional, etc.) to put together the Inventory. This will ensure you are well organized and efficient in the data collection phase of the ERS.

Prepare ERS Worksheets

Once you have determined the extent of the Task Inventory, prepare the needed ERS worksheets. Depending on how you plan on collecting the data, you will either prepare printed out ERS Worksheets for each ERS and write in basic information as you collect the data OR you may bring a laptop in and fill in the Excel spreadsheet as you collect the data.

Our preference is to use the printed ERS Worksheet approach. It is fast while on-site and also provides opportunity for written notes you can refer to as you finalize the ERS report.

Step Two – Ergonomics Analysis Tool Box

Put together your **ERS Tool Box**; it will have several trays.

Personal Protective Equipment

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

Don't take it for granted; communicate with your company contact to understand what the company requirements are.

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

Measurement Devices

To take measurements of the workplace, you'll need:

- Stopwatch
- Tape measure
- Force gauge
- Photographic equipment (still/video camera, etc.)

Typically, you must get approval for the pictures from the appropriate individuals, including the person being assessed, supervisors, managers, etc. In a few cases a written release may be needed.

And in some cases, due to the proprietary nature of the workspace, pictures may not be allowed at all.

Why use Video?

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

- Using video is one of the best ways to document an ergonomics analysis.
- You can study the video over and over again at a later date.
- You can show the video to other interested parties for their input.

Video "Secrets"

Don't be accused of making home videos, follow these guidelines.

- We suggest a camera with a flip-out view finder. This allows you to position the camera to get the shot and still see the view finder.
- Use enough light; low light causes grainy video that is hard to analyze. If you know you will be in a low light area, see if you can obtain more light in the area.
- Use a tripod or monopod as much as you can. You will get much better quality video.
- A monopod works very well to get overhead shots. A swivel ballhead mounted between the camera and the monopod works well. A wide angle lens will allow you to work in close quarters.
- If you have to use a handheld technique, build a bridge with your arm against your body for stability.
- Always have a backup power supply; either additional battery packs or able to run off of wall current with the AC adapter.
- Plan your video sequence. Think ahead to know what shots you want.
- Use the zoom sparingly. Zooming in and out in and out will drive your audience crazy.
- Use manual focus (if available) to stop the auto focus from searching.
- Pan (move from side to side) the camera about three times more slowly than what your eyes can track.
- After videoing a few seconds, check to make sure the camcorder is working correctly. We have learned this the hard way!
- In a loud environment, use a separate microphone to pick up interviews.
- Be aware of your surroundings; don't walk into equipment, people, etc. We always have someone watching "our backs" to keep us out of trouble.

Videotaping Sequence

- Inform any people being videoed of your purposes.
- Record the date and time, this will also be captured on the video by the camera.
- Say the name of the job or task description on the audio portion of the video at the beginning of each task. You can also use the audio to take notes; just remember you need to view the video later to get the information.
- In the viewfinder, frame an overview of the job to "set the stage."
- Capture 5 to 6 cycles of the repetitive tasks. This will allow you time the tasks when you view the video later.
- Reposition the camera to get back, side and diagonal views. If possible, get an

overhead view.

- Video as many different workers as you need to get an accurate portrayal of the job. You want a representative sample of the workers doing the job
- Get close up views of each of the separate job tasks and identified issues
- If needed, video the tasks immediately before and after the task being reviewed – this may also lend additional insight.
- After you have videoed the job tasks, interview the worker and other company representatives to gain their input. DO NOT ask leading questions. Be wary of sharing your opinions about the job task at this time. You don't want to bias their comments.

Background Materials

Identify the proper background materials to have available. This includes the ERS Task Inventory, your ERS Worksheets and may also include job descriptions, sketch of the floor plan or layout, organizational chart, check lists, clipboard or notepad.

Clipboards

A word about clipboards and notepads. Some employees may associate clipboards with inspections and will have some concerns. We generally have the ERS Worksheets in a 3-ring binder. We always make sure the workers being observed are aware we are NOT inspectors; we are there to look at ergonomics factors with the intent to help improve the comfort level, health and safety of the worker and workplace.

Set of Objectives

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

- What are the outcome objectives?
- Make sure you bring an "open mind.

Do not hesitate to ask questions. In fact, you will find most people will tell you a lot about the job and issues they may have if you simply ask them to help you understand what they do. We often put ourselves in the role of ***"New Employee"*** and ask the worker to provide ***"Training".***

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

Step Three – Prep for ERS Data Collection

Schedule the ERSs

Working with the appropriate company representative schedule the ERS data collection. Ensure through the company representative, the employees you are observing have been informed of the data collection process.

Estimate Time

Estimate the time needed on-site to collect the data. This is made easier with the Task Inventory because you will know how many ERSs you will be doing.

Repetitive Manufacturing Tasks

You will find repetitive manufacturing jobs with short duty cycles can be done quickly. For example, the duty cycle for the task is 30 seconds. Let's say you want 2 cycles each of the side, back, front and overhead views. This is 8 cycles, so you are talking about 4 to 5 minutes for the overview. Add another 10 minutes get the closeup shots and final interview. Then add another 5 to 10 minutes to get the measurements you need.

So far, we have about 25 to 30 minutes total. Then add a 5 to 10 minute buffer to take any notes needed. So bottom line is about 30 to 40 minutes in total.

Other Tasks

If the tasks for the ERS are for example in the Maintenance Department. They may be performed on an infrequent basis; weekly or monthly or even yearly. In this case you can either spend a year with them to collect the data OR you ask them to set up task simulations that adequately represent the physical demands of the tasks. This simulation strategy works with a little preparation upfront.

Step Four – Obtain Data (Video, Interviews, Measurements)

Using the strategies discussed above to obtain the onsite video, interviews, measurements, fill out ERS worksheets, etc. Compare experienced faster and injury-free workers with those who are inexperienced, fatigued, uncomfortable or reporting pain or injury. Determine if there are differences in work technique among these groups.

Step Five – Complete ERS Worksheet and Report

Let's go step-by-step through completing the ERS Worksheet. Look for tips about how to efficiently interpret the data. The ERS Worksheet is in the Excel spreadsheet format.

Open the ERS Worksheet Template and save the file with an appropriate name.

ERS Step One – Background Information

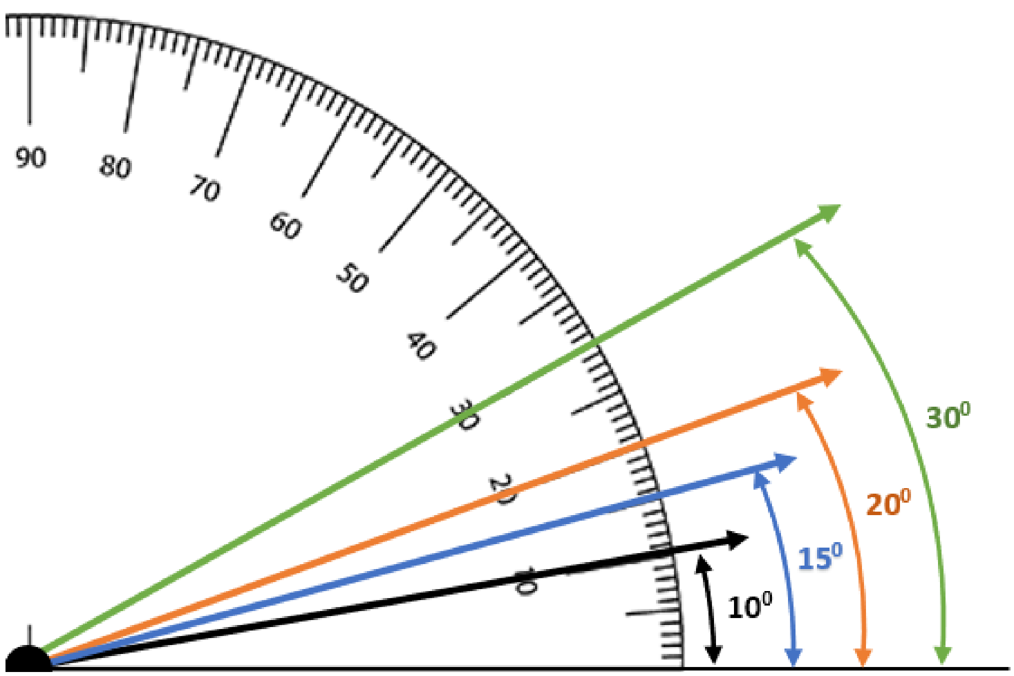
Company:	Enter the Company name and contact information.
Prepared by:	Enter the name and contact information of person conducting the ERS.
Job/Task observed:	Enter the name of the job/task being observed; try to use the existing name if available. Sometimes you may need to make up a descriptive name.
Date:	Enter the date the ERS data collection took place.
Employees observed:	Enter the names of Employees observed if available.
Job Number:	If the company has a specific job/task number in their system enter it to keep track of the ERS. Otherwise enter an ERS Job Number of your nomenclature. (e.g. #001)
Department:	Enter the Department name where the ERS was conducted.
Link to Video/Photo:	Enter the Link to the folder that contains the video/photo files. The complete ERS report will include the ERS Worksheet and any associated files.
Type of Assessment	Check the appropriate box indicating if this ERS is the Initial ERS or an Updated ERS/

ERS Step Two – Posture, Force, Duration, Frequency and Time Weighted Multiplier

Posture

Based on your observations check the appropriate boxes that for each of the posture sections. Essentially you are looking for out-of-neutral postures more than a defined amount. Is it possible to use a goniometer to obtain the measures (either by direct measurement or by way of video), but honestly the best strategy is to estimate them by eye. Don't agonize over 19 or 21 degrees when the guideline indicates 20 degrees. If it is about 20 degrees or more, that is accurate enough.

With a little practice you can get quite good at estimating angles.



Head/Neck/Eyes

Identify head and neck positions that are out-of-neutral as indicated.

Shoulders/Upper Back

Identify out-of-neutral positions that have impact on the shoulders and upper back. Think of this as impacting the shoulder girdle influenced by upper extremity position to accomplish the task at hand.

Back (Mid/Low)

Identify out-of-neutral mid and low back positions that impact the core of the body.

Arms/Elbows

Fully extended arms involve reaching out from the trunk with the elbows extended to reach to and/or handle materials.

Rotation of the wrists/forearms, palms up/down involves tasks that require alternating between palms up and down position (pronation and supination). Examples include wringing water out of towel or turning a screwdriver.

Hands/Wrists/Fingers

Identify out-of-neutral wrist positions to accomplish the task at hand.

Identify pinch and power grip hand activities.

Pinch Grip – The fingers are on one side of an object, and the thumb is on the other. Typically, an object lifted in a pinch grip does not touch the palm.

Power Grip – Formed with the fingers and the palm of the hand in order to move or manipulate objects.

Legs/Feet

Squatting – Defined as bending the hips and knees.

Kneeling – Defined as bearing body weight through one knee or both; either stationary or 'walking on the knees'.

On one leg/up on toes – Defined as standing on one leg only or up on the toes, for example to reach to a higher level.

Stationary Standing – Defined as standing in one position within a confined space for more than 10 minutes. Person can shift body weight from one leg to the other but not able to take steps away from the position.

Force

Material Handling

For each of the posture categories check the appropriate box based on the measured and/or estimated force levels. Force can be generated in a variety of ways:

- Body and extremity weight only – muscular force required to move and position body/extremities
- Material handling (lifting) – objects are lifted/lowered manually
- Material handling (push/pull) – objects are moved via push and/or pull forces (e.g. moving a cart and pushing on wrench handle)

Lifting force requirements can be determined through use of a force gauge or scale to determine the weight of the object.

Push/Pull force requirements can be measured with a force gauge. Typically, you will want to do three trials to get a consistent outcome and take the average of the three.

Hand Grasp (pinch and power)

Hand grasp force requirements involving pinch and power grips are more challenging to obtain. Here are some strategies:

- ***Tool specifications*** – some hand tools may have published force requirements to activate. For example, a hand stapler manufacturer may list them in the tool specs.
- ***Indirect measurements*** – using grip and pinch dynamometers you can obtain a reasonable indirect measurement by first performing the grip or pinch task as typically performed and then simulate the task using the grip or pinch dynamometer.

  Essentially you are using the body's neuromuscular sensory system as a measurement device. Typically, you will want to do three trials to get a consistent outcome and take the average of the three.

We'll go through each category to provide specific details.

Head/Neck/Eyes

Always select ***1 pt: Med*** if any Head/Neck posture is checked in the Posture section. This takes into account the weight of the head (about 6 to 7% of body, in the typical range of 8 to 14#) and the impact on the body to support the head in the out-of-neutral position.

Shoulders/Upper Back

If any of the postures are checked, estimate the load either imposed on the shoulders and upper back or required to be generated by the muscle groups of the shoulders/upper back.

Hands at/above head:

- If only reaching overhead with both arms without any object involved, check ***2 pts: Heavy 11# to 20#*** to account for the weight of both arms being held overhead. An upper extremity weighs about 5 to 6% of body weight.
- If only reaching overhead with only one arm without any object involved, check ***1 pt: Med 5# to 10#*** to account for the weight of one arm being held overhead. An upper extremity weighs about 5 to 6% of body weight.
- If an object is being handled, weigh the object and score appropriately based on the weight of the object.

Shrugged shoulders

- Determine the weight of the object being lifted or held in position that results in the shrugged shoulder position

Reach behind body

- If only reaching behind the body with one arm without any object involved, check ***1 pt: Med 5# to 10#*** to account for the weight of the arm. An upper extremity weighs about 5 to 6% of body weight.
- If an object is being handled, weigh the object and score appropriately based on the weight of the object.

Reach at shoulder level

- If only reaching at shoulder level with one arm without any object involved, check ***1 pt: Med 5# to 10#*** to account for the weight of the arm. An upper extremity weighs about 5 to 6% of body weight.
- If reaching at shoulder level with both arms without any object involved, check ***1 pt: Med 11# to 20#*** to account for the weight of the arm. An upper extremity weighs about 5 to 6% of body weight.
- If an object is being handled, weigh the object and score appropriately based on the weight of the object.

Back (Mid/Low)

If any of the postures are checked, estimate the load either imposed on the back (low/mid) or required to be generated by the muscle groups of the back (low/mid).

If no object is being handled check ***0 pt: Light <20#.*** The Duration and Frequency scoring will pick up the extent of the stress from the postures.

If an object is being handled, weigh the object and score appropriately based on the weight of the object.

If an object is being pushed or pulled, determine the force requirements and score appropriately.

Arms/Elbows

Estimate the force required to perform the tasks involving the arms reaching out from the trunk with the elbows extended to reach to and/or handle materials. Consider the weight of objects being handling and/or manipulated.

Estimate the force required to rotate the wrists/forearms, palms up/down to accomplish the tasks. Consider the weight of objects being handling and/or manipulated.

Hands/Wrists/Fingers

For the out-of-neutral wrist positions estimate the force involved. Refer to the ***Hand Grasp (Pinch and Power)*** section above for additional information.

Legs/Feet

Always select ***1 pt: Med*** if any Legs/Feet position is checked in the Posture section. This takes into account the weight of the body on the weight bearing joints (spine, hips, knees, ankles and feet.

Duration (static)

For each of the Posture categories score the Duration based on the indicated point system.

The scoring is same for all the categories except for Legs/Feet. Recall the Stationary Standing box was checked if greater than 10 minutes was identified. If so, for Duration check ***2 pts: High > 5 min.***

Frequency

Frequency is determined by how often the identified positions occurs. Reviewing the video is the best way to determine frequency; you can time the task based on the time code on the video.

The scoring system varies a bit across the postures. This is a reflection of the different impact frequency has on different body parts.

For example, a ***Flexed Forward Back (Mid/Low)*** posture frequency of 5/minute would involve significantly more physiological effort than 5/minute for the Hands/Wrists/Fingers.

Take a moment to look at the nomenclature used.

- 0.5/min equates to once every 2 minutes
- 0.25/min equates to once every 4 minutes

For ***Legs/Feet***, if ***Stationary Standing > 10 min*** is checked in the Posture section, the Frequency is checked as ***0 Pt Low < 2 min*** because we have already accounted for it in the Duration category.

Time Weighted Multiplier

Recalling that Exposure is an important factor in assessing overall relative risk the next step is to apply the Time Weighted Multiplier (TWM). The TWM reflects the amount of exposure of each category in terms of hours/day. The breakdown is:

- 1 hr or less (0.75)
- 1 to 2 hrs (1.0)
- 2 to 4 hrs (1.25)
- 4 + hrs (1.5)

When you perform the data collection obtain the needed information to be able to fill in the TWM.

ERS Step Three – Raw and Weighted Score

The Raw and Weighted Scores have now been calculated per body part.

ERS Step Four – Other Factors

In ***Step Four – Other Factors*** we examine a number of other factors that influence the performance of the task. Each Other Factor we identify as issue receives one point in the Other Factors score.

One way to think about Step Four is it helps us get to the underlying reasons why we saw the scores we saw in Step Two. For example, we may have identified a **RED** score in the

Back (Low/Mid) section due ***Flexed Forward > 20 degrees***. In ***Step Four*** we identify the ***Worksurface Height is too low***. This information also leads in directions of potential intervention recommendations.

Let's review the ***Other Factor***s and offer some tips to complete the Step.

General Factors

Production/Quality

Production/Quality may be negatively impacted by poor ergonomics design. In discussion with company representative try to determine through production and quality metrics if this is the case, if so check the box.

Training

Competency-based training is one of the ten major ergonomics principles. Inadequate safety and/or process training may be evident. For example, if you observe three employees doing the same task and see three different ways of doing it, determine if training (or lack of) is at the base.

Vibration (Hand/Arm and Whole Body)

Once you identify vibration (hand/arm and whole body) is occurring determine if it is significant enough to cause medical related issues based on injury/illness records or by subjective employee reports.

Environment (Hot/Cold)

Check out the Environment Checklist for additional information.

Contact Stress (Sharp Edge and Hard Surface)

Identify any contact stress (Sharp Edge and Hard Surface) issues and check the box if needed.

On Feet (standing or walking > 50% of shift)

Check if standing and/or walking is occurring more than 50% of the shift.

Lighting –Ambient

Investigate if ambient lighting levels are inadequate for safe area ingress/egress. You yourself may have issues with the lighting in conjunction with worker reports. Consult with the appropriate company representatives as needed.

Lighting – Task

Investigate if task lighting levels are inadequate for precision assembly and quality inspections. You yourself may have issues with the lighting in conjunction with worker reports. Consult with the appropriate company representatives as needed.

Vision

Based on observation and worker interviews determine if visual acuity in seeing parts/materials to assemble or inspect is an issue.

Foot Controls

Use of foot controls while standing.

Wrong or Incorrectly Used:

Investigate the workstation and associated accessories to determine if they are the correct items and used correctly. Apply the ergonomics principles and access the checklists for additional information. This includes:

- Equipment
- Fixtures/Jigs
- Controls
- Tools
- Workstation
- Chair
- Display
- Foot Support
- Worksurface height (too low/high)

ERS Step Five – Scores from Steps 3 and 4

In Step Five the scores from Steps 3 and 4 are tabulated.

ERS Step Six – Corrective Actions

Step Six provides an opportunity recommend ***Corrective Actions*** specific each of the Risk Areas. It can be used as an ***Action Plan*** with assignments of the Responsible Person, Due Date and Status update (pull down menu for ***No Corrective Action Needed, Not Started, In Process, Completed)***

Step Six also has space to enter **Other Issues** and **Additional Corrective Actions if Needed**.

Step Six – Implement Solutions

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

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

Cost Analysis

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

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

ROI = Total Estimated Benefits/Total Cost of Intervention

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

Benefits of Intervention:

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

Indirect Benefits:

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

Costs of Intervention:

- Material/Hardware Costs

- Labor cost for installation
- Training costs
- Any other costs related to the intervention

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

ROI Worksheets

Cornell University Ergonomics (http://ergo.human.cornell.edu/CUROIEstimator.htm) has produced worksheets to assist in calculating ROI: 1.) if actual cost data is available, 2.) if estimated cost data is used, and 3.) if no cost data is used. Please refer to the worksheets for additional details

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

Step Seven – Follow-up

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

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

Session Two Homework Review

Completion Requirements

To meet the completion requirements of this course (and get Continuing Education or Professional Development credit), you will need to attend both webinar sessions, complete several learning exercises and complete course evaluations for each of the 2 online sessions.

Please complete the ***Worksheets*** in this binder following this session and then submit the requested information from your homework by completing the **Session 2 Homework Test** in the CONTENT section of this course in the WorkWell Provider Learning Center.

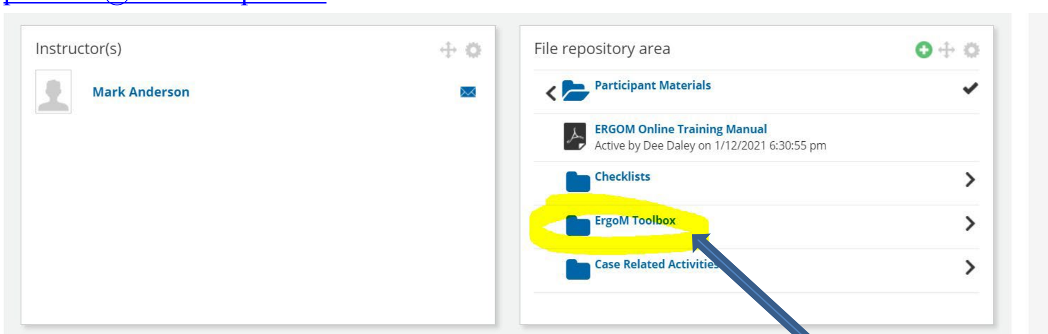
PLEASE READ AND COMPLETE THIS ENTIRE WORKSHEET CAREFULLY PRIOR TO COMPLETING THE TEST IN http://www.workwellprovidertraining.com/.

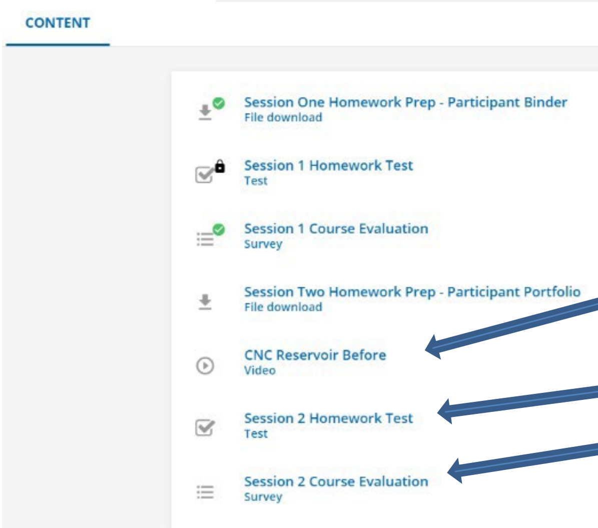
Reporting Test Answers

When you have completed the worksheets and have about 15-20 minutes to enter the information, log in to http://www.workwellprovidertraining.com/ and complete the **Session 2 Homework Test**.

If you score below 80%, you may retake the test to achieve a passing score. Upon completing the test with a passing score, complete the **Session 2 Course Evaluation**.

If you have any questions, or need any clinical assistance, please email provider@workwellpc.com.





1. Download the Ergonomics Risk Screen (ERS) worksheet from the ErgoM Toolbox folder in the File Repository Area.
2. Review the Case Study background and task descriptions on this worksheet
3. Watch the **CNC Reservoir Before** video
4. Complete the ERS worksheet
5. Complete the ERS worksheet questions
6. Complete the Session 2 Homework Test
7. Complete the Session 2 Course Evaluation

Worksheets in this packet include:

- Session Two Overview Test Questions (you will enter these results in the Session 2 Homework Test)
- CNC Reservoir – Case Study
  - Background description
  - Task description
  - Ergonomics Risk Screen (ERS) – *downloaded from ErgoM Toolbox folder in the File Repository Area*
  - ERS Worksheet Questions (you will answer questions in the Session 2 Homework Test, based on this information)

The ERS Worksheet is a fillable form. If you fill them out electronically, please save and print a copy of your pdf binder to reference as you complete the Session 2 Homework Test in www.workwellprovidertraining.com. You will want to use the "save as" function and give your document a name.

CNC Reservoir – Case Study Background

The CNC operator is responsible for maintaining the CNC reservoir level for seven CNC machines at the appropriate fill level.

No injuries had occurred; however, employees reported significant physical strain with the manual handling method.

Production quality had not been affected yet. The Operators were performing the task as they had been trained to perform it. They performed other tasks with less than 50% of the time on their feet throughout the shift.

The task involves:

- Filling empty five gallon buckets with a hose to about 75% full
  - Based on 8#/gallon, each bucket weighs approximately 30#
  - Two buckets weigh 60# total
- Picking up and carrying two buckets at a time a distance of 100 feet for a duration of about 30 to 40 seconds for the carrying/handling component
- Tipping the bucket into the CNC reservoir one bucket at time

Depending on the level of use, each of the CNC machines requires*:

- Two buckets of fluid 1 to 3 times weekly
- For the worst case, this would be about 8 buckets/day
- About 2 to 3 minutes of total carrying/handling time per day.

**Seven CNC machines times 6 buckets/machine/week equals 42 buckets/week. In a five day workweek about 8 buckets/day carried two at a time for a total of 4 trips/day of about 30 to 40 seconds of actual carrying/handling time for a total per day of about 2 to 3 minutes.*

ERGONOMICS – A POTENT TOOL!

Ergonomics is a potent tool!

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

Thanks for your time and attention!

APPENDICES

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Ergonomics, Taylor and Francis.

Human Factors, Human Factors and Ergonomics Society.

(Reference www.ergoweb.com for a very complete list of ergonomics related journals)

Professional Organizations

American Industrial Hygiene Association
2700 Prosperity Avenue, #250
Fairfax, VA 22031
(703) 849-8888

American Society of Safety Engineers
1800 E. Oakton St.
Des Plaines, IL 60018-2187
(847) 699-2929

Board of Certification in Professional Ergonomics
2950 Newmarket Street
Ste 101 PMB 244
Bellingham WA 98226
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Human Factors and Ergonomics Society
PO Box 1369
Santa Monica, CA 90406-1369
(310) 394-1811

International Ergonomics Association
Secretary General IEA
Pieter Rookmaaker
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PO Box 2286
3500 GG Utrecht
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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. On 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.