DRAFT MATERIALS

ERGONOMICS IN FOUNDRIES

University of Louisville Research Foundation, Inc.

Center for Ergonomics at the University of Louisville

Project Director:
Naira Campbell-Kyureghyan, PhD
Assistant Professor and Director
Center for Ergonomics, IE Dept
University of Louisville
Louisville, Kentucky 40292, USA
Ph: (502) 852-1416
Fax: (502) 852-5633
nhcamp01@louisville.edu

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ERGONOMICS AWARENESS TRAINING

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University of Louisville
Center for Ergonomics

TRAINERS

- Naira Campbell-Kyureghyan, PhD
  - Assistant Professor, Industrial Engineering
  - Director, Center for Ergonomics

- Karen Cooper, MS, CPE
  - Research Engineer, Center for Ergonomics

GOALS

- Understand the need for ergonomics
- Recognize ergonomic risk factors
- Appreciate the value of ergonomic programs
- Incorporate ergonomic program into workplace

REDUCE RISK OF INJURY

POTENTIAL BENEFITS

REDUCE:

- Number of work related injuries
- Insurance and workers' compensation costs
- Human error due to poor workstation design

IMPROVE:

- Profitability
- Competitiveness
- Product quality and productivity
- Safety
- Job satisfaction

Everyone, can benefit from ergonomics program and training…

!

WHAT IS ERGONOMICS?

- The term ergonomics is derived from the Greek words:
  - *ergon* – work
  - *nomos* – natural laws
- First used in the modern lexicon by Wojciech Jastzebowski in 1857

WHAT IS ERGONOMICS?

DEFINITION:

"The study of the physical interaction of workers with their tools, machines, and materials so as to enhance the worker's performance while minimizing the risk of musculoskeletal disorders."

Chaffin, D.B., Anderson, G.B.J., (1991). *Occupational Biomechanics* (2nd ed.). New York: Wiley.

MUSCULOSKELETAL DISORDERS (MSDs)

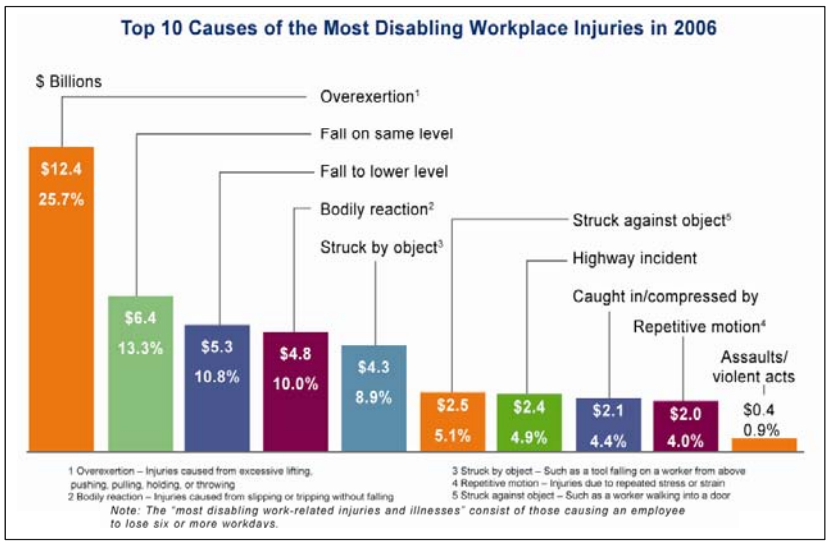
DEFINITION:

- Various conditions that involve the damage to bones, joints, ligaments, muscles and tendons, intervertebral discs and nerves

- MSDs can be acute, cumulative or chronic, and in the most severe cases may be disabling

You may have heard of injuries such as low back pain, muscle strains, carpal tunnel syndrome, tendonitis

WORK RELATED INJURY COSTS



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DIRECT COSTS

- Medical bills
- Worker's Compensation Costs

INDIRECT COSTS

- Costs to find temporary or permanent replacement staff
- Training costs
- Production losses
- Long term disability costs
- Litigation
- Overtime costs

WORK RELATED INJURY COSTS IN US

- Estimated overall cost of MSDs (1994) [a]

  $100 billion
- Estimated overall cost of MSDs (1995)[b]

  $215 billion
- Estimated overall cost of MSDs (1997)[c]

  $1.25 trillion

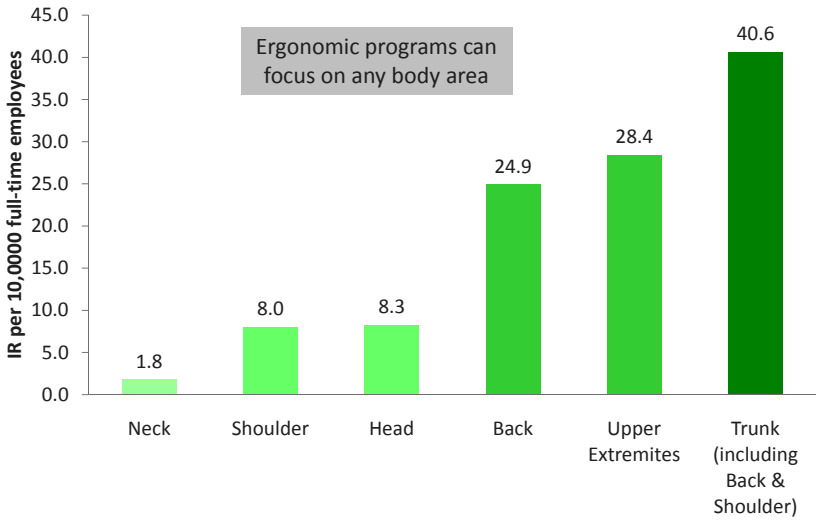
[a]Dear, A. (1996). Upper limb musculoskeletal disorders. Retrieved January 7, 2009, from http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=205&p_table=SPEECHES.
[b]Praemer A., Furner S., Rice D.P. (1999). Musculoskeletal Conditions in the United States. American Academy of Orthopaedic Surgeons: Rosemont, IL.
[c]Brady, W,. Bass, J., Royce, M., Anstadt, G., Loeppke, R., & Leopold, R. (1997). Defining total corporate health and safety costs: Significance and impact. *Journal of Occupational and Environmental Medicine, 39, 224–231.*

WORK RELATED INJURY COSTS

- Total annual cost of back disability in US: $50 to $100 billion [a]
- Average worker's compensation claim cost in 2008 [b] :
  - Carpal tunnel case: $17,757/case
  - Lower back injury: $23,820/injury

a Frymoyer, J. W., & Cats-Baril, W. L. (1991). An overview of the incidences and costs of low back pain. *Orthop Clin North Am, 22(2), 263-271.*
b Permission to reprint granted by the National Safety Council, a membership organization dedicated to protecting life and promoting health, National Safety Council, http://www.nsc.org

INCIDENCE RATES FOR VARIOUS BODY PARTS



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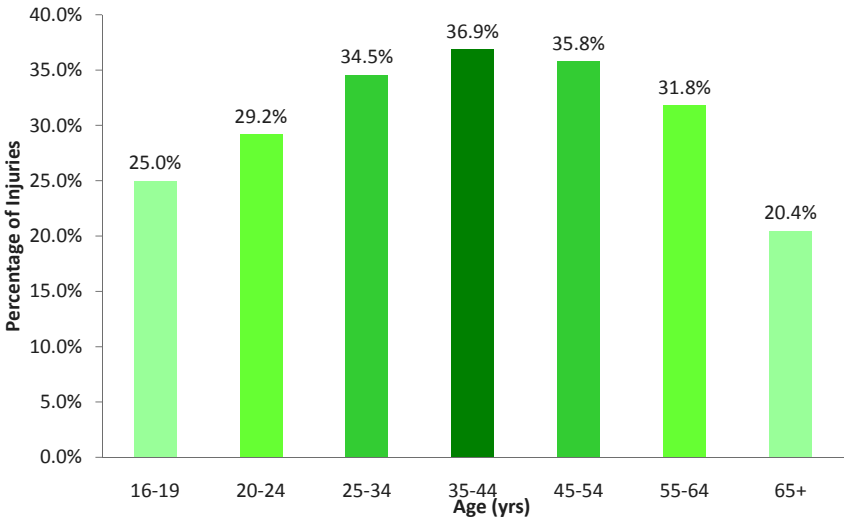
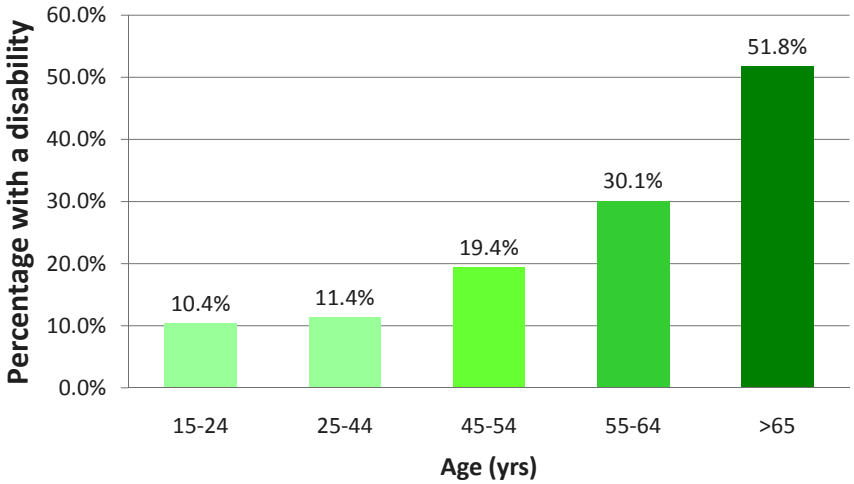
Bureau of Labor Statistics, 2007

PERCENT OF MUSCULOSKELETAL INJURIES BY AGE



Bureau of Labor Statistics, 2001

LIKELIHOOD OF HAVING A DISABILITY



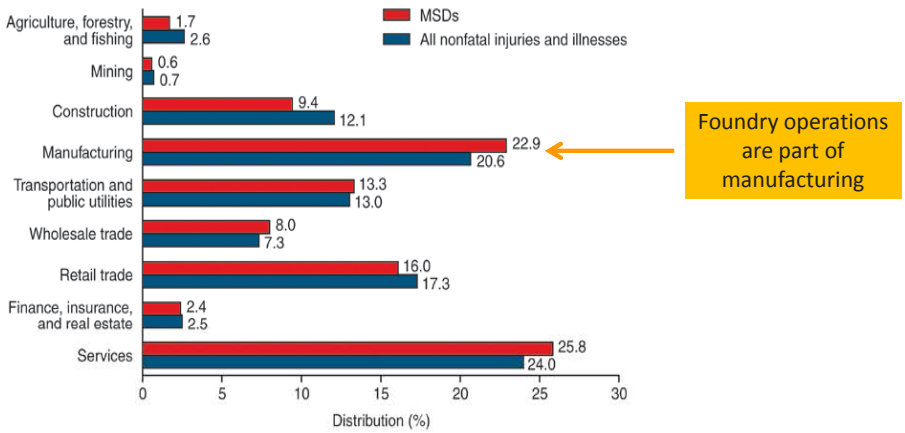
U.S. Census Bureau Americans with Disabilities, 2005

WHAT IS THE EXTENT OF THE PROBLEM IN FOUNDRIES?

Foundries ranked among **top 25** highest IR in 2007, 2006, 2005, …, 1998!

Bureau of Labor Statistics, Workplace Injuries and Illnesses ,1998-2007

2001 MUSCULOSKELETAL INJURIES BY INDUSTRY



Foundry operations are part of manufacturing

Figure 2-44. Distribution of MSD cases and all nonfatal injury and illness cases involving days away from work in private industry by industry, 2001.
Manufacturing (22.9%) and services (25.8%) accounted for about half of all MSD cases in 2001. Distributions of MSD cases are notably different from distributions of all nonfatal injuries and illnesses by industry sector, with the greatest differences in services, construction, manufacturing, and retail trade.

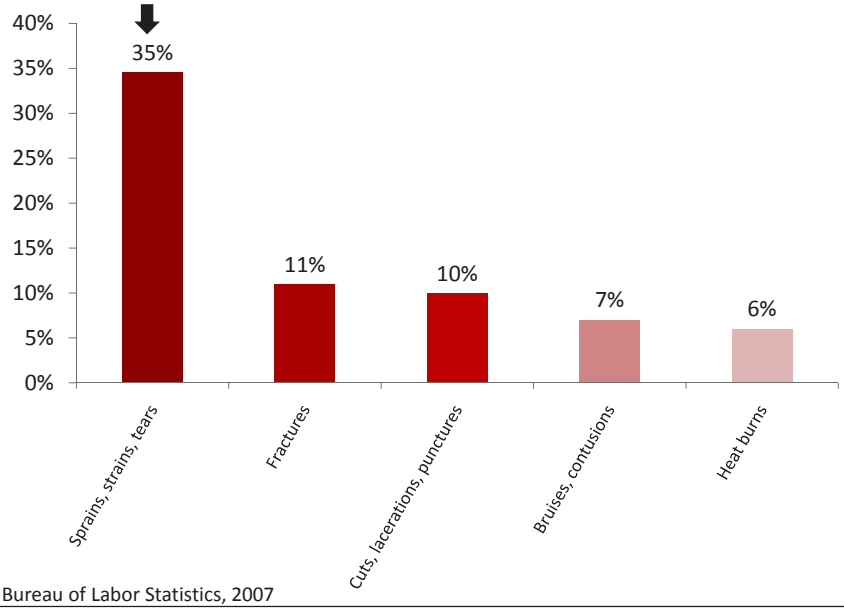
Worker Health Chartbook (2004). Retrieved January 7, 2009. from http://www.cdc.gov/niosh/docs/2004-146

NON-FATAL INCIDENCE RATES (IR) IN FOUNDRIES

- Primary metal manufacturing {all foundries} IR: 8.1
  - Steel foundries (except investment) IR: 13.8 (>8.1)
  - Iron foundries IR: 13.6 (>8.1)
  - Copper foundries (except die casting) IR: 10.9 (>8.1)
  - Aluminum foundries (except die-casting) IR: 9.0 (>8.1)

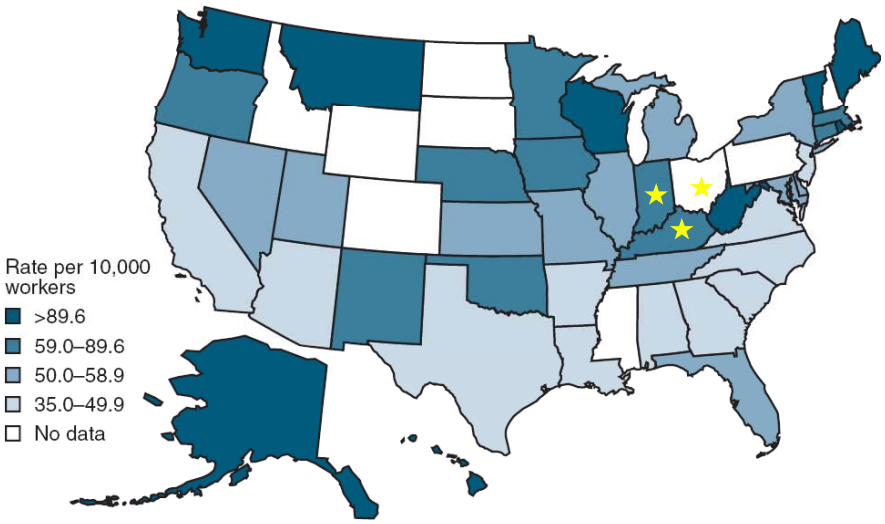
Bureau of Labor Statistics, Workplace Injuries and Illnesses ,2007

SELECTED OSHA RECORDABLES IN FOUNDRIES (2007)



Bureau of Labor Statistics, 2007

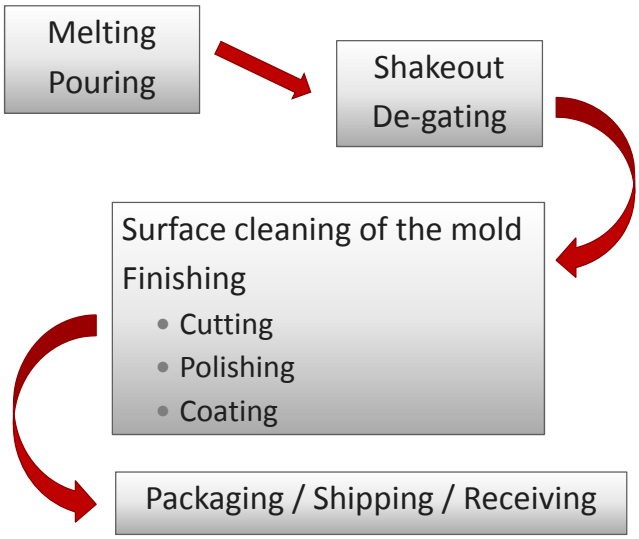
MUSCULOSKELETAL INCIDENCE RATE BY STATE



Worker Health Chartbook. (2004). Retrieved January 7, 1009. from http://www.cdc.gov/niosh/docs/2004-146/.

HOW CAN YOU REDUCE INJURIES?

GENERAL TASKS IN FOUNDRIES



ERGONOMICS RISK FACTORS OBSERVED

- Forceful exertions
- Frequency
- Awkward postures
- Duration
- Vibrations
- Cognitive stresses
- Environmental stresses
- Noise
- Individual Differences

DEFINITIONS

- ***Force*** – exerting energy or strength to move (push, pull, lift or carry) an object
- ***Posture*** – position of the body at any given time
- ***Duration*** – length of the exposure throughout the day
  - Example: 20 minutes or 8 hours
- ***Frequency*** – number of times or how often task repeats
  - Example: 5 times per minute
- ***Vibration*** – back-and-forth or side-to-side motion of body/tool

!

DEFINITIONS

- ***Environmental stressor*** – conditions of the physical environment that increase the demands on the body
  - Examples: heat, cold, humidity
- ***Noise*** – unwanted sound
- ***Cognitive stressor*** – conditions exceeding a person's mental workload
  - Example: **GREEN**
- ***Individual Differences*** – characteristics of a person
  - Examples: gender, weight, anthropometry, strength
- ***Low Light / Visual Demands***
  - Example: a dim area make it difficult to complete an inspection task

!

IDENTIFYING ERGONOMIC RISK FACTORS

- Foundry Picture will be here

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

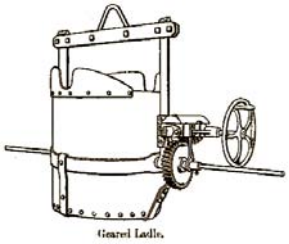
☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

QUESTIONS?

FORCE

DEFINITION:

Exerting energy or strength to move (push, pull, lift or carry) an object



- Observed at foundries
  - Lifting bars of material into furnaces
  - Lifting finished parts onto pallets
  - Pushing carts filled with parts or scrap
  - Pushing kettle filled with molten metal to molds for pouring
  - Pulling off (removing) slag

HOW MUCH IS TOO MUCH?

- Measure force using tools
- Compare the results to recommended limits

TRY IT – Measure your grip strength

- *Grip dynamometer*

... the job should fit the person

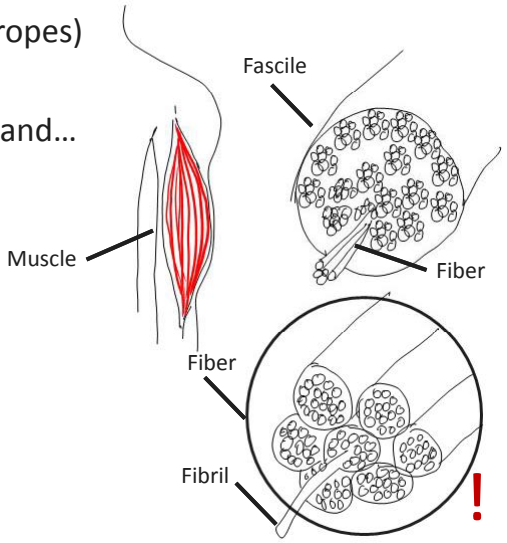
!

MUSCLE

- Bundle of fibrils (like ropes)
- Exceed the tolerance and…

Fatigue
Damage
Failure

INJURY



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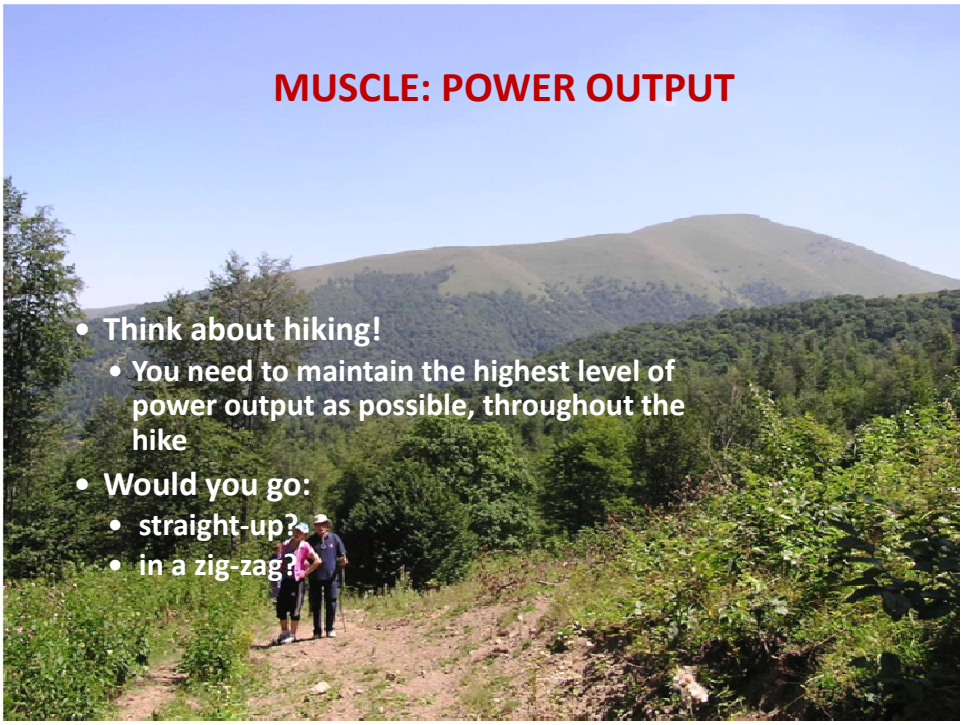
DEFINITIONS

- ***Strain*** – an injury to a muscle or tendon
  - Tendon connects muscle to bone
  - Example: back strain
- ***Sprain*** – an injury to a ligament
  - Ligament connects bone to bone
  - Example: knee sprain

!

MUSCLE: POWER OUTPUT

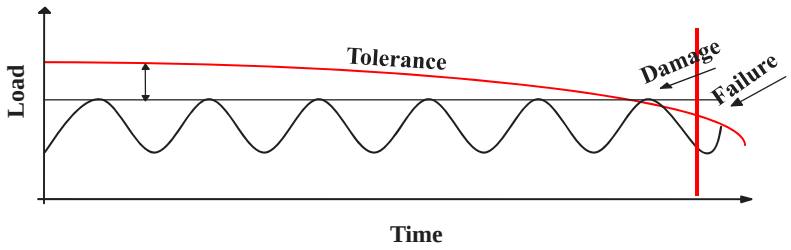


- Think about hiking!
  - You need to maintain the highest level of power output as possible, throughout the hike
- Would you go:
  - straight-up?
  - in a zig-zag?

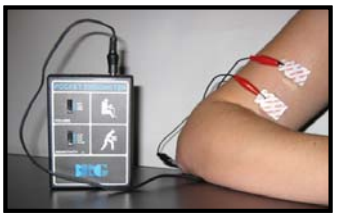
MUSCLE: POWER OUTPUT

- Workers must be able to sustain their energy expenditure (and power bursts) for 8-12hrs/day

MUSCLE ACTIVITY



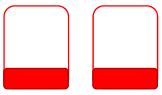
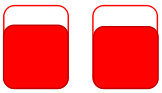
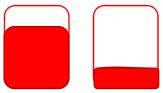
- *TRY IT: Measure Muscle Activity*
  - Ergometer demonstration



KEY POINTS: FORCE

- *Transferring heavy parts* can be very strenuous
- Tasks should be design so that joints are in neutral postures, using low or no force or speed.
- *Design tasks for lowering rather than lifting*
- Try to use larger, stronger muscle groups
- Keep objects close to body
- Keep healthy
- *Exercise can also increase your strength*

STATIC VS. DYNAMIC

Resting	Dynamic Exertion	Static Exertion
 Blood demand Blood supply	 Blood demand Blood supply	 Blood demand Blood supply
		

PROBLEM AREAS

- Static vs. Dynamic
  - Shoulder
  - Wrist
  - Neck
  - Back
    - Standing
    - Sitting

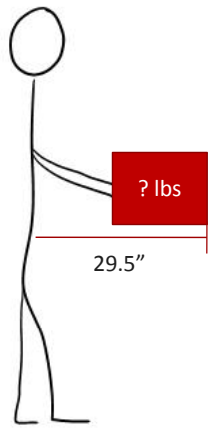
LIFTING HEAVY LOADS

RECOMMENDED LIFTING

75th Percentile Males (Females)

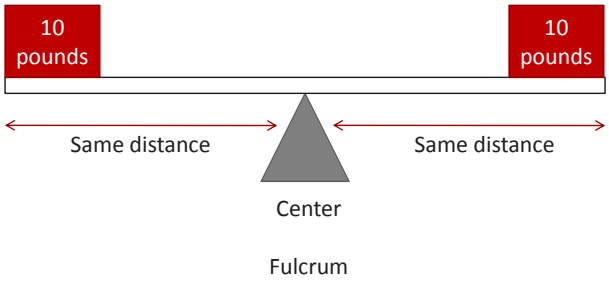
Distance traveled= 10”

Frequency of lifting	Maximum acceptable weight of lift		
	Floor level to knuckle	Knuckle height to shoulder	Shoulder height to arms reach
1 lift / 9 secs	28 (22)	37 (17)	28 (15)
1 lift / 2 min	53 (26)	55 (26)	42 (20)
1 lift / 30 min	62 (39)	66 (37)	51 (26)

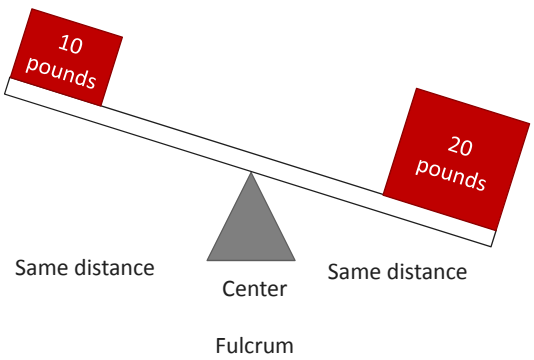


Snook, S.H. & Ciriello, V.M. (1991). Design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics, 34, 1197-1213.*

THE SEE-SAW EXAMPLE



THE SEE-SAW EXAMPLE



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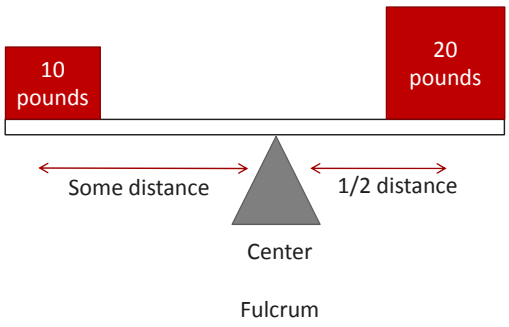
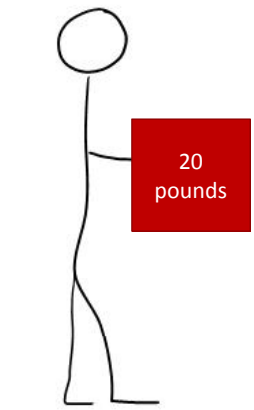
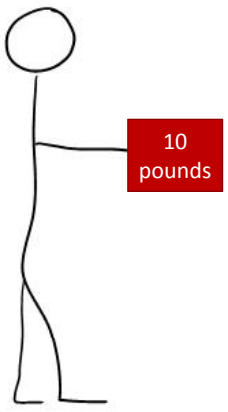


WHEN LIFTING, REMEMBER



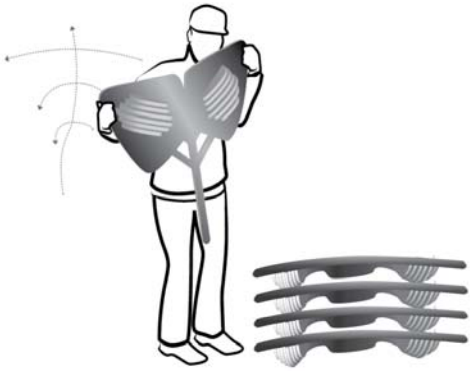
Heavier, close to body



Lighter, away from body

$Force_1 \sim Force_2$!

CAN YOU RECOGNIZE THE RISK FACTORS?



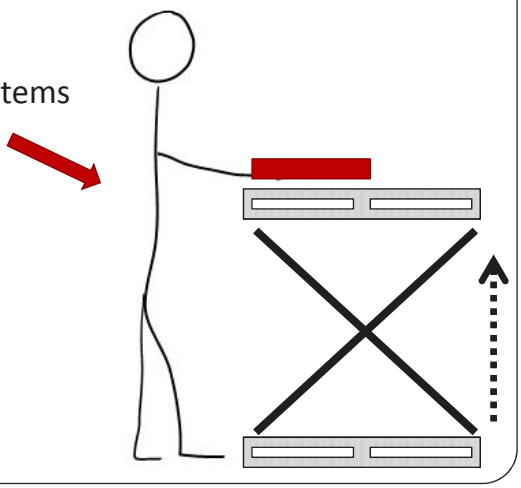
Worker is adding metal into the furnace from a pallet

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

WHAT CAN YOU DO ABOUT IT?

- Get help – 2 man lift
- Use lift assist to move/transfer
- Use fork lift to move items to waist level
- Avoid twisting



EXAMPLES

CAN YOU RECOGNIZE THE RISK FACTORS?

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
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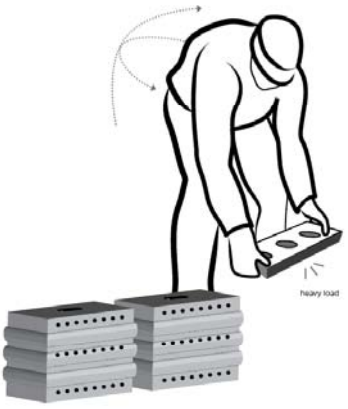
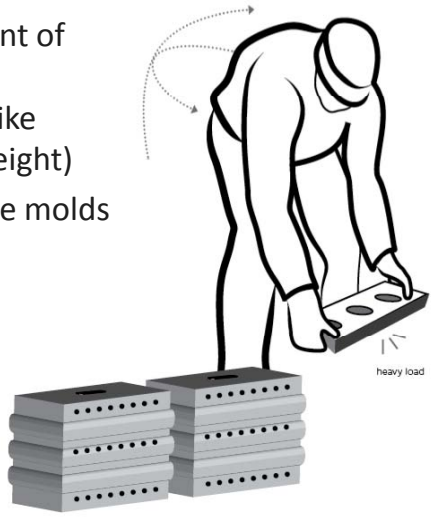


Worker is rotating a mold before another worker pours in metal.

The orientation was not set correctly when the mold was placed on the floor.

WHAT CAN YOU DO ABOUT IT?

- Pre-plan the placement of the molds to reduce corrections needed (like making them waist height)
- Use jib cranes to move molds



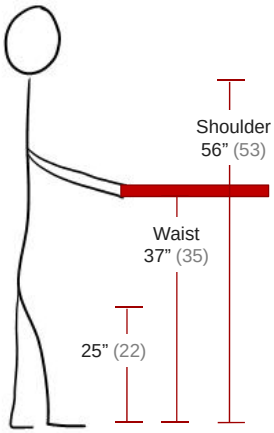
PUSHING/PULLING

RECOMMENDED PUSHING FORCE (SUSTAINED)

75th Percentile Males (Females)
One push every 5 minutes

Vertical Distance inches	Pounds of force		
56 (53)	53 (35)	39 (22)	28 (25)
37 (35)	55 (33)	39 (24)	28 (25)
25 (22)	55 (28)	37 (22)	26 (18)
feet	68	498	1500

Horizontal Distance



Snook, S.H. & Ciriello, V.M. (1991). Design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics, 34, 1197-1213.*

PUSHING AND PULLING STRENGTH

Handle Height		Pushing (N) Mean	SD
1.7 m	M	300	50
	F	181	75
1.3 m	M	337	83
	F	221	103
0.7 m	M	393	134
	F	185	57

Handle Height		Pulling (N) Mean	SD
1.7 m	M	263	60
	F	196	56
1.3 m	M	347	53
	F	223	80
0.7 m	M	541	81
	F	292	97

Daams, B.D. (1994). *Human Force Exertion in User-Product Interaction- Backgrounds for Design. Physical Ergonomics Series, Vol. 2*. Delft, The Netherlands: Delft University Press.

CAN YOU RECOGNIZE THE RISK FACTORS?

Worker is activating the machine with a two-handed safety lever to create part

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

WHAT CAN YOU DO ABOUT IT?

- Pull from the lower part of the handle
- Adjust the handle height

QUESTIONS?

POSTURE

DEFINTION:

Position of the body at any given time

Awkward posture – body deviation from the neutral position that increases the risk of injury

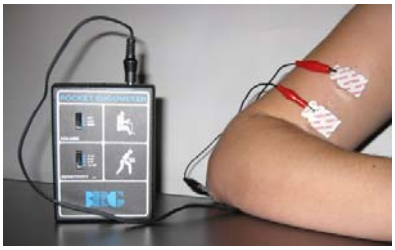
- Examples of awkward postures observed at foundries
  - Bending forward to grab an object
  - Head/neck sideways or twisting, to inspect piece
  - Reaching with arms out, to level sand in sand casting
  - Arms/elbows at/over shoulders, to drill out a part

POSTURE

- Checklists and evaluation tools compare observations to known, researched capabilities of populations

TRY IT: Posture affects muscle activity

- Ergometer demonstration



AWKWARD POSTURE

AWKWARD POSTURE

PLANNING HELPS POSTURE

"To a man with a hammer, everything looks like a nail"
- Mark Twain

- *TRY IT - Let's see how planning can help improve ergonomics (hands on demonstration)*

DURATION

DEFINITION:

Length of the exposure throughout the day

- Example: 20 minutes or 8 hours

How long is too long?

- A stop watch is a easy tool to measure duration
- Then the values are compared to the known limits
  - Duration becomes a concern when another risk factor is present

DURATION

- Video example

HIGH FREQUENCY/REPETITIVE TASK

DEFINTION:

The number of times or how often task repeats

- Example: 5 times per minute

- Examples of frequency/repetitive tasks risks observed at foundries
  - Hand grinding parts
  - Inspecting parts on a conveyor

HIGH FREQUENCY/REPETITIVE TASK

- What do you think is better

→ A) Frequent short breaks?

B) Infrequent long breaks?

For example, a 5 min rest every hour is more helpful than a 20 min rest every 4 hours

- If you are *experiencing pain* in a repetitive task, should you be concerned? **YES**
- If you are *not experiencing pain* in a repetitive task, should you be concerned? **YES**

!

HIGH FREQUENCY/REPETITIVE TASK

CAN YOU RECOGNIZE THE RISK FACTORS?

Worker is pulling down on a lever so that sand will drop into the mold below.

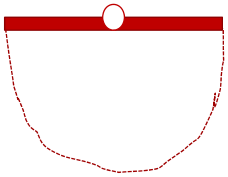
☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

WHAT CAN YOU DO ABOUT IT?

- Suggest an improvement for getting the sand
- Minimize all other factors as much as possible, such as posture

Lower handle location



Add a rocker arm/ rope or chain to extend the handle location

QUESTIONS?

VIBRATION

DEFINITION:

Back-and-forth or side-to-side motion of body/tool

- Examples of vibration observed at foundries
  - Using air-powered tools to compact sand in a mold
  - Using saws or sanders to finish surface
  - Operating construction equipment/tractors or fork trucks

VIBRATION

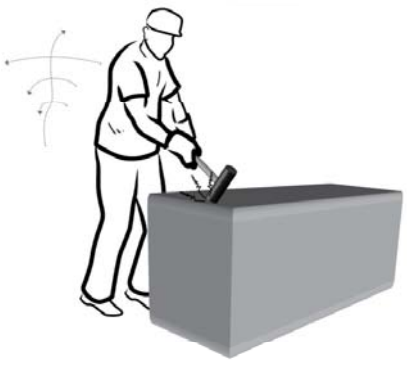
- Ranges
  - Low, Medium, High Frequency
- Affected areas:
  - Whole-body
  - Various body segments
- Vibration energy is absorbed by human tissues and organs
- Vibration can cause muscle fatigue

WHOLE BODY VIBRATION

Frequency (Hz)	Symptoms
4-10	Discomfort
	Abdominal pain
	Influence on breathing
	Muscle contraction
5-7	Chest pain
10-18	Urge to urinate
13-20	Head symptoms
13-20	Influence on the speech
20-23	Increased muscle tone

Rasmussen, G. (1982). *Human Body Vibration Exposure and Its Measurement Technical Review.* Bruel & Kjaer Instruments, Inc.: Denmark.

CAN YOU RECOGNIZE THE RISK FACTORS?



- Also see video clip for vibration

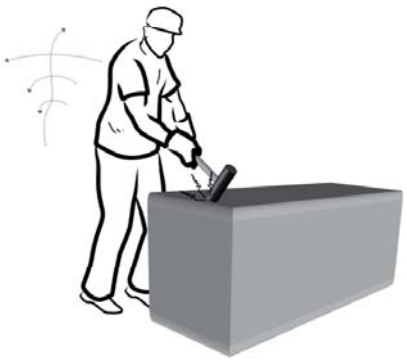
☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

!

WHAT CAN YOU DO ABOUT IT?

- Report tools or equipment maintenance issues
- Reduce duration of exposure
- Use dampers on tools that vibrate
- Avoid continuous use



VIBRATION CONTROL AND PREVENTION

- Vibration should be eliminated, whenever possible
- Exposure to vibration should be reduced
- Proper maintenance can reduce tool vibration
- Rubber dampers placed between the tool and handle can reduce vibration by about 65%
- Design/choose seats to minimize the transmission of vibration (public transportation, helicopters, etc)

VIBRATION CONTROL AND PREVENTION

- Use of vibrating tools in the cold should be avoided
- Keep hands warm & dry
- Allow the tool or machine to do the work
- Whenever possible, offer work tools which do not vibrate, and alternate tools
- Take 10 to 15 minute breaks every hour

LOW/HIGH FREQUENCY VIBRATION

!

QUESTIONS?

ENVIRONMENTAL STRESSORS

DEFINTION:

Conditions of the physical environment that increase the demands on the body

- Examples observed at foundries
  - Working near a furnace
  - Pouring hot metal in a mold
  - Working outside when it is hot or cold

ENVIRONMENTAL STRESSORS

- Humans are well adapted to tolerate heat, but there are limits
- Serious problem in industry and sports
  - Up to 1 in 100 workers have heat related illness per year
  - Approximately 5 football players per year die of heat related illness
- Heat strain occurs whenever the body generates more heat than can be dissipated

Bridger R. S. (2009) Introduction to Ergonomics. Boca Raton, FL CRC Press

TYPES OF COLD INJURY

- Freezing Cold Injuries
  - Frostbite
  - Result of short-term exposure to very low temperatures
  - Usually affects extremities: fingers, toes, nose, neck, cheeks, ears
- Nonfreezing Cold Injuries
  - Tissue damage without freezing, “frost nip”
  - Result of long-term (>10 h) exposure to cold
  - Usually affects limbs: legs, arms, hands, feet

CAUSES OF HEAT STRESS

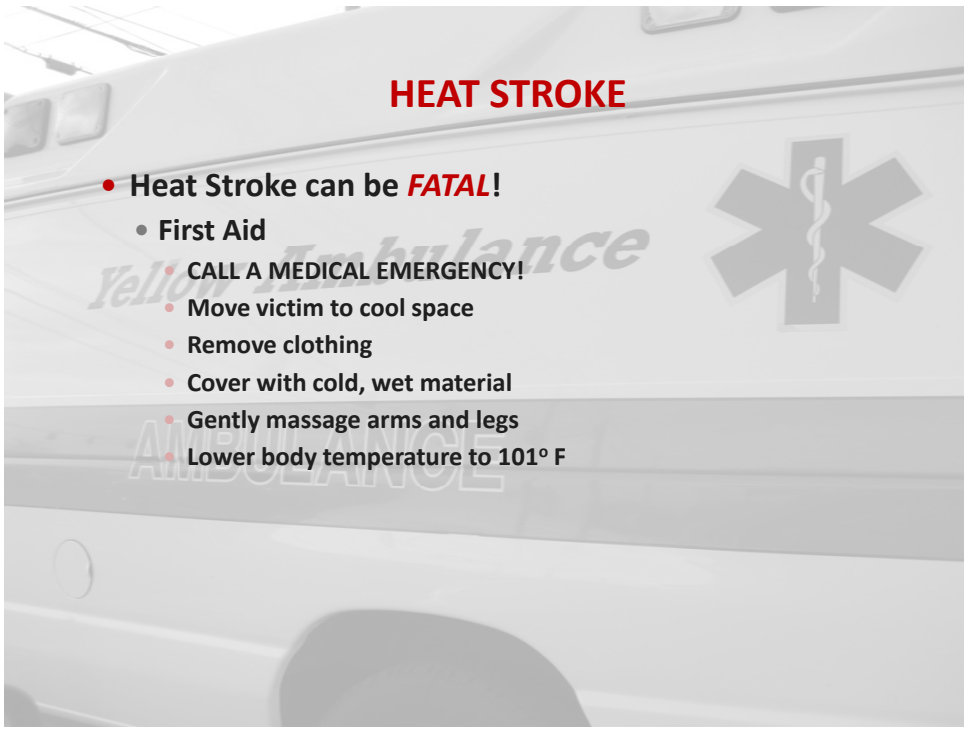
- Wearing protective clothing
  - Chemical Suits
  - Fire Fighting Ensembles
  - Proximity Suits
- High humidity + Heavy exercise
- Illness
- Intoxication
- Poor physical state
- Poor hydration

SYMPTOMS OF HEAT STRESS

- Fatigue
- Severe headaches
- Nausea
- Decreased performance
  - Physical
  - Mental

HEAT ILLNESSES

- Heat Rash
  - Leads to swelling and irritation
- Heat Cramps
  - Due to loss of body salt from over-sweating
    - Pain can last 2 – 3 days
- Heat Exhaustion
  - Dehydration due to lack of water/salt replacement



HEAT STROKE

- **Heat Stroke can be *FATAL*!**
  - **First Aid**
    - **CALL A MEDICAL EMERGENCY!**
    - **Move victim to cool space**
    - **Remove clothing**
    - **Cover with cold, wet material**
    - **Gently massage arms and legs**
    - **Lower body temperature to 101° F**

CAN YOU RECOGNIZE THE RISK FACTORS?

Worker pouring metal into molds on a conveyor system.

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

WHAT CAN YOU DO ABOUT IT?

- Allow body to adjust to heat
- Take required recovery time when leaving a heat stress area
- Report heat stress problems (steam leaks, poor ventilation, etc.)
- Stay away from coffee, sodas, and salt tablets
- Drink plenty of liquids
- Know your own limitations
- Get sufficient rest

PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Personal Protective Equipment (PPE) acts as a barrier against a variety of hazards (flying debris, cuts, etc.)
- If PPE is improperly fit or in poor condition, it may create more hazards
  - Maintain your PPE in good working condition
  - Replace items in poor condition
  - Make sure the PPE fits you **PROPERLY**

!

QUESTIONS?

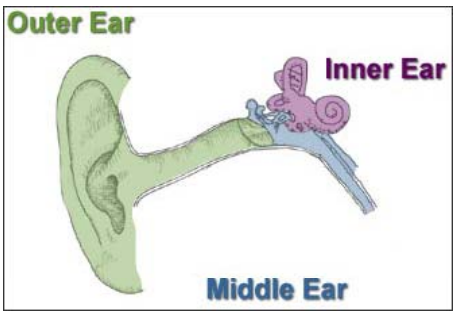
SOUND AND HEARING

- ***Sound*** – the result of pressure fluctuation generated by vibrations from some source
- ***Hearing*** – the phenomenon of sensing sound vibrations

- Hearing is probably the second most important sense associated with human performance

Primary Divisions of the Ear

- ***Outer Ear*** – collects sound energy
- ***Middle Ear*** – made up of 3 small bones which transmit vibrations from the eardrum to the oval window of the inner ear
- ***Inner Ear*** – transmits changes in sound pressure sensed by cochlea to the brain



Noise and Hearing Conservation. (n.d). *Retrieved January 7, 2009 from http://www.osha.gov/dts/osta/otm/noise/health_effects/index.html*

Decibels dB(A)	Exposure level	Sources
140	Harmful to hearing	Jet engine 25m away; Shotgun blast
130	Threshold of pain	Jet takeoff 100m away
120		Disco; Propeller aircraft
110	Possible hearing loss	Live band; Jet takeoff 600m away
100		Electric mower; Pneumatic drill; Tractor
90		Open top car ride on motorway; Food blender; Heavy traffic 5m away
80	Very noisy	Alarm clock; Sink garbage disposal
70	Upper limit for hearing conversation	Vacuum cleaner; Private car
60		Conversation at 1m; Singing birds
50	Quiet	Light traffic 30m away; Quiet office
40		Dripping tap; Library
30	Very quiet	Soft whisper at 5m
20		Broadcasting studio
10		Leaves rustling
0		Threshold of hearing

Mansfield, N. (n.d). *Noise. Retrieved January 7, 2009. from* http://www.ergonomics4schools.com/lzone/noise.htm

NOISE

DEFINTION:

Unwanted sound

- Examples of noise observed at foundries
  - Working near a furnace
  - Using air-powered tools to compact sand in a mold
  - Using saws or sanders to finish parts
  - Operating construction equipment/tractors or fork trucks

HOW MUCH IS TOO MUCH?

- A noise dosimeter measures the sound in decibels
- Measurements are compared to OSHA allowable exposure limits

OSHA NOISE STANDARD

- Action Level is 85 dB(A) = Program Required

Duration per Day (Hours)	Sound Level, dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 (=15 minutes) or less	115

!

NOISE

- Exposure to noise can reduce what you are capable of hearing

TRY IT: How old are your ears?

  - Play different tones, and if you have young ears, you can hear up to this level

EFFECTS OF NOISE

- Noise can:
  - Be annoying and distracting
  - Cause hearing loss
  - Affect performance and productivity
  - Interfere with spoken communication
- Physiological Stress
  - Raised blood pressure
  - Accelerated heart rate
  - Slowed digestion
  - Increased muscular tension

AUDITORY DEFECTS

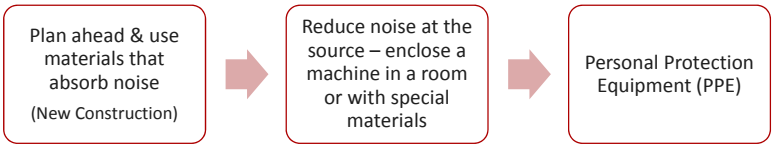
- ***Conduction deafness*** – roughly same hearing loss at all frequencies
  - Caused by rupture and/or dislocation of eardrum and bones in middle ear due to sudden intense pressure.
  - Could be partial or total, temporary or permanent
- ***Nerve deafness*** – characteristic that hearing loss is greater at higher frequencies
  - Caused by swelling of the cells *of the organ corti* due to prolonged noise exposure
  - Could be temporary or permanent

NOISE INTERFERENCE

- For offices and factories, background noise should not exceed 55 dB
- Normal range: 40-50dB
  - background noise needs to be at least 10dB below the level of the speaking voice so speech comprehension is not impaired
  - We usually speak at 65-70 dB

WHAT CAN YOU DO ABOUT IT?

- ***Ear plugs*** – can reduce noise level by 30 dB
  - (85-100dBA)
- ***Ear muffs*** – can reduce noise by 40-50 dB
  - (> 100dBA)



CAN YOU RECOGNIZE THE RISK FACTORS?

- Video file(s)

☐	Lifting Heavy Loads
☐	Pushing/Pulling
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☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

QUESTIONS?

OTHER FACTORS

- ***Cognitive stressor*** – conditions exceeding a person's mental workload
  - Example: **GREEN**
- ***Individual Differences*** – characteristics of a person
  - Examples: gender, weight, anthropometry, strength
- ***Low Light / Visual Demands***
  - Example: a dim area make it difficult to complete an inspection task

COGNITIVE STRESS

- Examples of cognitive stress observed at foundries
  - Timed actions and rushing to get work done
    - Result: Worker may forget a critical step
  - Alarms going off in a noisy environment
    - Result: Missing or misinterpreting signal
  - Multiple scenarios required different procedures
    - Result: Slowed learning of task or instruction may be repeated several times
- TIPS:
  - Chose symbols and signals carefully
  - Minimize and simplify the information provided

INDIVIDUAL DIFFERENCES

- Examples of individual differences observed at foundries
  - Having to reach because items are stacked too tall
  - Straining or stooping because facilities and workstations are designed for the opposite gender

LOW LIGHT/VISUAL DEMANDS

- Examples of low light/visual demands observed at foundries
  - Working in a dim area
- A light meter measures the foot candles or lux in an area
- Measurements are compared to recommended tables for various types of tasks

INTERACTIONS PRESENT

- Did you notice that most pictures had more than one risk factor present?
- ***Interactions*** – having more than one risk factor
- The more risk factors present, the higher the risk for injury

EXAMPLES OF IMPROVEMENTS

SUMMARY

NOW YOU CAN:

- Identify ergonomics risk factors
  - Force Exertions
  - Frequency
  - Awkward Posture
  - Duration
  - Vibration
  - Cognitive Stress
  - Environmental Stress
  - Noise
  - Individual Differences
- Improve workplace safety and ergonomics
- Reduce risks of injury

QUESTIONS?

Thank you!

ERGONOMICS TRAINING: PART II

This material was produced under grant number SH-17087-SH-8 from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U. S. Government.

University of Louisville
Center for Ergonomics

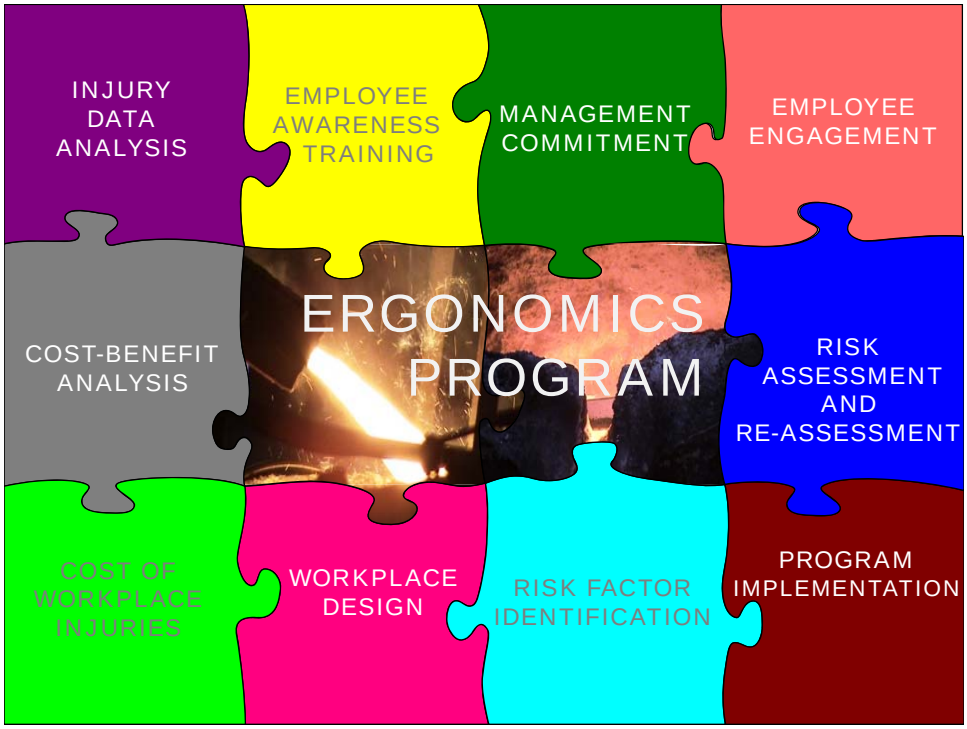
GOALS

PART I - LEARNED HOW TO:

- Understand the need for ergonomics
- Recognize ergonomic risk factors
- Appreciate the value of ergonomic programs

NOW, LEARN HOW TO:

- Implement a successful Ergonomics Program
  - Injury data analysis
  - Ergonomic workplace analysis
  - Engagement of employees
  - Workstation design
  - Cost-benefit analysis



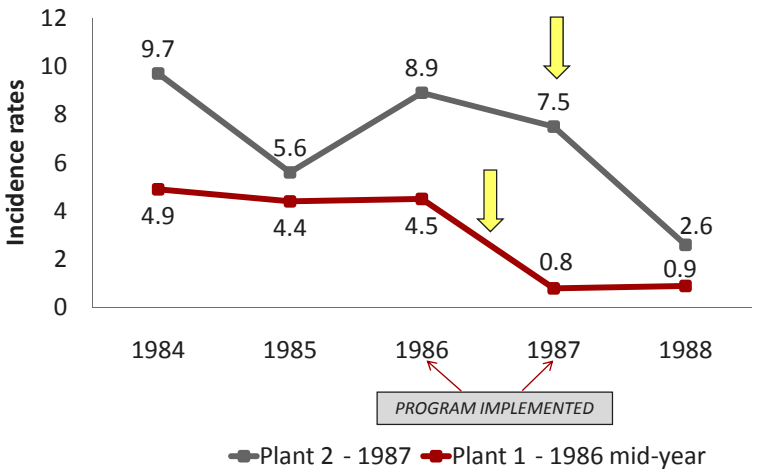
EXAMPLES OF SUCCESSFUL ERGONOMIC PROGRAMS

GOODYEAR

- In 1986, Goodyear established an ergonomics element in their safety program including:
  - Awareness training
  - Established ergonomics committee
  - Established an audit program
  - Fixed identified problems

Geras, DT et al,. (1989). *Advances in Industrial Ergonomics and Safety, I.* London: Taylor & Francis.

GOODYEAR'S ACCIDENT RATES BEFORE & AFTER ERGONOMICS PROGRAM



Geras, DT et al,. (1989). *Advances in Industrial Ergonomics and Safety, I.* London: Taylor & Francis.

WISCONSIN ALUMINUM FOUNDRY

- Foundry has approx. 390 employees
- Implemented safety & ergonomics inspections
- Fixed identified problems

RESULTS:

- WC costs reduced by 76.6% over 2 years
- Positive reports from employees

Foundry Ergonomics Partnership Helps Employers Improve Safety and Efficiency. (n.d.). Retrieved December 7, 2008, from Occupational Health and Safety Administration Web Site: http://www.osha.gov/dcsp/success_stories/partnerships/region5/261_fep_success.html.

IMPROVEMENT I

- Installed lift and tilt tables for baskets of parts and conveyors
  - Reduced lifting
  - Reduced bending and reaching
  - Increased productivity

Foundry Ergonomics Partnership Helps Employers Improve Safety and Efficiency. (n.d.). Retrieved December 7, 2008, from Occupational Health and Safety Administration Web Site: http://www.osha.gov/dcsp/success_stories/partnerships/region5/261_fep_success.html.

IMPROVEMENT II

- Installed a core lump crusher to eliminate the use of jackhammers to break up air set cores from casting
  - Reduced bending
  - Reduced exposure to vibration

Foundry Ergonomics Partnership Helps Employers Improve Safety and Efficiency. (n.d.). Retrieved December 7, 2008, from Occupational Health and Safety Administration Web Site: http://www.osha.gov/dcsp/success_stories/partnerships/region5/261_fep_success.html.

FOUNDRY IMPROVEMENTS

- Installed hydraulic opening system on permanent mold dies
  - Reduced strain
  - Reduced fatigue
  - Less burn cases
  - Increased productivity

Foundry Ergonomics Partnership Helps Employers Improve Safety and Efficiency. (n.d.). Retrieved December 7, 2008, from Occupational Health and Safety Administration Web Site: http://www.osha.gov/dcsp/success_stories/partnerships/region5/261_fep_success.html.

WHERE DO YOU START?

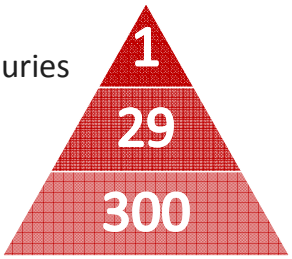
WHERE DO YOU START?

- STEP 1: Review injury history
- STEP 2: Evaluate workplace
- STEP 3: Implement improvements
- STEP 4: Engage employees
- STEP 5: Re-evaluate, measure improvements

STEP 1: REVIEW INJURY HISTORY

- REVIEW
  - OSHA recordable incidents
  - First Aids/Near Misses

- WHY
  - OSHA recordables = actual incidences
  - First aids/Near misses = potential incidences/injuries



OSHA 300 LOGS & INCIDENCE RATE

- OSHA 300 Logs
  - Date of injury
  - Employee name
  - Job Title
  - Injury location (department)
  - Body area affected
  - Type of injury
  - Death/ Days away/ Lost time

$$OSHA \text{ Incidence rate} = \frac{\text{Number of Injuries and Illnesses X } 200{,}000}{\text{Employee hours worked}}$$

EXAMPLE: OSHA 300 LOG RESULTS

Injury By Job Title

Job Title	2008
Saw Operator	5
Caster	10
Finisher	3
Packer	1
Fork Truck Driver	1
	20

Injury By Location

Location	2008
Saw	5
Sand Cast	10
Finishing	3
Packing	1
Warehouse	1
	20

Injury By Body Area

Body	2008
Leg	1
Arm & Hand	4
Back	9
Shoulder	3
Eye	3
	20

OSHA 300 Logs are the first level of information

EXAMPLE: CALCULATIONS PER JOB TITLE

Job Title	2008	Total number of employees	Percent injured
Saw Operator	5	1	500%
Caster	10	50	20%
Finisher	3	10	30%
Packer	1	10	10%
Fork Truck Driver	1	10	10%

- Let's calculate the percentage of injured employees by their job title
- How does this change the perspective?

EXAMPLE: BODY AREA PER JOB TITLE

- Use details to identify the root-cause(s)
- Focus proper resources to generate preventative measures

Body	Saw Operator	Caster	Finisher	Packer	Fork Truck Driver	2008
Leg				1		1
Arm & Hand	3			1		4
Back		7	1	1		9
Shoulder		3				3
Eye	2				1	3
Total	5	10	1	3	1	20

EXAMPLE: SAW OPERATOR

- Highest % injuries
- Review eye and arm/hand protection

Job Title	2008	Total employees	Percent injured
Saw Operator	5	1	500%

Body	Saw Operator
Leg	
Arm & Hand	3
Back	
Shoulder	
Eye	2
Total	5

EXAMPLE: CASTER

- Highest number of injuries for the given year/period of time
- Review individual incidents for the root-cause and for any other potential contributing factors

Body	Caster	2008
Leg		1
Arm & Hand		4
Back	7	9
Shoulder	3	3
Eye		3
Total	10	20

INJURY INVESTIGATION

OSHA 301 FORM:

- Time employee began workday
- Time of event
- What was the employee doing just before the incident occurred?
- What happened?
- What was the injury or illness?
- What object or substance directly harmed the employee?

INJURY INVESTIGATION (CONT)

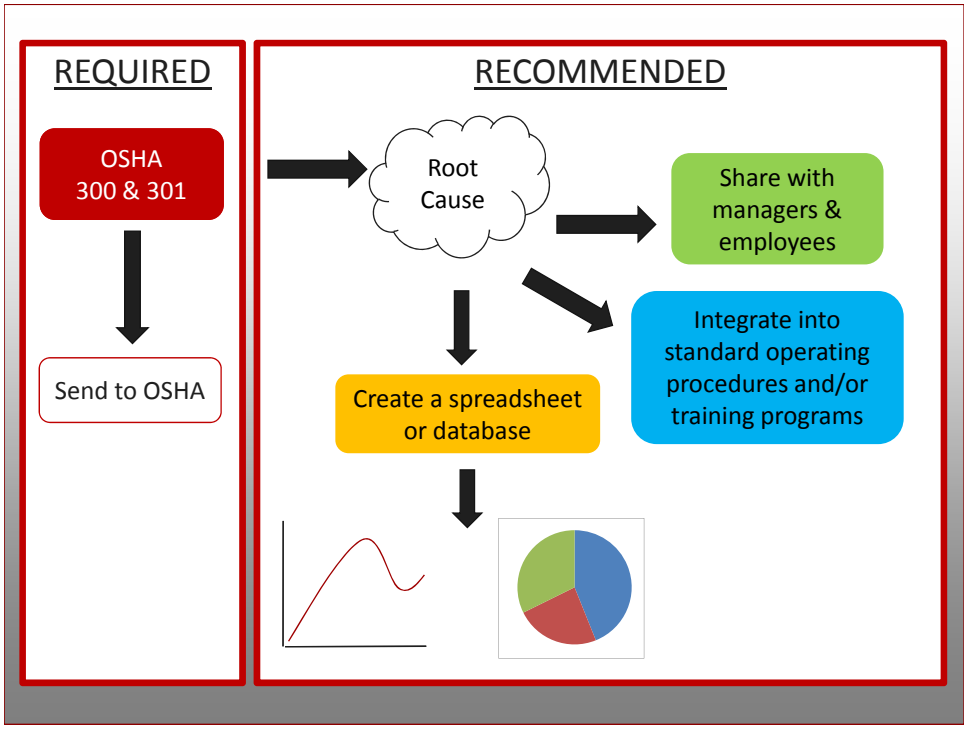
ADDITIONAL QUESTION SUGGESTIONS:

- Primary and secondary causes:
  - Was there a work procedure? Was it followed? Was it changed recently?
  - Were the appropriate tools and/or PPE in place?
  - Was there an equipment failure?
  - Was the area poorly lit, too bright, hot or cold, or did any other environmental conditions contribute?
  - Were there distractions, such as noise or vibration?

INJURY INVESTIGATION (CONT)

ADDITIONAL QUESTION SUGGESTIONS:

- Work Schedule:
  - What was the employee's work schedule 1-2 weeks prior to the incident?
  - Was this the employee's normal work shift?
- Experience:
  - How many years has the employee worked here?
  - How many years had the employee performed this task when event occurred?
  - Was the employee trained?
- Employee Input:
  - What does the employee think could have done to prevent the injury?
  - Are there other hazards not being addressed in their work area?



SUGGESTIONS

FIRST:

- Create a spreadsheet
- Use spreadsheet to track/organize information
- Share information with managers & employees

THEN:

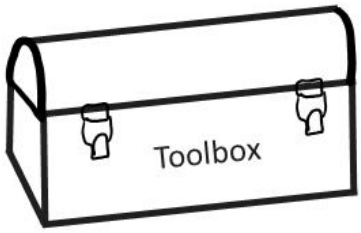
- Injury Data Analysis
  - Create charts and graphs to look for trends
  - Modify standard operating procedures
  - Improve employee training programs

QUESTIONS?

REDUCE THE RISK OF INJURY

- STEP 1: Review injury history
- STEP 2: Evaluate workplace
- STEP 3: Implement improvements
- STEP 4: Engage employees
- STEP 5: Re-evaluate, measure improvements

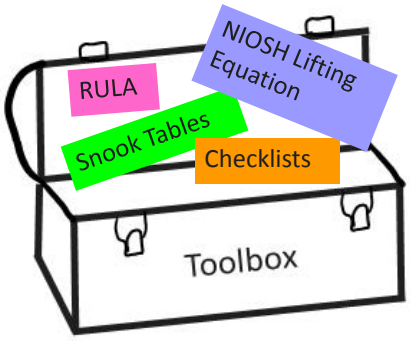
HOW DO YOU FIX SOMETHING?



- Hammer
- Nails
- Level
- Tape measure
- Screw driver
- Screws
- Tape
- And more…

STEP 2: EVALUATE WORK ENVIRONMENT

- Tools
  - Qualitative
  - Semi-Quantitative
  - Quantitative



QUALITATIVE METHODS

- Analysis is based on a checklist of job risk factors
- Follows two paths:
  - Professional judgment
  - Experience
- Supplementary knowledge of the injury and accident history is helpful

QUALITATIVE METHODS

- Advantages:
  - Simplicity
  - Speed
- Disadvantages:
  - Limited conditions of applicability
  - Require some training and ergonomic experience
  - Can be very inconsistent
  - Superficial and sometime insufficient results

QUALITATIVE METHODS

- Tool(s) covered in this training:
  - OSHA checklist
- Examples of other tools in this category:
  - WISHA checklist
  - PLIBEL

CHECKLISTS

- The person or team using a checklist considers whether a particular job risk factor is present in the job
- Depending on the checklist used, there will be considerations of:
  - Strength
  - Fatigue
  - Cumulative trauma disorders (CTD)
  - Environment

CHECKLIST ANALYSIS ORIENTATION

- Body regions
  - Back and legs
  - Hand and wrists
  - Elbows
  - Shoulders and neck
- Type of work
  - Manual handling
  - Lifting and lowering
  - Pushing and pulling
  - Workstation design
  - Etc.
- Conditions
  - Posture
  - Repetition
  - Force
  - Environment
  - Etc.

SEMI-QUANTITATIVE METHODS

- Semi-quantitative tools require:
  - More focused screening of specific job risk factors, usually distinguished by risk to a specific body region
  - More effort to collect and process data
- Follows two paths:
  - Qualitative assessment
  - Professional judgment
- May consider more than one contributing factor

SEMI-QUANTITATIVE METHODS

- Tool(s) covered in this training:
  - RULA
- Examples of other tools in this category:
  - Rodgers Muscle Fatigue Assessment
  - REBA
  - Strain Index

QUANTITATIVE METHODS

- Quantitative tools:
  - Require more effort and expertise
  - Help to understand how job risk factors combine in order to assess risk
  - Suggest contributing factors to control
- Based on static or dynamic strength criterion

QUANTITATIVE METHODS

- Tool(s) covered in this training:
  - NIOSH Lifting Equation
  - Liberty Mutual Manual Materials Handling Tables (Snook Tables)

- Examples of other tools in this category:
  - iLMM
  - 2D or 3D Static Biomechanical Analysis

TOOLS

- OSHA checklist
- RULA
- Liberty Mutual Tables
- NIOSH Lifting Equation

OSHA CHECKLIST OVERVIEW

- Ratings
  - Either the risk factor is present or not
- Considers (in general categories)
  - Awkward postures (some by body part, some in groups)
  - Repetition, duration, vibration
  - Force: pounds lifted, contact stress
  - Specific section for computer workstations
- Easy to understand = Great for ergonomics teams!

OSHA CHECKLIST EXAMPLE

- Refer to video and checklist in your workbook

TOOLS

- OSHA checklist
- RULA
- Liberty Mutual Tables
- NIOSH Lifting Equation

RULA OVERVIEW

- Rapid Upper Limb Assessment
- Ratings
  - Multiple levels, assigns a “score”
- Considers by body part
- Static and dynamic work
  - Posture
  - Duration
  - Force: pounds lifted, surface contact
- Focused on upper extremities (upper limbs)

RESULTS

- Results given in Action Levels

Action Level	RULA score	Action (including further assessment)
1	1-2	Posture is acceptable if it is not maintained or repeated for long periods
2	3-4	Further investigation is needed and changes may be required
3	5-6	Investigation and changes are required soon
4	7	Investigation and changes are required immediately

RULA EXAMPLE

- Refer to video and RULA in your workbook

TOOLS

- OSHA checklist
- RULA
- Liberty Mutual Tables
- NIOSH Lifting Equation

LIBERTY MUTUAL TABLES

- Pushing/Pulling tasks

LIBERTY MUTUAL TABLES

- Refer to video and Liberty Mutual Tables in your workbook

TOOLS

- OSHA checklist
- RULA
- Liberty Mutual Tables
- NIOSH Lifting Equation

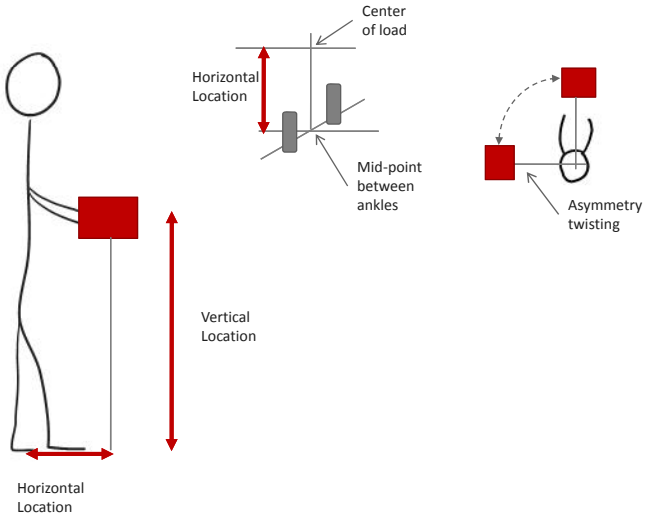
NIOSH LIFTING EQUATION

- ***NIOSH*** - National Institute for Occupational Safety and Health
- Lifting/lowering tasks
- Does not consider:
  - One-handed lifts
  - Team lifts
  - Patient handling
  - Pushing, puling, holding, carrying, walking
  - Lifting/lowering for over 8 hours
  - Lifting/lowering while seated
  - Lifting/lowering while kneeling
  - Lifting/lowering in an adverse environment (hot, cold, humid, etc)

NIOSH LIFTING EQUATION

- Compares initial location of load to final location
- Rating: Lifting Index
- Considers:
  - Posture
  - Duration
  - Frequency
  - Position of the load
  - Asymmetry (twisting)
  - Weight/force of the load
  - Coupling

NIOSH LIFTING EQUATION FIGURE



NIOSH LIFTING EQUATION EXAMPLE

- Refer to video and NIOSH Lifting Equation in your workbook

LI < 1	➡	Safe
1< LI < 3	➡	Increased Risk
LI > 3	➡	Not Safe

*When using the NIOSH lifting equation no worker should be performing a task with a lifting index greater than **3!***

!

BENEFITS OF EVALUATION

- Determine risk level of the jobs
- Prioritize which jobs to improve
- Target areas within a job to improve
- Allow for *Before & After* analysis

SUMMARY

- Repetitive tasks are usually easier to evaluate
- Multi-task jobs OR jobs with longer cycles are more difficult to evaluate
- Every evaluation tool has strengths and weaknesses
- Ergonomic workplace evaluations are a multi-step process
- Every tool considers ***ideal conditions***, i.e. comfortable environment, healthy employees

QUESTIONS?

REDUCE THE RISK OF INJURY

- STEP 1: Review injury history
- STEP 2: Evaluate workplace
- STEP 3: Implement improvements
- STEP 4: Engage employees
- STEP 5: Re-evaluate, measure improvements

STEP 3: IMPLEMENT IMPROVEMENTS

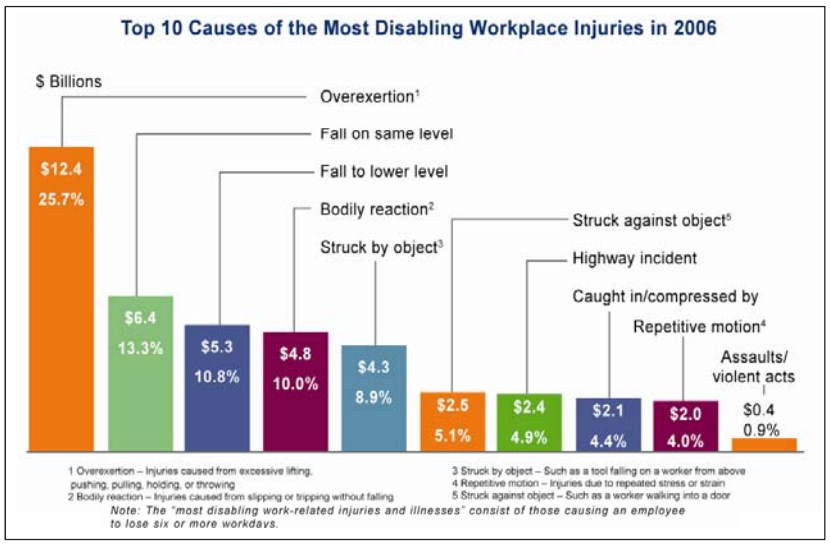
JUSTIFICATION:

- Improving the safety of the workplace
- Cost-benefit analysis

BENEFITS:

- Delivering on commitments
- Reducing injury risk
- Reducing potential injury costs

WORK RELATED INJURY COSTS



Source: Liberty Mutual Research Institute for Safety

DIRECT COSTS

- Medical bills
- Worker's Compensation Costs

INDIRECT COSTS

- Costs to find temporary or permanent replacement staff
- Training costs
- Production losses
- Long term disability costs
- Litigation
- Overtime costs

WORK RELATED INJURY COSTS

- Estimated overall cost of MSDs (1994) [a]

  $100 billion
- Estimated overall cost of MSDs (1995)[b]

  $215 billion
- Estimated overall cost of MSDs (1997)[c]

  $1.25 trillion

[a]Dear J. (1996). *Upper limb musculoskeletal disorders.* Retrieved January 7, 2009, from Occupational Health and Safety Administration Web Site: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=205&p_table=SPEECHES
[b]Praemer A., Furner S., Rice D.P. (1999). Musculoskeletal Conditions in the United States. American Academy of Orthopaedic Surgeons: Rosemont, IL.
[c]Brady, W,. Bass, J., Royce, M., Anstadt, G., Loeppke, R., & Leopold, R. (1997). Defining total corporate health and safety costs: Significance and impact. *Journal of Occupational and Environmental Medicine, 39, 224–231.*

WORK RELATED INJURY COSTS

- Total annual US cost of back disability: $50 to $100 billion [a]
- Average cost of a worker's compensation claim cost in 2008[b]
  - Carpal tunnel: $17,757 /case
  - Lower back: $23,820 /injury

a Frymoyer, J. W., & Cats-Baril, W. L. (1991). An overview of the incidences and costs of low back pain. *Orthop Clin North Am, 22(2), 263-271.*
b National Safety Council 2008 http://www.nsc.org

PRIORITIZATION BY PRODUCTIVITY

- Oxenburgh Productivity Model
  - Focus on jobs with absenteeism or high turnover
    - Completing modifications to tools, equipment or work organization = ↑increase productivity in these problem jobs
  - What areas in your company would fall into this category?

PRODUCTIVITY CALCULATIONS

- Oxenburgh Productivity Model

Direct wage costs = wage + obligatory charges to the wage
+ personnel + administrative costs

Indirect costs = costs of losing trained employees
+ costs of hiring and training new employees
+ costs of additional overtime + over employment costs

PRIORITIZATION BY IMPACT FACTOR

NEED TO KNOW:

- Number of injuries for a given job or similar jobs
  - worker's compensation costs
  - lost-time costs
  - training costs
  - If no injuries - use typical cost figures for work-related musculoskeletal disorders
- What is the occurrence frequency?
- What is the impact factor?
  - How many people would be affected by a positive change?

QUESTIONS?

IMPROVEMENT EXAMPLES

EXAMPLE I

ADDING SAND TO THE MOLD

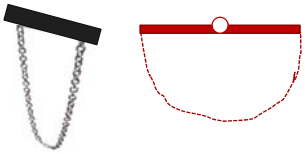
- Employee suggests changes to this job after ergonomics awareness training

- OR -

- Employee has shoulder pain, but can still perform the job

POTENTIAL ERGONOMICS IMPROVEMENT

~$250 Add rocker arm and chains to extend lever



~$1500 Foot pedal installed

~$100 Foam packing hose to minimize material loss

POTENTIAL IMPROVEMENT EVALUATION

1. Talk to the operator(s)
   What do they think?
2. Determine if a solution will have a negative outcome if implemented
3. Implement solution
4. Re-evaluate

~$250 Add rocker arm and chains to extend lever

~$1500 Foot pedal installed

~$100 Foam packing hose to minimize material loss

COST-BENEFIT ANALYSIS

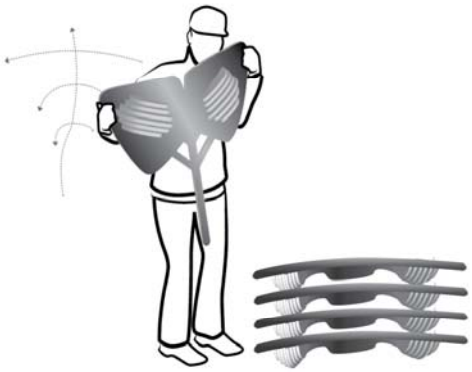
- Hose
  - $100 labor + materials
  - $10/ day reduces clean-up time & material loss
- Pays for itself in 10 days

- Rocker arm & chain
  - $250 labor + materials
  - 20% reduction in awkward shoulder posture
  - Reduces fatigue
  - Improves worker productivity by 10 minutes / day
- Pays for itself in 94 days

IMPROVEMENT EXAMPLES

EXAMPLE II

CAN YOU RECOGNIZE THE RISK FACTORS?



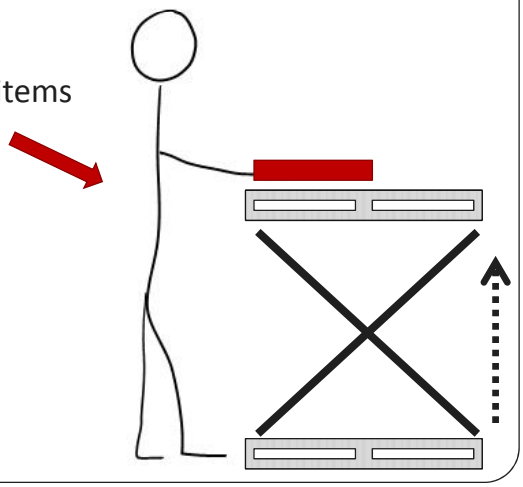
Worker is adding metal into the furnace from a pallet

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

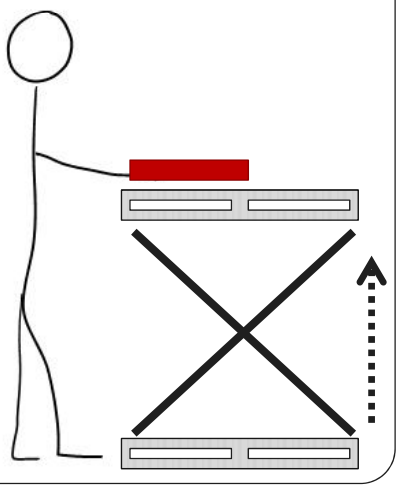
WHAT CAN YOU DO ABOUT IT

- Get help – 2 man lift
- Use lift assist to move/transfer
- Use fork lift to move items to waist level
- Avoid twisting



POTENTIAL ERGONOMICS IMPROVEMENT

1. Talk to the operator(s) *What do they think?*
2. Determine if a solution will have a negative outcome if implemented
3. Implement solution
4. Re-evaluate



COST BENEFIT ANALYSIS

OPTION 1

- 2-man lift
  - Operator time $15/hr for a total of 1 hour per day
  - Cost: $15,700 for 3 years
- Back injury history
  - 1 injury in last 3 years
  - Cost $15,000
  - Lost time 30 days
- Nearly pays for itself
  - $16,200 cost for 3 years

COST BENEFIT ANALYSIS

OPTION 2

- Fork truck to lift
  - Operator time $12/hr for a total of 1 hour per day
  - Cost: $12,600 for 3 years
- Back injury history
  - 1 injury in last 3 years
  - Cost $15,000
  - Lost time 30 days
- Pays for itself
  - $12,960 cost every 3 years

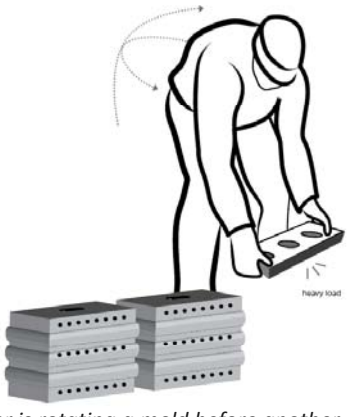
IMPROVEMENT EXAMPLES

EXAMPLE III

CAN YOU RECOGNIZE THE RISK FACTORS?

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

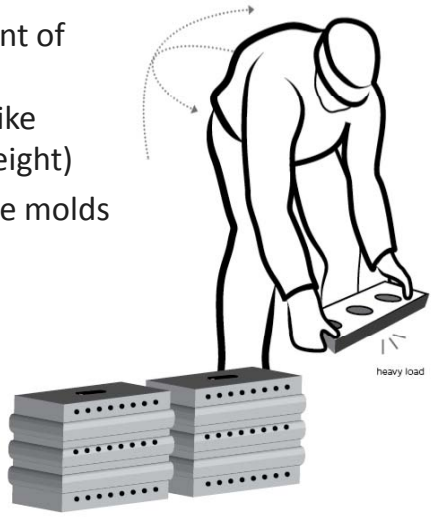


Worker is rotating a mold before another worker pours in metal.

The orientation was not set correctly when the mold was placed on the floor.

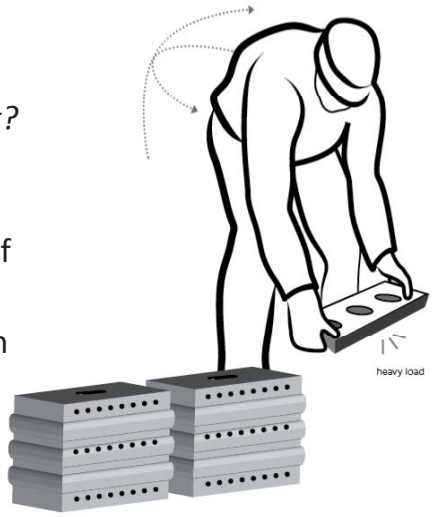
WHAT CAN YOU DO ABOUT IT

- Pre-plan the placement of the molds to reduce corrections needed (like making them waist height)
- Use jib cranes to move molds



POTENTIAL ERGONOMICS IMPROVEMENT

1. Talk to the operator(s) *What do they think?*
2. Determine if a solution will have a negative outcome if implemented
3. Implement solution
4. Re-evaluate



COST-BENEFIT ANALYSIS

OPTION 1	*OPTION 2*
PLACEMENT TRAINING:	**JIB CRANE:**

• Training for 1 hour
  ◦ Cost: $50
• Improves productivity
  ◦ 10 min reduced daily
	• Cost: $30,000
	• Back injury history
	  ◦ 1 injury in last 3 years
	  ▪ Direct costs $15,000
	  ◦ Lost time 30 days
	  ▪ Training & overtime costs $2000

• Pays for itself in 19 days	• Pays for itself in 22 months

IMPROVEMENT EXAMPLES

EXAMPLE IV

CAN YOU RECOGNIZE THE RISK FACTORS?

Worker is activating the machine with a two-handed safety lever to create part

☐	Lifting Heavy Loads
☐	Pushing/Pulling
☐	Awkward Posture
☐	Work Duration
☐	High Frequency/Repetitive Task
☐	Low/High Frequency Vibration

☐	Heat / High Humidity
☐	Noise
☐	Cognitive Stresses
☐	Low Light/Visual Demands
☐	Individual Differences

WHAT CAN YOU DO ABOUT IT

- Pull from the lower section of the handle
- Adjust the handle height

POTENTIAL ERGONOMICS IMPROVEMENT

1. Talk to the operator(s)
   What do they think?
2. Determine if a solution will have a negative outcome if implemented
3. Implement solution
4. Re-evaluate

COST-BENEFIT ANALYSIS

OPTION 1

PULL FROM THE LOWER SECTION OF THE HANDLE:

- Cost: $50 for 1 hour of training
- Improves productivity
  - 10 min reduced daily
- Pays for itself in 50 days

COST-BENEFIT ANALYSIS

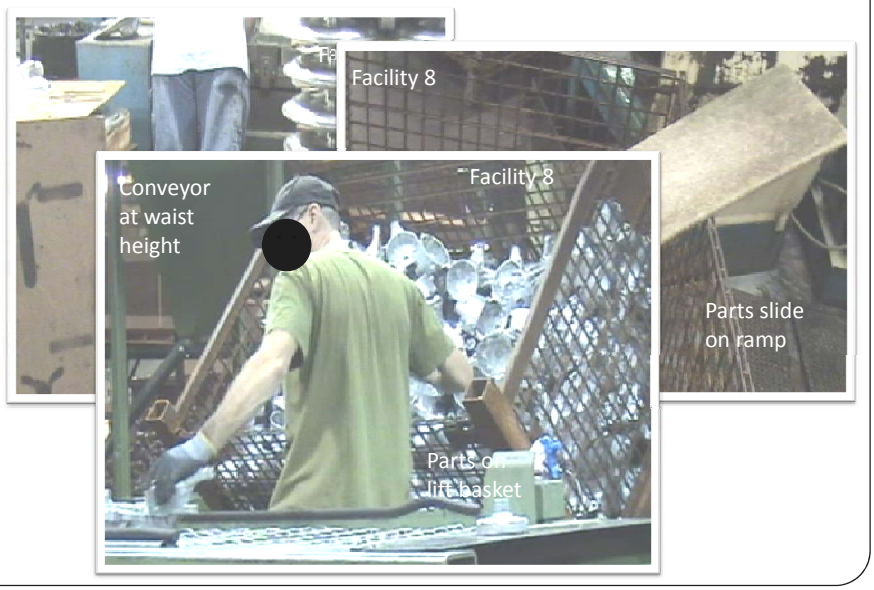
OPTION 2

ADJUST THE HANDLE HEIGHT:

- Cost: $250 = labor + materials
- 20% reduction in awkward shoulder posture
- Reduces fatigue
- Improves worker productivity by 10 minutes per day
- Shoulder injury history
  - 1 injury in last 3 years
  - Direct Costs $5,000

- Pays for itself in 35 days, if 0 shoulder injuries occur

GOOD ERGONOMIC WORKSTATIONS



WORKSTATION DESIGN TIPS

- In the workplace, it is important to accommodate the functional capabilities and limitations of the *majority* of the workforce
  - Ability to reduce number of overexertion injuries
  - Ability to replace people (e.g. vacation)
  - Ability to stay on the job longer
  - Ability to implement job rotation

WORKSTATION DESIGN TIPS

- Design for adjustability
  - As seen in the previous slides, the operator had to reach to activate the machine
- Design for average
  - For example, when a control or level needs to accessible to everyone, choose the shortest/smallest person in the work area and make sure they can reach it
- Design for extreme
  - For example, when placing equipment into a production line, make sure maintenance employees will be able to fit inside the area to perform repair work

TOOL-TASK DESIGN

- Consider the orientation of the tool and task

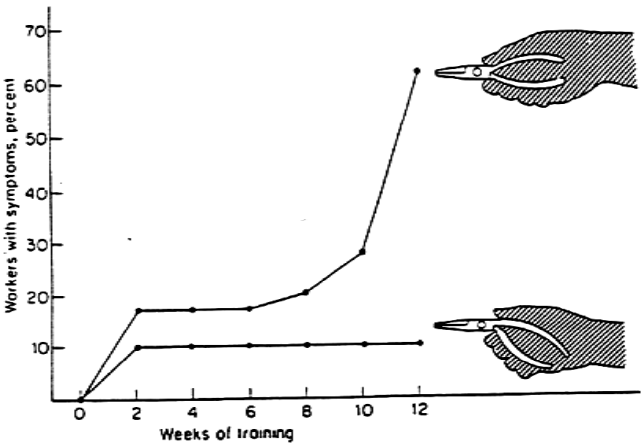
BAD

Bending to get a part

BETTER

Basket with parts on a lift/tilt table

TOOL DESIGN EXAMPLE



Comparison of two groups of trainees using different pliers.
Shows % of workers with symptoms compared to weeks of training.

Tichauer, E.R., (1976). Biomechanics sustains occupational safety and health. *Industrial Engineering*, February: 46-56.

QUESTIONS?

REDUCE THE RISK OF INJURY

- STEP 1: Review injury history
- STEP 2: Evaluate workplace
- STEP 3: Implement improvements
- STEP 4: Engage employees
- STEP 5: Re-evaluate, measure improvements

STEP 4: ENGAGE EMPLOYEES

TRUE OR FALSE

- Employees should not get involved too early in the re-design of their workstations, because they don't know much about ergonomics and will be resistant to changes.

FALSE

Employees do this job everyday, they are a great source of information

ENGAGE EMPLOYEES

- Listen to your employees, involve them in the decision process and ask for input
  - Example: *before* purchasing a new hand tool, have a trial period with a select group of employees and ask for their opinion
- Make commitments and deliver
  - Example: Ask about near-misses or how an incident might occur. Follow-up with each of the reasons given, and if possible, fix them

ENGAGE EMPLOYEES

- Show leadership
  - Example: wear the required PPE while in the work area
- Drop-in on employees, talk with them on a regular basis
  - Example: Ask how their production day is going, whether the equipment is working well or if they noticed anything different. These are *clues* to quality or safety issues

ENGAGE EMPLOYEES

- Recognize and reinforce good practices
  - Example: For employees without safety violations for one year, you:

_____

_____

ENGAGE EMPLOYEES

- It is also important to enforce established safety procedures
  - For example, what do you do if an employee is not wearing their required hearing protection?

_____

_____

ENGAGE EMPLOYEES

- Consider programs:
  - Tip / Suggestion box
  - Quarterly round table discussions
- Provide positive reinforcement
  - Reward good ideas
    - For example, a gift card for the local movie theater for the best ergonomics/safety idea

_____

_____

REDUCE THE RISK OF INJURY

- STEP 1: Review injury history
- STEP 2: Evaluate workplace
- STEP 3: Implement improvements
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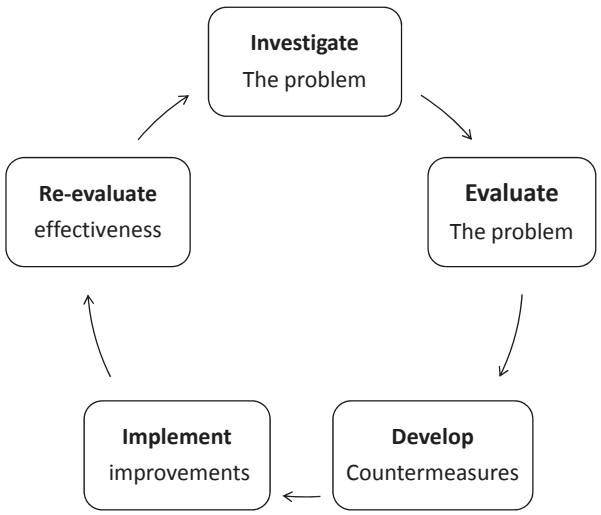
- STEP 5: Re-evaluate, measure improvements

IMPROVEMENT PROCESS CIRCLE



EVALUATE, RE-EVALUATE AND FOLLOW UP

- Training feedback questionnaire
- Post training evaluation test
- Follow up on the training effectiveness in the next 3-4 months

Questions?

Thank you!

ERGONOMICS AND SAFETY AT YOUR FOUNDRY
COURSE PRE-TEST / POST-TEST

Part 1: Multiple Choice Questions: ***circle only one answer***

1. What are the potential benefits of this course?
- A. Learn about safety
- B. Learn about risk factors for work related injury
- C. Reduce workplace injuries
- D. Increase productivity
- E. A, B and C
- F. All of the above

2. Which of these might be a concern of ergonomics?
- A. Environmental noise
- B. Indoor air quality
- C. Fitting the job to the person
- D. Whether your chair is comfortable
- E. A, C and D
- F. All of the above

3. If you are injured on the job, what should you do?
- A. Request and complete an incident report form from your supervisor
- B. Request a leave of absence
- C. Call your doctor to schedule an appointment
- D. A and C only
- E. All of the above
- F. None of the above

4. What is the purpose of Personal Protective Equipment (PPE)?
- A. Protect from exposure to hazardous substances
- B. Make a worker look more professional
- C. Protect parts of the body vulnerable to injury
- D. Enhance conformity
- E. A & C
- F. All of the above

5. When lifting a load, keeping the load closer to your center of your body allows you to lift _____.
- A. lighter items
- B. heavier items
- C. awkward items
- D. items more frequently
- E. All of the above
- F. None of the above

6. Which of the following poses a risk from exposure to vibration?
- A. Keeping your cell phone in your pocket on 'vibrate' all day
- B. Doing jumping jacks during your breaks
- C. Driving to your work site in a car with worn shocks for a week
- D. Continuously driving a forklift at your worksite
- E. None of the above

Part 2: True or False Questions: ***circle only one answer***

7. People who work in offices don't have to worry about workplace health and safety

A. True
B. False

8. Your boss is required by law to train you if you are exposed or are likely to be exposed to known hazards

A. True
B. False

9. If no pain is noticed while performing a repetitive task then you do not have to worry about musculoskeletal disorder.

A. True
B. False

10. Fatigue increases your risk of injury

A. True
B. False

11. Frequent short breaks are better than infrequent long breaks; for example, a 5 min rest every hour is more helpful than a 20 min rest every 4 hours

A. True
B. False

12. Ergonomic programs aimed at early intervention are only appropriate for low-back injuries

A. True
B. False

13. The OSHA recommended maximum permissible exposure to continuous noise throughout an 8 hour working day is 115 dBA

A. True
B. False

14. Strain is an injury to a ligament

A. True
B. False

15. All risk factors can be eliminated

A. True
B. False

THANK YOU!

Your Score _____

ERGONOMICS AND SAFETY AT YOUR FOUNDRY
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B. False

THANK YOU!

Your Score _____

FEEDBACK QUESTIONNAIRE

Facility: <Foundry Name> **Name of Trainer : <Trainer Name>**

Name: _____ **Date: _____**

How satisfied were you with the training?

1. **Overall quality of the training**

   Excellent Good Satisfactory Poor N/A

2. **Attitude of the trainer**

   Excellent Good Satisfactory Poor N/A

3. **Trainer's knowledge of the topics**

   Excellent Good Satisfactory Poor N/A

4. **Handouts and training aids**

   Excellent Good Satisfactory Poor N/A

5. **Interaction level**

   Excellent Good Satisfactory Poor N/A

6. **The content of the training met my expectations**

   Agree Neutral Disagree N/A

7. **I will try to apply knowledge learned to my job**

   Agree Neutral Disagree N/A

8. **What would you recommend to the trainer to be done differently? (Please use the back of the paper if you need more space.)**