



Learning Objectives

- The Goal of this session is for attendees to walk away with an understanding of the physical risks that are associated with power tools and what technology is being implemented to mitigate it.
- Themes
 - Ergonomics
 - Muscular Skeletal Disorders
 - Emerging Technology

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What is Ergonomics?

Ergonomics is “the study of work”.

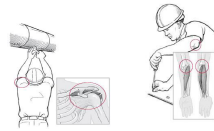
It is the process of **making the job fit the person** that is doing it instead of trying to make the person fit into the job.

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What's at risk?

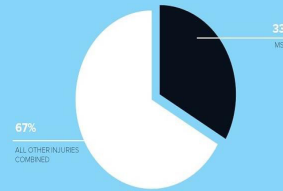
Great ergonomic solutions often go **un-noticed** when done correctly...

BUT, when developed incorrectly, it effects users and the entire ecosystem of the jobsite.



JOBSITE MSD INJURIES ARE INCREASING BOTH IN INCIDENT AND RATE

MSDs ACCOUNT FOR 33% OF ALL WORKERS COMPENSATION COSTS

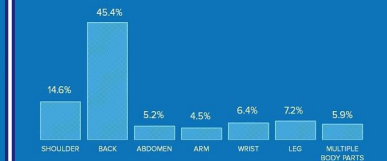


EXAMPLE: CALCULATING THE TOTAL COST OF THE MSD PROBLEM

Do you know how much MSDs are costing you?
To find out, use OSHA's Safety Pays cost calculator to estimate the total costs for injuries at your facility. Below is an example using a few common injuries.

	DIRECT	INDIRECT	TOTAL
Sprain	\$ 28,866	\$ 31,752	\$ 60,618
Strain	\$ 33,528	\$ 36,880	\$ 70,408
Carpal Tunnel	\$ 30,000	\$ 33,000	\$ 63,000
Strain	\$ 33,528	\$ 36,880	\$ 70,408

MSDs ACCOUNT FOR ALMOST 400,000 INJURIES/ILLNESSES



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Outline

- Identifying Key Ergonomic Risk Factors
- Designing the Right Tool for the Job
- Ergonomic Power Tool Innovations
- Applying Practical Guidelines for Power Tool Selection

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Key Ergonomic Risk Factors



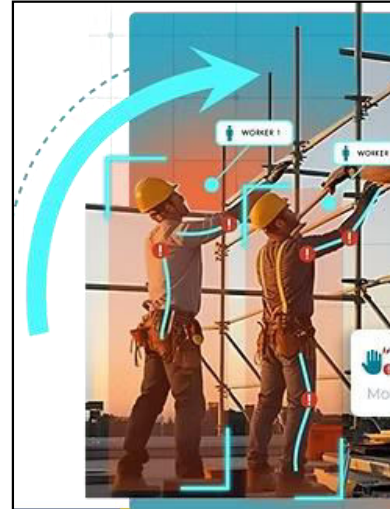
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Ergonomic & MSD Risk Factors

- Forceful Exertions
- Awkward Postures
- Repetitive Motions
- Static Postures
- Vibration
- Contact Stress
- Extreme Temperatures



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Forceful Exertions

Amount of effort required to complete a task:

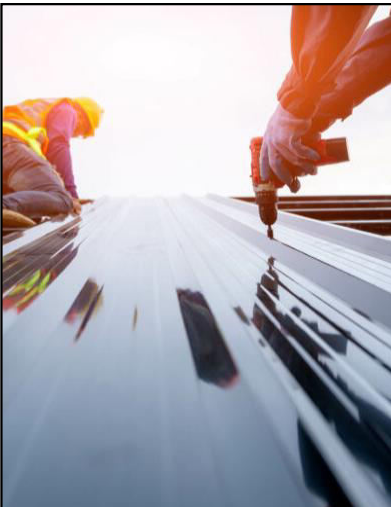
- High Force, short duration
- Sustained efforts over time

Risks:

Place high loads on muscles, tendons, ligaments and joints, increasing risks of MSDs



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Awkward Postures

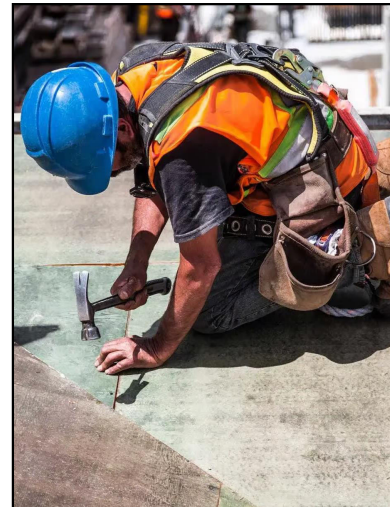
Body positions that deviate from neutral position while performing a task:

- Reaching, bending, twisting, overhead work, kneeling, squatting, or static postures

Risks:

Strain muscles and joints – making them more susceptible to injuries

May be harder to generate force making tasks more challenging and fatiguing



Repetitive Motions

Tasks that require repeated movements of the same body parts:

- Especially important when combined with awkward postures and high force

Risks:

Strain muscles and joints – causing injuries and conditions such as carpal tunnel syndrome, tendonitis and tenosynovitis



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Static Postures

Holding the same body position for extended periods:

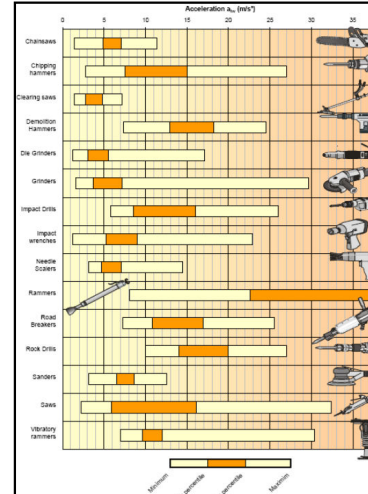
- Maintaining a certain position for precision tasks
- Example: Holding a pipe overhead while preparing a fitting

Risks:

Muscle fatigue and strain
MSDs such as back pain, neck pain, and carpal tunnel syndrome
Reduced blood circulation



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Vibration

Power tool or equipment rapidly moves back and forth about a stationary point:

- Hand-arm vibration (HAV)
- Whole-body vibration (WBV)

Risks:

High frequency vibration causes damage to nerves and blood vessels
Indirect cause of MSD risk to the upper limbs – increases the force required by to perform the task



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Contact Stress

A hard or sharp object comes into contact with the skin:

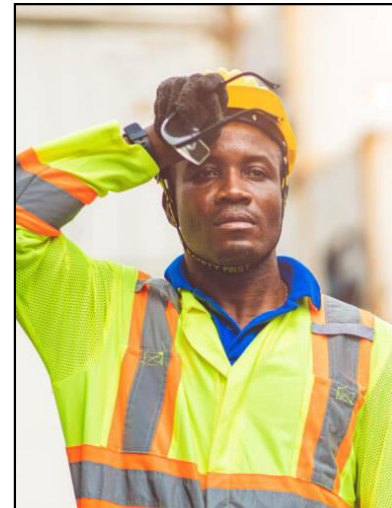
- Ridges and hard edges on tool handles
- Edges of work surfaces digging into forearm/wrist
- Striking objects sharply with foot/hand

Risks:

Nerves and tissues can be injured by pressure created



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Extreme Temperatures

Cold stress can cause muscles and joints to stiffen:

- Reduces flexibility and manual dexterity
- Intensifies repetitive strain injuries

Heat stress can cause:

- Heat strokes
- Heat exhaustion
- Heat cramps

Risks:

Increases risk of strains and sprains
Impaired blood flow – negatively impacting grip strength and dexterity
Increased effort required for tasks



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Designing the Right Tool for the Job

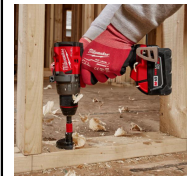


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Ergonomic spectrum

Integrated into Milwaukee's development process but often varies due to the solutions needs.

Common ← Ergonomic Development Spectrum → Specialized



Products that will be held or interacted with by users (Almost everything)



Handle sizes, accessibility and placement of features (75-85% percentile male)



High grip force tasks that require a sensitivity to form and handle size



Highly repetitive tasks that require high force or weight. The most important for ergonomic studies.

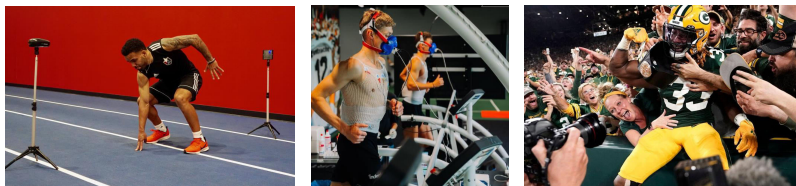


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Picture this...



We study our core end users with the same amount of focus as others might study professional athletes



Driving for optimal safety and performance for the longevity of an entire career



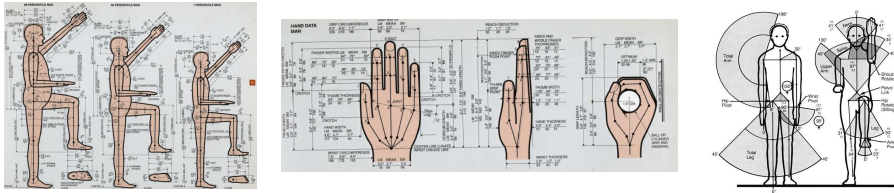
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It starts as simple as...



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Anthropometry the scientific study of the measurements and proportions of the human body such as size, weight proportion, mobility and strength.

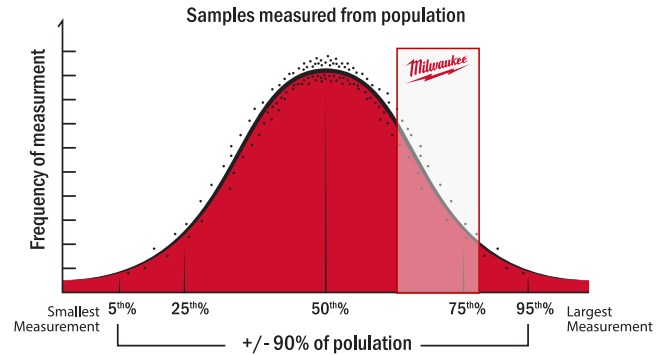


We use this data to decide on the sizes, weights, and proportions of our products to enhance the efficiency, safety and comfort of our user.



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Ergonomic Database

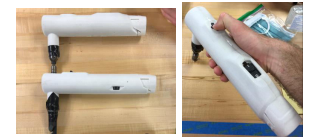


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But how does design of power tools affect an end user's muscle effort and motion?

Anthropometry for Design

Design for mean when neither extreme is compromised



Design for extreme (fit vs. reach) when one extreme accommodates the other extreme.



Design for adjustability when consequences are critical.



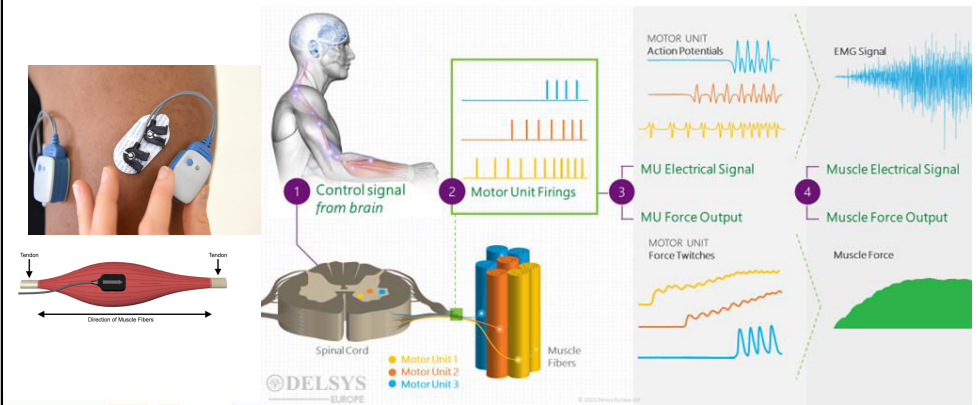
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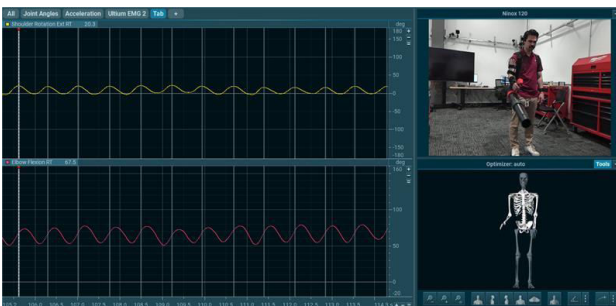
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Using Biomechanical Technologies for Tool and PPE Design

Surface Electromyography (sEMG) Muscle Activation



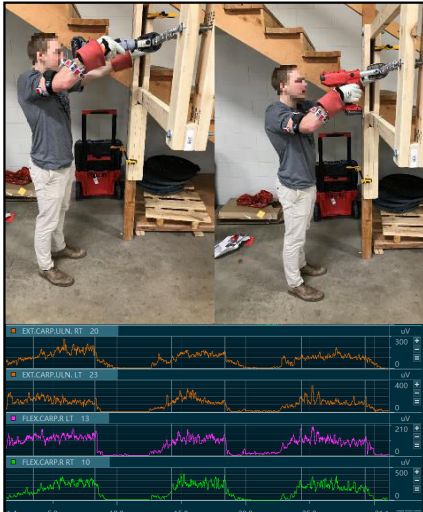
Inertial Measurement Units (IMUs) Motion Capture



Technology with gyros and accelerometers, combined with advanced kinematic modeling.

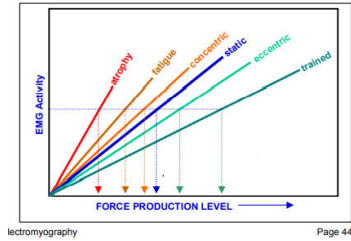
Capture joint angles, orientation, acceleration to provide insight into how a person moves





Muscle Effort Analysis

How much work or effort a particular muscle needs to perform a certain exercise or task. Analyzed as a percent of your maximum effort.



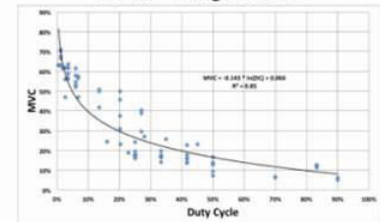
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ACGIH® Fatigue Curve



- Duty Cycle Range: 0.5% to 90%
- For multiple tasks that are 2h or more each, none should exceed the TLV®

Ideally mean muscle effort is maintained under 20% MVC during a workplace task and peak exertions are below 60% MVC to prevent MSDs.



Anthropometry Grip Width and Tool Mass

Optimizing handle diameter to hand length can increase grip strength and decrease muscle effort needed to grip the tool.

When possible, minimizing weight of a single-hand operated tool to below 1.4kg (3lbs) will help in ergonomics.

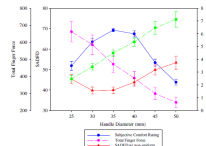


Fig. 6. The relationships among subjective comfort rating, total finger force, and the sum of the absolute differences between measured and ideal force distributions (SADFD) with the uniform and non-uniform ideal force distribution alternatives. (See Appendix A for explanation of SADFD calculation.)

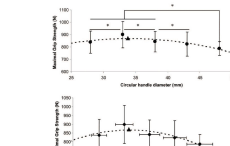


Fig. 5. Maximal Grip Strength (N) as a function of hand-to-hand distance. An unexpected relationship was found. * means a significant difference between hand distances. The dashed curve represents a polynomial regression using the experimental values (range and R^2 are in the text). ▲ represents the theoretical maximal value of MVC component from the polynomial regression. The horizontal line shows the theoretical value of the grip component in the subject's hand length. A polynomial regression and the theoretical maximal value of the regression curve are also shown.



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User Complaint and Injuries

Overhead work is strongly correlated with the development of MSDs in the shoulder/rotator cuff

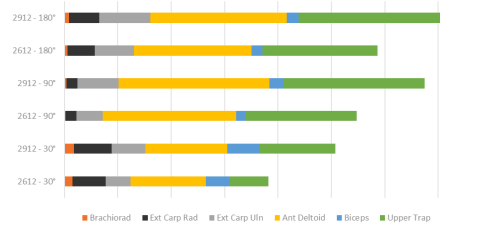
Overhead drilling into concrete with rotary hammers + dust extraction that can weigh anywhere from 8-14 pounds expose workers to a high level of risk to develop an MSD

Overhead Drilling Design



30 degrees 90 degrees 180 degrees

Peak %MVC - Two-handed - Overhead Elevation



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Overhead Drilling Design

- M18 FUEL™ Overhead Rotary Hammer w/ Integrated Dust Extraction



Newly Designed Side Handle

- ✓ Max shoulder flexion of 71 degrees in the non-dominant arm
- ✓ Approximately no shoulder abduction

Traditional Side Handle

- ✗ Max shoulder flexion of 105 to 115 degrees in the non-dominant arm
- ✗ Approximately 140 degrees of shoulder abduction

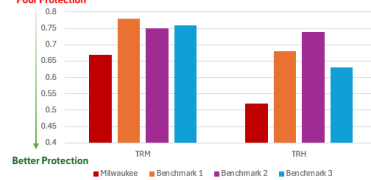


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Anti Vibration Gloves



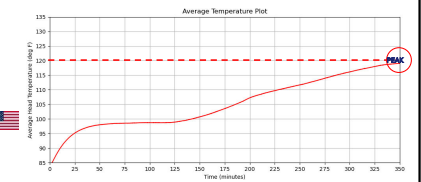
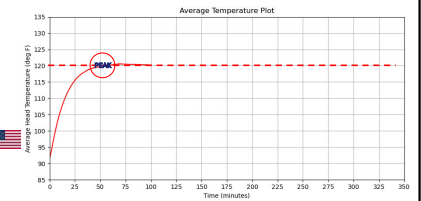
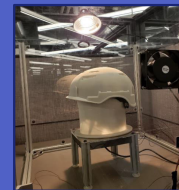
ISO 10819 Vibration Transmissibilities



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Cooling PPE


20 DEGREE REDUCTION INSIDE HELMET WITH COOLING LINER



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STANDARD IMPACT DRIVER VS SURGE™ TECHNOLOGY

REDESIGNED FLUID-DRIVE™ HYDRAULIC MECHANISM REDUCES SOUND / VIBRATION




STANDARD IMPACT DRIVER
Metal hammer contacts metal anvil generating noise and vibration

VS.


SURGE™ HYDRAULIC DRIVER
Sealed mechanism filled with hydraulic fluid that rapidly compresses and expands

50% QUIETER
vs. STANDARD IMPACT

3X LESS VIBRATION
vs. STANDARD IMPACT



FLUID-DRIVE™

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Milwaukee **M18 FUEL SURGE™ HYDRAULIC DRIVER** **NEW 2ND GENERATION**

VIBRATION REDUCTION IMPROVES END USER SAFETY & INCREASES CONTROL

SMOOTHER DRIVING & LESS VIBRATION


3X LESS VIBRATION
3 VECES MENOS VIBRACION
3 FOIS MOINS DE VIBRATION

M18 FUEL™ SURGE™ vs Standard Impact




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IMPROVED END USER SAFETY







Reduced Vibration In Application
To Reduce User Fatigue Over Time
For Daily Use Tool

INCREASED APPLICATION CONTROL



Hydraulic Mechanism Improves
Control / Finesse In Light Applications

Questions?

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