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Today's Agenda

- Introduction
- Ergonomic risk factors basics
- Industry 4.0 and the connected worker
- Personal wearables & biometrics
- Wearable sensors types – single versus multi
  - Benefits and challenges
- Wearable sensors in construction sites
- Computer vision and ergonomic assessments
- Wrap up

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A little about me…

- **David Wein**
  - VP-Environmental, Health, Safety, and Sustainability for Milwaukee Tool
  - Primary responsibility for manufacturing, distribution, service, engineering facilities in the US and MX
  - Almost 30 years working both on-site and corporate EHS roles. Over 15 years specifically focused on:
    - Industrial ergonomics
    - Process improvement
    - Human factors and user-centered design

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My Journey…

UNIVERSITY OF WISCONSIN WHITEWATER
BSE – Occupational Safety

UNIVERSITY of WISCONSIN UWMILWAUKEE
Masters in Engineering - Ergonomics

- Polaris Industries
- Castle Rock Container
- Kohler Company
- Bemis Company
- Oshkosh Corporation
- Milwaukee Tool






Milwaukee

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Disclaimer

- The material presented today includes examples of different wearable and video AI software that is available on the market today, primarily in the US.
- I am not working on behalf of any product vendor nor am I being compensated by any vendors for presenting their information.
- This is not an all-inclusive list of products.
- These are products that I have experience with, researched, and/or had contact with their respective representative.
- I am not endorsing any of these products.

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Interaction


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Injury Facts - MSDs

- Musculoskeletal Disorders (MSD's) account almost 30% of all workers' compensation costs, according to the Bureau of Labor Statistics https://www.bls.gov/iif/oshsum.htm
- US Companies spent $50B dollars on direct costs of MSD's
- According to OSHA, indirect costs can be up to 5X's direct costs

The Relationship between MSDs and the Workplace -- Occupational Health & Safety (ohsonline.com)

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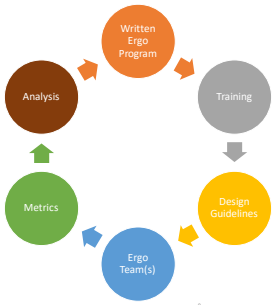
Basic Elements of Ergonomic Program



- **Ergonomics Program**
- **Training**
- **Design Guidelines**
- **Ergonomics Teams**
- **Metrics**
- **Analysis**

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What are the primary ergonomic risk factors?

Start presenting to display the poll results on this slide.

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Primary Risk Factors


Force


Frequency
(Repetition)


Posture

The devices we discuss today will focus Frequency and Posture

Cold | Vibration | Static Positions | Impact/Contact Stress

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Steps to Conducting an Ergonomic Analysis

- Establish a common set of tools
- Interview the worker
- Video record the job/task
- Take measurements and forces
- Watch and re-watch the video to count the motions
- Watch and re-watch the video to measure the angles of posture
- Use your chosen assessment tool to determine a risk level
- Prioritize jobs based on risk
- Work with engineering to fix the issue and lower risk

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Today's Focus

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4 Stages of Industrial Revolution

	Stage 1	Stage 2	Stage 3	Stage 4	Industry 4.0
Circa	Late 18th Century	Early 20th Century	Early 1970's	Today	
Major Advancements	First mechanized manufacturing equipment powered by water and steam	Introduction of mass production with the help of electrical power	Use of electronics and computers to automate manufacturing	Cyber-physical systems, real objects linked and responding to virtual data. Industrial internet of things	
	(yr. 1784) - First mechanical loom	(yr. 1870) – First assembly line - slaughterhouse	(yr. 1969) – First programmable logic controller (PLC)	Connect Workers, smart factories	




KINETIC - Injury Reduction (wearkinetic.com)

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Emerging Technology in Safety & Ergonomics

Safety Technologies - National Safety Council (nsc.org)

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My company has started experimenting with or is currently using wearable sensors to aid in conducting ergonomic assessments.

Start presenting to display the poll results on this slide.

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Today's Focus

Wearable Sensors

Reactec

R-Link ® HAVS Monitoring Smart Watch | Reactec

Lifebooster

LifeBooster - Eliminate workplace injury

Video Ergonomic Analysis

CerebrumEdge

ErgoEdge - AI Powered Ergonomics Assessment Tool (cerebrumedge.com)

TuMeke

TuMeke Ergonomics | Safety: powered by AI

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Personal Wearables – Fit Bit

2009

Fitbit Classic

- Steps
- Distance traveled
- Calories burned
- Activity Intensity
- Sleep

2013

Fitbit Flex

- First fit bit to be worn on the wrist
- Lights display progress towards goal
- Steps
- Distance traveled
- Calories burned
- Activity Intensity
- Sleep

Cost: $99

2018

Fitbit Versa 2

Purchased by Google (2019)

- Heart rate
- Menstrual cycle (user input data and device sensor data)
- Oxygen
- Skin temp
- Uses phone GPS

Cost: $149.95

2022

Fitbit Charge

- ECG heart health reader
- Onboard GPS

Cost: $159.95

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Personal Wearables - Biometrics

Apple
(First Released 2015)

Ultra 2

Sensors
- Heart rate
- ECG
- Temperature
- Blood Oxygen
- Accelerometer
- Gyrometer
- Depth gauge

Features
- Crash Detection
- AFib – atrial fibrillation (irregular heartbeat)
- Skin Temp
- Fall detection
- Low heart rate detection
- GPS
- Phone calls

Starts at $799

Garmin
(First Released 2003)

Fenix 7

Sensors
- Wrist heart rate
- Pulse Oximeter
- Compass
- Altimeter
- Barometer
- Wireless sensors

Features
- GPS
- Remote data collection
- Bike speed sensor
- Pedal force sensors
- Monitor air tanks

Starts at $699

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Sensor Types & Major Players

Single Point

Modjoul – Industrial Athlete (iap.com.au)

SafeWork Platform | StrongArm Technologies

KINETIC - Injury Reduction (wearkinetic.com)

Multi-Point

LifeBooster - Eliminate workplace injury

Ultium EMG | Noraxon USA

ViSafe+ | (dorsavi.com)

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Single Point Sensors

- **Typically worn at the waist, back, or arm**
- **Biofeedback – Self-Posture Correction**
  - Some provide haptic response for "in the moment" feedback (alerts or vibration).
- **Risk Identification**
  - Analyzes the range of motion, speed or duration of posture to assess risk
- **Creates a dashboard and user "risk" profile for assessment and individualized coaching**
- **Collects less data join angle data, but more easily deployed on greater number**
- **Intended to be worn for extended periods of time**
  - Multiply days, weeks, or months

StrongArm

Wearable Technology For Workplace Safety | StrongArm Tech

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Multi-Point Sensors

- **Multiple Sensors**
  - Variable, 6
- **Motion**
  - Repetitive strain
  - Multi-joint analysis
  - Cumulative analysis of variable work patterns
- **Thermal (heat stress)**
  - Body ambient temperature
  - Work/rest cycles
  - Humidity measurement
- **Posture**
  - Task focused analysis
  - Sustained awkward posture
- **Vibration**
  - Hand/arm

Ideal for collecting a large amount of data on a representative sample of worker(s)

Technology - LifeBooster

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Dashboards
Data Filters
Date
Program Progress
All Time
1121
Locations
35
2024 Target
1000
56
1000
Assessments Completed By
Division
Truck
Engine
Car
Electric
SUV
Battery
304
229
193
188
184
60
Assessments By Month

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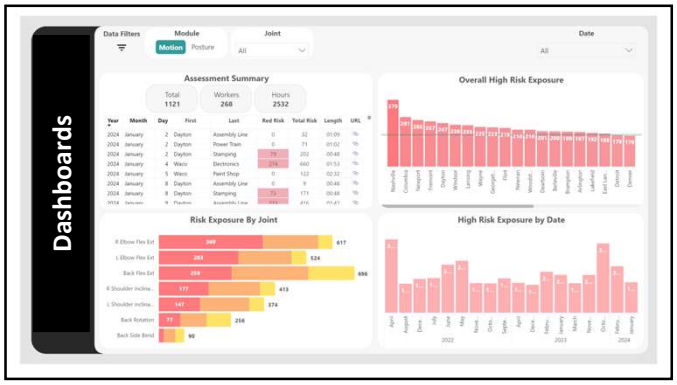
Dashboards
Data Filters
Module
Motion
Posture
Joint
All
Date
Assessment Summary
Total
1121
Workers
268
Hours
2532
Overall High Risk Exposure
Risk Exposure By Joint
High Risk Exposure by Date

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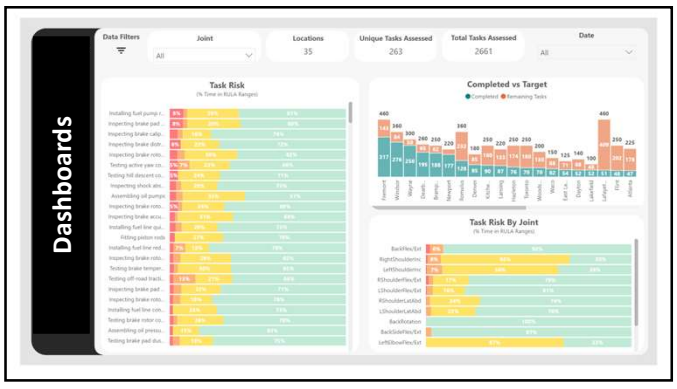
Dashboards
Data Filters
Joint
All
Locations
35
Unique Tasks Assessed
263
Total Tasks Assessed
2661
Date
Task Risk
Completed vs Target
Completed
Remaining Tasks
Task Risk By Joint

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Wearable Sensors

- **Caution**
  - Sensor placement, data calibration, and signal interference can be factors that affect data quality (Schall et al., 2022)
  - Devices will need to be connected or uploaded to cloud storage
  - There is an extremely large data set generated, enlisting the help of a data analyst can be useful in managing the data and gather insights
  - In my experience, workers can get annoyed by wearing the device or having the biofeedback (vibration)
  - You still need to be able to understand the data, the risk, and more importantly, how to fix the issue

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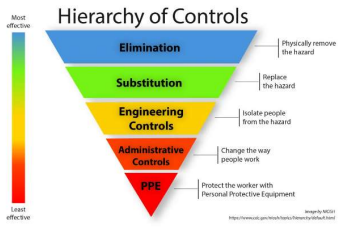
Hierarchy of Controls

- **Sensor types and use:**
  - Single point sensors place a high emphasis on training the worker on how to "properly lift."
  - Multi-point sensors are heavily focused on risk identification, data analysis
  - Better data analysis aids in prioritization and decision making on where to spend engineering resources
  - Goal is to Reduce/Eliminate the risk through better design



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Sensors in Construction

- Small wearable badges (tokens)
- Wall mounted sensor hubs (anchors)
- Creates a connected mesh on the job site
- Tokens periodically broadcast their latest data
  - Time
  - Location
  - Movement
- Sensors
  - Temperature
  - Humidity
  - Air quality
  - Motion detection
  - Sensors can determine proximity to other sensors
    - Pedestrian vs. Vehicle Safety

TokenMe (token-me.com)

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My company has started experimenting with or is currently using computer vision to aid in ergonomic assessments.

ⓘ Start presenting to display the poll results on this slide.

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AI – Computer Vision Process

- **Video Capture**
  - Record a video with your phone's camera while individual performs a task or activity
  - The video captures the person's movements, postures, and joint angles
- **Computer Vision Algorithms**
  - Computer vision algorithms are applied to the video frames to extract relevant information
  - Algorithms analyze the data, identify key points (joints), and track positions
- **Pose Estimation**
  - Determines 3-dimensional positions of body joint angles based on 2D frames
  - The models learn to recognize body parts and infer their spatial relationships

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AI – Computer Vision Process

- **Joint Tracking**
  - Once the joints are estimated the system tracks their movement through the video
- **Risk Assessment**
  - The tracked joint angles are compared to ergonomic guidelines or assessment tools such as RULA/REBA, NIOSH Lift Index, etc, or a proprietary assessment
  - At Risk postures are identified, flagged, and counted
  - System calculates a risk score
- **Use of Data and Analysis**
  - Risk score can be used to prioritize jobs for improvement
  - Determine level of risk to a specific body part
  - Run the analysis before or after changes to determine level of improvement

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AI – Computer Vision Process

- **Potential Issues**
  - Works best for short task assessments. A few minutes in length. The video files are really large and take a long time to process.
  - Videos are stored in the cloud. Your company may be concerned with protecting confidential trade secrets.
  - Works best in a well-lit area
  - Need a clear view of the extremities
  - Current apps/technology do not consider force exerted or weights being handled
  - Video assessments do not consider posture at the wrist
  - Limited evidence regarding their ability to accurately estimate MSD Risk

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Major Players - Computer Vision Ergo

Soter Analytics

3motionAI

VelocityEHS®

Soter Analytics | 3motionAI | Velocity EHS

ewiworks. ERGONOMICS · WELLNESS · INNOVATION

TuMeke Ergonomics

Inseer

PoseChecker-EWIWorks | TuMeke Ergonomics | Inseer

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Summary

- This is a competitive market and new players are joining in
- Technology is continuing to advance
- More research is needed to validate the accuracy of these new technologies
- Both sensors and computer vision show promise as a method to help reduce time to complete an ergonomic analysis
- Someone still needs to interpret the data and determine how to fix the issue

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Audience Q&A Session

Start presenting to display the audience questions on this slide.

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Conclusion

Thank you!

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