Emerging Technologies for the Ergonomics Practitioner

National Ergonomics Conference & Expo

September 29, 2021

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Learning Objectives

1. Understand the history and limitations of traditional ergonomics practices & methods

2. Understand how the following emerging technologies are being used by ergonomics practitioners:
   - Artificial intelligence / Computer vision
   - Wearable sensors
   - Advanced data analytics

3. Gain some insights into the future potential & considerations of such technologies for practitioners
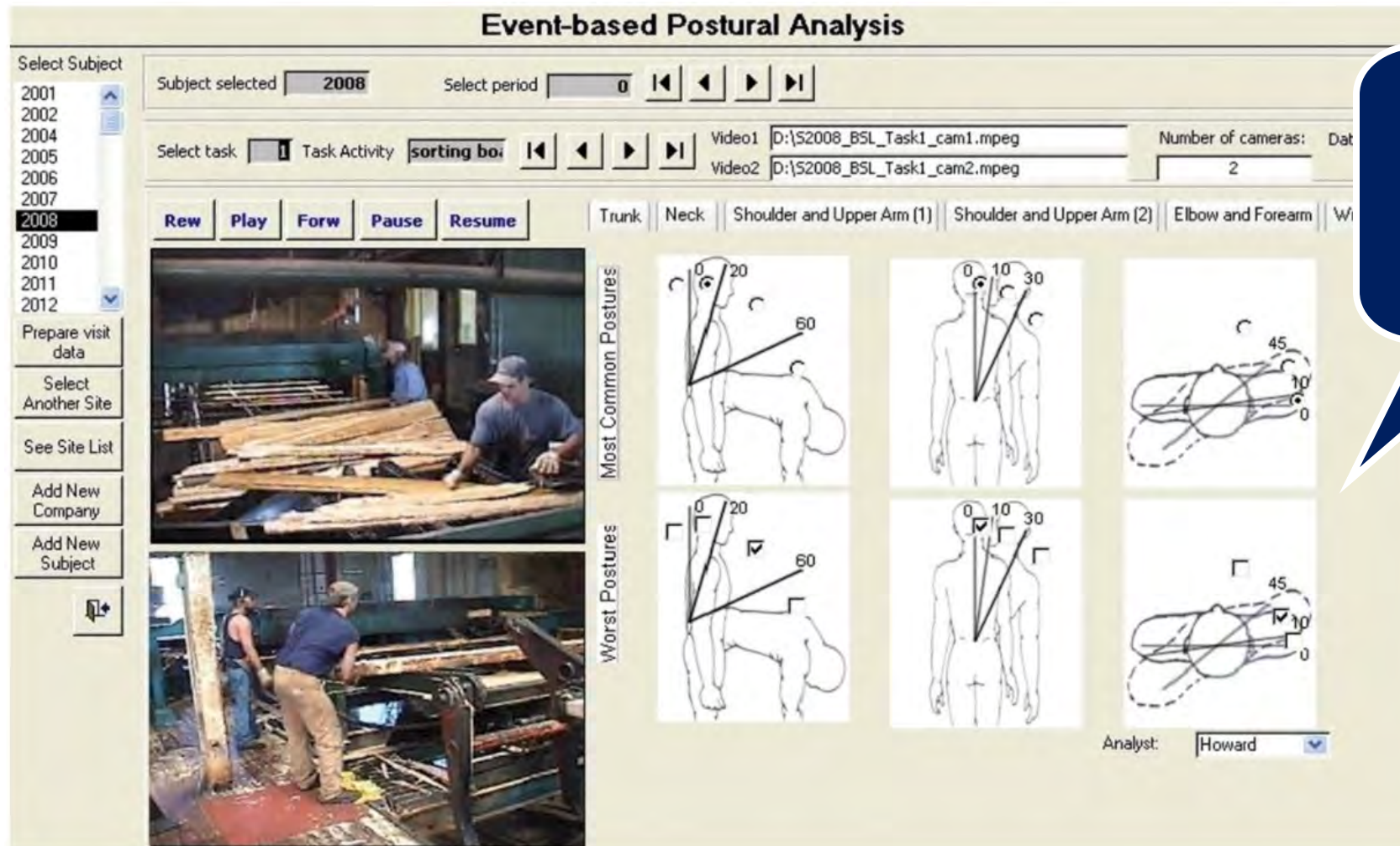
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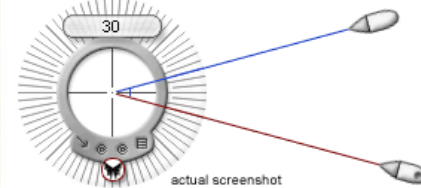# Traditional Ergonomics Practices & Methods

Limitations

- Skilled ergonomists, SMEs, and/or teams

- Human observation-based

- Subjectivity & accuracy concerns

- Interruption to the worker

- Time consuming analysis

actual screenshot

Traditional Ergonomics Practices & Methods

Source: Bao, et. al., *Ergonomics* (2007)

Artificial Intelligence

Defined:

- **Artificial Intelligence (AI)** – Broad branch of computer science that that deals with giving machines the ability to seem like they have human intelligence

- **Applications (examples):**
  - Speech recognition
  - Language translations
  - Computer vision
  - Predictive analytics / Decision-making

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Computer Vision

Defined:

- **Computer Vision (CV)** – Field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and takes action *(per data)*

- **Applications (examples):**
  - Facial recognition
  - Object detection – detect damages on equip./machinery needing maint.
  - Object tracking – autonomous vehicles, *automated ergo analysis*

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Advanced Data Analytics

Defined:

- **Advanced Analytics** – Methods of analyzing data using sophisticated tools and *computational power* to understand trends, patterns, and performance metrics

- **Predictive Analytics** – Sub-division of advanced analytics that focuses on identification of *future* events, outcomes, and probabilities

Advanced Data Analytics

- How is this technology being used?
    - Sales forecasting
    - R & D – Product improvements based on performance and/or failures
    - Manufacturing – Injury, risk, bottleneck, quality/rework predictions
    - Maintenance / Servicing – Predictive Maintenance & repair operations

- Benefits of Advanced Data Analytics:
    - Decision-making and prioritizing based on data
    - Design improvements
    - Employee well-being, mfg. efficiency and quality
    - Service and repair logistics = customer satisfaction

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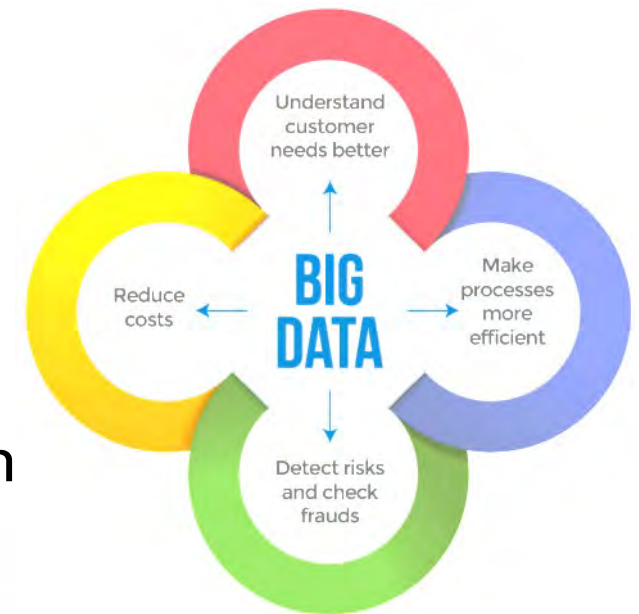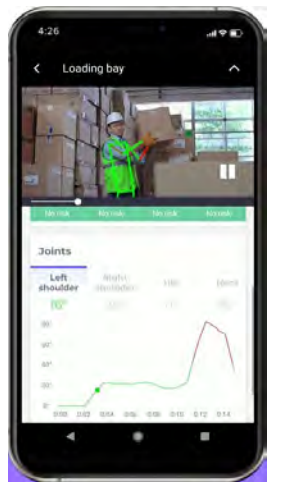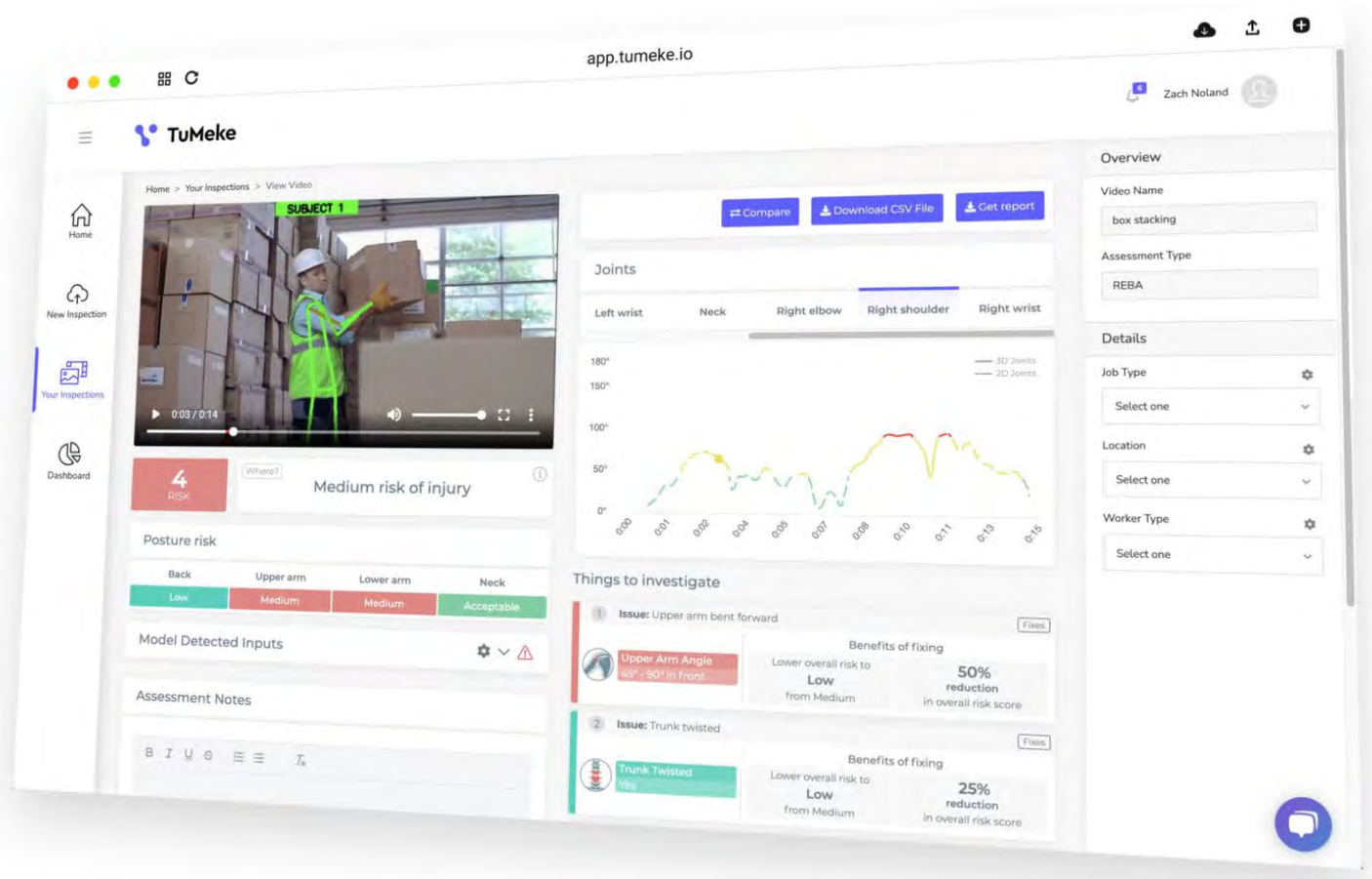
Computer Vision for Ergo Analysis

Kinetica Labs

Ergo Analysis Tools:
(partially automated)
- RULA
- REBA
- NIOSH Lifting Equation
- Liberty Mutual MMH Guidelines (a.k.a. Snook Tables

https://kineticalabs.com/software/motion-capture-app

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Computer Vision for Ergo Analysis

TuMeke Ergonomics

Ergo Analysis Tools:
(partially automated)
- RULA
- REBA
- NIOSH Lifting Equation

https://www.tumeke.io/

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Computer Vision for Ergo Analysis

Ergo Insight

Ergo Analysis Tools:
(partially automated)
- Whole-body Assessment (proprietary)
- NIOSH Lifting Equation
- Liberty Mutual Push/Pull/Carry
- Physical Demand Posture Analysis

https://www.ergoinsight.com/

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Computer Vision for Ergo Analysis

SwiftMotion Vize

Office Ergo Analysis Tools:
(partially automated)
- RULA
- REBA
- ROSA

https://swiftmotion.io/   www.youtube.com/watch?v=9jlTBFcnxSE

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Computer Vision for Ergo Analysis

- NCSU created a **M**ultimodal **O**ccupational **P**ostur**E D**ataset using camera-based system that includes full-body pose & motion for 25 occupational tasks (MOPED25) & automated **RULA.**
  - All the data was made publicly available
  - https://github.com/human-systems-ise-ncsu
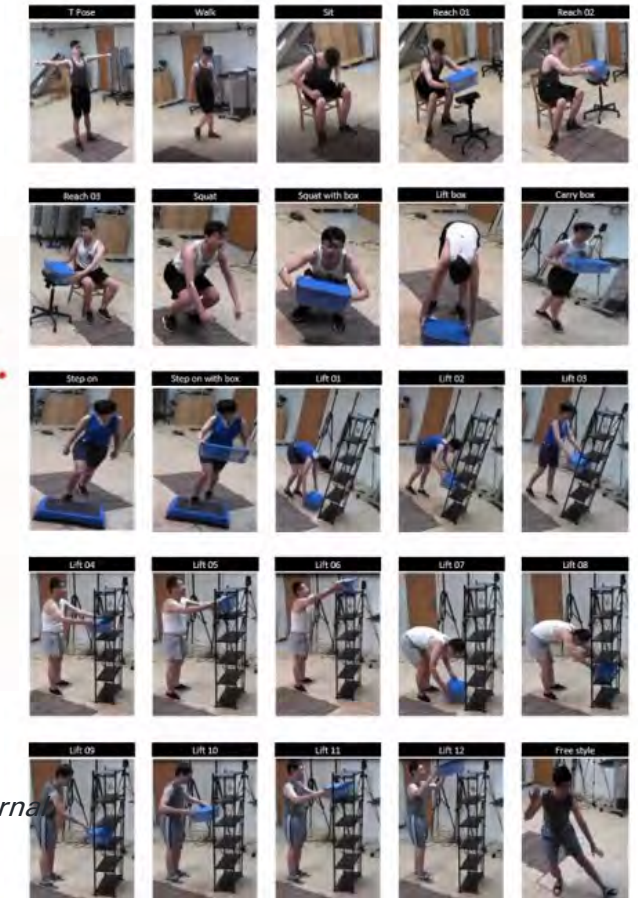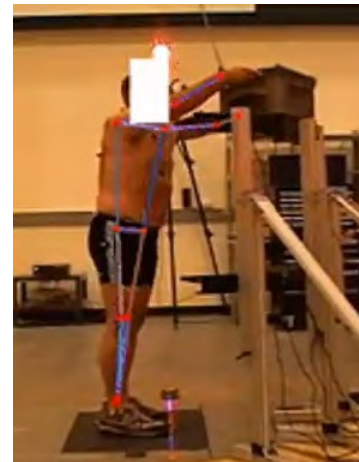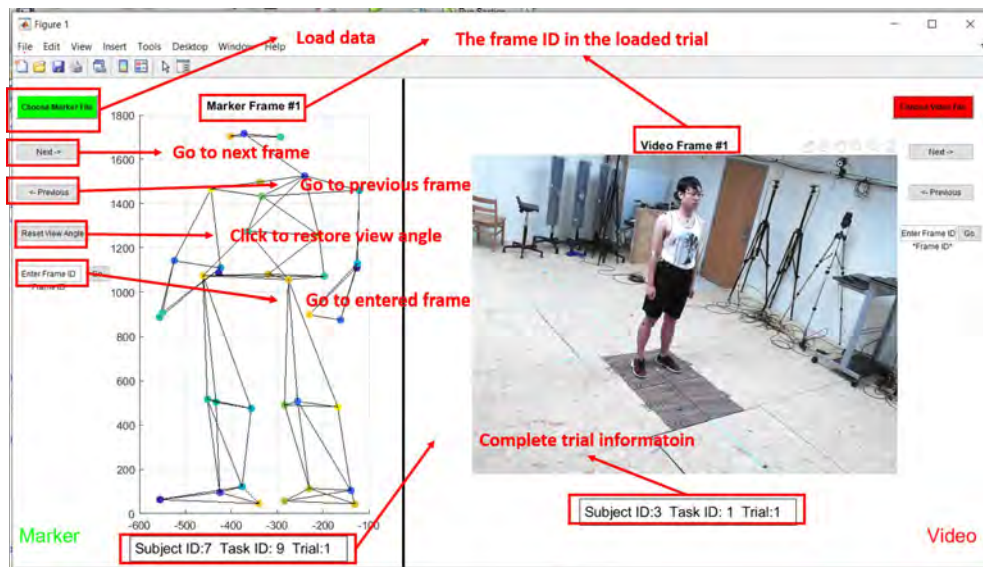
Li Li, Ziyang Xie, and Xu Xu (2020). MOPED25: A multimodal dataset of full-body pose and motion in occupational tasks. *Journal of Biomechanics*, 113, 110086.
Li Li, Tara Martin, Xu Xu (2020). A novel vision-based real-time method for evaluating postural risk factors associated with musculoskeletal disorders. *Applied Ergonomics*, 87, 103138.

Computer Vision: Challenges (Current State)

Video Access
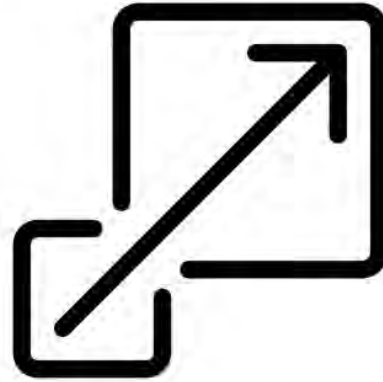
Scalability

Data Accuracy

Data Security

Data Processing Power

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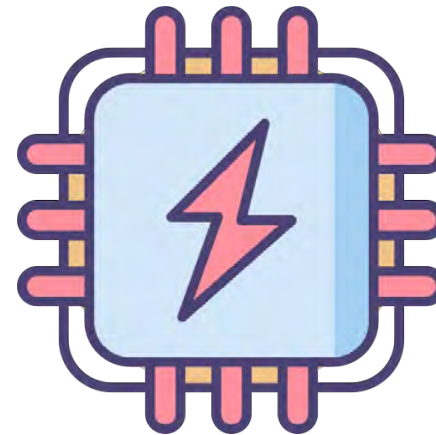
Wearable Sensor Technology

Lumo Lift

1

CONNECT

Download the free Lumo Lift App onto your supported device and follow the detailed instructions to set up your Lumo Lift.

2

WEAR

Remove the magnetic clasp from your Lumo Lift. Place your Lumo Lift under your shirt, right below your collarbone and use the magnetic clasp to secure it in place.

3

RECORD

Get into your best posture and **press your Lumo Lift once** to set your target posture.

4

IMPROVE

Receive a simple vibration when you slouch, reminding you to sit up straight.

BATTERY LIFE

1-2 days on single charge. Zero to fully charged in 2-4 hours.

BLUETOOTH WIRELESS SYNCING

Tracks daily progress to see how your posture and activity is improving.

www.lumobodytech.com/lumo-lift/

Wearable Sensor Technology
(monitors postures & movements, location/proximity)

Kinetic REFLEX

www.wearkinetic.com

Modjoul SmartBelt
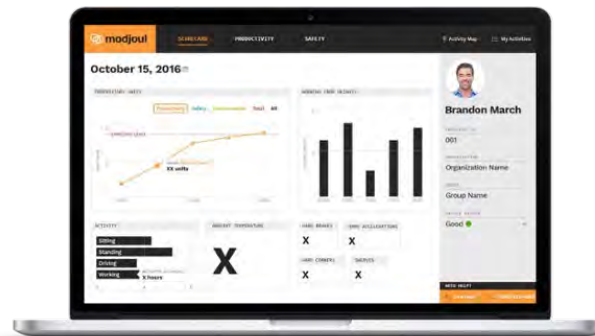
www.modjoul.com

StrongArm FUSE

www.strongarmtech.com

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Wearable Sensor Technology
(monitors postures & movements, location/proximity)

GoX Labs Boost or Boost Plus

1 User puts on watch at the beginning of the day.

www.goxlabs.com/

2 Critical physiological & biomechanical data collected measures risk shown in green, amber, & red. If risk is too high haptic feedback alerts the worker.

3 Data is continuously collected on the watch and uploaded to the cloud when connectivity is established via wifi or cellular.

4 At this time, managers, executives, and workers can view the data from the dashboard on their computer or phone.

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Toyota Reported Results: Wearable Sensors

Indiana Plant Trial

Marisol Barrero
Safety & Innovations
Toyota Motor
North America

2 months, 120 team members

95% reduction in time to complete risk assessments

83% team members improved lifting techniques from haptics alone

15% risk reduction by end of trial

https://www.youtube.com/watch?v=E4LmX5E4yWI

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Walmart Reported Results: Wearable Sensors

Grocery Distribution

Wendy Johnson
VP, Supply Chain
EH&S, Walmart

"Within the first year of deploying [wearable sensor tech], targeted, ergonomic-related injuries decreased by nearly **65%** across participating associates."

"Furthermore, we saw an additional year-over-year targeted injury reduction of **27%** in year two, and **16%** in year three. Since 2018, we've launched across **18-buildings and 6,000** associates, and additional program growth is underway."

https://corporate.walmart.com/newsroom/2021/05/04/safety-wearables-help-keep-associates-safe-at-work

Wearable Sensor Technology
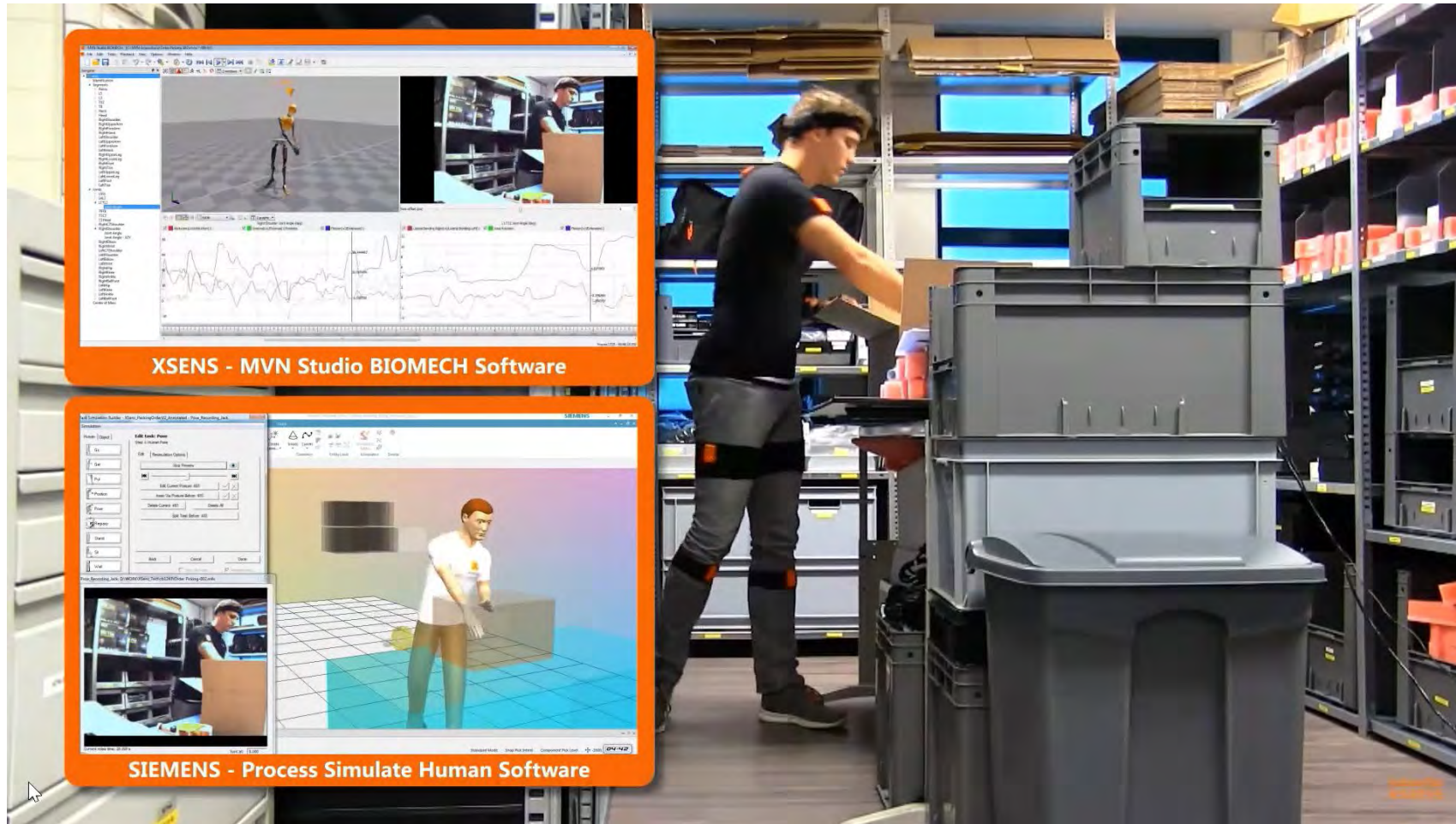
Xsens

www.xsens.com/products/mvn-analyze; www.youtube.com/watch?v=mb43UqVpqOw

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Wearable Sensor Technology

SwiftMotion FUZE

Ergo Analysis Tools:
(integrated)
- NIOSH Lifting Equation
- Liberty Mutual Push/Pull/Carry
- WISHA Low Back Lifting Calculator
- Univ. of Utah Low Back Compressive Force Model
- Ohio State LBD Risk Model

https://www.youtube.com/watch?v=nOL9ea2WO0E; https://swiftmotion.io/
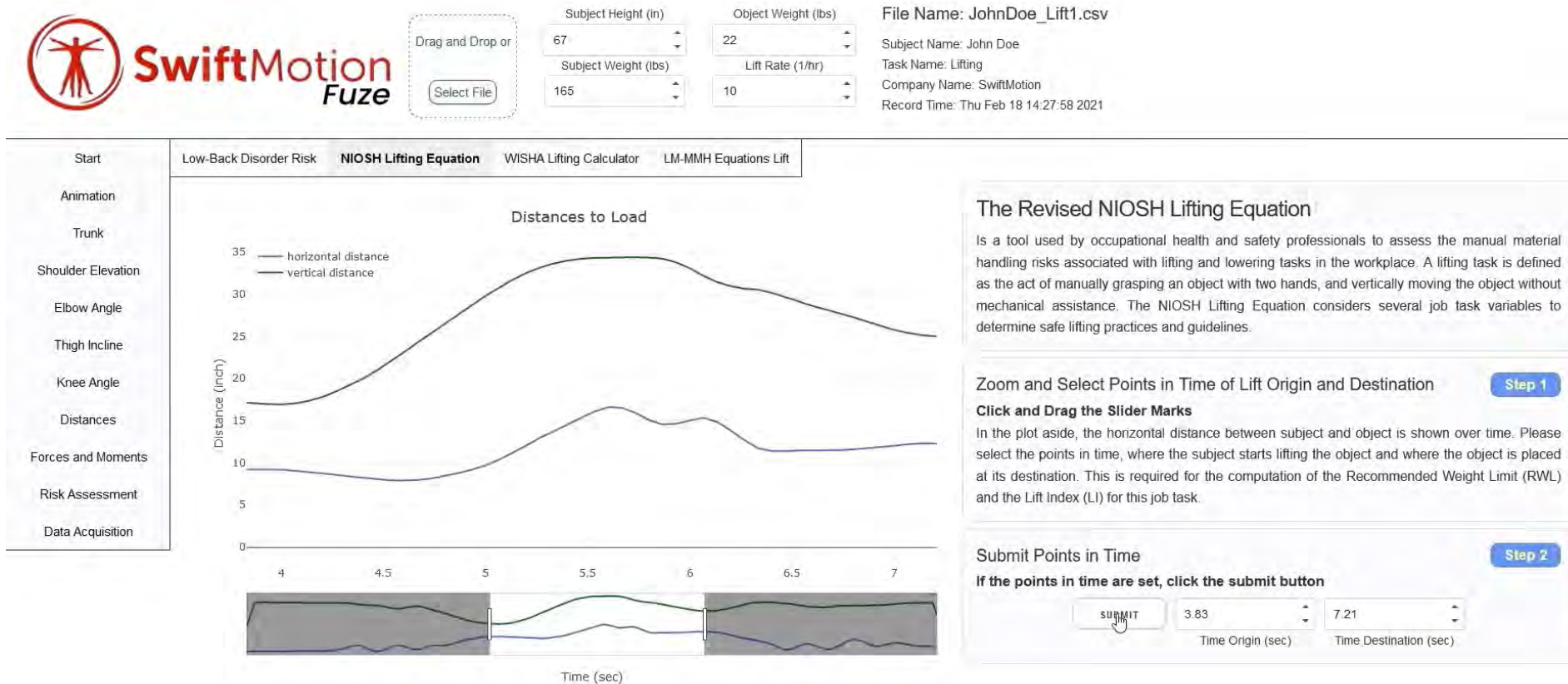
Wearable Sensor Technology

SwiftMotion FUZE

Ergo Deep-Dive Tools:
(integrated)
- NIOSH Lifting Equation
- Liberty Mutual Push/Pull/Carry
- WISHA Low Back Lifting Calculator
- Univ. of Utah Low Back Compressive Force Model
- Ohio State LBD Risk Model

https://www.youtube.com/watch?v=nOL9ea2WO0E; https://swiftmotion.io/

Wearable Sensor Technology

Somaxis Cricket

Measures EMG (muscles), EKG (heart), EEG (brain), respiration, posture, & movement

www.somaxis.com/

Noraxon Portable Lab

Measures EMG (muscles) – 16 channels, total body motion capture & posture (camera-sys)

www.noraxon.com/

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Wearable Sensor Technology

EMOTIV

Wireless EEG Brainwear® and machine-learning software to assess cognitive performance such as stress, focus/attention, distraction

www.emotiv.com/

Other Vendors: BrainBit, NeuroSky, Wearable Sensing

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Wearable Sensor Technology

Neurotechnology Applications:

- Workplace Wellness, Safety, & Productivity
  - Auditory cues to employees when distracted or not attentive
  - Tailored software to trigger work activities throughout shift

- Training
  - Assess and optimize training effectiveness & retention

- Work Accommodations (Brain-Controlled Tech.)
  - Disabled workers
  - Return-to-work

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Wearable Sensors: Challenges (Current State)
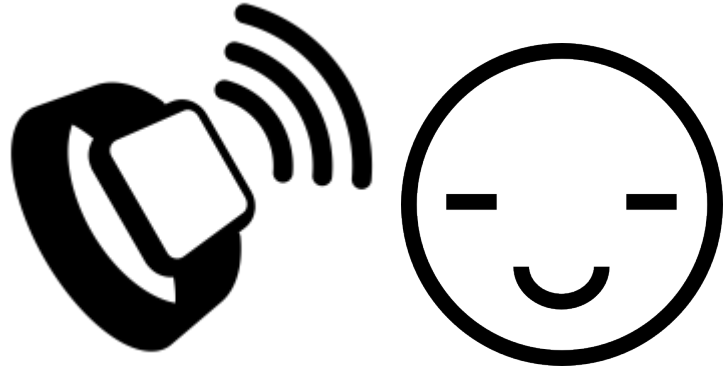
Comfort & Durability

Battery Life

Data Accuracy

Data Security

Data Processing Power

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Applications: Computer Vision, Wearables, Analytics

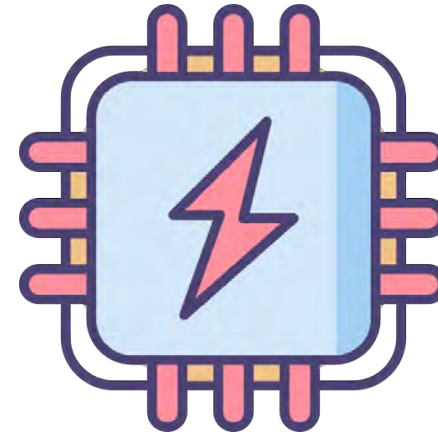Aeronautics – F35 & F-22 Maintenance Process Autonomic Logistics Information Systems (ALIS) software - 3D imaging technology to streamline & improve accuracy of ops., maint., prognostics, supply chain & customer services data
https://enterpriseiotinsights.com/20160902/data-analytics/big-data-lockheed-martin-tag31-tag99

Construction – Wearables, data analytics & machine learning used to proactively identify and predict jobsite risks, streamline tasks, improve safety, and better meet scheduling deadlines
https://blog.plangrid.com/2019/06/technologies-for-construction-risk-management/

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Future Potential of Emerging Tech
(from Practitioner's Perspective)

⬆ **AI, Computer-Vision, Wearables, and Data Analytics in Ergo**

- Hiring, Employee Engagement & Retainment
- Training
- Job Prioritization (trends analysis)
- Job Assessments
  - ↑ Speed, ↑ Accuracy, ↓ Training/Expertise
  - New risk model development
    - Force metrics integrated into tech
    - Multi-factorial interactions
    - Cumulative exposures
- Job Design & Controls
  - Predictive cost-modeling of solutions
- Program / Cultural Evaluation and Continuous Improvement

Physical Factors

Personal Factors

Social Factors

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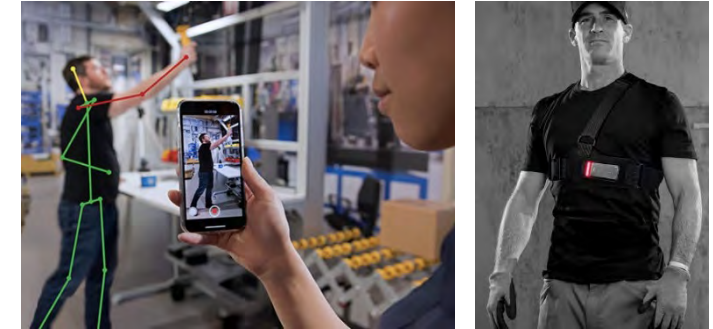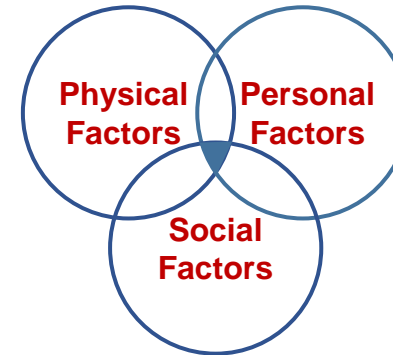
Emerging Technology Resources/Vendor Info

Wearable Sensors / Suits	
GoX Labs	Vendor
Iterate Labs	Vendor
Kinetic	Vendor
Lumo Bodytech	Vendor
LifeBooster	Vendor
Modjoul	Vendor
Noraxon	Vendor
Notch	Vendor
Somaxis	Vendor
Soter Analytics	Vendor
StrongArm Technologies	Vendor
SwiftMotion	Vendor
Xsens	Vendor

Wearable EEG Systems	
BrainBit	Vendor
EMOTIV	Vendor
NeuroSky	Vendor
Wearable Sensing	Vendor

Computer Vision Tech for Ergo	
Altius Analytics Labs	Vendor
Cerebrum Edge	Vendor
Ergo Insight	Vendor
Kinetica Labs	Vendor
Soter Analytics	Vendor
SwiftMotion	Vendor
TuMeke	Vendor

Resources	
Computer-vision & analytics at Boeing	Resource
Computer-vision & analytics at Lockheed Martin	Resource
Computer-vision & AI collaboration at Liberty Mutual	Resource
NCSU's computer-vision dataset & code	Resource
Wearable sensor tech reported on by Cardinus	Resource
The evolution of wearable tech by Liberty Mutual	Resource
Wearables & analytics in construction	Resource
Wearable sensors at Walmart	Resource
Emerging tech at Toyota	Resource

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Questions?

If you have questions, please contact us at:

Web: www.ErgoCenter.NCSU.edu

Email: JAHoyle@ncsu.edu

Phone: (704) 483-2837

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November 2-4, 2021

PARIS LAS VEGAS HOTEL & CASINO

David Brodie, CPE

NA Ergonomist Lead

Cargill, Inc

NEC Program Co-Chair

Industrial, Program, and Technology Tracks

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Advances in Ergonomics Technologies

Evolution of a Track

- Significant advances in technology that affect ergonomics and health and safety

- Success stories from companies showing how technology affects both processes, behaviors, and strategies for risk reduction

- A continually evolving area = new information and ideas that warrant focus

(Quick answer – everything Jeff just presented!)

Key Topics at Conference

- **Wearable technology:**
  - **Gain insight, enhance interventions**
  - **Harnessing rapidly advancing technology**
  - **Actionable injury reduction strategies**
  - **AI and digestible data driving proactive efforts**

- **Exoskeletons:**
  - **Asking the right questions for your organization**
  - **Guidance from new and experienced implementors**
  - **Touch and feel new technology**

Some of our speakers

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Advance Your Knowledge @

National **Ergo**

Affiliated with ▶ **THE INSTITUTES**

November 2-4, 2021

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