Wearable Ergonomics – Measured Management of Worker Performance and Injury Prevention
Agenda

• Introduction
  • Who is Briotix?
  • Who am I?
• Ergonomic Problems
  • Basic Movement
  • Injuries
  • Waste
• Exoskeleton Field Trials
• Exoskeleton Considerations
• Wearable Sensor Considerations
Who is Briotix Inc.?

GLOBAL LEADERS IN ERGONOMICS, INJURY PREVENTION, RETURN TO WORK AND ONSITE REHABILITATION

Experience the Briotix Difference...

AT THE SCALE & PRICE YOU NEED
We work with Fortune 500 companies all the way down to a single office.

NO JOB IS TOO HARD
From offshore oil rigs, to world wide office locations and highly sensitive clean rooms – no job is too hard.

NEXT GENERATION SMART
A technology enabled partner for your business, reaching your workforce with more effective tools.
Briotix Mission, Vision, Values

Mission: Transforming Organizations by Unlocking Human Potential.

Vision: Delivering a competitive advantage through the application of science in the physical, cognitive, and organizational disciplines.

Values:
- Apply our passion and innovative spirit to what we do
- Deliver meaningful results with every client
- Work in a way that makes our mothers proud
- Care about people
Who am I?

Matthew Marino, PT, MSPT, CPE, CWcHP, CSCS, TSAC-F, CPT, SFMA, FMS
Interdependent Systems

- Neuromuscular Function
- Mechanical Capacity
- Motor Control
Research Summary:

- Previous Injury (24)
- Asymmetries (8)
- Motor Control (7)
- BMI (5)

(# prospective studies)
Disparities In Movement Quality And Capacity

Functional Movement Screen (FMS) Results:
This employee failed 5 out of 7 movement tests
He has **prior injuries**
He has **poor motor control**
He has **asymmetrical movement patterns**

Functional Movement Screen (FMS) Results:
This employee failed 1 out of 7 movement tests
He has **no prior injuries**
He has **good motor control**
He has **symmetrical movement patterns**
Posture Matters

Research Summary:

• Researchers are attempting to identify the “best” standing or sitting posture (Dolphens, O’Sullivan, Claus, Collins)

• Correlation between various postures and neuromuscular function (Park, Sapsford, Jull, Chan, Tsao; Hodges; Claus, Ainscought Potts, Capson, Collins)

• Correlation between various postures and pain (Dolphens, Straker, Edmondston)
Posture Matters

Mean increase in force with correct posture 20 lbs

Mean increase in force with correct posture 22 lbs
Work Related Injuries Are A Problem

80% of people will have back pain in their lifetime

$50 billion/year spent in USA on low back injuries

Back pain is the leading cause of disability worldwide, causing more lost workdays than everything except the common cold

Shoulder: 7.5 million MD visits

Back: 21 million MD visits

Knee: 12 million MD visits
Nature Of Injuries Requiring Days Away From Work

% distribution for occupational injuries and illnesses with days away from work by selected nature of injury or illness, all ownerships, 2015

- Sprains, strains, tears: 37%
- Soreness, pain: 21%
- Cuts, lacerations, punctures: 9%
- Buise, contusions: 9%
- Fractures: 9%
- All other nature of injury or illness: 16%
- Total cases: 1,153,490

Causes Of Injuries Requiring Days Away From Work

Chart C. Incidence rates for occupational injuries and illnesses with days away from work by selected detailed events or exposures, all ownerships, 2011-15

Source: U.S. Bureau of Labor Statistics

- Falls on the same level
- Struck by object or equipment
- Overexertion in lifting, lowering
Chart A. Incidence rates for occupational injuries and illnesses with days away from work by selected occupations, 2011-15

Note: These occupations had at least 0.1 percent of employment and among the highest case counts in their respective ownership classes.
Source: U.S. Bureau of Labor Statistics
Work System Waste

- Transport
- Inventory
- Motion
- Waiting
- Skills
- Defects
- Over-Processing
- Over-Production
Exoskeleton Applications

Industry
Defense/Military
Rehabilitation
Mobility
Recreation/Sports
Prosthetics & Orthotics

Overlapping Areas of Exoskeleton Expertise

Source: Exoskeleton Report 2016
Exoskeleton Categories

- Power Suits
- Power Armor
- Powered Exoskeletons
- Passive Exoskeletons
- Exosuits
- Ergosuits
- Powered Orthotics
- Powered Assist Devices

Source: Exoskeleton Report 2016
Industrial Exoskeleton Types

- Full Body Power Suits
- Supernumary Robot Arms
- Power Gloves
- Chairless Chairs
- Back, Shoulder & Leg Support
- Tool Holding

Source: Exoskeleton Report 2016
Exoskeletons for industrial application and their potential effects on physical work load.

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Abstract
The aim of this review was to provide an overview of assistive exoskeletons that have specifically been developed for industrial purposes and to assess the potential effect of these exoskeletons on reduction of physical loading on the body. The search resulted in 40 papers describing 26 different industrial exoskeletons, of which 19 were active (actuated) and 7 were passive (non-actuated). For 13 exoskeletons, the effect on physical loading has been evaluated, mainly in terms of muscle activity. All passive exoskeletons retrieved were aimed to support the low back. Ten-to-forty per cent reductions in back muscle activity during dynamic lifting and static holding have been reported. Both lower body, trunk and upper body regions could benefit from active exoskeletons. Muscle activity reductions up to 80% have been reported as an effect of active exoskeletons. Exoskeletons have the potential to considerably reduce the underlying factors associated with work-related musculoskeletal injury. Practitioner Summary: Worldwide, a significant interest in industrial exoskeletons does exist, but a lack of specific safety standards and several technical issues hinder mainstream practical use of exoskeletons in industry. Specific issues include discomfort (for passive and active exoskeletons), weight of device, alignment with human anatomy and kinematics, and detection of human intention to enable smooth movement (for active exoskeletons).
Field Trial #1: SuitX Modular Agile Exoskeleton (MAX)

MAX components: BackX, LegX, ShoulderX, Balancing Tool Holder
SuitX MAX Trial – BackX In Meat Dept
SuitX MAX Trial – BackX In Deli Dept
SuitX MAX Trial – BackX In Produce Dept
BackX EMG Data

Electromyography (EMG) Test Result

- **Without TSE**
- **With TSE**

**Erector Spinae Muscle Groups**

1. Left Lumbar Erector Spinae
2. Right Lumbar Erector Spinae
3. Left Thoracic Erector Spinae
4. Right Thoracic Erector Spinae
BackX Survey Data (n=5)

• 3/5 felt the exo would reduce work related fatigue
• 3/5 felt the exo would improve work performance
• 4/5 felt the exo would help them manage musculoskeletal health
• 4/5 would use the exo for at least part of their work day
• The exo can be worn over work clothing and under a jacket
• The fit of the exo is very important for comfort and successful outcomes
Field Trial #2: StrongArm Technologies FLx Ergoskeleton

V22 Ergoskeleton

FLx Ergoskeleton
V22 & FLx Ergoskeleton Details

V22 Ergoskeleton is considered a Load Re-Distribution Lift Assist Device

FLx Ergoskeleton is considered a Postural Support Device
StrongArm Trial – FLx Ergoskeleton In Meat Dept

Before

After
FLx Ergoskeleton Survey Data (n=3)

• The workers felt the exo provided them with a reminder to avoid bending and twisting via tactile cues from the device – “It talks to me”
• The workers felt the belt provided some low back bracing
• The exo can be worn over work clothing and under a jacket
• The fit of the exo is very important for successful outcomes
Considerations for Industrial Exoskeletons

- Goal
- Powered or Passive
- Body Part & Joints Involved
- Movement Limitation
- Fatigue
- Balance
- Size & Weight
- Clothing, PPE, Tool Belts
- Adjustability, Comfort & Fit
- Don/Doff Time & Complexity
- Pitfalls
Considerations for All Wearable Technology

- Wearability
- Usability
- Customization
- Durability
- Ergonomics
- Overload
- Satisfaction
- Pitfalls

Wearable Sensor Applications

Wearable Sensors in Physical Therapy

Biofeedback has been used in rehab for over 50 years

- Biomechanical
  - Movement
  - Postural Control
  - Force
- Physiological
  - Neuromuscular
  - Cardiovascular
  - Respiratory

Wearable Sensors in Fitness

What can we do with data from a GPS watch and HR monitor?

- Distance: 6.4 miles
- Speed: 1.2 mph
- Cadence: 101 RPM
- Heart Rate: 145 BPM
- Elevation Gain: 84 ft
- Elevation Loss: 64 ft

Wearables Sensors in Ergonomics

With the exception of the LMM, wearable sensor use in ergonomics is relatively new and not widely accepted as a standard practice, yet...

*However, sensors may be critical for testing exoskeletons...*

https://www.iiit.ac.uk/our-areas-of-excellence
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The Future of Ergonomics?

Faber et al. A novel wearable measurement system for ambulatory assessment of joint loading in the occupational setting
Let’s Review

• Humans are not created equal
• Injuries are a huge problem
• Exoskeletons and wearable sensors are here
• Traditional ergonomic assessment methods are not sensitive to exoskeleton benefits
• Wearable sensor technology may be the best way to evaluate exoskeleton technology in the field
• Further research is needed