Welcome

Applied Ergonomics: Advances in Technology to Assess Risk Factors

Webinar will begin at 10:00am

Presented by:
Dr. Majed Zreiqat

Pennsylvania OSHA Consultation Office
Phone: 724-357-4095
Website: **www.iup.edu/pa-oshaconsultation**

Applied Ergonomics: Advances in Technology to Assess Risk Factors

Webinar General Info

PowerPoint Presentation

Q&A

Questions

Chat is open to submit questions.

We will be answering questions through this chat feature. If due to the technical nature
question a more thorough response is required, we will post the answer on our websit
seven days of the webinar.

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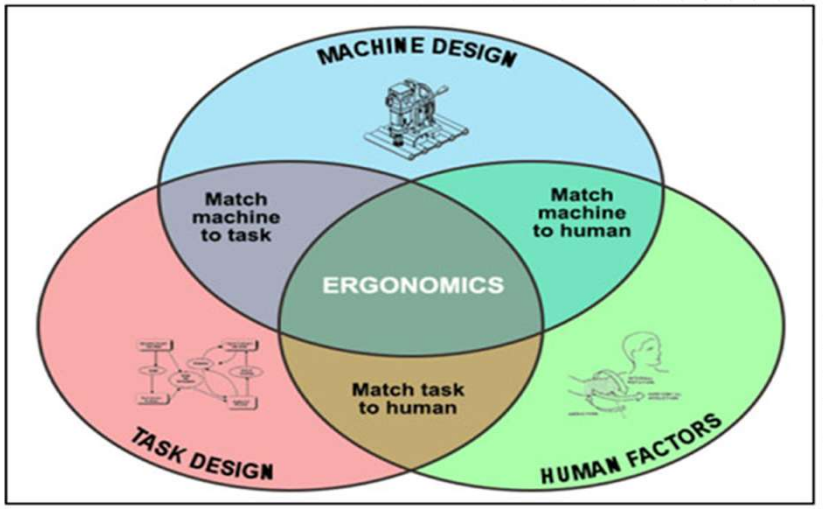
Dr. Majed Zreiqat

- PhD in OSH with a minor in Applied Statistics from WVU in 2014
- Background: Chemical and Process Eng.
- 11 years teaching at IUP SSEE

Ergonomics

- is a multidisciplinary field that applies psychological and physiological principles to design products, processes, and systems that are safe, comfortable, and effective for humans to use. *(IEA)*
- Human-centered design
- Study of people's efficiency in working env.
- Consider and asses physical capabilities
- To reduce MSDs



Human Factors:

- Another phrase for the concept of ergonomics
- Subset of ergo
- Psychological capabilities

Organizational Ergonomics

EFFICIENCY

Systems and processes

Communication & Teamwork

Work Organization

Safety leadership

Supervisory style

Safety Climate

PRODUCTIVITY

WELL-BEING

Cognitive Ergonomics

MENTAL PROCESSES

Task demands

Humans-Systems Interaction

Perception

Motor response

Memory

Reasoning

Resources

SAFETY CULTURE

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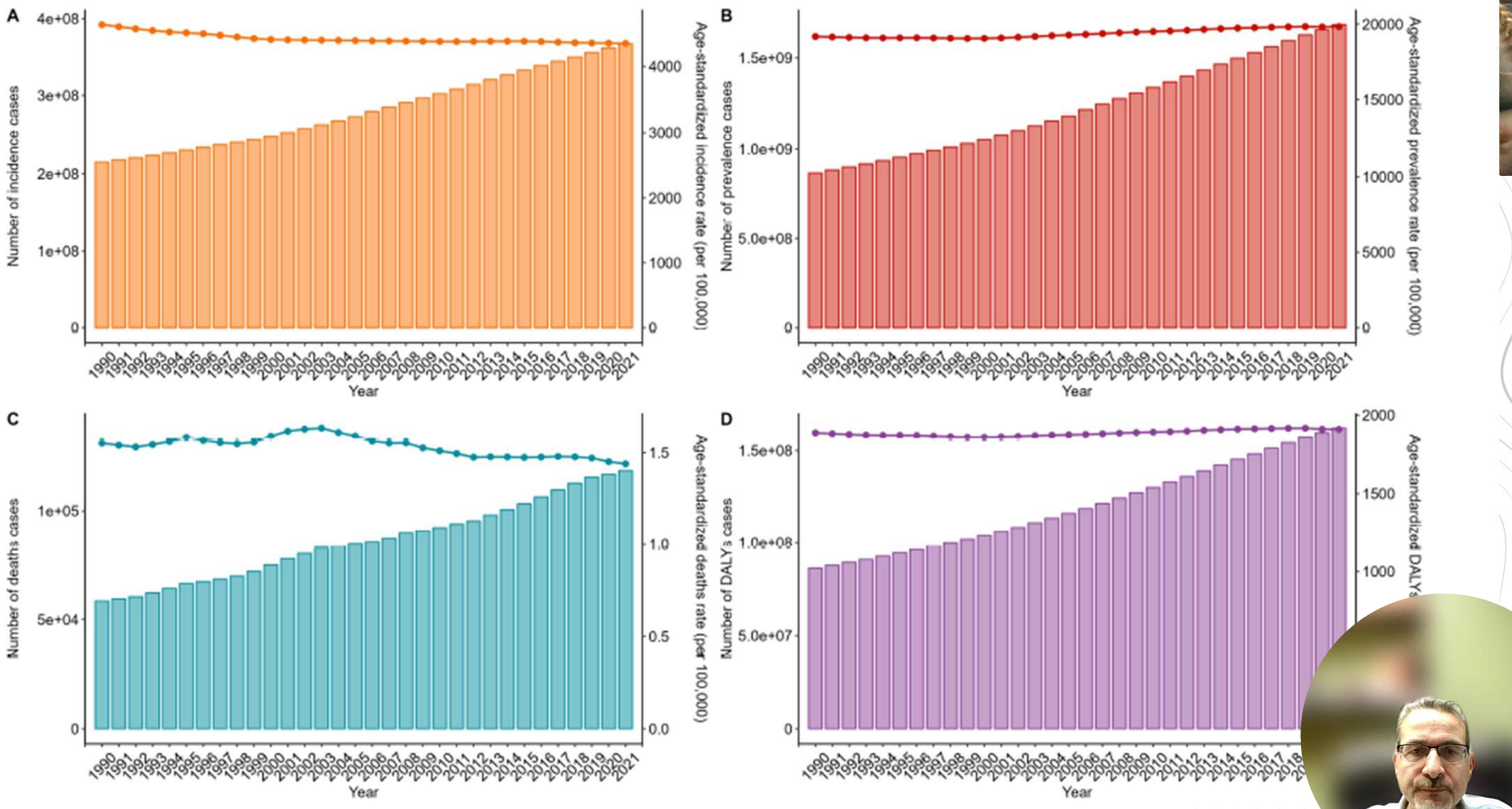

https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2024.1358867/full

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Musculoskeletal Disorders (MSDs)

LATEST NUMBERS

Nonfatal injuries and illnesses, private industry

2,804,200 Total recordable cases: in 2022

	DAFW	IR
Total MSDs	**502,380**	**25.3**
Traumatic injuries and disorders	487,960	24.5
To muscles, tendons, ligaments, joints, etc.	365,420	18.4
Sprains, strains, tears	342,480	

Source: msd-case-and-demographic-nature-2021-2022-national (1).xlsx

Slide 7

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U.S. businesses spend more than $1 billion per week on workplace injuries, for a staggering total of more than $58 billion per year. The top 10 causes cost U.S. businesses $47.93 billion per year or 82.5% of total.

Understanding top risks in the workplace is the first step to protecting your workers and your business. The Liberty Mutual Workplace Safety Index helps you make your workplace safer by identifying critical risk areas so that you can better allocate safety resources.

Developed annually, the Index ranks the top 10 causes of serious, nonfatal workplace injuries by their direct costs to U.S. businesses.

The top 10 causes

		Cost in billions	Percent of total
1	**Overexertion involving outside sources** *(handling object) – This event category includes injuries related to lifting, pushing, pulling, holding, carrying, or throwing objects.*	$12.49	21.51%
2	**Falls on same level**	$9.99	17.21%
3	**Falls to lower level**	$5.68	9.78%
4	**Struck by object or equipment** *(being hit by objects)*	$5.55	9.56%
5	**Other exertions or bodily reactions** *(awkward postures) – include bending, reaching, twisting, climbing, crawling, kneeling, sitting, standing, walking, and running.*	$3.68	6.34%

These top five injury causes account for 64.4 percent of the total cost.

The remaining five injury causes combined for 18.1 percent of the total direct cost of disabling injuries.

6	**Roadway incidents involving motorized land vehicle** *(vehicle crashes)*	$2.76	4.76%
7	**Slip or trip without fall**	$2.34	4.02%
8	**Caught in or compressed by equipment or objects** *(running equipment or machines)*	$2.05	3.54%
9	**Struck against object or equipment** *(hitting in-place objects)*	$1.84	3.17%
10	**Repetitive motions involving microtasks**	$1.54	2.65%

Liberty Mutual. INSURANCE

2024 Workplace Safety Index
Annual report from Risk Control Services

$47.90B 2024 WSI Top 10 total

$58.07B 2024 WSI total cost of workplace injuries

1	**Overexertion involving outside sources** *(handling object) – This event category includes injuries related to lifting, pushing, pulling, holding, carrying, or throwing objects.*	$12.49	21.51%
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10	**Repetitive motions involving microtasks**	$1.54	2.65%

$17.71B

30%

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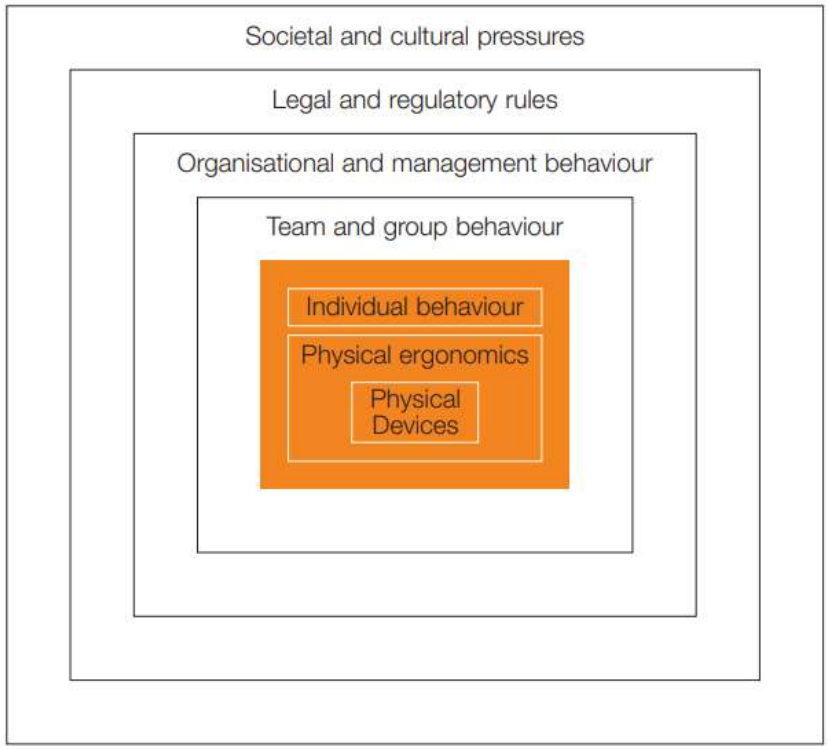
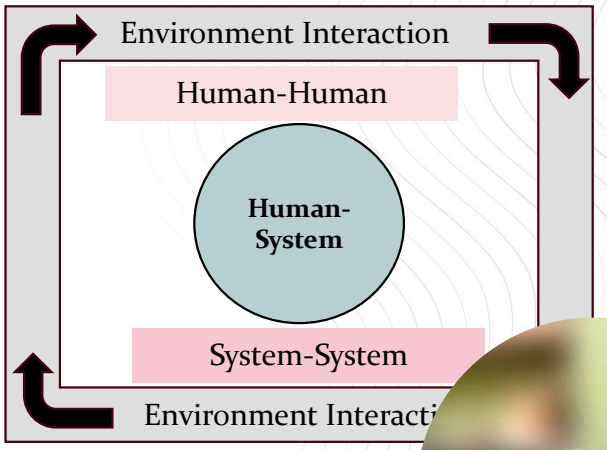
Risk Factors



(after Moray, 2000)

- **Physical:**
- Frequency/Repetitive motions
- Forceful exertions
- Awkward postures
- Vibrations
- Temperature
- Duration



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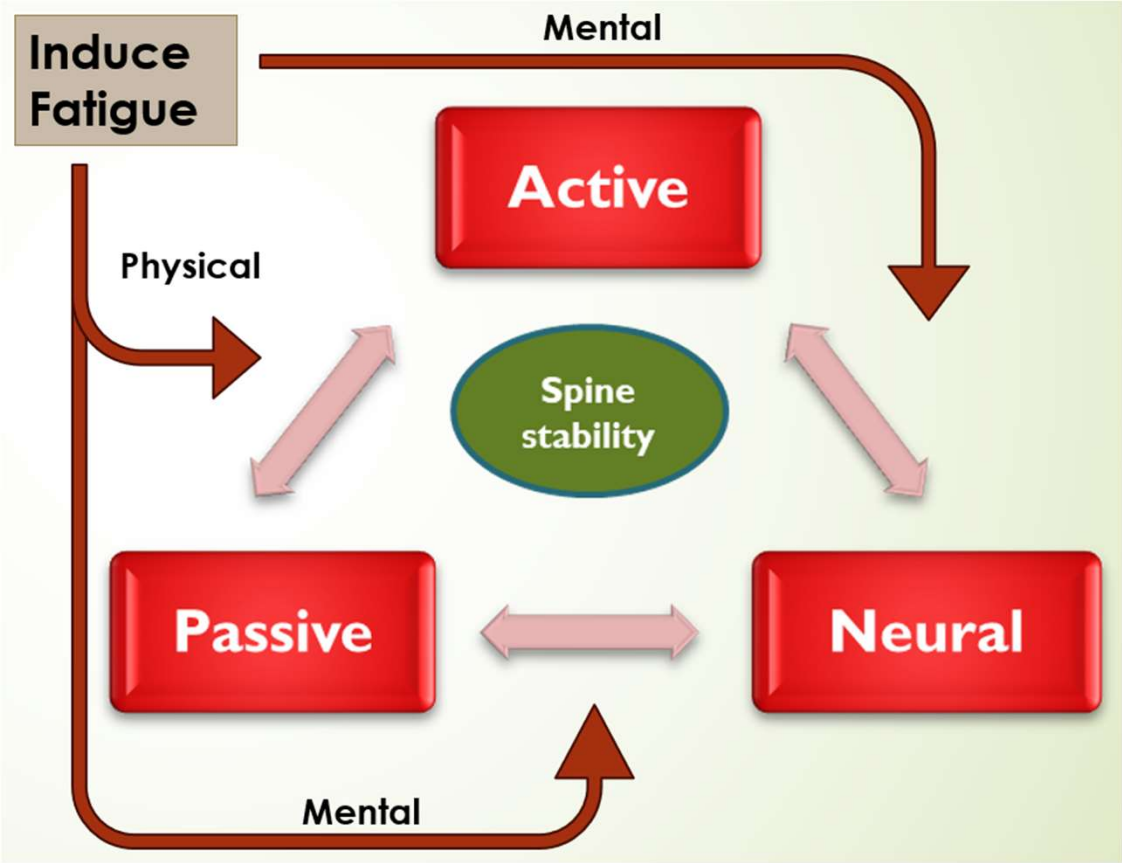
Source: RR211 - Further development of the usability and validity of the Quick Exposure Check (QEC) (wa.gov)

Physical Risk Factors



Tec

Tech

- Rel
- Ob
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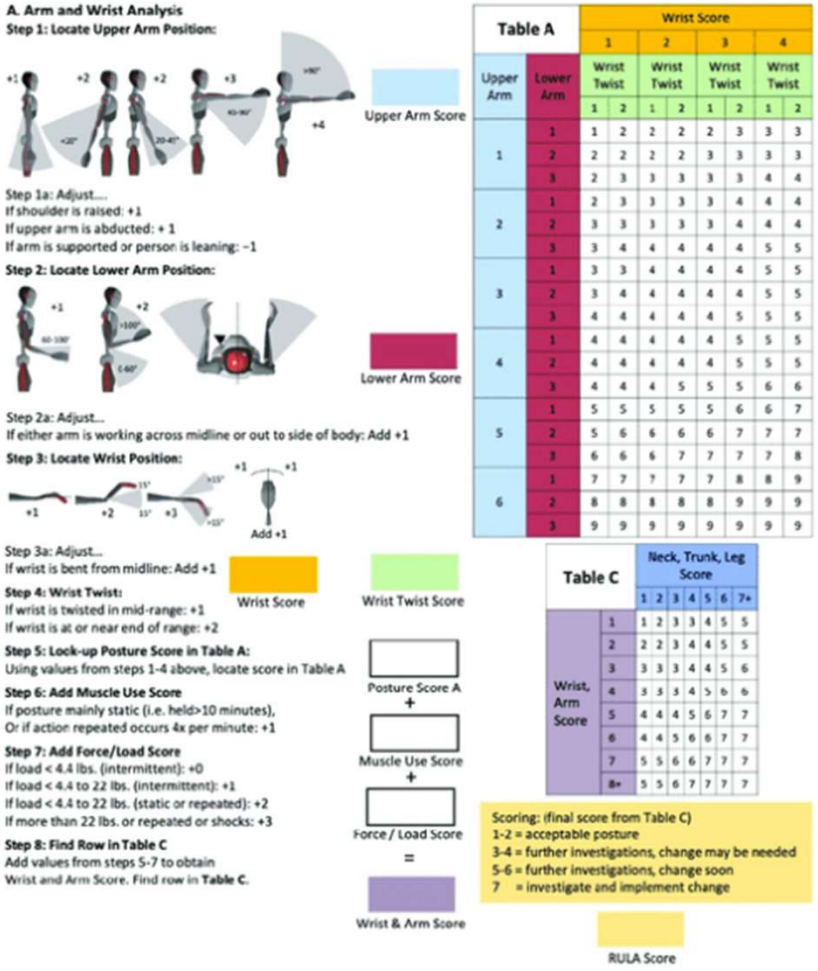

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:

Step 1a: Adjust....
If shoulder is raised: +1
If upper arm is abducted: + 1
If arm is supported or person is leaning: −1

Step 2: Locate Lower Arm Position:

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:

Add +1

Step 3a: Adjust...
If wrist is bent from midline: Add +1

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Step 5: Lock-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4x per minute: +1

Step 7: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load < 4.4 to 22 lbs. (intermittent): +1
If load < 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain
Wrist and Arm Score. Find row in **Table C**.

Upper Arm Score

Lower Arm Score

Wrist Score

Wrist Twist Score

Posture Score A
+
Muscle Use Score
+
Force / Load Score
=
Wrist & Arm Score

Table A

Upper Arm	Lower Arm	Wrist Score 1 Wrist Twist 1	1 2	Wrist Score 2 Wrist Twist 1	2	Wrist Score 3 Wrist Twist 1	2	Wrist Score 4 Wrist Twist 1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C

Wrist, Arm Score	Neck, Trunk, Leg Score 1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1-2 = acceptable posture
3-4 = further investigations, change may be needed
5-6 = further investigations, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position:

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 10: Locate Trunk Position

Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bencing: +1

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Neck Score

Trunk Score

Leg Score

Table B: Trunk Posture Score

Neck Posture Score	1 Legs 1	2	1 Legs 2	2	1 Legs 3	2	1 Legs 4	2	1 Legs 5	2	1 Legs 6	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above, ocate score in Table B

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held<10 minutes),
Or if action repeated occurs 4x per minute: +1

Step 14: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load < 4.4 to 22 lbs. (intermittent): +1
If load < 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in **Table C.**

Neck, Trunk, Leg Score

Posture Score B
+
Muscle Use Score
+
Force / Load Score

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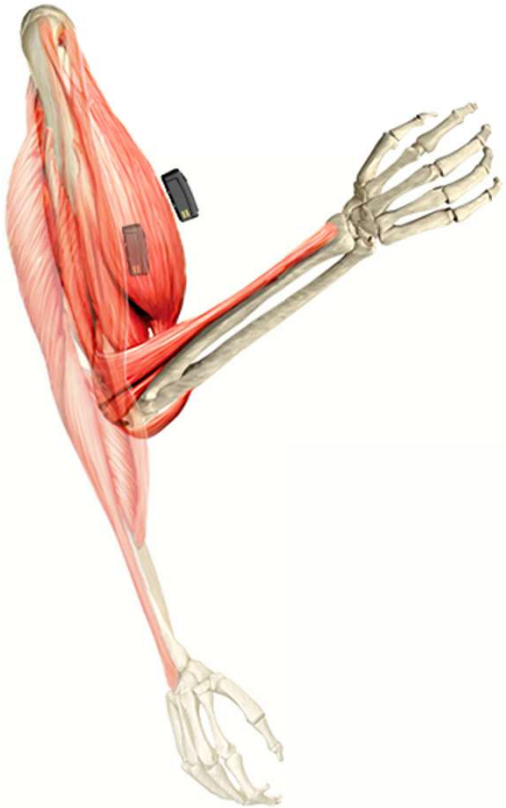
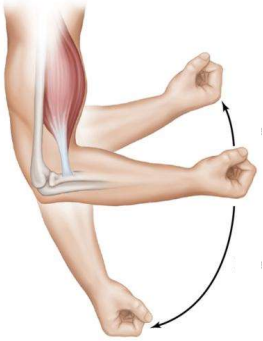
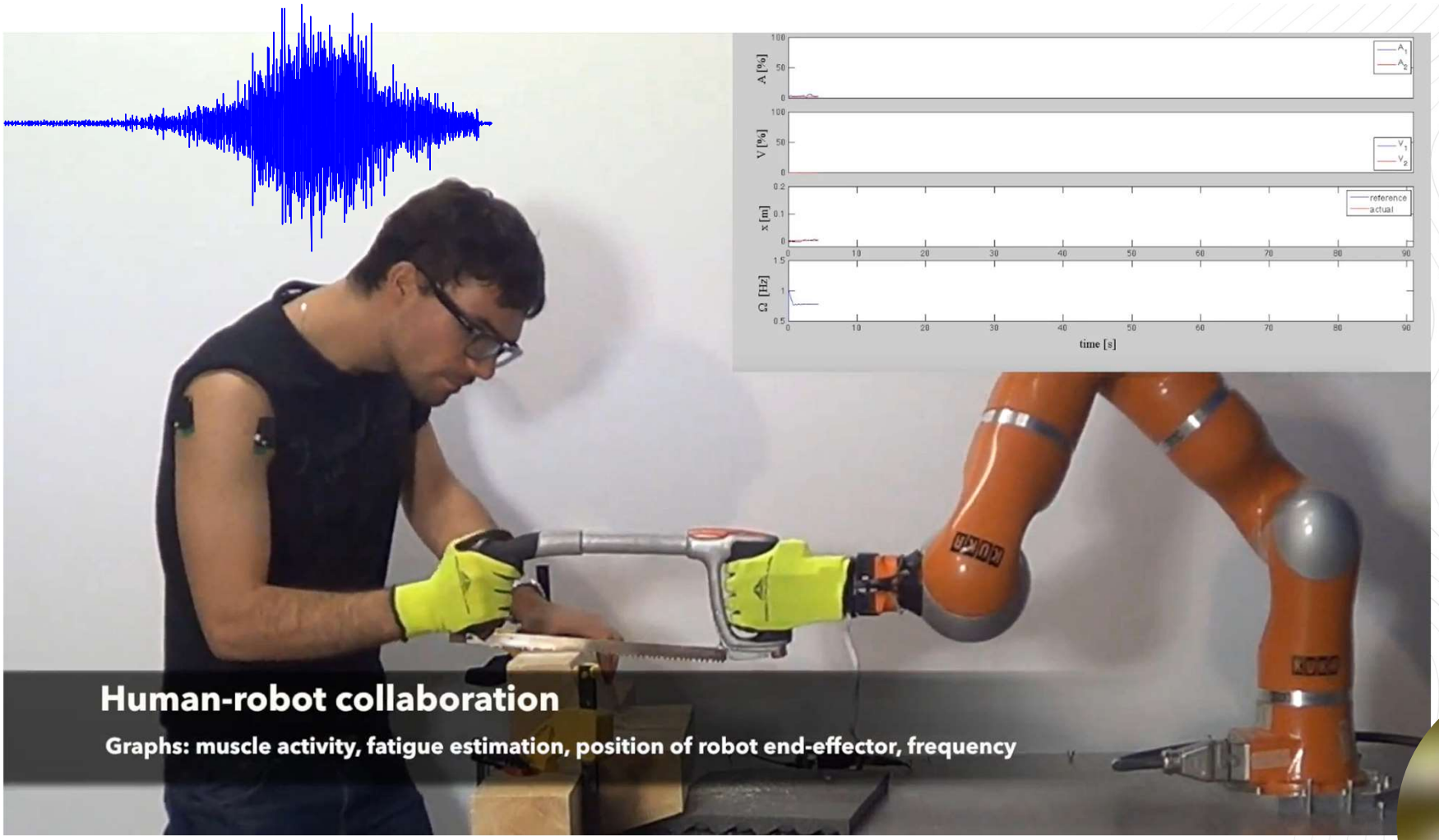
Exertions: Electromyography (EMG)





Electromyography is the study of muscle function through the inquiry of the electrical signal the muscles emanate.

The greater the stimulation, either by higher frequency firing of the motor neurons or greater recruitment of motor units, the large the electrical signal will be



Human-robot collaboration

Graphs: muscle activity, fatigue estimation, position of robot end-effector, frequency

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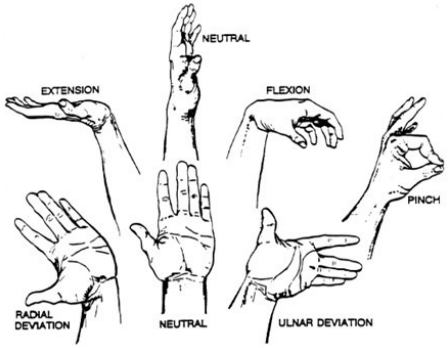
Awkward Postures

Low Stress - Back Flexion
- 0 – 29 degrees

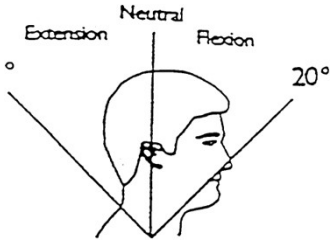
High Stress - Back Flexion
- 30 deg and >



Straight wrist: 100% strength

Halfway bent: Reduce to 65-75%

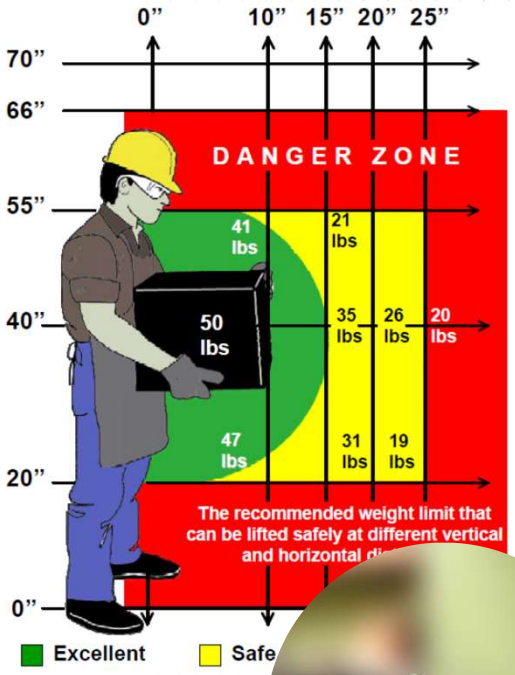
Fully bent: Reduce to 15 to 20%



Best - 5 - 10 degrees

Low Stress Position
- 0 to 20 degrees

High Stress Position
- 21 deg and >



Liftin

Safe-lifting

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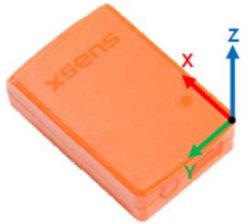
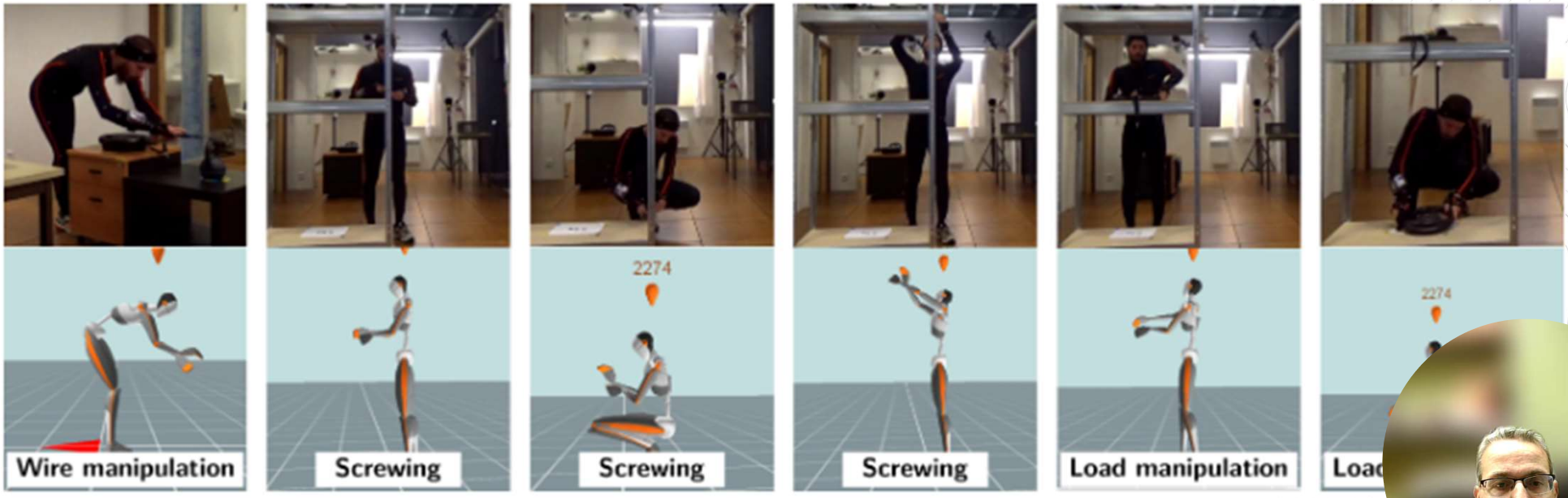
Posture Monitoring

- Real time Motion tracking systems





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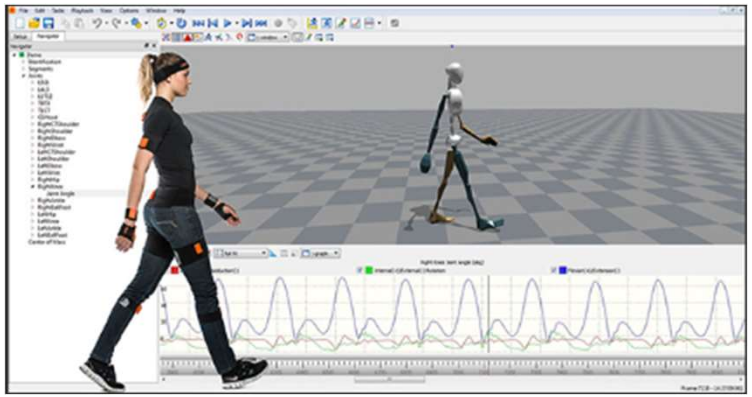
Posture: Motion tracking Systems



AI Technology for Motion tracking

Build 3D models of human activity from 2D video. Account for joint positions, repetition of movements, and duration of risk exposure. Tumeke Ergonomics

Camera Based Assessments

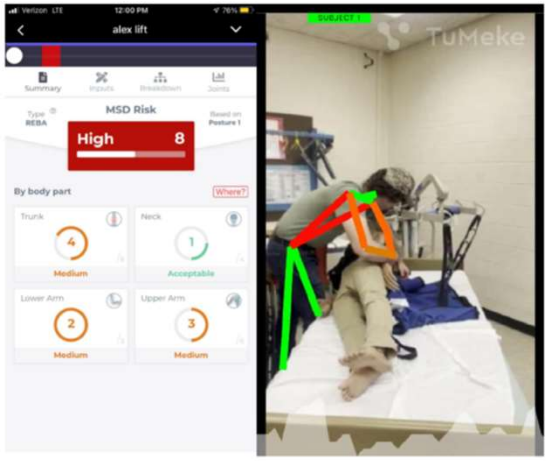
No need for wearables, goniometers, or other equipment. Measure and automatically track the safety of employees without stopping production.

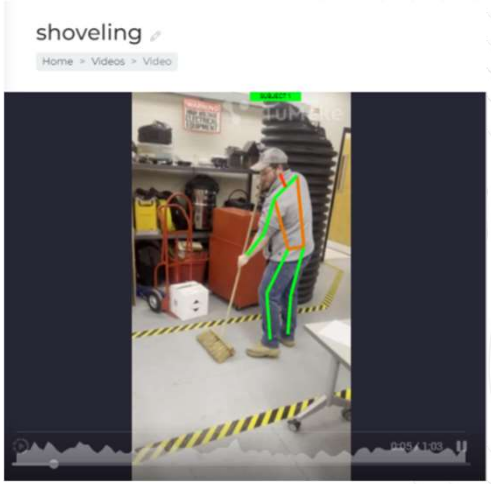
Use your phone's camera in the app

Upload an existing recording

https://www.tumeke.io/product/tumeke-suite#how-it-works

COMPUTER VISION AND ARTIFICIAL INTELIGENCE





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Posture : UPRIGHT GO 2

Wear it

Get Instant Feedback

Thank You

Any Questions?

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