EXOSKELETONS

AGENDA – EXOSKELETON WEBINAR

1. WHO is involved today. WHY is all of this important?
2. WHAT are the different types of Exoskeletons?
3. WHAT / WHEN / WHERE / HOW /WHY DEMO AND PILOT?
4. Additional Resources

EXOSKELETONS

SCRA
South Carolina Research Authority

JTEKT

ASTM INTERNATIONAL
Helping our world work better

WHO

POLL – LEVEL OF EXPERIENCE?

A Beginner

B Intermediate

C Expert

WHO

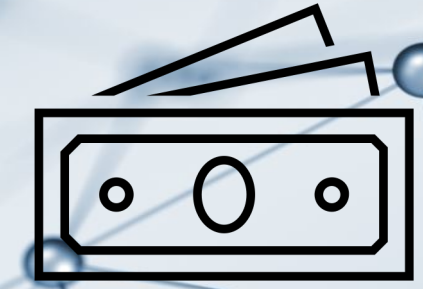
“Exoskeletons embody the technological promise of empowering humans to be all they can be,” says committee member William Billotte, a physical scientist at the U.S. National Institute of Standards and Technology.

ASTM INTERNATIONAL
Helping our world work better

ASTM International’s committee on exoskeletons and exosuits (**F48**) has published its first two standards, providing consensus terminology (**F3323**) as well as labeling and other informational requirements (**F3358**).

WHY IS THIS IMPORTANT

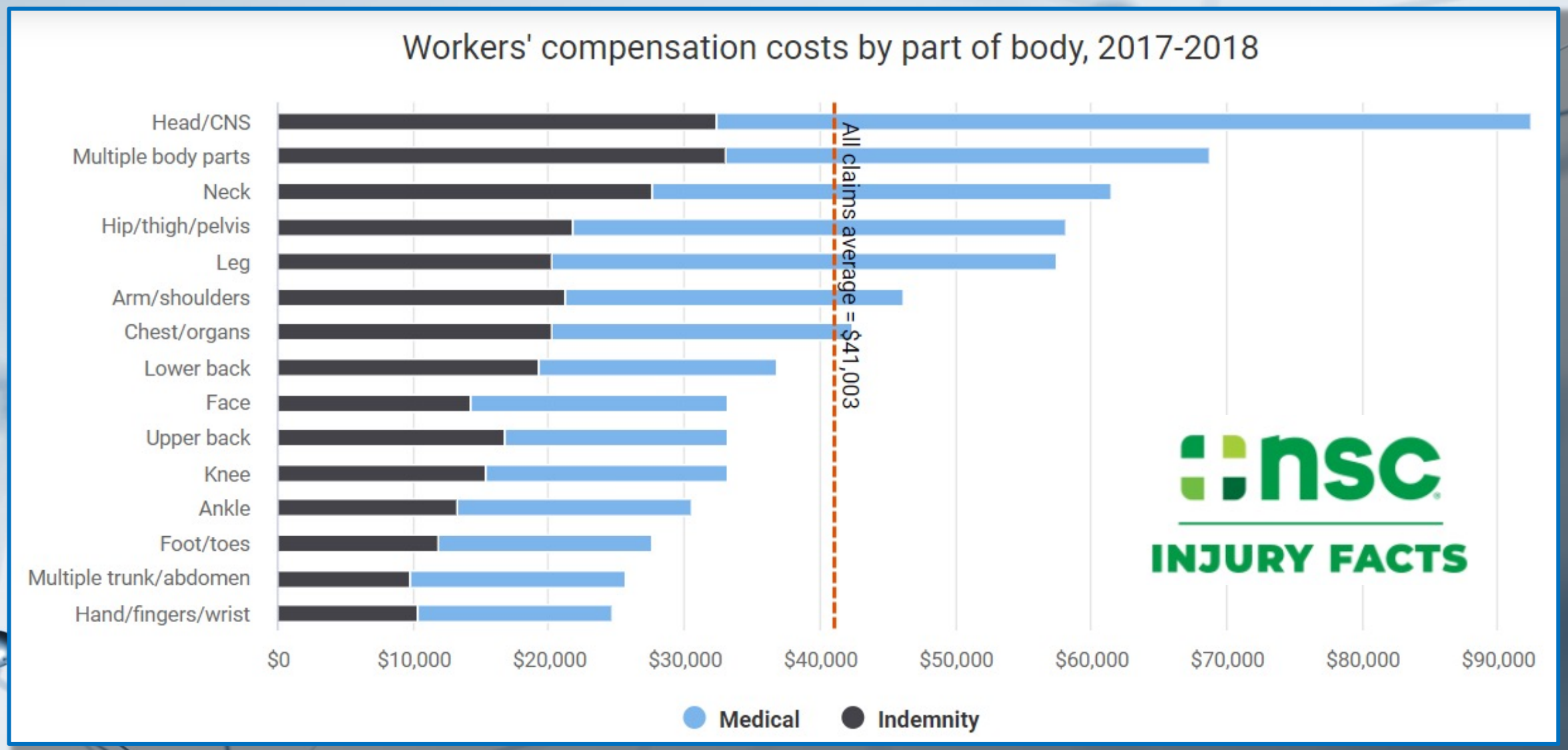
HEALTH



COST

QUALITY

EXOSKELETONS – ROI JUSTIFICATIONS



ABOUT NSC

The National Safety Council is America's leading nonprofit safety advocate

EXOSKELETONS - PROOF IN THE PUDDING

AGENDA – EXOSKELETON WEBINAR

1. WHO is involved today. WHY is all of this important?
2. WHAT are the different types of Exoskeletons?
3. WHAT / WHEN / WHERE / HOW /WHY DEMO AND PILOT?
4. Additional Resources

INTRODUCTION

"When you think of exoskeletons, does this come to mind?"
– Russ Angold, Co-Founder Ekso Bionics

INTRODUCTION

INTRODUCTION

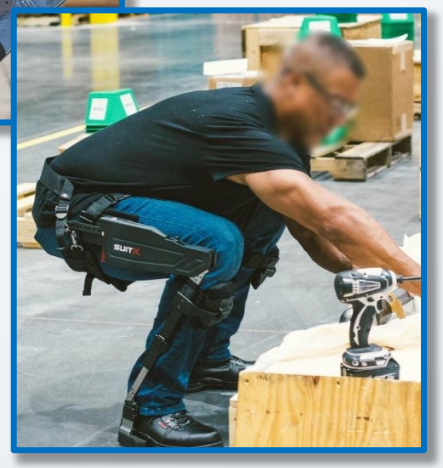
Global Industrial Exoskeletons Market to Boom, Led by Automotive Manufacturing Industry, Finds Frost & Sullivan

INTRODUCTION

“The global industrial exoskeletons market is expanding rapidly, driven by high injury costs and aging and shrinking skilled workforces across sectors.”

EXOSKELETON - TYPES

- A Full Body - Powered
- B Shoulder
- C Back
- D Legs
- E Hand

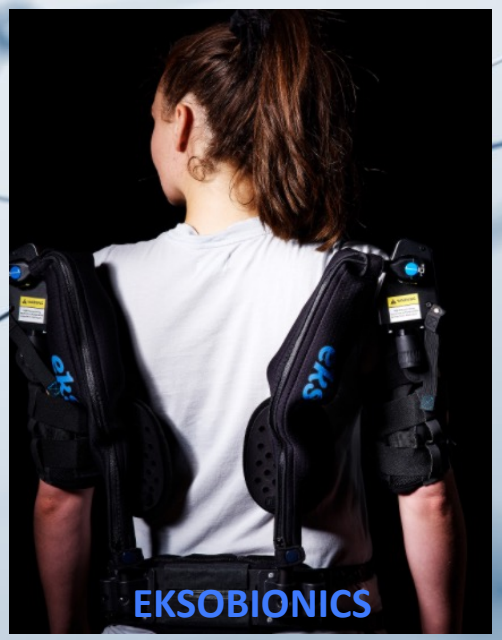


EXOSKELETON - POWERED

EXOSKELETONS - SHOULDER


OTTOBOCK


LEVITATE


EKSOBIONICS


SKELEX


SUITX


COMAU

EXOSKELETONS - SHOULDER

AIRFRAME

LEVITATE TECH

Armor-Man 2

TILTAMAX (AMAZON)

BESK

CYBER HUMAN

CDYS

CRIMSON DYNAMICS

EVO

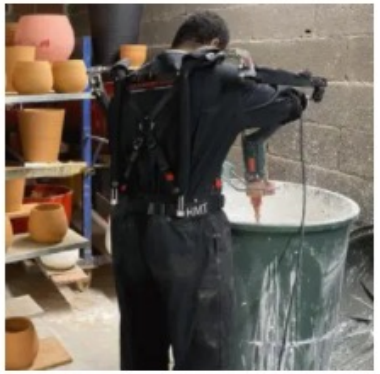
EKSO BIONICS

Exhauss

EXHAUSS

Exy ONE

EXY



LIGHT'

HMT

Credit:
Associate Dean Dr. Thomas Sugar Barrett, The Honors College

EXOSKELETONS - BACK

EXOSKELETONS - BACK

ALDAK

CYBER HUMAN

ALDAK – Passive

CYBER HUMAN

Apex

HEROWEAR

AWN-12

ATOUN

backX

SUITX

CarrySuit

AUXIVO

Cray X

GERMAN BIONIC

DARWING PA-Jacket

DAIYA

EXOSKELETONS - LEGS

EXOSKELETONS - LEGS

Archelis

ARCHELIS

Chairless Chair

NOONEE

Hercule

RB3D

legX

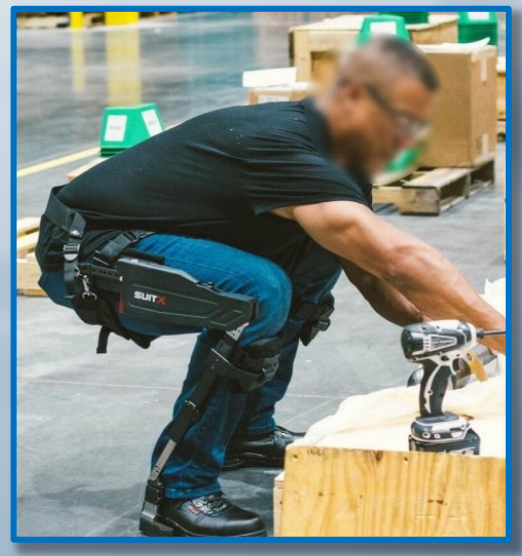
SUITX

EXOSKELETONS - HAND

EXOSKELETONS – WHERE USED

Determining where to use exoskeletons.

- Types of jobs
- High Injuries
- Terrible jobs



POLL – WHICH INTERESTS YOU?

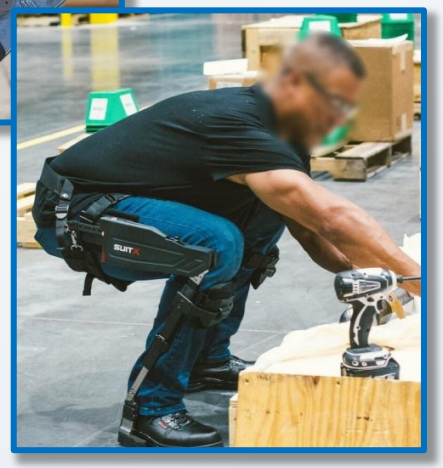
A Full Body - Powered

B Shoulder

C Back

D Legs

E Hand

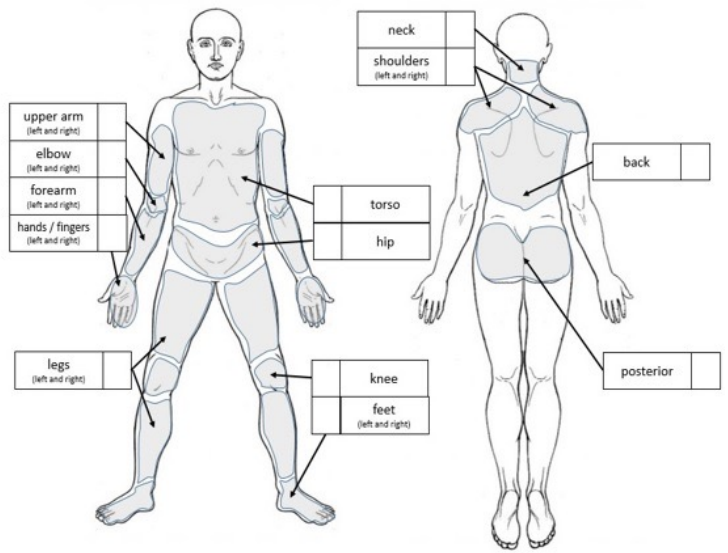


EVALUATIONS

BODY-MAP.

- With and without exoskeleton
- before - after - after

Numerical Value	Description
0	no strain
1	very weak
2	weak
3	moderate
4	rather strong
5	strong
6	
7	very strong
8	
9	extreme
10	maximal



GENERAL QUESTIONS

- Wearing Comfort
- Operation
- Working Environment and Application Eligibility
- Stand
- Walk
- Bend down
- Etc.

Wearing Comfort

1.1	How long did you wear the exoskeleton on average per shift and how many days in total? (in h)	On average ____ h at a total of ___ days
1.2	Had the exoskeleton been uncomfortable as the duration of wearing increased?	☐ Yes ☐ No
	1.2.1 If yes, please describe to what extent:	

___ h

Handling

		Strongly agree					Strongly disagree
1.3	… can be easily put on and taken off.	☐	☐	☐	☐	☐	☐
1.4	… comfortably fits my body.	☐	☐	☐	☐	☐	☐
1.5	…is easy to set up and to handle.	☐	☐	☐	☐	☐	☐
1.6	…is rigid and inflexible	☐	☐	☐	☐	☐	☐
1.7	… can be easily integrated into my everyday work (e.g. breaks, hygiene, storage etc).	☐	☐	☐	☐	☐	☐

NASA-TLX.

- Work Execution
- Acceptance

NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

Name	Task	Date

Mental Demand — How mentally demanding was the task?
Very Low — Very High

Physical Demand — How physically demanding was the task?
Very Low — Very High

Temporal Demand — How hurried or rushed was the pace of the task?
Very Low — Very High

Performance — How successful were you in accomplishing what you were asked to do?
Perfect — Failure

Effort — How hard did you have to work to accomplish your level of performance?
Very Low — Very High

Frustration — How insecure, discouraged, irritated, stressed, and annoyed wereyou?
Very Low — Very High

EVALUATIONS

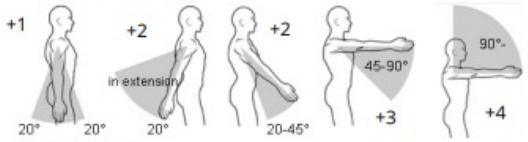
ERGONOMICS PLUS

RULA Employee Assessment Worksheet

Task Name: Date:

A. Arm and Wrist Analysis

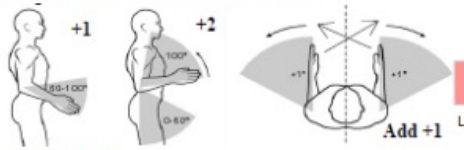
Step 1: Locate Upper Arm Position:



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

Upper Arm Score

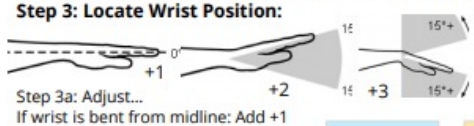
Step 2: Locate Lower Arm Position:



Lower Arm Score

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

Step 3: Locate Wrist Position:



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

Wrist Twist Score

Wrist Score

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

Posture Score 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

Muscle Use Score

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

Force / Load Score

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

Wrist & Arm Score

Scores

Table A

Upper Arm	Lower Arm	Wrist Score 1: Wrist Twist 1	1: Wrist Twist 2	2: Wrist Twist 1	2: Wrist Twist 2	3: Wrist Twist 1	3: Wrist Twist 2	4: Wrist Twist 1	4: Wrist Twist 2
1	1	1	2	2	2	3	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

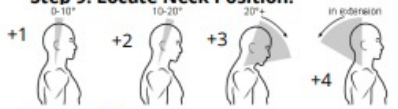
Wrist / Arm Score	Neck, Trunk, Leg Score 1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

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

RULA Score

B. Neck, Trunk and Leg Analysis

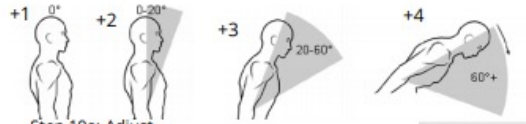
Step 9: Locate Neck Position:



Neck Score

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 bending: +1

Trunk Score

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

Leg Score

Table B: Trunk Posture Score

Neck Posture Score	1: Legs 1	1: Legs 2	2: Legs 1	2: Legs 2	3: Legs 1	3: Legs 2	4: Legs 1	4: Legs 2	5: Legs 1	5: Legs 2	6: Legs 1	6: Legs 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, locate score in Table B

Posture B Score

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

Muscle Use Score

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

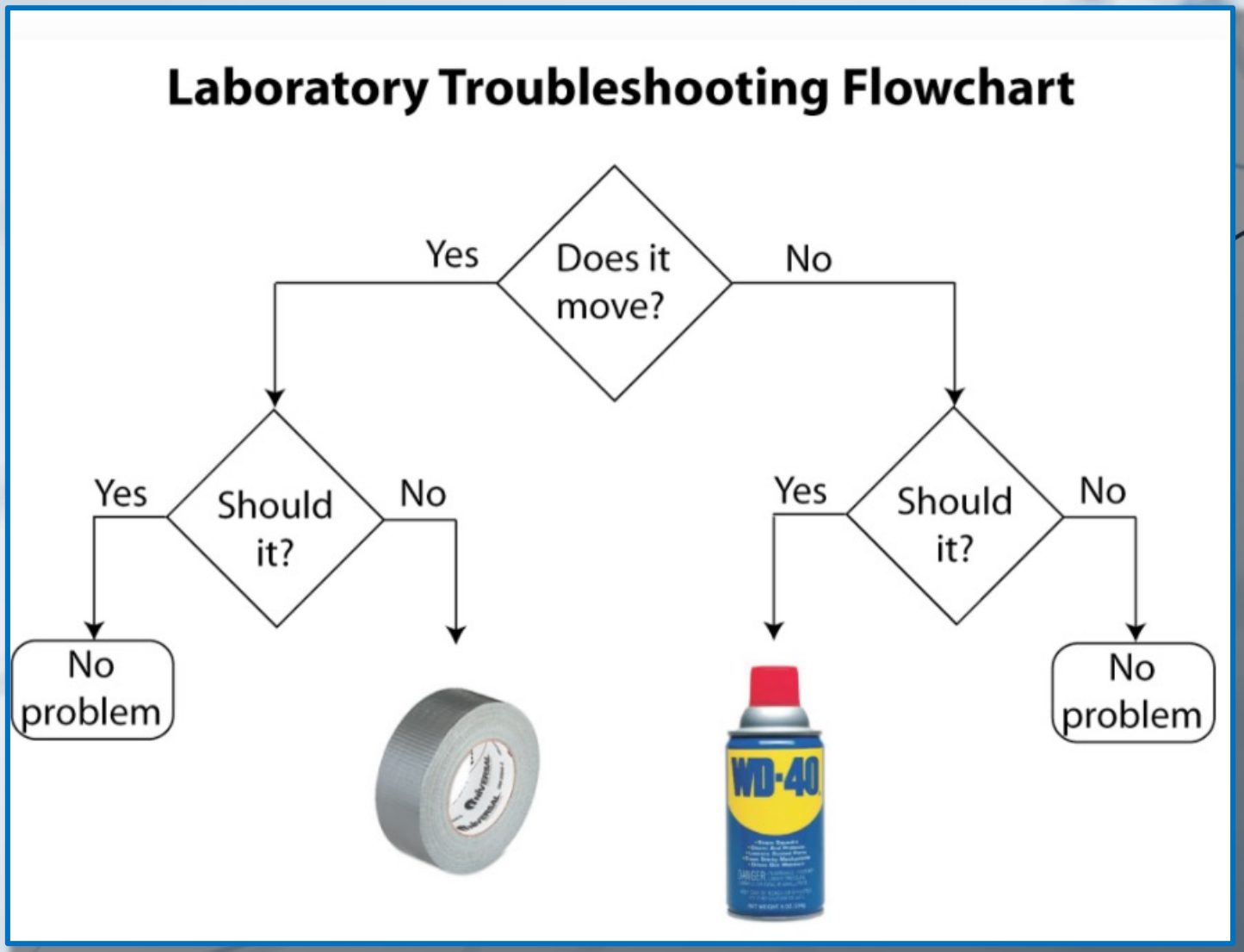
Force / Load Score

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**.

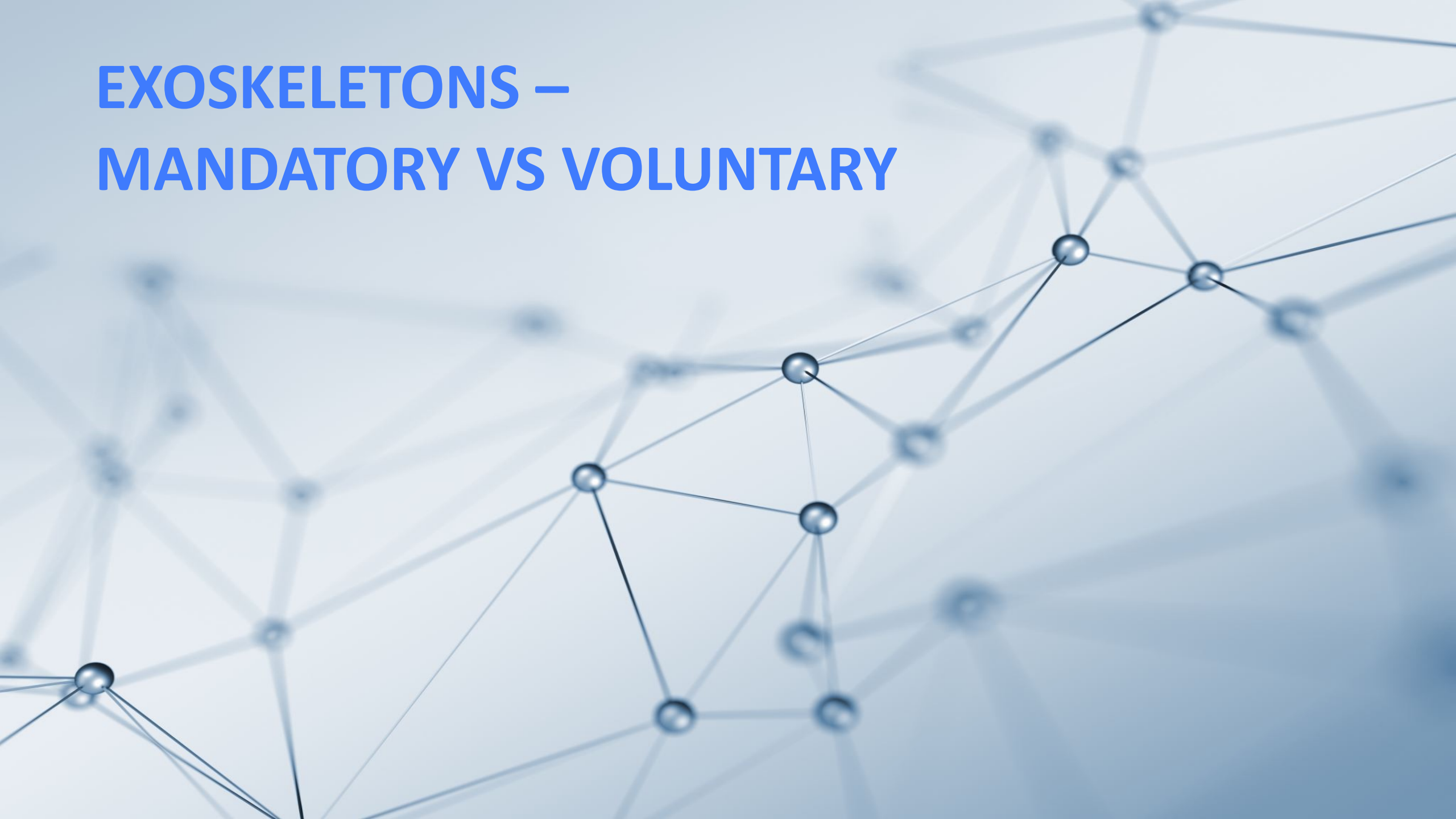
Neck, Trunk, Leg Score

Original Worksheet Developed by Dr. Alan Hedge. Based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

EXOSKELETONS – STRATEGY - INTRO



EXOSKELETONS – MANDATORY VS VOLUNTARY



EXOSKELETONS – MANDATORY PPE

7 Types of Personal Protective Equipment (PPE)
To Guarantee Your Safety

EXOSKELETONS – VOLUNTARY

AGENDA – EXOSKELETON WEBINAR

1. WHO is involved today. WHY is all of this important?
2. WHAT are the different types of Exoskeletons?
3. WHAT / WHEN / WHERE / HOW /WHY DEMO AND PILOT?
4. Additional Resources

SCRA EXOSKELETON DEMO

AUDIENCE: Manufacturing & Logistics

DATE: Nov 11 - 12, 2021

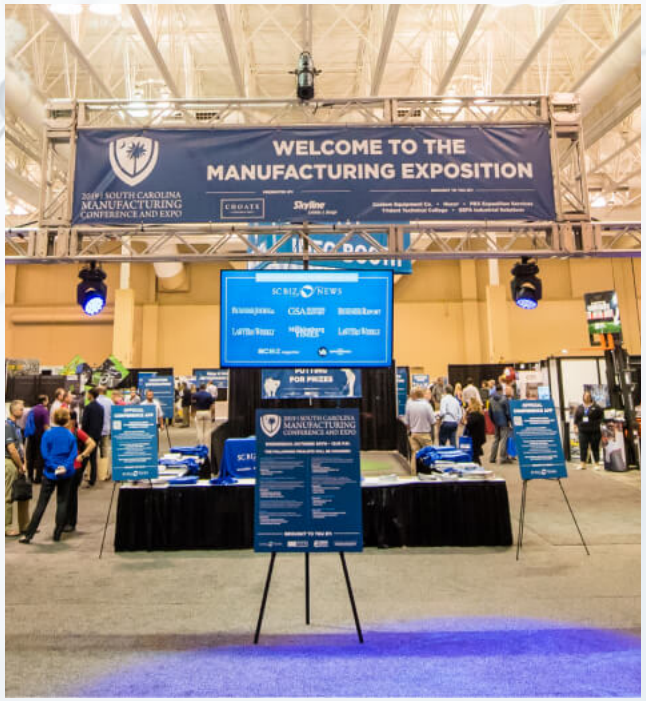
LOCATION: SC Manufacturing Conference 2021

Greenville Convention Center

1 Exposition Drive, Greenville, SC 29607

FEE: $50/person + Conference EXPO Fee $25/person

SCRA de-risk EXO DEMO cost for participants



HTTPS://SCMANUFACTURINGCONFERENCE.COM/

SCRA EXOSKELETON DEMO

TASKS TO BE DEMONSTRATED

- Task 1 Lower Back: Box handling
- Task 2 Upper Extremities: Overhead assembly mockup

TASK 1
Box handling

TASK 2
Overhead assembly

As references, test apparatus and methods to demonstrate load handling and movement can be found at these links:

NIST PUBLICATION ON 'TOWARDS STANDARD EXOSKELETON TEST METHODS FOR LOAD HANDLING' HTTPS://WWW.NIST.GOV/PUBLICATIONS/TOWARDS-STANDARD-EXOSKELETON-TEST-METHODS-LOAD-HANDLING

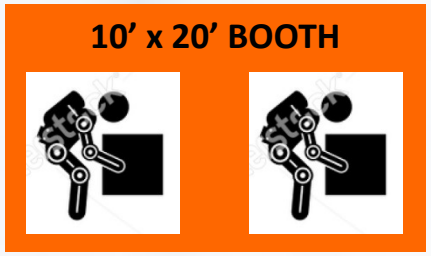
ASTM F3443 - STANDARD PRACTICE FOR LOAD HANDLING WHEN USING AN EXOSKELETON. HTTPS://WWW.ASTM.ORG/STANDARDS/F3443.HTM

ASTM F3517 - STANDARD PRACTICE FOR MOVEMENT TESTS WHEN USING AN EXOSKELETON. HTTPS://WWW.ASTM.ORG/STANDARDS/F3517.HTM

SCRA EXOSKELETON DEMO

Pre-Survey: EXO experience

EXO DEVICE A



EXO DEVICE B

EXO DEVICE C

EXO DEVICE D

EXO DEVICE E

Process for DEMO: ABA

- 5X without EXO
- 5X with EXO
- 5X without EXO

Post-Survey: EXO experience

SCRA EXOSKELETON DEMO

WHY PARTICIPATE IN THE SCRA EXO DEMO?

1. See a variety of commercial exoskeletons all in one place
2. Try multiple devices for specific tasks that simulate your workplace
3. Learn about next steps to PILOT, INTRODUCE & IMPLEMENT exoskeletons in your workplace.
4. SCRA financial & technical support to de-risk the EXO DEMO with multiple vendors
5. Guidance from ASTM, Industry Partners, Clemson University & EXO Vendors to design the EXO DEMO

POLL – Interest in the SCRA EXO DEMO ?

A Yes, I would like more information to register for the Nov 11-12 DEMO.

B Yes, I would like more information on a future DEMO.

C No interest in participating in an EXO DEMO.

SCRA EXOSKELETON PILOT PROJECT

1. **SCRA will de-risk an industrial pilot project**
   - Provide technical and financial support with matching funds from industry partners.
2. **SCRA will assist to design the EXO PILOT Project**
   - Utilizing expert guidance from ASTM, Industry Partners, EXO Vendors & Clemson University
   - Consider types of devices for your industrial application/s
   - Determine the duration of an effective PILOT
   - Provide steps to plan, introduce and implement EXOs in your workplace
   - Conduct Pre – during – post EXO Surveys
   - Propose ROI justification using PILOT outcomes & studies that evaluate EXO use
3. **With industry interest now, intent to PILOT in Q1 2021**

POLL – INTEREST IN PILOT PROJECT ?

A Yes, I am interested to learn more about the SCRA/Industry Partner Exoskeleton PILOT Project.

B No, I do not have interest in an Exoskeleton PILOT project.

AGENDA – EXOSKELETON WEBINAR

1. WHO is involved today. WHY is all of this important?
2. WHAT are the different types of Exoskeletons?
3. WHAT / WHEN / WHERE / HOW /WHY DEMO AND PILOT?
4. Additional Resources

RESOURCES


AEXG
AUTOMOTIVE EXOSKELETON GROUP
WearRA
WEARABLE ROBOTICS
ASSOCIATION
SCRA
South Carolina Research Authority
ASTM INTERNATIONAL
Helping our world work better
NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

EXOSKELETONS

Q&A

POLL – FUTURE WEBINARS ?

A In depth on exoskeleton types and use cases?

B In depth on strategy for first steps of introducing exoskeletons to a new organization or company?

C In depth on strategy for implementing a sustainable exoskeleton program at a company?

D In depth on the results of studies of the use of exoskeletons on users?

EXOSKELETONS

THANKS

SCRA
South Carolina Research Authority

JTEKT

ASTM INTERNATIONAL
Helping our world work better