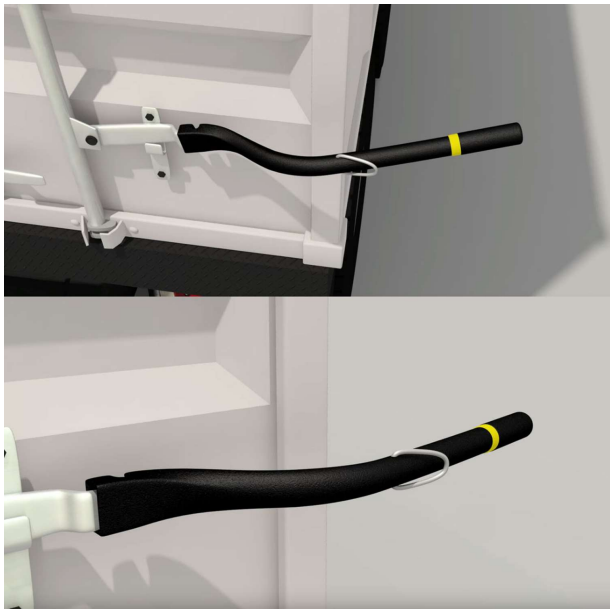

ERGONOMICS REPORT

OPNBAR

ABSTRACT

This intermodal cargo container inspection tool and leverage safety bar aids in opening and closing side-by-side container and truck trailer doors found within the trucking, shipping, railroad, harbor industries, and more. It is made keeping in view all important Ergonomic Procedures

SCS International

www.OPNBar.com

OPNBAR ERGONOMIC ANALYSIS & DISCLAIMER

This document contains an ergonomic study on OPNBar and is constantly being updated as our study is ongoing. The information contained here is for general information purposes only. We are not medical professionals and do not claim to be. The information provided is based on our own understanding and research and is not intended to treat or diagnose any medical condition or to provide medical advice.

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ERGONOMICS

The practice of designing or arranging workplaces, items, and systems to fit the users of them is known as ergonomics.

Most people have heard of ergonomics and believe it has to do with seating or the layout of car controls and instruments, which isn't entirely accurate. But it is a lot more than that. Anything that involves people, such as workplaces, sports and leisure activities, and health and safety, must be designed with ergonomics in mind.

The goal of ergonomics, or "human factors" as it is known in North America, is to gain knowledge of human capabilities and limitations and then use that knowledge to enhance how people interact with objects, systems, and environments.

The purpose of ergonomics is to reduce the risk of harm or injury by improving workspaces and environments. Therefore, as technology advances, it becomes increasingly important to make sure that the tools we use for work, rest, and play are created with our bodies' needs in mind.

WHY IS ERGONOMICS IMPORTANT?

The total economic cost of work-related illnesses and injuries is estimated by Safe Work Australia to be $60 billion. According to recent studies, lower back pain affects workers from offices, construction sites, and, in the highest risk category, agriculture, making it the most prevalent work-related disability worldwide.

By factoring in human abilities and limitations, such as body size, strength, skill, speed, sensory abilities (vision, hearing), and even attitudes, ergonomics aims to create safe, comfortable, and productive workplaces.

In the larger population: Over the next 50 years, Australia's population of people 75 and older is expected to double. To accommodate the growing needs of the aging population, equipment, services, and systems will need to be designed. This applies to public transportation, building amenities, and living spaces.

HAND TOOL ERGONOMICS

OPNBar is a hand tool so we will first discuss Major ergonomic issues with the design of a hand tool.

Weight of the Tool

A worker should ideally be able to use a tool with just one hand. Depending on the use, the tool's weight may vary:

If the hand tool will be used away from the body or above shoulder height, the weight limit is 2.3 kg (5 lb).

For precision tools, 0.4 kg (1 lb) is recommended to ensure good control.

Tools that are above the level of these suggestions should have a counterbalance.

OPNBar tool weight is 3lbs which is well in the safe range.

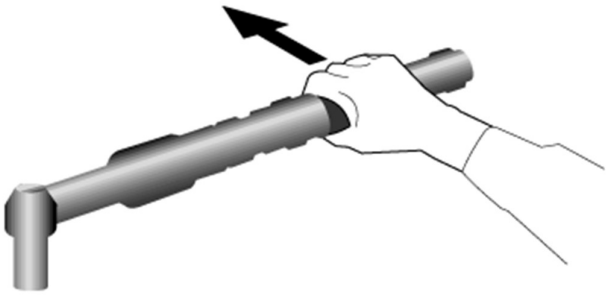
It is also important that the center of gravity be aligned with the center of the gripping hand. In other words, tools should feel "easy" to hold either in an upright position or in the position it will be used (i.e., pointing down). For example, drills that are "front-heavy" will require effort (especially in the wrist and forearm) to hold in a usable position and should be avoided. The exception to this principle is a power hand tool, such as a grinder, that has to be heavy in order to reduce the force that the worker has to exert while using it.

Handle

With the exception of tools for precision work (e.g., watchmaking, microsurgery, carving), the handles and grips of hand tools should be designed for a power grip. The assumption that smaller instruments should have smaller handles while larger equipment have larger ones is disputed.

Handle Shape

Tools with "bent" or angled handles or tools with pistol-grips are advantageous where its pressure is acted in a straight line in the same direction as the straightened forearm and wrist, — particularly when the pressure should be imposed horizontally



Recommended Hand Shape Figure

OPNBar was made keeping in view this risk of extreme long-term injury of an odd, angled wrist. In addition to common injuries like cuts, lacerations, and bruises, frequent and prolonged use of hand tools can cause soreness, aches, pains, and fatigue, which, if ignored, can lead to chronic musculoskeletal injuries (MSIs) of various types.

Straight-handled tools are used for tasks where force is applied perpendicular to the straightened forearm and wrist, such as when the force must be applied vertically. As we can see the tool handle is wrist-friendly and does not put extra pressure on the wrist.

For choosing the appropriate tools for any given activity, it is essential to understand the tasks and the arrangement of the workspace where they will be utilized. When choosing instruments, avoid those that call for wrist flexion, extension, or deviation. Choose instruments that enable you to maintain a neutral or straight wrist, in other words.

Even if it is right and important, the essential ergonomic principle in tool use and design -bend the tool, not the wrists - does not always avoid discomfort and injury when bent-handle tools are used carelessly, independent of the layout of the work scenario.

Diameter

The recommended handle diameter varies. In general, cylindrical handles 40mm (1.5 in) or larger offer a better power grip, with a range of 30-50mm (1.25 to 7 in). A diameter of 12mm (0.45 in) is recommended for precision grips, with a range of 8-16mm (0.3 to 0.6 in).

OPNBar handle is well in the range. The larger diameter allows for maximum torque, while the smaller diameter aids in dexterity and speed.

Length

To reduce the negative effects of any compression, tool handles should be no shorter than 100 mm (4 in). Handles with a diameter of 120 mm (5 in) are typically recommended. Remember that wearing gloves necessitates longer tool handles.

OPNBar handle is of perfect length. A short handle can cause unnecessary compression in the palm's center. It should span the width of the palm.

Materials and Texture of Handles

A sufficient amount of friction must exist between the hand and the handle to ensure a good grip. This is especially important when exerting significant force with a sweaty hand. Hand tools should be made of materials that are non-slip, non-conductive, and compressible. Textured rubber handles, for example, provide a good grip, reduce the effort required to use the tool effectively, and keep the tool from slipping out of the hand. Avoid glossy coatings and highly polished handles.

For power hand tools, the electrical and heat insulation properties of the handles are critical. Plastic or compound rubber handles are recommended. To prevent lacerations, cover sharp edges and contours with cushioned tape.

The information provided is based on our own understanding and research and is not intended to treat or diagnose any medical condition or to provide medical advice

BIOMECHANICS-BASED ANALYSIS

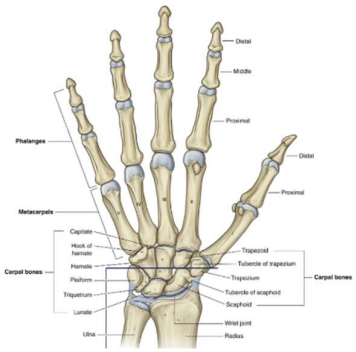
There are also ergonomic evaluation techniques that use biomechanical calculations. These techniques frequently base their assessments on tasks that require moving a load by pushing, pulling, carrying, lowering, or lifting it. They take longer to complete and yield more precise, numerical results when compared to observational posture-based analysis techniques.

Liberty Mutual, an American insurance company, developed an analysis tool to evaluate lifting, lowering, pushing, pulling, and carrying tasks in the workplace based on the initial research work on materials handling presented by Doctor Stover Snook and Vincent Cariello in 1978 (Snook & Cariello, 1991). The tables provide criteria levels at which lifting can be judged as suitable or unsuitable for a well-defined working population, considering the costs associated with back disabilities and decreased productivity brought on by manual materials handling tasks. It is regarded as an objective risk assessment because it is supported by statistics. This technique is also sometimes referred to as "Snook's Lifting Recommendation" or "The Snook Tables" because it was based on the work of Doctor Snook.

Information is provided in a variety of tables about the population's lifting, lowering, pushing, pulling, and carrying abilities for both men and women. The population segment that should be able to carry out such tasks as part of their daily work can be determined using the tables. The appropriate table is chosen for the target population and the task at hand, and the resulting maximum criteria value aids in changing or redesigning the work task to minimize or completely eliminate injury risk.

Ergonomic Evaluation of Biomechanical Hand Function

The human hand is a complicated organ that serves a variety of purposes in daily life and in jobs. The approaches used to assess hand functions from a biomechanics perspective are reviewed in this work, including anthropometry, kinematics, kinetics, and electromyography. The measurements and dimensions of the hand are described by anthropometry.

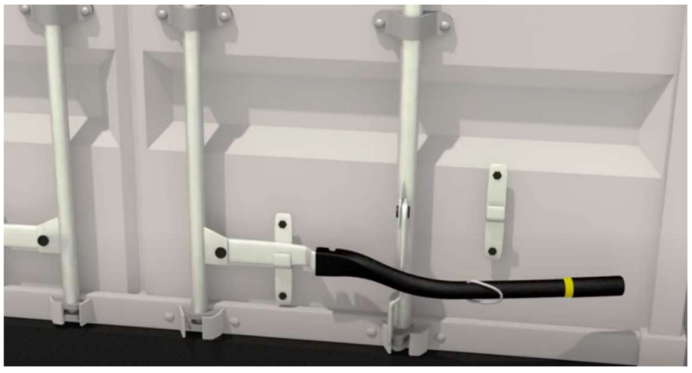


Hand motions and the range of motion in finger joints are included in kinematics. For the investigation of tendon and joint forces, kinetics includes hand models. EMG is employed in signal-processing technology and on hand muscles related to hand functions.

The human hand is made up of the thumb, the index finger, the middle finger, the ring finger, the little finger, and the palm, which has creases and the thenar and hypothenar eminences. The 19 bones in the fingers include metacarpal bones, proximal phalanges, middle phalanges, and distal phalanges. The thumb has carpometacarpal (CMC), MCP, and interphalangeal (IP) joints whereas the fingers have metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints. The hamate, pisiform, triquetral, capitate, lunate, trapezoid, trapezium, and scaphoid are among the eight bones found in the wrist. The hand consists of 28 muscles and 27 bones overall. The hand can carry out a variety of tasks thanks to its numerous bones and muscles.

The opening of a container door exerts severe pressure on the palm between the thumb and index finger. This can cause severe joint problems between carpal bones

OPNBar tool is designed to overcome this danger for many different movements, the handgrip is a crucial and fundamental component. One of the movements used most frequently in daily tasks and professional settings is manipulating objects with a secure grip. Physical and psychosocial factors may contribute to a decrease in grip strength and control.

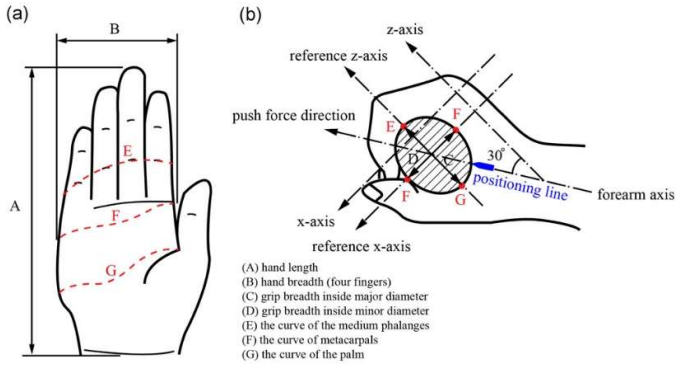


Physical factors may include a decrease in the number of muscle fingers that are contracting or a change in the type of muscle fiber. Pain, a fear of pain, and a fear of reinjury are examples of psychosocial factors. Pain can weaken a grip, which lessens the muscles' ability to contract voluntarily. This results in reductions in force production, electromyographic (EMG), motor unit discharge rate, and grip strength.

For non-experts in the field of biomechanics, such as hand-tool designers and safety supervisors, detailed information on the technologies and methodologies used for hand analysis is needed in order to comprehend and select simple and appropriate methods. Biomechanical analysis simply starts with hand anthropometry. The most popular functional measurement variable is range of motion (ROM). Designing hand products and hand rehabilitation typically involves using anatomical measurements and the ROM. Currently, the most popular method for measuring kinematic variables like the trajectory, angle, velocity, and acceleration is the three-dimensional (3D) motion analysis system. Marker sets and kinematic models are required for the analysis of this system. Based on the goals of various studies, various marker sets and kinematic models have been created.

Hand Anthropometry

The design of products for human hands must take hand anthropometry into consideration. Machine guards, hand tools, and luggage handles are a few examples. Engineering anthropometry divides hand anthropometric parameters into functional measurement variables like the handgrip span, flexion and extension ROMs of the fingers and wrist, and abduction/adduction and deviation ROMs of the wrist in addition to anatomical measurement variables like the length, width, and circumference.



Digital calipers, circumference tapes, and finger circumference gauges can be used to measure the anthropometry of the hand directly. It can also be measured from images and scans. The width, flexion, and extension ROMs are measured using goniometers and 3D motion analysis systems. Direct measurement is quick and effective, but there is a chance of skin movement and experimenter error.

Measurement by photography takes less time than direct measurement, and the recorded data can be used repeatedly, but measuring the circumference is challenging. Although different hand areas can be precisely measured using 3D scans, data can be distorted as a result of movements made during the scan.

Numerous ergonomics researchers have been attempting to comprehend how people use their hands and what variables have an impact on hand function. In particular, biomechanical methodologies have typically been used to assess the physical capacity of the hand. Anthropometry, kinematics, kinetics, and EMG make up the four categories of biomechanical analysis for the human hand.

To prevent MSDs and enhance working conditions and productivity, biomechanical principles must be applied. The hand is primarily assessed in ergonomics, safety, and health to lower the risk of MSDs. The design of hand tools and mobile phones is actively studied in product development. In rehabilitation, the hand is examined to determine how patients and healthy people differ from one another.

Anatomical Measurement Variables

There are two types of anthropometry surveys: general and application surveys. The hand variation of large populations is explained using general surveys. They primarily serve to describe populations. Application surveys, in contrast, are used to gather data for a particular product. An application survey therefore frequently employs few individuals but with precisely defined populations, such as occupational groups.

Table 1

Summary of hand anthropometry dimensions

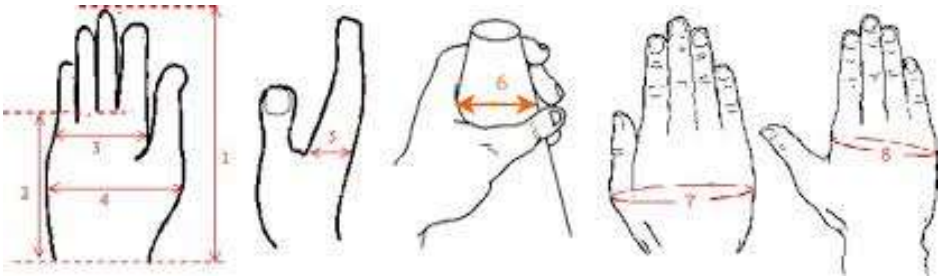
1	D1 length	26	D2 MCP link length	51	D2 PIP joint breadth
2	D2 length	27	D3 MCP 1 link length	52	D3 PIP joint breadth
3	D3 length	28	D4 MCP link length	53	D4 PIP joint breadth
4	D4 length	29	D5 MCP link length	54	D5 DIP joint breadth
5	D5 length	30	D1 PIP link length	55	D2 DIP joint breadth
6	Crotch 1 height	31	D1 DIP link length	56	D3 DIP joint breadth
7	Crotch 2 height	32	D2 DIP link length	57	D4 DIP joint breadth
8	Crotch 3 height	33	D2 MCP link length	58	D5 DIP joint breadth
9	Crotch 4 height	34	D2 PIP link length	59	Hand breadth from digitizer
10	D1 height	35	D3 DIP link length	60	D1 IP joint breadth
11	D2 height	36	D3 MCP link length	61	Hand breadth
12	D3 height	37	D3 PIP link length	62	D2 PIP joint circumference
13	D4 height	38	D4 DIP link length	63	D3 PIP joint circumference
14	D5 height	39	D4 MCP link length	64	D4 PIP joint circumference
15	D1 tip to wrist crease length	40	D4 PIP link length	65	D5 PIP joint circumference
16	D2 tip to wrist crease length	41	D5 DIP link length	66	D2 DIP joint circumference
17	D3 tip to wrist crease length	42	D5 MCP link length	67	D3 DIP joint circumference
18	D4 tip to wrist crease length	43	D5 PIP link length	68	D4 DIP joint circumference
19	D5 tip to wrist crease length	44	Palm length	69	D5 DIP joint circumference
20	D1 link length	45	Hand length	70	D1 IP joint circumference
21	D2 link length	46	Wrist-index grip length	71	Hand circumference
22	D3 link length	47	Wrist-thumbtip length		
23	D4 link length	48	Forearm-hand length		
24	D5 link length	49	Hand length from digitizer		
25	D1 MCP link length	50	Thumbtip reach		

Hand Kinematics

The angle, velocity, trajectory, and acceleration during various hand functions have all been evaluated in numerous studies. The following are typical tools used to gauge different hand functions: X-rays, MRI, manual goniometers, electro goniometry, video technique, and systems for marker-based motion analysis. Common techniques for clinical observation include X-ray and MRI examinations. However, radiation exposure is a possibility with X-ray measurements. It is challenging to use goniometry to measure the thumb trapezia metacarpal joint. Current research is actively investigating the use of motion analysis systems for measuring hand functions in order to make up for these limitations. Motion analysis systems have the advantage of obtaining more accurate data than other techniques because they continuously analyze posture and movement by computing 3D trajectories.

Reflective markers must be applied to hand joints as part of a motion analysis system in order to measure the angle, velocity, trajectory, and acceleration of each joint. After that, each joint is evaluated using a model based on a mathematical algorithm.

For hand analysis, four different types of marker sets can be used. There are three ways to attach skin markers. The "three markers per segment" method attaches triangular-shaped markers to finger segments, while the "two markers per segment" method places markers on the distal and proximal heads of finger segments. Analysis of static situations like power and pinch grips has been done using the "one marker per joint" attachment method.



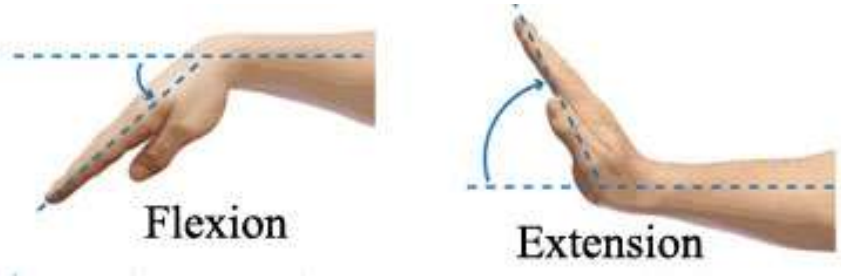
The "two markers per segment" attachment method has been applied to the study of dynamic movements, including the ROM of finger joints and a pinching motion. Analysis of dynamic movements, such as a grasping motion or the range of motion of finger joints, has been done using the "three markers per segment" attachment method.

The analysis of the angle, velocity, trajectory, and acceleration of a motion based on the measured markers is frequently done using the Eulerian angle model as well as Cheng and Pearcy's model. The most popular model for motion analysis that explains how a rigid body is oriented in space is the Eulerian angle model. By using three rotations and Eulerian angles, any direction in space can be

found. This information is used to calculate the flexion/extension, abduction/adduction, and supination/pronation of the finger joints.

ROM of Hand

The hand's range of motion is the functional measurement variable that is most frequently used. The CMC, MCP, and IP joints of the thumb, as well as the MCP, PIP, and DIP joints of the other four fingers, are included in the flexion/extension, abduction/adduction, and pronation/supination measurements of the ROM. There are two types of finger motion measurements: active ROM (AROM) and passive ROM. Like this, Hume et al. divided their measurements of finger motion into functional ROM (FROM) and normal ROM. While AROM and FROM explain dynamic or functional movements like gripping or pinching, PROM and NROM take the maximum and minimum angles in static positions. Hume et al. looked at the FROM for various daily activities, and Chao et al. looked at the FROM for the fingertips during pinching and grasping.



The flexion range of motion (ROM) of each finger joint for the earlier studies discussed in this review of the literature. Each study's angle difference varied depending on the AROM and PROM. In earlier studies, the angle of the MCP joint displayed the greatest variation.

The mechanism of the tendons inside the fingers can be better understood using experimental direct tendon-force measurement models. The three most popular techniques for experimental analysis are cadaveric, in vivo, and EMG. The EMG method is a simple tool that can be used to analyze force and muscle function. Many researchers have created force transducers for in vivo methods that allow them to measure the tendon force directly while performing various hand functions.

ANALYSIS ACCORDING TO NIOSH LIFTING EQUATION

To help businesses create an ergonomics program, the National Institute for Occupational Safety and Health (NIOSH) has created a number of helpful resources and materials. The NIOSH Lifting Equation, a widely used tool created by NIOSH, is used to estimate the risk of suffering a low back injury when carrying out lifting operations.

Importance of NIOSH Lifting Equation

Injuries to the back at work account for more than a million cases each year in the US, costing the economy $50 billion annually or 264 million missed workdays.

Low back pain and back injuries make up 38.5% of work-related musculoskeletal disorders (MSDs). MSDs affect the muscles, nerves, blood vessels, ligaments, and tendons, and if the causes of the issue are not addressed, MSDs progress over time and result in direct and indirect costs for business.

The Lifting Equation was created by NIOSH to aid in predicting the risk of lifting-related injuries. Based on the Recommended Weight Limit (RWL) for lifting duties that most employees may complete in an eight-hour day without increasing the risk of developing low back discomfort, the Lifting Equation defines a Lifting Index (LI).

- Horizontal distance of the load from the worker
- Vertical height of the lift
- Vertical displacement during the lift
- Angle of symmetry between the mid-plane of the body and the direction of lift
- Frequency, duration of lifting
- Coupling between the worker's hand and the object.

RWL = LC x HM x VM x DM x FM x AM x CM

The Lifting Index (LI), which provides a relative measure of the physical stress associated with a manual lifting duty, may be determined once the RWL has been determined. A LI greater than 1.5 suggests increased stress and, hence, increased risk of damage. The proportion of workers who can safely do the task declines as the LI rises.

As a Door Latch Handle Extender, it is a safety leverage bar thus assisting the driver operator in opening and closing the shipping container door without straining their backs. Great for opening and closing shipping and cargo container trailers that are rusted or frozen shipping container doors.

Our tool is designed to keep the LI less than 1.5 hence it decreases stress and in turn decreases the risk of damage. The total length of the bar is extended and due to which less force is required to move the handle as the force of turning is less causing less stress to the arms and back. Hence the worker's proportion which can safely do the work increases.

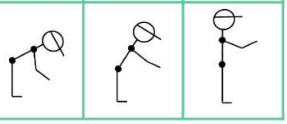
POSTURE-BASED-ANALYSIS

We will now discuss posture-based methods for analyzing work tasks from a physical ergonomics perspective after establishing an anatomical foundation for doing so in earlier chapters. Methods for evaluating posture-based ergonomics use point-based systems to rank identified problem areas. Usually, the further the body moves away from neutral

The worse the working posture is in a standing position, the higher the score. The methods described here are quick, easy to use, and solely based on observations. Consequently, they are somewhat open to interpretation. Through examination of various body parts and joint angles, the body's loads are ranked according to a predetermined risk scale severity.

In general, posture-based observation techniques serve as screening tools that estimate the risk.

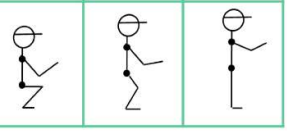
MS1

Flexion angle of the waist		
Level 1	Level 2	Level 3
more than 30°	15°-30°	0°-15°
		

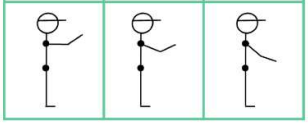
MS4

Rotation angle of the waist		
Level 1	Level 2	Level 3
more than 45°	15°- 45°	0°-15°

MS2

Flexion and stretching angle of the knee		
Level 1	Level 2	Level 3
more than 60°	30°-60°	0°-30°
		

MS7

Height of the working arm		
Level 1	Level 2	Level 3
Higher than shoulder	At the height of the shoulder	At the height of the waist
		

The goal is typically to eliminate the causes of high rating points as a first step, allowing system designers to prioritize which risk factors to address first. More in-depth analyses—possibly using a different risk assessment tool—may be advised if the screenings produce results that show some uncertainty regarding the risk level. These methods are quick and easy ways to assess posture, but they have some limitations because they don't always take time exposure or accumulating loads into account, and they are subjective because they involve observation. In general, the same method should be used both before and after a design change to track its effects and determine whether enough posture improvements resulted.

RULA & REBA ANALYSIS

Upper and Neck back pain is often attributed to poor posture. RULA is a postural targeting method for estimating the risks of work-related upper limb disorders. The result of the test is a Rapid Upper Limb Assessment score. It gives you a fair idea of where you stand with your posture.

REBA always provides easy and quick measures in assessing many of the working postures that are at risk of WMSDs. It divides the body into sections to be independently coded, according to movement planes and offers a scoring system for muscle activity throughout the entire body, dynamically stagnantly, fast-changing, or in an unsteady way and where manual handling may happen which is referred to as a coupling score as it is significant in the loads handling but may not always be using the hands. REBA gives an action with signs of importance and requires minor equipment. This is the best method that matches the needs of occupational safety.

Rapid Upper Limb Assessment (RULA)

The RULA Assessment Tool was created to assess the introduction of individual specialists to ergonomic danger factors related to the furthest point MSD. The RULA ergonomic evaluation apparatus considers biomechanical and postural burden necessities of occupation errands/requests on the neck, trunk, and furthest points.

The RULA Assessment Tool was developed to determine how much exposure each worker has to ergonomic risk factors for upper extremities MSDs.The needs for biomechanical and postural loading of job tasks/demands on the neck, trunk, and upper limbs are considered by the ergonomic assessment tool RULA.

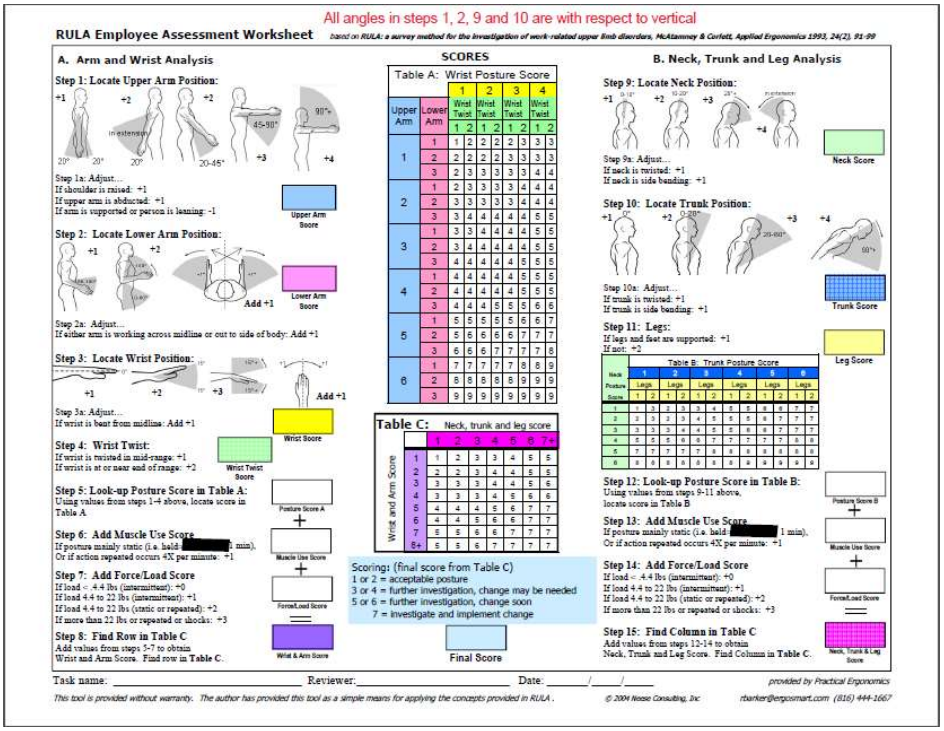
Two methods that can be used to quickly screen and identify harmful postures are RULA and REBA. While REBA (Hignett & McAnarney, 2000) covers whole-body intensive work because it was developed in a hospital/healthcare setting, RULA (McAnarney & Corlett, 1993) is better suited to hand-arm intensive work as it was developed to study sitting assembly work in the textile confectionery industry context. Both approaches center on a single posture that appears during work tasks.

The RULA was designed to be easily used without the requirement for a high level of ergonomic training or an expensive device. The evaluator will utilize the RULA worksheet to rate the following body parts: the upper arm, lower arm, wrist, neck, trunk, and legs. Following the accumulation and scoring of data for each region, tables on the form are used to gather the danger component variables, producing a single rating that indicates the degree of MSD hazard as follows:

Score	Level of MSD Risk
1-2	Negligible risk, no action required
3-4	Low risk, change may be needed
5-6	Medium risk, further investigation, change soon
6+	Very high risk, implement change soon

The RULA was planned for simple use, with no requirement for a serious degree in ergonomics or costly hardware. Utilizing the RULA worksheet, the evaluator will allocate a score for every one of the accompanying body locales: upper arm, lower arm, wrist, neck, trunk, and legs. After the information for every locale is gathered and scored, tables on the structure are then used to arrange

the danger factor factors, creating a solitary score that speaks to the degree of MSD hazard. (www.ergo-plus.com)



RULA ANALYSIS OF THE PRODUCT

To analyze the product that it is ergonomically fit to use. Different postures of the operator are analyzed while opening the shipping container. Some of the postural analysis is detailed below.

1)

Arm & Wrist Analysis

SR#	Step	Reason	Score
1	Upper arm position	90 degree	+4
2	Lower arm position	>60 degrees	+2
3	Wrist position	<15 degrees	+1
4	Wrist twist	twisted near the end range	+1
5	Muscle use	Repeated 4x per minute	+1
6	Force/load	Repeated force applied	+1

Wrist / Arm Score = Posture A Score + Muscle use score + Force score | Wrist / Arm Score = 4+1+1= 6

Neck, Trunk, and Leg Analysis

Sr#	Step	Reason	Score
1	Neck position	0-10 degrees	+1
2	Truck position	0 degrees	+1
3	Legs	supported	+1
4	Muscle use	repeated	+1
5	Force/load	4-22 lbs	+2

Neck, Trunk, and Leg= Posture B score + Muscle use score + Force score | Neck, Trunk, and Leg=1+1+2=4

Final score = 6

2)

Arm & Wrist Analysis

SR#	Step	Reason	Score
1	Upper arm position	90 degree	+4
2	Lower arm position	>60 degrees	+3
3	Wrist position	<15 degrees	+1
4	Wrist twist	twisted near the end range	+1
5	Muscle use	Repeated 4x per minute	+1
6	Force/load	Repeated force applied	+1

Wrist / Arm Score = Posture A Score + Muscle use score + Force score | Wrist / Arm Score = 4+1+1= 6

Neck, Trunk, and Leg Analysis

Sr#	Step	Reason	Score
1	Neck position	0-10 degrees	+1
2	Truck position	0 degrees	+1
3	Legs	Not supported	+2
4	Muscle use	repeated	+1
5	Force/load	4-22 lbs	+2

Neck, Trunk, and Leg= Posture B score + Muscle use score + Force score | Neck, Trunk, and Leg=3+1+2=6

Final score = 7

3)

Arm & Wrist Analysis

SR#	Step	Reason	Score
1	Upper arm position	90 degree	+4
2	Lower arm position	>60 degrees	+2
3	Wrist position	<15 degrees	+1
4	Wrist twist	twisted near the end range	+2
5	Muscle use	Repeated 4x per minute	+1
6	Force/load	Repeated force applied	+1

Wrist / Arm Score = Posture A Score + Muscle use score + Force score | Wrist / Arm Score = 4+1+1= 6

Neck, Trunk, and Leg Analysis

Sr#	Step	Reason	Score
1	Neck position	10-20 degrees	+2
2	Truck position	0 degrees	+1
3	Legs	Not supported	+2
4	Muscle use	repeated	+1
5	Force/load	4-22 lbs	+2

Neck, Trunk, and Leg= Posture B score + Muscle use score + Force score | Neck, Trunk, and Leg=3+1+2=6

Final score = 7

RULA CONCLUSION

In this example, the final RULA average score for three different postures while opening and closing the shipping containers of approx. 6 indicates risk and calls for Work Aids, engineering, and/or work method changes to reduce or eliminate MSD risk.

The very final RULA score of 7 indicates high risk and necessitates engineering and/or work procedure changes to minimize or eliminate the risk of MSD as shown in the chart. Worker upper arm role, wrist twist, and lower arm role, which is not in a natural posture, is the primary reason why the RULA score is so high.

IMPROVEMENTS

The ergonomic modification that can be done to lower the RULA rating from high risk is to change the employee's upper arm position from bending more than 30 degrees to much less than 10 degrees, and wrist twist to move less than 15 degrees as this will help him to minimize arm and wrist pain when working in a normal posture.

Score	Level of MSD Risk
1-2	negligible risk, no action required
3-4	low risk, change may be needed
5-6	medium risk, further investigation, change soon
6+	very high risk, implement change now

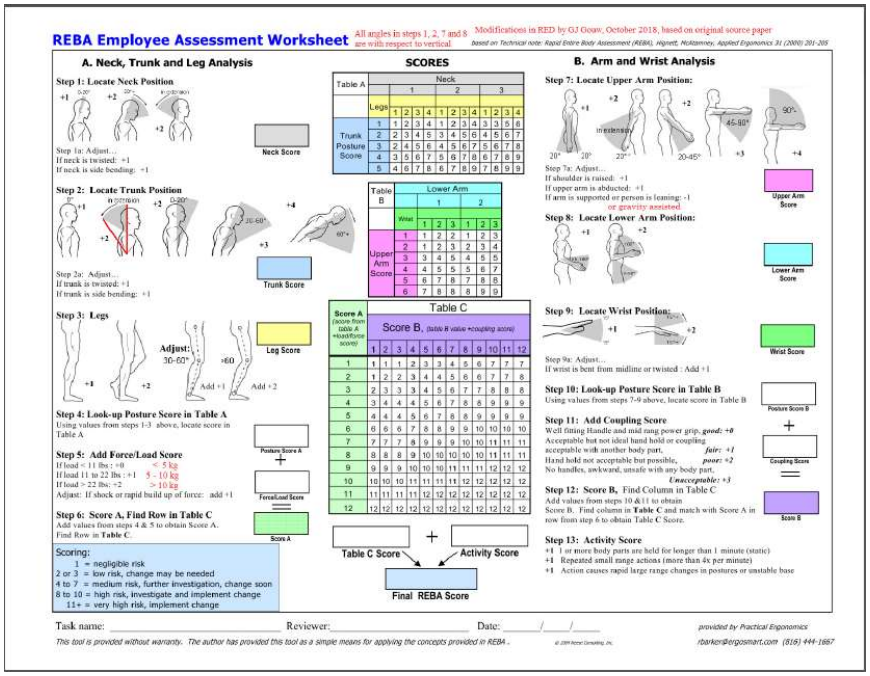
Rapid Entire Body Assessment (REBA)

This ergonomic appraisal instrument utilizes a precise cycle to assess the entire body's postural MSD and dangers related to work undertakings. A solitary page worksheet is used to assess the required or chosen body pose, intense efforts, kind of development or activity, redundancy, and coupling.

This ergonomic evaluation tool employs a systematic process to examine risks associated with activity responsibilities and total frame postural MSD. REBA (Hignett & McAtamney, 2000) is a similar method for evaluating body postures during work tasks, but unlike RULA it focuses on whole-body intensive work. Similarly, to RULA, one specific posture that occurs during the work task is analyzed to provide an overall score. A REBA analysis considers the same six body regions as RULA, but it goes one step further by also taking couplings and grips into consideration. Points are added for conditions that worsen the nature of the posture, and points can also be subtracted if something contributes to lessening the loading impact of the posture (such as gravity-assisted postures). The final score between 1–15 is calculated using the REBA assessment form is typically determined by making observations and talking to the worker. The postures that are typically chosen for analysis are those that are frequent, last a long time, involve strong forces or muscular activity, are uncomfortable, or are thought to be extreme. During an evaluation, the entire task is observed, and important postures are noted.

Then, using the RULA assessment form, these data points can be visually recorded (e.g., recorded, photographed, or observed), allowing a RULA score to be computed. Additional "penalty" points are added for circumstances that are thought to make the posture worse. The final score is used as a gauge for how quickly the observed posture needs to be addressed.

Utilizing the REBA worksheet, the evaluator will allot a score for every one of the accompanying body locales: wrists, lower arms, elbows, shoulders, neck, trunk, back, legs, and knees. After the information for every district is gathered and scored, tables on the structure are then used to accumulate the danger factor factors, creating a solitary score that speaks to the degree of MSD hazard. (www.ergo-plus.com)



REBA ANALYSIS OF THE PRODUCT

To analyze the product that it is ergonomically fit to use. Different postures of the operator were analyzed while opening the shipping container. Some of the postural analysis is detailed below.

1)

Neck, Trunk, and Leg Analysis

SR#	Step	Reason	Score
1	Neck position	0-20 degrees	+1
2	Trunk position	0 degrees	+1
3	Leg position	Both legs down	+1
4	Force/load	11-22lb	+1

Leg Score, Trunk, and Neck = Table A Score + Force score | Leg Score, Trunk, and Neck = 1+1=2

Arm and Wrist Analysis

Sr#	Step	Reason	Score
1	Upper arm position	90 degrees	+4
2	Lower arm position	60-100 degrees	+2
3	Wrist position	<15 degree	+1
4	Wrist twist	twisted near the end range	+1

Arm and wrist Score = Table B score +Coupling score | Arm and wrist Score =6+0=6

Final Score

Final score = Table C score + Activity Score

Activity Score = +1 (Repeated small range actions 4x times)

Final score = 4+1=5

2)

Neck, Trunk, and Leg Analysis

SR#	Step	Reason	Score
1	Neck position	0-20 degrees	+1
2	Trunk position	0 degrees	+1
3	Leg position	Both legs are not down	+2
4	Force/load	11-22lb	+1

Leg Score, Trunk, and Neck = Table A Score + Force score | Leg Score, Trunk, and Neck = 2+1=3

Arm and Wrist Analysis

Sr#	Step	Reason	Score
1	Upper arm position	90 degrees	+3
2	Lower arm position	60-100 degrees	+2
3	Wrist position	<15 degree	+1
4	Wrist twist	twisted near the end range	+1

Arm and wrist Score = Table B score + Coupling score | Arm and wrist Score =5+0=5

Final Score

Final score = Table C score + Activity Score

Activity Score = +1 (Repeated small range actions 4x times)

Final score = 4+1=5

3)

Neck, Trunk and Leg Analysis

SR#	Step	Reason	Score
1	Neck position	0-20 degrees	+1
2	Trunk position	0 degrees	+1
3	Leg position	Both legs are not down	+2
4	Force/load	11-22lb	+1

Leg Score, Trunk and Neck = Table A Score + Force score | Leg Score, Trunk and Neck = 2+1=3

Arm and Wrist Analysis

Sr#	Step	Reason	Score
1	Upper arm position	90 degrees	+4
2	Lower arm position	60-100 degrees	+2
3	Wrist position	<15 degree	+1
4	Wrist twist	twisted near the end range	+1

Arm and wrist Score = Table B score + Coupling score | Arm and wrist Score =6+0=6

Final Score

Final score = Table C score + Activity Score

Activity Score = +1 (Repeated small range actions 4x times)

Final score = 5+1=6

REBA CONCLUSION

In this case, the final REBA average score of three different postures is 5 indicates Medium risk and calls for further investigation and engineering and/or work method changes to reduce or eliminate MSD risk.

From the above analysis, we conclude that the final scores of REBA & RULA analysis indicate there is medium risk involved in the product usage but it can be omitted by using the work aids and providing accurate guidance to the operators about the postures and the work-related muscular disorders involved in it.

IMPROVEMENTS

The ergonomic change that can be made to lower the REBA score from excessive risk is to change the employee's neck and upper arm posture from bending more than 30 degrees to much less than 20 degrees in order to help him reduce neck and upper arm pain while working in everyday posture. Additionally, the trunk role needs to be changed from zero to twenty degrees.

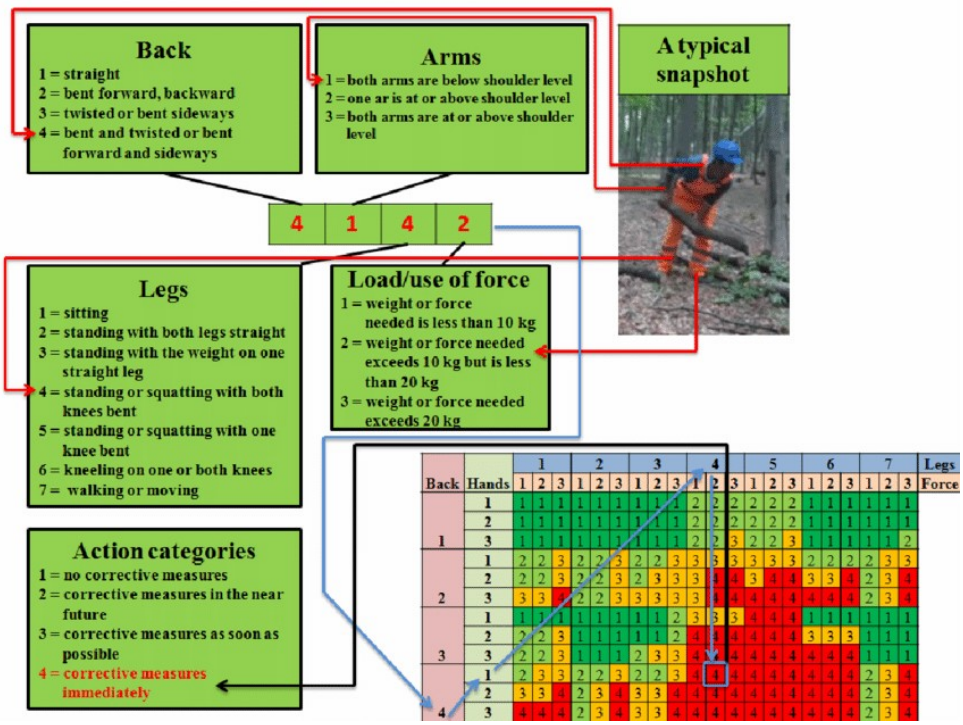
Score	Level of MSD Risk
1	negligible risk, no action required
2-3	low risk, change may be needed
4-7	medium risk, further investigation, change soon
8-10	high risk, investigate and implement change
11+	very high risk, implement change

OWAS (OVAKO WORKING POSTURE ANALYZING SYSTEM)

In that it provides a number indicating how harmful a posture is, WAS, short for Ovako Working Posture Analysing System, is somewhat comparable to REBA and RULA (Louhevaara and Suurnäkki, 1992). The technique was initially developed with heavy lifting in mind because it had its beginnings in the steel industry.

The analysis yields a four-digit score that describes posture, with the first value reflecting the back, the second reflecting the arms, the third reflecting the legs, and the fourth reflecting weight or external load.

The final product identifies the locations where most of the riskiest work postures occur. The entire procedure Louhevaara and Suurnäkki describe the steps required to conduct an OWAS analysis (1992).



HARM (HAND ARM RISK-ASSESSMENT METHOD)

HARM (Douwes and de Kraker, 2014) is a method created by researchers at the Dutch institute TNO (the Netherlands Organization for Applied Scientific Research), which is specifically designed to analyze risks for MSDs in the hand and arm. It considers forces, time factors (including repetitiveness), and the posture of the arms, wrists, neck, and head.

The method is available as HARM1.0 (Douwes and de Kraker, 2014) and the updated HARM 2.0 (TNO, 2012), which simplifies the force categories, reduces the relative weight of task duration, and adds some clarifications and changes to the manual and instructions.

Indicate which hand is the most active		Duration of the force exertion in seconds per minute			Number of force exertions per minute (frequency)		
		< 4	4-30	30-60	< 4	4-30	≥ 30
Amount of force	**Description and examples**						
(extremely) Low: Weight: <100 g Force: <1 N	Light pressure with fingers (e.g. holding a pencil with 2 or 3 fingers, sorting letters/objects, pressing with the fingers, pushing light objects over a smooth surface)	0	1,5	3	1	2,5	4
Average: W: 100-1000 g F: 1-10 N	* using fingers/hand to hold small motorised tools * grasping/gripping, holding or attaching parts, pressing firmly	0	2,5	4	1	2,5	4
Somewhat high: W: 1-3 kg F: 10-30 N	Holding firmly with hand (use of a knife/pliers, using tools, pushing heavy objects (e.g. cashier operator)	0	3,5	6	2	3,5	6
High: W: 3-6 kg F: 30-60 N	High force exertion by the arm (holding heavy tools; operating a stiff lever)	0	4,5	7	2	4,5	7
Peak force	Striking with flat hand/fist	-	-	-	3	5	8
Step 3D **Force score = highest score circled = ...**							
In the event of **extremely high forces**: *Please note!* If the force exertion is more than 6 kg, these must be assessed using a different method (e.g. lifting, or pushing/pulling risk assessment method).							

For occupational health officers to perform risk assessments of developing arm, neck, or shoulder pain during hand-arm tasks, the Hand Arm Risk Assessment Method (HARM 1.0) was developed. The tool can also aid in identifying the risk reduction strategies and calculating their impact on the risk level.

This essay describes the current situation and how HARM is used in practice. The risk assessment of a particular hand-arm task serves as an explanation and illustration of how to use HARM. Additionally, a stone factory in The Netherlands describes its experiences applying HARM.

Arm & Wrist Analysis

SR#	Step	Reason	Score
1	Upper arm position	90 degree	+4
2	Lower arm position	>60 degrees	+2
3	Wrist position	<15 degrees	+1
4	Wrist twist	twisted near the end range	+2
5	Muscle use	Repeated 4x per minute	+1
6	Force/load	Repeated force applied	+1

Wrist / Arm Score = Posture A Score + Muscle use score + Force score | Wrist / Arm Score = 4+1+1= 6

Neck, Trunk and Leg Analysis

Sr#	Step	Reason	Score
1	Neck position	10-20 degrees	+2
2	Truck position	0 degrees	+1
3	Legs	Not supported	+2
4	Muscle use	repeated	+1
5	Force/load	4-22 lbs	+2

Neck, Trunk and Leg= Posture B score + Muscle use score + Force score | Neck, Trunk and Leg=3+1+2=6

Final score = 7

HEURISTIC EVALUATION

A heuristic evaluation is a quick inspection or "checklist" technique that makes it possible to find general ergonomics problems. Heuristics are "rules of thumb" or "shortcuts" for making decisions that are based on conventional wisdom. With this approach, a work environment or job duties are assessed in accordance with a set of accepted principles, based on knowledge of theoretical human capabilities and physical limitations and prior knowledge of how a design should be made to function well. Alterations or Concerning factors are identified and ranked. A structured heuristic evaluation uses a set of heuristics that have been predetermined before the study, but there are also some advantages to using an unstructured approach and creating a list of heuristics as you go along. To conduct a meaningful and worthwhile study when using an unstructured approach, the analyst must possess a significant amount of theoretical knowledge. Heuristic evaluations must therefore involve an expert in order to be considered reliable. When analyzing a workstation, common heuristics to consider include:

- No bending of the neck backwards.
- Pinching grasps should be avoided.
- For heavier work, a working height of 100–250 mm below elbow height is recommended
- For light work, a working height of 50–100 mm below elbow height is recommended or push buttons, a height between elbow and shoulder is recommended
- Lifting should be carried out close to the body
- Adaptation to anthropometric variation (different body sizes) should be possible.

CONCLUSION

According to the results of the above analysis, there is some risk associated with using the product, but it can be avoided by using work aids and giving operators accurate instructions about postures and the associated work-related muscular disorders. Bending and twisting of the wrist spine should be avoided.

TESTIMONIALS

"As a practicing Chiropractor, I feel that this is an invaluable tool to prevent work injuries, especially of the shoulder, wrist and back. It's ergonomic design was well thought out. I am impressed."

Dr. Todd Masler, DC, Chiropractor

"As an occupational therapist, I think an ergonomic tool like this is so important to prevent work injuries, promote employee retention, improve performance without compromising safety, and enhance job satisfaction. Prioritizing employee safety should be vital in the work place and a product like this was truly designed with that in mind."

Pam Suphaphinant, OT, Occupational Therapist