



2023 Wisconsin Safety Council Annual Conference

APRIL 18, 2023

81ST ANNUAL SAFETY CONFERENCE

Ergonomics - MMH & Cumulative Trauma Disorders



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State of Wisconsin / DWD WC Division

<https://dwd.wisconsin.gov/wc/safety/bio/dave-leix.htm>

The lighter side of Ergonomics – don't be a 'Ted'



Dilbert



Sit / Stand Desks

Sit/Stand Desktop Riser - Small



Help relieve an aching back or boost employee productivity. Position desk risers to fit any height.

- Transitions easily from sitting to standing with side lever and gas lift assistance.
- Sits on desktop. Height adjusts 6-20".
- Desk riser lifts straight up and down.
- 5/8" thick scratch-resistant laminate.
- Easily install Monitor Mounts onto risers.

ULINE 1-800-295-5510

MODEL NO.	DESCRIPTION	RECOMMENDED USE	DIMENSIONS W x D	CAP. (lbs.)	WT. (lbs.)	PRICE EACH
H-6306	Small	Portable Laptops	27" x 31"	35	43	\$330 / \$320

The Napping Desk



Seinfeld - George Costanza



https://www.youtube.com/watch?v=W_qCFWtKAdt-8s



<https://www.pedestrian.tv/news/some-genius-made-george-costanzas-sleeper-desk-a-reality/>

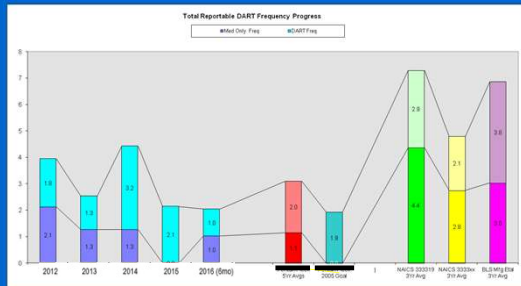
Enter **The Sleeper Desk**, a multi-function, desk-meets-bed that would have been the answer to **George Costanza's** dreams.

Session Objectives

- ◆ Identify potential risk factors associated with MMH & CTD's
- ◆ Identify ergonomic principles which can be applied to reduce the risk of MMH & CTD's
- ◆ Provide reference materials to assist in implementing solutions
- ◆ Discuss Benchmarks & Loss Sources

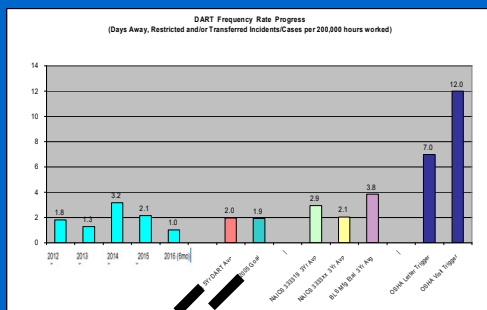
Benchmarking – How are we doing?

“ABC Co.” OSHA Incidence Rates – 2012-2016 (6mos)



Benchmarking – How are we doing?

“ABC Co.” OSHA DART Rates – 2012-2016 (6mos)



Workers' Compensation – Loss Sources

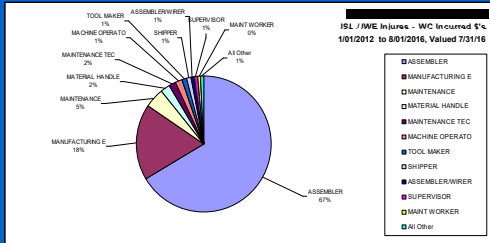
“ABC Co.” – 2012-2016 (7mos)

Policy Effective Year	Count of Claim Number	Incurred Total Incl. Tot Expenses	Paid Total Incl. Total Expense
2012	18	\$ 44,369.85	\$ 30,557.39
2013	9	\$ 102,274.14	\$ 102,274.14
2014	14	\$ 20,383.96	\$ 20,383.96
2015	7	\$ 8,171.09	\$ 8,171.09
2016 (7mos)	5	\$ 2,308.33	\$ 2,308.33
	53	\$ 177,507.37	\$ 163,694.91

Workers' Compensation – Loss Sources

"ABC Co." – 2012-2016 (7mos)

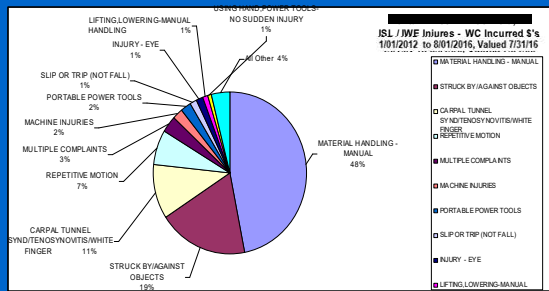
Occupation – Incurred \$ Losses



Workers' Compensation – Loss Sources

"ABC Co." – 2012-2016 (7mos)

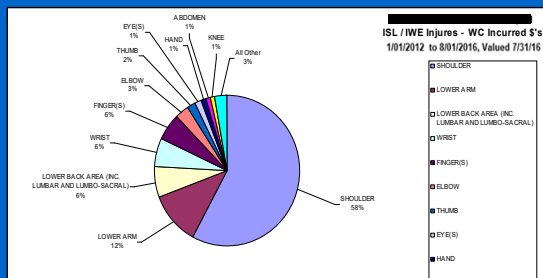
Cause / Type – Incurred \$ Losses



Workers' Compensation – Loss Sources

"ABC Co." – 2012-2016 (7mos)

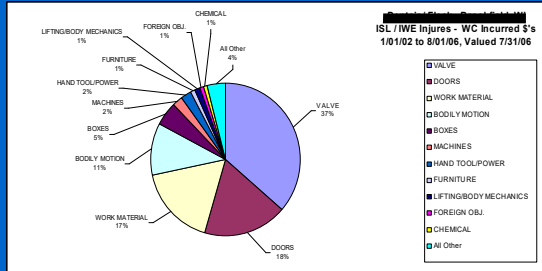
Body Part – Incurred \$ Losses



Workers' Compensation – Loss Sources

“ABC Co.” – 2012-2016 (7mos)

Body Part – Incurred \$ Losses



Ergonomics – What’s in a name?

- Ergon – work (Greek)
- Nomus – natural law

– Other names:

Human Factors
Human Engineering
Biomechanics
Work Physiology
Engineering Psychology
Engineering Anthropometry.

Goal of Ergonomics

- Obtain a good match between the Worker and the job
- Design jobs to fit the workers’ capabilities
- Ergonomics benefits:
 - Increased Productivity
 - Decreased Injuries and Muscular Skeletal Disease

What are Cumulative Trauma Disorders?

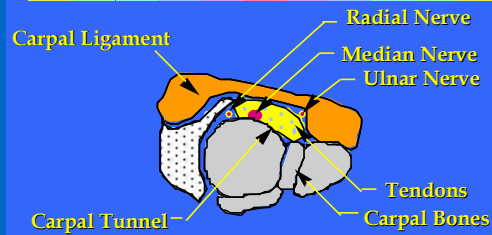
What are Cumulative Trauma Disorders?

- ◆ Injuries to the tendons, tendon sheaths and related muscles and nerves
- ◆ Caused by repetition over time

Most Common CTDs

- ◆ Carpal Tunnel Syndrome
- ◆ Tendonitis
- ◆ Tenosynovitis
- ◆ Epicondylitis (Tennis Elbow)
- ◆ DeQuervain's Disease
- ◆ Trigger Finger
- ◆ Vibration syndrome

Carpal Tunnel Syndrome



Median Nerve Position



Symptoms of CTDs

- ◆ Restricted joint movement
- ◆ Soft tissue swelling, pain, tenderness
- ◆ Tingling or numbness in fingertips
- ◆ Loss of sensation, and “nocturnal numbness”
- ◆ Feeling of “pins and needles”
- ◆ Dull aching pain that worsens when activity has stopped.

CTD Risk Factors

- ◆ Repetition
- ◆ Force
- ◆ Awkward Postures
- ◆ Contact Stress
- ◆ Vibration
- ◆ Cold Temperature

Personal Activities

- ◆ Knitting, needlepoint, sewing
- ◆ Tennis, racquetball, squash
- ◆ Golf, bowling, baseball
- ◆ Gardening
- ◆ Home maintenance
- ◆ Musical instruments
- ◆ Home computer use
- ◆ Adequate Sleep & Rest



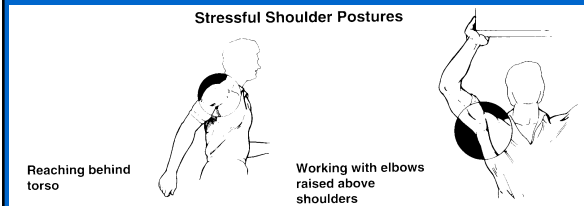
Comparative Odds Ratio Chart

(from Silverstein)

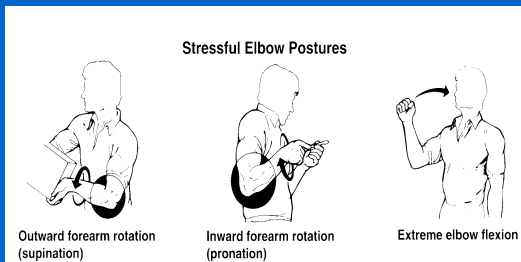
The odds of sustaining a CTD increase 30 times for tasks involving high force and repetition.

		Repetition Frequency	
		Low	High
Exerted Force	Low	1.0	3.6
	High	4.9	30.3

Stressful Shoulder Postures



Stressful Elbow Postures



Stressful Wrist Postures

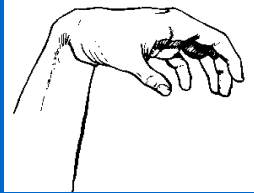


Radial Deviation

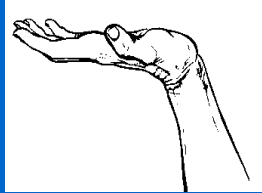


Ulnar Deviation

Stressful Wrist Postures

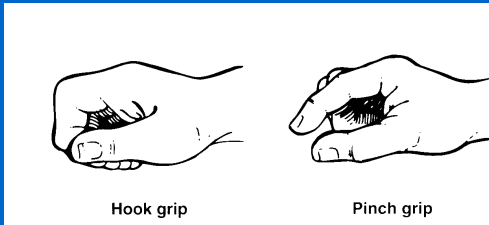


Flexion



Extension

Stressful Hand Postures

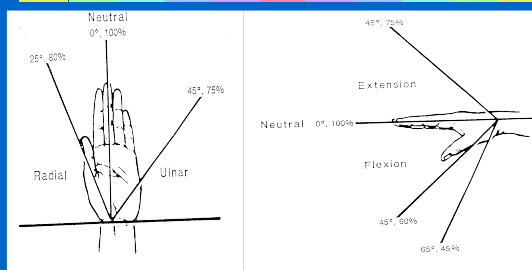


Hook grip

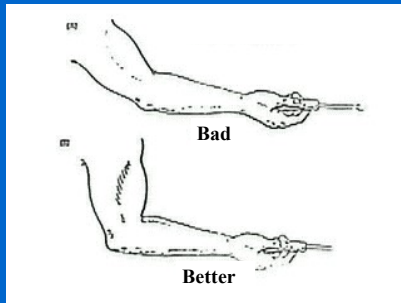
Pinch grip

Avoid repetitive pinching in excess of 2 lbs.

Effect of wrist posture on grip strength



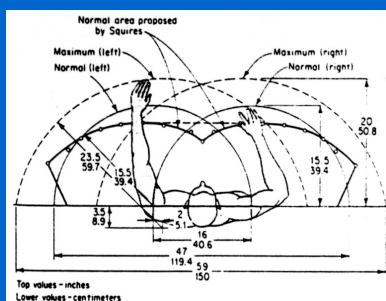
Avoid tasks with forearm rotation
and extended reaching



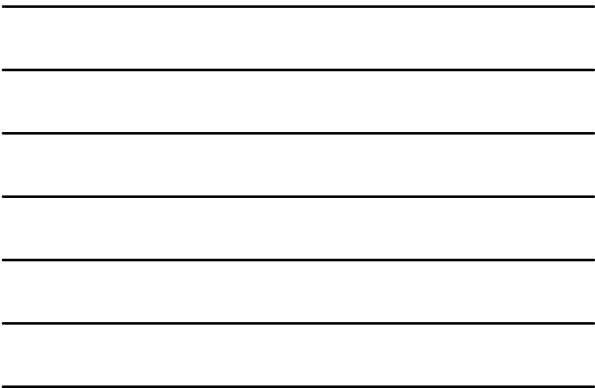
Anthropometrics

- What is it?
- The study of human body measurements, especially on a comparative basis
- Has it's roots dating to WWI –
Petite vs XXL

Minimize reaching
Keep repetitive reaching with 16 inches





[illegible]

Humanscale - Henry Dreyfuss Associates

HDA designers Niels Diffrient and Alvin R. Tilley created Humanscale.

Humanscale consists of pictorial selectors equipped with rotary dials. This portfolio contains selectors (two sides each) which present over 60,000 bits of information, basically encompassing anthropometry, guidelines for seating design, and requirements for the handicapped and elderly. Men, women, and children—large and small—are represented. Measurements are given in metric as well as English units.

Engineers, architects, industrial designers, planners, interior and furniture designers, and craftsmen will find that the selectors minimize their searching through numerous and conflicting sources and unreliable information.

Humanscale 1/2/3

1. Sizes of People
2. Seating Considerations,
3. Requirements for the Handicapped and Elderly

Humanscale 4/5/6

4. Human Strength and Safety
5. Controls and Displays
6. Designing for People

Humanscale 7/8/9

7. Standing and sitting at work
8. Space planning for the individual and the public
9. Access for maintenance, stairs, light, and color



to purchase
<https://humanscalemanual.com/store/complete-collection>

Control Strategies

- ◆ Engineering - the workplace, the tools and the product when possible
- ◆ Work Methods - How we get the task completed.
- ◆ Administrative - scheduling of work, rotation, training

Administrative Controls

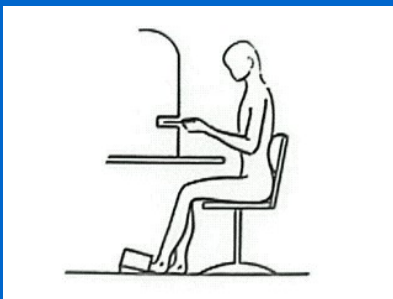
- ◆ Early Symptom Reporting
- ◆ Gradual break-in
- ◆ Rotation
- ◆ Job enlargement
- ◆ Breaks/interruptions
- ◆ Avoid incentive pay
- ◆ Avoid machine pacing
- ◆ Training in preferred work method- minimize forces and postures

Repetition - Engineering Controls

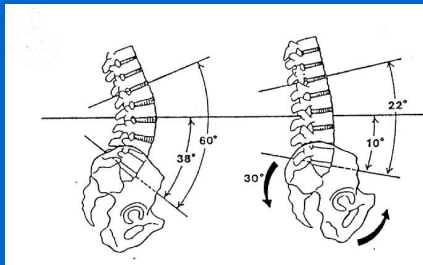
- ◆ Automation
- ◆ Combining operations
- ◆ Product design changes to reduce repetitions
- ◆ Alternative process

Sitting Workstations

Sitting - neutral posture



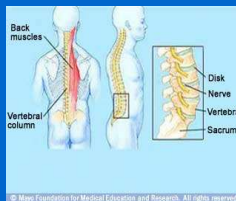
Sitting posture rotates pelvis backwards and flattens spine



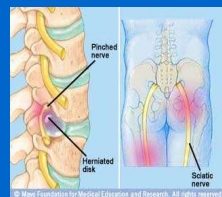
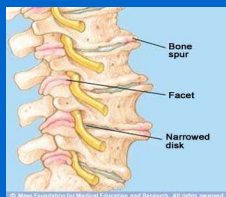
Standing

Sitting

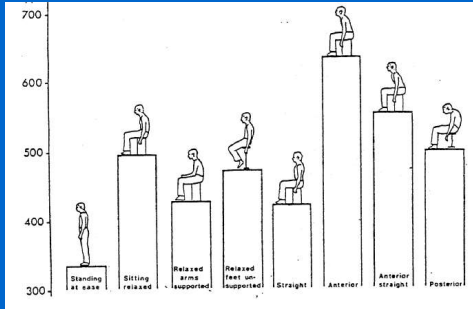
The Human Back Muscles vs. Spine



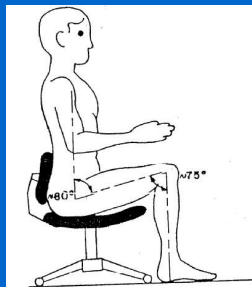
The Human Spine



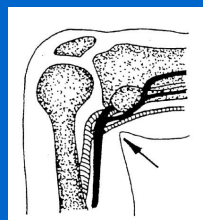
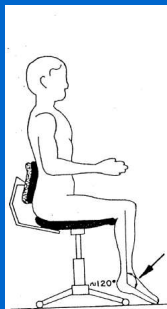
Effect of back posture on stress on lower back (in #'s PSI on L4-L5)



When chair is too low, the knee flexion angle becomes small and the weight is transferred to lower back



When chair is too high, it increases stress behind the knee, decreases blood circulation and increases pressure on the nerve.



Forceful Exertion - Engineering Controls

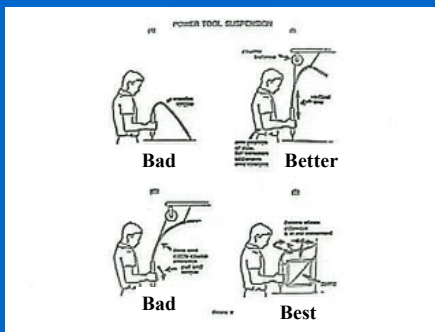
- ◆ Use power tools instead of hand tools
- ◆ Use pneumatic tools with air disengagement clutch (torque reducer)



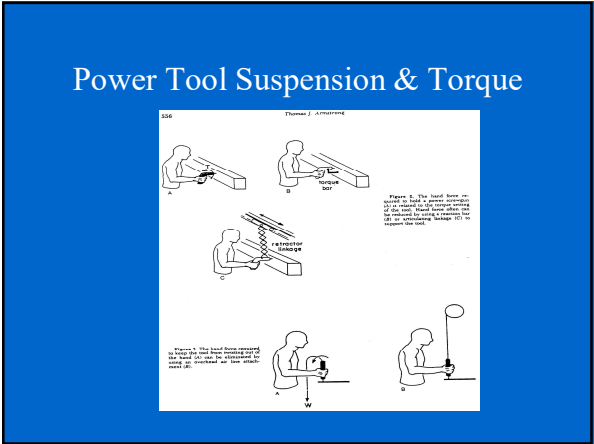
Forceful Exertion – Good Torque Arm and Handle Controls



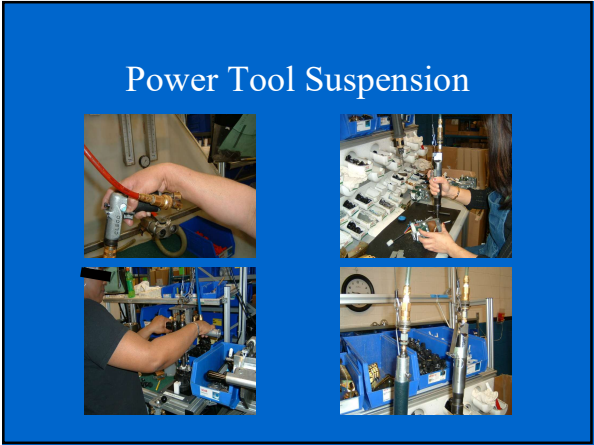
Power Tool Suspension



Power Tool Suspension & Torque



Power Tool Suspension



Power Tool Suspension & Anti Torque Control



Forceful Exertion - Engineering Controls

- ◆ Provide good grips on tools
(Increase coefficient of friction)
- ◆ Reduce friction when sliding an objective

Forceful Exertion - Engineering Controls

- ◆ Use power grip instead of pinch grip
In takes 4-5 times more force to pick up something using a pinch grip than a power grip.



- ◆ Tool handle diameter for a power grip
1.0 - 1.75"

Grip Spans – Torque – Tactile vs. Slippery (oily) Parts

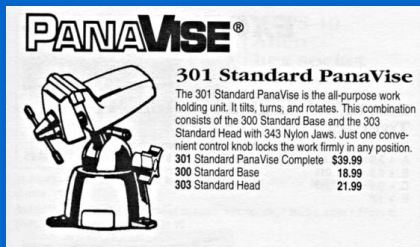


Grip Spans – Torque – Tactile vs. Slippery (wet) Parts

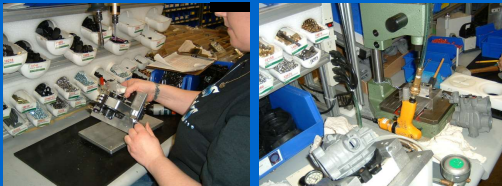


Forceful Exertion - Engineering Controls

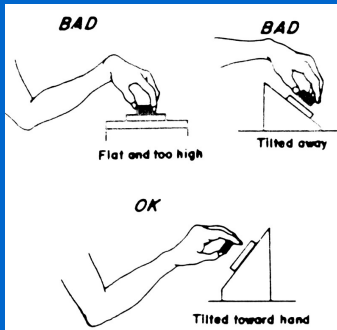
◆ Use clamps & jigs for holding



Forceful Exertion - Engineering Controls – Good Fixture(s) Use



Work Surface Orientation



Forceful Exertion - Engineering Controls – Good Fixture Use



Forceful Exertion - Engineering Controls – Manual Fixture Bolt Up

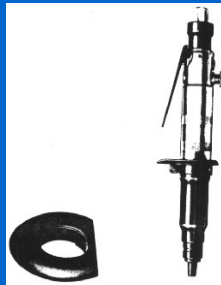


Forceful Exertion - Engineering Controls – Good New Clamping Fixtures



Forceful Exertion - Engineering Controls

- ◆ Use ring flanges to reduce downward pressure



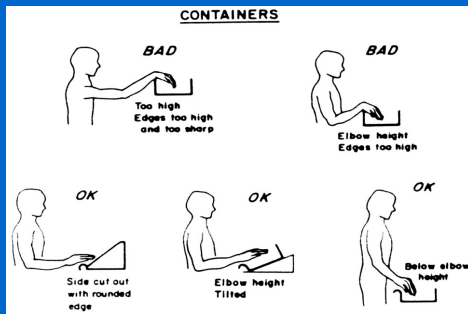
Forceful Exertion – Holding Tools



Forceful Exertion – Holding & Pushing Down on self tapping screws



Parts Container Placement: (Maintain neutral posture)



Parts Container Placement: (Maintain neutral wrist/back postures)



Adjustable - Height Packing Stands



Parts Dispenser & Container Placements:

(Maintain neutral wrist/back postures)



Parts Container Access & Placement:

(Maintain neutral back posture)



Adjustable - Height Workstations

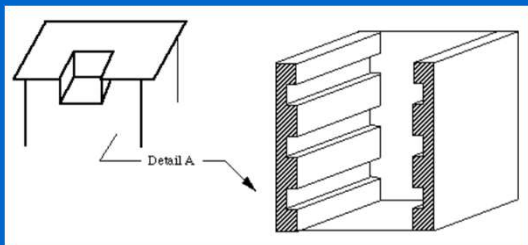


Adjustable - Height Workstations

Both adjustable for individual worker preferences



Multi - Level Worksurface



Adjustable - Height Workstations

Both adjustable for individual worker preferences



Adjustable - Height Workstations

Adjustable for individual worker preferences



Multi - Level Worksurface



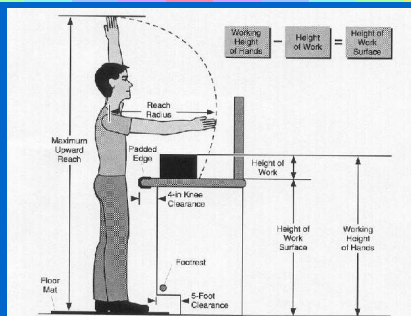
Standing Workstations

Standing Workstations - Engineering Controls

Standing workstations are preferred when the job regularly requires workers to:

- ◆ Lift objects weighing more than 10 lbs.
- ◆ Push downward
- ◆ Push or pull laterally
- ◆ Move between operations frequently
- ◆ When adequate knee space is not available

Working Height of hands - $H_t \text{ of Work} = \text{Work Surface Height}$



Work Surface Heights for Multi-User Workstations

	Precision Work	Light Work	Heavy Work
Very Tall Adult	51 in	47 in	41 in
Average Adult	46 in	42 in	36 in
Very Short Adult	42 in	37 in	31 in

Work Surface Heights for Multi-User Workstations



Work Surface Heights



Variable Work (er) Surface Heights



Work Surface Heights – Power Tool Types & Orientation - Use Postures

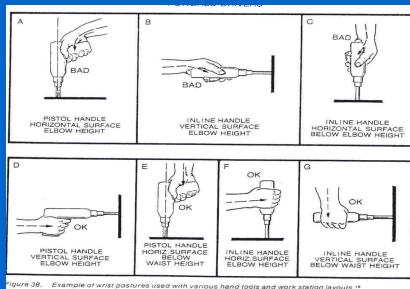


Figure 20. Example of wrist postures used with various hand tools and work station layouts.

Work Surface Heights – Power Tool Types & Orientation - Use Postures



Figure 23. Stressful ulnar deviation associated with faulty tool and workstation layout.

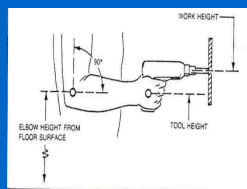


Figure 21. Graphic aid for determining correct height, based on tool.

Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



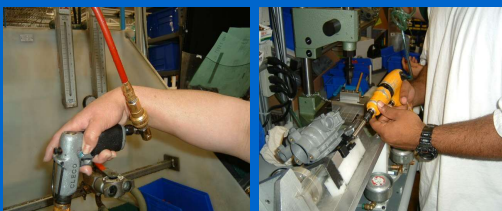
Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



Work Surface Heights – Tool Use Postures



Standing Workstations - Engineering Controls

- ◆ Avoid foot controls for standing workers -
Provide electric or pneumatic foot switches, designed for operation with either foot.
- ◆ Avoid elevated or mechanical foot actuated devices
- ◆ Provide a footrest up to 8 inches in height

Standing Workstations - Engineering Controls

- ◆ Avoid hard floors -
Provide anti-fatigue matting for tasks with 2 or more hours of standing



Sitting Workstations

Sitting Workstations - Engineering Controls

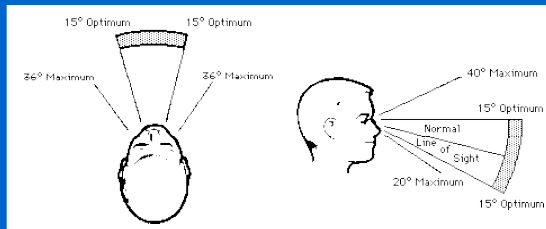
Work Surface Height for Sitting Operators

- ◆ Writing or light assembly
25.25 to 30.5 inches
- ◆ Coarse or medium work
23.25 to 28.5 inches
Adjust so hands are at elbow height

Sitting Workstations – Foot Rests



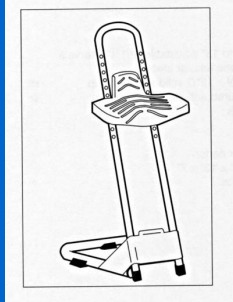
Avoid tilting the head more than 15 degrees forward



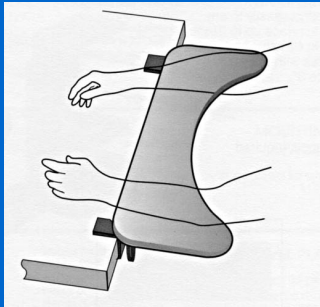
Characteristics of Ergonomic Chairs



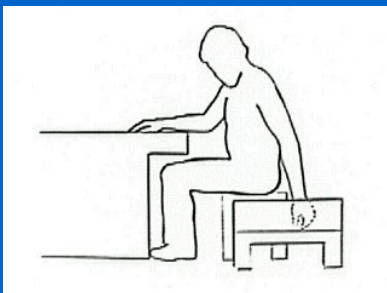
Sit/Stand Ergonomic Chairs



Arm rests to reduce static loading



Shoulder abduction: Minimize reaching down and behind the body

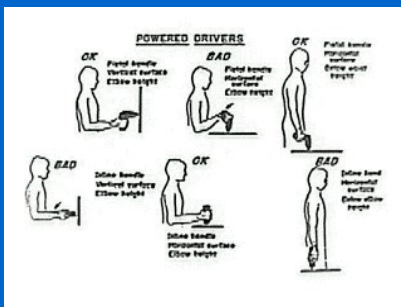


Hand Tools

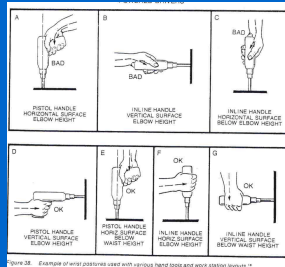
Hand Tool Controls

- ◆ Provide a variety of hand tools
- ◆ Tool Handles should be textured, not smooth or highly polished
- ◆ Tools should fit hand comfortably
- ◆ Tools should allow for straight wrist
- ◆ Keep tools in good repair and cutting tools sharp

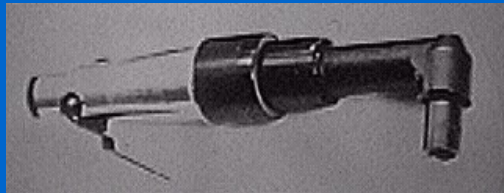
Proper match between work surface and power tool grip



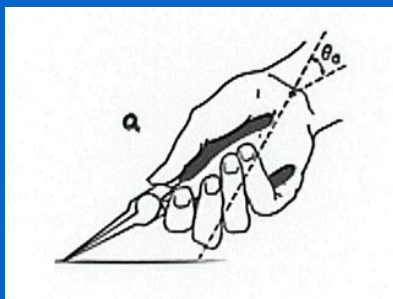
Proper match between work surface and power tool grip



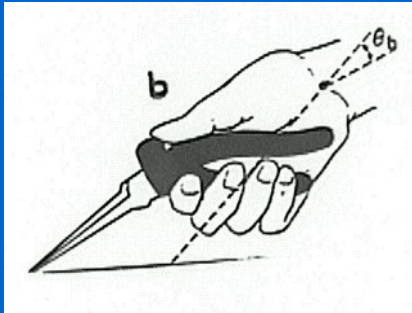
Angle nut runner enables straight wrist operation



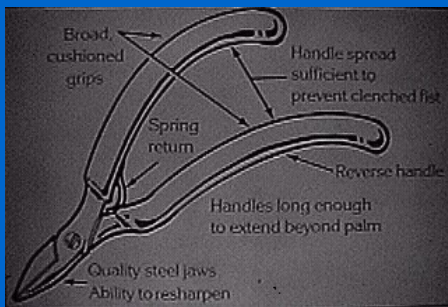
Awkward wrist postures using standard pliers



Design tool for straight wrist operation



Spring Action Return Handle

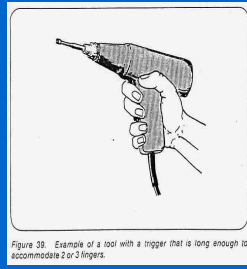
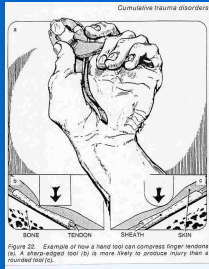


Extend handle to accommodate:

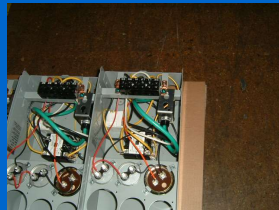
- ◆ Finger span > 3.75 "
- ◆ Hand grip > 4.5 "



Handle & Trigger Pressure Points



Design tools & fixtures for straight wrist operation



Good Multiple Finger – Spade Grip Triggers



Single Finger Activation - Stressor



Vibration - Engineering Controls

- ◆ Uncouple the operator
- ◆ Maintain light grip
- ◆ Use vibration absorbing materials
- ◆ Isolation mounts for handles
- ◆ Tool and equipment maintenance

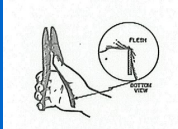


Left Handed Workers

- ◆ **Approximately 10% of population (923 million people)**
- ◆ **Design for both right and left handed workers**
- ◆ **If not possible, two designs should be available**

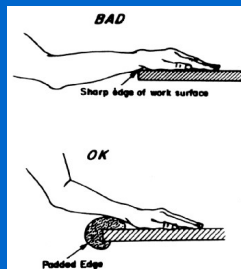
Mechanical Stress - Engineering Controls

- ◆ Tool Handle size
- ◆ Tool handle shape
- ◆ Avoid form - fitting handles
- ◆ Round edges of parts containers



Mechanical Stress - Engineering Controls

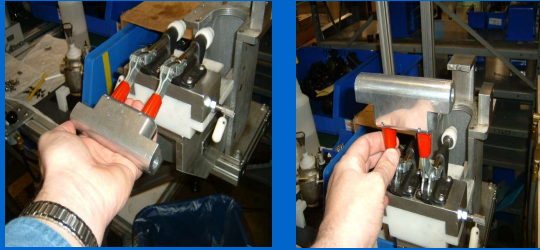
- ◆ Round edges of table tops



Mechanical Stress – Round & Pad Edges – Don't use Hand as Hammer

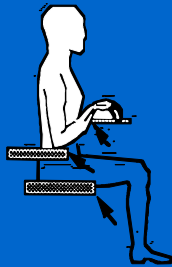


Mechanical Hand Stress – Good, Broad Pressure Points – Leverages



Mechanical Stress - Engineering Controls

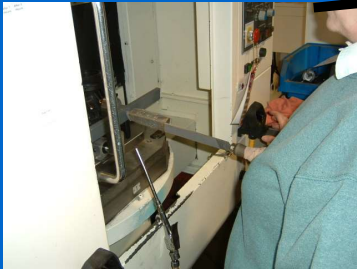
◆ Pad edges of support
surfaces



Mechanical Stress - Engineering Controls??



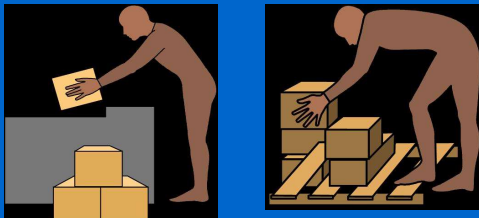
Mechanical Stress & Pressure - Engineering Controls??



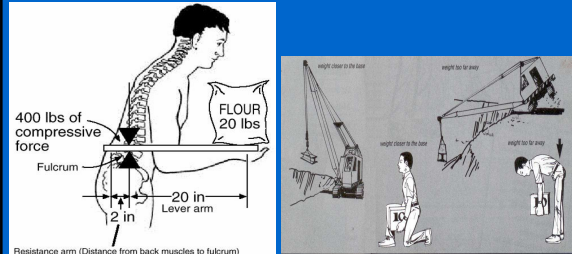
MMH - Manual Materials Handling



MMH – Palletizing



Spine – Fulcrum Forces



Liberty Mutual MMH – Task Evaluations

[LibertyMutualTables.pdf](#)

Task Evaluations on line at:
www.libertymutual.com

[Manual Materials Handling | Liberty Mutual](#)
[Manual Materials Handling Tables](#)

Liberty Mutual Manual Materials Handling (MMH) – Task Evaluations

Manual Materials Handling Calculators

<https://libertymmhtables.libertymutual.com/>

Liberty Mutual Manual Materials Handling (MMH) – Task Evaluations

Manual Materials Handling Calculators

Manual Materials Handling Analysis Tool

Task Type

Unit

System of Units (SI)

Imperial Units

Hand Coupling

Good

Poor

Very Poor

Frequency

Life: Months

Object Weight (lb)

Start Hand Height (in)

End Hand Height (in)

Start Hand Distance (in)

End Hand Distance (in)

Calculate

Tasks

Population Percentages

MALE

FEMALE

Task Type

Unit

System of Units (SI)

Imperial Units

Hand Coupling

Good

Poor

Very Poor

Frequency

Life: Months

Object Weight (lb)

Start Hand Height (in)

End Hand Height (in)

Start Hand Distance (in)

End Hand Distance (in)

Calculate

Tasks

Population Percentages

MALE

FEMALE

Liberty Mutual Insurance

Manual Materials Handling Tables: Using Liberty Mutual Tables

Table 100

Male Population Percentages for Lifting Tasks Ending Between Shoulder and Shoulder Height (5'0" to 5'7")

Frequency: One Lift Every

Object Weight (pounds)

Lifting Distance (inches)

Horizontal Distance (inches)

Vertical Distance (inches)

Table with 10 columns of data

Liberty Mutual Insurance

LibertyMutualTables.pdf

<https://libertymutualtables.libertymutual.com/CN/1-NA/TablesWeb.pdf>

Liberty Mutual Tables.pdf

Manual Materials Handling Calculators

	Twist Angle	Reaching	Bending	Energy Expenditure (Kcal/min.)	Male %	Female %	Max Male Dur.	Max Fem Dur.
EVALUATION FOR ENTIRE TASK	160	Considerable	Considerable	2.16	46	<10	8.	8.

[illegible]

A photograph of a worker in a warehouse, wearing a grey t-shirt and dark pants, moving a large cardboard box. The worker's face is obscured by a black redaction box. The warehouse has high ceilings with industrial lighting and various equipment visible in the background.

MMH – Liberty Task Evaluation

MMH – Palletizing 2510’s

Component	Hand Height at Start (in)	Distance Moved	Hand Distance (in)	Force1 Weight (lb/kilopounds)	Force2 constant (lb/seconds)	Frequency	Twisting Angle	Reaching	Bending	Male %	Female %	Energy Expenditure (Kcal/min)	Max Male Dur.	Max Fem Dur.
Lower	16	10 in.	10	20	0	20. min.	15	Moderate	Considerable	>90	>90	2.15	8.0	8.0
Lift	16	6 in.	10	20	0	20. min.	10	Moderate	Considerable	>90	>90	2.15	8.0	8.0
Lift	16	22 in.	10	20	0	20. min.	10	Moderate	Considerable	>90	86	2.15	8.0	8.0
Lift	16	38 in.	10	20	0	20. min.	10	Moderate	Considerable	>90	54	2.16	8.0	8.0
Lift	16	54 in.	10	20	0	20. min.	10	Moderate	Considerable	>90	22	2.16	8.0	8.0

	Twisting Angle	Reaching	Bending	Energy Expenditure (Kcal/min.)	Male %	Female %	Max Male Dur.	Max Fem Dur.
EVALUATION FOR ENTIRE TASK	15	Moderate	Considerable	2.15	>90	22	8.0	8.0

Liberty Mutual - Residual Risk Reduction (R3) Worksheet

“Current Methods”


Hazard	Existing Controls	Frequency	Likelihood	Severity	Risk
Palletizing outbound units/boxes - tier 1 onto outbound pallet	Box weights under 20lb's; Safety Lifting Training; Controlled "lower" guide to pallet	5	3	3	45
Palletizing outbound units/boxes - tiers 2 & 3 onto outbound pallet	Box weights under 20lb's; Safety Lifting Training; Controlled "handling in mid range" onto pallet (MMH between knuckle height to heart heights)	5	2	3	30
Palletizing outbound units/boxes - tiers 4 & 5 onto outbound pallet	Box weights under 20lb's; Lifting / "handling in mid range" onto pallet (MMH between knuckle height to heart heights)	5	4	4	80
					0
				Risk Index:	155

Liberty Mutual - Residual Risk Reduction (R3) Worksheet

“Proposed Revised Methods”

Hazard	Proposed - New Controls	Frequency	Likelihood	Severity	Risk
Palletizing outbound units/boxes - tier 1 onto outbound pallet	Box weights under 20lb's; Safety Lifting Training; Controlled "lower" guide to pallet	5	3	3	45
Palletizing outbound units/boxes - tiers 2 & 3 onto outbound pallet	Box weights under 20lb's; Safety Lifting Training; Controlled "handling in mid range" onto pallet (MMH between knuckle height to heart heights)	5	2	3	30
Prohibiting the Palletizing of outbound units/boxes - tiers 4 & 5 onto outbound pallet	No manual lifting or handling of boxes over 3rd tier (above heart height) allowed	0	0	0	0
					0
				Risk Index:	75

R3 = 52%




Washington State Department of
Labor & Industries

MMH – NIOSH Lifting Equation

State of WA –

<https://lni.wa.gov/safety-health/safety-topics/search-by-topic/?query=sprainsStrains>



Form Details: This form is used to calculate the maximum recommended weight limit (RWL) for a one-handed lift. It includes sections for lift parameters (frequency, duration, asymmetry, etc.), a table of frequency multipliers, and a final calculation section. The form is titled "NIOSH Lifting Equation" and "Form 7090 (Rev. 10-2018)".

Calculator for analyzing lifting operations

ENTER YOUR INFORMATION HERE

Company name _____

Job title _____

Evaluator _____

Date _____

- Enter the weight of the object (What task is being done?)
 lbs
- Click on the blue circle which corresponds to the task description that most closely describes the lifting task. (What is the lift posture?)

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99. Freely selected

100. Freely selected
- Click on the blue circle which corresponds to the task description that most closely describes the lifting task. (What is the lift posture?)

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100. Freely selected
- Click on the blue circle which corresponds to the task description that most closely describes the lifting task. (What is the lift posture?)

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[illegible]



Washington State Department of
Labor & Industries

Evaluation Tools ([wa.gov](http://www.lni.wa.gov/safety-health/preventing-injuries-illness/sprains-strains/evaluation-tools))

<http://www.lni.wa.gov/safety-health/preventing-injuries-illness/sprains-strains/evaluation-tools>

Safety & Health
Claims
Patient Care
Insurance
Workers' Rights
Learning & Metrics

Home > Safety & Health > PREVENTING INJURIES & ILLNESSES > Sprains/Strains

Evaluation Tools

PREVENTING INJURIES & ILLNESSES

Get Started With Safety & Health

Create a Safety & Health Program

Workplace Injuries & Fatalities

Request Consultation

You can use the evaluation tools below to:


- Find jobs that pose an injury risk.
- Prioritize your injury prevention efforts.
- Determine if a solution adequately fixed the hazard.

BASIC EVALUATION TOOLS

ADVANCED EVALUATION TOOLS

Use these basic evaluation tools to quickly find potential hazards:

- [L&I Caution Zone Checklist](#)
- [L&I Hazard Zone Checklist](#)
- [Lifting Calculator App](#)
- [Push/Pull/Carry Calculator](#)
- [Push/Pull Guidelines](#)
- [One-handed Lifting Guidelines](#)



http://www.lni.wa.gov/safety-health/preventing-injuries-illness/sprains-strains/evaluation-tools

(Active hyperlinks:)

- [L&I Caution Zone Checklist](#)
- [L&I Hazard Zone Checklist](#)
- [Lifting Calculator App](#)
- [Push/Pull/Carry Calculator](#)
- [Push/Pull Guidelines](#)
- [One-Handed Lifting Guidelines](#)

The screenshot shows the Washington State Department of Labor & Industries website. The navigation bar at the top includes links for 'Safety & Health', 'Claims', 'Parent Care', 'Insurance', 'Workers' Rights', and 'Learning & Events'. The 'Evaluation Tools' section is highlighted in the sidebar. The main content area lists various evaluation tools, including 'Prevention Resources & Services', 'Get Started With Worker Safety', 'Create a Safety Program', 'Washington Specific Tools & Features', 'Recent Content', and 'News & Events'. A blue arrow points to the 'Manual Materials Handling Calculators' link. A red box highlights the 'Quick Exposure Check' link.

[illegible]

The image displays three book covers related to the NIOSH Lifting Equation. The left cover is the 'Applications Manual for the Revised NIOSH Lifting Equation' by Thomas R. Waters, Ph.D., Verna Poth-Arnsperger, Ph.D., and Arun Garg, Ph.D. The middle cover is the 'NIOSH Lifting Equation' manual. The right cover is the 'NIOSH Lifting Equation: Revised NIOSH Lifting Equation' manual.

NIOSH Lifting Equation <https://www.cdc.gov/niosh/docs/94-110/default.html>

JOB ANALYSIS WORKSHEET

DEPARTMENT _____ JOB DESCRIPTION _____
 JOB TITLE _____
 ANALYST'S NAME _____
 DATE _____

STEP 1. Measure and record task variables

Object Weight (lb.)	Hand Location (in.)	Vertical Distance (in.)	Asymmetry Angle (deg)	Frequency Rate (per min)	Duration (Hours)	Object Coupling
W	H	V	A	F	D	C
1	2	3	4	5	6	7

STEP 2. Determine the multipliers and compute the RWL's

ORIGIN RWL = $W \times H \times V \times A \times F \times D \times C$

DESTINATION RWL = $W \times H \times V \times A \times F \times D \times C$

STEP 3. Compute the LIFTING INDEX

ORIGIN Lifting Index = $\frac{RWL}{L}$

DESTINATION Lifting Index = $\frac{RWL}{L}$

- Task Measurement Variables
- 1) Weight
 - 2) Origin Hand Loc
 - 3) Destination Hand Loc
 - 4) Vertical Distance
 - 5) Asymmetry Angle (degrees)
 - 6) Frequency
 - 7) Duration
 - 8) Coupling

NIOSH Lifting Equation <https://www.cdc.gov/niosh/docs/94-110/default.html>

Table 1: Horizontal Multiplier							
H	MM in	H cm	MM	V in	VM	V cm	VM
10	1.00	1.25	1.00	0	.78	0	.78
11	.91	.88	.89	5	.81	10	.81
12	.83	.80	.83	10	.85	20	.84
13	.77	.72	.78	15	.89	30	.87
14	.71	.64	.74	20	.93	40	.90
15	.67	.58	.69	25	.96	50	.93
16	.63	.58	.66	30	1.00	60	.96
17	.59	.49	.63	35	.96	70	.96
18	.56	.42	.60	40	.93	80	.99
19	.53	.44	.57	45	.89	90	.96
20	.50	.46	.54	50	.85	100	.93
21	.48	.46	.52	55	.81	110	.90
22	.46	.50	.50	60	.78	120	.87
23	.44	.52	.48	65	.74	130	.84
24	.42	.54	.46	70	.70	140	.81
25	.40	.56	.45	>70	.60	150	.78
>25	.00	.58	.43			160	.75
		.60	.42			170	.71
		.63	.40			175	.70
		.65	.00			>175	.00

Table 2: Vertical Multiplier							
H	MM in	H cm	MM	V in	VM	V cm	VM
10	1.00	1.25	1.00	0	.78	0	.78
11	.91	.88	.89	5	.81	10	.81
12	.83	.80	.83	10	.85	20	.84
13	.77	.72	.78	15	.89	30	.87
14	.71	.64	.74	20	.93	40	.90
15	.67	.58	.69	25	.96	50	.93
16	.63	.58	.66	30	1.00	60	.96
17	.59	.49	.63	35	.96	70	.96
18	.56	.42	.60	40	.93	80	.99
19	.53	.44	.57	45	.89	90	.96
20	.50	.46	.54	50	.85	100	.93
21	.48	.46	.52	55	.81	110	.90
22	.46	.50	.50	60	.78	120	.87
23	.44	.52	.48	65	.74	130	.84
24	.42	.54	.46	70	.70	140	.81
25	.40	.56	.45	>70	.60	150	.78
>25	.00	.58	.43			160	.75
		.60	.42			170	.71
		.63	.40			175	.70
		.65	.00			>175	.00

Table 3: Distance Multiplier							
D in	DM	D cm	DM	A deg	AM		
<10	1.00	<25	1.00	0	1.00		
10	.84	40	.50	15	.80		
20	.81	55	.50	30	.80		
30	.80	70	.50	45	.80		
40	.80	85	.50	60	.80		
50	.80	100	.50	75	.78		
60	.80	115	.50	90	.75		
70	.80	130	.50	105	.68		
80	.80	145	.50	120	.62		
90	.80	160	.50	135	.57		
100	.80	175	.50	150	.50		
>100	.00						

Table 4: Asymmetry Multiplier							
D in	DM	D cm	DM	A deg	AM		
<10	1.00	<25	1.00	0	1.00		
10	.84	40	.50	15	.80		
20	.81	55	.50	30	.80		
30	.80	70	.50	45	.80		
40	.80	85	.50	60	.80		
50	.80	100	.50	75	.78		
60	.80	115	.50	90	.75		
70	.80	130	.50	105	.68		
80	.80	145	.50	120	.62		
90	.80	160	.50	135	.57		
100	.80	175	.50	150	.50		
>100	.00						

Table 5: Frequency Multiplier							
F (times/min)	1 hour		1-2 hours		2-4 hours		
	<V30 in	V30 in	<V30 in	V30 in	<V30 in	V30 in	
12	1.00	1.00	.95	.85	.85	.85	
11	.90	.90	.90	.80	.80	.80	
10	.84	.84	.80	.75	.75	.75	
9	.80	.80	.75	.70	.70	.70	
8	.75	.75	.70	.65	.65	.65	
7	.70	.70	.65	.60	.60	.60	
6	.60	.60	.55	.50	.50	.50	
5	.50	.50	.45	.40	.40	.40	
4	.40	.40	.35	.30	.30	.30	
3	.30	.30	.25	.20	.20	.20	
2	.20	.20	.15	.10	.10	.10	
1	.10	.10	.05	.05	.05	.05	
<1	.00	.00	.00	.00	.00	.00	

Table 6: Coupling Multiplier							
Coupling Type	V<30 in		V30 in		V>30 in		
Good	1.00	1.00	1.00	1.00	1.00	1.00	
Fair	.85	1.00	.85	1.00	.85	1.00	
Poor	.70	.85	.70	.85	.70	.85	

A series of general design/ergonomic suggestions for each job-related risk factor are provided in Table 6. These suggestions can be used to develop a practical ergonomic design/ergonomic strategy.

NIOSH Lifting Equation <https://www.cdc.gov/niosh/docs/94-110/default.html>

JOB ANALYSIS WORKSHEET

DEPARTMENT _____ JOB DESCRIPTION _____
 JOB TITLE _____
 ANALYST'S NAME _____
 DATE _____

STEP 1. Measure and record task variables

Object Weight (lb.)	Hand Location (in.)	Vertical Distance (in.)	Asymmetry Angle (deg)	Frequency Rate (per min)	Duration (Hours)	Object Coupling
W	H	V	A	F	D	C
1	2	3	4	5	6	7

STEP 2. Determine the multipliers and compute the RWL's

ORIGIN RWL = $W \times H \times V \times A \times F \times D \times C$

DESTINATION RWL = $W \times H \times V \times A \times F \times D \times C$

STEP 3. Compute the LIFTING INDEX

ORIGIN Lifting Index = $\frac{RWL}{L}$

DESTINATION Lifting Index = $\frac{RWL}{L}$

[illegible]

Figure 1 displays a 10x10 grid of scatter plots illustrating the relationship between the number of children in the household (X-axis) and the number of children in the family (Y-axis). The plots are arranged in rows corresponding to the number of children in the family (1 to 10) and columns corresponding to the number of children in the household (1 to 10). Each plot shows a positive correlation, with the density of points increasing as the number of children increases. The plots are labeled with the number of children in the household (1 to 10) and the number of children in the family (1 to 10).

3.3.2 Dish-Washing Machine Unloading, Example 1

3.3.2.1 Job Description

The job description for the dish-washing machine unloading task is as follows: The worker is responsible for unloading the dish-washing machine and placing the dishes in the rack. The worker must ensure that the dishes are clean and dry before placing them in the rack. The worker must also ensure that the machine is properly cleaned and maintained.

3.3.2.2 Job Analysis

The job analysis for the dish-washing machine unloading task is as follows: The worker must be able to lift and move heavy objects, such as the dish rack and the dishes. The worker must also be able to handle hot water and steam. The worker must be able to follow safety procedures and use proper lifting techniques.

3.3.2.3 Job Design

The job design for the dish-washing machine unloading task is as follows: The worker should be trained in proper lifting techniques and safety procedures. The worker should be provided with the necessary equipment, such as a dish rack and a dish brush. The worker should be encouraged to take breaks and stay hydrated.

3.3.2.4 Job Evaluation

The job evaluation for the dish-washing machine unloading task is as follows: The job is a moderate level of difficulty and requires a moderate level of skill and experience. The job is a moderate level of risk and requires a moderate level of safety awareness.

3.3.2.5 Job Training

The job training for the dish-washing machine unloading task is as follows: The worker should receive training in proper lifting techniques and safety procedures. The worker should also receive training in the use of the dish-washing machine and the dish rack.

3.3.2.6 Job Monitoring

The job monitoring for the dish-washing machine unloading task is as follows: The worker should be monitored for proper lifting techniques and safety procedures. The worker should also be monitored for the use of the dish-washing machine and the dish rack.

3.3.2.7 Job Improvement

The job improvement for the dish-washing machine unloading task is as follows: The job can be improved by providing the worker with the necessary equipment and training. The job can also be improved by encouraging the worker to take breaks and stay hydrated.

3.3.2.8 Job Conclusion

The job conclusion for the dish-washing machine unloading task is as follows: The job is a moderate level of difficulty and requires a moderate level of skill and experience. The job is a moderate level of risk and requires a moderate level of safety awareness.

Figure 10: Dish-Washing Machine Unloading, Example 1

Diagram illustrating the dish-washing machine unloading process. A worker is shown standing next to the machine, which is labeled "Dish-Washing Machine". The worker is holding a "Dish" and is about to place it in the "Dish Rack". The machine is connected to a "Water Supply" and a "Drainage System". The diagram also shows a "Floor" and a "Sink".

Manual Lifting & Palletizing
– Team Lifts Where Necessary



Manual Lifting – Raise Parts to
Avoid Below Knuckle Heights



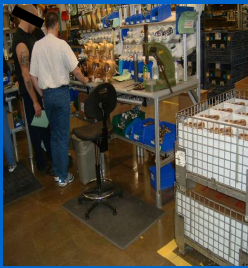
Manual Lifting – Avoid Below
Knuckle Height Lifts



Tilt workstation towards worker to
reduce reaching and bending motions



Manual vs. Mechanical Lifting – Avoid
Excessive Weights & Adverse Postures



Use a fixture or jig to reposition work surface
to minimize body posture deviations





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Notes
