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#424 Lean-ergonomic methods to reduce workers' compensation costs, Part 1 of 2

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1:15 to 2:15 p.m.

Ohio | Bureau of Workers' Compensation

Lean-Ergonomic methods to reduce workers' compensation costs (Part 1 of 2)

Qualifications and experience of the instructor

Name of the instructor:
Title of the instructor:

- Dr. Govind Bharwani
- Director of training, Ergonomics training Co.
- Co-Director of Ergonomics and Continuing Education Programs Dept. of Biomedical, Industrial and Human Factors Engineering Wright State University, Dayton, OH

Educational qualifications:

- Ph.D. in Biomedical Engineering
- M.S. in Industrial Engineering
- M.B.A. in General Management
- B.S. in Mechanical Engineering

Academic experience: (currently teaching)

- Introduction to Industrial Ergonomics
- Advanced Industrial Ergonomics
- Kaizen / Lean Manufacturing
- Six Sigma for Engineers
- Occupational Safety and Health

Industry experience:

- Over 20 years of industrial management and engineering experience
- Over 10 years of ergonomic consulting experience
- Provided on-site consulting to over 100 companies

Provided on-site training to following companies:

Dana Corp., Eaton Corp., Emerson Electric, Fedders, Jostens, Lennox Industries, Maytag, Miller Brewing Co., W L Gore, Weyerhaeuser Co, Becton-Dickinson, Heatcraft, Cooper Lighting, Woodstream Corp., Thomas Industries Inc., Inc., Toastmaster, Engelhard Corp., Dupont Photomasks, Cardinal IG, Lucas NovaSensor, Indy Lighting, Medeco Security Locks, Nordyne, Monroe Auto Equipment Co., Rexnord Corp, Osram Sylvania, Phillips Display Components, Signet Systems, Mueller Co., Southwest Mobile & Systems, Technotrim, The Metalloy Corporation, Z F Industries Inc., Rubbermaid Commercial Products, Pella Corporation, Modine Manufacturing Co, Kraft Foods, Kellogg's, Harley Davidson, Georgia Pacific, Frigidaire Home Products, Berwick Industries.

Today's Objective

1. What is Lean-Ergonomics?
2. How does Lean-Ergonomics affect your plant goals such as Worker's Comp. costs, Productivity, Quality, Absenteeism, etc .
3. How can the plant use ergonomic tools to achieve production and safety goals.

Principles of Ergonomics

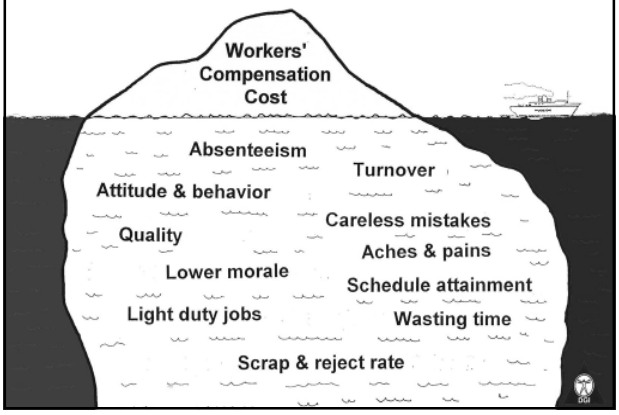
1) **All human beings have physiological differences of height, weight, gender & age, which affect physical work.**
2) **Any work performed within the physiological zone of peak performance will result in lower muscular fatigue.**
3) **Any repeated deviation outside the zone of peak performance will result in musculoskeletal stresses on specific parts of the body causing employee to waste time.**
4) **Continuous musculoskeletal stresses over time lead to Cumulative Trauma and Back pain.**
5) **<u>Our objective</u>: Use Ergonomic principles on the design of hand-tools, equipment, workstations, and environment to help employees minimize musculoskeletal stresses during any physical work.**

Your major concerns

1) **Employee productivity**

2) **Employee's health**
(Workers' Compensation Cost)

Iceberg Analogy



What is Ergonomics ?

"Ergonomics" combines 2 Greek words

ERGON means WORK
NOMOS means NATURAL LAWS

It deals with the effect of tools, equipment, workstations and environment on both, employees PERFORMANCE and HEALTH

HUMAN

PHYSIOLOGY

AND

BIOMECHANICS

Areas of stress during physical work (4 fulcrums – stress points)

Stress points
1) Lower back
2) Shoulder joint
3) Elbow joint
4) Wrist joint

- Back fulcrum gives few signals
- Shoulder, elbow and wrist fulcrums give many signals

Human behavior & the Nervous System

All human beings are affected by their nervous system. Therefore:

1) **To change employee behavior, you must understand the effect of nervous system on the body of the employees.**

2) **The nervous system is influenced by muscle fatigue and musculoskeletal stresses. In psychology, it is called pain-pleasure principle.**

What causes resistance to change?

The nervous system is influenced by muscle fatigue & musculoskeletal stresses in the body. When aches & pains develop in the body of the employee, the nervous system causes the employee to stop the physical work. It forces an employee to take steps to neutralize fatigue and stresses; in other words start "wasting time".

Any negative experience by the employee, which increased musculoskeletal stresses in the past due to process changes, will result in resistance by the nervous system of the employee.

Any positive experience by the employee, which reduces musculoskeletal stresses, will result in positive attitude and improved productivity by the employee.

Hence, any increase or decrease of muscle fatigue & musculoskeletal stress in the body of the employees is the key to their productivity, behavior, attitude, morale and most of all . . . . .

RESISTANCE TO CHANGE

Major Concerns

1) Workers' Productivity

2) Workers' Health

(Workers' Compensation Cost)

What is metabolic balance ?

During any physical work, there are two important things happening simultaneously inside the body of the employee

1) Demand of Energy : energy required to do the physical (production) work.

and

2) Supply of Energy : energy regeneration, conversion of low energy phosphates (ADP) to high energy phosphates (ATP).

If the demand of energy exceeds the supply of energy, then the metabolic balance is upset against the employee.

Metabolic imbalances in the plant affects :

1) Employee productivity
   a) Degree of muscular fatigue
   b) Performance and efficiency
   c) Manufacturing costs
2) Workers' Compensation Cost
   a) Musculoskeletal stresses in the body
   b) Risk of Cumulative trauma disorders
   c) Lost time accidents & light duty jobs

Over time, it also affects employee behavior (morale), reject rates (quality) and schedule attainment (customer delivery).

Two factors affect Metabolic Balance

Factor #1 is in the hands of the employees. Management has no control on it.

Factor #2 is very critical. It is this factor which is primarily responsible for productivity/health of the employees and is affected by the Management

DYNAMIC EFFORT

Muscles work in such a way so that blood is flowing constantly to the muscles

STATIC EFFORT

Muscles work in such a way so that blood flow is restricted to the muscles

EXAMPLES OF STATIC EFFORT

1) Stretch your arms above shoulder level

2) Pick up a small weight and stretch your arms

3) Incorrect sitting postures also cause static loads on some of the muscles and some of you will begin to feel tired

Examples of static postures in a manufacturing plant

1) Bending or twisting the wrists
2) Raised elbows
3) Using pinch grip
4) Working above shoulder level
5) Excessive reach and bending the body
6) Pressing at the palm of the hand
7) Working with bent neck posture
8) Twisting the body with a load

Effect of Physiology on Workers' Performance and Health

a) Any factor which restricts the blood flow to the muscles during physical work increases muscle fatigue

b) Any factor which enhances the capability of the muscles to get the blood supply reduces muscle fatigue

Examples which reduce blood flow & negatively effect the performance & health of the employees

1) Static (awkward) postures
2) Force & repetition
3) Cold and vibration
4) Direct pressure

The objective of physiological solutions is to:

1) Change muscles from contraction to relaxation mode.
2) Change postures from static to dynamic.
3) Increase blood circulation to the working muscles.

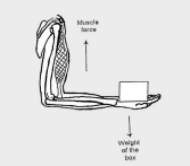
Biomechanics

The basic Laws of Physics affect every human body when employees do any physical or production work.

We have over 200 lever systems in our body. To improve the productivity of the employee, we must understand the effect of the lever systems working inside the body of the employee

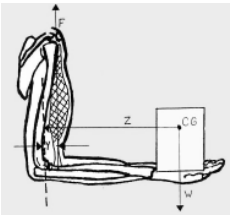
In every lever system

Bones act as lever bars
Joints act as fulcrums
Muscles supply the effort (energy)
Result is the physical work



Why is the human body a poor biomechanics machine?

Analysis of forces in the elbow joint



F x Y = W x Z

Based on the average male anthropometry

Y = 2 inches

Z = 14 inches

W = 20 lbs

F x 2 = 20 x 14

F = (20 x 14) / 2 = 140 lbs

It is not what you lift, but how you lift which is more important.
It is not what you do, but how you do the work which is critical.

Effect of Biomechanics on Workers' Performance and Health

1) An awkward posture (i.e. excessive reach) will increase the bending moment, causing forces to increase in muscles and joints.
2) When the forces are increased, the blood supply to the muscles is reduced.

RESULT OF POOR BIOMECHANICS

1) Complaints of aches and pains
2) Tendency to "waste time" & cause "errors"
3) Increased risk of CTD and back pain

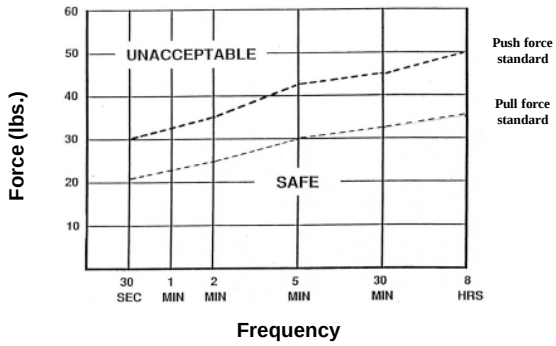
Management should focus on how the job is done

Lean-Ergonomics Analysis

1. Push-Pull analysis
2. Manual Lifting analysis
3. CTD analysis

Analysis of pushing or pulling operations

Operation Description_____



Four solutions for Push-Pull analysis

1) Reduce the weight on the cart

2) Increase the size of the wheels
(It will reduce frictional force between the cart & the floor)

3) Job rotation

4) Two people pushing the cart

Practical examples of Push-Pull Analysis

Guidelines for Pushing & Pulling Operations

1) Height of the handle should be 36 - 45 inches from the floor.
2) Use light weight shoes with toe protection.
3) Sustained force for continuous pushing & pulling operation should be less than 29 lbs.
4) Avoid cracked floors during pushing & pulling operation.
5) Ensure regular maintenance of wheels and castors
6) Rear wheel castors should have rotation capability to help in turning the cart.

Pushing vs. Pulling

If you have a choice between pushing and pulling a cart, always select:

"Pushing the cart"

During pushing, the body momentum helps the process and reduces musculoskeletal forces in your body (Ergonomic factor)

Lean-Ergonomics Analysis

1. **Push-Pull analysis**
2. ☞ **Manual Lifting analysis**
3. **CTD analysis**

MANUAL MATERIAL HANDLING ANALYSIS SHEET

DATE_____ REF. NO _____
ANALYST_____
PERSON OBSERVED_____
F = FREQUENCY (LIFTS / MN)_____
DURATION OF LIFTING <1hr. <2hrs <8hrs

DEPT._____ PART NAME & NUMBER _____
JOB DESCRIPTION _____

		ORIGIN	DESTINATION
"H" Horizontal location (inches)		_____	_____
"V" Vertical location (inches)		_____	_____
"D" Vertical travel distance (inches)		_____	_____
"A" Angle of asymmetry (degrees)		_____	_____
Use tables on the back for the following			
"HM" Horizontal multipler (10 / H)	Table 1	_____	_____
"VM" Vertical multiplier { 1 - (.0075 x | v-30 |)	Table 2	_____	_____
"DM" Distance multiplier {.82 + (1.8 / D)}	Table 3	_____	_____
"AM" Asymmetric multiplier { 1-(.0032 x A)}	Table 4	_____	_____
"FM" Frequency multiplier	Table 5	_____	_____
"CM" Coupling multiplier	Table 6	_____	_____
"RWL" Recommended weight limit = 51 x HM x VM x DM x AM x FM x CM		_____	_____
Weight of the object lifted (lbs.)		_____	_____
Is this task acceptable? (Yes / No)		_____	_____
LIFTING INDEX "LI" = WEIGHT LIFTED / RWL		_____	_____

LI<1 (SAFE) LI = 1-3 (CAUTION) LI>3 (HAZARDOUS)

Tables for NIOSH formula for two-handed lifting operations

TABLE 1

HORIZONTAL MULTIPLIER (HM)			
H	HM	H	HM
< 10	1.00	18	0.56
10	1.00	19	0.53
11	0.91	20	0.50
12	0.83	21	0.48
13	0.77	22	0.45
14	0.71	23	0.43
15	0.67	24	0.42
16	0.63	25	0.40
17	0.59	> 25	0.00

"H" is the horizontal distance between the ankles and the hand

TABLE 2

VERTICAL MULTIPLIER (VM)			
V	VM	V	VM
0	0.78	38	0.94
2	0.79	40	0.93
4	0.81	42	0.91
6	0.82	44	0.90
8	0.84	46	0.88
10	0.85	48	0.87
12	0.87	50	0.85
14	0.88	52	0.84
16	0.90	54	0.82
18	0.91	56	0.81
20	0.93	58	0.79
22	0.94	60	0.78
24	0.96	62	0.76
26	0.97	64	0.75
28	0.99	66	0.73
30	1.00	68	0.72
32	0.99	70	0.70
34	0.97	> 70	0.00
36	0.96		

"V" is the vertical distance between the floor and the hands

TABLE 3

DISTANCE MULTIPLIER (DM)			
D	DM	D	DM
< 10	1.00	22	0.90
10	1.00	24	0.90
11	0.98	25	0.89
12	0.97	30	0.88
13	0.96	35	0.87
14	0.95	40	0.87
15	0.94	50	0.86
16	0.93	60	0.85
18	0.92	70	0.85
20	0.91	> 70	0.00

"D" is the vertical travel distance against gravity (between origin and destination)

TABLE 4

ASYMMETRIC MULTIPLIER (AM)			
A	AM	A	AM
0	1.00	75	0.76
5	0.98	80	0.74
10	0.97	85	0.73
15	0.95	90	0.71
20	0.94	95	0.70
25	0.92	100	0.68
30	0.90	105	0.66
35	089	110	0.65
40	0.87	115	0.63
45	0.86	120	0.62
50	0.84	125	0.60
55	0.82	130	0.58
60	0.81	135	0.57
65	0.79	> 135	0.00
70	0.78		

"A" is the twisting angle of the body in the horizontal plane

TABLE 5

FREQUENCY MULTIPLIER (FM)						
	DURATION OF LIFTING					
Freq.	< 8 Hrs		< 2 Hrs		< 1Hr	
Lifts/Min	V < 30	V > 30	V < 30	V > 30	V < 30	V > 30
< 0.2	0.85	0.85	0.95	0.95	1.00	1.00
0.5	0.81	0.81	0.92	0.92	0.97	0.97
1	0.75	0.75	0.88	0.88	0.94	0.94
2	0.65	0.65	0.84	0.84	0.91	0.91
3	0.55	0.55	0.79	0.79	0.88	0.88
4	0.45	0.45	0.72	0.72	0.84	0.84
5	0.35	0.35	0.60	0.60	0.80	0.80
6	0.27	0.27	0.50	0.50	0.75	0.75
7	0.22	0.22	0.42	0.42	0.70	0.70
8	0.18	0.18	0.35	0.35	0.60	0.60
9	0.00	0.15	0.30	0.30	0.52	0.52
10	0.00	0.13	0.26	0.26	0.45	0.45
11	0.00	0.00	0.00	0.23	0.41	0.41
12	0.00	0.00	0.00	0.21	0.37	0.37
13	0.00	0.00	0.00	0.00	0.00	0.34
14	0.00	0.00	0.00	0.00	0.00	0.31
15	0.00	0.00	0.00	0.00	0.00	0.28
> 15	0.00	0.00	0.00	0.00	0.00	0.00

To calculate frequency, count total number of lifts (N) over 15 min production. Frequency = N /15

TABLE 6

COUPLING MULTIPLIER (CM)			
	V < 30	V > 30	Container or loose part ?
GOOD	1.00	1.00	For CONTAINERS: good handles or hand-hold cut-outs. For LOOSE PARTS: comfortable grip in which both hands can easily wrap around the object.
FAIR	0.95	1.00	For CONTAINERS: less than optimal handles and cut-outs for material handling. For LOOSE PARTS: a grip in which fingers can move freely during lifting operation
POOR	0.90	0.90	For CONTAINERS: no handles or hand-hold cut-outs. For LOOSE PARTS: irregular or bulky or hard to handle parts.

Practical examples of Manual Lifting Analysis

Muscle Compensation Techniques

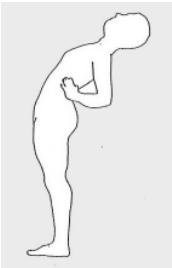
(OSHA calls it Administrative Controls)

Muscle compensation for the BACK is to bend the BACK backwards for 5-10 sec. Repeat it 3 times.

This moves the muscles from Contraction to Relaxation mode and increases the blood circulation to the muscles

<u>How often should it be done ?</u>

Every 30 minutes or when the employee feels muscle fatigue or musculoskeletal stress



Back extension exercise

Summary - Steps to reduce the risk of back injury

If any employee complains about back pain, ask the following 4 questions:

Question # 1: **Is the employee pushing or pulling anything?**
- **If yes** . . . . **do push-pull analysis**
- **If no** . . . . . go to question # 2

Question # 2: **Is the employee lifting something with 2 hands?**
- **If yes** . . . . **do NIOSH analysis**
- **If no** . . . . . go to question # 3

Question # 3: **Is the employee working with standing posture?**
- **If yes . . . . do the following:**
  - **a) prevent twisting motion**
  - **b) provide anti-fatigue mat**
  - **c) do back extension exercise every half hour**
- **If no** . . . . . go the question # 4

Question # 4: **Is the employee working with seating posture?**
- **If yes** . . . . do the following:
  - **a) provide lumbar support on the chair**
  - **b) adjust the height of the chair**
  - **c) improve the seated posture**
  - **d) if the above do not help, then do back extention exercise every hour for 15 seconds**

Any Questions ?

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