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Providing Ergonomic Solutions in a Lean Manufacturing Environment

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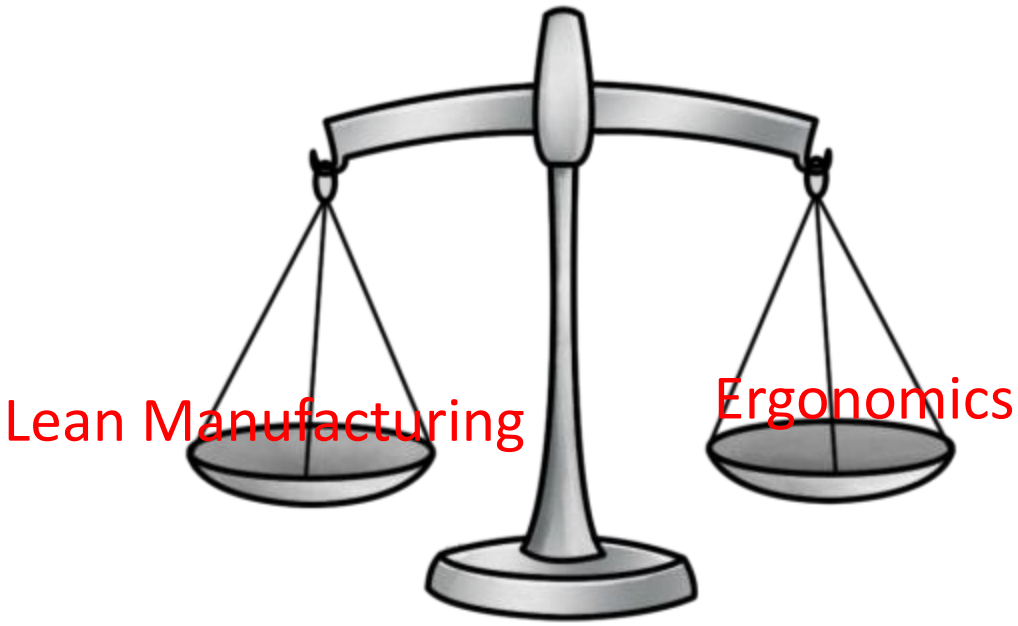
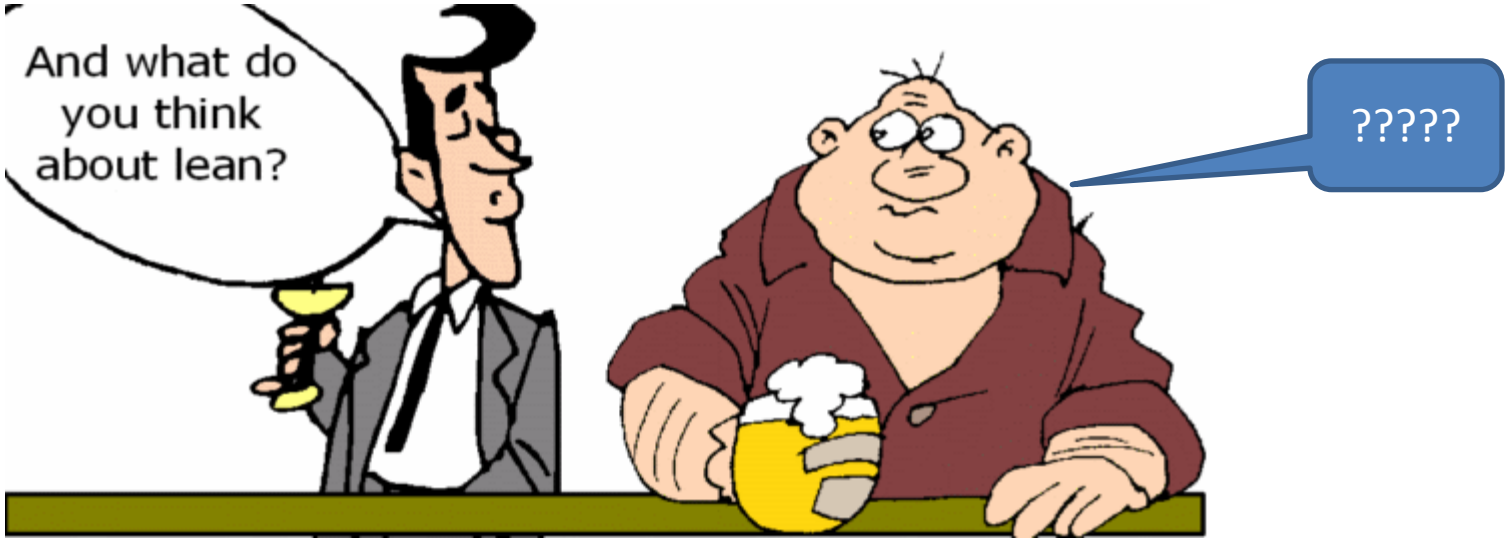
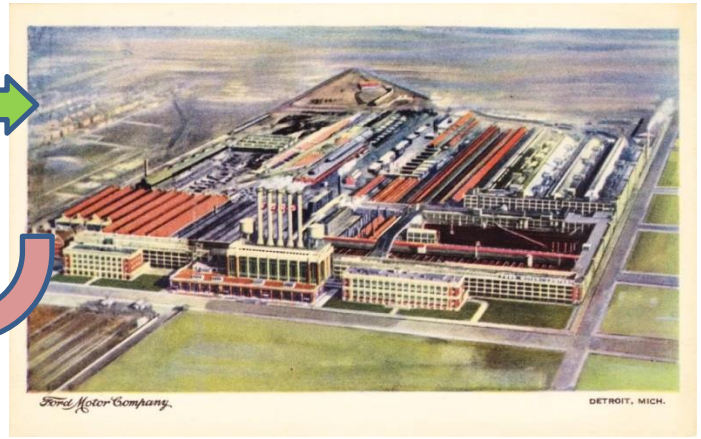
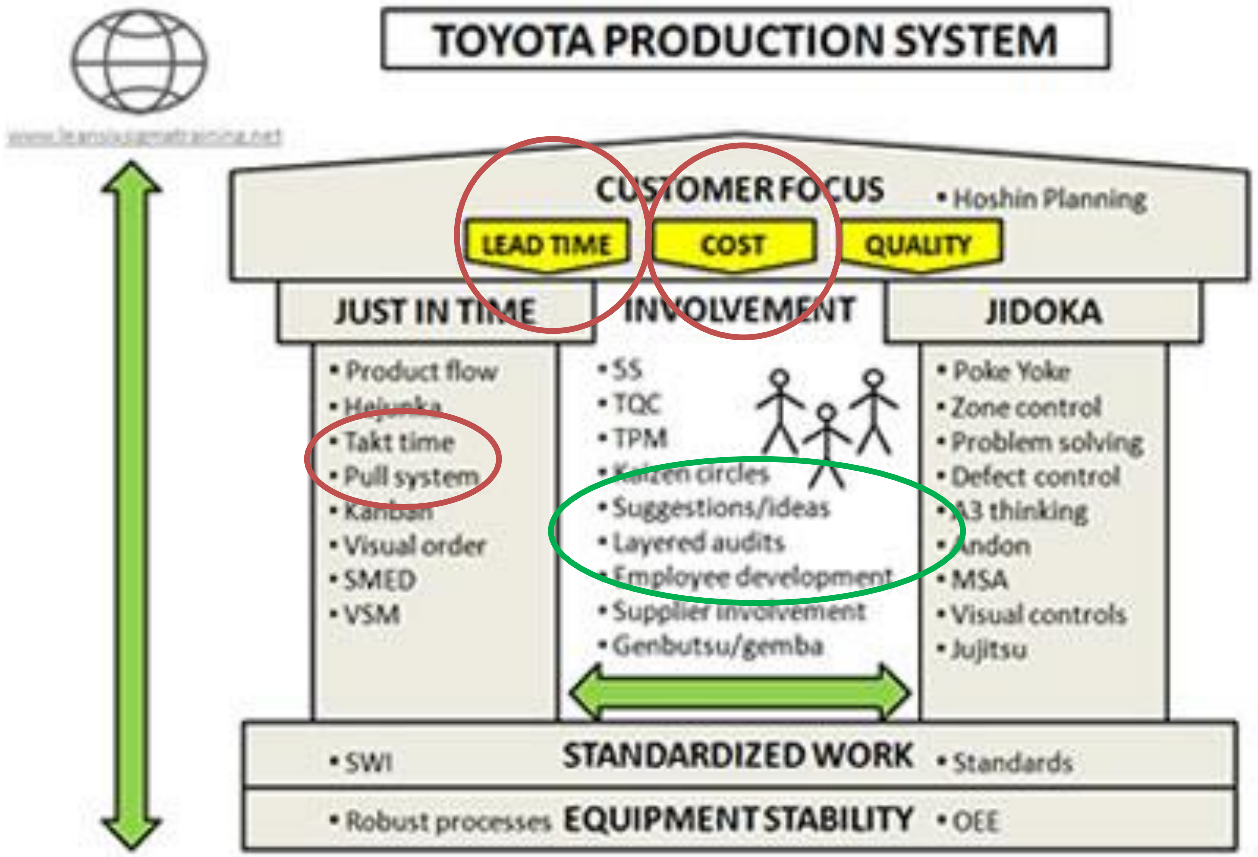
Can we balance Lean manufacturing practices and Ergonomic Practices ?







Japanese engineer Eiji Toyoda, he left for a three month study by the Ford Rouge plant in Detroit, after studying carefully the system of factory production, the largest and most efficient manufacturing complex in the world, after much analysis and studies he came to a conclusion that mass production would never work in Japan "In this early experiment was born what Toyota came to call Toyota Production System, and finally “lean production"



The Toyota Production System (TPS) was established based on two concepts: The first is called "jidoka" (which can be loosely translated as "automation with a human touch") which means that when a problem occurs, the equipment stops immediately, preventing defective products from being produced; The second is the concept of "Just-in-Time," in which each process produces only what is needed by the next process in a continuous flow.

What is Ergonomic Handling?

Ergonomics + Handling

Ergonomics :

[ur-g*uh*-nom-iks]

The applied science of equipment design, as for the workplace, intended to **maximize productivity by reducing operator fatigue and discomfort**.

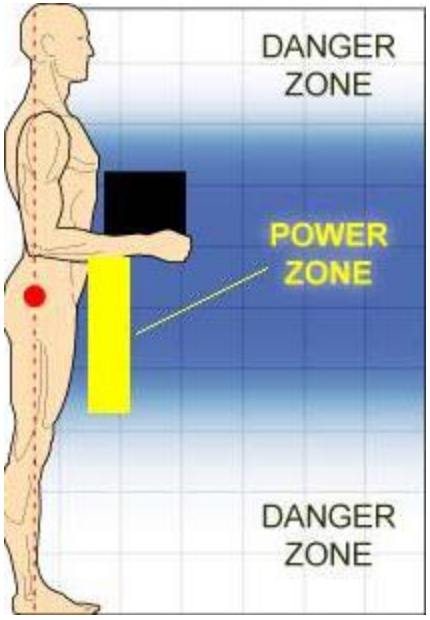
Handling – U.S. Department of Labor definition:

Seizing, holding, grasping, turning, or otherwise working with the hand or hands. Fingers are involved only to the extent that they are an extension of the hand, such as to turn a switch or to shift automobile gears.

What is Ergonomic Handling?

Ergonomics + Handling

- Promoting use of neutral joint postures
- Locating work, parts, tools, and controls at optimal anthropometric locations
- Providing adjustable workstations and a variety of tool sizes
- When appropriate, providing adjustable seating, arm rests, back rests
- Utilizing feet and legs, in addition to hands and arms
- Conserving momentum in body motions
- Providing strategic location (in the ***power zone***), for lifting, lowering,
- Accommodating for a broad variety of workers with respect to size, strength, and cognitive abilities

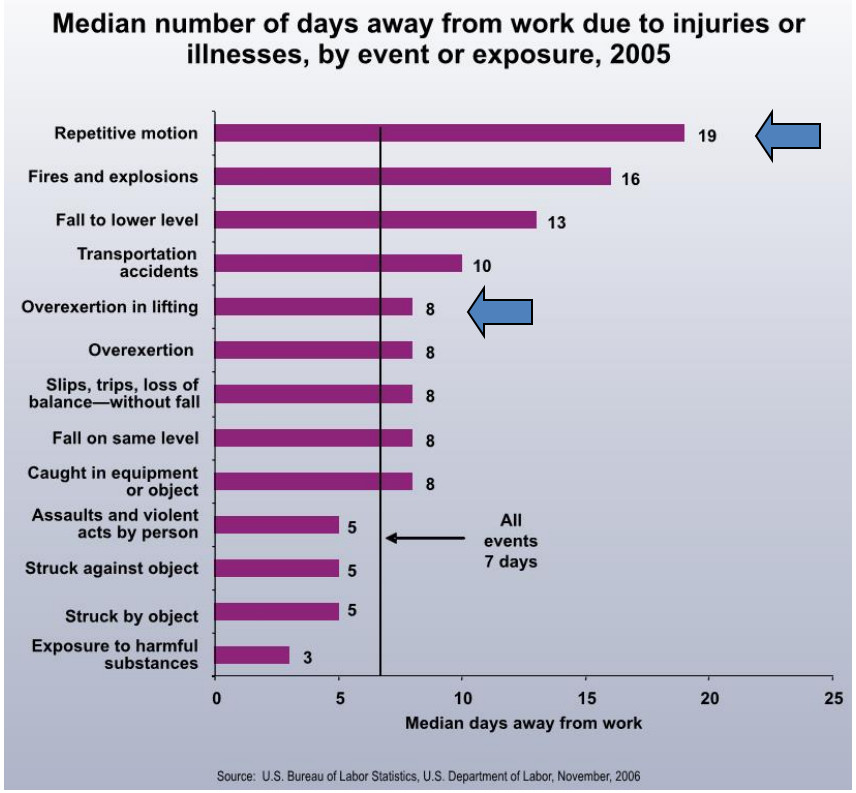


What is Ergonomic Handling?

Why it's important

According to the Bureau of Labor Statistics:

- **Lost time** from job related injuries totals 105 million work days each year.
- Median number of days away from work for repetitive motion is 19 and 8 days for **overexertion in lifting**.
- The Average overexertion injury costs an employer $38,000
- Manual materials handling represents an estimated 35% of total **workers' compensation** claims.
- Medical expenses, lost wages, lower productivity, and other expenses from these injuries amounts to **$116 billion** annually.
- **Back injuries** account for 20% of all compensation claims according to various studies.



Ergonomic Handling addresses Repetitive Motion & Overexertion in lifting

What is Ergonomic Handling?

Organizations & Standards

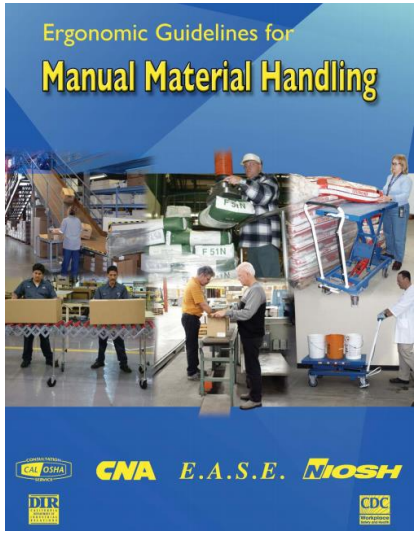
Ergonomics & Safety are governed by various organizations including:

- OSHA: *www.osha.gov/SLTC/ergonomics*

- NIOSH: www.cdc.gov/niosh/

- Ergonomic Assist Systems and Equipment Council

  - www.mhia.org/industrygroups/ease



Download at:
www.cdc.gov/niosh/docs/2007-131

A Lean focus and how it affects Ergonomic performance and safety

PRO's

- Lean can generate lower human effort, hence reduce the impact on the body
- Lean teams can promote positive environments thru work rotation
- Lean can minimize isolation hence reducing risk
- Lean can lead to " larger work environments , which leads to less micro injuries and increases healing

CON's

- Many Lean companies are focused on production gains, and sacrifice the well being of workers
- Lean can increase the occurrence of one sided work movements which lead to WMSD
- Lean reduced cycle times can lead to repetitive motion injuries
- Lean drives reduce costs, which may reduce spend hence decreasing the well belling of the employee
  A. Increased long term sick leave
  B. burned out personnel
  C. Stressed people
  D. Cost cutting of EH& S staff members

Table 1
Main cited advantages and disadvantages of LPS

Dimension	Advantages		Disadvantages	
Human effort (work intensification; work pace)	low	A1	high	D1
Qualification of the workforce (job enrichment) multi-skills requirements	high	A2	low	D2
Job enlargement	good	A3	bad	D3
Stress	decrease	A4	increase	D4
Workforce perceived as central element	clear	A5	not clear	D5
Hierarchical levels	decrease	A6	increase	D6
Workers' autonomy	increase	A7	decrease	D7
Workers' participation and engagement	high	A8	low	D8
Work pattern	flexible	A9	inflexible	D9
Teamwork	increase	A10	decrease	D10
Risk of WMSD development	low	A11	high	D11

Lean Job Design and removing Musculoskeletal Injury Risk

Work-related musculoskeletal disorders (WMSDs) are a group of painful disorders of muscles, tendons, and nerves. Carpal tunnel syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are examples.

- Repetitive motion injuries.
- Repetitive strain injuries.
- Cumulative trauma disorders.
- Occupational cervicobrachial disorders.
- Overuse syndrome.
- Regional musculoskeletal disorders.
- Soft tissue disorders.

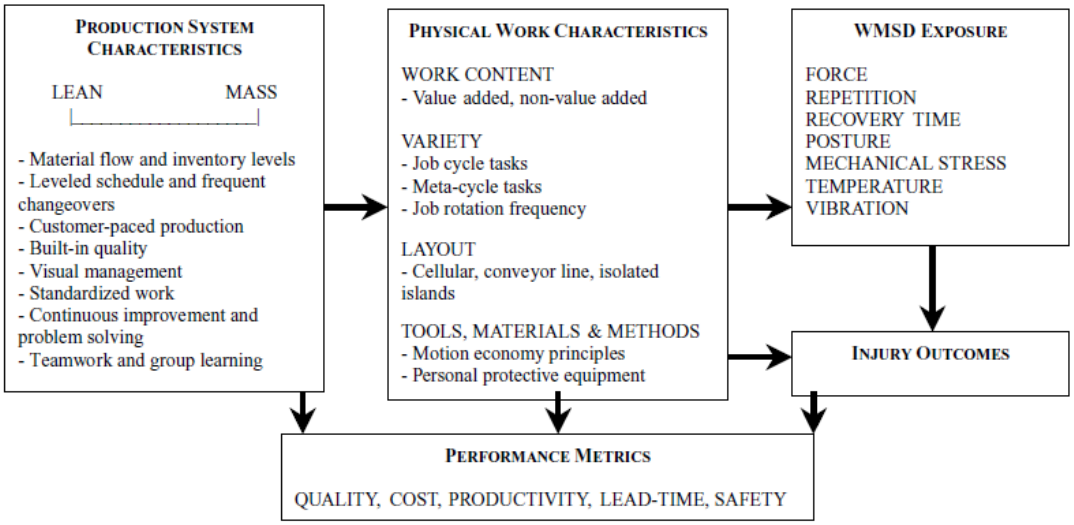


Figure 1 Conceptual framework for links between lean manufacturing implementation, work characteristics, and injury outcomes.

What are the risk factors for WMSDs?

- Fixed or constrained body positions.
- Continual repetition of movements.
- Force concentrated on small parts of the body, such as the hand or wrist.
- A pace of work that does not allow sufficient recovery between movements.

- **How can we prevent WMSDs?**

- **Job Design**
- **Mechanization**
- **Job Rotation**
- **Job Enlargement and Enrichment**
- **Team Work**
- **Workplace Design**
- **Tools and Equipment Design**
- **Work Practices**

Lean vs. Traditional Auto Plant

TABLE 1. Differences between the Lean and Traditional Plants

Production Characteristic	Lean Plant	Traditional Plant
Leveled product mix	3 vehicles per assembly line	1 vehicle per assembly line
Team structure	5–8 production workers per team leader, 3–4 teams per group leader	18–20 production workers per team leader
Quality systems	*Andon* cords pulled frequently and responded to within seconds	*Andon* cord pulls not prevalent during observation period
Job rotation/flexibility	Hourly rotation to each team job	≈20%(voluntarily) rotate
Standardized work	Updated by team and used as benchmark for continuous improvement	Updated by industrial engineers

TABLE 3. Sample Means (and Standard Deviations) of WMSD Factor Ratings for Each Plant

Risk Factor	Lean ($n = 56$)	Traditional ($n = 56$)	p Value
HAL	5.5 (0.8)	5.0 (1.1)	0.001
Peak hand force	4.5 (2.1)	5.2 (2.0)	0.01
Back posture: Average	0.5 (0.6)	0.6 (0.8)	0.10
Back posture: Peak	3.1 (1.9)	3.6 (2.1)	0.09
Shoulder posture: Average	1.4 (0.8)	1.4 (0.9)	0.44
Shoulder posture: Peak	7.4 (1.4)	7.5 (1.6)	0.41
Wrist posture: Peak	6.8 (2.0)	6.4 (2.2)	0.15

Process Quality Inputs	Task	Force (Lean)	Force (Traditional)	Description of Difference
Quality parts	Attach glove box	3.25	9.0	Parts were forced fit by using hand as hammer on traditional job.
Quality tools	Run down fasteners	4.5	5.8	Large (heavier) power tool was used to run down fasteners. Medium sized power tools with better grip were used on lean job.
Quality part presentation	Attach right hand door	3.25	5.75	Aligning door required supporting its weight with one hand. A fixture was used to eliminate holding door on lean job.
	Transport panel with hoist	2.75	6.5	Hoist was initiated/pulled with one hand due to rack arrangement. Hoist was initiated/pulled with two hands due to parallel rack arrangement on lean job.
Quality methods	Attach hose to powertrain	2.5	7.5	Attaching hose required rocking back and forth. Hose attached smoothly with lubricant on lean job.

Plan-Do – Check- Act (PDCA) model on Health and other Moderators for the Lean Plant

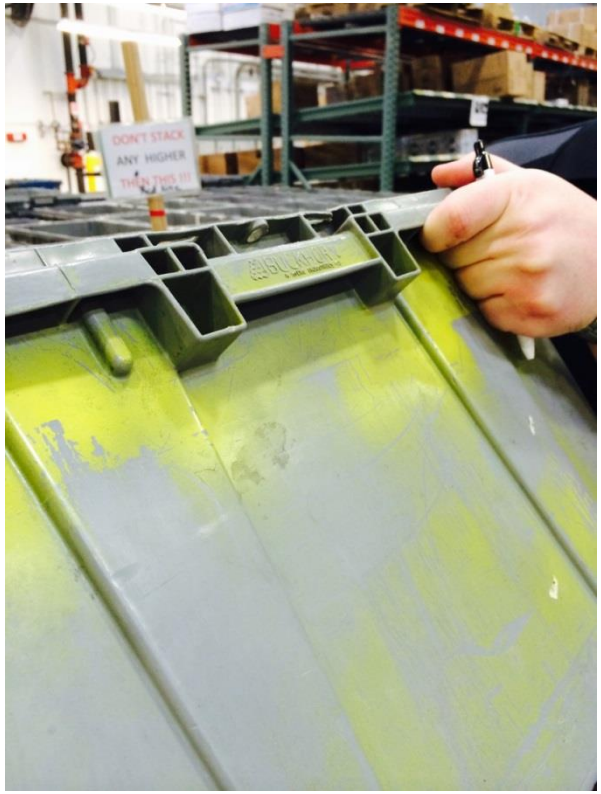
Ergonomic Guidelines used in product development
Pilot Team
Early Symptom Team
Kaizen Teams
Job Rotation
How is your health today ?

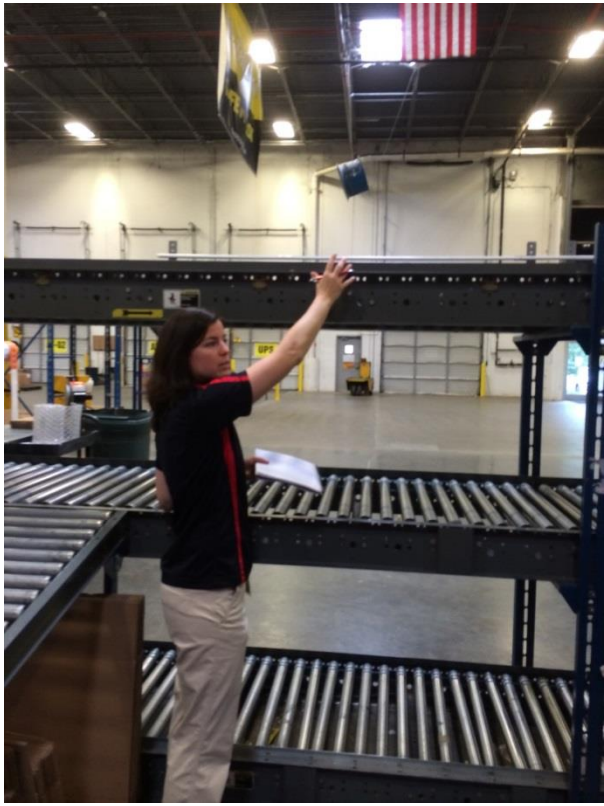
Results : 19% reduction in OSHA recordable incidents , Greater Productivity

So you didn’t think about Ergonomic design when you did your Lean work cell design..

What can you do now ???

Tote and Lifting Movement





Risk Evaluation factors

1. Kodak Score 12/29
2. NIOSH Lifting Limit 28lb @ 1.25 LI

Kodak Scores

Condition	X if a Concern	Comments
REPETITION		
High-speed process line or work presentation rates		
Similar motions every few seconds	✓	
Observed signs of fatigue		
WORKSTATION DESIGN		
Work surface too high or low	✓	
Location of materials promotes reaching	✓	
Angle/orientation of containers promotes non-neutral positions	✓	
Spacing between adjacent transfer surfaces promotes twisting	✓	
Obstructions prevent direct access to load/unload points		
Obstacles on floor prevent a clear path of travel		
Floor surfaces are uneven, slippery, or sloping		
Hoists or other power lifting devices are needed but not available	✓	

Condition	X if a Concern	Comments
LIFTING AND LOWERING		
Heavy objects need to be handled		
Handling bulky or difficult-to-grasp objects	✓	
Handling above the shoulders or below the knees	✓	
Lifting to the side or unbalanced lifting	✓	
Placing objects accurately/precisely	✓	
Sudden, jerky movements during handling		
One-handed lifting		
Long-duration exertions (static work)		
PUSHING/PULLING/CARRYING		
Forceful pushing/pulling of carts or equipment required		
Brakes for stopping hand carts/handling aids are needed but not available		
Carts or equipment design promotes non-neutral postures		
Long-distance carrying (carts not available)		
CONTAINERS/MATERIALS		
Lack adequate handles or gripping surfaces	✓	
Are unbalanced, unstable, or contents shift	✓	
Obstructs leg movement when being carried		
OTHER		
Inappropriate work techniques used		
Buildup of process material /product increases worker effort		
Personal protective equipment needed but not available/used		
TOTAL SCORE (Optional)		*To score, add up the total number of Xs identified.*

Lift Data

Data Entered

	Origin	Destination
Horizontal Location (in.)	0.00	10.00
Vertical Location (in.)	6.00	60.00
Angle of Asymmetry (deg)	0.00	0.00
Frequency (lifts per minute)	0.20	
Duration	2-8 hour	
Coupling	fair	
Weight of Object (lbs.)	35	

Multipliers

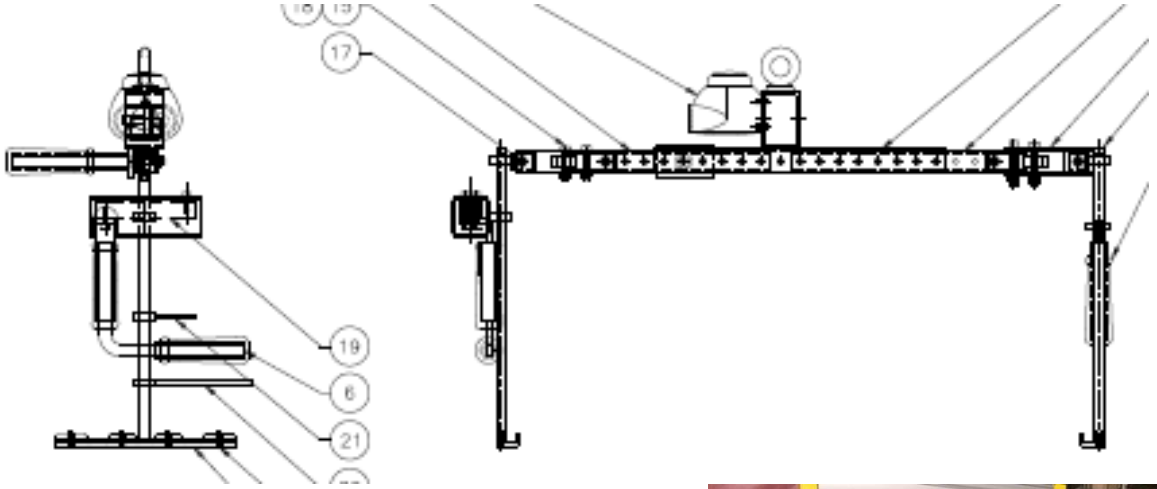
	Origin	Destination
Horizontal	1.00	1.00
Vertical	0.82	0.78
Rotation	1.00	1.00
Distance	0.85	
Frequency	0.85	
Coupling	0.95	

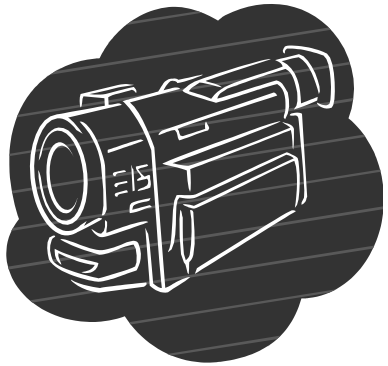
	Origin	Destination
Recommended Weight Limit (RWL)	28.82	27.24
Lift Index (LI)	1.21	1.29

Notes

No notes for this lift.

Tote and Lifting Movement Solution





Improved Risk Evaluation factors

1. Kodak Score 4/29 (-66%)
2. NIOSH Lifting Limit LI .07 (-94%)

Kodak Scores

Condition	X if a Concern	Comments
REPETITION		
High-speed process line or work presentation rates		
Similar motions every few seconds	✓	
Observed signs of fatigue		
WORKSTATION DESIGN		
Work surface too high or low		
Location of materials promotes reaching		
Angle/orientation of containers promotes non-neutral positions	✓	
Spacing between adjacent transfer surfaces promotes twisting	✓	
Obstructions prevent direct access to load/unload points		
Obstacles on floor prevent a clear path of travel		
Floor surfaces are uneven, slippery, or sloping		
Hoists or other power lifting devices are needed but not available		

Condition	X if a Concern	Comments
LIFTING AND LOWERING		
Heavy objects need to be handled		
Handling bulky or difficult-to-grasp objects		
Handling above the shoulders or below the knees		
Lifting to the side or unbalanced lifting		
Placing objects accurately/precisely		
Sudden, jerky movements during handling		
One-handed lifting		
Long-duration exertions (static work)		
PUSHING/PULLING/CARRYING		
Forceful pushing/pulling of carts or equipment required		
Brakes for stopping hand carts/handling aids are needed but not available		
Carts or equipment design promotes non-neutral postures		
Long-distance carrying (carts not available)		
CONTAINERS/MATERIALS		
Lack adequate handles or gripping surfaces		
Are unbalanced, unstable, or contents shift		
Obstructs leg movement when being carried		
OTHER		
Inappropriate work techniques used		
Buildup of process material /product increases worker effort		
Personal protective equipment needed but not available/used		
TOTAL SCORE (Optional)		*To score, add up the total number of Xs identified.*

Lift Data

Data Entered

	Origin	Destination
Horizontal Location (in.)	0.00	10.00
Vertical Location (in.)	6.00	60.00
Angle of Asymmetry (deg)	0.00	0.00
Frequency (lifts per minute)	0.20	
Duration	2-8 hour	
Coupling	good	
Weight of Object (lbs.)	2	

Multipliers

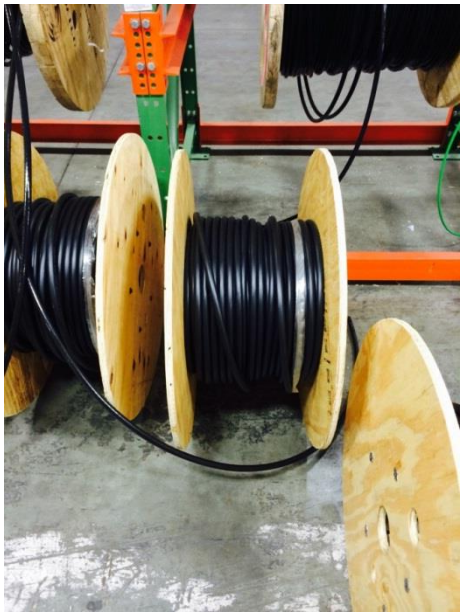
	Origin	Destination
Horizontal	1.00	1.00
Vertical	0.82	0.78
Rotation	1.00	1.00
Distance	0.85	
Frequency	0.85	
Coupling	1.00	

	Origin	Destination
Recommended Weight Limit (RWL)	30.33	28.67
Lift Index (LI)	0.07	0.07

Notes

Warehouse solution

Wire Spool Movement



Risk Evaluation factors

1. Kodak Score 13/29
2. NIOSH Lifting Limit 36 lb 1.5LI

Kodak Scores

Condition	X if a Concern	Comments
REPETITION		
High-speed process line or work presentation rates		
Similar motions every few seconds		
Observed signs of fatigue		
WORKSTATION DESIGN		
Work surface too high or low	✓	
Location of materials promotes reaching	✓	
Angle/orientation of containers promotes non-neutral positions	✓	
Spacing between adjacent transfer surfaces promotes twisting	✓	
Obstructions prevent direct access to load/unload points		
Obstacles on floor prevent a clear path of travel		
Floor surfaces are uneven, slippery, or sloping		
Hoists or other power lifting devices are needed but not available	✓	

Condition	X if a Concern	Comments
LIFTING AND LOWERING		
Heavy objects need to be handled	✓	
Handling bulky or difficult-to-grasp objects	✓	
Handling above the shoulders or below the knees	✓	
Lifting to the side or unbalanced lifting	✓	
Placing objects accurately/precisely	✓	
Sudden, jerky movements during handling	✓	
One-handed lifting		
Long-duration exertions (static work)		
PUSHING/PULLING/CARRYING		
Forceful pushing/pulling of carts or equipment required		
Brakes for stopping hand carts/handling aids are needed but not available		
Carts or equipment design promotes non-neutral postures		
Long-distance carrying (carts not available)		
CONTAINERS/MATERIALS		
Lack adequate handles or gripping surfaces	✓	
Are unbalanced, unstable, or contents shift		
Obstructs leg movement when being carried	✓	
OTHER		
Inappropriate work techniques used		
Buildup of process material /product increases worker effort		
Personal protective equipment needed but not available/used		
TOTAL SCORE (Optional)		*To score, add up the total number of Xs identified.*

Lift Data

Data Entered

	Origin	Destination
Horizontal Location (in.)	5.00	5.00
Vertical Location (in.)	12.00	40.00
Angle of Asymmetry (deg)	0.00	0.00
Frequency (lifts per minute)	0.10	
Duration	< 1 hour	
Coupling	poor	
Weight of Object (lbs.)	55	

Multipliers

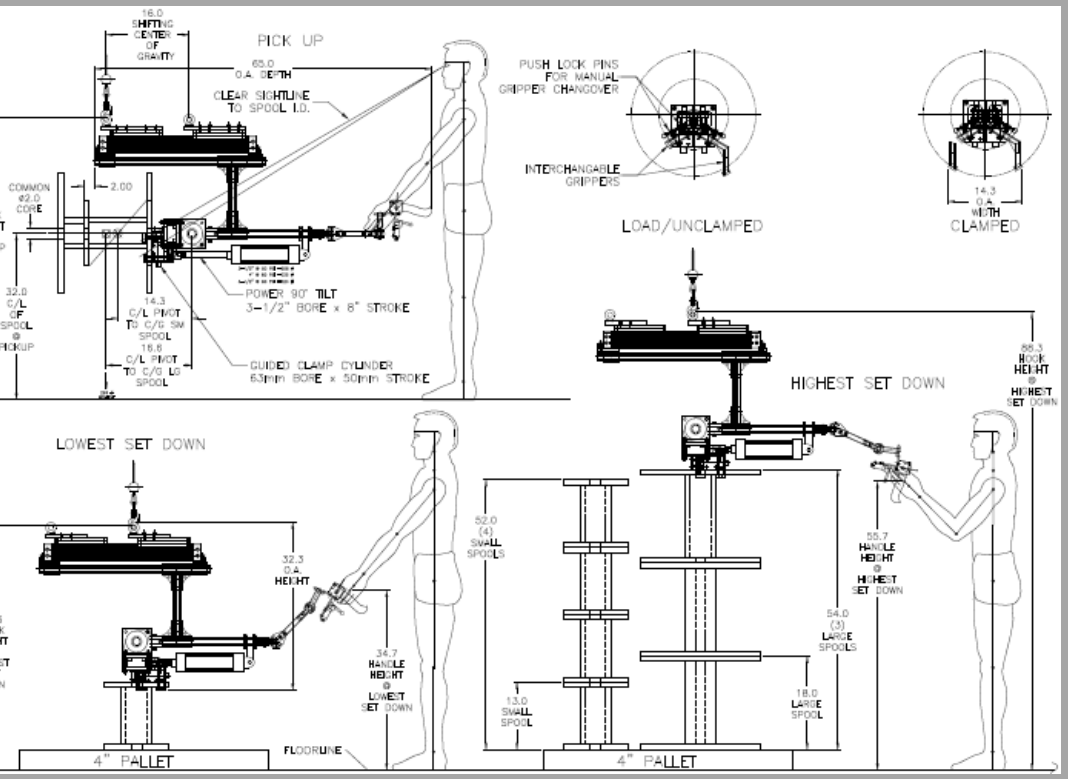
	Origin	Destination
Horizontal	1.00	1.00
Vertical	0.86	0.92
Rotation	1.00	1.00
Distance	0.88	
Frequency	1.00	
Coupling	0.90	

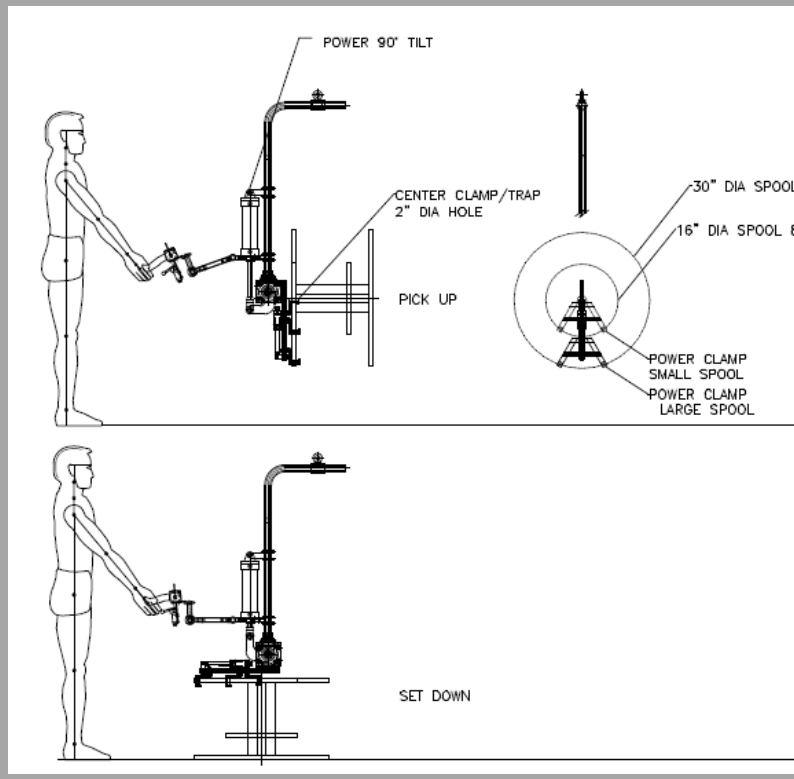
	Origin	Destination
Recommended Weight Limit (RWL)	35.11	37.54
Lift Index (LI)	1.57	1.46

Notes

Wire spool ... No solution

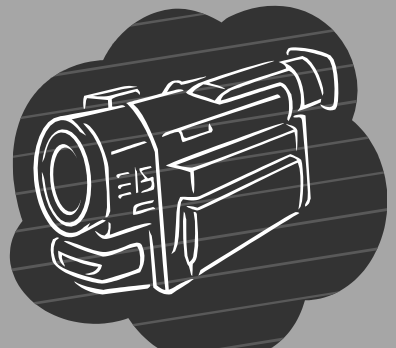
Wire Spool Lifting Solution





Improved Risk Evaluation factors

1. Kodak Score 4/29 (-69%)
2. NIOSH Lifting Limit .13 LI (-91%)



Kodak Scores

Condition	X if a Concern	Comments
REPETITION		
High-speed process line or work presentation rates		
Similar motions every few seconds		
Observed signs of fatigue		
WORKSTATION DESIGN		
Work surface too high or low		
Location of materials promotes reaching		
Angle/orientation of containers promotes non-neutral positions	✓	
Spacing between adjacent transfer surfaces promotes twisting	✓	
Obstructions prevent direct access to load/unload points		
Obstacles on floor prevent a clear path of travel		
Floor surfaces are uneven, slippery, or sloping		
Hoists or other power lifting devices are needed but not available		

Condition	X if a Concern	Comments
LIFTING AND LOWERING		
Heavy objects need to be handled		
Handling bulky or difficult-to-grasp objects		
Handling above the shoulders or below the knees	✓	
Lifting to the side or unbalanced lifting		
Placing objects accurately/precisely		
Sudden, jerky movements during handling	✓	
One-handed lifting		
Long-duration exertions (static work)		
PUSHING/PULLING/CARRYING		
Forceful pushing/pulling of carts or equipment required		
Brakes for stopping hand carts/handling aids are needed but not available		
Carts or equipment design promotes non-neutral postures		
Long-distance carrying (carts not available)		
CONTAINERS/MATERIALS		
Lack adequate handles or gripping surfaces		
Are unbalanced, unstable, or contents shift		
Obstructs leg movement when being carried		
OTHER		
Inappropriate work techniques used		
Buildup of process material /product increases worker effort		
Personal protective equipment needed but not available/used		
TOTAL SCORE (Optional)		*To score, add up the total number of Xs identified.*

Lift Data

Data Entered

	Origin	Destination
Horizontal Location (in.)	5.00	5.00
Vertical Location (in.)	12.00	40.00
Angle of Asymmetry (deg)	0.00	0.00
Frequency (lifts per minute)	0.10	
Duration	1-2 hour	
Coupling	good	
Weight of Object (lbs.)	5	

Multipliers

	Origin	Destination
Horizontal	1.00	1.00
Vertical	0.86	0.92
Rotation	1.00	1.00
Distance	0.88	
Frequency	0.95	
Coupling	1.00	

	Origin	Destination
Recommended Weight Limit (RWL)	37.06	39.63
Lift Index (LI)	0.13	0.13

Notes

No notes for this lift.

Conclusion

- Lean manufacturing practices can benefit ergonomics if practiced the correct way
- Lean in RAW form is detrimental to Ergonomics
- WMSD's are common but preventable in a Lean environment
- Lean can be beneficial to Ergonomics in MVI
- PDCA
- Abate your Ergonomic issues

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