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Post Project Ergonomic Evaluation
Hamann Angus Ranch
Mint Trailer Landing Gear Power Unit
November 2001

An on-site ergonomic evaluation of the task of raising/lowering truck trailer landing gear using the new air powered tool was conducted at Hamann Angus Ranch on November 12, 2001. This was done at the request of Don Hulick, Manufacturing Consultant from OMEP, as a part of an Oregon OSHA Worksite Redesign Grant project for this company, with the goal of reducing the risk of MSD injuries. Videotaping and digital photos of the use of the tool were conducted and are available for review. Employee discomfort surveys were completed.

Purpose/Background:

The purpose of this evaluation is to provide an assessment and documentation of the improvements in the Musculoskeletal Disorder (MSD) risk factors associated with the use of this new device.

General Description:

Truck drivers couple and uncouple trailers used to haul and process mint, up to 24 times per shift. Each time, the trailer landing gear must be raised or lowered. Now, using the new landing gear power tool, the driver attaches the air hose to the tool, places the end device (modified nut driver socket) on the landing gear drive shaft and while gripping the handles, activates the tool with the finger trigger switch. The landing gear can be operated in either high or low gear. The tool torque can be changed from high to low as needed with an air pressure regulator, and speed can be varied by the amount of force on the trigger switch. Thus, using this tool, all manual cranking of the landing gear has been eliminated.

Work Environment and Equipment: Relevant dimensions:

Work is performed outdoors during mint harvest (summer)
Center pivot point of landing gear is approximately 36" high (when truck and trailer are coupled)

Device Description:

<u>Air powered landing gear tool</u>:
- Handles-16” long (end to end)
- Handle diameter- 1 ¼” – 1 ½” (padded)
- Tool length 15 ½”
- Tool weight- 8 pounds

The improvements in risk of musculo-skeletal injury due to the implementation of this new tool include:

1. Forces and Loads- have been nearly eliminated other than that required to hold and manipulate the 8 pound tool. This has removed the significant sustained muscle loading of the trunk extensors while bending forward and of the muscles in the dominant upper extremity while grasping and turning the crank handle with the manual method.

2. Repetition- movements related to grasping and rotating the crank handles affecting the back, shoulders, arms, wrists and hands have been eliminated by the use of the new tool.

3. Awkward postures- Have been nearly eliminated by the removal of the manual cranking task. These postures previously included frequent bending and twisting of the trunk, extension and rotation of the neck, reaching forward with the dominant shoulder, elbow flexion/extension and wrist flexion/extension related to turning the crank handle. The Rapid Upper Limb Assessment (RULA)* results improved from the worst rating (action level 4, using the manual cranking method) to the best rating (action level 1, using the new powered landing gear tool).

4. Posture and Body Mechanics- workers are now generally able to utilize good body mechanics technique, maintaining an upright posture, holding the tool handles close to the body at waist level.

The power landing gear tool is capable of generating significant torque which, fortunately, can be adjusted and controlled by managing the air pressure, selecting the appropriate tool gear (high vs. low) and controlling the variable speed of the tool by the trigger pressure. Without these features, the torque could be excessive and difficult to manage, imposing significant forces and loads on the upper body musculature.

The following design principles for hand tools have been well incorporated into this device:

Hand Tool Design Principles

1. Maintain neutral joint postures- Avoid tool designs that cause awkward wrist, forearm and shoulder positions. The hands should remain in front and close to the body, elbows near the trunk and not raised, shoulders should stay relaxed, not elevated. The neck should not have to bend severely downward, sideward or rotate significantly to see while operating the tool.

2. Use the appropriate muscle groups- Use larger muscle groups (i.e. the whole hand or arm) when exerting higher levels of force. Use smaller muscle groups (i.e. the fingers) when doing fine precision work. Design tools to be used by the entire hand rather than individual fingers. Design in low trigger forces if the trigger is used repetitively. Use trigger “strips” or 2-finger triggers for repetitive work rather than single finger triggers.

Hand tool principles cont.

3. Use proper grips- The grip orientation should encourage maintenance of neutral joint postures. The handles should extend from either side of the hand when in use. Recommended handle diameter is 1.5" for power grip (whole hand) with an acceptable range of 1.25" to 2". Recommended diameter for precision grip (finger pinch) is .45" with an acceptable range of .3 to .6" Grip span for tools with two grips like pliers and strippers should not exceed 3.5" grip span. For maximum grip force the ideal span is between 2.5" and 3.5".

4. Design adequate grip surfaces- Mildly compressible, slightly textured handles enhance gripping ability, minimizing slip. Grips should be non-conductive to heat and electricity. Avoid using finger recesses on the gripping surface.

5. Minimize repetitions- Design tools that can be used by either hand to split the workload. Consider incorporating foot controls to reduce repetitive hand movements. Minimize repetitive gripping and squeezing (use power when possible).

6. Minimize the amount and duration of force- Avoid static muscle loading associated with the tool use. (Minimize tool weight or use tool balancers for heavy tools). For precision operations, tools should not weigh over 1 pound.

7. Allow sufficient hand clearance- Be careful that the tool use does not cause pinch points, contact to hot surfaces or sharp materials.

8. Eliminate pressure points on hands and fingers- Pressure points (contact stress) on fingers and palms of hands can cause localized damage to nerves and blood vessels. Minimize exposure through padded and rounded edges. Be careful not to increase recommended grip diameters by added padding.

9. Use power tools rather than human muscle- Mechanical energy is more efficient than human energy while minimizing exposure to repetition and force risk factors. Power cords should be flexible and not interfere with the job.

Employee Discomfort Survey: <u>Pre Project</u>

Job Title- Field hand/Driver Number of surveys completed N= **9**

Discomfort Area	Number of employees with discomfort	Percentage of total	Average Rating (0-10 scale)
Neck	6	67%	4.8
Shoulder	9	100%	7.0
Chest	3	33%	5.3
Elbow/forearm	8	89%	6.0
Hand/wrist	9	100%	5.1
Upper back	7	78%	5.1
Lower back	9	100%	6.6
Hip/thigh	7	78%	3.4
Knee	5	56%	3.6
Lower leg	4	44%	3.3
Ankle/foot	4	44%	2.3

Average Rating= 4.8

Employee Discomfort Survey: <u>Post Project</u>

Job Title- Field hand/Driver Number of surveys completed N= **7**

Discomfort Area	Number of employees with discomfort	Percentage of total	Average Rating (0-10 scale)
Neck	2	29%	3.5
Shoulder	2	29%	3.5
Chest	0	0%	NA
Elbow/forearm	3	43%	5.7
Hand/wrist	3	43%	6.0
Upper back	1	14%	2.0
Lower back	0	0%	NA
Hip/thigh	0	0%	NA
Knee	0	0%	NA
Lower leg	0	0%	NA
Ankle/foot	0	0%	NA

Average Rating= 4.1

Employee Discomfort Survey Summary

The pre and post project employee discomfort surveys indicate a substantial decrease in the number of areas of reported discomfort and in the severity of discomfort (15% reduction in average over-all rating) after the project improvements were completed. Four employees now report no discomfort whatsoever related to the operation of trailer landing gear following implementation of the improvements. This is a very positive and important measurement of the success of this project.

Job Hazard Analysis Tools Utilized

Rapid Upper Limb Assessment (RULA)* results: Action level = **1** (rating score **2**).

A RULA rating score of 2 (on a scale of 1-7) results in a RULA action level of 1. This is the lowest possible action level classification (on a 1-4 classification scale) and results in an assessment that "the posture is acceptable if it is not maintained or repeated for long periods".

**See Applied Ergonomics 1993, 24(2), 91-99, "RULA: a survey method for the investigation of work-related upper limb disorders" RULA is a survey method developed for use in ergonomics investigations of workplaces where work-related upper limb disorders are reported. This tool requires no special equipment in providing a quick assessment of the postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicated the level of intervention required to reduce the risks of injury due to the physical loading on the operator.*

The Requirements for action into which the grand scores are divided is summarized into action levels as follows: (The action level leads in most cases, to proposals for a more detailed investigation)

Action level 1- A score or 1 or 2 indicates that posture is acceptable if it is not maintained or repeated for long periods

Action level 2- A score of 3 or 4 indicated that further investigation is needed and changes may be required.

Action level 3- A score of 5 or 6 indicated that investigation and changes are required soon.

Action level 4- A score of 7 indicates that investigation and changes are required immediately.

Worksite Redesign Project Completion Summary

The evaluation of MSD risk factors identified above and the RULA results, combined with the discomfort survey results indicate that the engineering controls and related work processes involving the use of the new powered landing gear tool have been very successful. All of the goals for this tool outlined in the initial ergonomic evaluation report have been accomplished with this device. The MSD risk factors have been substantially reduced. Employees and management indicate satisfaction in the over-all outcome of the engineering changes.

For further assistance or questions regarding this report please contact Rob Strickland, 503-667-3564.

Respectfully,

Rob Strickland, OTR
Ergonomic Specialist

Photos

Figure 1

Landing Gear Air-Powered Tool attached to landing gear drive shaft

Figure 2

Typical operating position, standing upright with arms close to body