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Post-Project Ergonomic Evaluation
PED Manufacturing Ltd.
Improved Investment Casting Sawing Process
December 2001

An on-site ergonomic evaluation of the new investment casting sawing process was conducted at PED Mfg. on December 18th at the request of Mark Biederbeck, Manufacturing Consultant and Project Director from OMEP. Videotaping and digital photos of the work tasks 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 Musculoskeletal Disorder (MSD) risk factors associated with the use of this device as compared to the old (manual) method. This is being done as part of the Oregon OSHA Worksite Redesign Program Grant which has been awarded to PED. The intended goal of this project is to make engineering improvements to reduce the identified health, safety and MSD risk factors in order to prevent work injury.

General Description: The new task involves the following job steps:

1. Carry casting to cutoff saw and place on part platform
2. Align part on platform using laser for proper positioning
3. Close doors and operate/adjust controls on instrument panel
4. Monitor cutting of parts through window
5. If needed, open doors & shake casting ring off saw
6. Pick up small parts from far end of conveyor and arrange on tray
7. Place tray of parts on racking
8. Pick up scrap parts from conveyor & throw away into bin or on pallet

Repeat this process with a new casting at a rate of approximately once every 14 minutes

Device Description and Relevant Dimensions:

Part table holding castings 32" high
Casting without shell material 20 lb. – 44 lb.
Part platform in casting saw 37” high (12” reach)
Weight of individual parts varies from less than a pound to 5 lb. or more
Typical daily production rate = 72 parts per hour
Number of parts on each casting is variable (average 12 per casting).

The primary health, safety and ergonomic improvements resulting from the new casting saw include:

Elimination of potential contact with the cutting blade
Reduction in exposure to metal dust
Elimination of exposure to heat from the saw blade
Reduction in noise exposure
Elimination of pushing forces related to manually cutting parts with the saw
Significant reduction in awkward and static postures

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

1. *Awkward/ static postures*- forward flexion of the spine (lumbar, thoracic and cervical), flexion of the shoulders and extension of the wrists related to manipulation and pushing of castings through the saw **have been eliminated**.

2. *Forces and Loads*- sustained muscle loading of the arms, trunk and legs while leaning forward and pushing the alloy castings through the band saw **have been eliminated.**

3. *Repetition*- repetitive movements of the arms and hands to manipulate and push the alloy castings through the saw **have been eliminated**

4. *Pressure points*- hard metal castings against soft tissues of hand, edges of metal cutting platform against elbows and forearms **have been significantly reduced**

5. *Vibration*- exposure to vibration generated from the band saw through the castings **has been eliminated.**

6. *Posture and Body Mechanics*- workers are now generally able to maintain good body mechanics technique (standing upright while moving around between parts table, knockout booth, casting saw and conveyor, monitoring the equipment).

7. *Muscle Recovery Time*- very much improved because of the shift from the manual work of sawing (old process) to loading and monitoring machinery in the new process.

Job Hazard Analysis Tools Utilized

Snook Push/Pull Hazard Tables*

This tool was <u>not</u> used on the Post-Project Ergonomic Evaluation because the pushing requirements have been eliminated with the new casting saw. (See Initial Ergonomic Evaluation Report)

***See "The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces," Snook, S.H. and Ciriello, V.M., Ergonomics, 1991, 34 (9): 1197-1213.*

Rapid Upper Limb Assessment (RULA)* results: Class 2 (rating score 3).

A RULA rating score of 3 is considered a *class 2*, second best possible rating (2 on a 1-4 classification scale). This is a very significant improvement by two classifications, over the old manual sawing method.

**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.*

Strain Index Analysis results* Strain Index (SI score) = 3

An SI Score of 3 or less is the lowest classification and is rated *"probably safe"* in terms of risk for distal upper extremity disorders. This is a very significant improvement compared to a score of 27 with the old manual sawing process.

***See American Industrial Hygiene Association Journal 56:443-458 (1995) "The Strain Index: A Proposed Method to Analyze Jobs for Risk of Distal Upper Extremity Disorders". The Strain Index is a semi-quantitative job analysis methodology that results in a numerical score (SI score) that is believed to correlate with the risk of developing distal upper extremity disorders. The index is based on multiplicative interactions among its task variables, consistent with physiological, biomechanical, and epidemiological principles. The SI score represents the product of (1) intensity of exertion, (2) duration of exertion, (3) exertions per minute, (4) hand/wrist posture, (5) speed of work, and (6) duration of task per day. Preliminary testing has revealed that jobs associated with distal upper extremity disorders had SI Scores greater than 5. SI Scores less than or equal to 3 are probably safe. SI Scores greater than or equal to 7 are probably hazardous.*

Remaining physical demands and musculo-skeletal disorder (MSD) risk factors:

1. *Awkward postures*- Trunk flexion occurs if the worker prematurely retrieves small parts from the lower end of the conveyor (emerging from the cutoff saw) rather than waiting for the parts to arrive at the far end.

2. *Forces and Loads*- lifting and carrying the casting presents a minor ergonomic hazard while placing it on the platform of the casting saw. This is essentially unchanged from the old manual method.

Employee Discomfort Survey Results

Pre-project: Job Title- Saw Operator Number of surveys completed= **2**

Discomfort Area	Number of employees with discomfort	Percentage of the total (n= **2**)	Average Rating (0-10 scale)
Neck	1	50%	3
Shoulder	2	100%	3.5
Upper back	0	0%	NA
Lower back	1	50%	4
Elbow/forearm	2	100%	4
Hand/wrist	1	50%	6
Hip/thigh	0	0%	NA
Knee	1	50%	5
Lower leg	0	0%	NA
Ankle/foot	0	0%	NA

Employee Discomfort Survey Results: (Post Project)
Job Title- **Saw Operator** Number of surveys completed= **1**

Only one employee has been using the new cutoff saw. He now reports no discomfort other than mild low back discomfort (rated at 3 on 0-10 scale). He noted in the comments of the survey- *"much better than when operating friction saw!"*

Employee Discomfort Survey Summary

Although the sample size for both surveys was small, the results do indicate that at least for the one employee using the new saw, a substantial benefit has been realized by the near elimination of task related discomfort. This benefit is directly attributable to the expanded job tasks and ergonomic improvements that have occurred with the new casting saw.

Worksite Re-design Project Completion Summary

The reduction (or elimination) of health and safety hazards and reduction in MSD risk factors as discussed above, combined with the favorable discomfort survey results, indicate that the engineering controls involving the new investment casting saw have been very successful. The device has met all of the original goals for the project. It is efficient, simple to operate and has not created any additional MSD risk factors. The employee who has used the device reports high satisfaction in the over-all outcome of the engineering improvements. Early indications are that productivity levels are increased and will continue to increase as the engineering improvements are fully integrated into the production flow.

Additional Recommendations:
Engineering controls

None recommended.

Administrative controls

Provide body mechanics training for employee(s), reinforcing the need to wait for small parts to emerge from the far end of the conveyor rather than pre-maturely picking them up from the lower end of the conveyor (which causes bending and unnecessary carrying of parts).

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

Respectfully,

Rob Strickland, OTR
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Photos

Figure 1

Placing casting on platform in new enclosed casting saw

Figure 2

Arranging individual parts on tray at end of conveyor