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Ergonomic Evaluation
Electronics Assemblers Inc.
Wire Stripping Workstation
April 2001

A worksite visit was conducted at Electronics Assemblers Inc, (EAI) on April 24, 2001 to evaluate the manual wire stripping tasks. This was done at the request of Mark Biederbeck, Manufacturing Consultant from OMEP as a part of an Oregon OSHA Worksite Redesign Grant project for this facility. 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 initial assessment of the musuculo-skeletal disorder (MSD) risk factors associated with the manual wire stripping process. These job tasks have resulted in one carpal tunnel case and five other work injury claims. Numerous employee complaints have been reported involving hands, wrists, forearms, elbows, shoulders, neck, upper and lower back. EAI intends to improve this job process in an effort to reduce the incidence of MSD injuries.

General Description & Observations:

Employees sit on padded office chairs at a table, elbows resting on the table top. The employee picks up and holds a bundled wire (multiple strands) with the non-dominant hand and uses a wire stripping tool with the dominant hand to manually strip the end of each wire. In many cases, the stripper is used to simply create a small gap in the insulation rather than removing the insulation from the end of the wire. The task is tedious and repetitive.

Work Environment and Equipment: Relevant dimensions

Work is performed in-doors in heated (not cooled) environment. (Can become hot in summer months)
Work tables are 32.5" high
Chairs are various older style, padded office chairs without arm rests

The primary physical demands likely to contribute to risk of musculo-skeletal injury include:

1. Awkward/ static postures- significant, prolonged, static positioning- sitting at a fixed height table while manipulating wire bundles and a wire stripper. Moderate neck flexion, shoulder flexion & wrist extension.

2. Forces and Loads- sustained & repetitive muscle loading of the neck, shoulders, forearms, hands and fingers to manipulate and hold wire bundles and wire stripper.

3. Repetition- highly repetitive, generally small movements of forearms, wrists and hands to manipulate wire stripper.

4. Pressure points- hard metal wire stripping tool against soft tissues of hand and fingers and hard surfaces & edges of the workstation tables against elbows and forearms.

Job Hazard Analysis Tools Utilized

Rapid Upper Limb Assessment (RULA)* results: Action level score 2, (rating score 4).

A RULA rating of 4 (on a scale of 1-7) results in a RULA class score of 2. This results in a recommendation of "investigate and changes may be required"

*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)= 20.3

An SI Score above 7 is the highest classification and is rated hazardous in terms of risk for distal upper extremity disorders.

*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.

Employee Discomfort Survey Results:

Job Title: Assembler Number of surveys completed= 10

Discomfort Area	Number of employees with discomfort	Percentage of the total (19)	Average Rating (0-10 scale)
Shoulder	10	10%	6.6
Hand/wrist	7	70%	7.2
Neck	7	70%	6.7
Elbow/forearm	5	50%	7.0
Upper back	3	30%	7.0

Lower back	3	30%	7.7
Eyes	2	20%	7.5
Hip/thigh	1	10%	6.0

These identified ergonomic risk factors, job hazard analysis tool results, discomfort survey results and EAI claims data together indicate a need for engineering controls to eliminate or greatly reduce worker exposure to this task.

Recommendations:
Engineering controls

Design and build a new, mechanized small wire stripping tool as per section C of the Worksite Re-design Grant Application, which will eliminate the manual gripping and pulling currently required of the manual tool. (Please see design goals listed as "favorable attributes would include" as stated in the Grant Application). The device should be efficient, simple to operate and not create additional MSD risk factors.

The following design principles for hand tools should be incorporated to the extent that they are feasible:

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.

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.

Hand tool design principles (cont.)

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.

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

Respectfully,

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