

Rob Strickland, OTR
Ergonomics Consulting

27422 SE Division Drive
Gresham, Or. 97030
503-667-3564

DRAFT

Post Project Ergonomic Evaluation
Electronics Assemblers Inc.
Wire Stripping Tool
June 2002

An on-site ergonomic evaluation of the task stripping wires and cables using the new pneumatic wire stripping tool was conducted at EAI Inc. on June 24, 2002. 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 company, with the goal of reducing the risk of MSD injuries. Videotaping and digital photos of the use of the device were conducted and are available for review.

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:

The wire stripping tool is used to cut and separate or remove wire insulation material without having to manually squeeze and pull the tool. The device can be hand held for easy manipulation or, bench mounted in a fixture. It can be activated by a finger switch on the tool handle or by a foot switch. After the tool has been adjusted for the specific wire gauge and stripping requirements, the individual wires are inserted one at a time into the tool bushing. The tool is activated and the wire insulation is cut and separated. The wire is removed and the process is repeated.

Work Environment:

Work is performed indoors at a table. The worker sits in a chair holding the tool or securing it in a bench mounted fixture.

Device Description and Relevant Dimensions:

Tool: IDEAL Pow-R-Lite #45-850, air powered
Weight= 2.0 lb.
Handle- 4.25" long, 1.25 " square with rounded edges.
Vinyl covering over handle to reduce exposure to cold/hard metal
Finger trigger bar- 3.75" long X .5" wide- very light pressure to activate
Tool Fixture- adjustable tool positioning in all planes of movement
Tool Fixture height- 4.25" above table surface

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

1. Awkward postures- have been minimized by allowing the worker choice of a hand held tool or bench mounted tool depending on the task and application. This allows the worker to use hands and arms in near neutral postures.
2. Static postures- Workers continue to be exposed to mild static postures of sitting at a fixed height table while holding and manipulating wire cables or the tool.
3. Forces and Loads- have been substantially reduced by eliminating repetitive squeezing of the wire stripper and pulling the wire and stripper to remove insulation. This is accomplished automatically by air power with the new tool. Light, fine manipulation of wire with fingers and low force is used to activate tool with hand or foot switch.
4. Repetition- Fewer movements are required to strip wires, reducing manual manipulation to simply inserting wires into the tool, and removing them (especially when the tool is mounted in the fixture).
5. Pressure points- Workers continue to be exposed to mild contact pressure from workstation edges & surfaces against forearms or elbows. This can easily be ameliorated by the addition of corner and surface padding material (see recommendations).

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.
- 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".

Hand tool Principles (cont)

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: Pre Project

Job Title- Assembler- heat shrink Number of surveys completed= 10

Discomfort Area	Number of employees with discomfort	Percentage of total	Average Rating (0-10 scale)
Shoulder	10	100%	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

Average rating = 7.0

Employee Discomfort Survey: Post Project

Due to business slow-down and lack of wire stripping projects prior to the time of the post-project survey, no post –project employee discomfort surveys were completed. This could be done in the future after a period of production using the tool.

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”. This is a substantial improvement over the pre-project RULA score of 4 (action level 2).

**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 of 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)= **1.5**

An SI Score below 3 is the lowest classification and is rated “probably safe” in terms of risk for distal upper extremity disorders. This also represents a marked improvement over the pre-project Strain Index score of 13.5.

Strain Index (cont)

*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.

Worksite Redesign Project Completion Summary

The evaluation of MSD risk factors identified above combined with the RULA and Strain Index results, indicate that the engineering controls and related work processes involving the use of the new pneumatic wire stripping 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.

Additional suggestions/ideas:

1. Provide a few standing height workstations which employees can choose while operating the equipment to minimize the physical stresses of static sitting positioning for prolonged periods.
2. Provide foot bars, platforms or moveable foot rests where possible underneath workstations to allow an alternating, foot-up position (4"-6" high) while standing.

Note: 1 & 2 above are suggestions made for EAI to respond to if able, and as such are not considered part of the Worksite Redesign Grant changes.

3. Provide edge and surface padding to reduce contact pressure to elbows and forearms.
4. Consider replacing the vinyl handle cover with expendable padded tool wrap material which provides non-slip grip and softer padding surface.
5. Consider adding a quick release suction mounting feature to the bench mounted tool fixture.
6. Provide employee training in best practices for optimal positioning, neutral postures and body mechanics using the new tools.

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

Respectfully,

Rob Strickland, OTR
Ergonomic Specialist