

**Post Project Ergonomic Evaluation**  
**Luhr Jensen & Sons Inc.**  
**Weld Ring Form/Weld Station**  
**April 2002**

An on-site ergonomic evaluation of the new semi-automated Weld Ring workstation was conducted at Luhr Jensen Inc. on April 4, 2002 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 Luhr Jensen. 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 semi-automated weld ring workstation performs the forming and welding of the ring in a semi-enclosed, ventilated chamber. This device has eliminated the tasks related to manually forming and welding the rings. Thus, the ergonomic risk factors and health/safety issues previously identified with those tasks have been completely eliminated. The tasks related to attaching weld rings to lures and hooks has been improved to reduce many of the awkward postures and forces previously used in the old manual methods.

**Device Description/ Relevant dimensions:**

Weld Ring workstation overall dimensions- 33.5 " wide X 41.5" deep (footprint)

Workstation work platform- 33.5" wide X 10" deep at 26" vertical height from floor

Indexing table contains 4 weld ring fixtures evenly spaced (on the quarter hour positions)

Effective work height of each weld ring fixture is 41" vertical height from floor

Reach distance from front of platform is 12.5"

Safety Light Curtain located across the front in the vertical plane prevents inadvertent hand/finger contact with the moving parts of the device

Foot pedals are approximately 4.75" wide at the front X 5.5" deep X 1.75" high. (They are secured to a plywood base on the floor but can be repositioned/re-secured for optimal positioning)

Fully adjustable ergonomic chair- Steelcase Criterion

**Work flow process:** The worker now sits at the workstation and by activating a foot pedal on the left, lowers a positioning jig into place next to one of four weld ring fixtures on the workstation turntable. If there is a completed part present, that part is dropped onto a shelf for the operator to place into a bin or rack. The new ring is placed into the fixture and turned to contact the jig assuring the correct forming/welding orientation. (This may be done with fine manipulation of fingers or with the aid of pliers). Additional lure components (e.g. spoon bodies, hooks) are then manually placed onto the ring at the split opening. The operator then presses the right foot switch to index the station to allow loading of the next station. After passing by an idle station, the ring is first automatically formed closed and then welded by a plasma welding system. After the batch of lures have had one weld ring attached and welded, the entire process is repeated with a second weld ring and hook being attached to the opposite end.

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

The ergonomic risk factors and health/safety issues related to the tasks of welding rings to lures (identified in the initial ergonomic evaluation report- "Operator 2" tasks) have been completely eliminated since the new semi-automated weld ring workstation performs these steps.

"Operator 1" tasks (identified in the initial ergonomic evaluation report) related to attaching rings to lures and hooks have been modified substantially with the improved workstation and new processes and do not require the use of pliers. The lure fixture holds the ring securely (mechanically). One hand turns the ring to the proper welding orientation while the other hand places the lure or hook through the ring opening (slit). The observed upper extremity movements and postures, while not described as "neutral" are considerably improved over the old manual methods. (The wrists and forearms do not pronate, flex, extend or deviate to the same degree as the old manual method using pliers).

The forces and loads (muscular effort) have been significantly improved by making it easier to attach the lures and hooks without having to hold and close the ring with pliers. (The device does all of the work of holding and closing the ring).

Repetition has been reduced by requiring fewer manual movements of hands and fingers to attach the rings. Each hand can perform separate and independent functions rather than being simultaneously involved in one operation (i.e. using both hands with pliers to close a ring) resulting in improved movement efficiencies.

Pressure points have been eliminated from forearms and elbows by use of padded arms of the chair. Exposure to pressure points of the palmar surface of the hands has been reduced (or eliminated) by the employee's choice of whether to use pliers in the operation at all.

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

1. Static postures/positioning- sitting at the workstation while reaching forward and back to place lures and hooks on rings in the fixture
2. Awkward postures- mild deviations from neutral include wrist extension & ulnar deviation, forearm pronation & shoulder forward flexion while performing these operations
3. Forces and Loads- mild muscular exertions involving the arms to reach forward, the fingers to manipulate the rings into the fixture and to manipulate lures and hooks into the ring slit
4. Repetition- moderate repetitive movements of upper extremities to perform the operations described above
5. Pressure points- mild contact pressure of the weld ring against soft tissues of first & second finger tips and thumb of right hand

**Employee Discomfort Survey Results: (Pre Project)**

**Job Title-** Weld Ring Assembly **Number of surveys completed: N= 4**  
*(A pain rating scale of 0 to 10 was used to estimate level of discomfort intensity)*

One employee reported no discomfort (2<sup>nd</sup> day on the job)  
Three employees reported hand/wrist discomfort, rated 1 or 2  
Two employees reported shoulder/upper back discomfort rated 2 or 3  
One employee reported neck discomfort rated 2

**Employee Discomfort Survey Results: (Post Project)**

**Job Title-** Weld Ring Assembly **Number of surveys completed: N= 3**

One employee reported no discomfort  
One employee reported discomfort in the upper back and lower back, rated 4  
One employee reported discomfort in the neck (rated 3) and left hand (rated 1)

**Employee Discomfort Survey Summary**

Because of the very small sample size, it is difficult to arrive at any strong conclusions about the survey results. It appears that with the new workstation, employee discomfort has generally shifted away from hand and wrist locations and is otherwise essentially unchanged.

## Job Hazard Analysis Tools Utilized

### **Rapid Upper Limb Assessment (RULA)\* results: Rating score 3 (Action level 2).**

A RULA rating score of **3** (on a scale of 1-7) results in a RULA action level of **2**. This is the second from the lowest possible classification (2 on a 1-4 classification scale). This has improved significantly from a rating score of 6 initially with the old manual 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 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)= 4.5**

An SI Score of 4.5 is the middle classification and is a significant improvement compared to the pre-project evaluation of 20.3 and 13.5 for the two manual weld ring operations.

*\*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*

### Strain Index (cont.)

*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.*

### Recommendations

The following minor adjustments and modifications are suggested to further decrease ergonomic risk factors associated with the new weld ring equipment and process:

1. Cut back the front edge of the plywood floor platform by 3" to 4" thus allowing closer access of the chair, reducing reach distance.
2. Adjust chair height, tilt and seat depth for each worker to allow a comfortable, upright sitting posture with good lumbar support (rather than sitting on front edge of chair).
3. Adjust the chair arm rests upward and inward so that the employee's forearms are supported by padded rests while reaching forward to the weld ring fixture.
4. Explore options to modify foot control pedals to allow for adjustability of placement (location) for optimal employee comfort.

### Worksite Redesign Project Completion Summary:

The new semi-automated weld ring workstation has fulfilled the primary objectives of this worksite redesign project with the elimination of MSD risk factors and health/safety issues related to the manual welding of weld rings. The device is simple to operate and does not create additional MSD risk factors. The remaining manual tasks of attaching rings and hooks to lures have been substantially improved in all respects as shown by the significant reduction in MSD risk factors (evidenced by RULA and Strain Index evaluation results).

A secondary goal of having the workstation to be height adjustable between sitting and standing positions, was changed in favor of working in a sitting position with a fully adjustable ergonomic chair.

Worksite Redesign Project Completion Summary (cont)

Preliminary production figures during the first few weeks of operation with the new equipment indicate that overall product out-put is nearly the same as with the older manual method and expected to rise gradually over time as employees get used to the device and new processes.

All of these factors point to a very successful outcome for this worksite redesign project.

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

Respectfully,

Rob Strickland, OTR  
Ergonomics Consulting

## Addendum- Photos



Figure 1

**Weld ring workstation with foot control pedals and adjustable ergonomic chair**

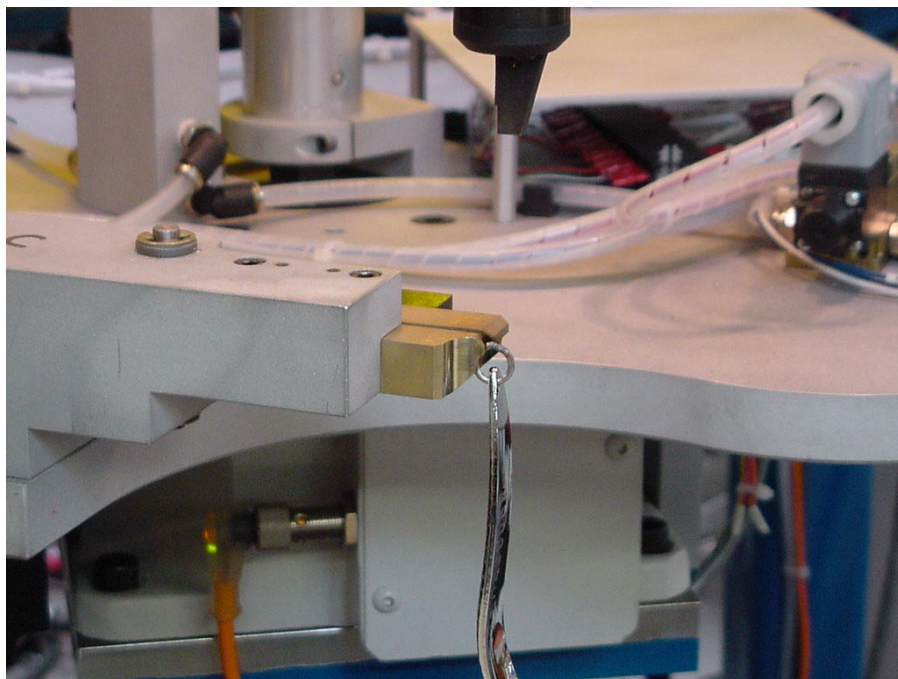


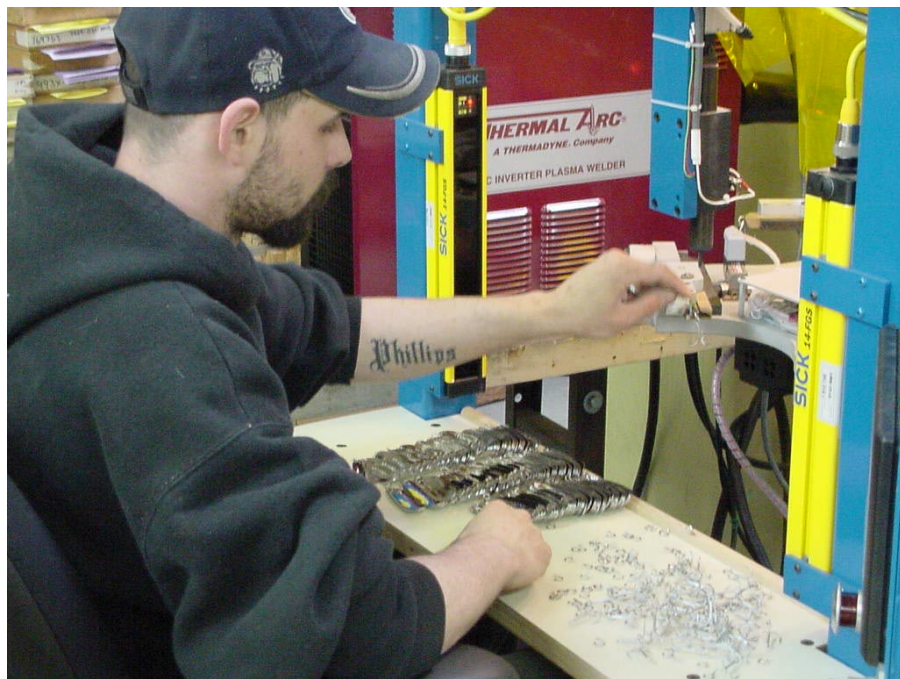
Figure 2

**Weld ring & lure secured in fixture with positioning jig retracted above**



**Figure 3**

**Placing weld ring into fixture and orienting it against jig for proper welding position**



**Figure 4**

**Placing lure into weld ring slit opening**