

## **Ergonomic Risk Assessment for Eyeglass Manufacturing NAVFAC East Division**

An ergonomic survey of material handling at the Eyeglass manufacturing was conducted on February 9, 2000. This assessment is based upon interviews with employees, supervisors, and safety personnel as well as evaluation by the ergonomist. Recommendations are included with as much vendor information as possible.

### **Material Handling**

It has been estimated that the employees spend 20% of their time performing material handling. The facility currently produces up to 1600 pairs of glasses per day. For every pair of glasses, the order slip, materials, and tools are placed in an individual tray which remains with the glasses for the duration of the manufacturing process. Carts, like the one shown in Figure 1, are used to transport trays between operations. Trays are manually loaded and unloaded from the cart. Each cart has a capacity of 300 trays. The top shelf is 51" high requiring the operator to reach above shoulder height to load and unload trays. Lifting and placing a load above shoulder height places load strain throughout the upper extremities. The bottom shelf is 9.5" above the floor, which requires the operator to kneel or bend over to access, placing biomechanical stress on the knee and/or back.

At each workstation the trays are manually transferred from the cart to the work area. During the manufacturing process, trays weigh from 1.25 to 3 pounds each. Operators carry 5 to 20 trays at a time depending on load weight and employee preference. Figure 2 shows how one operator carries the trays. Since there are no handles on the trays, the bottom edge of the stack places a mechanical stress on the operator's hands which is compounded by the weight of the entire load. Other operators were found to hold a stack of trays with one hand on the bottom and the other placed on the top for stability. This posture puts the entire weight of the load on one hand and increases stress to the shoulder of the raised arm.



Figure 1: Loading Carts



Figure 2: Employee carrying trays

After being removed from the cart, trays are then stacked in each work area. Operators at seated workstations can stack trays on their work surface, encouraging a reach above shoulder height to the top trays, as shown in figure 3. At machining operations, trays are stacked on the floor or on top of the machine. Trays stacked on the floor require the operator to bend over to pick up the order, as shown in figure 4. Trays stacked on a running machine pose a possible hazard if they were to fall off.



Figure 3: Trays stacked on workstation



Figure 4: Trays stacked on the floor by machine

**Recommendations:**

1. Install self-elevating carts to move trays throughout the facility. Self-elevating carts maintain a constant work height, thereby eliminating the need to bend to the bottom or reach to the top of a standard cart. These carts will have less capacity, but they can be placed directly in a work cell, perpendicular to a work table. An operator can then reach to one side to unload a tray, perform the operation, and store the tray on the worksurface or reload it onto an outgoing cart. Smaller carts in the work area will eliminate the need for the operator to unload a larger cart and carry trays to their workstation. Carts can also be used as mobile work stations. Cart vendors with pricing and tray capacity are listed in Table 1. Smaller carts may be a more feasible option in work cells with limited room. A combination of smaller and larger capacity carts, implemented in stages with employee feedback is recommended.

Vendor	Model	Platform WxL	Load Capacity	Price	Capacity
Vestil Mfg. 800-348-0868	ETS-230	20"x20" (11" to 33" ht. Range)	230 lbs.	\$790.00	45 Trays
Vestil	ETS 460	20"x20" (11" to 33" ht. Range)	460 lbs.	\$889.00	90 Trays*
Vestil	SCSC-500-2040	20"x40" (14" to 34" ht. Range)	500lbs.	\$790.00	120 Trays
Vestil	SCSC-500-4242	42"x42" (14" to 34" ht. Range)	500lbs.	\$980.00	315 Trays
Vestil	SCSC-500-2440-SPJP** (custom)	24"x40" (14" to 34" ht. Range)	500lbs.	\$965.00	150 Trays
New Dominion 800-850-8559X132	ESX-21	19.75"x32"	460lbs	\$725.00	90 Trays
New Dominion	ESX-40	20"x39"	880 lbs.	\$1050	120 Trays
Hooker Handling 800-248-1717	DLVH-500	23.6"x35.8" (18"-31.5" ht. Range)	Adjustable 220 lbs. to 1100 lbs.	\$1080.00	150 Trays
Alimed 800-225-2610	R70326	20"x20" (11"-33" ht. Range)	230 lbs.	\$850.77	45 Trays

\*In house modification of a 22"x24" plate (with rounded edges) bolted to the top of the cart can increase the tray capacity to 90 trays.

\*\*Custom Design



Auto-Hite Cart



Spring Self-Elevating Cart

2. Small staging platforms located to the side of each machine should take the place of trays stacked on the floor or on top of machines. The staging areas currently attached to the front of the surfacers are not large enough and may interfere with machine loading. These platforms can be produced in-house since the size of the platform will vary by available space. A flat surface with rounded edges can be attached with a bracket to a machine. The platform height should be equal to the machine loading height.
3. Eliminate all unnecessary non-value added material handling. Currently, incoming order slips are placed into individual trays in a cart. Each tray is then taken to a sorting area where it is unloaded, sorted for each different retrieval systems and then reloaded in a cart which is delivered to the specific retrieval system. A group of trays is then unloaded from the cart, taken to the retrieval system where it is filled with parts and reloaded into an outgoing cart. The cart is then taken to the servicing area where trays are again unloaded. The order slips are covered in plastic and the boxes are removed from all parts and the trays are re-loaded into a cart to begin processing. All successive stations unload and reload the carts.

Material handling can be reduced by combining tasks. All order slips can be placed into plastic before being placed in a tray. Each tray could then be placed in a cart designated for the appropriate retrieval system. Each retrieval system would have its own cart. The operator filling the trays with parts at the retrieval system can remove boxes before loading the trays for the servicing area. This proposed process would decrease material handling, increase job variety and responsibility, and reduce repetitive motion by incorporating additional tasks into each cycle.

The vertical retrieval systems are a new ergonomic improvement and the storage and retrieval process is being changed continually in order to determine the most efficient method. The process described above has been modified since the ergonomic evaluation and parts of the above recommendation may not be relevant. Material handling can be reduced by grouping orders by storage system and retrieval order from the beginning of the process and placing groups of trays (with the same process pattern) on specific carts that will remain with them until they leave the storage area. Carts can also be used instead of sorting tables to eliminate the transfer of sorted trays from tables to carts.

## Standing Workstations

Most of the employees at the facility spend the majority of their day walking or standing. Few workstations are designed for seated work. Prolonged periods of standing can lead to fatigue and back problems.



Figure 5: Operator standing at the retrieval system

**Recommendation:** Anti-fatigue matting or sole inserts are recommended for standing work areas. If the employee remains in a confined area, anti-fatigue matting is a durable and efficient way to reduce fatigue. If the operator regularly leaves their workstation or spends much of their time transporting parts, sole inserts are recommended. The quotes obtained in Table 2 are for 8'x3' smooth matting with beveled edges. This size is optimal for use in front of Lektreiver storage system. Smooth matting with beveled edges is more compatible with carts than contoured anti-fatigue matting.

<b>Table 2: Anti-Fatigue Matting and Insoles</b>			
Vendor	Product	Price	Details
Global Industrial 1-800-645-1232	Vinyl Tech	\$119.60	8ft.x3ft.
Matting World 800-257-8557	M-2401	\$282.00	Custom cut 8 ft. length, 3 ft. width
New Dominion 800-850-8559X132	Ecomat	\$206.00	8ft.x3ft.
Alimed 800-225-2610	Poron 4000	\$17/pair	Insoles

## Tool Retrieval

Each order requires two metal tools used for surfacing and finishing each lens. Each tool weighs just under a pound. The tools are retrieved manually from a rack as shown in figure 6. The extreme range in heights for the tool rack requires kneeling, bending, and reaching above shoulder height to retrieve tools.



Figure 6: Operator kneeling to retrieve tools

Each tool used on a lens has an adhesive pad applied to it in the tool section. After machining is completed, the pad is removed by hand before the tool can be replaced into stock, as shown in figure 7. The operator has applied tape to build up the handle of the small knife used in this operation. This task involved repetitive hand and wrist motions. The left hand is in extension with a finger press, while the right hand undergoes repeated ulnar and radial deviations of the wrist combined with mechanical stress from the knife.



Figure 7: Operator using a knife to remove pads

## Recommendations:

1. An automated retrieval system, similar to the one used in parts area, would eliminate the ergonomic hazards in this area associated with poor work heights. An automated retrieval system would also improve productivity by organizing retrieval order. A retrieval system of Lektrievers can be purchased from the vendor that supplied the storage area.
2. The employees have built up the handle on the knife they are currently using to improve comfort and ease of use while removing pads. A paring knife with a thickened handle will achieve the same goals by reducing the force required for use and reducing mechanical stress to the fingers and palm of the hand.



OXO Good Grips paring knives are available for under \$5.00. (1-800-545-4411)

\*Some information has been removed from this report that is specific to the activity.