

ERGONOMICS DEMONSTRATION PROJECT

# Precor

## Manufacture and Assembly operations

January 2002



## Introduction

**P**recor, Inc. considers itself to be an international leader in ergonomic design and innovation in fitness equipment, and it has taken the lead in applying ergonomic principles to increase the simplicity and safety of its own workplace.

**A** design innovator for more than 20 years, Precor today develops and markets treadmills, elliptical crosstrainers, stairclimbers, exercise cycles, stretch-training and strength-training equipment. Within those categories, Precor products are customized to meet varying requirements of homes and health clubs, as well in corporate fitness centers, and health, medical and educational organizations.

**T**he manufacturing processes at the company's facility in Woodinville, WA include fabrication, welding, painting, assembly, and packaging, etc. Due to the nature of the exercise equipment, heavy metal parts are frequently handled and high forces are often required in the operations. Many of the jobs would be considered as hazard zone jobs under Washington State's Ergonomics Rule if the potential hazards are not properly controlled. However, with the effort of the management, engineers and workers, the company is continuously making improvements to reduce or eliminate musculoskeletal disorders' hazards and making the jobs easier and safe to perform.

### Systematic approach for improving manual handling

**H**heavy components, such as frames of treadmills, elliptical fitness crosstrainers, and exercise bicycles have been handled in the manufacturing processes. The company has adopted a process where inputs from different parties involved in the manufacturing are solicited when it launches any new products. The inputs include how the components will be handled at each of the workstations in the corresponding manufacturing processes, and what kind of fixtures could be used to make the lifting and handling of the components easier. The aim of the process is to develop a single fixture that can be used throughout the complete manufacturing process for that specific product so that lifting and handling could be easy and safe.

### Worker's involvement for better working conditions

**A**fter prototypes of the fixtures are built, the workers involved in the different manufacturing processes test them. Workers are asked to give comments and suggestions to improve the designs of the fixtures. Incentives such as tickets to sport events are given to encourage worker's involvement.

## Examples of solutions

### 1. Welding

**H**heavy metal components and frames are frequently handled at welding stations. The metal frames weigh approximately 100 lbs each. A welder usually makes 60 units per workday. Metal components need to be secured on fixtures for welding. To secure these components, about 30 clamps are used.

#### Potential musculoskeletal hazards

**H**heavy lifting could be a risk factor if the lifting was done manually. Due to the large size of a treadmill, two workers would be needed in order to manually lift a treadmill frame. Because of the asymmetric shape of the frame, 67 pounds lifting was needed on the heavier end of a 100 pounds metal frame. Assuming that the operators were able to lift the frames in the near reach range but were required to lift the frames from a fixture around the waist level and place it on floor level, and also maintain the productivity rate (i.e. each worker needed to make 60 units per work day), the weight limit should be about 60 lb based on Washington State's Ergonomics Rule. The manual lifting of 67 lb would make this a hazard zone job.

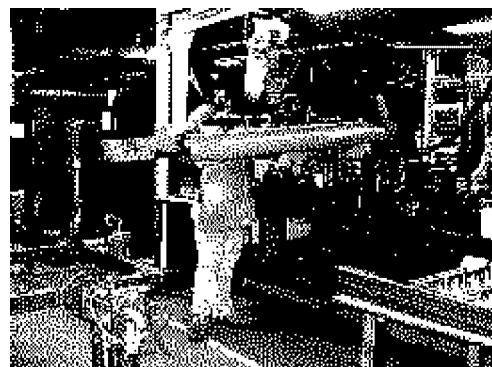
**R**epetitive high hand forces would definitely put the job into the hazard zone if the clamps were manually put on and taken off from the frames. The force required to open a clamp would be much higher than the defined high handgrip force by Washington State's Ergonomics Rule (10 lb). The repetition rate would be considered as high because 30 clamps were needed to put on and taken off from each frame and 60 units were built each workday. If the worker spent more than 3 hours on this activity, the risk factor of high hand force would make this job as a hazard zone job.

**M**anually welding might involve awkward neck bending and poor wrist/arm postures. However, due to the use of welding robots, manual welding is limited only to short periods (less than 2 hours per work day). Therefore, neck bending and poor wrist/arm postures may not be a significant concern at this job.

#### Solutions

The company has implemented the following solutions to reduce or eliminate exposures to these risk factors. This job is no longer in the hazard zone because of these improvements.

A lifting hoist is used for lifting and transporting heavy frames. Manual lifting is no longer required. The heavy lifting hazard is eliminated. The productivity is also improved, as only one worker is needed to operate the lifting device compared to two operators' lifting manually.



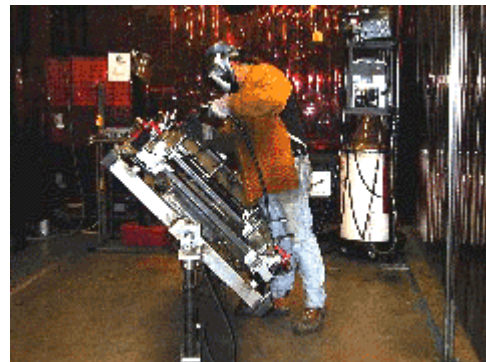
A specially designed cart is used to transport frames. This cart can be used at different workstations (e.g. welding, painting and assembly) throughout the complete manufacturing process. This solves similar lifting problems at multiple workstations.



A Programmable Logic Controller (PLC) for clamps is used, instead of manual clamps. This improvement eliminated 3600 high hand force applications at this job. The repetitive high hand force hazard is eliminated. This improvement also reduced the welding cycle time because it takes much less time to position the components on the fixture.



A swivel fixture is used when some minimal manual welding is required. Frames are loaded onto the fixture by the lifting hoist shown above. The swivel fixture improves the working postures (although awkward postures at this job are probably not in the hazard zone). The swivel fixture is also used for inspections, and no manual lifting is required to turn the frames during the inspections.



## 2. Painting

**F**rames and other metal parts are transported to the painting department, and then hooked up onto conveyors that send them into painting booths. After the painting process, they are unloaded back to the carts. Weights of the different components are varied, and could be up to 100 lb for treadmill frames.

### Potential musculoskeletal hazards

**H**heavy lifting could be a risk factor if the lifting was done manually. Due to the large size of a treadmill, two workers would be needed in order to manually lift a treadmill frame. Because of the asymmetric shape of the frame, lifting 67 pounds was needed on the heavier end of a 100 pounds metal frame. One worker might lift other smaller components. The weights could often be more than 50 lb. The lifting could happen at the floor level due to the position of skids, and above the shoulder level due to the level of the hooks on the conveyors.

**A**ssuming that the lifting frequency of a worker is around one lift every minute and a worker was performing the lifting task for more than two hours (it would usually be the case even when considering that they sometimes rotate to painting booth tasks during a work day), the weight limit was 49 lb when the worker would be able to lift the component near his/her body based on Washington State's Ergonomics Rule. Lifting heavy treadmill frames or any other metal components heavier than 50 lb frequently would cause the job to be in the hazard zone.

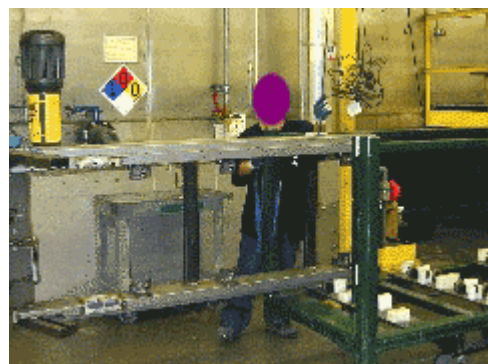
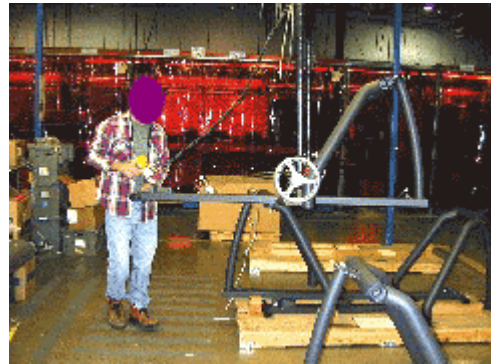
### Solutions

**T**he objective of solving the lifting problem at the painting department is to reduce the amount of lifting tasks, particularly try to eliminate lifting large and heavy metal parts manually. As mentioned previously, specially designed carts are used for transporting different metal parts. These carts can be used for the different workstations throughout the complete production process. Metal parts can be transported to the paint department and be placed under the conveyors. Specially designed hooks are able to pick up the parts on the cart. The worker does not need to lift the parts but only helps to position the hooks. Lifting devices are also used to lift other large and heavy parts so that no manual lifting is required. These measures have significantly improved the working conditions at the paint department and reduced the exposure to the risk factor of heavy lifting.





Lifting devices are also used to lift other large and heavy parts so that no manual lifting is required



### 3. Assembly lines

The majority of workers at the company work at the assembly lines. At a typical assembly line, workers put various parts and mechanisms onto the main frames of the exercise machines. Some activities include: uploading frames and plywood board onto the line, getting parts out of boxes for assembly, and adjusting tensions of drive belts etc. Depending on the type of products, about 50 to 80 units are made on each assembly line.

#### Potential musculoskeletal hazards

Several heavy parts (e.g. frames of 100 lb, plywood boards of 43 lb and motor assemblies of 48 lb) are required to be lifted onto the assembly lines. Due to the large size of the treadmill frames, two workers would be required to lift a frame. The lifting force on the heavier end would be 67 lb. Most assembly lines usually produce 50 to 80 units per workday. Assuming that workstations were properly designed so that the heavy lifting would be performed near the operator's body, most of the jobs involving heavy lifting would only fall in the caution zone based on Washington State's Ergonomics Rule. However, if workstations were not properly designed (e.g. a worker needed to reach far to get a heavy motor assembly on a cart, or a worker had to reach far to lift a heavy frame), these heavy lifting jobs could be in the hazard zone. If the productivity were increased to produce 100 units per day, many of the heavy lifting jobs would fall in the hazard zone as well.

One of the assembly jobs at the line requires lifting a metal part of 20 lb out of a box. This job was previously done manually when the worker used two hands to lift the part from the top with pinch grips. The metal part has a smooth surface that requires higher hand force to grip compared with a rough surface. The estimated pinch force on each hand was 15 lb. A worker performing this job for more than 3 to 4 hours a day would be considered as working on a hazard zone job.

High hand force might also be required when adjusting the belt tension manually. The workers previously considered this job as one of the most physically demanding jobs on the line.

Accessibility is often a concern at assembly jobs. Workers might have to be forced to use awkward hand and wrist postures in order to tighten some bolts. Awkward hand and arm postures would increase the risk



of causing musculoskeletal disorders, especially when the jobs require high hand force and are performed repetitively.

### Solutions

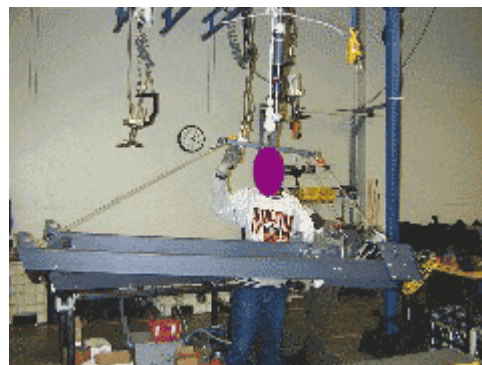
Various lifting assist devices have been used to eliminate or reduce heavy manual lifting. For example, a scissors lift is used to raise plywood boards for assembly.



Vacuum hoists are used to lift plywood boards as well.



Lifting hoists are used to lift heavy frames onto the assembly line. Some assemblies can also be performed while the frames are lifted.





**A** hydraulic tension-adjusting device helps reducing high hand force applications. The workers no longer consider this job as a physically demanding job.



**W**ith these improvements, the exposure to heavy lifting and high hand force has been controlled. They are no longer hazard zone jobs.

## 4. Drive cell station

**M**otors (drive cells) were previously assembled on the assembly line. Due to the heavy weight (48 lb) and positions where they were placed, this job could be in the hazard zone. A high incidence of musculoskeletal injuries was seen at this job previously. Changes have been made so that the drive cell station is separated from the main assembly line. Assembly work is done on a specially designed rotatable fixture. Over 100 drive cell units are produced each day. Tool balancers are used to hold power hand tools.

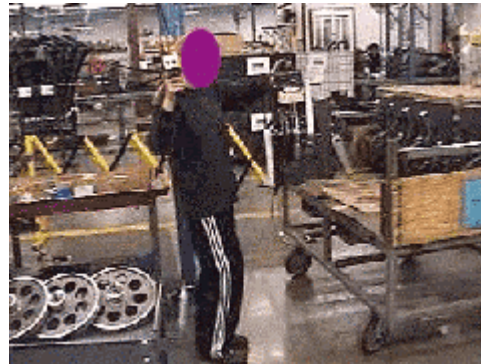
### Potential musculoskeletal hazards

**I**f the heavy drive cells (48 lb) were lifted manually onto and off of the fixture, there would be over 200 lifts per workday. As the drive cells are placed on a cart, the reach distance could be in the mid-range of reach distance. This job would be considered as a hazard zone job according to Washington State's Ergonomics Rule.

**I**f the assembly were not done on a rotatable fixture, the unit would also have to be turned frequently to get the best angles for assembly. Highly repetitive motions and high hand force would be required in the turning. If the unit was not properly positioned, awkward postures might be assumed in the assembly. Both situations would put the job in the caution zone, or even in the hazard zone if the frequency were high and/or duration was long.

### Solutions

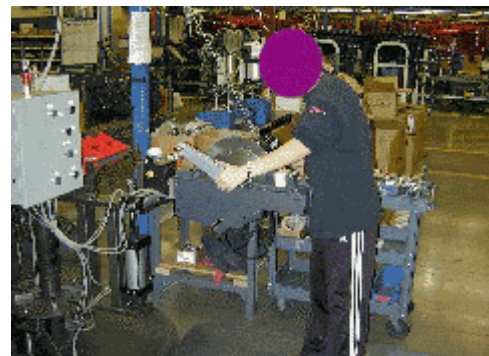
**T**his job was separated from the main assembly line to increase the possibilities to make bigger changes. Lifting devices are used to upload and unload drive cells, so that no manual heavy lifting is required.



**A**ssemblies are done on a rotatable fixture, so that better work postures can be assumed and the units can be easily rotated and no high hand force is required in the handling. Tool balancers eliminate the need to hold the tools while they are not used, and also make it easier to access.



Tool balancers eliminate the need to hold the tools while they are not used, and also make it easier to access



**T**hese changes have significantly improved this job and made it no longer stay within the hazard zone.

## 5. Packaging

**P**ackaging is the last step on the assembly line. At this stage, all the products become very heavy. Workers are required to put pads around the machines and pack them with cardboard boxes. The packed machines are then unloaded from the assembly line and placed on wooden skids. Two workers are usually assigned at the packaging station and about 50 to 80 units are produced each workday. Staple guns that weigh 8.5 lb are used to staple the cardboard boxes.

### Potential musculoskeletal hazards

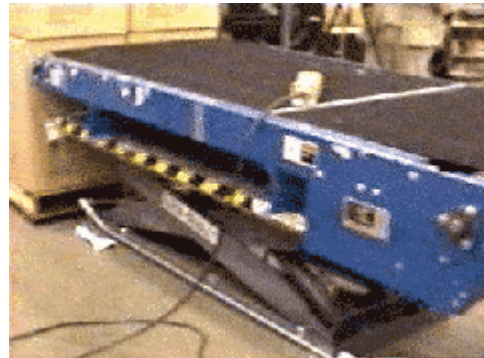
**T**he job could be in the hazard zone if the machines were manually lifted from the assembly line and placed on the wooden skids. Even if the lifting was done by two workers, the weight lifted by each worker could be more than 70 lbs, which is the limit as defined in Washington State's Ergonomics Rule for lifting at the waist to shoulder and below knee levels.

**A**lthough a staple gun weighs only 8.5 lb, operating it might still require more than 10 lb grip force due to the stiffness of the hoses, and the force required to activate it. If there were no tool balancer installed to hold part of the tool's weight, the worker would have to hold it continuously and the total duration of high hand force would be increased. This risk factor could make the job a caution zone job.



## Solutions

**H**heavy lifting is eliminated by the use of a scissors lift and an innovative plastic sliding board at the packaging station. The machines are packed on the assembly line and transported onto a scissors lift. One operator lowers the scissors lift and then starts the conveyor belt on the scissors lift to move the packed machine onto the wooden skid. The other operator places the plastic sliding board on the wooden skid and pulls the machine into position. No heavy lifting is required in this job at all.



**A**lthough tool balancers might be used to hold heavy staple guns, improper installation may prevent workers to use it due to inconvenience. A swivel arm has been installed so that the worker can easily use the tool at any positions while packing the machines. The risk of high hand force is reduced.



## 6. Console assembly

Console assembly is to put various small components on the consoles for treadmills. Screwdrivers are used at this job. Tool hangers are used at the workstation. A rotatable fixture is used to hold the console during assembly and rotates it for assembly at different angles. This job is done on a workstation separated from the main assembly lines.

### Potential musculoskeletal hazards

If the rotatable fixture were not used, the console had to be turned around frequently to get the best angle for the assembly activities. Assemblies might also be done sometimes at awkward hand and arm postures. This would increase risks of highly repetitive motions and awkward postures. If the exposure to some of these risk factors were more than 2 hours, the job could be in the caution zone based on Washington State's Ergonomics Rule.

### Solutions

Although caution zone jobs are not required to be fixed under the ergonomics rule, Precor chose to improve this operation. With the rotatable fixture at this station, the consoles can be easily rotated. Therefore, the worker does not have to manually turn the consoles (so the risk to repetitive motions is reduced), and can also assume reasonable hand and arm postures during assemblies (so the risk to awkward postures is also reduced). With the overhead tool hanger (tool weight balancer), it does not only make it easier to access the different screwdrivers, but also helps to reduce the exposure to hold the tools.



## Conclusions

**W**ith the commitment of the management to improve working conditions, Precor has developed an effective systematic approach to develop solutions to make jobs easier, healthier and safer. With the cooperation between different departments involved in the production system, some solutions can be developed and shared across the different departments. This is not only economical as it avoids developing duplicated equipment, but also effective as it reduces or eliminates risk factors. For example, transporting carts can be used at the different production processes so as to avoid extra steps of loading and unloading the products and make the jobs easier. With the active involvement of the workers, it is possible to test the various solutions, make continuous improvements and develop new solutions.

**I**t has been shown that the various engineering controls developed at Precor have effectively eliminated or reduced exposures to heavy lifting, high hand forces, repetitive motions and awkward postures. Apart from the improvements in the working conditions, work productivity has also improved significantly, as most of the jobs are much easier to perform after these engineering improvements.

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