

Can Job Changes Initiated by a Joint Labor-Management  
Task Force Reduce the Prevalence and Incidence of  
Cumulative Trauma Disorders of the Upper Extremity?

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ABSTRACT

A joint labor-management task force was established in an automotive plastics manufacturing plant to effect work station, tool, and method changes, in order to reduce the incidence and severity of upper extremity cumulative trauma disorders (CTD's) among hourly workers. Job analyses and epidemiologic surveillance over a 20 month study period were conducted. Initial epidemiologic surveillance showed the location of upper extremity CTD's to be associated with worker tasks such as recurrent shoulder problems among stock handlers, and hand and finger problems among assemblers. Recommendations for reducing these job specific CTD's were implemented by the task force in several departments. Awareness of ergonomic principles and the etiology of CTD's motivated many workers to fabricate job specific tools which made their jobs less stressful and more productive.

INTRODUCTION

Past research has shown that cumulative trauma disorders (CTD's) of the neck, shoulder, arm, forearm, wrist, and hand are common problems for workers who perform repetitive manual tasks (Nelson, 1957; Hymovich, 1966; Ferguson, 1971; Bjelle, 1979; Armstrong, 1982). Many CTD risk factors, including repetition, posture, and force, have been associated with elevated risk of upper extremity CTD's among workers. By reducing exposure to these factors the risk for CTD development should be reduced. The purpose of this investigation was to determine if job change recommendations from a plant-wide joint labor-management committee would alter the incidence of CTD's of the upper extremity. Only the preliminary results will be presented.

METHODS

This investigation included formation of an Ergonomics Task Force (ETF), analysis of jobs and worker health surveillance in a plant which produces and assembles plastic parts for automobiles. Job analyses were performed to determine the risk factors for CTD's of the upper extremity. Jobs selected included all hourly jobs with twelve or more workers (press operators, assemblers, stock handlers, quality control inspectors, and hilo drivers). Job analyses were performed at the beginning of the project in May 1982, and at the end of the project in December 1983. Sixty-two workers in nine departments were videotaped and their jobs analyzed for risk factors using Therblig

elements, job cycle time, tool handling time, tool operating time, posture of the upper extremity, and physical stresses such as force and vibration. The results of the May 1982 analyses along with recommendations for tool changes, job redesign and new work procedures were then presented to the ETF.

The ETF consisted of representatives of labor, medical, production, industrial engineering, and safety. The task force was trained by University personnel to analyze jobs and identify factors which might cause CTD's. Following the review of University of Michigan's recommendations the task force made recommendations on possible job changes such as selection of more appropriate tools, redesign of the work station, and introduction of ergonomically sound work methods. It then monitored the implementation of these recommendations.

Worker health screening involved interviewing all workers from the study jobs. The surveys included a main questionnaire; three supplemental questionnaires, a range of motion physical examination and a two-point discrimination test for finger tip sensitivity. The main questionnaire, physical examination, and two-point test were administered to all workers in the study population. The supplemental questionnaires were administered to workers who had complaints of recurrent neck, shoulder, arm, elbow, forearm, wrist, hand or finger problems.

In addition, a passive surveillance system was set up in the plant medical department to record complaints relating

to CTD's. Each worker with a complaint between March and December 1983 was asked to fill out a questionnaire describing the details of possible upper extremity disorders by nursing staff. This was followed by an examination by the plant physician who recorded the results of his history and physical examination on a second form. With each follow-up visit, the physician filled out a third questionnaire which documented the progression of the complaint and its treatment. These data were used to estimate the prevalence and incidence of CTD's occurring throughout the plant.

#### PRELIMINARY RESULTS

##### Job Analysis

The department, job, cycle time, tool holding time, and tool operating time were determined. Stock handlers (workers who manually loaded finished parts into shipping bins) had the shortest work cycle time ( $0.197 \pm 0.003$  minutes), and surface finishers (workers who used air-activated, powered rotary sanders to smooth surfaces of automobile parts) had the longest cycle time ( $2.01 \pm 0.59$  minutes). Surface finishers also held and operated their tool longer than any of the other study jobs. Assemblers in all departments had the most repetitive hand motions. Assemblers in two departments (1600, 1750) performed over 5000 repetitive hand motions in an 8-hour work shift. The majority of these hand repetitions were to insert clips, screws, or studs to assemble parts. Press operators in two departments (1700, 1750) performed repetitive cutting and trimming motions and averaged approximately 4000 cuts per 8-hour shift. Recommendations for changes in tools, job station design, and work procedure were given to the ETF for stressful job elements.

##### Implementation of ETF Recommendations

Following completion of the first interview survey, the task force recommended improvements in several jobs. The first jobs considered by the task force were: assembly study jobs (Dept. 1610), small and large injection mold press operators (Dept. 1700), blow mold press operators (Dept. 1750), and compression mold press operators (Dept. 1790). For the assembly line jobs in 1610, five recommendations were initially presented by the University to the ETF: (1) pad front edge of bench, (2) provide in-line screw driver, (3) provide gloves, (4) move bracket assembly, and (5) reorient alignment pins. Four recommendations were considered by the ETF, and one was implemented (providing gloves). There were 13 recommendations given by the University for the small and large injection mold press operators; three were

considered feasible by the ETF: (1) obtain power cutters for cutting sprues from part, (2) provide a fixture to hold knife when not in use, and (3) increase knife handle diameter to 1.5". The knife-holding fixture and new knife handles of larger diameter were furnished to the workers. For the compression mold operators two recommendations were made by the University: (1) obtain a knife with an angled handle, and (2) the use of a rubber mallet to seat clips on work pieces; both were implemented. Blow mold operators were given four recommendations by the University, three were considered feasible by the ETF; two were implemented: (1) provide knife sharpeners for worker's knives, and (2) build a workbench which tilted 36 degrees toward the worker.

##### Active Epidemiologic Surveillance

The prevalence of possible upper extremity CTD's in the plant were determined by the interview survey. The 361 workers had a mean age of  $32.2 \pm 8.6$  years. Workers were stratified by department and subgrouped as assemblers, press operators, surface finishers and "others". Of those reporting problems, complaints of the wrist, hand and fingers were most prevalent across all departments.

A normalized "p" chart (Duncan, 1965) was constructed to determine confidence limits for the number of upper extremity complaints by workers by job. For this chart the center line (CL), the Upper Control Limit (UCL), and Lower Control Limit (LCL), are as follows:  $CL = Np$ ;  $UCL = CL + 2.975 \sigma \sqrt{Np}$ ;  $LCL = CL - 2.025 \sigma \sqrt{Np}$ .

For each area of the upper extremity at least one of the jobs or departments had an elevated rate of complaints ( $p < 0.05$ , Figure 1). Similarly, at least one of the departments or jobs had a significantly lower rate for each area of the upper extremity. Two departments, 1800 (primarily stock handlers) and 1600 (assemblers), had significant elevations in three regions. Three departments, 1200 (hilo drivers), 1550 (regrind operators), and press operators in 1750, had significantly lower rates of complaints in three regions.

Two-way contingency tables were constructed to determine significant differences between departments with few upper extremity complaints, and departments with many upper extremity complaints. Quality Control inspectors and hilo drivers (originally considered a low risk group) were compared against all other "study group" departments for CTD complaints of the neck, shoulder, forearm/elbow, and hand/wrist. Chi-square tests showed only the hand/wrist complaints as significantly different between the two groups of departments ( $p=0.03$ ). Results from the May and December 1983 surveys indicating whether

DISTRIBUTION OF COMPLAINTS BY DEPARTMENT & JOB  
Recurring Complaints from 1980 - 1982

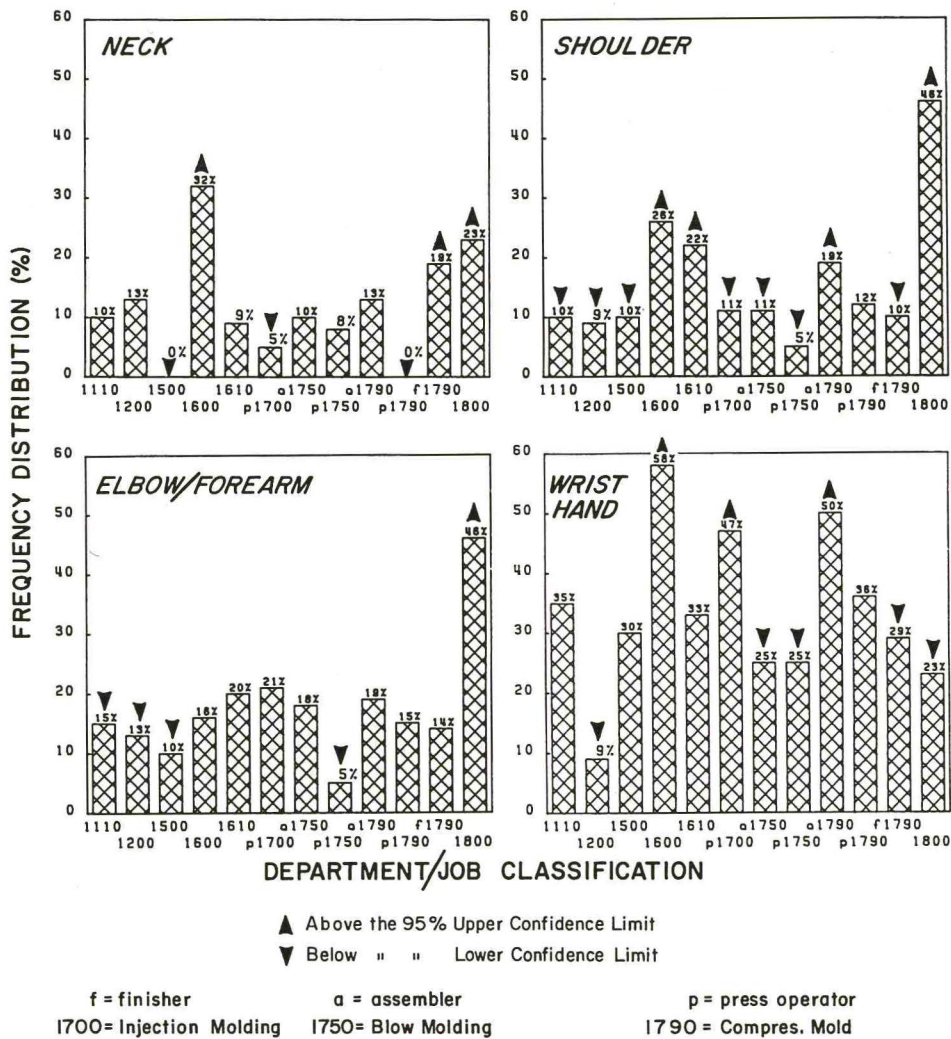


FIGURE 1.

further job changes have reduced CTD's are not available at this writing.

Passive Epidemiologic Surveillance

The mean age of workers who filled out questionnaires was 34.4 ± 9.5 years, divided into three categories: assemblers (N=44/42%), press operators (N=42/41%), and others (N=18/17%). Others include maintenance workers, stock handlers, surface finishers, painters, and hilo drivers.

Press operators in department 1700 most frequently visited the dispensary (N=33/179) for upper extremity CTD problems; assemblers in department 1610 had the second highest (N=14/81). Wrist, hand, and finger disorders were most frequently reported by the workers (54%), while 24 percent had forearm and elbow

problems, 19 percent had shoulder and upper arm complaints and 2.5 percent had neck disorders. The body side affected was predominantly the right (67%). The left side was affected in 19 percent of reported cases, and 14 percent reported bilateral problems.

Twenty-five percent of the workers reported they experienced their upper extremity problem for one week or less, 26 percent reported two weeks to one month, 23 percent reported two months to one year, and 27 percent had their problems from one to four years. Diagnosis by plant physicians for these disorders included tendinitis (N=26), fatigue (N=25), tenosynovitis (N=19), myositis (N=19), neuritis (N=3), bursitis (N=1), and synovitis (N=1). Initial visit treatment included anti-inflammatory agents (N=64), heat (N=44), braces (including ace and splints)

(N=30), aspirin (N=40), and cold packs (N=7). Physician diagnosis of worker CTD problems on first follow-up visit showed that, in general, workers returning within one to two months of their initial visit had no further deterioration, or felt better. Generally, workers returning later than two months after the initial visit reported their condition to be worse.

## DISCUSSION

### Job Changes

Several CTD controls have been implemented in the plant as the result of the task force recommendations. Other management initiatives to control CTD's have included rotation of workers, and fabrication of tools, parts, conveyor systems, carts, and storage racks. Administrative controls such as rotation of workers tended to be implemented at the older work stations (like injection mold presses), while engineering controls such as rotatable jigs tended to be implemented at the newer work stations. The reason for these different approaches appeared to be the availability of funds to perform such changes. For example, a new work station is given "launch money" which aids in its success and productivity. Some of this launch money may be allocated for ergonomic controls such as suspended tool retractors, rotatable jigs, and work benches which have parts within the standing reach envelope of the worker.

One notable change was the reduction in use of hand held metal clips in console assembly. Workers complained of pain in thumbs and fingers from forcefully pressing up to 5000 metal clips onto these consoles during an 8-hour shift. A recommendation was made to recast the dies for some of the console holes, and to fabricate a soft plastic "thumb" clip to replace most of the original metal clips. A clip was designed which was easy to insert during assembly and featured collapsible probe fasteners. This change not only reduced tendinitis problems but more than tripled productivity for this job.

### Task Force

The task force seemed to understand the biomechanical rationale for job changes. At monthly meetings, all affected parties were involved in the planning and decision making process. Generally, the changes that have been successfully implemented have been those in which front line supervisors participated, and acted upon the ETF recommendations. They did this while continuing to meet standards of production, quality and safety in their departments.

### Active Epidemiologic Surveillance

Surveillance of injuries in the plant-at-large during the study indicate that assemblers in department 1600 and stock handlers in department 1800 were at the top of list in nearly every category of recurrent problems for the upper extremity. Several things became evident when the nature of the job for these two departments was examined in detail. Assemblers in this 1600 worked on benches that could not be adjusted for the height of the worker, work surfaces were often irregular, and workers manually assembled more small parts than in any of the other departments. Stock handlers in department 1800 reported more problems with their shoulders, and elbows and forearms, than in any other department surveyed. Their job includes lifting or hanging parts each weighing up to seven pounds onto a moving conveyor. In an 8-hour shift they may extend their arms to load and unload over 2300 parts.

Hand, wrist, and finger problems were prevalent in most assembly jobs with the exception of assemblers in blow molding (Dept. 1750). Two factors made this job (1750) different from assembler jobs in other departments: (1) these workers used only hand held power tools to assemble parts, and (2) the parts were assembled on rotatable jigs which angle the part toward the worker. The use of powered tools, and a jig tilting the part toward the worker not only reduced fatigue to the hands, wrists, and fingers, but reduced neck and shoulder fatigue for these workers as well.

Press operators in injection molding (Dept. 1700) were above the 95 percent UCL for complaints in the hand, wrist, and finger areas. Many press operators in 1700 reported that the use of wirecutters caused their hands to become sore by the end of the day. Some workers complained that their wrists pain was due to the after shock of the wirecutters (called "sidecutters" by the workers) biting through the sprue, rather than the pressure required to cut into and through the sprue itself. One employee developed long-handled sidecutters for use by workers with small hands. These became popular because both hands could be used for better leverage and less stress on the palms and fingers. Powered cutters have been recommended for this job, but an easy to handle, safe cutter, has not yet been found.

Perhaps as a response to the control program many workers have taken initiative in developing their own tools to reduce CTD's. In several departments tools were fabricated by workers from scrap parts to reduce job specific CTD stresses. For

example, two different employees developed unique clip holders to reduce stresses on the hands and fingers. In addition these clip holders enabled them to increase their productivity three- to five-fold.

These preliminary analyses have not considered the influence of job duration or gender, among other variables, all of which are possible effect modifiers or confounders.

#### Passive Epidemiologic Surveillance

There were two main objectives of the passive surveillance program: (1) to provide a systematic early detection system for controlling upper extremity CTD's; and (2) to compare CTD injury patterns with those found in the active surveillance surveys. The first objective was, in part, successfully met when it was observed that a cluster of five press operators in one department reported to the plant dispensary in a one month period compared to three workers visiting the dispensary in the previous two months. Wrist, hand, and finger problems were reported for all five workers. Investigation of this department revealed that some of the presses were not sealing properly, resulting in excess plastic flash that had to be trimmed by these workers. Maintenance was notified, the presses fixed, and only one initial visit to the dispensary occurred the following month for this department.

Tendinitis and fatigue were the most frequent CTD problems found by the plant physician. Treatment for these disorders included anti-inflammatory agents and rest (often in the form of work restriction).

#### SUMMARY

Task force recommendations were visible evidence that both labor and management were committed to making job improvements. While rigorous statistical analysis of epidemiologic data have not quantified the reduction in the incidence and severity of CTD's, an ergonomic awareness among workers has developed in which many were motivated toward

conceiving and fabricating job specific tools which made their jobs less stressful and more productive. The passive epidemiologic surveillance component of the control program has served as an early detection system for reducing the severity of CTD's among workers, and is continuing under the direction of the medical staff at this plant.

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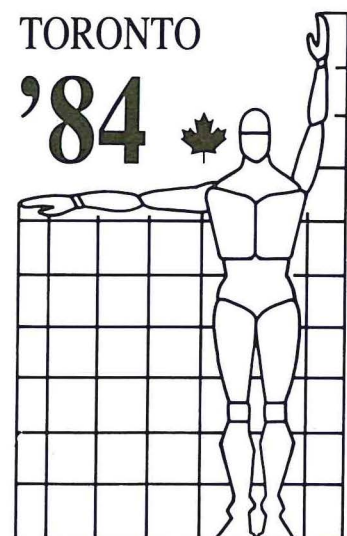
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