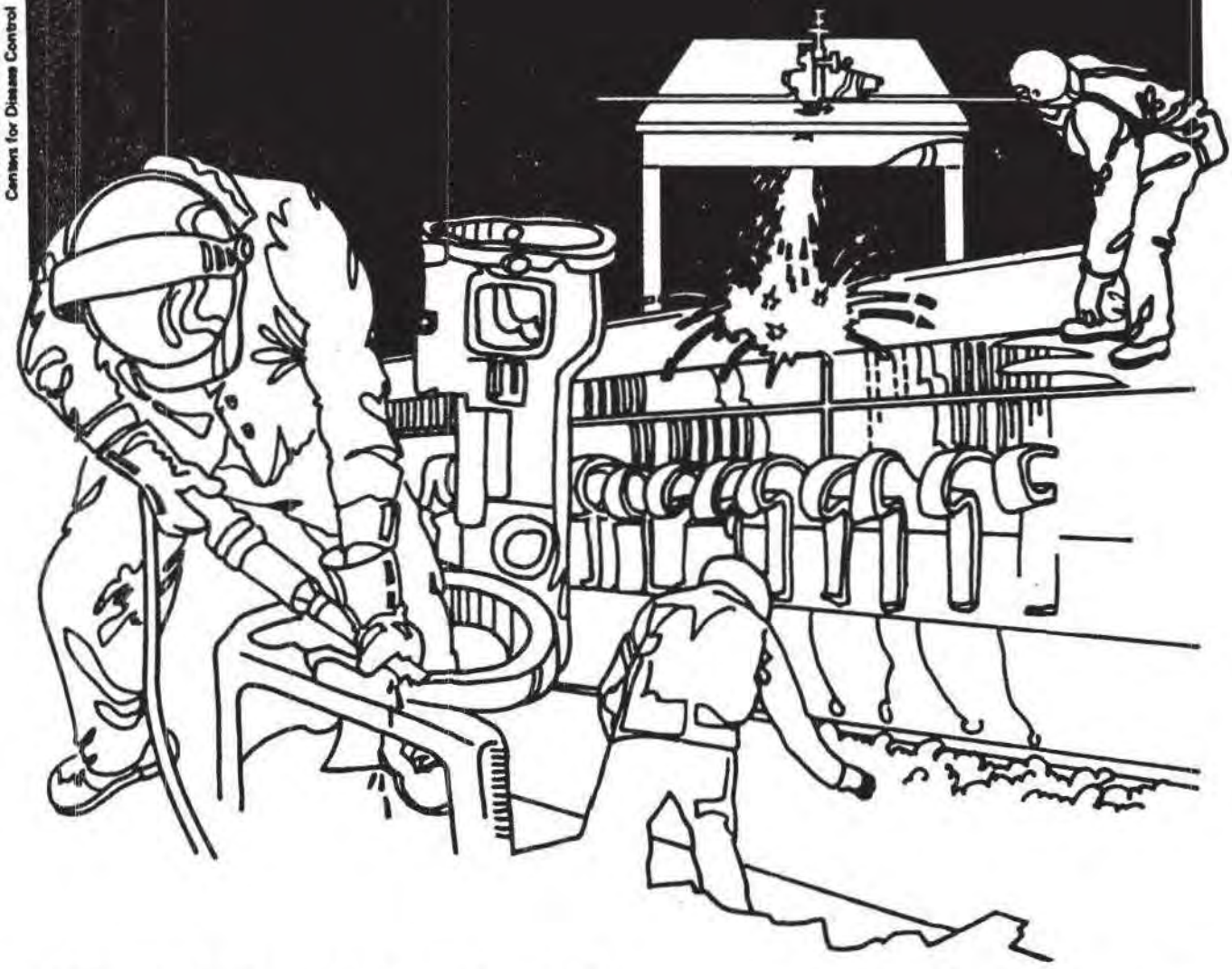
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 81-375-1277
KP MANUFACTURING COMPANY
MINNEAPOLIS, MINNESOTA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-375-1277

MARCH 1983

KP MANUFACTURING COMPANY

MINNEAPOLIS, MINNESOTA

NIOSH INVESTIGATORS:

DONALD W. BADGER, PH.D.

I. SUMMARY

In June, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation (HHE) at KP Manufacturing Company, a Minneapolis, Minnesota based manufacturer of hand-held lubrication equipment. The objective was to make an ergonomic assessment of jobs whose demands upon the musculoskeletal system (MSS) were thought to be associated with 19 cases (18 females, 1 male) of carpal tunnel syndrome diagnosed in production employees during a 2 year period.

At the time of the request, 157 employees (92 males, 65 females) were engaged in various cutting, stamping, threading, welding, assembling and similar tasks. The majority of these tasks required extensive and repetitive use of the hands.

From observations of production and assembly operations, the NIOSH investigator and a consultant selected 15 jobs which imposed stressful ergonomic demands on workers. These demands included fatiguing postures and motions of the trunk and upper limb; awkward stock locations requiring excessive reach; machine design or positioning which required excessive

limb travel distances; lack of mechanical aids to move stock; and the use of defective parts in assembly operations which required the application of forceful hand gripping.

Recommendations for modifying or eliminating these problems were submitted to the company in May, 1982, and implementation of most recommendations was completed by October, 1982. Only one case of carpal tunnel syndrome (a recurrence in one female) was reported subsequent to the onset of workplace changes.

On the basis of these observations, NIOSH determined that production work at KP Manufacturing Co. was associated with a high number of MSS disorders. However as a result of implementing NIOSH recommendations for workplace redesign, KP has made significant progress in effecting job changes designed to reduce conditions conducive to the development of such disorders. The company should continue to assess jobs associated with such complaints and modify them when possible. In addition, employees should be encouraged to report such complaints promptly.

KEYWORDS: SIC 3499 (metal fabrication, general) musculoskeletal disorders, carpal tunnel syndrome, hand, wrist and forearm postures and forces, ergonomics.

II. INTRODUCTION

In June, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to perform a health hazard evaluation (HHE) at the KP Manufacturing Company, Minneapolis, Minn., a manufacturer of hand-held lubrication equipment. The request, initiated by both KP management and representatives of the United Electrical, Radio and Machine Workers of America Union Local 1139, was prompted by concern for the number of workers who had incurred musculoskeletal (MSS) disorders, particularly carpal tunnel syndrome, while employed as production and assembly workers at this plant. The objective was to determine if excessive musculoskeletal demands were associated with those jobs being performed by workers reporting OSHA Code 26 (hand, wrist and forearm) complaints.

An initial ergonomic assessment of production and assembly jobs was carried out on September 9-10, 1981. Subsequently, on February 9-10, 1982, a comprehensive evaluation of 15 jobs deemed to be particularly stressful was carried out by the NIOSH ergonomics specialist and a consultant, Mr. James Foulke, University of Michigan Department of Industrial and Operations Engineering). An interim report prepared by the consultant, containing recommendations for job modifications was sent to KP management and representatives of Union Local 1139 on May 5, 1982. Based upon NIOSH recommendations,the company commenced a program of extensive job modifications, and reported the status of completed and scheduled changes to NIOSH on November 5, 1982.

III. BACKGROUND

KP Manufacturing Company is a Minneapolis-based manufacturer of hand-held lubrication equipment. At the time of the HHE request by KP, 157 production workers (92 males, 65 females) were employed in a variety of production and assembly jobs. While some of the cutting and threading operations of bar stock were automated, the majority of tasks required extensive and highly repetitive hand motions. Production operations consisted of cutting, shaping, threading and machining bar and pipe stock, stamping and welding aluminum stock, and miscellaneous sub-assembly tasks. The latter department included riveting, hose coupling and other assembly tasks, and painting.

During the two year period prior to the HHE request, KP had recorded 19 complaints of OSHA Code 26 (hand, wrist and forearm) problems which were subsequently diagnosed as carpal tunnel syndrome. Eight of these referred complaints required surgical intervention. All but one of the 19 MSS complaints and 7 of the 8 surgical cases involved female employees. In an attempt to determine to what extent, if any, work assignments played in the large number of MSS complaints they were experiencing, the company contacted several physicians in the Minneapolis area. KP was advised that assembly tasks involving highly repetitive hand and wrist motions quite frequently have a high incidence of MSS disorders (e.g., tendonitis, tenosynovitis, carpal tunnel syndrome, etc.) associated with them. Subsequently, KP contacted OSHA for assistance, and was referred to ergonomics specialists

at NIOSH who recommended that the company submit a request for an HHE, indicating their concern for the number of musculoskeletal complaints by KP employees.

IV. EVALUATION PROCEDURES

A. Medical

During the initial visit of the NIOSH investigator in September, 1981, company medical records were reviewed to determine which jobs were associated with reported MSS complaints. Of the 19 complaints, 9 occurred in production while 10 were in assembly jobs. Production complaints could not be attributed to any specific job; there were 3 complaints associated with one riveting job in assembly and 3 in a job involving final assembly of air guns, a job which had been modified prior to the NIOSH inspection. Consequently, a more widespread ergonomic review of operations was indicated.

B. Ergonomics

During the September visit, an initial walk-through tour of the day shift production and assembly areas was made with the 2 foremen and the plant personnel officer.The purpose of this tour was to become familiar with plant operations and to identify specific tasks for more detailed evaluation. Jobs so identified were photographed with 35 mm still camera and 8 mm motion picture cam-

era for for future job evaluation. Operations in each area were discussed with foremen to further identify problem task elements. Finally, union representatives on the company safety committee and individual workers were interviewed about their perception of fatiguing operations in the plant.

Subsequently, films were reviewed and a list of problem jobs compiled. Preliminary findings were discussed with the NIOSH consultant. On February 9-10, an in-depth ergonomic audit of 15 jobs was performed at KP.

V. EVALUATION CRITERIA

Few quantitative criteria exist which clearly identify hazardous motions and postures associated with this type of work. Rather, generally accepted ergonomic principles concerning workplace layout are utilized which involve the application of professional judgement. Since complaints centered around hand and wrist usage, particular emphasis was placed upon task elements which resulted in excessive wrist extension and flexion, ulnar and radial deviation,and excessive usage of pinch grips. Recommendations centered around reorienting workplace layout to eliminate these stressful hand positions and motions.

VI. RESULTS AND DISCUSSION

A comprehensive ergonomic evaluation was performed on 15 production and assembly jobs. Detailed observations and recommendations are contained in the contractor's report which is appended to this report (Appendix A). A summary is given below. The 15 jobs evaluated had deficiencies in one or more of the following categories:

1. Operator posture. The operator was forced to assume a fatiguing posture, either seated or standing. In some cases, this was the result of improper height of work surface or obstructed view, necessitating bending. In others, poor seat design or location was responsible. (cf. Fig. 7, Appendix A)

2. Upper extremity positions and motions. Frequently, location of fixture ,tool, or stock resulted in excessive ulnar or radial deviation of the hand. Often excessive hand forces were required to hold or manipulate parts, particularly during assembly tasks. (cf. Figs. 3, 13, 27, 28, Appendix A)

3. Access to stock. In many instances, operators had to reach excessive distances or to awkward locations for stock, or for depositing parts following completion of a task. (cf Figs. 5, 6, 22, Appendix A)

4. Poor machine or machine part design. Placement of stock or parts in the machine or removing them often required excessive reach or force. Levers often required unnecessary, often fatiguing motions. Motions could be modified or eliminated without interfering with the operation. (c.f. Figs. 17, 29, 30, Appendix A)

5. Transporting and loading/ unloading stock. A lack of use of load levelling stock carts often required excessive bending motions conducive to back strain. Frequently, parts were unloaded with coal scuttles. This was a frequent complaint of employees. (c.f. Fig. 30, Appendix A)

6. Defects in Parts. In some assembly operations, defects in parts required the use of excessive hand forces to complete the assembly. In some cases, this appeared to be due to manufacturing defects, while in a few instances, bulk handling of parts in stock carts may have produced the defect.

During the ergonomic evaluations, individual workers were requested to describe specific problems related to their jobs. Also, union representatives of KP's safety committee were asked to identify work-related problems. Comments most often given included, 1) unreasonably high production standards, 2) poor

quality of parts encountered in assembly tasks which often required the use of excessive force, 3) problems with unloading stock which necessitated the use of coal scuttles to shovel parts, and 4) fatiguing postures and reach distances required in some jobs. The question of excessive production standards was not addressed in this investigation, primarily for lack of appropriate criteria to evaluate fatigue. The other employee complaints were addressed, and recommendations for alleviating these problems have been incorporated into the Recommendations Section.

VII. RECOMMENDATIONS

A. Interim Report

Specific recommendations for each of the 15 jobs were developed by the consultant, reviewed and approved by NIOSH, and forwarded to KP management and Union Local 1139 on May 5, 1982. While the major concern of the company was in reducing the risk factors likely to contribute to the development of carpal tunnel syndrome, NIOSH also recommended more general workplace changes, which if implemented, would reduce the risk factors associated with other overexertion related disorders involving the musculoskeletal system (shoulder strain, low back strain, etc.). The nature of these recommendations was such that they could be applied to all production and assembly jobs as well as the 15 jobs that were evaluated. (See Appendix A).

A summary of recommendations includes the following:

1. Hand and wrist positions and motions

   a. When possible, reorient machine, tool, lever and/or operator position so that a neutral wrist position is maintained. This may involve positioning the machine or tool in a non-traditional manner (e.g. other than perpendicular to the floor).

   b. Relocate stock or part delivery at beginning and end of operation to optimumize hand, wrist and forearm positions. This often can be done by positioning the worker in front of the machine in the required operating position, noting the reach characteristics of the worker, and locating stock flow at the beginning and end of operation. takeaway accordingly.

   c. Use clamps, jigs, etc. to hold parts while assembling when excessive hand forces are required. Discourage workers from using poorly formed parts and trying to force a fit.

   d. Use mechanical action or air jet, rather than hand force to extract parts after stamping, welding, etc.

2. General

a. Use load leveling stock carts or other mechanical aids to avoid excessive bending or reaching for stock. Load stock into machines over as short a distance as possible.

b. Locate work surfaces so that workers have an unobstructed view, thus avoiding awkward trunk or neck positions which require prolonged static effort.

c. Eliminate unnecessary travel on lever arms (e.g. drill presses, etc.). Economy of motion reduces excessive fatigue, particularly to the shoulder musculature.

d. Arrange stock flow to minimize reach distances and eliminate awkward limb positions.

e. Provide uncluttered footspace for seated operators. Avoid seating positions which force the operator to straddle supports, etc. Often, such positions force the operator to assume an awkward, strained posture which is conducive to shoulder, neck or back discomfort.

B. Company Actions Following Interim Report

On October 29, 1982, approximately 7 months after receiving the NIOSH interim report, KP submitted a schedule of operations to describe implementation of the recommended changes. They included a description of the changes made, a completion date or projected date of completion. All changes were to be completed by the end of calendar year 1982. (See Appendix B). The company stated that following these changes, only one case of carpal tunnel syn-drome had been reported (aggrevation of a former injury).

C. Final Recommendations

1. KP should continue to implement changes indicated in their report of October 29, 1982.

2. Methods should be sought to modify riveting operations (Job 14, Appendix A). If the job cannot be modified, rotation of workers on this job should be considered, to minimize exposure.

3. KP should continue to alert workers to the hazards of carpal tunnel syndrome and other MSS disorders, and should encourage continued reporting MSS complaints promptly.

IX. AUTHORSHIP/ ACKNOWLEDGEMENTS

Report Prepared By:

Donald W. Badger, PhD
Research Physiologist
Division of Biomedical
and Behavioral Science

Acknowledgement:

James Foulke
Department of Industrial
and Operations Engineer-
ing, University of Mich-
igan, Ann Arbor, MI

Originating Office:

Applied Psychology and
Ergonomics Branch, Div-
ision of Biomedical and
Behavioral Science
Cincinnati, OH

Report Typed By:

Mayme B. Culver

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available througjh the National Technical Information Service (NTIS), Springfield, Virginia. Copies of this report have been sent to:

1. Confidential Requestors
2. KP Manufacturing Company
3. United Electrical, Radio and Machine Workers of America Local 1139
4. NIOSH, Region
5. OSHA, Region V

For the purpose of informing the 157 "affected" employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 90 calendar days.

APPENDIX A

CONSULTANT REPORT

(ABRIDGED)

Identification of Hand/Wrist Trauma Conditions for Light Manufacturing

K-P Manufacturing Co.

James Foulke
Dept. Industrial and Operations Engineering
University of Michigan
Ann Arbor, Michigan

April 23, 1982

Job 1 Tap Handle

Task: Load Fixture, Manually Operate Power Tapper in Drill Press

Recommendations:
1. Fixture orientation should be improved.
2. Increase fixture height.
3. Operating force requirements should be reviewed.
4. Handle design and location should be reviewed.

The drill press is a widely used manufacturing tool, adaptable to a wide variety of operations. When equipped with a power feed device, significant arm and shoulder loads are eliminated. The concern in this job is with the magnitude and frequency of improper posture resulting from the positions of the fixture and the feed handle. In this operation the left hand is used to hold the part in a fixture, thus placing the operator's body close to the drill press which results in posture requiring the operator to stand with the left shoulder lowered. The operator is at a disadvantage in operating the feed lever when constrained by this posture. Tipping the machine assembly back fifteen (15) degrees would improve the operators posture by placing the work at a better elevation.

Work Place Changes:
1. Reorient fixture to facilitate left hand loading by rotating the fixture 45° clockwise, providing a more natural direction for left hand loading.
2. Raise the fixture to eliminate the need for the left arm to be fully extended.

Figure 1, Job 1: Tilted shoulders are required to pull drill press lever at eye level while holding a part in a fixture at waist level.

Job 2 (continued)

An alternative method for loading the fixture would improve hand posture and reduce bending at the wrist.

Rods could be placed in the fixture with the heel of the hand away from the body and fixture by inverting the hand, palm down, in a prone position. The drill press for this alternate method should be inclined away from the operator by twenty degrees. If the drill press could be replaced by an automatic drilling head, the orientation of the rod for drilling could be nearly vertical, an ideal orientation for hand loading. As conceived, the rod would be dropped through a guide hole and the drilling would be done below the surface of the load point.

The probable best method from a performance viewpoint could utilize a rolling motion to feed the rods over a table and into groove locating them for drilling.

* Normal hand orientation/position is that posture for which the wrist-arm angles are near a neutral or relaxed posture.

Job 2 Drill Cross Hole

Task: Load Fixture and Operate Automatic Power Feed

Recommendations:
1. Fixture orientation should be improved.
2. (Increase/Decrease?) fixture height.
3. Redesign layout to permit operator to be seated - remove utility panel from below table to provide leg room.

An operation which should be classified as a light duty can be made physically stressful by poor workplace layout. The location of the utility panel below the drill press table in this operation intrudes into the space needed for the operator to be comfortably seated which would provide an oportunity to vary the working conditions. The drill press in this operation has a power feed device which does eliminate the need for the operator to hand feed the tool.

The stress produced by the motion to load and unload the fixture is of concern. Ulnar deviation of the wrist is caused by the insertion of the rod stock forward into the fixture. The normal orientation of a hand held rod, near the load point of the fixture, would be inclined upward 45° and away from the center by 45°. Rather than a normal hand orientation*, the hand is forced into a supine posture when loading/unloading the fixture with consequent flexing and ulnar deviation of the wrist. Tilting the machine and fixture <u>toward</u> the operator would improve the hand posture by placing the fixture at an angle closer to the normal orientation of a part held in the neutral hand.

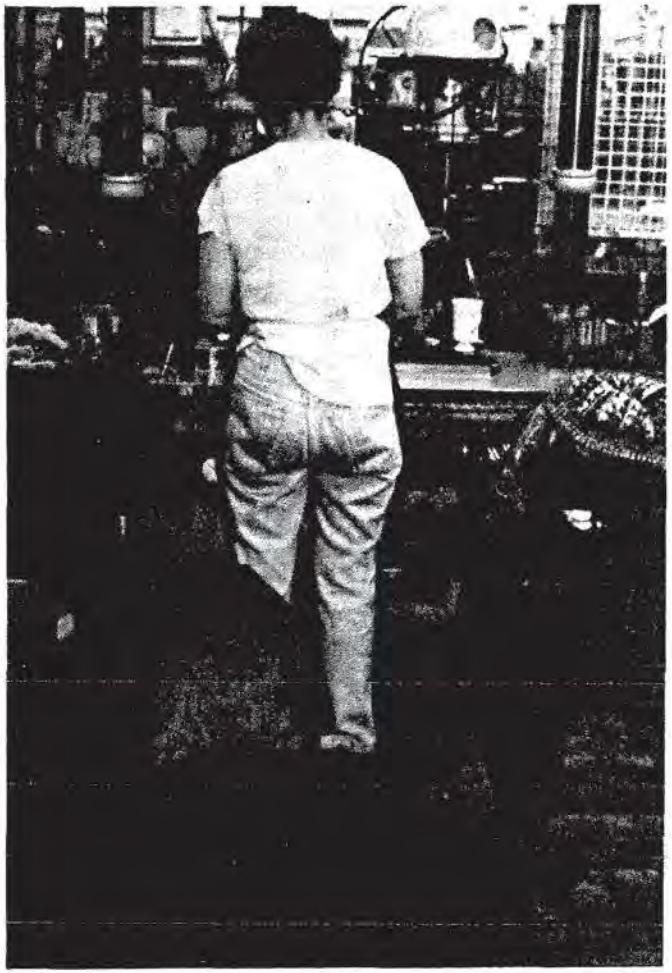


Figure 2, Job 2: Utilities below table which interfere with a seated operator.

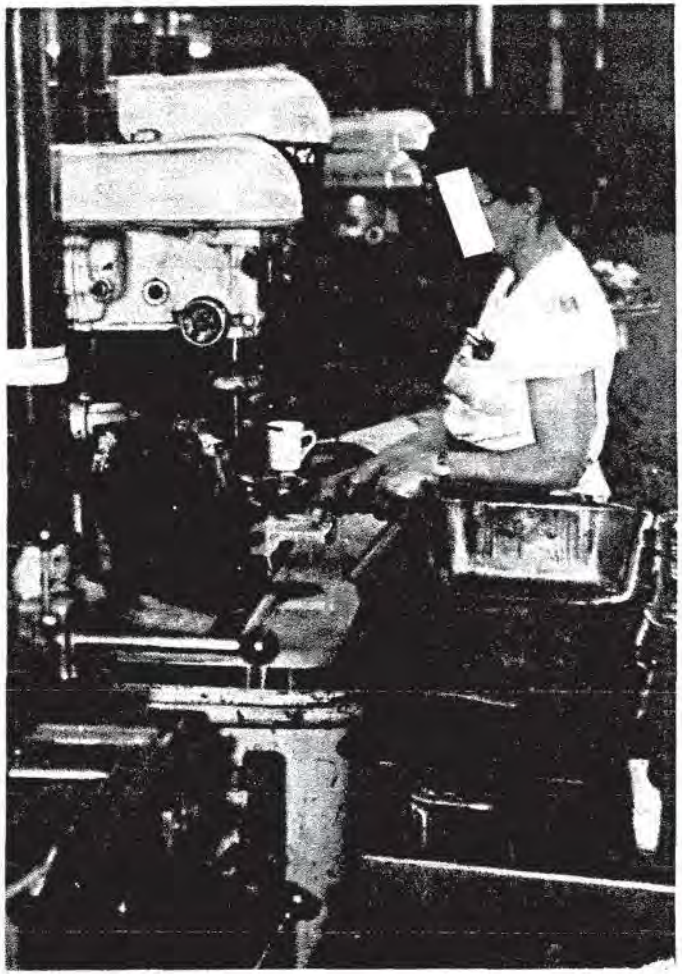


Figure 3, Job 2: Left wrist ulnar deviation is required to position part in fixture directly in front of the operator.

Job 3 Debur Pump Spout

Task: Load Deburring Machine and Cycle Operating Lever

Recommendations:

1. Redesign lever handle to swivel (the handle must rotate on a horizontal axis perpendicular to the forearm).
2. Install the machine on an open base to provide adequate leg room for a seated operator.
3. Chamfer jaws to facilitate locating spout in machine chuck with a minimum stroke of lever.
4. Locate stock adjacent to point of use - raise stock supply to work surface level and eliminate toss aside.
5. Tube entry should be reoriented clockwise 90°.
6. Adapt Bellows air power feed to provide power operator.

The tube deburring machine illustrates a number of design problems which result in excessive stress on the operator. The machine as purchased is too low to use when standing. Also it does not accommodate a seated operator because of the closed construction of the manufacturer provided machine base. Another major design problem is due to the physical interference between the part being processed and the operator.

The machine is designed to be operated by pulling on a lever located at the right side and adjacent to the loading chuck. This lever is operated with the right hand. The motion of the lever requires the operator to be located in front of the machine chuck. This places severe limits on the length of pieces which can be processed in the machine since pieces greater than about twelve

inches would project into the space occupied by the operator. As presently designed, the location of the loading point directly in front of the operator is inconsistent with the use of the left hand for loading material. Logically, the chuck would be oriented at about 8 o'clock in relation to the operator with entry of stock from the left side.

Handle redesign and operator accommodation are issues which must be immediately addressed to alleviate the current problems with operating the deburring machine. The recommendation is to make this a light duty operation by (1) providing good accommodation for both a standing and a seated operator and (2) providing an effective handle for operating the machine.

The machine should be reset on a base to raise the stock loading height to 36 inches (average female elbow less 2 inches); this will permit an open arm motion (elbow angle greater than 90°) to load the fixture. The area below the base should be open with a foot rest located directly below the chuck 14 inches above the floor. A standard 30 inch shop stool will provide necessary seating.

The handle must be redesigned to swivel to prevent the wrist bending caused by the hand following the handle as it rotates. Fitting the machine with a swiveling handle set perpendicular to the forearm of the operator (L-shape or spade D-handle) would allow the handle to be operated with a direct pull and no torque loading of the hand wrist joint.

Chamfering the chuck entry should facilitate inserting the tube into the chuck and minimize the handle stroke necessary to open the chuck.

Consideration should be given to changing motion of the handle travel. If the path of the handle could be modified either through a supplementary drive or by bending the handle outward from the machine, the operator's position in front of the machine could be improved. The operator should be located toward the right of the machine to the greatest extent possible to simplify stock handling operations with the left hand. This would require the handle be extended as far to the right as practical (12 to 18 inches) or the axis of the handle to be changed.

Currently the stock is picked from the left of the operator. The finished piece is disposed of by tossing it into a bin located to the right. Tossing motions which cause a repeated snapping of the wrist should be avoided. Stock should be supplied at a convenient location to the left of the operator with the finished piece disposed of by dropping onto a chute and discharged into a storage bin.

The Bellows drill press air power drive could be adapted to this machine eliminating both postural and effort components of the task. The lever used on this machine is similar in function to that on a drill press, therefore, similar techniques should be used to improve this job.

Figure 4, Job 3: Radial deviation and extension of the right wrist is required to push down on the lever. Radial deviation and extension of the left wrist is required to position tubuler spout in deburring machine directly in front of the body. The operator is unable to sit close to the deburring machine because the bench interferes with the legs and the spout is positioned between the body and the deburring machine.

Job 4 Weld Spout

Task: Position Spout for Weld

Recommendations:
1. Relocate supply parts:
   a. Lower the stock supply so that the hand can reach directly to stock.
   b. Tilt stock toward the operator for better access.
2. Consider inclined welder tips.
3. Mechanical tripping of piece counter.

Elementary work methods analysis identifies reaching for the spout (as shown in Figure 5.1) to be inefficient. Excessive shoulder and elbow movements are required to reach into the poorly located stock pan, placing an excessive stress on the operator. Straight line or smooth arc motion paths are desired. Lowering and tilting the stock toward the operator would provide necessary access to the stock by allowing the operator's hand to reach to and drop onto the spouts. An alternate stock delivery system should be considered which would eliminate the stock pans and the need to reach into a pan.

Inclining the welding tips toward the operator would improve the hand posture. The desired neutral hand posture cannot adequately accommodate the forward horizontal orientation of the spout on the weld. Inclining the weld position by offsetting the tips would improve hand posture in this operation.

Manual tripping of the piece counter is an unnecessary element of work.

Job 4 (continued)

Consider the number of motions each shift to trip the counter; the time and effort could be saved by using either a counter linked to the welder cycle or using a different method of material control, or by counting in a different operation.

Figure 5, Job 4: Extreme reach is required to reach into the stock pan.

Figure 6, Job 4: Operator is required to reach into high, horizontal stock pan.

Job 5 Weld Filter Wrench

Task: Load Parts into Fixture, Cycle Welder, Remove Welded Assembly

Recommendations:
1. Improve access to fixture
2. Add ejector to facilitate removal of the welded assembly.
3. Remove visual obstruction caused by the machine guard.

The fixture is very badly located for loading and removing parts. The welder has a rotating table, used in other operations done on this machine, that the operator must reach across to load and unload parts. Ideally the unused table would be removed for this operation. Awkwardness and particularly difficulty of loading and unloading the fixture are the major stress sources in this operation.

Accepting the requirement to work with the present fixture configuration, the following improvements should be implemented: fixture clearances should be reviewed to eliminate any unnecessary mechanical interference with loading and removing parts. The operator was observed to have difficulty, particularly, removing parts from the fixture. If this condition cannot be eliminated through adjustment or maintenance of the fixture; a device to facilitate removal of the welded part should be installed. Either a manual or powered ejector to loosen the part is required. A stiff spring or plunger which would be actuated when the welder tip opens could cause the parts to be released from the fixture when tip is withdrawn at the end of the weld.

The operator's vision appears obstructed. A barrier guard is present;

the lower edge of the guard obstructs the operator's view of the fixture. This causes the operator to twist and to bend her head to see the fixture while loading parts. Relocation or modification of the guard is required to reduce neck and back stresses. Posture stress of this type must be avoided when working at the maximum reach distances such as required when loading this fixture.

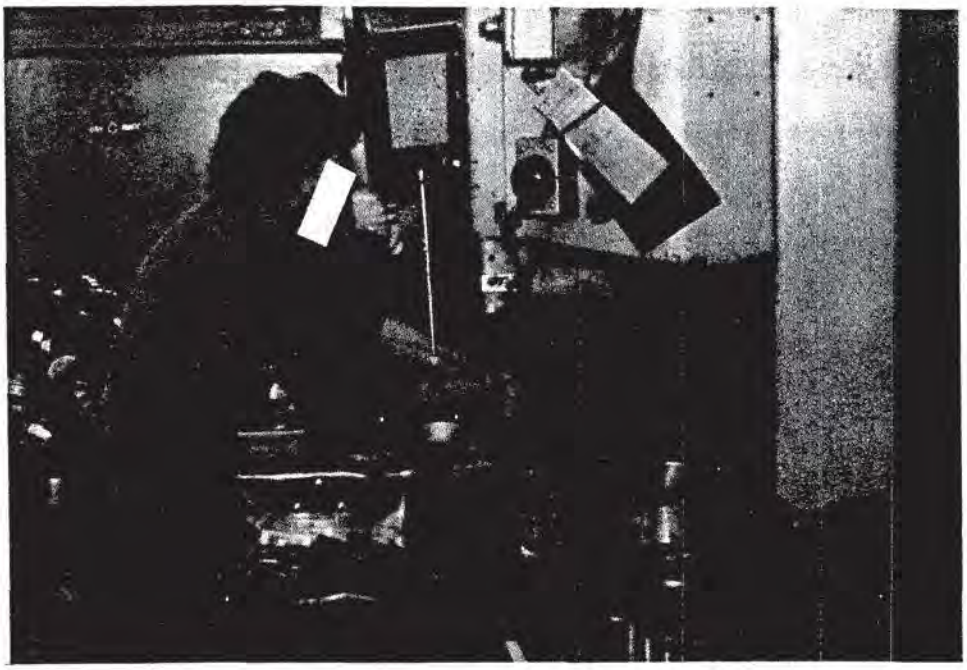


Figure 7, Job 5: Extreme reach is required to reach over base and to fixture inside machine.

Job 6 Weld Cap and Cylinder

Task: Load Parts, Cycle Welder

Recommendations:
1. Improve work height - increase bolster height.
2. Remove interference with stock handling - reshape and remove edges on stock bins.

Contact between the wrist and the metal edges of the stock hopper is a possible source of wrist trauma. When reaching to get a part the hand must be flexed over the hard metal edge. It would be difficult for the operator to avoid frequently striking this surface which, because of the thinness of the edge, places a concentrated load on the wrist. The edge should be modified to avoid the small hard contact point in the path of motion as follows: (1) remove excess edge material and/or (2) reshape by bending the edge clear of the motion path. The operator should be able to reach freely to the stock without looking or bumping into structures. The hand should fall open onto the stock permitting an easy grasp of the material.

Access to the welding fixture could be improved by raising the operator's position with a higher platform on which to stand. Wrist bending as the operator loads the fixture will be minimized by lowering the fixture relative to the operator. This may most easily be done by raising the operator working height if it is not practical to modify the machine height. Note the operator's elbow is below the fixture height placing the forearm in an upward direction, thus leading to the wrist bending to place a part down into the fixture.

Job 6 (continued)

The caps which are located to the left of the operator are currently lower than desirable and should be raised approximately three (3) inches relative to the present operator height (Figure 8). The small standing female elbow is 37 inches above floor; stock should be accessable with the wrist straight, maintaining a neutral posture, and the origin of the forearm at 37 inches above the standing reference. Thus, target height of 37 inches for locating the stock would be desirable for a standing operator.

Figure 8, Job 6: Right wrist flexion is required to position grease gun cap in fixture on a horizontal surface at mid torso height. Left wrist flexion is required to reach over edge of flat parts bin. Edge of bin has been worn shiny by frequent contact with left hand. Extra effort is required to handle parts with gloves. The edge of the stock bin which causes unecessary flexion of the left wrist and may lead to impact trauma through inadvertent contact between the bin and wrist is shown below the left hand.

Job 7 Cylinder and Cap Drill

Task: Loosen Clamp, Unload, Load and Tighten Fixture Clamp

Recommendations:
1. Forearm interference with barrier must be eliminated.
2. Reduce effort to operate clamp.
3. Increase operator accomodation.

The custom machine used in this operation was designed to be loaded manually by a machine operator; however inadequate space was provided to perform the required tasks. The clamping element was not well designed because: (1) the clamping motion requires a rather severe arc path resulting in significant wrist bending, (2) the clamp handle does not provide a full hand grip, (3) a barrier intrudes into the space in which the operator's arm should be located and (4) minimum standing and/or sitting space for the operator is not provided.

The barrier must be modified by lowering the top edge and providing a broad, well rounded edge to minimize any inadvertent contact with the arm. The operator, ideally, should have full access to the fixture and use a straight line push-pull motion with a fixed lever to clamp the parts. The wrench currently forces the hand to follow the curved path of the tool as it is rotated while tightening the clamp. The cramped location and limited space make it difficult to use two hands in this operation.

Consideration should be given to modifying the side of the machine adjacent to the operator to remove as much structure interfering with the

operator as possible. Knee room and foot support particularly should be reviewed in addition to the arm clearance requirements previously stated.

Figure 9, Job 7: Lack of operator accomodation resulting from poor work station design. The picture shows: (1) poor seating, (2) interference with the left arm and barrier, and (3) poor accessibility to machine to load parts.

Job 8 Assemble Oil Can

Task: Screw Pump onto Can Base

Recommendations: 1. Provide power chuck.

Excessive and highly repetitive motions should be avoided as risk factors in cumulative trauma problems. This operation requires what can best be described as dramatic hand motions to screw the oil can together. The hand was seen to be extended to its limit to enable it to grasp the broad base of the oil can. This operation should be reviewed to develop an assembly process other than hand assembly. A power driven chuck similar to that used in assembling the grease gun should be used to eliminate the many repetitive motions.

Caution should be exercised in designing a new operation. The pump head may not provide an adequate grip for power driving the can onto the pump head. Consider loading the two parts into a fixture which will align the parts for power assembly.

Figure 10, Job 8: Rapid right hand-forearm motion required to screw can to head.

Task: Load Coupler in Chuck, Load Hose into Clamp and Foot Actuate Cycle

Recommendations:
1. Eliminate arm interference with bin edges.
2. Improve operator posture by increasing the height of the work.
3. Redesign the disposal chute to improve operator access and accommodation.

In common with a number of operations in this study, interference is present when the operator reached for stock. Poorly located, shaped and trimmed edges cause excessive wrist bending and probable impact of the wrist with the storage system. The figures illustrate the problem. Removing the bin edges or bending out to provide an extended supply surface is required to provide direct access to stock.

The following principles should be utilized in designing work spaces:

1. Motion paths should be as direct as possible:
   a. The length of the motion paths should be short.
   b. Either a straight line or simple arc path motion should be used.
   c. The path must be consistent with simple hand motions.
2. No interferences: surfaces, objects or edges should not be in the path of a motion.
3. All surfaces which body members may be in contact with or rest on shall be:
   a. Smooth.

b. Have large radius contours or flat.

c. Be padded when needed.

The drop chute is too low for the operator to be seated comfortably. The drop chute should be narrower (it does not need to be centered under the work) and should be inclined, sloping the surface toward the back. Raising the chute sufficiently for the operator's legs will permit the operator to sit comfortably at the work place.

Figure 11, Job 9: Right wrist ulnar deviation is required to reach over the high front edge of the stock bin. Forearm rests on bare edge of sheet metal bin.

Figure 12, Job 9: Left wrist flexion required to pick up stock over a bin edge. Operator cannot get adequate knee room, with the seat pan lower than the back of the thigh, even with low stool.

Figure 13, Job 9: Right wrist ulnar deviation and flexion is required to reach over the bin edge.

Job 10 Assembly Grease Gun Body

Task: Install Plunger Assembly into Grease Gun Body, Install Pump Head on Body, Locate Pump Head onto Body and Power Screw Pieces Together

Recommendations: None

This operation lacks the crispness of a concise compact layout. However no significant problems were identified. The effective location of stock at a convenient height and the mobility of the standing operator allow the operator to assemble grease gun bodies without experiencing the stresses of a more constrained workplace.

The use of a power scissor lift to position the stock bin, into which the assembled guns are placed, is a particularly effective method for using large capacity stock containers.

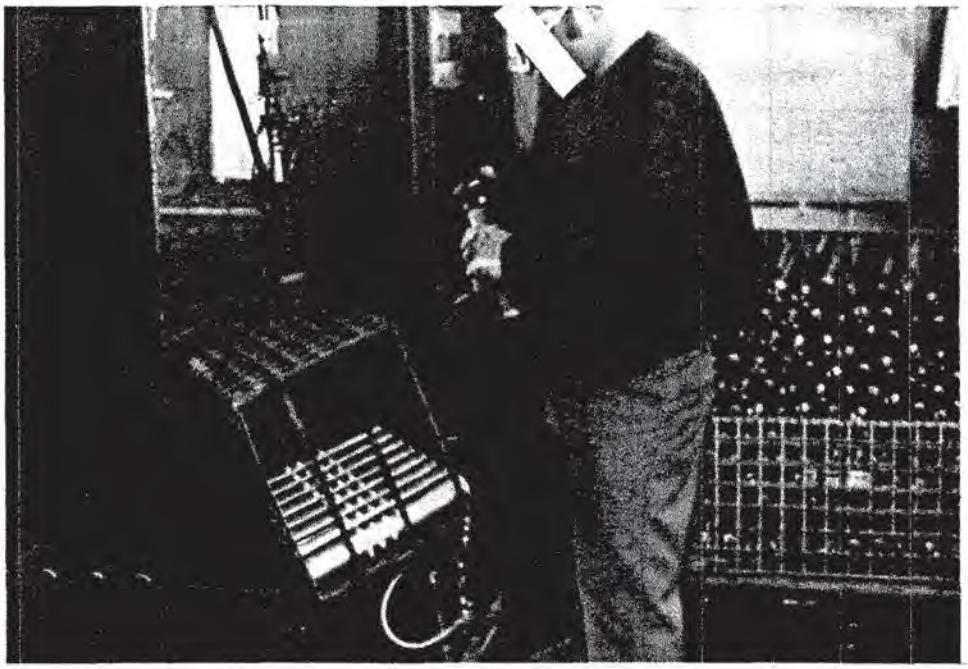


Figure 14, Job 10: Product assembly with stock properly located at working height.

Job 11 Micro Lube Cap Assembly

Task: Assemble and Rivet Cap

Recommendations:
1. Research rivet anvil design.
2. Reset rivet machine; incline toward operator.
3. Increase seat height to improve work posture.

Locating parts over the anvil on a rivet machine is a much more difficult task than might be imagined. The shape of the anvil end makes positioning parts onto the anvil and pressing them into position difficult. Because the anvil edges are sufficiently sharp and clearances sufficiently small, parts tend to catch and bind as they are assembled on the riveter. As the parts catch and bind, the operator must exert significantly greater force to press the pieces into place. Ideally, pieces to be mated can be chamfered to aid in locating and guiding the pieces into place. An improved anvil shape could greatly facilitate locating the cap assembly on the riveter.

The vertical orientation of the anvil makes placing the parts onto the anvil difficult for several reasons. First, vision is obstructed; as the parts are brought up to the anvil they mask the anvil. Blind assemblies in which parts fit over rather than into engagement, block the visual cues normally utilized by the operator. Secondly, when maximum manual control is required in locating parts, awkward postures are to be avoided. The ulnar wrist deviation present when the parts are over the anvil is undesirable because in addition to the stress of the bent wrist, the operator lacks the reference of a neutral posture when positioning the parts. The figures 15 and 17 show the presence of

wrist bending during the critical motions of locating the parts onto the anvil. Reorienting the anvil by tilting the rivet machine toward the operator would permit more neutral postures when aligning and positioning the parts onto the anvil. Placing the operator higher relative to the anvil would improve both wrist posture and vision.

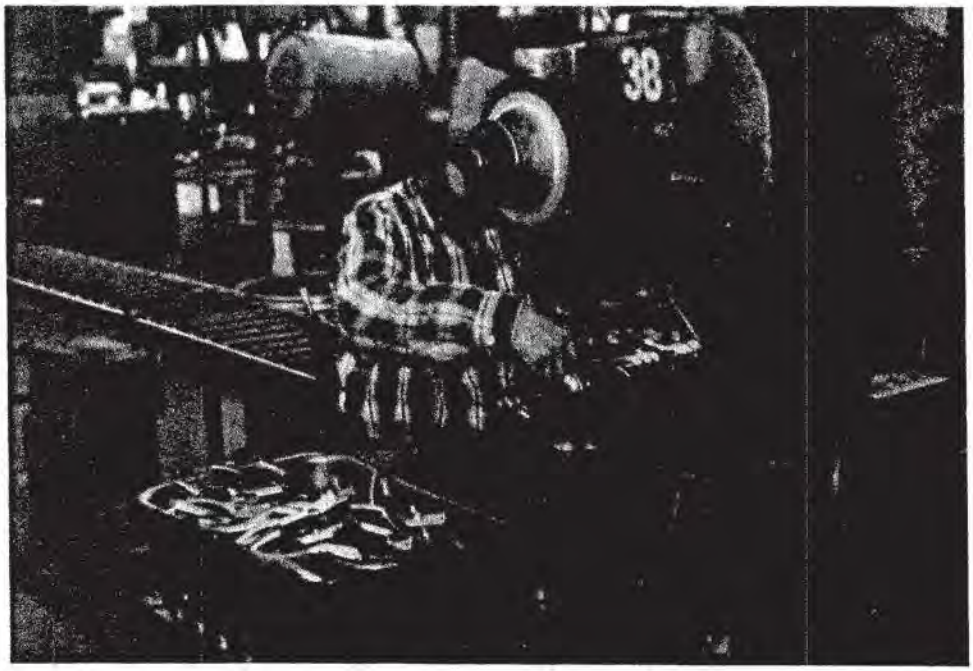


Figure 15, Job 11: Right wrist flexion and ulnar deviation are required to place assembly over the riveter anvil.

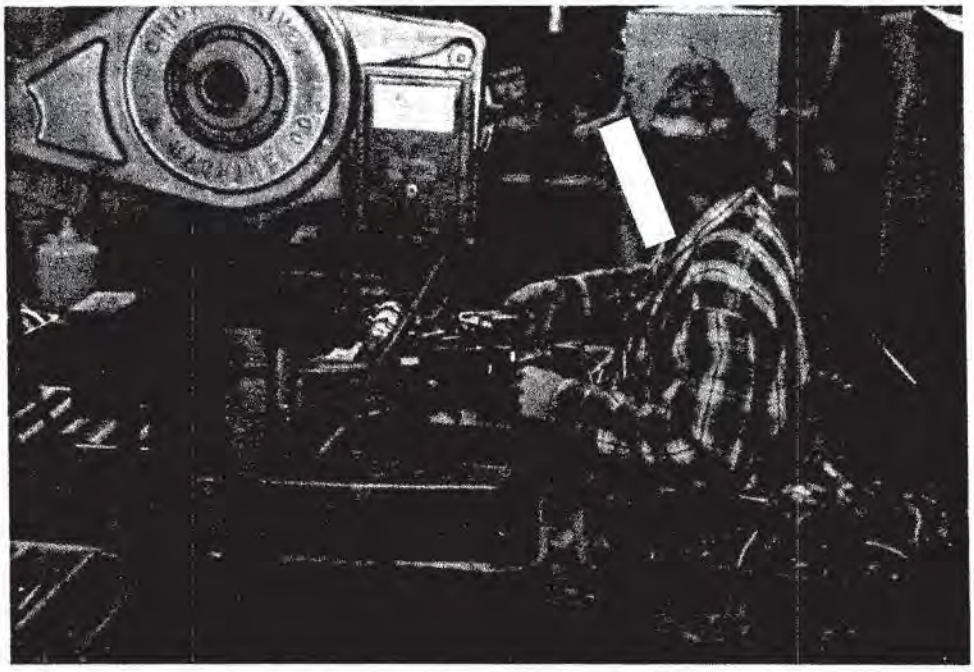


Figure 16, Job 11: Ulnar deviation of right wrist is required to position the assembly on the riveter anvil. Left elbow rests on edge of metal parts bin.

Figure 17, Job 11: Extreme right wrist extension is required to "pump" the assembled part horizontally in front of the body.

Recommendations:

1. Modify bar stock rack:
   a. Shorten stock support bars.
   b. Rebuild bar stock storage rack.
   c. Raise bolster.
2. Lower Traub machine.
3. Relocate control panel and air valve to eliminate operator interferences on Traub machine.
4. Redesign racks to obtain proper heights and minimum motion distance.
5. Locate gauging at effective work height.

The machine operator performs various tasks to maintain and operate two screw machines and a custom machine including loading: stock, moving materials and guaging parts.

Many tasks performed by the operator in this job require excessive or awkward motions. The variety of the tasks performed and the limited time spent doing each mitigates the impact of each on the operator. Through workplace modifications, many of the stresses can be eliminated or substantially reduced. Variety in the tasks performed provides the operator in this job an opportunity to recover from the stress of a poor motion and to avoid static or frozen postural stress which results from repetive work in a fixed location. However, when many tasks require excessive or awkward motionss, the cumulative effect on the operator of the stress caused by all the tasks should be considered. The following tasks are considered to place excessive postural stress on the

Job 12 (continued)

operator:

1. Machine loading height - bending and bracing the body to perform routine tasks is an unnecessary strain on the operator. The following tasks are each performed beyond the normal reach distance of an average operator.
   A. Load Bar Stock - The stock can be loaded from the back of one screw machine but loading front of the second requires the operator to lean over the stock rack and reach over the bar feed rack to load bars into the machine rack. The stock rack should be thinner with an adequate rail to lean against, perhaps saving 6 inches of reach distance. Reducing the capacity of the bar supply by shortening the rack two inches would shorten the loading distance significantly without reducing the supply capacity which appears more than that required to maintain the machine. Raising the loading platform approximately six inches would place the elevation of the loading at a lower and better height (the edge of the platform should have a distinctive surface).
   B. Load Rods - The excessive height of the Traub machine results in several awkward tasks. The machine was setup for a seated operator but provides poor access to materials. Leaning from the stool to load rods into the hopper or parts into the shaker is not satisfactory. In fact the rods were loaded from behind the load position, next to the wash rack, from where the rods are

supplied. Loading from the back position requires the operator to load over the electrical control panel. This position is more convenient and central to the operator's activity and should be the primary load point for the Traub machine. The Traub machine had been built for bottom discharge of assembled parts. The machine height resulting from this design required the operator to load parts at an excessive height. Since the bottom discharge is not now used, the machine should be lowered to provide reasonable working heights. The control panel and utilities should be relocated to prevent interference with the operator's tasks.

2. Tray Racks - The rod discharge pans and wash rack are set too low. The operator should not be required to bend to handle parts. Placing work below normal hand height requires the operator to bend and experience significant postural loading of the back. This back work results from poor workplace design. The employer gets very little value for the effort expended in tasks such as this. The problems here are also in sharp contrast to the superior work leveling systems used throughout the plant.

3. Gauging Tasks - The operator infrequently performs two gauging tasks measuring the length and diameter of the rods produced by the screw machine. For both tasks the tooling is located below the normal maximum reach distance of the operator; requiring the

operator to bend to reach the tool. Locating the tools at a convenient height and providing good operator vision is required. A small rack or shelf on which the gauges could be located at 50" to 60" height would allow the operator to quickly, accurately and comfortably perform these tasks.

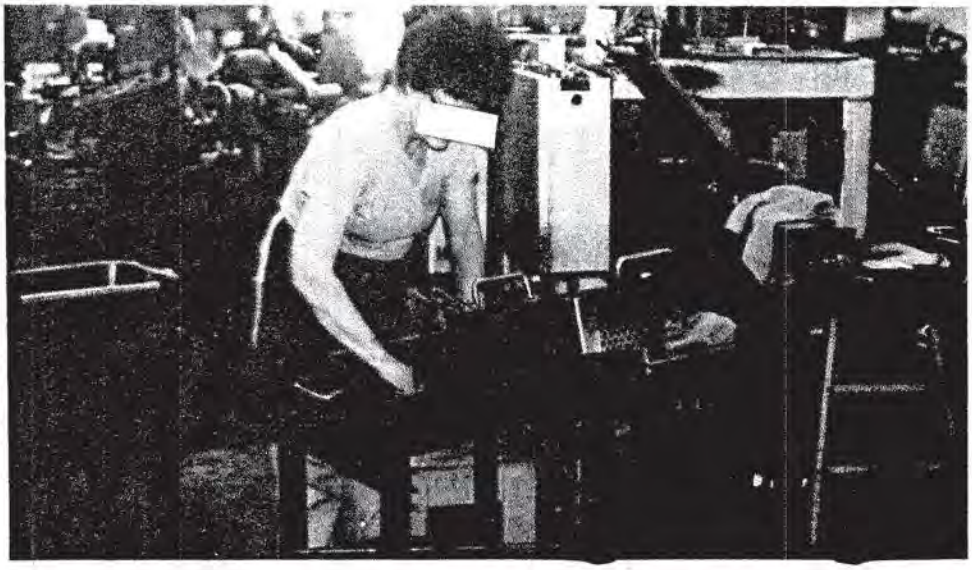


Figure 18, Job 12: The operator must lean forward to wash rods in bin at mid thigh level.

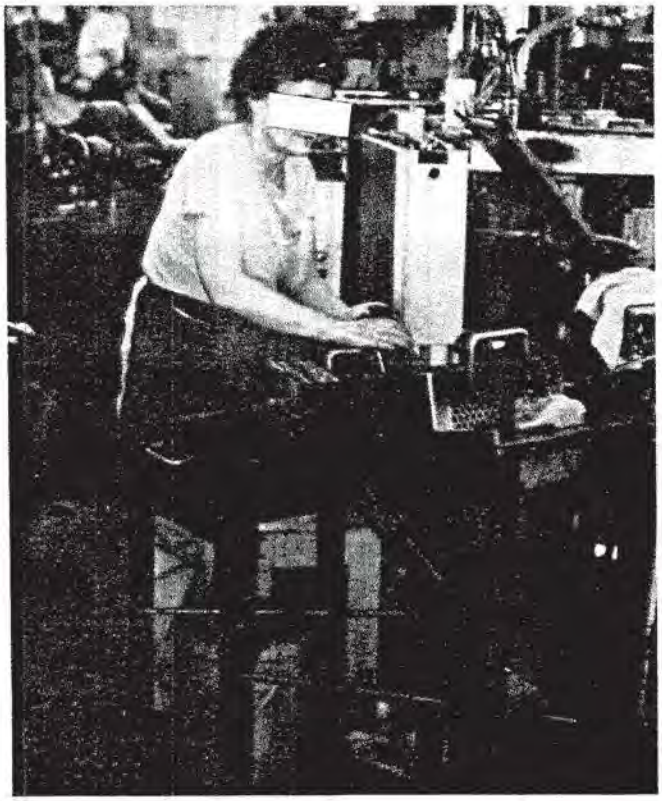


Figure 19, Job 12: Worker must lean forward to position handful of rods in basket located across wash tank.

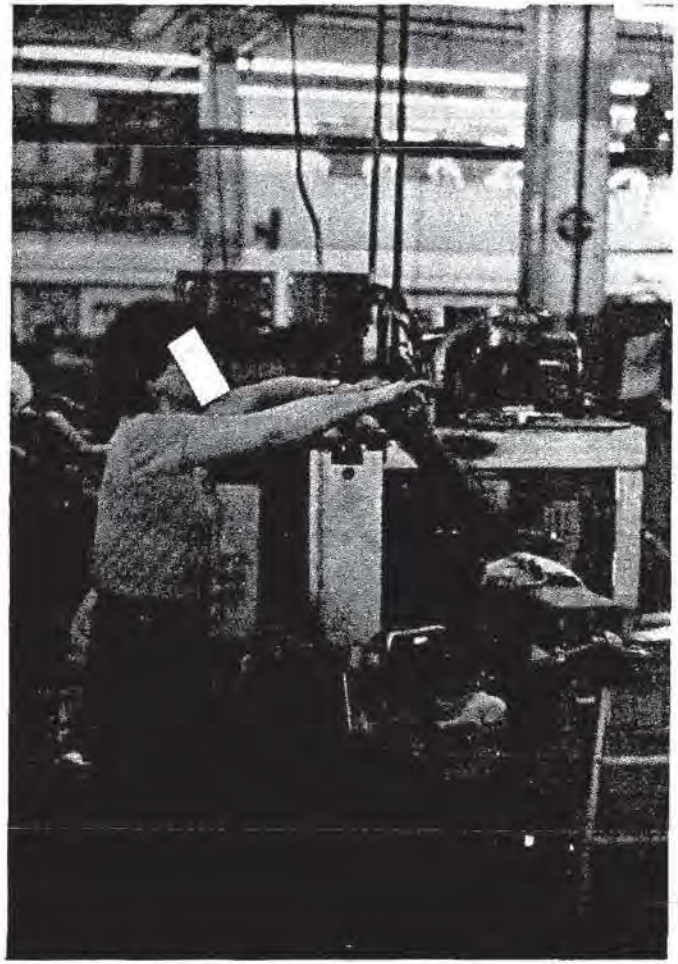


Figure 20, Job 12: Loading a machine from behind because of convenience. Excessive height of the load station is shown.

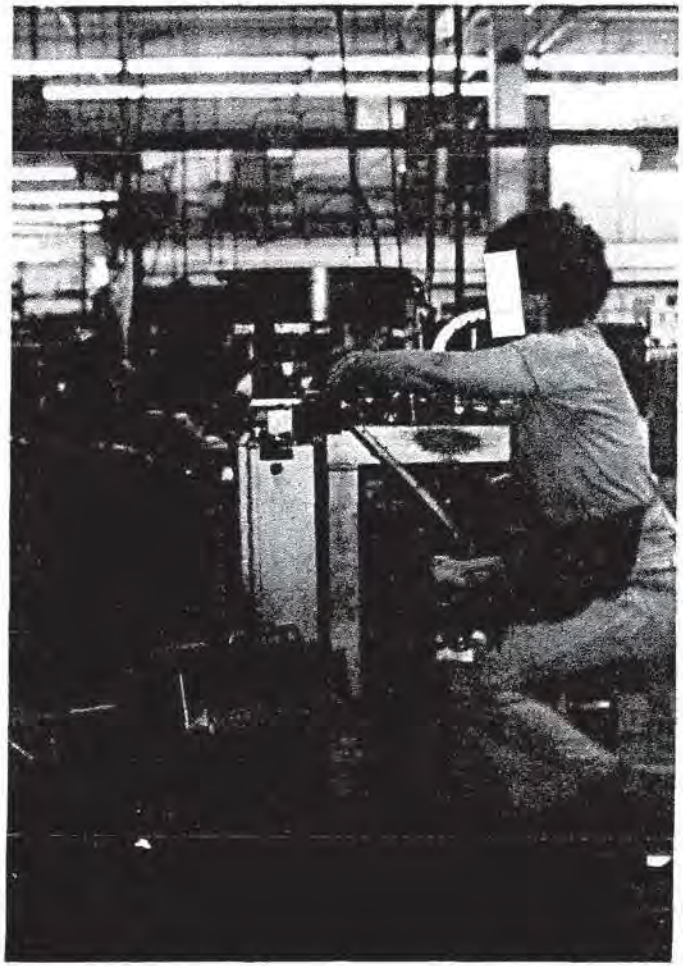


Figure 21, Job 12: Loading machine from front requires extreme reach to shoulder height chute that tilts away from work station.

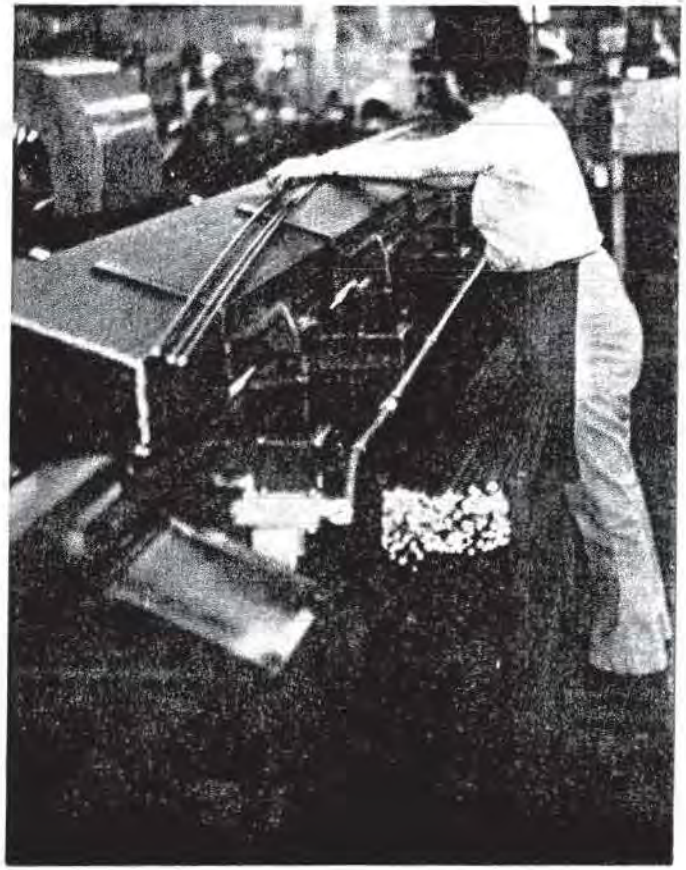


Figure 22, Job 12: Extreme reach required to load bar stock onto rack over machine base and stock rack. Operator standing on edge of wooden platform could trip and fall.

Figure 23, Job 12: Extreme right reach is required to load parts into feeder. Note interference between the right elbow and side edge of machine stand.

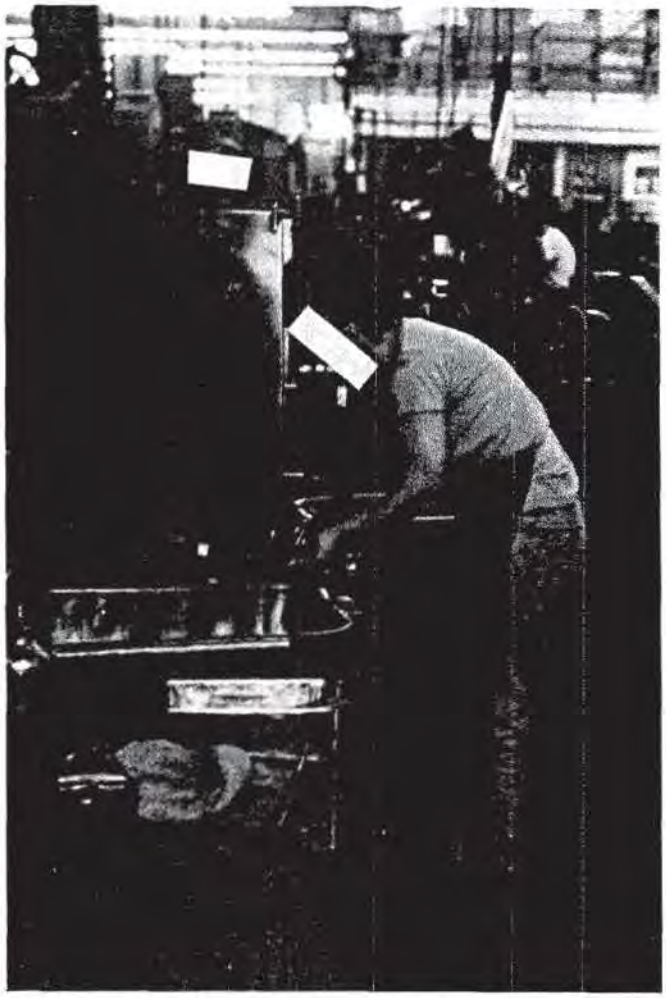


Figure 24, Job 12: The operator must lean forward to use a length guage which has been mounted below waist height.

Recommendations:
1. Relocate power chuck inclined 45° up.
2. Improve access to stock by reshaping the stock bins and removing barrier edges.
3. Provide adequate space for comfortable seating.

The operator orients the barbs, places barb in chuck and screws hose adapter onto the barb.

Considerable wrist bending is required to load the barb into the chuck and hold the adapter for assembly. A power driven chuck is located directly in front of the operator. The horizontal orientation of the chuck requires the supination and extension of the wrist. Interference with the edges of the stock trays forces the arms into a more extreme posture by creating a barrier over which the arms must be held. The natural orientation of the part in the hand suggests an inclined loading orientation of 45° to the vertical.

Redesign of the workspace should provide better access to the stock trays without hard edges protruding into the reach path. The operator should not have to flex the wrist over a barrier edge to grasp materials. When the stock is located too high with respect to the operator, that is, above elbow height, the forearm will be directed upward making reaching down over edges awkward and resulting in excessive wrist motion. No surface or edge should interfere with the simplest direct reach of the hand from the last work location to the stock.

The operator requires adequate open area for the legs and feet for

Job 13 (continued)

reasonable accomodation of the seated operator. This operation had an unused conveyor rack crossing the operator's feet and part of the bench frame also interfered with the operator's legs.

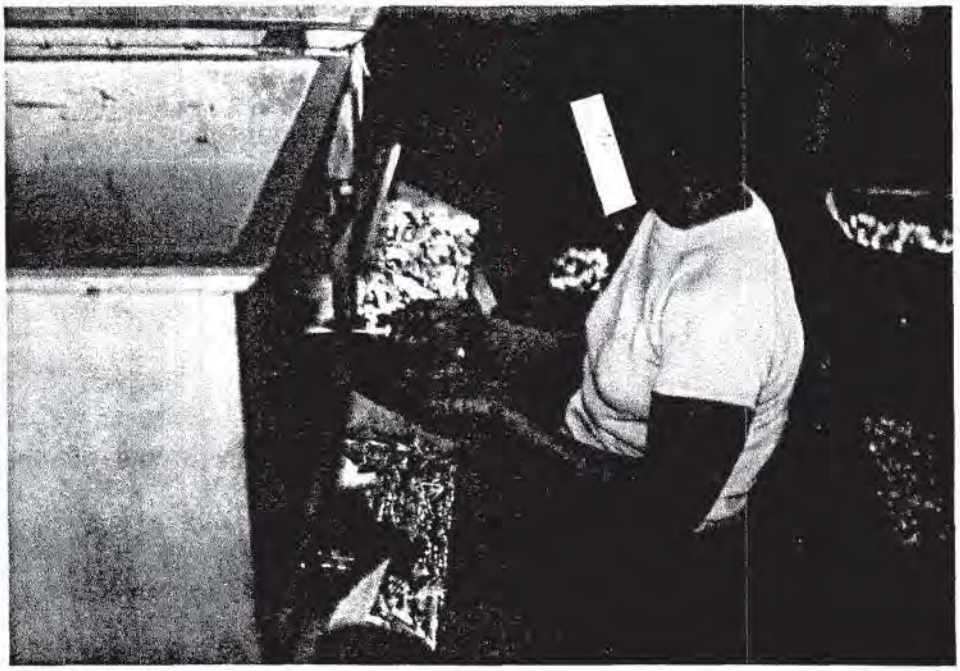


Figure 25, Job 13: Wrist extension and ulnar deviation are required to hold a part which is being screwed, under power, by a machine located directly in front of operator at mid torso height.

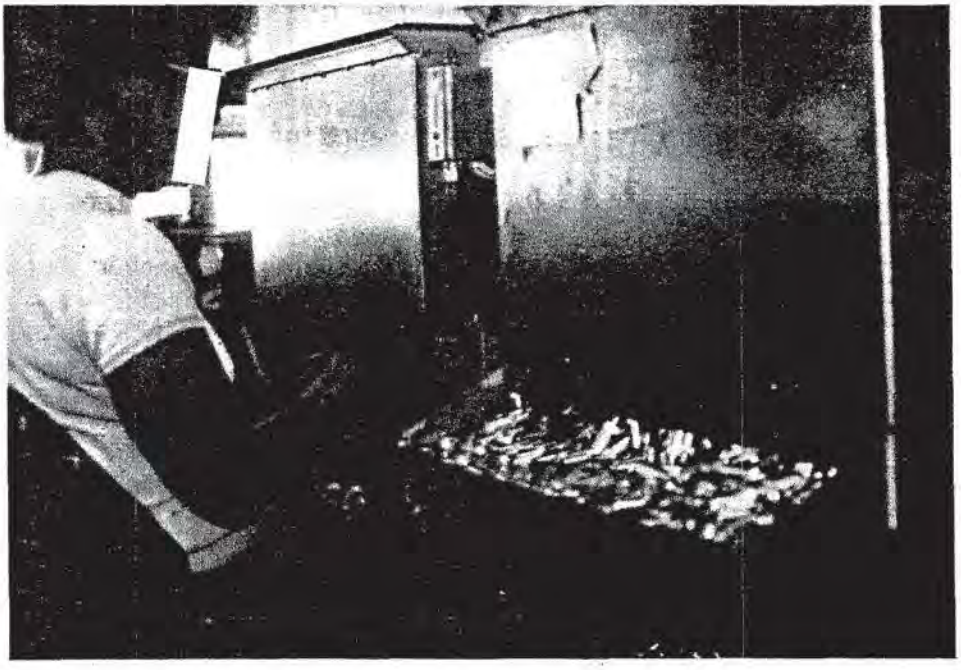


Figure 26, Job 13: Wrist extension and ulnar deviation are required to hold part in the machine. Wrist flexion is required to reach above the elbow over the sheet metal edge of the bin for parts.

Job 14 Assemble Handle to Head

Recommendations:
1. Research rivet anvil design.
2. Reset rivet machine - incline toward operator.
3. Improve layout and access to stock and output conveyor.
4. Improve seating.

The operator rivets the grease gun handle to the gun head.

This operation is built around a standard rivet machine. Locating the assembly to be riveted on the riveter anvil is awkward. Considerable wrist binding is required in order to place parts on the vertical anvil. The anvil would have to be inclined significantly toward the operator to permit nominal wrist postures to be used. (Review discussion of Job 11.)

Inadequate access to parts and interference with movements add to the operator's stress. Figure 29 shows how the operator's right arm is located in the stock bin which restricts the range of right arm movement and causes the operator to use a very excessive motion to toss the riveted part onto the output conveyor. The ends of the bins should either be removed or the work space relaid out to relocate the bin more in front of the operator (situated forward and 45 degrees counter clockwise from the present position).

Adequate seat height and foot support could improve the operator's access to placing parts onto the rivet anvil. Wrist angles will be minimized by lowering the effective work height. Using adequate seating, which will require good foot support, together with an improved layout of the bins, would seem to be the most practical and immediate improvement to be introduced into this job.

Figure 27, Job 14: Maximum flexion of the right wrist is required to position the assembly on the riveter anvil. The slouched posture probably results from poor seating.

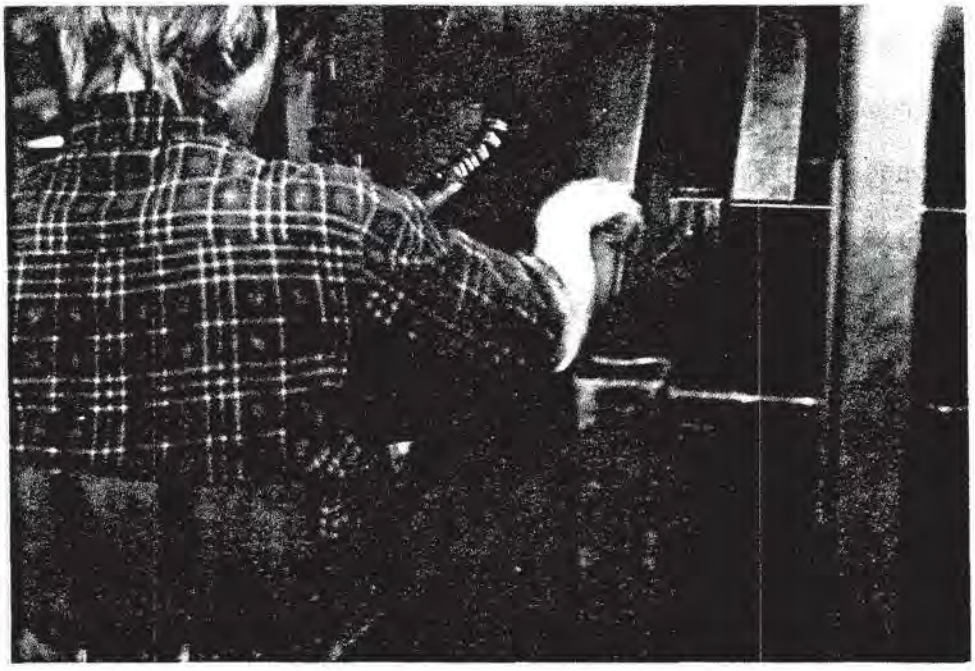


Figure 28, Job 14: An awkward snapping wrist motion is required to toss a finished assembly aside onto a conveyor, because there is poor accessability. The paint on the edges of the metal bin has been worn away by contact with the elbow and forearm.

Job 15 Install Oil Spout into Pump

Recommendations:
1. Relocate drive tool handle away from shoulder.
2. Reorient fixture clockwise 45°.
3. Modify tooling to avoid hand tightening spout.

Locate pump head into fixture, locate spout to pump head and into drive chuck, drive spout and orient spout.

The right arm posture required when driving the oil spout into the pump head is a classic example of a biomechanical limiting posture. The arm is permitted to become fully flexed such that the strengths at both the shoulder and elbow are minimized. This results in a very ineffective posture. Excessive shoulder movement is required to compensate for the strength and mobility lost by the closed shoulder and elbow angles. A tool handle held near the shoulder when the force is directed down stands in contrast to the recommendation that strength will be maximum when directed toward the shoulder.

Relocating the drive handle further away from the operator with the loaded position inclined up and infront of the operator as illustrated by Job 2 is recommended.

Relocation of the fixture by orienting the fixture 45° clockwise would facilitate locating the pump into the fixture, reducing wrist bending by placing the fixture orientation consistant with the way the part is held with the left hand. The left hand is used to load the pump since the tool can only be driven with the right hand. Thus orienting the fixture square to the

operator, which may be desirable when right and left hands must have equal access to the workspace, has no basis in this job. Fixture orientation must be adjusted to minimize the posture stresses of the job.

Figure 29, Job 15: The left hand is used to align the parts while the right arm operates the drive lever. The left arm is near the limits of its range of motion. The right wrist is moved between full extension and full flexion as the chuck is turned to align the assembly.

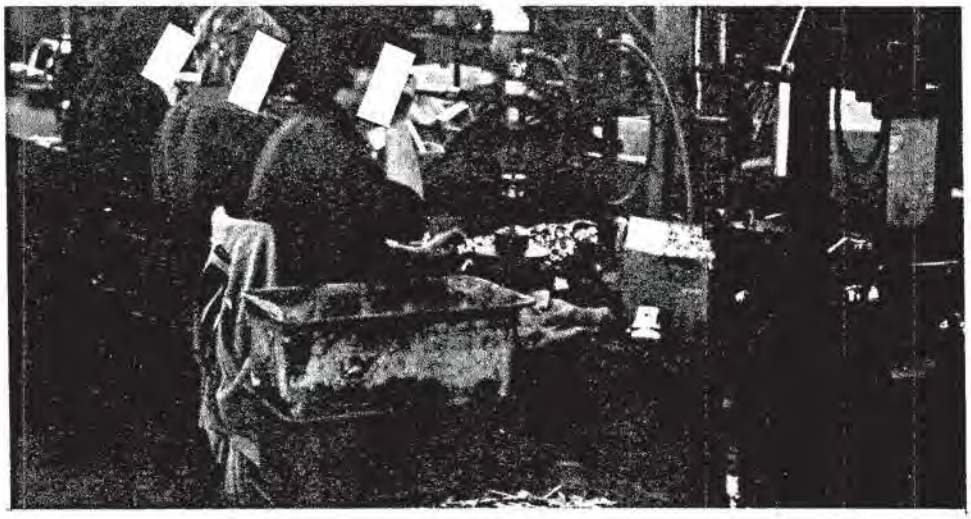


Figure 30, Job 15: Holding the drive handle with the arm near the limits of its range of motion results in the loss of strength and mobility.

Job 16

Task: Use Power Lift to Level Work

An operation was observed which is an excellent example of the use of a device to position stock to eliminate excessive operator effort and stress. Heavy lifting, lifting from floor level and frequent body motions caused by materials located outside the standing reach sphere, place an unnecessary load on the worker and result in lost productivity. Body motions are slow in comparison with arm motions, adding time and representing a significant source of fatigue in the job.

The use of a small power lift by a production operator in a manufacturing operation is a far-sighted method for dealing with the physical stresses of a job. The lift used was designed for handling loads of stock. Providing the operator access to the lift with control and adjustment of the work height is a notable improvement over the usual work station in which the stock is located without regard to the needs of the worker. Typically, an employee, designated as a material handler, will bring stock to the work station with a powered device and deposit the stock. The difficulty with this is that the location of material is left to the descretion of the material handler.

The material handler when moving unit loads such as palletized or containerized materials is restricted in locating stock by the maneuverability of the material handling equipment. This frequently, if not generally, results in stock being poorly positioned for access by the worker. The problem with locating stock for use by an operator is that both height and orientation

Job 16 (continued)

requirements will not be satisfied by the limited access to the work station usually provided for material handling equipment. This job demonstrates that by using the material handling equipment in the work station large and heavy units of stock can be optimally located for access by the worker who also can have control and adjustment of the working height as stock is consumed in the operations.

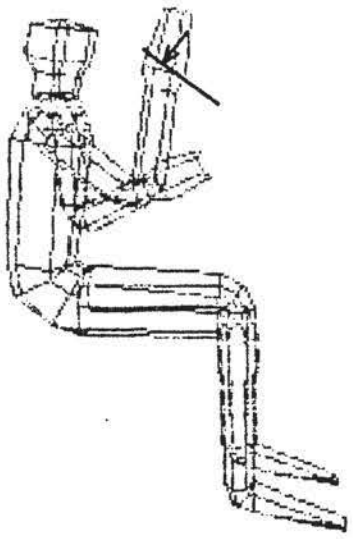
Figure 31, Job 16: Example of properly located stock. Operator is reaching for stock which has been located with a power lift that can be adjusted for each operator.

8. Graphic Study of Selected Jobs

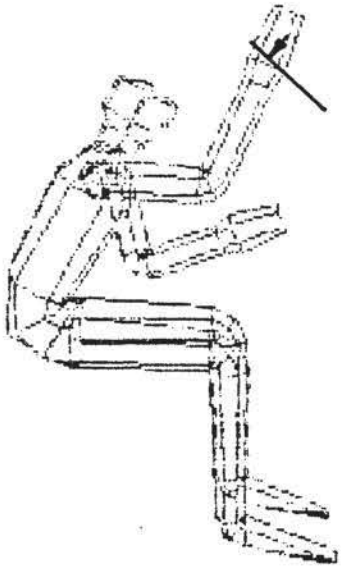
Interesting postures can be illustrated through the use of computer aided graphics. Several representative posture problems are shown in the following graphics.

The dimensions critical to establishing the posture for a seating operator are measured relative to the height of the seat pan as a vertical reference and from the hypothetical intersection of the seat pan and chair back. The model used to construct the graphics is the Biomechanical Strength Model (12 and 13) for this model the dimensions are established relative to the intersection of the ankles. Right hand model coordinate are given for vertical, side and forward dimensions relative to the ankle. Seated dimensions are given relative to the 17" seat pan height.

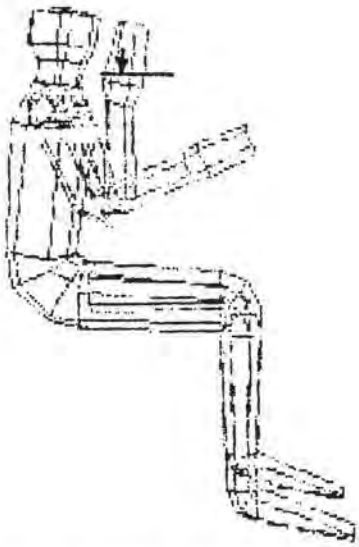
Where applicable, the orientation of a handle is shown with a solid line and the direction of the hand force is shown with an arrow.



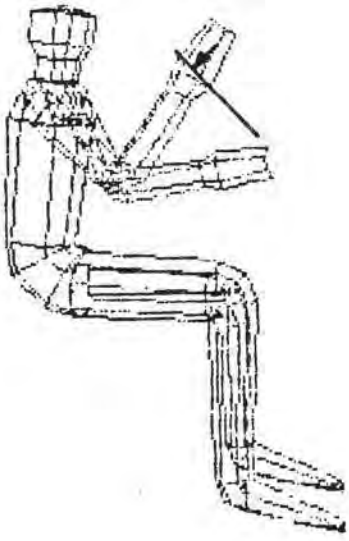
A - Machine or drill press lever close to body 18" above bench, 26" above seat pan (43,8,-6).



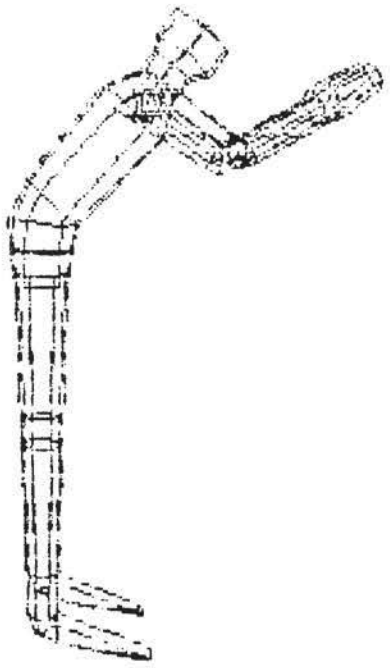
B - Machine or drill press lever high position 22" above bench, 30" above seat (43,8,-6).



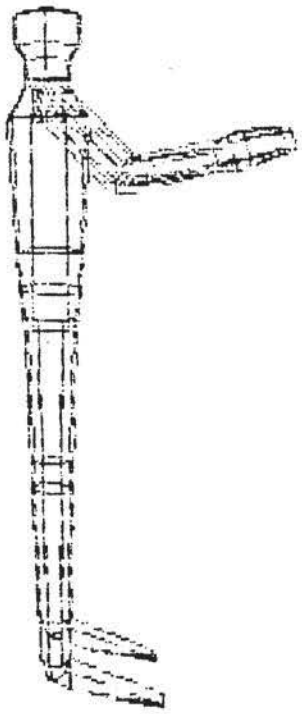
C - Spout driver simulation: machine or drill press lever too close to body. 8" above bench, 23" above seat pan (40,8,-10).



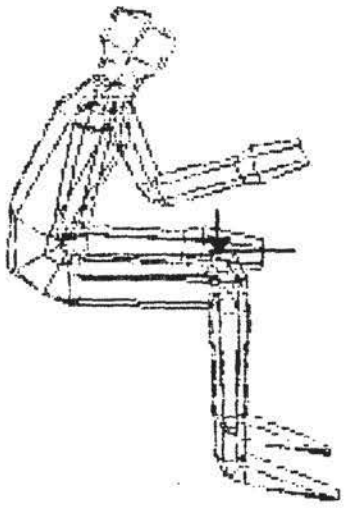
D - Spout driver improved posture. Suitable for debur operation (40,8,-2).



E - Result of average size woman reaching 29" at 52" height to load bar stock (52,0,29).



F - Simulation of loading bar stock at a reasonable location (50,0,20).



G - Simulation of debur operation, right hand presses down in weak direction at knee level (28,8,-1).

9. Glossary of Terms

Flexion - The hand is flexed toward the palm side, e.g., the fingers are flexed to grip or make a fist.

Extension - The hand is extended toward the back of the hand, e.g., the fingers are extended to open the hand.

Ulnar Deviation - The wrist is ulnarly deviated when it bends away from the thumb toward the ulnar bone side of the forearm.

Radial Deviation - The wrist is radially deviated when it bends toward the thumb, the radius bone side of the forearm.

Cumulative Trauma - Posture and exertions which are repeated with sufficient frequency to cause pain and soreness greater than simple fatigue.

10. References

1. Tichauer, E. R. 1966. Some aspects of stress on forearm and hand in industry. JOM 8.2:63-71.

2. Damon, F. A. The use of biomechanics in manufacturing operations. J. of Biomechanics.

3. Chaffin, D. B.; Herrin, G. D; Keyserling, W. M.; and Foulke J. A. 1977. Pre-employment strength testing in selecting workers for material handling jobs. HEW Report: NIOSH-USD No. CDC-99-74-62.

4. Herrin, G. D. 1981. A new method for evaluating manual lifting tasks. AIIE.

5. Armstrong, T. J.; Chaffin, D. B.; and Foulke, J. A. 1979. A methodology for documenting hand positions and forces during manual work. J. of Biomechanics 12:131-33.

6. Armstrong, T. J.; Foulke, J. A.; Joseph, B. S.; and Goldstein, S. A. 1982. Investigation of cumulative trauma disorders in a poultry processing plant. American Industrial Hygiene Association J. 43:103-116.

7. Diffrient, N.; Tilley, A.; and Harman, D. Humanscale 7/8/9. Henry Dreyfuss Association: MIT Press.

8. Greenberg, L., and Chaffin, D. B. 1976. Workers and their tools. Midland: Pendell Press.

9. Herrin, G. D., and Chaffin, D. B. Evaluation of the hazards of manual materials handling.

10. Armstrong, T. J.; Foulke, J. A.; Joseph, B; and Goldstein, S. 1981. Analysis of cumulative trauma disorders and work methods. NIOSH, PO-08-2891.

11. Chaffin, D. B.; Herrin, G. D.; Keyserling, M.; and Garg, A. 1977. A method for evaluating the biomechanical stress resulting from manual materials handling. American Industrial Hygiene Association J. 38: 662-75.

12. Boydstun, L. 1980. Three dimensional man model documentation. Center for Ergonomics, The University of Michigan.

13. Evans, S. M. 1981. Lower body postural improvements for strength prediction model. Center for Ergonomics, The University of Michigan.

APPENDIX B

KP MANUFACTURING COMPANY

MINNEAPOLIS, MINN.

Upgrading of Work Conditions

and Operations

September 8, 1982

KP MANUFACTURING COMPANY
415 ROYALSTON AVE. • MINNEAPOLIS, MINN. 55405
PHONE 612/333-5811 TELEX NO. 290903

October 29, 1982

Donald W. Badger, Ph.D.
Biomechanics Section
N.I.O.S.H.
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati, Ohio 45226

Dear Don,

The attached schedule of operations to be changed should give you satisfaction in knowing that your efforts were worthwhile. We are pretty much on schedule with the estimated completion dates and we have total commitment from upper management.

This year I have only had one carpal tunnel case but this was an old injury.

I am ordering new adjustable shop chairs at a rate of three per month. Business is poor and this is about all we can afford at this point in time.

The only real problem that currently plagues us is how to modify the riveting operation. I am not sure there is a feasible answer to this question.

Thanks again for your assistance. We have certainly learned a great deal and have come along way in correcting our problems.

Sincerely,

Lonnie McNamara
Personnel Manager

LM/mh

9/8/82

NIOSH PROGRAM

UPGRADING OF WORK CONDITIONS AND OPERATIONS

RICK RALEY
PLANT ENG.

The purpose of this program is to upgrade work conditions and manufacturing operations to the point whereby the hourly employee has a minimum exposure to work related conditions which are contributary to back injuries, carpal tunnel syndrome, and other medical problems that have created our high Workman Compensation Insurance Reserves.

This program is based upon the findings of a study conducted by NIOSH and their subsequent report. In addition to the NIOSH report, the program contains the findings of surveys and studies conducted by KP Supervisors, Managerial people, and our Insurance Companies.

The problems and subsequent corrective action to be taken will be addressed in the following manner:

1. IMMEDIATE - Those items which can be done immediately requiring a minimal amount of time to correct and will provide a permanent or temporary correction.

2. INTERMEDIATE - Those items which may be a priority 1 or 2 but in terms of time to correct require more time than an Immediate item but less time than a Long Term item.

3. LONG TERM - Those items which may or may not present the most hazardous conditions but require the most time to restudy, evaluate and engineer to provide the proper correction.

The work will be conducted by the Maintenance Dept. and completed per the attached schedule with targeted completion dates.

NIOSH-KP

INTERMEDIATE ITEMS

	COMPLETION TARGET DATE	ACTUAL COMPLETION DATE
e Barb & Adapter	11-15-82	
ıange angle to machine		
ıke hopper for parts		
ljustable chair		
ındle Machine	11-22-82	
evise rod magazine for easier oading		
ljustable seating		
Machine	11-7-82	
vise operating handle		
arrange work area		
embly Machines	11-7-82	
able seating		
ad & Handles	11-15-82	
de out of handle bin for easier		

NIOSH-KP

IMMEDIATE ITEMS

	COMPLETION TARGET DATE	ACTUAL COMPLETION DATE
1. OPERATION: Rivet Head and Handles		
(Tool-Redo Die)	9-24-82	
1. Make KP Handle wider on next run		
2. Improve chair & seating arrangements	9-30-82	
3. Provide chute for dropping parts into	10-8-82	
4. Improve conveyor for head & handles	10-8-82	
5. Rotate operators- max. 4 hours per day	In process as of 8/20/82	
2. OPERATION: Cleaning Parts at A.S.M.		
1. Make different container for solvent	9-17-82	
2. Provide "Dip" basket for parts to be dipped into solvent	9-17-82	
3. OPERATION: Drilling 2-P300 Rods in Automatic Fixtures	9-10-82	
1. Change angle of fixtures to operator		
4. OPERATION: Assemble Pipe & Coupler		
1. Cut out front of bin	9-24-82	
2. Install sliding panel for loading of pipe	9-24-82	
5. OPERATION: Head Bench Riveting	Completed	Completed
Chute for heads and links sound dampened		
6. OPERATION: Hose Assembly Machines	9-10-82	Completed 9-10-82
1. Make sheet metal ramp to hold pans of parts		
7. OPERATION: Rod & Handle Machine		

September 13, 1982

NIOSH-KP

LONG TERM ITEMS

	COMPLETION TARGET DATE	ACTUAL COMPLETION DATE
1. OPERATION: Machine EZL Heads	12-17-82	
(Tool room to make)		
1. Change parts fixtures to EZ load		
2. Rearrange work area		
3. Adjustable seating		
2. OPERATIONS: Assemble Oiler Pump	12-24-82	
1. Power feed or different handle		
2. Rearrange work area		
3. Adjustable seating		
2. OPERATION: Assemble Cap & Spout to Body	12-24-82	
1. Power driver		
2. Different fixturing		
4. OPERATION: Foot Pedals-Approx 45 Machines	12-24-82	
1. Make adjustable		
2. Make foot rest for pedals		
4. OPERATION: Snow Machines	12-10-82	
1. Eliminate smoke with better exhaust system		
6. OPERATION: P100-P300 Head Machine (Tool room to make)	12-17-82	
1. Change to better parts clamping system		
7. OPERATION: Loading Caps into Cap Threader Bins	12-24-82	
1. Electric magnet or dump bins to eliminate shoveling of parts		

September 13, 1982

NIOSH-KP

LONG TERM ITEMS

		COMPLETION TARGET DATE	ACTUAL COMPLETION DATE
10.	OPERATION: Assemble Plungers	12-10-82	
	1. Standardize baskets for rods		
	2. Some type of lift for baskets		
11.	OPERATION: P300 Pump Assembly	10-29-82	
	(Tool room to make) Tightner for barrel & heads		
12.	OPERATION: P100 Assembly	12-17-82	
	1. Dump bin for heads		
	2. Change set up		
13.	OPERATION: Dispenser & P300 Head & Handle Riveting	12-17-82	
	1. Standard bins for handles		
	2. Electric lift for bins		
14.	OPERATION: P300 Packing	12-24-82	
	1. Telescope pipe in standard bin		
	2. Some type of adjustable lift for bin		
15.	OPERATION: Head Bench-All Operations		
	1. Rearrange work area		
	2. Seating		
16.	OPERATION: Assemble Pipe & Couplers	10-22-82	
	(Tool room to make) 1. Install new assembly machine		
	2. Rearrange work area		

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396