

Ergonomics Evaluation and Design Modification of Foot Operated Punching Machine used by Workers

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ABSTRACT: There are many causes of WMSDs, and to prevent them, the whole work situation must be taken into consideration; it is therefore a difficult issue to handle. First, it is important to understand what is going on, to get rid of any biases, to find out the facts. Then, it is necessary to address and evaluate the seriousness of the situation prevailing in the workplace. If the situation is acceptable, it may be sufficient to simply remain alert and ready to intervene at the slightest sign of deterioration. If, however, it becomes obvious that the situation is problematic, either because there are already signs of identified. This project demonstrates that there is ample room for ergonomic improvements in the lock industry. We need to continue to identify problems and, more importantly, implement solutions to reduce the risk of injuries in situations where we know problems exist.

KEYWORDS: WMSDs (work related musculoskeletal disorder), Elbow, Upper Arm, Lower Arm,

1 INTRODUCTION

In 1994 (NIOSH 1997) work related upper extremity compressed 13 % of the illness cases involving lost day from work and the total illness cases reported is 69 %. In 1990's there are lots of occupational health problem to be encountered. In 1990 the bureau of labour collect the statistics report which shows that all the reported cases of occupational illness 56% were associated with repeated traumas. According to Bernard (1997), the bureau of labour statistics (BLS 1990) reported a further cause in that there were approximate 705800 (32 %) cases of over exertion or repetitive motion injuries among all the injuries repeated. They also reported that 92576 injuries or illness occurred as a result of repetitive motion. The percentage of work related musculoskeletal disorder (WMSD) to total injuries and illness has continued to increase from 62 % in 1995 to 66 % in 1999 (BLS 2000a). In 1999 approximate 25000 WMSD's cases were reported with the meat processing industry (BLS200b). There were approximately 26266 new CTS cases reported in 1998 (BLS 2000c).The prevalence of clinically verified commutative trauma disorder of wrist and Luanda, consisting primarily of tendon disorder ranged from 1% to 25 % in an industrial working population. According to the force demand and repetitiveness of the works (Silverstein 1985, Silverstein et al 1986).Work related neck and upper lib musculoskeletal disorders is a worldwide problem in north America, 20% of newspaper employees in Canada (Polanyi el al 1997) and 11.7% of U.S workers identify themselves with upper limb discomfort (Morse et al 2003) further 30% of non manual U.K workers report discomfort at one or more sites in the neck or upper limbs (Palmers et al 2001). In Taiwan the prevalence of neck and shoulder discomfort is 14.8 % and 16.8 %. In a survey of 17669 workers respectively (Lee et al 2005).WMSDs of the shoulder are common in manufacturing and construction trades. The prevalence of the disorders such as shoulder tendonitis has been reported to be as high as 30-40% (Olson 1987, Holmstrom el al. 1992). Herbert el al. (1981) estimated an18% prevalence for supraspinatus tendonitis in shipyard welders

and an overall incidence rate of 15-20% for the welder population. Roscrance et al. (1996) reported that 41% of a sample of construction workers in a pipe trades complained of the work related shoulder pain with tasks performed in differing postures including directly overhead. Hagberg and Wegman found that material handling and force/torque exertion with the aid of human powered hand tools, account for approximately 45% of all industrial overexertion injuries in US. Yun et al. reported 51.4% cases of shoulder MSDs problems among VDT workers in Bank of Korea. In an epidemiological investigation of WMSDs according to Smith et al. among the nursing student in Japan, the shoulder was the most affected part (14.9%). Similarly, among rural Australian nursing students, Smith and Leggat observed prevalence rates of 23.8% for shoulder WMSDs while Chyan et al. reported rates of 58% for shoulder WMSDs among Taiwanese hotel restaurant workers. Based on a cross-sectional study of 104 workers at an aluminum smelter, Hughes et al. recorded a prevalence rate of 11.6% elbow and forearm injuries. Similarly Ritz recorded a prevalence rate of 14% for humeral epicondylitis, among gas and water work employees.

2 TASK SELECTION

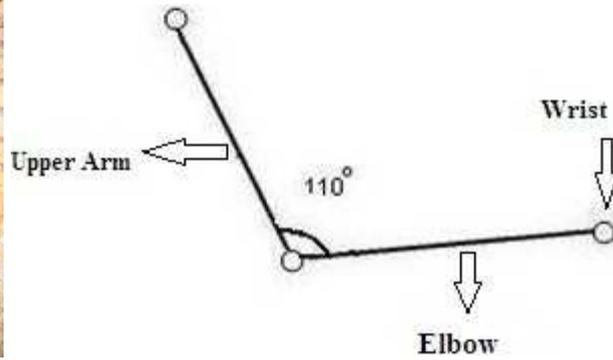
An industrial survey was conducted in lock factory in Aligarh. There were different types of operation performed on the machine for making locks. In this survey it was observed that workers faced many problems related to, work related musculoskeletal disorders (WMSDs). There were different types of task such as hand operated drilling, foot operated punching, and hand operated punching, flattening and assembly operation. Figures of these tasks as shown below.



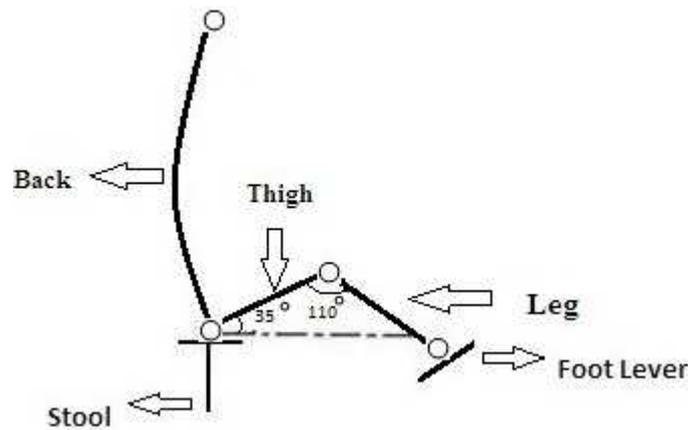
Figure 1:- (a) Hand operated drilling machine, (b) Hand operated punching machine, (c) Foot operated punching machine, (d) Final inspection

3 PROBLEM FORMULATION

There were different tasks in lock factory. The task selected for study purpose was foot operated punching Machine using power press. In this task, operator performs the operation with poor posture such that they bear the pain in thigh, wrist and back.



(a)



(b)

Figure 2:- (a) Position of hand during operation, (b) Position of Feet during operation

SPECIFICATION OF TASK

- Height of machine=56"
- Height of driller=28"
- Height of foot lever=9"
- Height of stool=17"
- Height of unfinished product=12"
- Distance between the unfinished product and hand=14"
- Distance between foot lever and stool=15"

4 MODIFICATION POSSIBLE

In this task the operator performed the operation with poor posture; their posture could be modified with ergonomics point of view. The existing postures of the operator are as given below.

4.1 EXISTING POSITION OF HANDS AND LEGS

During operation, the operator performed the task in such a manner that their existing posture was not good with ergonomics point of view. The angle of their forearm and knee joint with horizontal axis was very wide, thus they bear the pain during operation.

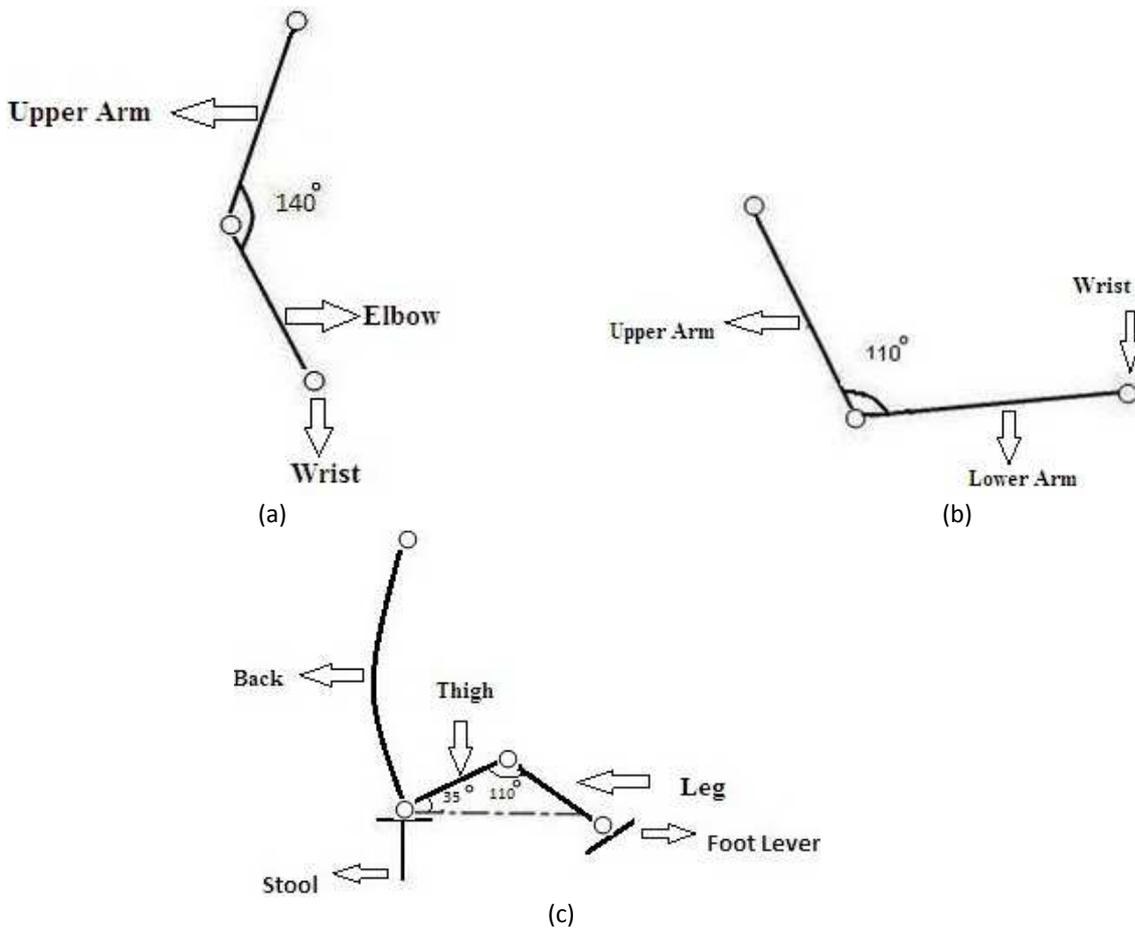


Figure 3:- When operator taking unfinished product, (b) during operation, (c) Pressing the foot lever

5 MODIFICATIONS IN FOOT LEVER

5.1 CHANGING THE POSITION OF FOOT LEVER

In this task, foot lever was so far away from the operator such that operator did not feel comfort during operation. If the foot lever was shifted to the center of the machine then the angle of knee joint will be reduce 110° to 90° . Thus the operator needs to apply less effort.

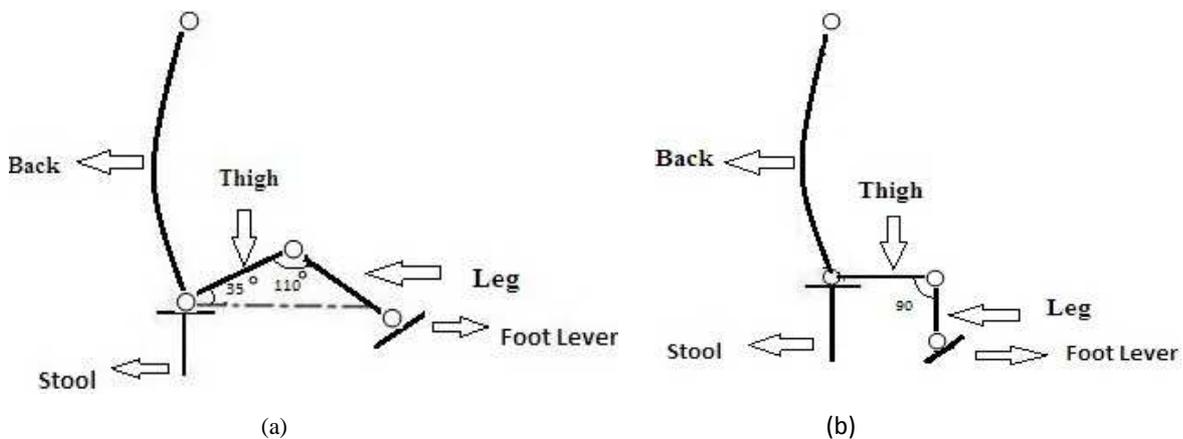


Figure 4:- (a) Existing position, (b) Modified position

5.2 DECREASE THE HEIGHT OF FOOT LEVER

If the height of foot lever was decreased then the angle between the thigh and horizontal axis will be reduced from 35° to 20° . Thus the thigh pain would be minimized.

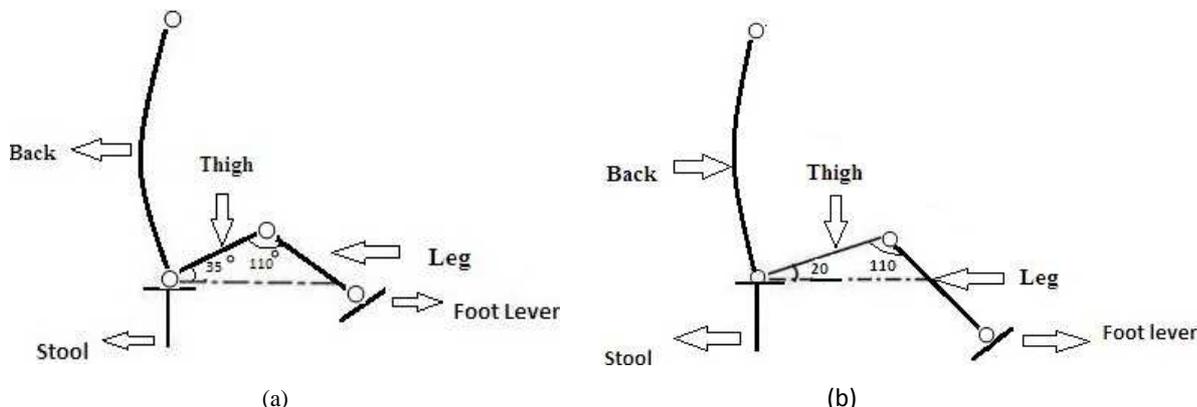


Figure 5:- (a) Existing position, (b) Modified position

5.3 DECREASE THE DISTANCE BETWEEN FEET AND FOOT LEVER

If the distance between the feet and foot lever was minimized then the angle between the knees joint will be minimize from 110° to 90° , and increase in angle between the thigh and horizontal axis.

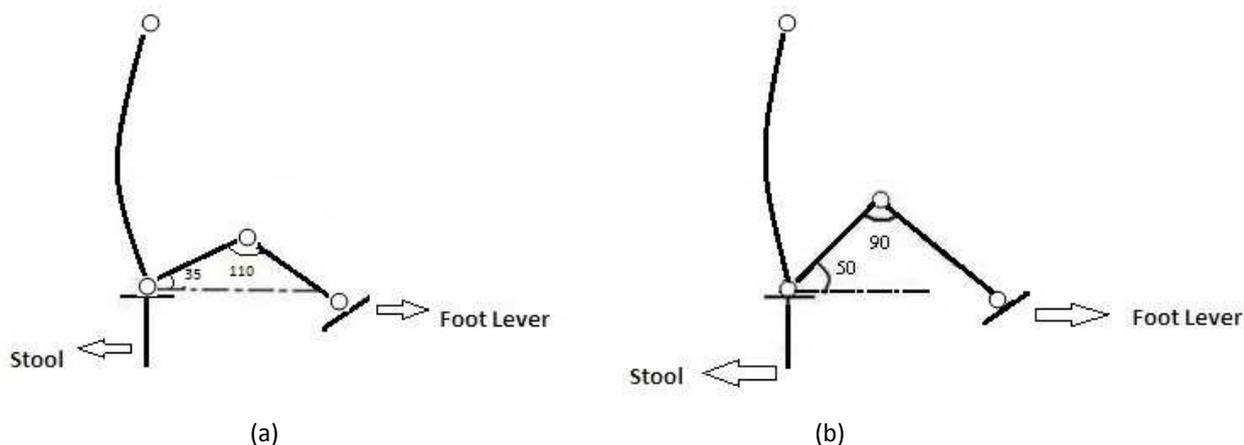


Figure 6:- (a) Existing position, (b) Modified position

6 MODIFICATION IN THE HEIGHT OF STOOL AND MACHINE

6.1 INCREASE THE HEIGHT OF STOOL

If the height of stool was increased then the elbow flexion angle of the operator could be reduced. During this operation the angle of elbow flexion was 110° and when the height of stool was increased then elbow flexion angle will be reduced to 90° . Thus the operator could perform the same task with less effort.

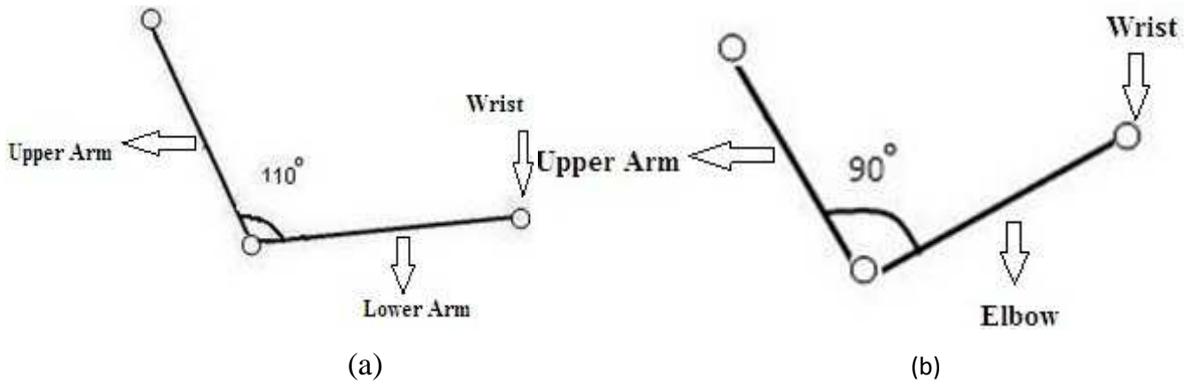


Figure 7:- (a) Existing Position of hand, (b) Modified Position of hand

6.2 INCREASE THE HEIGHT OF MACHINE TABLE

Elbow flexion angle can also be reduced by increasing the height of machine table. In this operation the height of drilling machine table was 28" such that during operation angle of elbow flexion of operator was 110°. If the height of table was increased then the elbow flexion angle could be reduced to 90°.

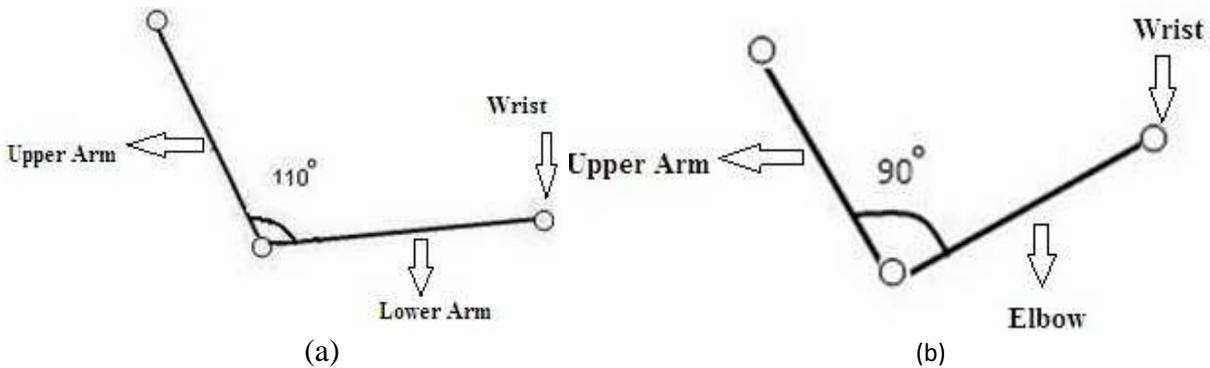


Figure 8:- (a) Existing Position of hand, (b) Modified Position of hand

6.3 MODIFICATION IN THE HEIGHT OF UNFINISHED CONTAINER

When the operator was taking the unfinished product then the elbow flexion angle was 140°. If the height of unfinished container was increased then the elbow flexion angle could be reduced to 110°.

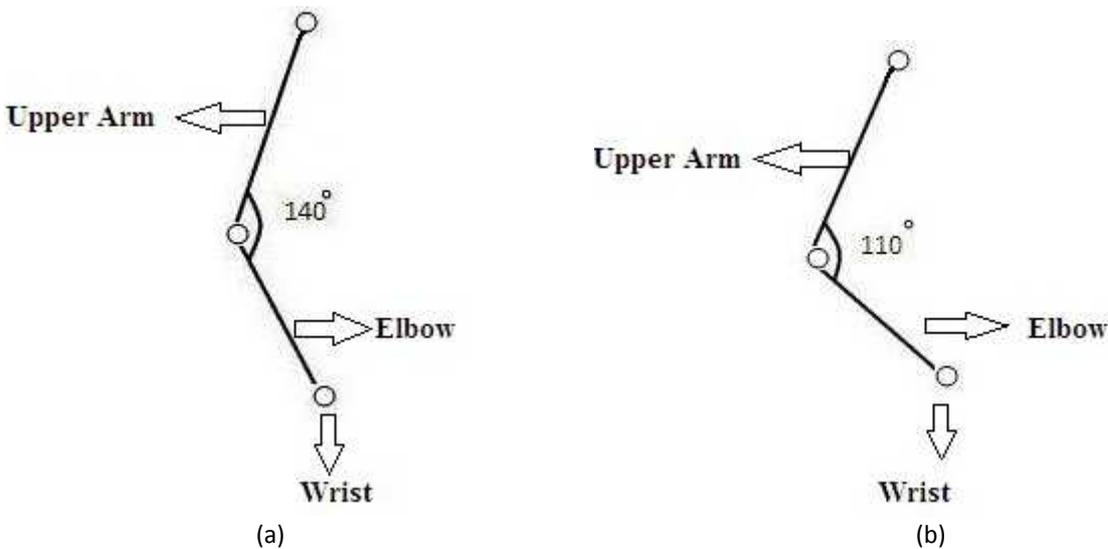


Figure 9:- (a) Existing Position of hand, (b) Modified Position of hand

7 IMPROVEMENT IN WORK PLACE, TASK AND TOOL

The risk of work related musculoskeletal disorders can be reduced by applying ergonomics principles. Workstation design, equipment and tools, work environment, and work organization are work components that affect ergonomic risk factors. An ergonomic design can include such factors as adjustable seating, angled hand tools, or a work pace that can change to suit the worker

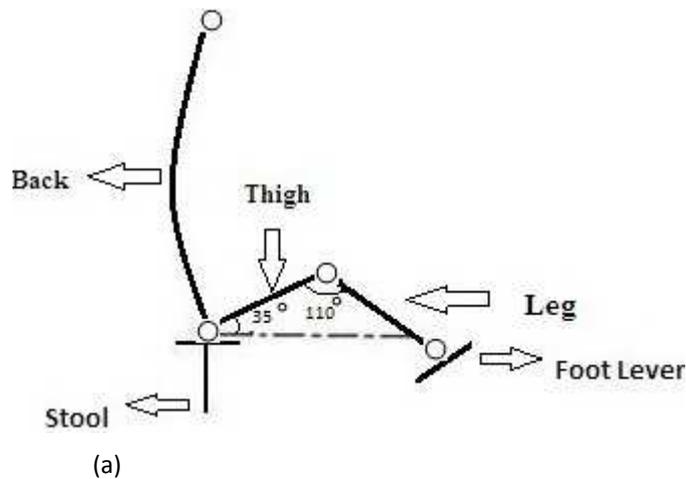
Working with the arms above shoulder height increases the risk of developing shoulder injuries. Awkward postures can be reduced by raising the worker on a platform and/or lowering the work piece. In this task the operation of machine is not so good ergonomics points of view. There were lots of awkward postures such that the operator did not perform the operation comfortably.

There are different types of risk factor during the operation.

- Uncomfortable of seating arrangement.
- Bending and twisting of hand.
- Lifting done above shoulder height.
- Adjustability of work table.
- Raising of elbow during operation.

7.1 CHANGING THE POSITION OF FOOT LEVER

In this task foot lever is so far away from the operator such that the angle of knee joint was 110° which is more uncomfortable for operation so we required to reduce that angle such that operator could performed the operation with less effort.



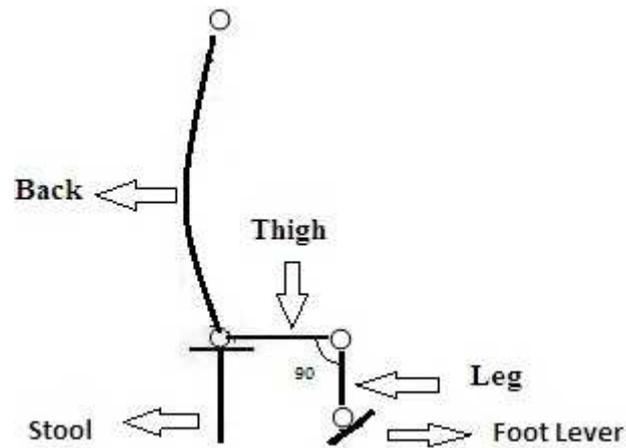
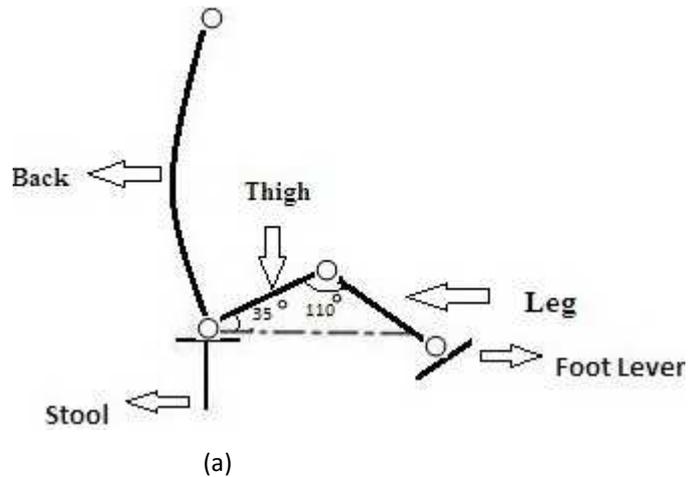


Figure 10:- (a) Existing position, (b) Modified position

7.2 DECREASE THE HEIGHT OF FOOT LEVER

In this task the height of foot lever is very high such that the operator was not feeling so good and they bear the pain in thigh so if the height of foot lever was decreased then the angle between the thigh and horizontal axis will be reduced from 35° to 20° . Thus the thigh pain would be minimized.



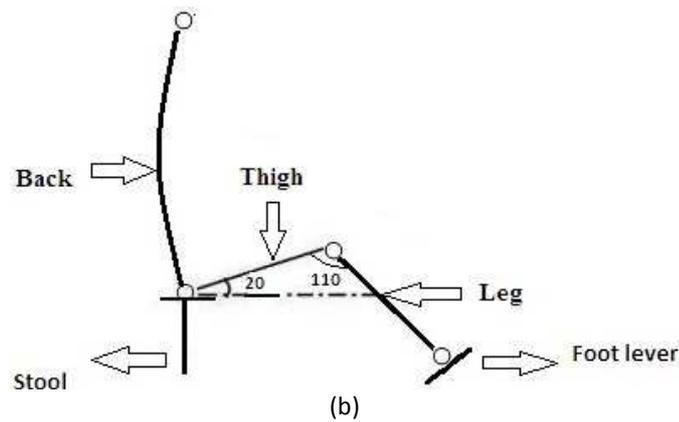
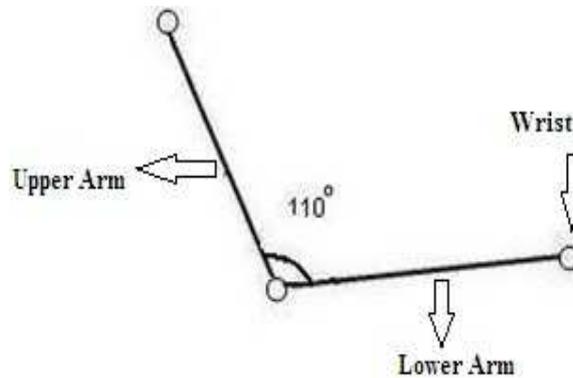


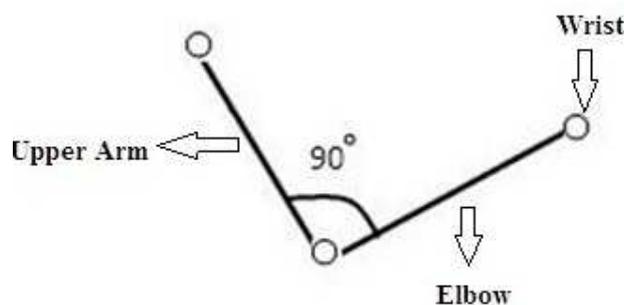
Figure 11:- (a) Existing position, (b) Modified position

7.3 INCREASE THE HEIGHT OF MACHINE TABLE

An ergonomic design can include such factors as adjustable seating, angled hand tools, or a work pace that can change to suit the worker. In this task if the height of machine table increased than we can reduce the elbow flexion angle from 110° to 90°.



(a)



(b)

Figure 12:- (a) Existing Position of hand, (b) Modified Position of Hand

7.4 FINAL MODIFICATION

Work-related musculoskeletal disorders (MSDs) are impairments of body structures such as muscles, joints, tendons, ligaments, nerves, bones or a localized blood circulation system caused or aggravated primarily by the performance of work and by the effects of the immediate environment where the work is carried out. In this task we have observed all awkward posture such as location of foot lever, position of foot lever, stool height, machine table height etc. In final modification, we have changed the location of foot lever (into the middle of the machine) and increase the height of machine table such that the angle of knee joint and elbow flexion angle would reduce from 110° to 90° and 110° to 90° respectively. So the operator can do the same work with less effort and feel more comfort than the previous same work.

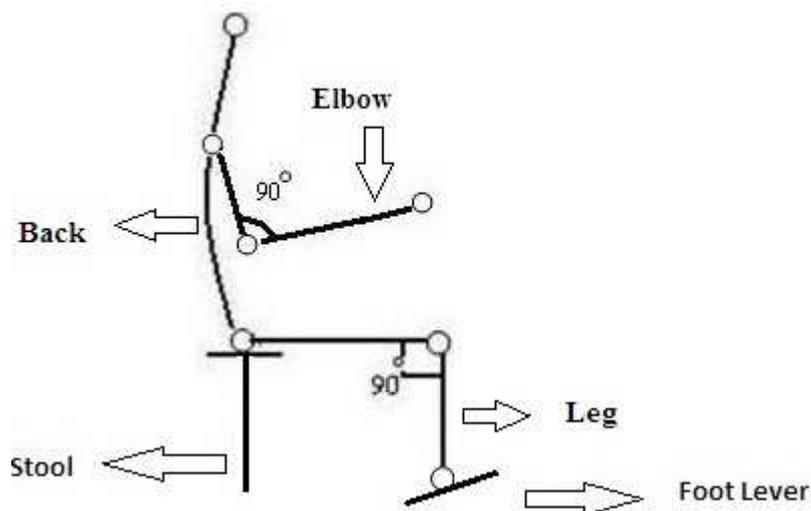


Figure 13:- Final Modification

8 CONCLUSIONS

WMSDs of muscles, tendons and nerves are a major cause of lost work in many labour-intensive industries. Occupational risk factors include continual repetition of movements, fixed body positions, forces concentrated on small parts of the body, and lack of sufficient rest between tasks.

Prevention must aim at eliminating the repetitiveness of the work by proper job design. Where this is not possible, preventive strategies such as good workplace layout, tool and equipment design, and proper work practices should be considered. Early recognition of these disorders is very important because medical treatments are unlikely to be effective once these injuries become longstanding. Preventive and control measures, in order to be truly effective, require significant involvement on the part of the workers, their representatives, and management to improve occupational health and safety

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