

Research Article

Ergonomic Workstation Design and Methods Improvement in a Food Processing Industry

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Abstract

Ergonomic work station design helps us to work comfortably, efficiently and effectively. Thus, it leads to increase in productivity. Non-ergonomic design can be harmful to the worker. Productivity also gets affected if we are in environment that is not ergonomically designed. In this paper we studied ergonomic aspects of the workstation for frying and washing area in a food processing industry. We observed the ergonomic issues and developed ergonomic workstation along with the improved method. These improved methods have been introduced in the unit.

Keywords: Ergonomics, work station design, methods improvement, food industry

Introduction

Workers are an important part of production process: Efficient work on the part of worker leads to increase in productivity. The term 'productivity' can be used to assess or measure the extent to which a certain output can be extracted from a given input (Kanawaty George *et al*, 1997). Workplace design and ergonomics can make the work comfortable for worker increasing worker satisfaction leading to improved work efficiently. Ergonomics is a multidisciplinary field incorporating contributions from psychology, engineering, industrial design, graphic design, statistics, operations research and anthropometry. In essence it is the study of designing equipment and devices that fit the human body and its cognitive abilities.

The ergonomic guidelines and principles are meant to provide an orientation towards the physiological and psychological needs of the operator. The design is essentially a compromise between the operator's biological needs, as determined by the ergonomics guidelines and physical requirements of the equipment. The design is primarily accomplished by considering the mutual effects of anthropometry and location of the equipment elements on posture, strength, reach, vision, clearance, and interference of the body segments with the equipment elements. All these design factors determine the postural requirements during work or task performance (Das and Grady, 1983; Das and Sengupta, 1996) (Das Biman *et al*, 2002).

Statistical report shows that in the year 1995, there were 891 cases of fatal industrial injuries in India. In the same year there were 70,500 non fatal injuries leading to loss of about 1,41,000 man-days. Also, in the same year the amount of Rupees 215.95 Lac was distributed under the Workers' Compensation Act, 1923. In the year 2003-04, there were 932 cases fatal injuries and 67,808 cases of non-fatal injuries (Kulkarni K. T.*et al*, 2007). In risk-free atmosphere people can co-ordinate and interact without tension and botheration. This promotes team work, which is one of the key elements of higher productivity. Safety record of all economically viable and progressive companies is equally good. This is in spite of the expenditure made on safety from humanitarian and statutory angle. Higher productivity is achieved and maintained by keeping low rates of accidents with consistent efforts (Kulkarni K. T.*et al*, 2007).

Improving worker satisfaction and productivity especially in repetitive production tasks are major concerns for management as these tasks are monotonous, boring, fatiguing and de-motivating and consequently affect satisfaction and productivity. Worker satisfaction is an emotional reaction where as worker productivity is the performance output of the worker (hikdara Ashraf *et al*, 2003).

In a large number of industrial occupations, hand tools are primary tools. A major concern of these industries is the high percentage of injuries that occur annually. In many occupations, some of the major causes of work-related disorders and diseases are linked to the use of hand tools. It has been shown that tool design may play an important role in the

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development of work-related problems in the upper limbs. The relationship between occupational musculoskeletal disorders (MSDs) and the use of hand tools is well known. Poor design of hand tools may result in cumulative trauma disorders. Occupational accidents can be linked directly to the use of specific hand tools as well. Ergonomically designed hand tools may reduce the risk of occupational injuries of the upper limbs. They also provide comfortable work for the users and give high product quality to the consumers. As the use of hand tools may play an important role in the development of disorders and accidents, it is obvious that improvements in the design of hand tools are essential for promoting professional users' health, particularly where there is intensive exposure (Motamedzade Majid *et al*, 2007).

Ergonomics aims at preventing injuries by controlling the risk factors such as force, repetition, posture and vibration that can cause injuries to develop. Method study is the systematic recording and critical examination of ways of doing things in order to make improvements (Kanawaty George *et al*, 1997). Method analysts should provide good, safe, comfortable working conditions for the operator. Experience has conclusively proven that plans with good working conditions out-produce those with poor conditions. The economic return from investment in an improved working environment is usually significant. In addition to increasing production, ideal working conditions improve the safety record, reduce absenteeism, tardiness, and labour turnover, raise employee morale, and improve public relations (Benjamin Niebel *et al*, 1999). Complaints, accidents even disasters, occupational diseases, drop in both productivity and quality, increased unit costs and a high number of breakdowns are just some of the consequences of the poor design of any product or system that does not take man and his role as a factor of reliability and safety into account (Sagot Jean-Claude *et al*, 2003).

Varsha Karandikar and Shriram Sane *et al*, (2014), discussed the P-SVRTn method of Ergonomic analysis of video recording of a subject based upon changes in postural severities. Elemental breakup of given task is done on the basis of changes in postural severity level as they occur. Some fundamental ergonomic principles that should be followed in our workplaces are to avoid awkward postures and to use ergonomically designed tools. A job should not be required to be done with hands above shoulder height on a regular basis. Arms should be kept low and close to body. Bending and twisting of your wrists, back and neck should also be avoided. Tools should be appropriate for a specific task being performed. Your tools should allow you to keep your hands and wrists straight – the position they would be in if they were hanging relaxed at your side (Kulkarni K. T. *et al*, 2007). Bend the tool – not the wrist! The tool should fit comfortably into your hand. If the grip size is too large or too small it will be uncomfortable for an operator and will increase the

risk of injury. Tools should not have sharp edges, create contact stresses in your hand, or vibrate (Jennifer Gunning *et al*).

Problem Statement

To study and improve the ergonomic aspects related with frying workstation and tasks in washing area in a food processing unit.

Methodology

We particularly took frying workstation and washing area for ergonomic analysis because working postures at these two workplaces were causing fatigue to operators, thus increasing absenteeism and reducing productivity. We photographed and video recorded the frying task. Observing 100 cycles of the task we studied the method used and postures involved during the course of production. Similarly for the washing area we observed the tasks through photographs. Analysing the ergonomic issues in the task, we resolved them through better methods developed by brainstorming.

Data collection and analysis

A] Workplace for frying activity

The original arrangement of the workplace for frying is shown in Fig. 1. Frying pan is in the front and frying pan containing raw material is on the right. The two tools are on the either side of frying pan. Finished product is kept in a tray on the left. Collecting raw material from container needs the torso to be twisted as shown in photograph number 2. This action takes place every two minutes and a worker works for about 90 to 120 minutes per day on this set up.

1. Bench-Seat for the Operator
2. Frying pan for Frying
3. Iron Block on which long spoon with holes is struck
4. Frying Pan Containing Batter
5. Position of long spoon with holes
6. Position of striking of long spoon with holes
7. Tray for Finished Products

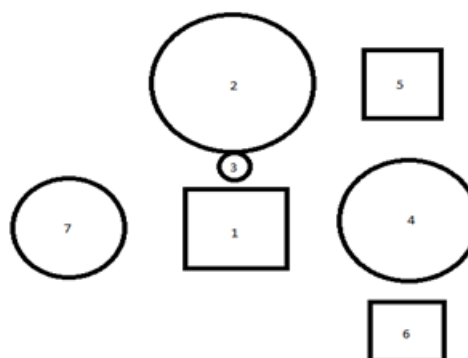


Fig.1 Original arrangement of the workplace for frying

By striking the tool on the iron block while pouring the batter, it is converted into small droplets. In every cycle the tool is struck for about 120 times. The weight of the tool is 1.2kg. This leads to jerks the right hand. The right shoulder is adducted and left arm extends to its maximum reach. The pot used for pouring is held by pinch grip where power grip should have been used. The batter makes the pot slippery and due to pinch grip it may slip from hands

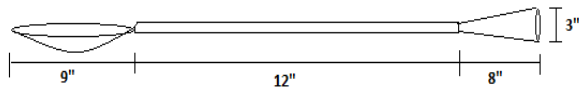


Fig.2 Long Spoon with Holes



Present posture of the worker at frying workstation



Torso twists in the present posture

Ergonomic Workstation Layout design

1. Bench-seat for the operator
2. Frying pan for frying
3. Iron block on which tool is now fixed
4. Frying pan containing batter
5. Position of frying tool
6. Tray for finished products

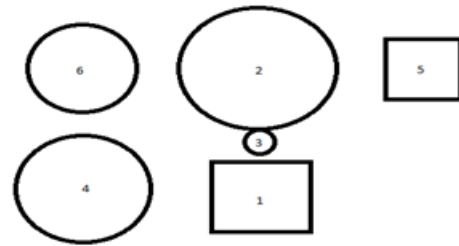


Fig.3 Diagram for improved workstation for frying

Workstation was improved considering anthropometric data for 5th percentile Indian male of age 21 to 65 years as the workers working on this workstation are adult males (Jennifer Gunning *et al*). For 5th percentile male worker, Sitting elbow height = 578 mm = 57.8cm. For present workstation it is 55.88cm, which is appropriate.

At the present workplace stool height is 38.1cm. According to anthropometric data, for 5th percentile male worker, sitting popliteal height is 34.11cm. Hence there is a need to reduce the stool height.

At existing tool the grip is of 20.32cm, but adding allowance front and rear we can have it as 25.4cm. While considering length of the grip Palm Width is to be considered, Palm width for 95th percentile male worker is 10.69cm. But in existing tool it is 20.32cm, hence it is quite sufficient.



Torso remains straight in improved posture



Long handle reduces the extension of the left arm & provide for the power grip

Details	Original	Improved	Effect
Stool Height	38 cm	34 cm	To match with polpiteal height
Grip diameter	7.6 cm	5 cm	To have proper grip

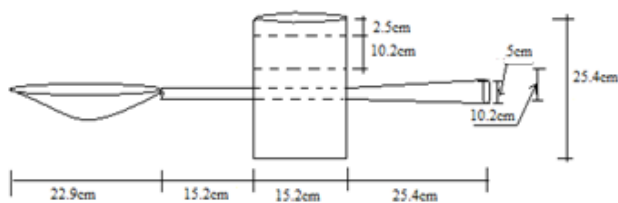


Fig. 4 Fixture with striking tool

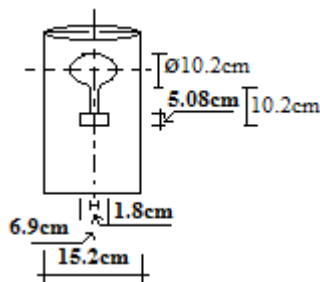


Fig. 5 Fixture

In improved workplace arrangement at frying workstation, the batter is kept on the left and finished product is kept in a tray on the left placed on the platform where the oil cans are presently seen. Now the torso remains straight while reaching for the tools. The tool which was struck on the block is now fixed in it and reciprocated in the vertical plane (Fig. 4). Due to the fixture provided (Fig.5) to the striking tool, the load carried by the right hand reduces drastically and the jerks are totally eliminated. A pot provided with a long handle reduces the extension of the left arm and provides the power grip as pouring is not a precision task.

Fixture for workstation improvement

We designed the fixture, as shown in Fig.5, for improving the ergonomic aspects of frying task. The same block, which was used as anvil to strike the tool upon, was modified to hold the tool as shown in figure 4. The worker-end of the tool (25.4 cm) is larger than the middle part (15.2 cm) (fig 4). The long spoon with holes is inserted in the block which acts as a fulcrum for its movement. Thus the weight of the tool will be supported by the fixture instead of by the worker's arm, as it was done initially. The jerks will be eliminated totally. After the end of the cycle the tool can be rotated and rested on a stand adjacent to the fixture.

B] Ergonomic approach at washing area

A worker spends about two hours for cleaning the utensils in washing area. As seen from the snaps the workers sit on trays and heavy bending is involved

while scrubbing the utensils. Most heavy task is cleaning the frying pan of diameter 2 feet and depth 9 inches. A frame for holding hold the frying pan at waist height was suggested so as to eliminate bending by a worker and improve working posture.

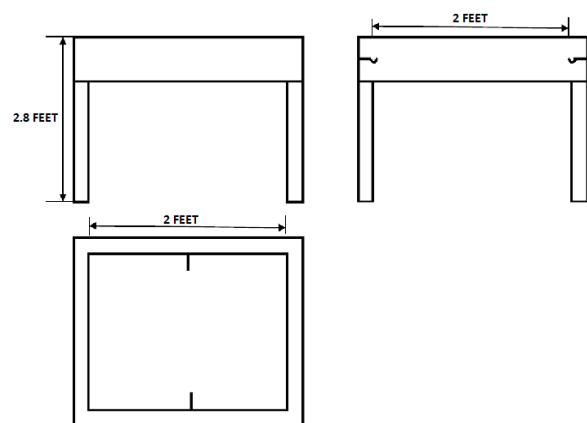


Fig. 6: Diagram for Suggested Frame to be used in washing area

Workers in the washing area are women. So we designed the frame for 5th percentile female. As shown below an iron frame, with hooks at standing waist height of 5th percentile adult female and inner width equal to the diameter of frying pan, will eliminate all

the bending and awkward sitting postures for the workers in the washing area. An alternative to iron frame is brick construction. Brick construction is stronger than iron frame but it is permanent and it is not portable. Iron frame is portable but its maintenance is difficult.

Advantages of ergonomic workstation design and methods improvement

1. For frying workstation
 - a) Jerks caused by striking the long spoon with holes having self-weight of 1.2 kg and batter weight of about .5 kg were avoided.
 - b) Fatigue caused by supporting this is also avoided
 - c) Shoulder, which used to remain adducted, now in neutral position
 - d) Full arm extension eliminated
 - e) Torso twisting eliminated
 - f) Pinch grip replaced by power grip for pouring task due to the new tool introduced.
 - g) Due to these modifications workers' arms don't get exposed to fumes emanating from boiling oil.
2. For washing area
 - a) Heavy bending eliminated
 - b) Improper seating arrangement eliminated

Conclusion

In this paper we studied the working posture at two workplaces viz. at frying and washing area. We noticed heavy bending in wash area and frying process required jerking of the shoulders. Due to the fixture provided to the striking tool, the load carried by the right hand reduced drastically and the jerks were totally eliminated. At washing area we suggested a frame which will hold the frying pan at waist height so as to eliminate bending and improve working posture.

Due to the new systems introduced, postures of the workers improved ergonomically, reducing the risks of injuries and eliminating fatigue.

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