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Department of Industrial & Production Engineering

Ergonomics and Safety Management Sessional
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Name of the Experiment: Study and Design of Different Types of Hand Tools: Hacksaw

Objectives:

- Study ergonomics principles in designing of hand tools.
- Observe some existing hand tools and machines.
- Designing hand tools and machines using ergonomic principles to eliminate the existing shortcoming.

Introduction

Hand tools are normally used in industry and at home despite the development of mechanization and automation. Using hand tools can reason musculoskeletal disorders in the long term. Risk factors causing these disorders include difficult hand postures, excessive muscular load and fatigue, some types of required grips, and repeated use. The relation between tool design and development of musculoskeletal disorders in the hand and forearm has been shown for many tools, e.g., wire-tying pliers, hammers, powered screwdrivers, and plate shears. Improvements in ergonomics characteristics of hand tools may be essential to reduce the risk of musculoskeletal disorders, as ergonomically designed hand tools cause users less harm, require less effort, and provide more comfort at work. Several studies have suggested ergonomics criteria for hand tool design relevant in terms of biomechanical and physiological stress. Even though it is expected that taking into account ergonomics criteria of design will result in a better hand tool, labeled as an ergonomically designed one, an evaluation is necessary. Designing hand tools is a complex task as it requires considering not only functionality, quality, and reliability, but also their users expectations and apprehensions. To integrate those requirements into tool design processes, several studies used the concept of quality function deployment, which allows designers to implement ergonomics at the very beginning of product development. The ergonomic quality of hand tools can be evaluated by their performance and users physiological strain with different design variables such as shape, thickness, length, volume, surface quality, and material of tool handles. Electromyography (EMG), grip force and distribution, and hand and wrist postures are used to evaluate performance and physiological strain objectively, and questionnaires or ratings with various scales are used for subjective assessment. Controversially, the users strongly preferred the standard tool configuration to the new version. Effect of ergonomic changes in hand tool

designs on physiological cost and users preferences may be influenced by the acceptability of a new method, familiarity with a tool or process, and psychological reactions to the change. The objective of the study was to investigate effect of ergonomic changes in design of hand tools on physiological cost and subjective assessment. Non powered handsaws that usually bend the wrist of the left hand underwent some design changes.

Characteristics of the existing tool



FIG: Regular used Hacksaw

Hacksaws consist of two main elements: a frame with a handle and a blade. It was originally and principally made for cutting metal, but can also cut various other materials, such as plastic and wood, for example: plumbers and electricians often cut plastic pipe and plastic conduit with them. In woodworking and carpentry, hand saws, also known as "panel saws", are used to cut pieces of wood into different shapes. This is usually done in order to join the pieces together and carve a wooden object. On hacksaws, as with most frame saws, the blade can be mounted with the teeth facing toward or away from the handle, resulting in cutting action on either the push or pull stroke. In normal use, cutting vertically downwards with work held in a bench vice, hacksaw blades are set to be facing forwards.

Characteristics & description of the existing model Hacksaw:

1. Most Hacksaws are made from Low Tungsten Steel or Carbon Steel. However, the more expensive blades are made from High-Speed Steel.
2. Hacksaw blades are generally classified as either hardened or flexible, though variations in terms of coarseness, teeth pitch and length should also be taken into consideration when choosing the proper hacksaw.
3. The combination of two Bi-metal (M2 and D6A steel) materials ensures excellent quality. HSS wire is welded by a laser to a spring steel tape which ensures flexibility, solidity and pliability of the blade body and also high teeth hardness.

Reasons for Changing:

Our main purpose of this study is to make a design of a hacksaw with the specifications on behalf of ergonomics. For this reason the changes should be done in the modified design. Because we took an existent hacksaw first. But we have got some problems in it during it will be used by human. If man uses it for long time, it will be very dangerous for his health or any specific organ. By these researches and analyses we have got some reasons for changing -

- **Straight Wrist:**

For maintaining a straight wrist, we have to avoid ulnar deviation and palmar flexion or both. Ulnar Deviation results in ‘Tenosynovitis’. Tenosynovitis is the inflammation of the fluid-filled sheath (called the synovium) that surrounds a tendon, typically leading to joint pain, swelling, and stiffness. This is one of the main reasons for changing the tool handle.

- **Reducing Pressure:**

Carpal tunnel syndrome (CTS) is a medical condition due to compression of the median nerve as it travels through the wrist at the carpal tunnel. The main symptoms are pain, numbness and tingling in the thumb, index finger, middle finger and the thumb side of the ring finger. It happens because of pressure on the median nerve, which runs the length of the arm, goes through a passage in the wrist called the carpal tunnel, and ends in our hand.

For reducing the pressure on the median nerve, arm and prevent Carpal Tunnel Syndrome, changing is essential for tool.

- **Prevent Repetitive Motion:**

When a person involves with repetitive works, can strain the muscles and put too much stress on the tendons. That constant tugging can eventually cause microscopic tears in the tissue and causes Tennis Elbow with pain in the elbow and arm and it is happened in an unergonomic tool. So preventing repetitive motion and too much stress tool design needs to be changed.

- **Decreasing Grip Strength:**

When, we use hacksaw, the repetitive motion in front and back is occurred by our hand. It is a continuous tusk till the job is machined or cut properly. So when this motion is generated, our hand is continuously bent. Then the grip strength should be reduced at the time of bending the wrist.

The gripping and wrist actions share several muscles; Flexor Digitorum Profundis (FDP) and Flexor Pollicis Longus (FPL) contribute to wrist flexion and grip force production, while Extensor Digitorum Communis (EDC) contributes to wrist extension and grip relaxation. The bellies of these muscles are located in the forearm, their tendons cross the wrist joint and insert at the base of the distal phalanges. Additionally, there are dedicated muscles for wrist flexion/extension that do not directly affect grip force, whereas the intrinsic muscles of the hand have no direct effect on wrist action but can contribute to grip force via the extensor mechanism. So, the total pressure will go to the muscle during bending hand.

Designing Appropriate Handle Size for Both Man and Woman:

The size of hand varies in man v's woman from the very earlier stage. And for the variation of this size of hand; the workload capacity, working capacity, stress receiving are not same from man to woman. In our existent hacksaw, the handle is made of wood and length of it is very small to use. If a woman use it, she can touch it by her two palms keeping one by one. But a man cannot keep his both palms one by one. He has to keep these one above. Because the size of a female's hand is two third of a man's hand. The average hand length was found to be about 1.3 cm greater in males than females. Hand index ≤ 40.55 is suggestive of females and >40.55 is suggestive of males. The index and ring finger ratio is

found to be higher in females. Again, long hands can take more stress and pressure than short hand. So the handle size and design should be changed.

Using Stainless Steel Instead of Pure Iron as Equipment Material:

If we observe the upper part of the blade in the existent hacksaw, the part is rod type and with larger diameter. In that part, they iron is used. But using iron metal is not preferable for long term use. First of all, rust is occurred very thoroughly in iron type metal. And we use the hacksaw in a very harsh environment. So, it is very normal that the material can be damaged one day. And secondly, the weight of iron is very high that is not reliable for use. So, the material with these considerations should be changed.

- **Using High quality blade:**

The number of teeth per inch differentiate the blade from the other. Different-sized teeth provide varying levels of cutting power. Choosing of the blade depends on the metal which will be cut. For heavy duty cutting jobs like steel reinforcing rod or pipe an 18 teeth per inch would be the best choice. If proper blade is not used in the hacksaw, various problems will be faced such as- feeling pain on hand, stress on wrist and too much force would be given. By high quality blade, motion will be provided smoothly.

- **Using Rubber Instead of Wood Handle:**

Handle is the most important part of a hacksaw if we think it ergonomically. Because the total force we exert on the handle. So the design of the handle has to be ergonomic. The existent hacksaw we showed used wood in handle. It is very tough to work with wooden material by using the palm of the hand. Because during working, a continuous reverse friction force is exerted by the tool. So it effects on hand injuriously. So, our planning is to change this material using a rubber coating onto it. The rubber will damp the friction force and one cut material easily by the hacksaw.

Proposed Model



Figure: Front View of Hacksaw

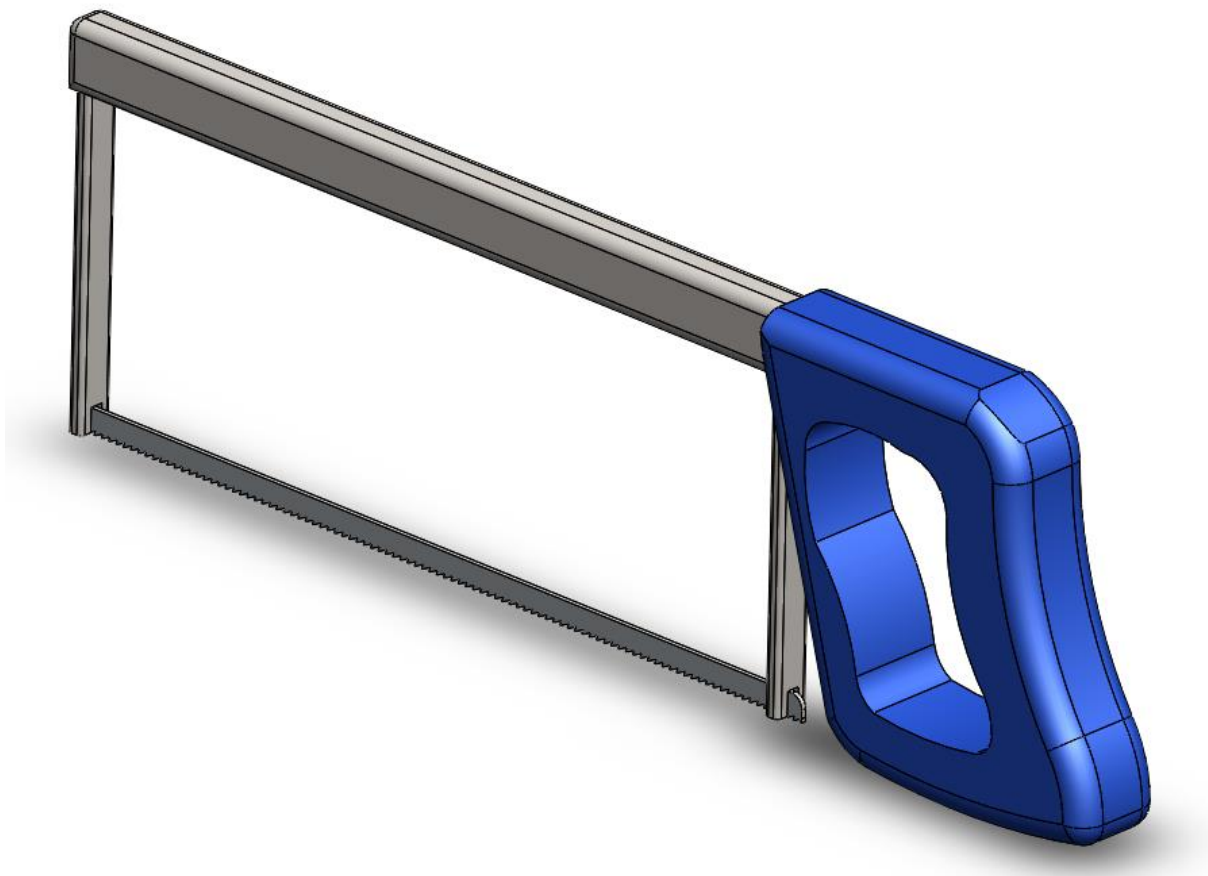


Figure: Isometric View of Hacksaw

Changes

1. In existing hacksaw the grip was inconvenient for long time use, also created tension in hand. In proposed hacksaw we changed the grip which is easier to grab and also convenient for long time use.
2. In existing hacksaw the grip was parallel to the cutting blade and in proposed hacksaw the grip is at an angle to the cutting blade.

Comparison with the existing system

1. We have used a high quality blade in our product which was not noticeable in the previous one.
2. We used rubber instead of wood handle to ascertain comfort of the consumers. But in the previous hacksaw, it was not comfortable to use.
3. We try to ensure that men and women can use this hacksaw. In the first one, it was not applicable for both men and women. We changed the hand length of the product.
4. We designed the product in such way so that users can prevent Tenosynovitis.
5. We tried to modify the design of the product to prevent repetitive motion

Conclusion

In conclusion, A good ergonomic product will allow any user to work in a neutral, relaxed, ideal working posture that will minimize the risk of developing any injury. In designing an ergonomic product, various considerations must be given to the items needed. Careful planning is therefore required to identify and evaluate these items to ensure that the use of such item will contribute to the creation of an ergonomic product. Hence, we selected a Hacksaw with some difficulties and tried to modify the design to ensure the comfort and safety of the users. Based on the discussion, it has been emerged that the necessity for each item will depend on the user of such item considering that these products should be selected to fit the user and not vice versa.

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