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ERGONOMICS ASSESSMENT OF TIN SNIPS

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Abstract: *Tin snips are widely used for sheet metal cutting, mesh wire screening, leather, asphalt roof shingles and many more. Depending on the design of the tin snips, the design may contribute to various ergonomic risk factors, such as excessive forces and awkward postures of the upper limb. An ergonomics assessment was conducted for 3 different tin snips (X1, X2 and X3).Hand tool comfort assessment questionnaire designed by Kuijt – Evers et al (2004) was utilized in this study. Eighty participants rated the tin snips. Results indicated that tin snip x3 (55.94%) gave the best score for ergonomics compared to x1 (51.48%) and x2 (54.06%).Participants were able to estimate certain ergonomic features such as good posture, absence of peak pressures on the palm and good friction force during the evaluation.*

Key Words: ***Hand tool ergonomics, tin snips***

1. INTRODUCTION

Manual physical activity involving the upper limbs remains to be the significant activity done by laborers, tradesmen, technicians and other personnel in many other types of blue collar occupations. Tools such as screwdrivers, pliers, spanners, wrenches are some of the examples of the most commonly used tools in many industries. Due to the fact that manual hand tools are here to stay, hand tool users are forced to exert heavy forces, usually done repetitively in order to accomplish any task. An example would be to use pliers to cut wires, or manipulate objects. As a result of excessive amounts of grip force and the repetitive nature of the job/task, people may began to experience symptoms of discomfort, and in some cases, severe musculoskeletal pain. The fact that hand tool usage can cause musculoskeletal pain have been documented by some researchers [1,2].

Manual hand tools often require a significant grip force to operate them. One such tool would be tin snips. Tin snips are used by a majority of handymen, as well as many other workers in various industries. The construction of a tin snips resembles a scissor, but tin snips are made from heavy duty material. The blades of tin snips are designed to cut thick materials like sheet metal, mesh wire screening, leather, asphalt roof shingles and many more. Depending on the size, type of material, and shape of the object, a significant gripping force is often required to operate tin snips. Adding complexity to the issue, different designs of tin snips would require different gripping force.

Apart from gripping force, the design of tin snips may promote awkward postures of the upper limbs. Awkward postures may result in compromised blood circulation to the wrists, and may also compress various nerves of the upper limb. Poor blood circulation and nerve compression are contributing factors various upper limb musculoskeletal disorders.

Design criteria for hand tools have been outlined in literature [3]. [3] discussed several factors relating to hand tools such as grip design, grip thickness, grip length, grip force, grip surface characteristics and the wrist orientation desired when operating hand tools. All of the factors discussed by [3] are essential in the design of hand tools. Tin snips come in various shapes and design, and therefore in the spirit of reducing ergonomic related injuries and disorders, three different designs of tin snips were evaluated in terms of ergonomics.

2. METHODS AND MATERIALS

A questionnaire based on [4] was used in this study. Participants had to evaluate three different designs of tin snips (X1, X2 and X3) by filling up a questionnaire. The tin snips are shown in the next page.

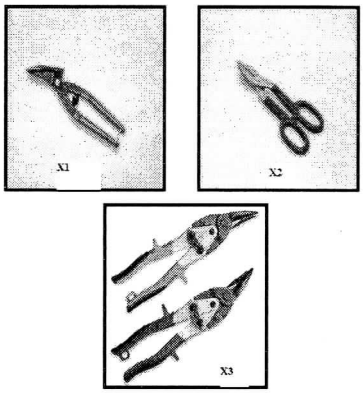

Figure 1 : Tin snips

80 subjects were recruited for the study (n=80). All of the subjects were third year undergraduate students. All of the participants were in the range of 19-24 years old. Pictures of the tin snips were taken and included in the questionnaire. The questionnaire consisted questions such as below:

1. Causes peak pressures on the hand.
2. Using this tool causes numbness of the hand.
3. The tool will promote a comfortable hand posture.
4. Needs low hand grip force supply.
5. This handle feels slippery.
6. Has a good friction between handle and my hand.
7. Has a good force transmission.

All of the questions above were rated with a Likert type scale ranging from (1 = strongly disagree) to (4 = strongly agree). It was decided that since subjects may be hesitant to select choices at the extreme end of the scale ,the neutral option was intentionally discarded to prevent central tendency bias [5].

From the original scales (1 = strongly disagree to 4 = strongly agree), responses of 1 and 2 were treated as "disagree" and responses of 3 and 4 were considered as "agree".

After the surveys were done, the Likert ratings were converted in order to obtain a total score, using a method similar to the System Usability Scale [6]. The ratings were converted as follows: The score contribution from items 1,2, and 5 is 4 minus the scale position,while for the rest of the items the score contribution is the scale position minus 1. The scores from all the items would be summed and then converted into percentages for easy comparison.

3. RESULTS AND DISCUSSION

Type of Tin Snips	Ergonomics Score
Tin Snip x1	51.48%
Tin Snip x2	54.06%
Tin Snip x3	55.94%

Table 1: Ergonomics Score

Among the three different tin snips, it appears that tin snips x3 had the highest score in terms of ergonomics. Compared to x1 and x2, x3 had the score of 55.94%. Tin snip x1 had the lowest score.

Among the tin snips, x3 seems to have a higher aesthetics appeal compared to x2 and x1. Since the participants did not physically touch the tin snips during the evaluation, it is highly possible tin snip x3 created a higher visual appeal, thus it is rated more favorably than tin snip x2 and x1. Past literatures have confirmed the connection between product aesthetics and ergonomic qualities [7].

Looking at the individual items in the questionnaire (Appendix), it seems participants were able to predict that tin snip x1 will cause peak pressures on their hand. The agreement rating was significantly higher (78.3%) as compared to x2 (69.6%) and x3 (66.3%). The design of the x1 handle was perceived to be less ergonomic as it has a tendency to cause peak pressures on the palms. Any peak pressures on the palm may cause blisters, discomfort and impaired circulation of blood to the palms. Since the gripping force required may be high for certain tasks, it is imperative that hand tool handles are designed in such a manner that it has a large area of contact between the palm and the handle. This is to ensure an even pressure distribution on the palms when using a particular hand tool.

Item 7 in the survey yielded a slightly interesting finding. More participants agreed that tin snip x1 has a good force transmission (87%) compared to tin snip x2 (84.8%) and x3 (83.7%). In terms of the overall score, tin snip x1 has the lowest ergonomics score, but in terms of force transmission it showed to be the otherwise. It was expected that tin snip x3 will have the best rating for force transmission compared to tin snip x1 and x2. It may be that participants were unable to understand the question properly. Ratings in item 7 should correspond with item 4. In item 4, a 10.9%

difference was noted for the agreement ratings of low grip force requirements, where x1 was at 63% while x3 earned 73.9% agreement. Participant's ratings seem to concur with the agreement ratings in friction force for tool handles, but differed for force transmission ratings. This could be due to the possibility that the participants may have difficulty understanding what force transmission means.

By looking at the design of the tin snips, the participants felt that tin snip x3 is only slightly less slippery (45.7%) than tin snip x1 (46.7%). Tin snip x2 was rated to be the least slippery by the participants. In actuality, tin snip x1 has a smooth rubber coating on the handles, and thereby it has a tendency to be slippery when contaminated with grease or water. The participants had managed to perceive the slipperiness of the tool handles somewhat correctly, although they did not hold the tools before.

In terms of the friction between the palms and the tool handles, there is a significant difference of 9.7% between the agreement ratings for x1 (69.6%) and x3 (79.3%). More participants believed that the x3 tool handle provides good friction between their palms and the tool handle. Good friction is essential in maintaining a good grip on the tool handles with performing tasks. According to [8], a tool handle should be smooth, compressible and non conductive. All of the tools, x1, x2 and x3 met the criteria outlined by [8]. Although the criterion of handles outlined by [8] was met, tool x3 was rated to be the best among all the tools in terms of good friction surface.

4. CONCLUSION

Among all the tin snips, tin snip x3 was perceived to be the most ergonomic tool. Tin snip x1 was rated to be the least ergonomic. Although tool evaluation in terms of ergonomics is important, the task demands in the workplace should be taken into consideration. A good ergonomic tool may offer little to no benefit if task demands are excessive.

The perception of ergonomics may be influenced by the design of the tool itself. There is some evidence that aesthetics and good ergonomics are correlated [7]. Thus it is imperative that aesthetics go hand in hand with desirable ergonomic features. Unfortunately, good ergonomic features may not be able to be perceived accurately by potential users. The priority for ergonomic features must be taken into paramount by designers and manufacturers.

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Appendix : Agreement ratings for tin snips (n=80)

	Questions	x1	x2	x3
1	Causes peak pressures on the hand	78.3%	69.6%	66.3%
2	Causes numbness in my hand	55.4%	53.3%	50.0%
3	The tool will promote a comfortable hand posture.	71.7%	69.6%	76.1%
4	Needs low hand grip force supply	63.0%	71.7%	73.9%
5	The handle feels slippery	46.7%	34.8%	45.7%
6	The tool handle has a good friction	69.6%	71.7%	79.3%
7	Has a good force transmission	87.0%	84.8%	83.7%