

The Perception of Usability, Ergonomics and Aesthetics for Three Different Types of Tin Snips

M.S Syed Mohamed

Technical University of Malaysia Malacca (UTeM)

Hang Tuah Jaya, 76100 Durian Tunggal, Melaka

Malaysia

E-mail: syafiq@utem.edu.my

Abstract

Upper limb disorders are frequently caused by excessive forces and awkward postures of the upper limbs. Improperly designed hand tools may lead to the application of excessive forces and awkward postures. Along with ergonomic and usability features, hand tool aesthetics might influence buying decisions. In this study, assessment of the perception of ergonomics, usability and aesthetics were taken for three different tin snips (x1, x2, and x3). Ninety two subjects (n=92) participated in the perception assessment. The Technology Acceptance Model (TAM) was utilized in order to assess usability, while the hand tool comfort descriptors were used to assess ergonomics. Results indicated that participants strongly preferred tin snip x3 over x1 and x2. In addition, tin snip x3 was rated as the most visually appealing hand tool. However, the correlation between perceived ergonomics, usability and aesthetics is very weak ($r=0.09$). Potential ramifications for users and designers are discussed.

Keywords: Ergonomics, hand tool usability, aesthetics

1.0 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, and wrenches are some of the examples of common hand tools. Despite the prevalence of automation and powered hand tools, factors such as affordability and practicality have prevented the full adoption of powered hand tools and automation. The usage of hand tools sometimes necessitates the repetitive exertion of heavy forces in order to accomplish any task. An example would be the usage of wrenches in tightening bolts and nuts; excessive amounts of force are sometimes required to accomplish the task. 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 (Aghazadeh and Mital, 1987; Chao et al., 2000).

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. Some tin snip designs resemble scissors, and some of them were designed like pliers. Tin snips are made from heavy duty material, which allows the cutting of thick materials like sheet metal, mesh wire screening, leather, 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. Various different designs of tin snips are available in the market, with different price ranges. Consumers would be in a dilemma to choose between different designs of tin snips. More often than not, hasty decisions would be made when purchasing, which may result in a disappointment later on. First impressions of the product would then be very crucial. Bloch et al (2003) pointed out that visual aesthetics are becoming more important than ever in selecting products. The most visually appealing product will probably be selected by the consumer, even though the product may be deficient in other aspects. In the case of tin snips, consumers may make an erroneous judgment when purchasing them.

The tension between form and function has always existed since the beginning of mass produced consumer products. Consumer products have always been, and have to be designed with strong aesthetic considerations. In the area of human computer interaction, Tractinsky et al (2000) conducted a study to determine the relationship between a computer system usability and beauty. The results of the study showed that the perception of computer system usability and beauty has a strong correlation. Participants rated the usability computer system before and after performing several tasks on the computer system. The results showed that the pre and post usability perceptions remained high for aesthetically pleasant computer system interface.

Whereas for tangible products like hand tools, the relationship between usability, ergonomics and aesthetics remains to be seen.

2.0 Aesthetics, usability and ergonomics.

Product aesthetics have been, and always will be of a central importance to consumers. While the consumer's predilection for aesthetics cannot be disputed, a growing number of consumers are becoming aware of other qualities in a product such as usability. Butters and Dixon (1998) stated that consumers used to place an emphasis on new functions, reliability and good after sales service. Nowadays, usability is one of the many factors that influence buying decisions of consumers. Usability has been defined by Shackel (1991) as "the capability to be used by humans easily and effectively." Other dimensions of usability include; satisfaction, learnability, memorability, and errors (Nielsen, 1993). Depending on the context, and the product being evaluated, only the pertinent usability dimensions will be applied during the usability evaluation of a certain product.

In the usability evaluation of consumer products, there has yet to be an agreed number of usability dimensions that should be included during the consumer product evaluation. The same goes with hand tools. Previous research done by Young Corbett et al (2010) used several usability dimensions such as ease of use, ease of learning, perceived comfort, and perceived productivity in evaluating drywall sanding tools. Apart from Young Corbett et al, other guidelines in hand tool usability evaluation was written by Miller (2001). Miller proposed several metrics for hand tool usability evaluation, namely: ease of use, force required, comfort levels, likelihood to drop parts, and physical characteristics of the hand tools. With many different usability metrics to choose from, narrowing down the suitable metrics can be a challenge. By taking into account the context required by the particular product, the number of usability metrics can be narrowed down. Perceived ease of use and perceived usefulness, the two popular usability metrics given by the Technology Acceptance Model (TAM) were utilized in this study. TAM was proposed by Davis (1989), and it has been used widely in usability evaluations. The two metrics proposed by TAM were used in Young Corbett et al (2010), where drywall sanding tools were evaluated. The TAM model was deemed to be appropriate as the two metrics would help in predicting the adoption of a certain technology.

The perception of ergonomics was assessed with the metrics proposed by Kuijt – Evers et al (2004). Kuijt Evers et al listed several descriptors that defined comfort in the usage of hand tools. The descriptors selected to assess them are listed in Figure 1. The metrics proposed by Kuijt Evers et al were in line with the ergonomic characteristics of hand tools outlined by Mital and Kilbom (2000). Mital and Kilbom (2000) described the scientific basis for selecting the appropriate grip size, grip force and the handle characteristics for hand tools in order to minimize ergonomic related injuries of the upper limb.

Apart from usability and ergonomics, the perception of aesthetics is equally important in the eyes of consumers. In a study conducted by Kurosu & Kashimura (1995), ease of use was rated higher for an aesthetically appealing ATM interface compared to a visually unappealing ATM interface. Researchers (Kurosu & Kashimura, 1995; Lavie & Tractinsky, 2004; Schenkman & Jönsson, 2000) have realized the importance of aesthetics in the domain of human computer interaction. In those studies (Kurosu & Kashimura, 1995; Lavie & Tractinsky, 2004; Schenkman & Jönsson, 2000), beauty and usability were found to be highly correlated. By evaluating the perception of aesthetics, usability and ergonomics of hand tools, will there be a relationship between the perception of usability, ergonomics and aesthetics? Therefore this study seeks to examine the connection between the perception of usability, ergonomics and aesthetics for three different tin snips designs.

3.0 Methods and materials

In order to answer the research question above, measures concerning usability, ergonomics and aesthetics were taken. Participants evaluated the tin snips based on the pictures alone (Figure 2). Participants were shown large, clear pictures of the hand tools on a screen.

3.1 Materials

The study employed ninety-two undergraduate students (n=92) in evaluating the tin snips. All of the participants were in the range of 19-24 years old. Three different designs of tin snips (X1, X2, and X3) were used in this study (Figure 2). Those tin snips were commonly available in the local hardware stores, and they differed in their prices. The details of the tin snips can be found in Table 1.

3.2 Evaluation procedure

Pictures of the tin snips were taken and included in the survey questionnaire.

The instruction and purpose of research were explained in the questionnaire. A Likert type scale was used in this study, where the subjects rated the items in the questionnaire from a scale of 0 (strongly disagree) to 4 (strongly agree). The neutral option was discarded intentionally to prevent central tendency bias. Demographic information such as age and gender were included in the questionnaire. The aesthetics of the tin snips were evaluated using a ten point scale, where (0= no aesthetic value; 10= most beautiful). 16 questions were developed for this research based on the usability metrics applied by Young Corbett et al., as well as from the hand tool comfort descriptors from Kuijt Evers et al. Questions that assess the perception of usability are marked with an asterisk in Figure 3 below, while the rest of the questions were focused on the perception of ergonomics.

3.3 Data analysis

The aesthetics rating were compared for the three tin snips. Total survey scores were obtained from the 16 item questionnaire (Figure 3). After the surveys were done, the Likert type ratings were converted in order to obtain a total score, using a method similar to the System Usability Scale (Brooke, 1996). The ratings were converted as follows: The score contribution from items 2,4,7,11 and 15 is 4 minus the scale position, while for the rest of the items the score contribution is the scale position minus 1 (refer to Figure 3). The scores from all the items would be summed and then converted into percentages for easy comparison.

4.0 Results and discussion

The perception of ergonomics and usability were evaluated by several aspects in the survey as listed in the Figure 3. From the total score, tin snip X3 earned the highest score, while tin snip X2 earned the lowest percentage score. The difference of scores between X2 and X3 were very slight (2.74%). Internal reliability of the 16 item survey instrument (Figure 3) is fairly high, with a Cronbach alpha of 0.85. On top of survey scores, the aesthetics ratings followed the same trend. Tin snip x3 earned the highest rating for aesthetics (7.05), while tin snip x1 earned the lowest rating for aesthetics (6.4). The correlation between the survey scores (which combined all the ratings from ergonomics and usability questions) and aesthetics were found to be weakly correlated ($r=0.09$). However, in the field of usability the association between aesthetics and usability has been noted. In Tractinsky's study, the correlation between perceived usability and aesthetics of a computer application was found to be strong. The correlation between perceived usability and aesthetics has been documented in literature (Kurosu & Kashimura, 1995; Tractinsky et al, 2000).

Therefore the importance of aesthetics in hand tool design cannot be understated. According to Creusen and Schoormans (2005), product ergonomics is defined as: "...concerning the comprehensibility and usability of a product, the suitability to perform and correctly to communicate its utilitarian functions." Plus, Norman (1988) stated that people may form an impression about the product's ease of use on how the product appears to them. Consumers have to experience the product in order to gauge the usability adequately. In many cases, consumers may be buying products off the Internet or a catalogue, where the usability and ergonomics may not be assessed correctly. Therefore, the product appearance should satisfy the aesthetic requirements of the consumers, as well as the usability and the ergonomic requirements. On the other hand, consumers might be deluded into thinking that ergonomics, usability and aesthetics will go hand in hand, whereas in reality that may not happen all the time. This is shown in this study where the correlation between aesthetics, perceived ergonomics and usability is almost nonexistent ($r=0.09$). Helander (2003) stated that consumers are able to differentiate factors related to aesthetics and comfort in chair design, but have difficulty in discriminating factors related to ergonomic factors.

In this study, an attempt to measure perceived ergonomics, usability and their association with aesthetics was made, and the results seem to support the findings of Helander's study. Factors related to aesthetics such as color and shape of the tool are easily perceived and understood; but ergonomics and usability factors may be hard to distinguish. Knowledge of ergonomics and usability may affect participants' perception of ergonomics and usability. Factors related to ergonomics such as grip force, hand posture, handle design and grip length may not be the first thing that comes into the mind of the participants when evaluating hand tools for purchase. The same goes with usability factors such as ease of use, effectiveness and efficiency; these factors are not easily perceived or measured. Depending on the knowledge of the participants in ergonomics and usability, their perception of ergonomics and usability of hand tools will be different. Taking into account the findings of this study, some designers may elect not to include ergonomic and usability factors into their product design and place a sole emphasis on aesthetics alone. Although ergonomics and usability cannot be perceived accurately from visuals alone, certain consumers with ergonomics and usability knowledge may be able to tell whether a product meets ergonomic and usability requirements.

Ergonomics and usability will and always be of importance, as ergonomics and usability are prerequisites for comfort (Helander, 2003). Therefore, ergonomic design features need to be integrated into product design, even though the connection between perceived ergonomics and aesthetics is almost nonexistent.

5.0 Conclusion

The study set out to examine the relationship between ergonomics, usability and aesthetics, for three different tin snips. The correlation between the total survey score and aesthetics indicated a weak relationship between perceived ergonomics, usability and aesthetics. The findings of this study have interesting ramifications for both users and designers of hand tools. Users may have some difficulty in distinguishing subtle design features of hand tools, thus leading to a poor perception of ergonomics and usability. Therefore, designers may take advantage of certain tool design features that are visually appealing as well as ergonomic and usable to their potential users and integrate them into the design of hand tools. A product that is aesthetically pleasing, should integrate ergonomic design factors as well in order for the product to be a success. Future studies should include more diverse groups of participants; older participants may have a different view on perceived ergonomics and usability. A measurement of the participant's knowledge about ergonomics and usability may be taken as well, in order to gauge their understanding of ergonomics and usability.

References

- Aghazadeh, F., & Mital, A. (1987). Injuries due to handtools: Results of a questionnaire. *Applied Ergonomics*, 18(4), 273-278. doi:10.1016/0003-6870(87)90134-7
- Bloch, P. H., Brunel, F. F., & Arnold, T. J. (2003). Individual differences in the centrality of visual product aesthetics: Concept and measurement. *Journal of Consumer Research*, 29(4), 551-565.
- Brooke, J. (1996). SUS-A quick and dirty usability scale. *Usability evaluation in industry*, 189-194.
- Butters, L. M., & Dixon, R. (1998). Ergonomics in consumer product evaluation: an evolving process. *Applied ergonomics*, 29(1), 55-58.
- Chao, A., Kumar, A., Emery, C. T. N. D., Nagarajarao, K., & You, H. (n.d.). An Ergonomic Evaluation of Cleco Pliers. *Human Factors and Ergonomics Society Annual Meeting Proceedings* (Vol. 441-442, p. 2). Human Factors and Ergonomics Society. Retrieved from <http://www.ingentaconnect.com/content/hfes/hfproc/2000/00000044/00000028/art00005>
- Creusen, M. E. H., & Schoormans, J. P. L. (2005). The different roles of product appearance in consumer choice*. *Journal of product innovation management*, 22(1), 63-81.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-339.
- Helander, M. (2003). Forget about ergonomics in chair design? Focus on aesthetics and comfort! *Ergonomics*, 46(13-14), 1306-1319. doi:10.1080/00140130310001610847
- Kuijt-Evers, L. F. M., Groenesteijn, L., de Looze, M. P., & Vink, P. (2004). Identifying factors of comfort in using hand tools. *Applied Ergonomics*, 35(5), 453-458. doi:10.1016/j.apergo.2004.04.001
- Kurosu, M., & Kashimura, K. (1995). Apparent usability vs. inherent usability: experimental analysis on the determinants of the apparent usability. *Conference companion on Human factors in computing systems* (p. 292-293).
- Lavie, T., & Tractinsky, Noam. (2004). Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies*, 60(3), 269-298. doi:10.1016/j.ijhcs.2003.09.002
- Mital, A., & Kilbom, A. (2000). Design, selection and use of hand tools to alleviate trauma of the upper extremities: Part II-The scientific basis (knowledge base) for the guide. *Elsevier Ergonomics Book Series*, 1, 217-231.
- Miller, M.(2001). Development of a methodology and hardware to conduct usability evaluations of hand tools, NASA Technical Report 20030061411.
- Nielsen, J. (1993). *Usability engineering*. Morgan Kaufmann.
- Norman, D. A. (1988). *The psychology of everyday things*. Basic books.
- Schenkman, B. N., & Jönsson, F. U. (2000). Aesthetics and preferences of web pages. *Behaviour & Information Technology*, 19(5), 367-377.
- Shackel, B. (1991). Usability-context, framework, definition, design and evaluation. *Human factors for informatics usability* (p. 21-37).
- Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with computers*, 13(2), 127-145.
- Young-Corbett, D. E., Nussbaum, M. A., & Winchester III, W. W. (2010). Usability evaluation of drywall sanding tools. *International Journal of Industrial Ergonomics*, 40(1), 112-118.

List of Figures and Tables

1. Has a nice feeling handle
2. Needs low hand grip force supply.
3. Hand tool is functional.
4. Causes peak pressures on the hand.
5. Causes numbness on the hand.
6. Promotes comfortable hand posture.
7. The handle feels slippery.
8. Has a good force transmission.
9. Has a good friction between my hands.

Figure 1. Descriptors of hand tool comfort

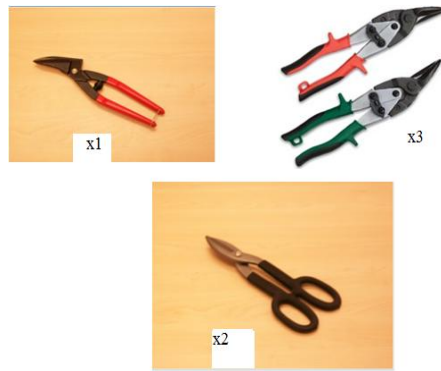


Figure 2. Tin snips

- *1. Using this Tool in my job would enable me to accomplish tasks more quickly
- 2. Causes peak pressures on the hand
- *3. Using this Tool in my job would increase my productivity
- 4. Causes numbness in my hand
- *5. Learning to operate this Tool would be easy to me
- 6. The tool will promote a comfortable hand posture.
- 7. The handle feels slippery
- 8. Needs low hand grip force supply
- 9. Has a nice-feeling handle
- *10. I would find it easy to perform cutting task
- 11. Feels clammy
- *12. I would find this Tool easy to use
- *13. Using this Tool would enhance my effectiveness on the job
- 14. The tool handle has a good friction
- *15. Using Tool would make it MORE DIFFICULT to do my job
- 16. Has a good force transmission

Figure 3. Survey questions

Tin snips	Tool Design Principle	Weight (Kg) Length of tool (cm)	Tool material
Tinsnip X1	Pliers principle	Total length =25 cm Weight = 0.36 kg	Stainless steel
Tinsnip X2	Scissors principle	Total length = 26cm Weight = 0.46 kg	Stainless steel
Tinsnip X3	Pliers principle	Total length =24.5cm Weight = 0.38 kg	Stainless steel

Table 1. Tin snips specifications

Tin snip type	Aesthetics rating (out of 10)
Tin Snip x1	6.4
Tin Snip x2	6.55
Tin Snip x3	7.05

Table 2. Survey scores

Tin snip type	Survey Scores (%)
Tin Snip x1	59.35
Tin Snip x2	58.94
Tin Snip x3	61.68

Table 3. Aesthetics ratings for tin snips