A Hand Tool for making thin strips of Bamboo

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Abstract: Making thin strips of bamboo requires skill and takes great effort to master it. The present method of making bamboo strips involves splitting the bamboo and later making thin strips out of it with the help of a knife. Although some rudimentary tools are available for splitting the bamboo, for making thin strips a plain knife is used which is supported by thumb and pushed through the split bamboo. This involves pressing the thumb on the bamboo surface, this can be dangerous when sharp splits are open and can cut and/or prick into the thumb. The objective was to make an ergonomic hand tool which would avoid pressing the thumb on the bamboo surface while pulling the knife down. The width of the bamboo strip will be exactly same every time and throughout the length. The proposed tool needs no support of thumb. The design of the handle is also considered to avoid pressure on the sensitive mid-palmer area.

1 Introduction

Bamboo Handicrafts have been the main attraction apart from the other very useful functions of Bamboo. Jewellery made by using thin strips of bamboo is in practice since 20-25 years. The tools available for this workmanship are minimal. Making Bamboo Handicrafts needs both skill and practice. The present method of making bamboo strips involves first to make bamboo splints of definite thickness and length and then making the thin strips using a knife. There are tools available for splitting the bamboo. However, for making thin strips, a knife is used to peel out the bamboo strip along the length of the splints. While making thin strips, the user makes a small first cut by nipping the knife blade into the splint and then using thumb and index finger the strips are pressed tightly and then drag along the length of the splint. This often causes injuries to the fingers when sharp splits are open and can prick into the thumb as well cause pain in the wrist joint due to awkward hand posture. However, availability of published literature especially on Bamboo tools is significantly very less.

Tools handle made from unsuitable material like steel and poor workmanship contribute to accidents [1]. Hand injuries contribute a significant proportion of all workplace injuries and lead to significant loss of time at work [2]. The basic fact of having or not having a handle or even without an ergonomically designed handle can make a large difference in performance and comfort [3]. Design of hand grip should be based on the type of gripping action used [4]. In many occupations, some of the major causes of work-related disorders and diseases are linked to the use of hand tools [5]. Tool design may play important role in the development of work-related problems in the upper limbs [6]. Ergonomically well designed hand tools may reduce the risk of occupational injuries of the upper limbs [7]. They also provide comfortable work for the users and give high product quality to the consumers. The objective is to make a tool which will avoid direct pressing the fingers on bamboo

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surface while pulling the knife down. The width of the bamboo strip can be controlled by the tool and will be exactly same every time and throughout the length. The modification of existing tool handle is also utmost important to avoid pressure on the sensitive mid-palmer area. Therefore, new design hand tool will help to reduce occupational health hazards while making bamboo thin strips with increased productivity.

2 Hand tool design

In present study, tool design is done in two stages 1. Blade design and 2. Tool handle design. Blade design is mainly focussed on to peel out a thin bamboo strip of definite width throughout (e.g. 5 mm) without having direct contact of fingers at the cutting edge of the tool or the unprocessed bamboo splints. Then tool handle is designed ergonomically to improve hand posture while operation and then comparative analysis is done between conventional cylindrical handle (Figure 1) with newly designed handle (Figure 2). Both the handles are made out of wood and polished with a fine sand paper [3].

2.1 Cylindrical handle

Figure 1 shows the tool with straight cylindrical handle. The radius of the cylindrical handle (viz. 15 cm) is selected such that a good power grip can be made by the user. In this attempt, the cutting blade is aligned with the axis of the tool handle.

Fig. 1 The tool with cylindrical handle.

2.2 Ergonomic handle

Figure 2 shows the tool with the proposed Ergonomic handle. Following design parameters listed in Table 1 were considered for designing the handle. The handle was designed for medium group (viz. 50th percentile of male and 95th percentile of female) hand measurements as per Winston and Narayan [6]. The handle follows the contour of the hand and eliminates the concentration of stress on the mid-palmer region with good palmer grip. The proposed tool needs no support of finger while pulling down the tool. For the hand arm alignment, the angle of the blade is made to be 20° with respect to the horizontal. This blade angle reduces the radial deviations of the wrist while operation.

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Fig. 2 The tool with Ergonomic handle.

Table 1 Design parameters considered according to Winston & Narayan [6].

Design Parameter	Description
Hand and forearm alignment	the gripping capability of the fingers is affected by position of the wrist
No Finger grooves	Variations in finger anthropometry, a person with large fingers may create compressive forces on the lateral surfaces of the fingers
Extended tool handle	to avoid forces on the centre of palm and prevent hand slippage
Rounded edges and corners	to avoid cuts and bruises
Handle thickness	broader handle avoids stress concentration in the three pressure sensitive areas (the palmar arch and ulnar nerve in the heel of the hand, and the mid-palmar area)

3 Prototype testing

Prototypes are made for both the cylindrical and the ergonomic handle as discussed in the previous section. Test is conducted to find the effectiveness of the ergonomic handle with respect to the cylindrical handle with the same blade design.

3.1 Subjects

Five male subjects are employed for the experiment. The mean age, height and body weight are 24 (± 0.707) years, 170.4 (±7.23) cm, 61.8 (±5.8) kg, respectively. All the five subjects are right handed.

3.2 Procedure

Figure 3 shows the layout of the experiment setup. During the experiment, the subject picked the Bamboo (Length = 45 cm, Diameter = 3 cm) with his left hand and held it vertically on the table, the bottom end of the Bamboo resting on the table. The height of the table was 75 cm from the ground. The subject holds the Bamboo knife with his right hand. The knife tip is placed on the top edge and nipping is done using a hammer on the whole Bamboo without making splints. Then the subject has pulled the knife in downward direction throughout the length.

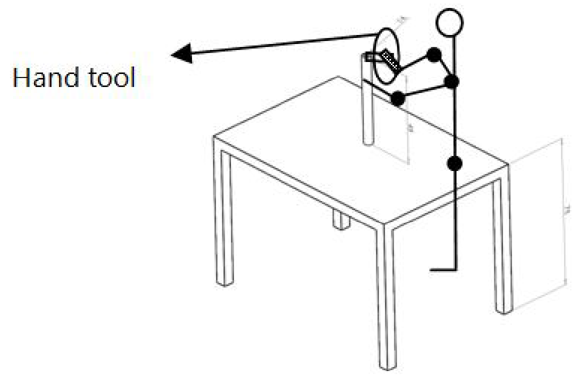

Fig. 3 Experimental set-up for user testing.

3.3 Data collection

The flex sensor is initially calibrated before actual measurement. Then this Flex sensor is fixed to the wrist of the subjects which measures the wrist angular deviations (viz. both Ulnar and Radial deviations) during operation. Force Sensitive Resistor is fitted to the subjects hand in the Mid-palmer region to measure applied force at that region while operation. The type of force sensor is selected based on the criteria mentioned by Raymond [8]. The Sensors outputs are then recorded throughout the process. Analog signals from the sensors are converted into Digital signals using an Arduino Uno board. The data was recorded using RS232 Data logger for further processing and stored in the computer. Force sensor data is then relatively compared among the tests. The subject is asked to make two trials for each handle and better among them is selected.

4 Results and Discussion

Figure 4 shows the Force sensor readings from a single subject. The result indicates that the total force acting on the mid-palmer region during operation is comparatively low when using the ergonomic handle. The force on the palm is distributed due to increase in contact area, so the force acting in the mid-palmer region is low. The increase in the contact area is due to the contour shape of the handle.

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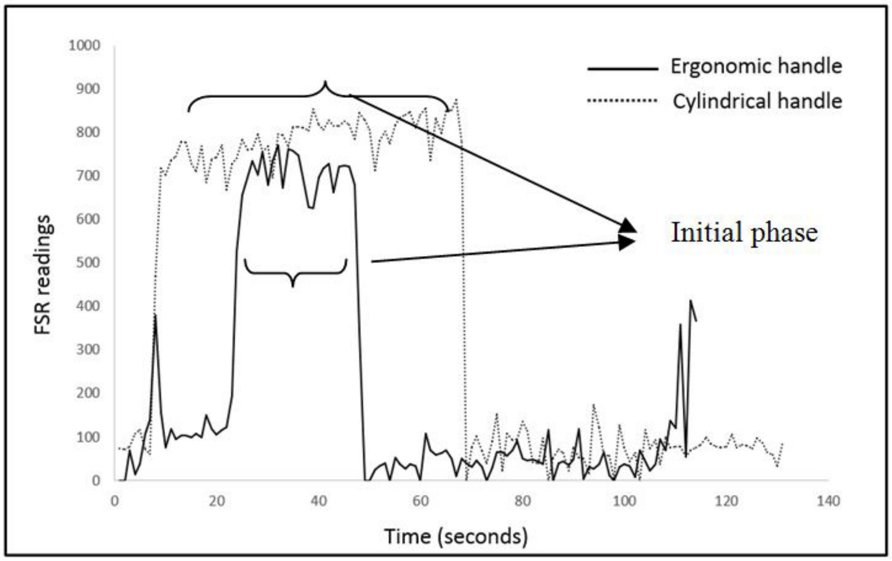

Fig. 4 Force Sensor readings of a subject while using the two different handles.

Figure 5 shows the right hand wrist deviations (viz. both Ulnar and Radial deviations) during the experiment. The positive axis shows ulnar deviation and the negative axis shows radial deviation. At many instances the deviation is more than 20º for the cylindrical shaped handle. Kai [9] has stated that wrist angular deviation of more than 20º causes strain injury at the joint.

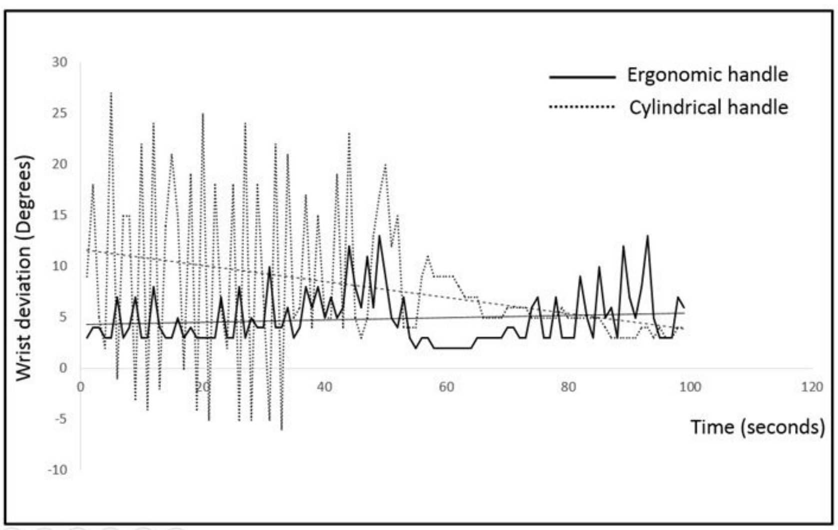

Fig. 5 Wrist deviations (Ulnar and Radial) of a subject while using the two different handles.

The result shows that the Ergonomic handle has minimum deviations than the cylindrical handle. Other subjects also show similar response with some added fluctuations. The fluctuations are mainly occurred as the subjects are college students and they are not adapted to this kind of operation; although familiarity of the operations is tested before trial recordings.

6 Conclusion

This study proposed a new hand tool for making thin strips of bamboo even without making the bamboo splint. The tool help to reduce the chances of hand injuries, and the sharp unfinished edges of splints can never prick into the thumb, as there is no direct contact of the user to the bamboo splint during operation. Tool with ergonomic handle provide promising result compared to the cylindrical one. The Usability of the proposed tool can be increased by conducting more in depth research on actual user.

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