International Journal on Robotics, Automation and Sciences

Review on Accessibility of Scissors for the Left-handed and Ambidextrous, and People with Fine Motor Difficulties in the Digital Era

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***Abstract* – There had been efforts to provide single-handed tools for small-scale and one-time work, from the industrial to the modern age. This is notable in the case of scissors. The modern era provides more options to produce scissors that fit the individual. This is made possible through 3D printing and rapid prototyping. However, accommodating the exact personal preferences of users remains a persistent problem, especially for the left-handed and ambidextrous, or those who have problems with fine motor skills. The other alternative in the digital era is coaching and instructions that are available through digital platforms for the purpose of helping people practice fine motor skills in the use of scissors. However, like other tutoring methods, their outcomes depend on the individual ability of the learners.**

***Keywords*— left-handed tools, ambidextrous tools, fine motor training, ergonomics**

I. Introduction

Single-handed tools remain present in the modern era, due to their portability [1]. This includes non-powered tools, which do not meet performance requirements for industrial applications but otherwise fulfills domestic and small-scale work [2]. A notable example of such tools is the scissors, a cutting tool that remains useful many years after its introduction [3].

In the digital era, the scissors would still be used for purposes of removing small amounts of materials, typically for one-off situations, such as conforming something to fittings and discarding of undesirable flashes from casts or molds [2]. Incidentally, in the digital era, 3D printing manufactures products that must be separated from each other through means that involve scissors, such as trimming burrs from the products.

With scissors being a hand tool, the ergonomic design of scissors is of importance to their ease of use [4]. Where design-based solutions are not available, manual practice is the alternative [5]. This article intends to review the design of scissors and practice in the use of scissors in the digital era.

II. Background & Problem Statement

The following passages provide a brief history of the design and usage of scissors, together with the problems that those who are not right-handed would encounter.

A. Predominance of Mass-Manufactured Right-Handed Tools

The foremost perennial issue in the design of scissors is that most hand tools, including scissors, are designed for right-handed people. Prior to the advent of 3D printing for individual use, the production of scissors depended on the manufacturing sector. The sector generally operates on economic sensibilities based on practical facts. Therefore, since most users of hand tools are right-handed, the bulk of manufactured tools are made for the right-handed [6]. This applies to scissors too.

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International Journal on Robotics, Automation and Sciences (2023) 5,2:73-78
https://doi.org/10.33093/ijoras.2023.5.2.8
Manuscript received: 23 June 2023 | Accepted: 10 August 2023 | Published: 30 September 2023

Published by MMU PRESS. URL: http://journals.mmupress.com/ijoras

For the left-handed, this means a scarcity of tools that are suitable. This is less of a problem for ambidextrous people. However, there might be situations in which an ambidextrous people would prefer to use a left-handed tool, such as when an ambidextrous surgeon encounter space constraints or visual obstructions that make a right-handed tool difficult to use for a surgery technique [7].

This issue remains to this day, due to the economics of mass production. It also affects right-handed users, because users must conform to the use of hand tools that have been designated as standard for their workplace but are not necessarily comfortable to their own individual hands [8].

In the case of people with persistent fine motor difficulties, the implementation of designs for left- or right-handedness would not help them [9]. For these people, adjustment and rehabilitation through practice is the alternative [10]. The solution of manual practicing will be elaborated further later.

B. Grip Factors in Scissors

The issue of ergonomics in single-hand tools is particularly pronounced in the case of scissors. This is because the use of scissors requires grips that are not necessitated in other kinds of single-hand tools [11]. The use of scissors requires simultaneous application of strength and dexterity, neither of which is reliably measurable separately from each other. Consequently, the measurement of performance in gripping scissors are estimated through the results of cutting materials with scissors, such as how closely a cutting path is followed [12].

The issue of grip factors further compounds the problem of having scissors fit to the hands of the user instead of the other way around. Particularly, scissors with grips that are designed for specific users are not easily usable for anyone. This is indeed the case for left-handed users trying to use right-handed scissors, and vice versa. In fact, different individuals can exhibit different gripping pressures across their fingers and palms, even among individuals with the same hand preference [13].

Another prevalent issue with the designs of scissors is the proliferation of finger-oriented grips. This is not a problem for either left- or right-handed people that have developed fine motor skills. However, those who have difficulties maintaining fine motor control would have to use scissors with palm grips. This in turn necessitates the inclusion of springs or other mechanisms to return the scissors to their default state [14]. This increases the complexity of design.

C. Material to Be Cut

As befitting a cutting tool, scissors must be designed such that they can cut the material that they are intended to cut. Consequently, different materials have different physical demands, which in turn impose different strains on the user. This is most notable in works involving fabrics, in which there are different kinds of fabrics and scissors that are specialized for those fabrics [15]. Including the factor of handedness, or mechanisms to return the scissors to their default state, increases the complexity of designing these specialized scissors.

D. Availability of Materials for Fabrication

In terms of relevance to ergonomic designs of scissors for people of different handedness, the availability of materials with which to fabricate scissors appears to be of the least relevance. A plausible situation where material choice may be relevant is when a user relies on the tactile stimuli from the gripping of the scissors for ease of use and comfort. For such cases, additional materials may be needed to implement additional components to the design of scissors, such as wires that assist the closing and opening of scissor blades [16]. The materials and components would then have to be calibrated for the user, inclusive of the factor of handedness.

In addition, scissor designs for people of different handedness in specific working conditions may require the use of specific materials. For example, surgical scissors must be made of materials that can be readily sterilized and of sufficient strength for use in either hand to avoid having awkward holding angles during surgeries [17].

Incidentally, in the digital era, there are comparatively more options for materials and the processes that use these materials. This will be expanded upon later.

E. Risk of Accidents

As a hand tool that is designed to cut, scissors have sharpened edges that will pose the risk of lacerations. Understandably, the sharp edges are the inner edges of the scissor blades. There are also the tips of the blades, which pose the risk of punctures. There has been research into developing the means to render these edges and the tips safe, but with the consequence of making the scissors less easy to use [18].

Designs that accommodate left-handed people reverse the alignment of the scissor blades, but otherwise does not remove the existing risks. Some designs that accommodate ambidextrous people introduce additional safety risks, such as having double edges [19].

III. Design Approaches

Solutions to the issues that are described earlier must balance between designing scissors to fit the user and fulfilling the purpose of the scissors. The following passages are the design approaches to hand tools such as scissors.

A. Outcome-Oriented Designs

Certain designs are focused on the outcomes, e.g., the cleanness of the cut that is made by the scissors. This is especially the case for surgical scissors, which must not pose risk to the patient and must be capable of being sterilized [18]. Comfort of the user is a secondary goal in such designs; instead, ergonomics concerns are solved through other factors such as posture and footwear [20].

B. Operations-Oriented Designs

Certain designs are focused on the operational requirements, e.g., the force that is needed for the cut, or the reach of the scissors. This is important for scissors that are intended to cut specific materials, as described earlier.

Such designs focus on the deployment of the mechanisms in the scissors that are necessary to fulfill the parameters [21]. Cases of scissors with resetting mechanisms, such as those for scissors with palm grips, would be more complex.

Incidentally, this design approach is suitable for automated manufacturing, such as the cutting of thin metal plates [22]. This is for when the human hand and arm could not provide the necessary strength to perform the task.

C. Ergonomics-Oriented Designs

Designs that focus on ergonomics have the goal of accommodating users with different grips. This approach gives the most solutions for the left-handed and ambidextrous, as well as people with fine motor difficulties. Solutions that follow this approach include mirroring the structure of the scissors and introducing mechanisms that change the position or orientation of the handles [23]. The latter example of changing the handles occurs for ambidextrous scissors, but also often necessitates the introduction of double edges because the blades must be rotated when switching from left-handedness to right-handedness and vice versa [24].

These solutions require studying of their needs in their working environment so that there is data for informed designs [25]. This design approach also has overlaps with outcome- and operations-oriented approach for practical reasons. For example, after having been designed, a left-handed scissors still needs to be tested for whether it is able to cut the intended material [23].

IV. Design and Production Methods Available in the Digital Era

The mechanical principles of scissors, which are a pair of sharpened edges sliding against each other, have not changed since its invention. However, the methods to fabricate scissors and familiarize oneself with their use have progressed. The following sub-sections mention technologies and techniques that can aid the design of scissors, followed by a passage on extant problems.

A. CAD/CAM

The handles of scissors must be formed with specific shapes and set against each other at specific angles so the scissors can be readily used in the situation that it is designed for. For example, sewing scissors need to have handles that allow for ease of motion of the wrist in both translation and rotation [26]. In comparison, the cutting edges are simply straight, with some designs changing the curves of the outer blunt edges for aesthetic or tactile appeal [27].

The foremost contribution that the digital era has made to the design and production of scissors is computer-aided design and manufacturing (CAD/CAM). As mentioned earlier, the performance of scissors is significantly dependent on their geometrical structure and motions of the blades. Thus, there is much mathematical analysis involved. Therefore, the use of CAD/CAM software is useful for aiding and optimizing the designs of scissors, according the operations-oriented approach [27].

B. 3D Printing

3D printing, colloquially known as additive manufacturing, is the complement to CAD/CAM. CAD/CAM can be used to produce molds that allow the casting of scissor parts if mold-casting is more feasible than direct 3D printing [28]. However, mold-casting may not be suitable for complex grips. This limitation also applies to designs other than those of scissor parts [29]. Thus, for designs with complex shapes for the handles, which is characteristic of ergonomics-oriented designs, 3D printing may be more suitable.

Nonetheless, it is still possible to use molding techniques to produce other parts of the scissors, such as the blades for the sharpened edges, if these parts have comparatively simple shapes [30]. It is also possible to source parts with simple shapes from mass-produced commercial sources. Again, the blades for the sharpened edges are an example.

C. Simulations

The digital era also provides the option of having simulations. Simulations may not directly contribute to design and production of scissors. However, they can produce results that can guide the decision-making stages of design and production, i.e., outcome-oriented approaches; the explanation is as follows.

Ostensibly, a database that is formed from measurement data of hand motions could be paired with the simulation of the solid physics of hand tools. The simulations from this pairing are then studied to assess the feasibility of a hand tool design; this can be extrapolated to include scissors [31]. Simulations also happen to be complementary to the application of CAD/CAM in the designs of hand tools like scissors [29].

However, the results of computer simulations can be disputed if the data of hand motions has not been obtained directly from the consenting individual user [32]. Furthermore, obtaining this data requires the use of rigs and devices that can capture the user’s motion, thus increasing the procedural complexity of design.

D. Existing Problems

Despite the design solutions that are available in the digital era, there are still problems that happen to be extant before this era.

To have scissors that are suitable for a person, physical models of scissors must be made so that they can be put in the user's hand for first-hand testing. Even with simulations (which are mentioned earlier), there is no guarantee that a design would be wholly satisfactory to the individual user, even after studies have been performed to identify issues with the use of scissors [33].

Therefore, at least one prototype must be made before the achievement of the final design that is wholly satisfactory to the intended user. This practice may be economical for scissors that are regulated, such as surgical scissors [34]. However, it is not feasible to those that are meant for sundry use.

V. Practice Methods Available in the Digital Era

As mentioned earlier, it may not be possible to have scissors that are perfectly designed for an individual user. The setback may be due to personal perceptions as much as it may be due to design flaws [33]. Thus, the other solution is for the user to practice the use of tools, including scissors, until the user is familiar with them. In fact, left-handed people cope with the prevalence of right-handed tools through practice, as shown by the expression of ambidexterity among left-handed surgeons [35].

This approach has been around before the digital era, though the digital era provides additional options.

A. Practice Kits

Practice kits are materials and recording devices that are used in fine motor activities. These activities are intended to give a measurement of a person's fine motor skills. Practicing with hand tools such as scissors happens to require the exercising of one's fine motor skills, so scissors may be included in such kits [36].

Developing fine motor skills requires long-term effort. Incidentally, this is best done early in life, so learning aids that are made for this purpose tend to be targeted at children. In the digital era, CAD/CAM provides the means to generate the lines and curves that are then printed on cardboard or paper cutouts in the physical practice kits for children [36]. This approach can also be applied to adults, including those who are left-handed and ambidextrous [9].

Present-day software also allows for recording and monitoring the performance of individuals at using scissors to cut those lines, though the reliability of any supposedly standardized assessment remains within doubt, even for specific categories of people such as people of specific handedness and children [9][37]. Methods in the digital era still cannot account for differences in individuals, especially personal preferences, e.g., ingrained habits.

The digital era does provide the means to quickly deploy practice kits, namely through apps on mobile devices [38]. Scissors are single-hand tools that are portable, so having similarly portable mobile devices to record performance is convenient.

B. Motion Tracking

The means to track the motion of body parts are available in the digital era. Motion-tracking software has aided the assessment of a user's hand motions when using scissors [39]. There has also been motion analysis of left-handed people when they are using scissors [40].

However, like practice kits, the reliability of such assessments is not beyond doubt, much less approaching any universally accepted standards. Still, there are attempts to implement empirical means of measuring performance, such as the mathematical application of Drury's Law in measuring one's ability to follow a path when cutting with scissors [41]. The digital era does provide the means to develop these methods, such as video recordings for further data analysis [41].

C. Existing Problems

The problems with practice methods for the use of scissors in the digital era have the same theme as that of the problems with the design of scissors.

The theme is the differences between individuals. Specifically, any solution that is to be implemented through practicing with one's hands must account for the individual's physiological and psychological traits, among other personal factors [42].

There are databases with accumulated information and measurement methods that are based on these in the digital era. They could be used in assessments, such as the work of Dehghan et al. in assessing the impact of developmental and environmental factors on a person's fine motor skills through the Mann-Whitney test [43]. However, such present-day means have yet to account for every conceivable factor that may affect an individual's fine motor skills.

VI. Conclusion

Table I provides a summary of the approaches to producing scissors, and their effects on the accessibility of the resulting scissors.

TABLE I. Approaches on Making Scissors and their Accessibility

Approach Type	**Effects on Accessibility**	
	Advantages	***Disadvantages***
Outcome-Oriented	The solutions would already be suitable for the individual user, due to the effort to calibrate the scissors to the user.	Significant effort and resources will have to be invested in the calibration work, and the results may not be suitable for other individual users.
Operations-Oriented	The solutions would fulfill the intended purpose of the scissors.	The user will have to practice with the scissors until familiarity has been achieved.

Approach Type	Effects on Accessibility	
	Advantages	***Disadvantages***
Ergonomics -Oriented	The solutions would be comfortable for the user.	The resulting scissors might not fulfill the intended purpose, thus necessitating a redesign.

In the digital era, there have been innovations that made the design of scissors more accessible and friendlier to people who are left-handed and ambidextrous, or people with fine motor problems. However, standardization and generalization of scissors designs or practice of usage for those who are not right-handed remain neither possible nor appropriate. Still, the digital era does provide convenient means to have personalized solutions based on software and additive manufacturing, which were not available in previous eras.

Acknowledgment

The inspiration for this paper is the work of then-final year Mechanical Engineering student of FET, Mohammed Ahmed Saleh Abdul-Rahman, which is also included as a reference. The use of rapid prototyping followed by mounting of a blade on the fabricated model gave the idea for preparing this review paper on tools for left-handed and ambidextrous people in the digital era.

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