UNIVERSITY OF BATH

Department of Mechanical Engineering
FACULTY OF ENGINEERING AND DESIGN

FINAL YEAR MEng PROJECT REPORT

Making Power Tools Safer by Calibrating Users' Perception of Risks: Effects of Grip Textures on User Behaviour

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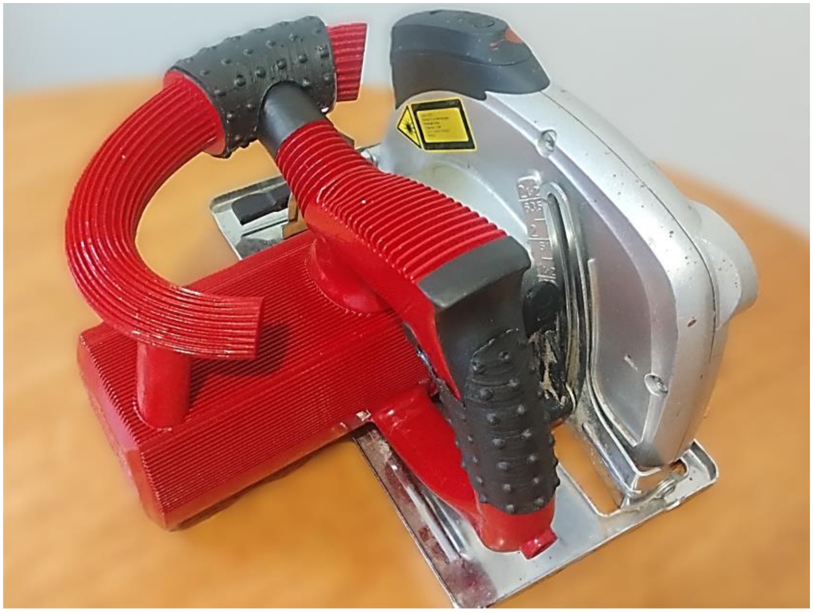

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Summary

The project aimed to explore the influence of texture on users' perceptions of risk to improve power tool safety. The effect of colour was investigated as a secondary influential measure. These goals were achieved through a series of iterative experiments, each of which built on the findings of its predecessors. This project focussed on novice operators of circular saws due to the high rate of injury from this tool and its common availability to untrained users.

The study explored current standard behaviour surrounding power tools and the associated risks to determine potential areas of improvement. 5 textures (Smooth, Dots, Lines, Squares, and Knurl) were considered for their recognisability, distinguishability, and influence on user risk perception. The study found the Smooth texture to be most tactilely recognisable, followed by Lines and Dots. The combinations of 'Smooth and Lines' and 'Dots and Lines' were both highly distinguishable and therefore tested for their impact on user behaviour and risk perception. Testing revealed Smooth and Dots to be preferred gripping textures, and Lines texture to have minimal effect on the users' chosen grip locations. The 'Dots and Lines' texture combination was found to most successfully influence the user to grip the correct locations of the saw handle, while avoiding unsafe locations. During physical testing, the addition of the 'Dots and Lines' texture increased the number of users correctly gripping the handle by 31.25% compared to the original circular saw. Upon adding colour (black on the grips and red elsewhere) this rose to 40.18% improvement. This highlights the positive effects of texture and colour on user behaviour leading to improved safety.

The demographic of participants involved in testing was limited to a small sample (42 people) consisting mostly of university students. Real-world factors such as vibrations and the forces necessary to operate the circular saw were not simulated during the experiments. Despite these limitations, the findings of this study suggest texture may be a valuable factor to influence user risk perception, warranting further research and optimisation.

Acknowledgements

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I acknowledge that ChatGPT-4 (Open AI, https://chat.openai.com/) was used to proofread my final draft and suggest more concise wording only. All ideas, analysis, and original content are my own.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ABS	Acrylonitrile Butadiene Styrene
CAD	Computer Aided Design
DIY	Do It Yourself
DOT	Dot Overlay Texture
ED	Emergency Department
MDF	Medium Density Fibreboard
OEM	Original Equipment Manufacturer
PPE	Personal Protection Equipment

Introduction

In the design of power tools, user safety is primarily reliant on mechanical features and PPE (personal protection equipment). However, many users choose to remove or ignore these features, often due to ignorance or complacency, leading to injury. Preventable injuries place unnecessary stress and cost on healthcare systems including NHS England which reported almost 4800 hospital admissions due to power tool use between April 2018 and April 2019 (NHS England, 2019). Power saws account for a significant proportion of power tool injuries (Judge et al., 2018) and therefore require improved safety procedures. Circular saws were chosen as the focus of this project due to their availability to novice users and the prevalence and severity of the injuries they cause. Despite the inclusion of blade guards in the design of these tools, lacerations remain the most common injury sustained by users (Jain et al., 2023). This suggests guards alone are not sufficient in preventing injury and other approaches should be investigated. Although many different mechanical and electrical features have been tested and implemented to mitigate user injury, the impact of user risk perception has not yet been explored as a method of improving safety by influencing user behaviour. This project aimed to assess and improve users' safety and risk perception during power tool use, considering their experience level. Textures were investigated as a potential way to achieve this.

Inaccurate or diminished perceptions of risk may be due complacency or ignorance and cause the user to behave without due consideration of their own safety. It has been found that the knowledge of present safety features decreases the risk perceived to be associated with an activity (Taylor and Snyder, 2017) which can lead users to underestimate the dangers of hazards. For example, a blade guard and emergency stop may lead novice users to believe a power tool is entirely safe as they lack awareness of other significant hazards such as kickback, projectile debris, or blade breakages. However, if hazards and risks are perceived in excess, users refrain from using the tool regularly limiting potential for skill growth and advanced knowledge of safety procedures. This highlights the importance of considering user risk perception during power tool design.

Passive safety features do not explicitly control user behaviour and instead suggest the safest mode of operation through non-restrictive design elements. This does not decrease the perceived risk of the activity as the user does not recognise the element as an explicitly safety-driven feature, so correct judgements of the hazards are maintained. However, if the user incorrectly assesses the risk of use as low, passive safety features guide them to safer working procedures. This is unlike a blade guard which can be removed if considered a hindrance, or PPE which may be ignored due to the additional equipment requirement. Despite the benefit of passively influencing user behaviour when operating power tools, few studies have been conducted to inform the design process. Studies by Taylor and Snyder (2017), and van Duijne et al. (2008) have presented conclusions surrounding the influence of risk perception on safe behaviour, but further research is needed to determine the optimal application of these findings within the design process. This project aimed to explore this area further and produce a prototype power tool with passive safety features for testing of its effect on user behaviour.

Although research suggests colours influence human risk perception, most power tools associated with injuries already utilise colours in their design indicating colour alone is not sufficient to improve safety. In addition, if a user becomes distracted while using a power tool, their hands may stray from grips signalled solely by colour without their awareness. Therefore, an additional method of influencing user behaviour could be of benefit both to re-enforce the correct holding position, and to indicate this position tactilely to account for loss of visual focus. The use of textures to signal safety has not been studied but there is research surrounding the response to textures regarding their comfort. This can used to inform the qualities of a handle preferred by the user and eliminate textures which should not be used to signal danger. This project furthers research into users' reactions to different textures and suggests appropriate applications of textures to power tool handle designs.

The specific circular saw adapted in this project (Figure 1) was chosen due to its unique handle design facilitating extensive testing and modification to investigate user behaviour. The large area allowed for varying texture across the handle. It should be noted that areas of the handle are intended for use in different scenarios, but this is not adequately communicated to the user.

This report details the results of 5 experiments and draws conclusions from their result to inform the design of a power tool handle. An online survey and in-person interviews were conducted to provide information about the typical power tool practices of novice and experienced users. These results, along with existing studies collating power tool use and injury data, determined the target tool and user demographic of the project. Handle texture was chosen as the passive safety feature to be developed and applied during this project, however there was a lack of existing research surrounding the influence of textures on human risk perception. Therefore, research was conducted to determine the influence of 5 different textures on users' handling behaviours and the reasons behind these decisions. A study was also conducted to establish to recognisability and distinguishability of these textures to ensure that, if applied, the user would notice and react to them. The experimental method and results of each of these tests are detailed in this report, followed by a discussion suggesting how these findings can be applied to the design of future power tools.

Figure 1: Circular saw to be adapted as the focus of this project

Literature Review

This project draws on research across multiple disciplines to improve power tool safety by influencing user behaviour through perception of risk. Studies from various fields were cited to inform design decisions for which no first-hand research was conducted. The relevance of this topic stems from the high number of power tool injuries caused by risky user behaviour. These injuries occur despite mechanical safeguards due to inefficient user risk perception suggesting a need for safety features which passively influence behaviour through psychological cues. Initially, hospital data studies were consulted to determine which power tool should be the focus of the project. Research surrounding the hazards associated with the tool highlighted possible areas of improvement. Human risk perception was studied to understand methods of effectively influencing user behaviour to mitigate these hazards. The impact of texture and colour was explored to establish the ability of these factors to alter user behaviour.

To determine the most beneficial power tool for adaptation, hospital studies investigating patient demographics, offending tools, and mechanisms of injury were reviewed. Woodworking injuries presented to emergency departments (EDs) were categorised and compared by Loisel et al. (2014). Of 79 cases studied, 51 were hobby related predominantly involving chainsaws (16) and band/circular saws (13). Injuries among professionals predominantly involved secondary processing industry work (16) and chainsaw use (10). A similar study in Queensland, Australia, analysed 4057 accidental power tool injuries over ten years across two EDs (Judge et al., 2018). It found 54% of injuries resulted from power saw and grinder use. Key user behaviours found to contribute to injury included lapses in concentration and modification or misuse of tools. Pre-event factors such as lack of formal training (51.1%), inappropriate safety measures (29.6%), and incorrect hand placement (8.6%) were also identified. Both studies are limited by their reliance on ED data, which excludes minor injuries—particularly those likely to be self-managed by experienced users—and the potential of risky behaviours to be underreported due to patient bias.

A similar study specific to circular saw injuries was conducted in an ED in eastern India (2019 to 2022) (Jain et al., 2023). This study focussed on injuries produced by handheld circular saws similar to the model adapted in this project. The results showed that the most common activity leading to injury was professional carpentry (36%) followed by DIY (14.8%). This study categorises the bodily areas of injury of the 175 participants and the type of injury sustained. The majority of patients suffered lacerations (88.5%); only 5% of patients wore PPE; and kickback was the most common mechanism of injury. Although the experience levels of patients were not specified, 86.5% of injuries occurred in occupational settings suggesting these users were experienced. This limits use of the data for targeting novices.

Further data specific to power saw use involving risk factors was collected in an 8-year study of 114 patients (Frank et al., 2010). This source is valuable to understand how users are most often injured by bladed rotary power tools, however the type of circular saws included in the study are not specified limiting its ability to directly inform the results of the project. 75% of incidents occurred during DIY and 'blade contact' accounted for 95.6% of cases. 30 cases of 'blade contact' resulted from atypical hand position (including holding the stock and cleaning the blade) 10 of which caused the operator's work glove to get caught in the saw. Kickback (27 cases), intrinsically dangerous operations (14 cases), and distraction of attention during operation (4 cases) also resulted in blade contact.

The relationship between risk perception and commitment to safety during physical tasks was investigate in an 80 person laboratory study (Taylor and Snyder, 2017). The participants completed seemingly dangerous activities and their compliance with various safety procedures was recorded. Participant also completed surveys to assess their cognitive risk perception. Tasks performed without safety procedures in place were found to be perceived as riskier. This suggests only visible safety features reduce perceived risk. It is beneficial for users to accurately perceive the high real-world risk posed by circular saws. Therefore, passive or embedded safety features may be beneficial (in addition to guards and other visible protections) as they are less noticeable, preserving the perceived high risk of the activity.

To further research physical risk perception, 10 participants were interviewed regarding their powered gardening tool use (van Duijne et al., 2008). The study found that 4 participants chose not to unplug their gardening tools before cleaning, believing the tool could not be activated accidentally demonstrating imprecise risk perception. None of the participants wore eye protection, underestimating the likelihood of projectiles. This judgement was found to be inaccurate by Judge et al. (2018) who found over half of power tool head injuries were the result of projectile contact with the eyes. Van Duijnu et al. concluded the characteristics of a product and the context in which it is operated collectively influence the user's perception of the associated risk. This study consisted of interviews from only ten participants by convenience to the researcher limiting the external generalisability of the results.

The Design of Everyday Things (Norman, 2013) provides – among other topics - advice about designing for product useability and mitigating error. Key takeaways include ensuring functional parts are visible and requiring all user actions to have apparent and predictable results. This should be considered both when developing and assessing safety features. Operational feedback is emphasised which suggests improving safety through passive influence may be difficult to effectively implement without visible user feedback. This source relies partially on personal anecdotes to draw conclusions about the topic of interest limiting its reliability as an evidence-based source; however, the book can be used to understand the principals of design surrounding the topic of interest.

Few studies link physical textures to risk perception. However, a study investigating consumer opinions of hairdryer handle designs (Zuo et al., 2016) provides insight into tactile factors contributing to user comfort. Comfortable grips were found to be soft, non-shiny, warm, non-sticky, and smooth. In contrast, uncomfortable grips were described as hard, shiny, rough, cold, and sticky. The handles in the study all had flat surfaces unlike the patterned textures that became the focus of this project. While this limits the study's direct applicability, its findings were valuable to inform the tactile design of intended holding locations. Its relevance is limited further by differences in safety considerations between hairdryers and power tools. Therefore, comfort data from the study should be applied with caution and additional factors involved in user behaviour with power tools should be considered.

Colour was also explored for its impact on user behaviour. Wexner (1954) found red and orange to be connected to hostility, blue to be relate to feelings of security and comfort, and black to be associated with power and strength (Wexner, 1954). This topic of research was expanded in 2007 by a study investigating the influence of the perception of risk on decision making (Williams and Noyes, 2007). Red was found to indicate the most hazard resulting in higher levels of compliance than green or black. Blue was associated with the lowest level of hazard. Therefore, the colour red may influence users to avoid hazardous holding positions and blue or black may promote preferred hand positions. Unfortunately, this information is not often utilised by power tool OEMs (original equipment manufacturers) in handle design as brand image is prioritised. Colour was explored as an additional factor to improve user safety.

The literature collected in preparation of this project contained information about power tool and circular saw injuries, risk perception including during power tool use, and the influence of texture and colour on human behaviour. These reports do not directly relate to or inform each other and have not yet been used together to inform power tool design. Current safety mechanisms largely focus on forcing user compliance, for example putting guards around a blade. Although these are initially effective in reducing injuries, users can remove the guards through ignorance or complacency. This project explored safety mechanisms which do not require active user interaction to alter behaviour and improve safety through perceived risk.

Experimental methods

Four tests were conducted to analyse behaviour surrounding power tool usage: an online survey (30 participants), in-depth interviews (6 participants), a texture recognition test (12 participants), and a texture influence test (8 participants). Prototype testing was also conducted to determine the optimal circular saw handle design. Participants were selected by convenience due to limited time and resources. Prior to testing, each participant received a participant information sheet and a consent form. After testing, they were given 'debrief' information.

Online Power Tool Usage Survey

The purpose of this study was to explore the population's current perception of risks and safety surrounding circular saw use. Due to limited literature available regarding this topic, a small study was necessary to investigate both novice and experienced users' understanding of the tool and its risks. The list of survey questions can be found in Appendix I. The survey was distributed via group messaging platforms to eligible participants across Somerset and Suffolk, 30 of whom chose to complete it. The participant group was comprised equally of males and females aged 19 to 67 years, with a mean age of 33.2 years. Twenty-five participants were right-handed, three were left-handed, and two were ambidextrous.

The survey consisted of 4 sections: demographic data; power tool and circular saw experience; risks and safety behaviour; and hand position. These topics reflected the focus area of this project and answered the following questions:

- Which injuries did the participants believe could be sustained from the tool?
- How did participants view the risks surrounding circular saw use?
- What influenced participant behaviour while using the circular saw?
- Where on the saw did the participants consider to be safe to hold?

The question format varied including multiple choice, ranking, comparison, and open-ended questions. Participants who had used a circular saw before were separated from those who had not for result analysis.

In-depth Circular Saw Interviews

Following the online survey, more detailed data was obtained through one-on-one in-person interviews conducted with set questions (found in Appendix II) in a conversational manner. This revealed how participants physically interacted with the tool upon their first time handling it so the results could be compared to those collect from the non-physical online study. A conversational tone was chosen to encourage participants to expand answers to gain a better understanding of their experience handling the tool. The average age of the interview participants was 22.5 years. Half of the participants were male and half were female. All participants had used power tools previously for DIY (predominantly power drills), but none had experience with circular saws. Therefore, all participants were classified as novice users.

Participants were individually invited to be interviewed at a time and place convenient to the participant and the interviewer. Participants completed the online survey prior to interviewing allowing for the comparison of online and in-person data. The first six questions (Appendix II) were asked before the participant was given access to the circular saw. The participant was then given the saw and allowed to handle it as they wished. Some questions required participants to perform specific actions or movements with the tool. Throughout each interview, the participant's responses were recorded including any elaboration on their answers, relevant or otherwise. This information was considered 'additional comments' and used to aid further analysis of the user's behaviour in relation to power tool risks.

For each question, all responses were collected in written format, summarised, and compared. These results supplemented the online survey results to inform conclusions about circular saw use and behaviour regarding risk.

Figure 2: In-depth Circular Saw Interview participant mimicking use of the saw during the interview. LEFT: The participant holds the saw with the blade oriented ***away*** *from them. RIGHT: The participant holds the saw with the blade oriented* ***towards*** *them.*

Texture recognition test

Based on findings from the literature research, online survey, and participant interviews, this project focussed on investigating the effect of circular saw handle texture on novice users' behaviour and risk perception. The texture recognition test aimed to determine the accuracy with which selected textures could be identified and distinguished from one another. The tested textures were chosen based on data provided by the online survey in which participants were ranked a selection of handlebars with different textures in order of comfort. This test involved of 12 participants studying at the University of Bath (20 to 25 years old) selected by convenience.

Ten tiles, each 40×40×4 mm, were 3D Printed in Acrylonitrile Butadiene Styrene (ABS). The surface of each tile contained two textures: a background texture, and a foreground texture creating a shape on the tile (see Figure 3 and Figure 4). The following textures were tested:

- Smooth - no texture applied.
- Dots – hemispheres 4 mm in diameter arranged 6 mm apart in a grid.
- Lines – lines 2 mm high, 1 mm wide, and 1.5 mm apart.
- Squares – 6×6 mm squares, 2 mm high, spaced 1 mm apart.
- Knurl – consecutive rows of triangular prisms of base 2 mm and height 2 mm, in both x and y directions.

The shape on each tile was one of the following, assigned in equal quantities at random: circle, triangle, square, or cross. See Figure 32 and Figure 33 in Appendix III for examples with labelled dimensions.

Participants were first shown examples of each texture and shape and allowed to touch them. Participants then placed their hands in a bag, to obscure them from sight, and given a tile by the researcher (via a hole cut in bag). Participants attempted to identify which two textures were present on the tile, and which shape they created. The correct answer was not revealed, and the tile was handed back to the researcher, then next tile was presented. The tiles were presented in a random order. Once all tiles had been tested, the experiment was concluded. The participant's view of the tiles was obscured to measure their ability to distinguish between different textures by feel alone. This simulated a situation in which a person is working with the circular saw and becomes distracted. Looking away from the tool and work piece could lead to their hands straying into atypical positions, increasing the risk of injury. As found by Frank et al. (2010) and Judge et al. (2018), both distraction and atypical hand position were significant causes of injury by power tools.

3 factors from the results of this test were analysed: how often a texture was correctly identified, how often two textures were correctly identified next to each other, and how often the shape created by the textures was correctly identified. These results provided information regarding the accuracy with which textures could be identified and distinguished from each other.

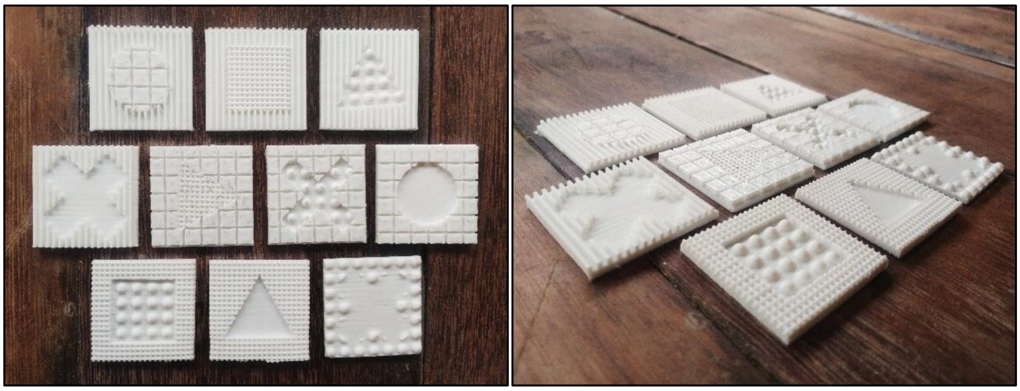

Figure 3: Collection of 10 tiles used in Texture recognition test

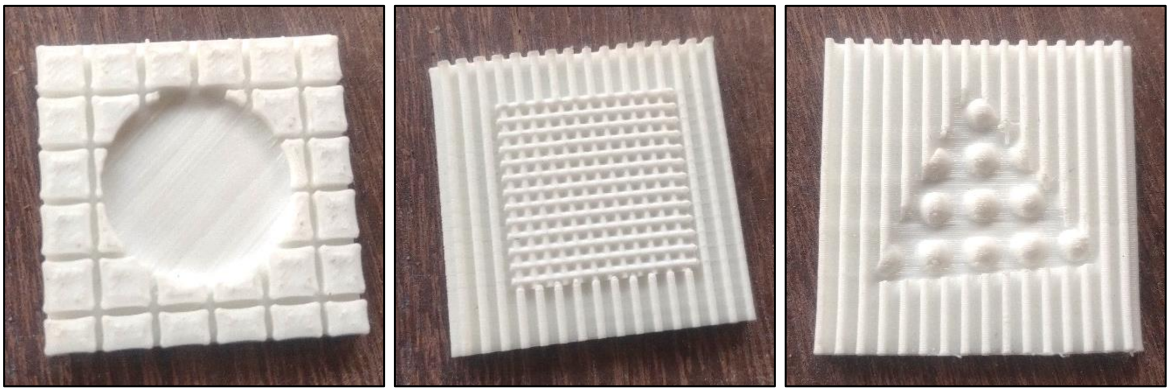

Figure 4: Selection of tiles used in Texture recognition test as examples. Tile with circle shape, Smooth texture, and Squares texture (Left). Tile with square shape, Knurl texture, and Lines texture (Middle). Tile with triangle shape, Dots texture, and Line (Right).

Figure 5: Participant completing Texture recognition test. They are feeling the textures of a tile with their hands in a bag to block their view, the remaining tiles to be tested are arranged out of view of the participant.

Texture influence test

This test determined how different textures influenced where participants held the mock-up circular saw handle (Figure 6). The specific circular saw at the focus of this project had a unique handle shape with a curved section dissimilar from many other designs, allowing for additional places for participants to hold. The mock-up handle closely matched the original handle's size and shape, whilst also accommodating the modularity of exchangeable textured handles. This allowed participants a wider range of gripping options and allowed the application of textures in a variety of locations to observe their impact on handling preferences.

Many novice users assumed manufacturers only place tool grips in 'safe' areas to hold, therefore reducing the perception of risk of these areas. The 8 participants in this test were selected from those who completed the Texture recognition test based on their availability. Figure 6 depicts mock-up saw test piece. The handle base piece and textured inserts were modelled in CAD software and 3D printed in ABS. The handle was simplified into straight sections (instead of the original curve) allowing for modular texture inserts that fit universally across the handle base. Five textured inserts were used in the experiment: Smooth, Dots, Lines, Squares, and Knurl (Figure 7). The textures closely matched those used in the tile test. The non-handle sections (motor casing, base plate, and guards, etc) were manufactured from laser cut Medium-Density Fibreboard (MDF) to better simulate the weight of the tool, increasing the accuracy of the results.

Each participant placed their hands under a cardboard platform and onto the test piece (Figure 9). The platform restricted the participants view so their gripping position was not influenced by visual factors. The test consisted of the following 5 steps:

1. All modular grips began smooth. The participant was asked to push the test piece forwards whilst gripping it in the most suitable position. Their hand positions were recorded as ‘preferred hand grips’.
2. Out of view of the participant, the researcher changed all preferred hand grips to the alternate texture (see Figure 8 for example) and recorded if the participant’s preferred hand positions changed. The first alternate texture was ‘Dots’, then ‘Lines’, ‘Squares’, and, finally, ‘Knurl’.
3. Next, the researcher reversed the textures so that the participant’s preferred hand positions were Smooth and all other grips were of the alternate texture. The participant again gripped the handle as they found most appropriate with consideration of the texture change.
4. The researcher recorded the participant’s new preferred hand positions and ask if the texture influenced the participant’s decision.
5. The researcher repeated the process with all alternate textures.

Data was collected separately for the participant’s left and right hands and the following results were calculated:

- Number of times a textured handle was preferred.
- Number of times a textured handle was avoided.
- Number of times each texture had no effect on preferred grip position.
- Additional comments made by the participants regarding the effect of the textures on their holding location.

Figure 6: Empty base Test Piece

Figure 7: Modular Grips: Smooth, Dots, Lines, Squares, Knurl (Left to Right)

Figure 8: LEFT: Empty base Test Piece. MIDDLE: Smooth grips on areas 1, 4, and 5 lower, and Lines grips on areas 3 and 5 upper. RIGHT: Square grips on areas 1, 4, and 5 lower, and Smooth grips on areas 3 and 5 upper.

Figure 9: Participant completing Texture Influence Test. They are griping the test piece with varying textures applied under a cardboard platform to block their view while allowing sufficient space to mimic the operation of the tool.

Prototype Testing

Prototype testing was conducted after all other testing had concluded the best potential textures to be applied to different areas of the circular saw handle. The prototype was 3D printed, and the handle was painted white (monochrome). To test both 'Smooth and Lines' and 'Dots and Lines' texture on the handle, the prototype was printed with smooth grips and separate Dot Overlay Textures (DOTs) were placed over the Smooth grips when required (Figure 10). Prototype testing consisted of blind, monochrome, and colour tests. As only one prototype was available, the monochrome and colour handles were tested in separate stages. The number of participants consulted at each stage varied due to the availability of the participants and test parts.

Blind Test

The prototype was placed in a bag with sufficient room for movement of the saw to block the participant's view of the textures. The participant placed their hands in the bag and gripped the prototype as though operating a circular saw. The test was repeated with the DOTs on the handle and all preferred hand positions were recorded.

Monochrome Test

The monochrome test piece was removed from the bag (without the DOTs) and shown to the participant (Figure 10). They were asked again to grip the saw as they would to use it. This was repeated with the DOTs on the saw and all of the results were recorded. Once sufficient monochrome data had been collected, the prototype was painted glossy red and matte black.

Colour Test

The colour test was performed the same as the monochrome tests, but the colour prototype was used in place of the monochrome prototype (Figure 11).

The results were separated by hand (left or right). The percentage of time the correct hand positions (right hand on area 1 and left hand on area 4 as labelled in Figure 12) was chosen was calculated for each stage of the test. These results were compared to corresponding data from the online survey, interviews, and texture influence test. Participants were selected by convenience and consisted of novice users only. The majority of the participants (26/32) were students from the University of Bath aged 18 to 23, and the remaining 6 were professionals aged 50 to 65.

Figure 10: Prototype Monochrome Test Pieces. LEFT: Monochrome test piece (Smooth and Lines Textures). RIGHT: Monochrome test piece with DOTs applied to intended handle positions (Dots and Lines Textures).

Figure 11: Prototype Colour Test Piece. LEFT: Colour test piece (Smooth and Lines textures). RIGHT: Colour test piece with DOTs applied to intended handle positions (Dots and Lines textures).

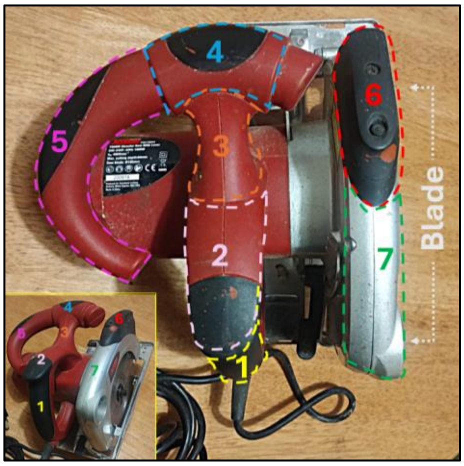

Figure 12: Labelled image of the circular saw presented to Online Power Tool Usage Survey participants

Results and Analysis

Online Power Tool Usage Survey Results and Analysis

For conciseness, the group of online survey participants who had not used a circular saw before – containing 19 participants – will be referred to throughout this report as the 'Novice Survey Group'. The group of online survey participants who had used a circular saw – containing 11 participants – before will be referred to throughout this report as the 'Experienced Survey Group'.

Demographic data

Novice Survey Group

Table 16Table 1 and Table 2 summarise demographic data regarding the Novice Survey Group. This group consisted of 36.8% males and 63.2% females aged between 19 and 56 years with mean age 29.2 years.

Table 1: Ages of the Novice Survey Group.

Age range	Frequency
0-20	3
21-30	11
31-40	1
41-50	1
51-60	3
61-70	0
71+	0

Table 2: Handedness of the Novice Survey Group.

Handedness	Frequency
Left-Handed	2
Right-Handed	17

Experienced Survey Group

Table 3 and Table 4 summarise demographic data regarding the Experienced Survey Group. This group consisted of 72.7% males and 27.3% females aged between 19 and 67 years with mean age 40.1 years.

Table 3: Ages of the Experienced Survey Group Participants.

Age range	Frequency
0-20	1
21-30	3
31-40	3
41-50	0
51-60	1
61-70	3
71+	0

Table 4: Handedness of the Experienced Survey Group participants.

Handedness	Frequency
Left-Handed	1
Right-Handed	8
Ambidextrous	2

The mean age of the Experienced Survey Group was 11 years greater than the Novice Survey Group. This was expected as older users have had more time to experience operating a range of tools. Since this project was centred around novice users, the lower average age of the Novice Survey Group was used to inform the target age of the project.

Experience Data

Participants self-assessed their previous level of experience with power tools. Figure 13 and Figure 14 show the Novice Survey Group results and Figure 15 and Figure 16 show the Experienced Survey Group results.

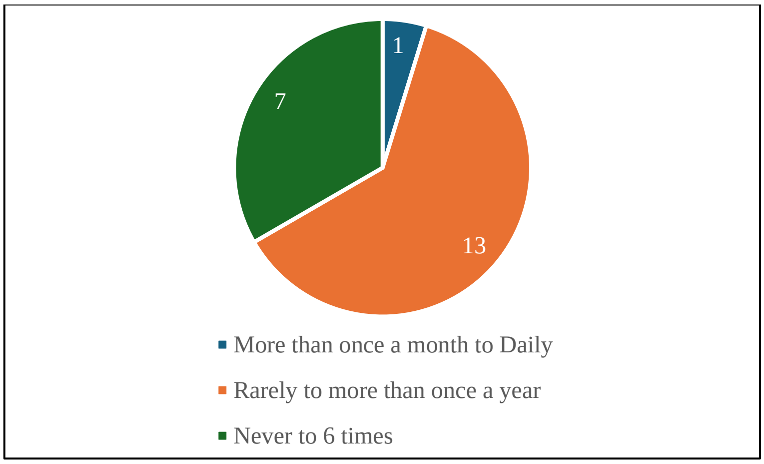

Figure 13: Previous power tool experience of the Novice Survey Group

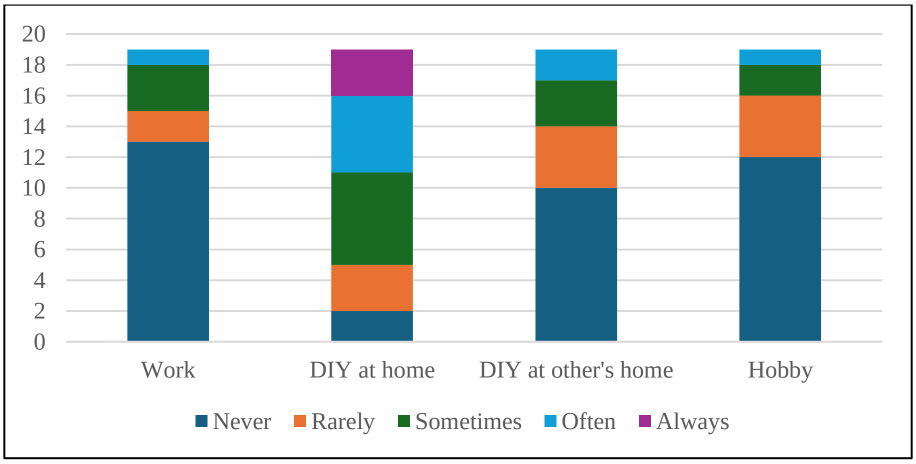

Figure 14: Settings of power tool use of the Novice Survey Group

Table 5: Setting of power tool use of the Novice Survey Group with frequency scores

Location of Use	Total Score (SUM (Frequency x Use Level score))	Weighted Score (Total Score / No. Participants
Work	12	0.63
DIY at home	42	2.21
DIY at other's house	16	0.84
Hobby	11	1.00

Use Level	Score
Never	0
Rarely	1
Sometimes	2
Often	3
Always	4

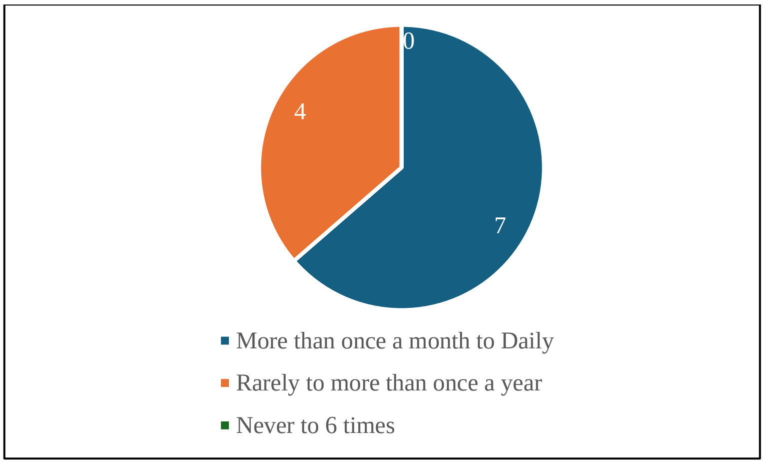

Figure 15: Previous power tool experience of the Experienced Survey Group

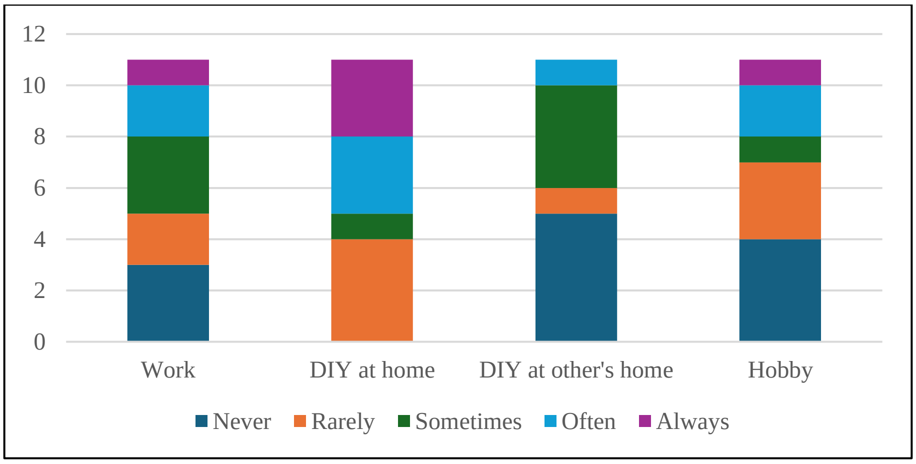

Figure 16: Setting of power tool use of the Experienced Survey Group

Table 6: Setting of power tool use of the Experienced Survey Group with frequency scores

Location of Use	Total Score (Frequency x Use Level score)	Weighted Score (Total Score / No. Participants)
Work	18	1.64
DIY at home	27	2.45
DIY at other's house	12	1.09
Hobby	15	1.36

Use Level	Score
Never	0
Rarely	1
Sometimes	2
Often	3
Always	4

Most of the Novice Survey Group had used power tools 'rarely to more than once a year'. A weighted score was calculated for the frequency of use per setting by multiplying the 'use level' (never, rarely, sometimes, often, or always) by the frequency with which that use level was chosen, and dividing the result by the total number of participants in that group (see Table 6). 'DIY at home' was the most popular setting with a weighted score of 2.21, only 2 out of 19 participants had never used a power tool in this context. This suggests novice users predominantly utilised power tools for the purposes of DIY and did so rarely. In contrast, most of the Experienced Survey Group participants used power tools 'more than once a month to daily'. The preferred setting was more varied for this group. 'DIY at home' remained the most common location of use, but the range of the weighted scores was much lower than that of the Novice Survey Group. This shows the frequency of use was more even across the settings in the Experienced Survey Group.

It follows that the Novice Survey Group participants were familiar with common DIY tools (power drills, palm sanders, etc) but less familiar with larger or specialist tools requiring more storage space and monetary investment. Whereas experienced users had encountered a wide range of power tools in different contexts and scenarios. These tools may have a wider range of risks and safety guidance to consider.

This data allowed the understanding of the difference in risk perceptions of novice and experienced users. Experienced users were more than twice as likely to have previously used power tools at work, a context in which formal training is required. Judge et al. (2018) found 'lack of formal training' to be a leading cause of power tool injuries which suggests training successfully leads to safer working practices and more accurate risk perception.

Risks and Safety Behaviour Data

Participants were asked questioned regarding their expected level of safety when using a circular saw and their understanding of involved risks. Figure 17 and Figure 18 summarise the results of the Novice Survey Group. The results of the Experienced Survey Group are shown in Figure 19 and Figure 20.

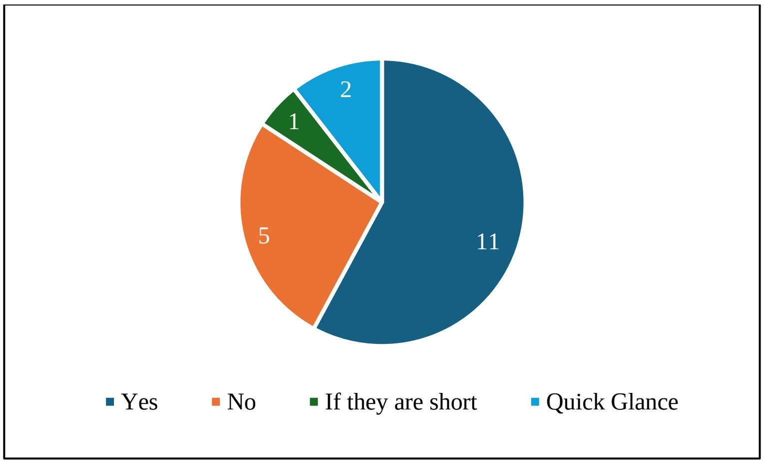

Figure 17: How often participants in the Novice Survey Group read the instruction manual before operating a circular saw for the first time

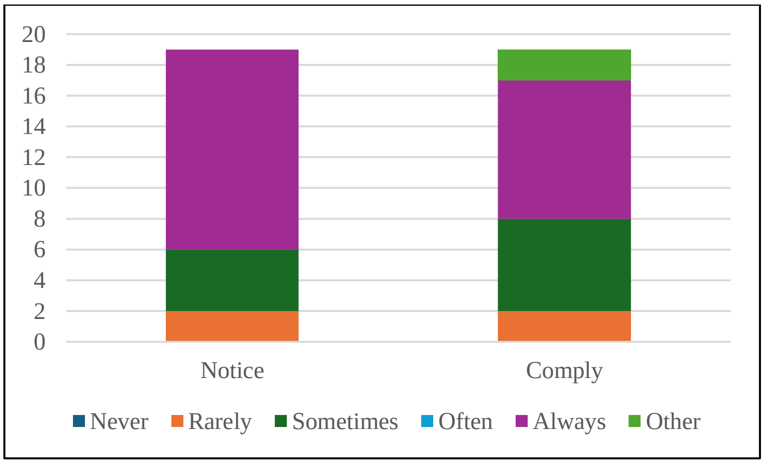

Figure 18: How often the Novice Survey Group participants notice and/or comply with safety warnings and stickers on power tools. The 'Other' category consisted of responses which clarified they would only notice/comply with stickers upon specific conditions, for example, if the instruction didn't interrupt their work.

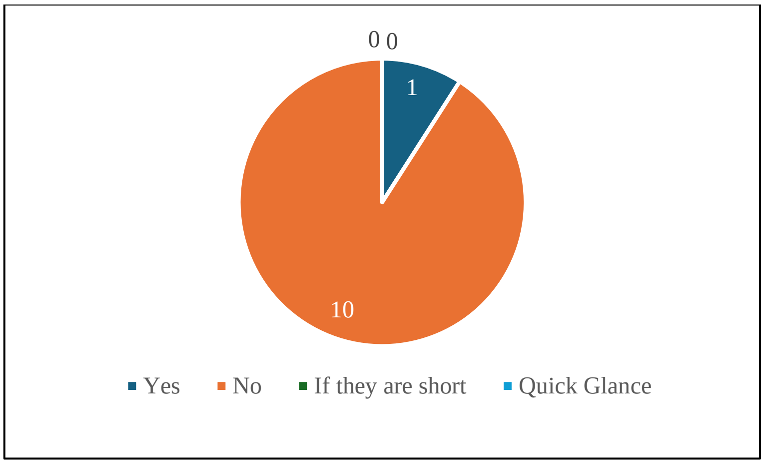

Figure 19: How often participants in the Experienced Survey Group read the instruction manual before operating a circular saw for the first time

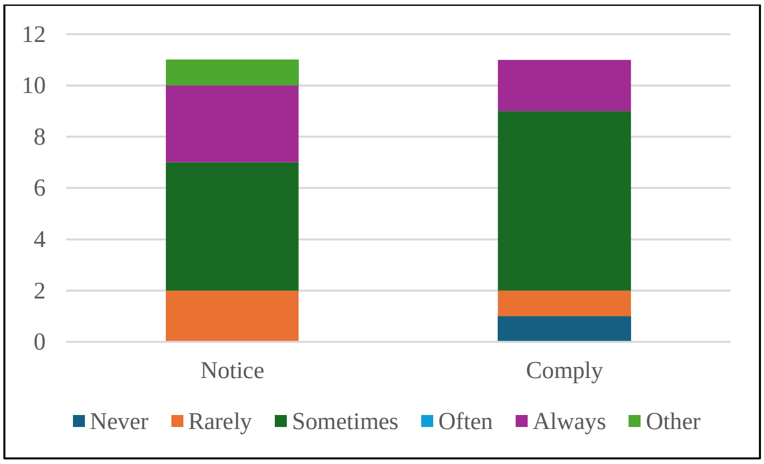

Figure 20: How often the Experienced Survey Group participants notice and/or comply with safety warnings and stickers on power tools. The 'Other' category consisted of responses which clarified they would only notice/comply with stickers upon specific conditions, for example, if the instruction didn't interrupt their work.

Most Novice Survey Group participants would read the instructions but 5 out of 19 would not. Participants who would not read the manual likely had a lower perception of risk than those who did, as they would not seek safety advise before using the saw. This suggests they did not view the tool as exceptionally dangerous. Therefore, safety improvements that do not require interaction with the manual were preferable to engage a wider range of novice users. All bar one the Experienced Survey Group participant did not read the instructions before operating a circular saw for the first time. Unlike the Novice Survey Group, this may be due their extensive prior experience with power tools, rather than ignorance to the risks involved. However, it could also reflect a sense of complacency when using different power tools despite varying risks and safety guidance. They may assume the risks and safety protocols of a circular saw to be the same as other power tools they have used. Although this project focussed on novice users, this insight re-enforces the conclusion that perception-based safety improvements should not require the users to read the manual to benefit.

Participants rated how often they noticed and/or complied with safety/warning stickers on power tools. The majority of the Novice Survey Group noticed and complied with warning stickers at least 'sometimes' with only two participants 'rarely' noticing and complying. This suggests novice users are influenced by safety stickers and likely to modify their behaviour accordingly. However, van Duijne et al. (2008) found that only half (5/10) of their study participants complied with warning stickers in practice and 3 out of 10 stated they had never even looked at the warnings. This suggests the self-reported compliance indicated by the online survey participants in this project may be an overestimate not reflected in observed behaviour. Therefore, safety and warning stickers should not be relied upon to influence user behaviour.

The frequency with which the Experienced Survey Group participants noticed and/or complied was lower than the Novice Survey Group. 9 out of 11 participants stated they would notice and comply at least ‘sometimes’, however a significantly lower proportion of participants noticed and complied ‘always’ than in the Novice Survey Group. 2 of the Experienced Survey Group participants stated they would ‘rarely’ notice, and one stated they would ‘never’ comply with warning stickers. This shows a larger disregard for manufacturer safety advice. These participants may have believed they had enough experience with power tools to accurately self-assess the risks. This shows that safety warnings and conscious decision to abide by professional recommendation should not be relied upon to influence experienced users.

Participants were also asked questions requiring written responses. The responses of the Novice and Experienced Survey Groups are detailed in Appendix IV. Both groups correctly identified the blade as the most dangerous part of the tool and all but one participant in each group identified cuts as a prevalent injury. Experienced users were more aware of eye injury and kick-back injuries. Distractions, cleaning, and holding the workpiece by hand were only identified as dangerous by experienced users. Shrapnel, sawdust, and lack of PPE were only identified by novice users. This highlights the difference between novice and experienced users’ assumptions of the hazards of the tool. Experienced users likely based their answers on past experience, whereas novice users made judgements from their experience of general safety procedures.

More mechanisms of injury were identified by the Novice Survey Group than the Experienced Survey Group when considered relative to the population size of each group. This suggests novice users are more conscious of a wider range of injuries, although the likelihood of many of these scenarios is low. This inflated perception of the risk may hinder their use of the circular saw as they may become overly fearful of low probability events or perceive the risk of injury as too high to justify learning how to use the tool.

Safety features were identified at similar rates between the two groups with reasonable accuracy, however some PPE identified was inappropriate for use with a circular saw in both groups. The most prominent of these was the belief that gloves should be worn when using a circular saw. Governing health and safety bodies advise that gloves should not be worn whist working with rotating power tools due to the danger of entanglement (CCOHS, 2025). Although the number of the Experienced Survey Group participants suggesting gloves was low, seventeen out of nineteen of the Novice Survey Group participants stated gloves should be worn. Some other suggestions from novice participants were also less relevant to the specific use of a circular saw (for example, safety trousers or a hard hat) which suggests this group were listing any/all items of PPE related to woodworking, rather than focussing on the circular saw. Using inappropriate PPE could increase their risk level when using the tool and therefore, mitigating this would be beneficial.

Hand Position Data

Figure 12 was presented to survey participant who were asked to state locations on the saw they considered appropriate to hold with each hand (multiple options could be chosen), the results of both the Novice and Experienced Survey Groups are shown in Figure 21. Next, participants were asked to state the location on the saw that they would avoid holding with each hand, the results of this are shown in Figure 22.

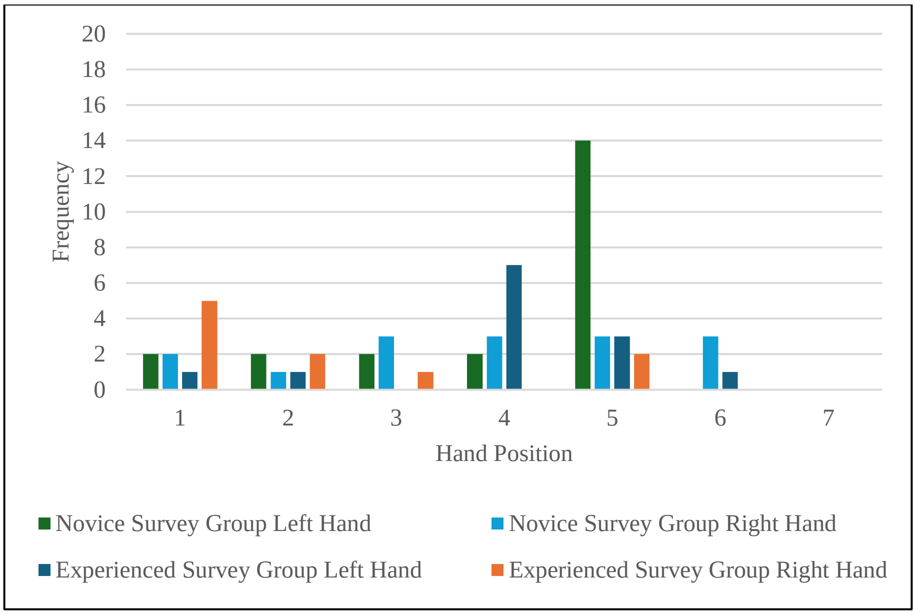

Figure 21: Frequency with which Novice and the Experienced Survey Group participants would prefer placing their hands on the circular saw labelled on Figure 12.

Figure 22: Frequency with which Novice and the Experienced Survey Group participants would avoid placing their hands on the circular saw labelled on figure 12.

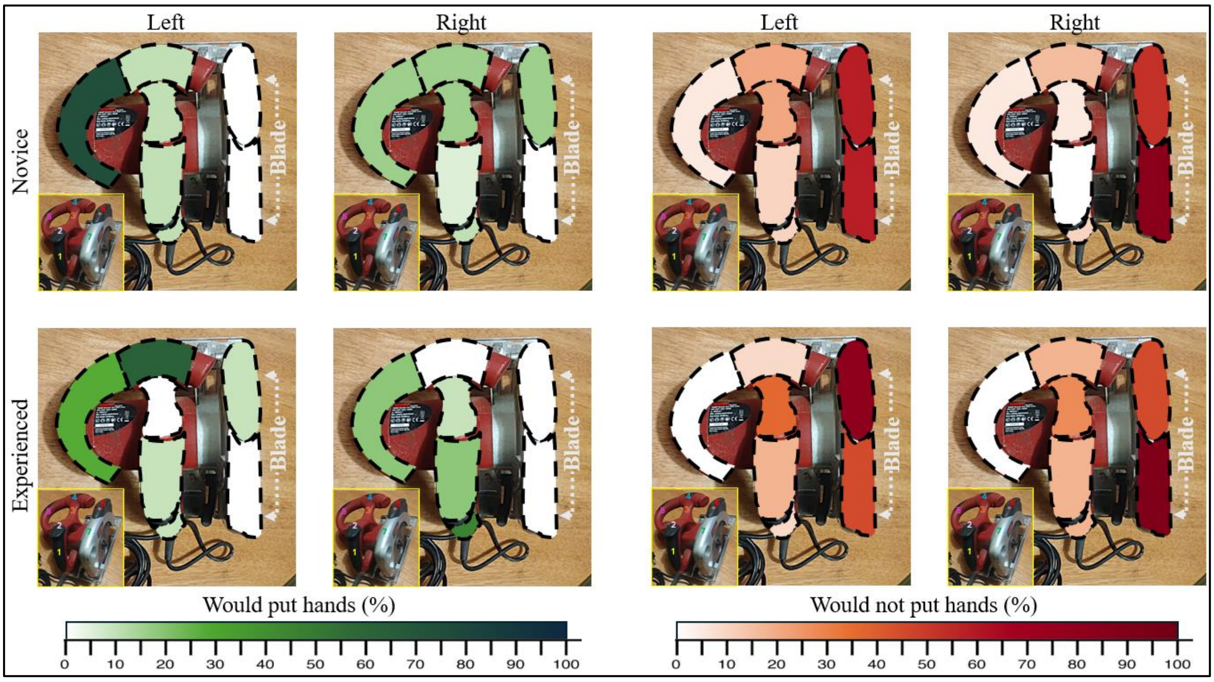

Figure 23: Results of positions novice and experienced participants preferred and avoided placing their hands to operate the circular saw

Areas 4 and 5 were the preferred left-hand locations of both groups. The preferred right-hand location was more varied with the avoidance of area 7 as the only common trend. This contrasts greatly with other test results detailed later in this report which show a strong favouring of area 1 for the right hand. Verbal feedback to the researcher suggested the angle of the circular saw in the photo given in the online survey may have diminished the importance of handle area 1 affecting the validity of this result. Areas 6 and 7 were avoided by both groups, however a small selection stated they may hold area 6. This may be due to its similar appearance to other areas of the saw which are intended as handles. Area 6 is a laser mount above the blade coated in black rubber; it is not intended to be held.

Area 5 was the overall preferred handling position and the least avoided location. In contrast, overall, area 7 was the least preferred location and the most avoided handling position. This indicated that participants' risk perception was strongly influenced by each area's proximity to the blade. This is a reasonable assumption, particularly from novice users who are more likely to be caution around the blade. However, area 5 provided less control over the tool in most applications as is only intended to be used for angled cutting (see user manual in Figure 34 in Appendix V). Area 4 is the intended location of the left-hand and area 1 is the intended location of the right hand. This shows users may benefit from additional guidance on the tool handle encouraging safer handling practices.

Participants were asked to explain their preferred and avoided grip locations. Their responses are shown in Figure 24 and Figure 25.

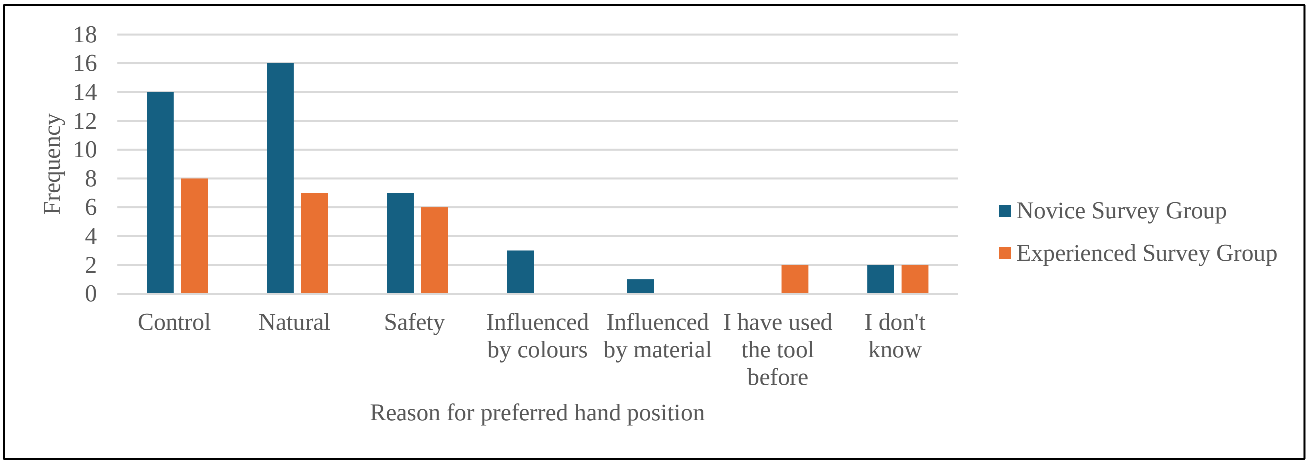

Figure 24: Novice and the Experienced Survey Group participants' reasons for choosing their preferred hand position on the circular saw

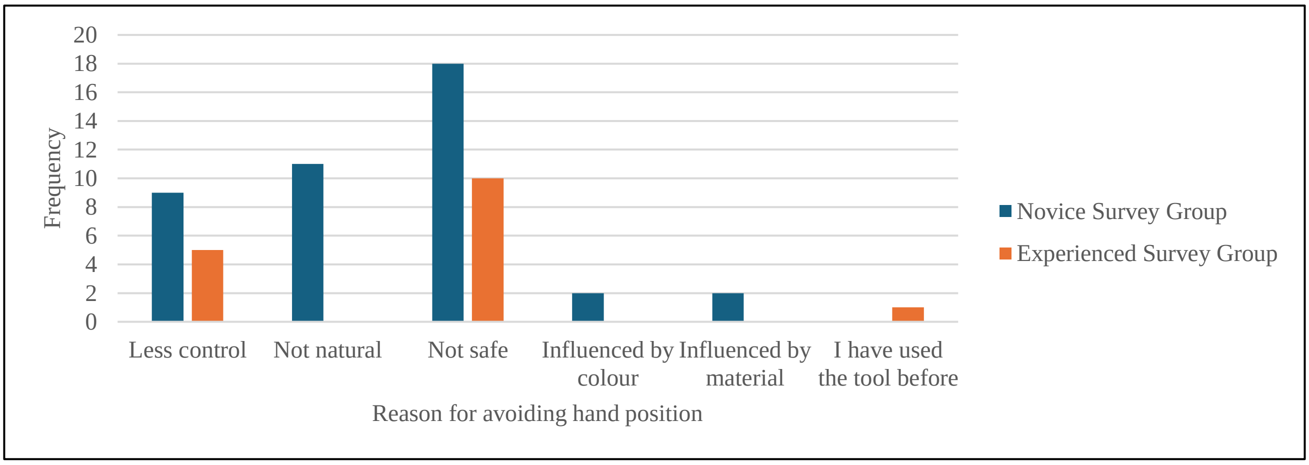

Figure 25: Novice and the Experienced Survey Group participants' reasons for choosing to avoid their specified hand positions on the circular saw

Both groups of participants favoured safety, control, and natural feel when selecting preferred hand positions. The tool colour and material influenced a small number of the Novice Survey Group participants, but did not influence the Experienced Survey Group participants. Both groups identified safety concerns and lack of control as reasons to avoid hand positions, and many Novice participants avoided certain locations due to a less natural feel. This shows participants were predominantly influenced by the practical factors of tool use, as opposed to factors introduced by the manufacture intended to influence the user. The participants' perceptions of the risk posed by each hand position impacted their avoidance of locations more than preference. This suggests that although participants sought to reduce risk by avoiding areas perceived as exceptionally dangerous, they did not prioritise optimising their safety. After disregarding the least safe locations, safety did not remain the primary factor to determine preferred hand position; practicality and comfort became the priority. Since comfort strongly influenced preferred locations, a disruption and redirection of this may be utilised to influence user behaviour.

Grip Comfort Data

Participants rated the comfort of 8 handle grips (of different textures) based on their past experience using similar handles (e.g., on bicycles or scooters). Figure 26 shows grip options and Figure 27 shows the frequency with which the grips were assigned each rank. Figure 28 shows the linear trendline of the ranking results of each grip, a lower line gradient indicates increased perceived comfort. Table 7 shows the overall grip scores for comfort of each grip option.

Figure 26: Handle grips used in online survey[1]

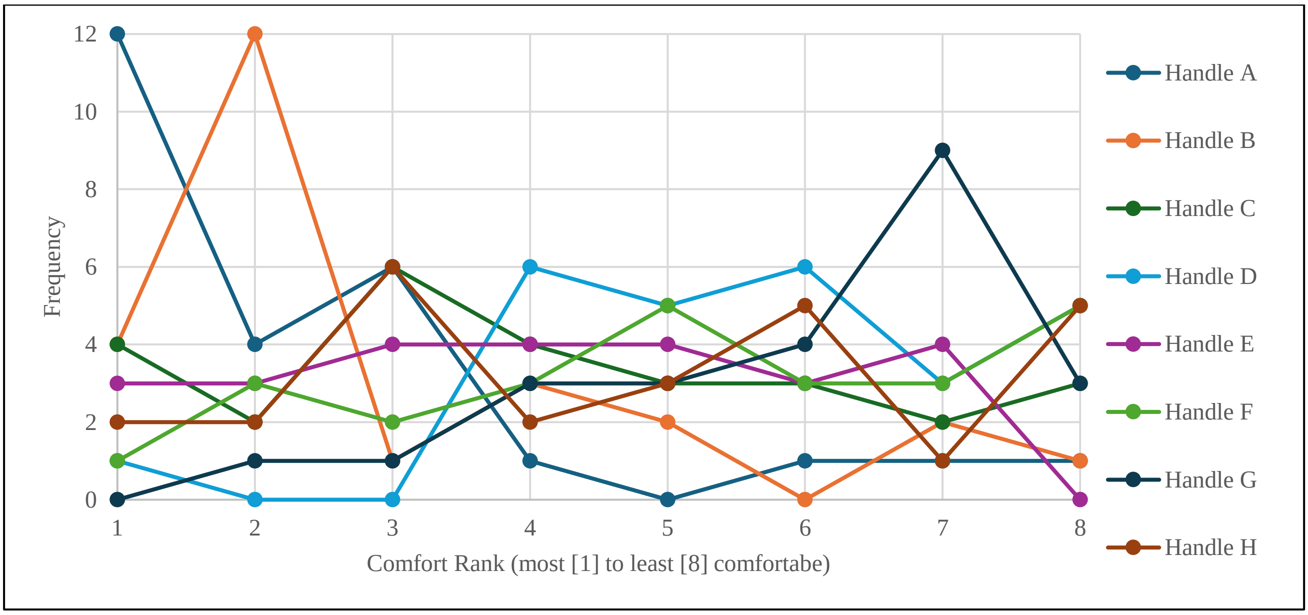

Figure 27: Frequency of given comfort rating of each handle grip

[1] Figure 26 Image references:
Handle C: Discount Scooters (Mobility Spares), 2021
Handle D: DJC Bikes, 2024
Handle H: Made in Britain, 2024
Handles A, B, F, and G: Sinclair and Rush, 2020a
Handle E: Sinclair and Rush, 2020b

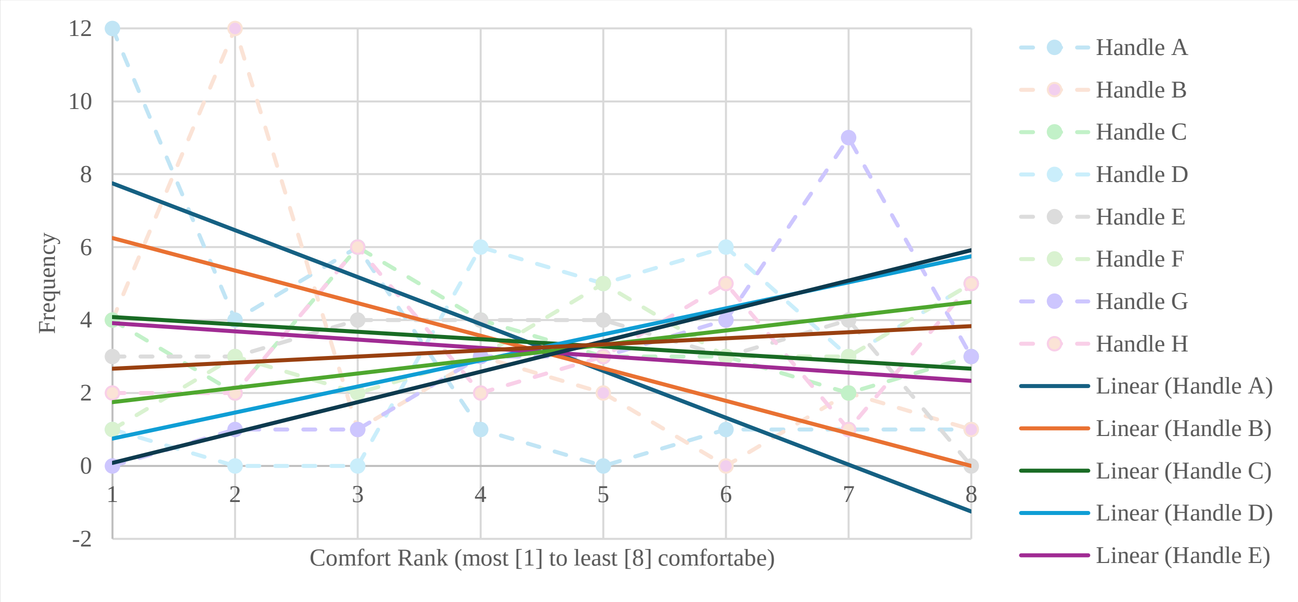

Figure 28: Frequency of given comfort rating of each handle grip overlayed with linear trendline to demonstrate gradient difference

Table 7: the Novice Survey Group and the Experienced Survey Group combined overall grip scores for comfort (lower score correlates to higher comfort level) ordered by comfort level (most to least).

Handle	Score [SUM (ranking*freq.)]
A	63
B	75
E	103
C	113
H	124
F	129
G	143
D	147

Both Figure 28 and Table 7 were used to determine the overall comfort of each texture. In Figure 27 and Figure 28, the frequence with which each handle was given each rank created a trend line demonstrating the popularity of each handle. A handle with a high average comfort level (therefore ranked on average closer to 1st than to 8th) had a lower trendline gradient. A handle with a neutral comfort level had a trendline gradient close to zero and a handle with low comfort had a higher gradient trendline. The results of this evaluation method lead to the following grip comfort rankings (most to least comfortable): A, B, E, C, H, F, D, G.

To correlate this result, an overall ranking score was calculated for each handle by multiplying the frequency of each rank (1 to 8) by its numerical value, then summing these products. Lower total scores indicated higher overall preference. See Table 24 in Appendix 4 for detailed information of the rankings given to each handle. Using this method of evaluation, the handles were ranked in the following order (most to least comfortable): A, B, E, C, H, F, G, D. This is almost identical to the results of the trendline method with only the final two grips (least comfortable) reversed suggesting high validity of both methods.

Handles A, B, and E were selected as the most comfortable grips. These handles are all textured with fine geometry (small dots, dimples, or knurling). Medium comfort handles C and H (4th and 5th) were smooth in texture with large features instead of fine detail. C had capped ends and a rounded mid-section, and H had moulded finger grooves. F and G were both ranked among the three least comfortable, these handles had textures with sharp geometrical edges. Finally, Handle H, a smooth cylinder with no apparent texture or additional geometry, was the lowest scoring grip texture. From these results it was concluded that participants preferred the handles with finely detailed textures and disliked handles with either sharper features or a complete lack of features and smooth surface texture. This test was limited to the visual impact of the grip types as the participants could not interact physically with the handles.

In-depth Circular Saw Interviews Results and Analysis

Six participants from the Novice Survey Group also participated in an In-depth Circular Saw Interview. Twenty-nine questions were presented to the participants. Key ideas extracted from the interview are summarise below.

All participants commented on the weight of the circular saw expressing differing opinions. Most participants agreed the weight of the saw was manageable during use but disagreed on how well the tool was balanced. One participant who thought the tool was not well balanced expressed multiple times throughout the interview that the saw should have a handle on each side of the blade.

All participants agreed the colours of the tool were provided to indicate to the user where to (black) and not to (red) hold the tool. One participant stated that colour was often only used for branding implying they would not always assume colour to indicate holding position. Another participant assumed that the colours only indicated where a bystander should be wary of touching the tool, not the user themselves. This suggests users may not rely on colours to determine where to hold the tool.

Half the participants stated the handle materials had no influence on where to hold, with the exception of the metal parts of the tool which indicated functionality implying they should be avoided. This suggests that, other than for metal, the participants sought no information from the rest of the handle materials. The other half of the participants stated the handle texture implied correct holding locations with 2 out of 3 considering rubber a good grip material. 4 out of 6 participants stated the handle texture (smooth plastic with some hard rubber coating) was comfortable to hold. This contrasts with the finding of Zuo et al. (2016) suggesting comfortable textures were soft, non-shiny, warm, non-sticky, and smooth; the circular saw handle tested only aligned with the final 2 conditions.

The interview participants' preferred hand positions largely aligned with those they selected during the online survey with only the left-handed participant altering their hand position from their online survey responses. This was done to avoid crossing their hands whilst using the tool. Control, comfort, weight distribution, and colour were all cited as factors influencing participants preferred hand positions. One participant identified area 4 as particularly dangerous due to its close proximity to the blade, they expressed this concern many times during the interview. This participant chose to hold area 5 instead as it was further from the blade. This demonstrates the negative impact of exaggerated perceptions of the risks affecting the user's ability to hold the tool with maximum control. 4 out of 6 participants preferred to hold the saw with the blade oriented away from them (as shown in Figure 2) for safety and comfort reasons.

Some features appeared to confuse the participants' judgements of the safety surrounding the saw. For example, one participant expressed concern as the housing vent - which they assumed would heat up during operation – was exposed and could burn them. Another participant stated they may hold area 7 (a highly hazardous area) to increase their control of the saw, however they would avoid putting the hand near the vacuum attachment hole in the guard. They failed to appreciate the danger of holding the guard and placing their fingers very close to the blade, but they chose to avoid the vacuum hole as did not know its purpose. These scenarios suggest more obvious guidance regarding the safety and purpose of different parts of the saw is required.

All participants assumed the blade lock lever was instead to lock the guard in place and uncover the blade. They stated this would be necessary to operate the saw. This demonstrates a dangerous misunderstanding of the function of the blade guard. Upon establishing the level did not lock the guard (through trial and error), 2 of the participants discovered its function of locking the blade and concluded this was necessary for an emergency stop of the blade. They stated the lock should be activated during use of the saw in the event of an emergency. This demonstrates further misunderstanding of the tool's safety functions and highlights an additional hazard that could be created by the user.

Participants also demonstrated insufficient knowledge of safety protocols when describing how to secure the work piece while cutting it. Although all participants suggested clamps to secure the wood to the workbench, 3 out of 6 stated free weights such as kettle bells or plates could be used instead. These would not reliably hold the workpiece in place or prevent movement caused by kickback of the saw. One participant also stated they would use a knee to restrain the workpiece explaining that this could not be considered unsafe as they would keep their body behind the blade. These misjudgements of appropriate securing methods suggest the participants did not understand the mechanisms of injury (e.g., saw recoil or kick back) often caused by a loose workpiece.

Participants identified behaviours they considered risky while using the tool. Moving the saw through the air, not securing the wood, and cutting with any body part in front of the blade were all mentioned by multiple participants. All behaviours suggested by the participants were also identified in the online survey demonstrating a high consistency of responses across data collection methods. The responses were also consistent with literature investigating the most common causes of power tool injury. Judge et al. (2018) found a lack of formal training, inappropriate safety, incorrect hand placement, and unsecured projects to be prevalent risky practices causing power tool injuries. The participants each identified at least one of these causes however lack of formal training was not suggested by any participant as a risk factor. It is likely that the disconnect in time between prior training and active use contributes to the participants' failure to consider this risk. Alternatively, the result may suggest participants do not view formal training as an appropriate risk prevention measure and therefore wouldn't take part in this activity.

To determine to ability of participants to identify potential circular saw injuries, they were asked to list body parts at risk of injury from the saw or the workpiece. These responses were compared to data collected in Singh et al.'s 2024 study detailing injuries caused by power tools. All 6 participants identified the injury potential of hands and fingers aligning with the study findings that hands and fingers accounted for 58.27% of bodily injuries. In contrast, the arms were only suggested by one participant, but Singh et al. (2024) found the arms (upper and lower combined) to be the second most prevalent location of injury (20.04%). The feet were not mentioned by as a notable location of injury in the study, however 4 out of 6 interview participants identified the feet as an area at risk. These results show that participants have a broad understanding of potential injury locations from power tools but lack the ability to accurately judge the risks posed. This could lead to the use of inappropriate precautions – such as incorrect PPE - that hinder safe tool use as opposed to improving it.

Many sources of insufficient or inappropriate safety were revealed from interviewing the participants. The majority of these problems (such as safe hand positions, blade lock function, and necessary PPE) are mentioned and corrected in the tool instruction manual which the participants did not have access to. However, as seen in the online survey, over one quarter of novice users would not read the manual before using the circular saw for the first time. This suggests these users are liable to make one of the mistakes encountered by the interview participants and compromise their safety. Therefore, the risks mentioned should be mitigated where possible by features which require minimal user engagement with manufacturer instructions.

Texture Recognition Test Results and Analysis

Participants were asked to determine two different textures on the surface of a tile and identify the shape they created. Table 8 quantifies the percentage of time each texture was correctly identified overall (regardless of which other texture was present on the tile). This shows the ease with which textures could be identify when not visible. Table 9 specifies which textures were successfully identified when compared to each other on the same tile, and Table 10 specifies how often the shape on the tile was identified for each texture combination. These results informed the distinguishability of each pair of textures. This provided insight into the best textures to alert the user of a power tool to their hand straying away from a designated grip.

Table 8: Texture recognition test: Percentage of times each texture was correctly identified

Texture	% Correctly identified
Dots	85.42%
Lines	95.83%
Squares	58.33%
Knurl	66.67%
Smooth	97.92%

Table 9: Texture Differentiation Text: Number of Times (out of 12) each combination of textures was correctly identified

Textures	Dots	Lines	Squares	Knurl	None/Smooth
Dots	-	10	6	8	10
Lines	10	-	2	5	12
Squares	6	2	-	9	9
Knurl	8	5	9	-	9
Smooth	10	12	9	9	-

Table 10: Texture Differentiation Text: Number of Times (out of 12) each tile's shape was correctly identified

Texture	Dots	Lines	Squares	Knurl	None/Smooth
Dots	-	10	6	9	11
Lines	10	-	8	8	11
Squares	6	8	-	9	12
Knurl	9	8	9	-	12
Smooth	11	11	12	12	-

Table 8 shows that the most identifiable textures were Smooth and Lines, and the least identifiable were Squares and Knurl. Table 9 suggests the most distinguishable combination of textures was 'Lines and Smooth'. 'Lines and Dots' and 'Dots and Lines' were also commonly distinguishable from each other. The least distinguishable combinations were 'Squares and Lines', 'Knurl and Lines', and 'Squares and Dots'. Table 10 produced similar results. The data in Table 10 suggests the Smooth texture was highly distinguishable from all other textures as the shape on the tile was correctly identified the vast majority of the time. Table 10 also shows 'Line and Dots' to be a highly distinguishable combination, and only 'Squares and Dots' scored particularly lowly. Overall (from the results of both Table 9 and Table 10), Smooth, Dots, and Lines were the most successful distinguishable textures (in descending order). Considering the results presented in Table 8, this outcome suggests that either 'Smooth and Lines' or 'Lines and Dots' textures should be used to maximise both differentiability and recognisability of the texture of the handle.

Texture Influence Test Results and Analysis

Participants held the circular saw mock-up in the locations they felt most comfortable and natural whist mimicking its active use. The power tool was obscured from the participants' views as seen in Figure 9. The positions the participants chose to put their left and right hands were initially recorded with all the grips Smooth to mimic the target circular saw handle. These grips were then changed for alternate grip textures any changes in hand position to either avoid or contact the grips was recorded in Table 11. Additional comments made by participants regarding their opinions of the textures were also recorded and used to inform the conclusions of this test.

Table 11: Texture Influence Test Results for Left hand (Left) and Right hand (Right) separately

Left Hand			
Texture	**No. times texture is preferred**	**No. time texture is avoided**	**No. times texture has no impact on hold position**
Dots	4	3	1
Lines	1	1	6
Squares	1	3	4
Knurl	2	1	5

Right Hand			
Texture	**No. times texture is preferred**	**No. time texture is avoided**	**No. times texture has no impact on hold position**
Dots	0	1	7
Lines	0	1	7
Squares	0	0	8
Knurl	0	0	8

Dots evoked the highest number of reactions from the participants; however, opinions were divided as to preferring or avoiding this texture. Some participants found the Dots comfortable to hold but others disagreed and stated the Dots were uncomfortable indicating the grip should not be held. This result was compared to the Grip Comfort Data: Dots were present on handles A and B, which ranked 1st and 2nd for comfort in the survey. That result was more decisive than found in this test where participants physically interacted with the textures. Handles A and B in the Grip Comfort Data were shaped as well as textured and had smaller Dots than presented in this test which may have impacted the results. This indicated that despite conflicting opinions regarding the comfort of Dots, the presence of a moulded handle positively outweighs the discomfort this texture may cause.

The Lines texture did not often evoke a reaction to change the participants hand positions. However, Lines was one of only two textures to encourage one participant to move their right hand away from handle 1. Due to its rarity, this choice of movement was considered an extreme negative reaction to Lines. However, comments about Lines were divided with some participants regarding the texture as comfortable and grippy and other finding the protruding lines uncomfortable. In the Grip Comfort Data, Lines scored lowly (6th/8) indicating although participants had limited reactions to feeling the texture, it is visually unappealing. It should be noted that the Lines in the Grip Comfort Data were thinner than those in this test and they were placed in a perpendicular orientation.

The Squares texture more often evoked a negative reaction than positive with only 1 participant stating this handle felt 'good and grippy'. In contrast, most participants had no reaction to the Knurled texture although 1 more person preferred it than avoided it. 1 participant stated it was 'grippy but uncomfortably spikey'. These results loosely align with those found in the Grip Comfort Data as Squares scored lowly (7th/8) and Knurl scored relatively highly (3rd/8). The textures used in the Texture Influence Test closely resembled those given to participants in the Grip Comfort Data (Figure 26) in both size and shape improving the correlation of these results.

From comments provided by the participants throughout the test, it was determined that they associated discomfort with an indication to avoid an area, whereas comfortable and 'grippy' textures facilitated holding.

Prototype Testing Results and Analysis

From the previous testing conducted for this project, the following prototype texture and colours where chosen for further testing:

- Body and areas not intended as handles: Glossy red with Lines texture.
- Intended handle areas: Matte black with Smooth OR Lines texture.
- Handle texture combination variations: 'Smooth and Lines', and 'Dots and Lines'

Data collected in previous tests was used as a control for this study. Due to limited availability of test pieces and participants, varying numbers of results were collected for each test and texture. The participant attendance of each stage of this test is detailed in Table 12. Table 13 summarises the success of the original tool and test piece handles (with all grips smooth) to guide the users' hands to the correct locations (left hand on area 4 and right hand on area 1). The percentage of times each texture produced the correct hand position result was calculated for each test and summarised in Table 14. The number of participants available for each test has also been noted due to its impact on the significance and validity of the results. The percentage of participants who correctly identified the handles for only Smooth or Dot texture, or was correct in both cases, is shown in Table 15 to determine which texture positively influenced holding location more effectively.

Table 12: The number of participants results recorded for each test and texture

Test	Smooth and Lines	Dots and Lines	Total Number of Participants in Test
Blind	23	16	23
Monochrome	23	16	23
Colour	9	7	9
Total Number of Participants Testing Textures	32	25	

Table 13: Success of participants' hand placements in control studies

Test Conducted	Total Number of Participants	Correct Left Hand (%)	Correct Right Hand (%)
Online survey responses containing correct answers (novice participants)	19	10.53%	10.53%
Online survey responses containing correct answers (experienced participants)	11	63.64%	45.45%
In-depth interviews (all novice participants)	6	50.00%	50.00%
Texture influence test (all novice participants)	8	12.50%	100%
Novice Average %	33	24.34%	53.651%
Experienced Average %	11	63.64%	45.45%
Total Average %	44	34.17%	51.50%
Average (novice) excluding the online survey %	14	31.25%	75%

Table 14: Prototype testing results

Test	Handle Texture	Total Number of Participants	Correct Left hand (%)	Correct Right Hand (%)
Blind	Smooth and Lines	23	30.43%	100%
	Dots and Lines	16	43.75%	100%
Monochrome	Smooth and Lines	23	52.17%	100%
	Dots and Lines	16	62.50%	100%
Colour	Smooth and Lines	9	55.56%	100%
	Dots and Lines	7	71.43%	100%

Table 15: Correct hand position results per texture per test

Test	Only correct response with Smooth and Lines texture (%)	Only correct response with Dots and Lines texture (%)	Both Smooth and Lines, and Dot and Lines textures correct (%)
Blind	12.50%	25.00%	18.75%
Monochrome	6.25%	18.75%	43.75%
Colour	0.00%	14.29%	28.57%

Excluding the online survey results for the right hand (as participants were more likely to overlook area 1 due to the angle of the presented photo), only 75% of participants identified area 1 as the correct right-hand location. In contrast, prototype testing produced perfect right-hand results suggesting the addition of textures allowed easier location of this handle. In regard to the left hand, when interacting with the original tool an average of 31.25% of novice users located the correct handle. This is a similar result to participants who interacted with the prototype in the blind 'Smooth and Lines' test (30.43%), but less than all other sections of prototype testing. When the 'Dots and Lines' texture was applied to the circular saw handle with a monochrome colour, participant recognition of the safe holding areas of the tool improved by 31.25%. This suggests that (when visible) both 'Smooth and Lines' and 'Dots and Lines' were an improvement over the original handle's all smooth texture. The users were successfully influenced to select their hand position based on passive factors designed to reduce user risk.

The correct location of the left-hand increased with the level of sensory information provided and, across all 3 tests, the 'Dots and Lines' texture combination produced more correct results than 'Smooth and Lines' (Table 14). The results collated in Table 15 re-enforce this; participants who only selected the correct result with one of the two textures were consistently more successful with Dots than Smooth texture. This suggests participants preferred 'Dots and Lines' over 'Smooth and Lines' showing Dots positively affected the hand positions of the user. 78.26% of participants (18/23) kept the same hand positions between blind and monochrome testing when interacting with the Smooth handles, and 68.75% (11/16) did so when interacting with the Dots handles. Due to the small number of participants in each group, these results were not considered to be significantly different and seeing the texture after the blind test had an equivalent effect for each texture on the actions of the users.

The colour prototype was presented to fewer than half the participants of the blind and monochrome studies. This was due to time and resource constraints and limits the result validity from this section. From the data collected, the addition of colour to the 'Smooth and Lines' texture did not significantly improve the participants handle selection, but there was a small improvement from the 'Dots and Lines' texture (10/16 increased to 5/7). This result should be investigated further with a larger popular of users to identify a definitive trend and draw conclusions. When both 'Dots and Lines' texture and red and black colour was applied to the circular saw handle, participant recognition of the appropriate gripping areas on the tool improved by 40.18%.

Participants also provided verbal feedback justifying their hand placements. As predicted by the findings of Wexner (1954) and Williams and Noyes (2007), the colours red and black correctly implied the intended holding positions (Figure 29). Two participants noted the matte black paint on the handles resembled rubber (in contrast to shiny red paint) which implied correct gripping area. Participants were divided over which texture suggested the correct holding area. 1 participant believed the Lines texture (not to be held) was indicative of holding while 1 voiced the opposite opinion. The remaining 31 participants did not comment on the Lines texture. This suggests Lines did not evoke a strong reaction regarding handleability. However, this neutral result was an improvement over the original smooth texture of the handle (on areas not to be held) as 2 participants stated smooth texture implied an area should be held. Dots were considered the least comfortable texture to hold as 3 participants noted discomfort; however, all of these participants chose to hold the area with Dots despite their discomfort. This shows other factors such as the colour and position of the handles may override the user's discomfort. The selection of Dots regardless of their comfort may also be caused by the belief they are grippier than the other textures on the saw (as observed by 3 participants). Other notable feedback results include the importance of geometry regardless of texture or colour, and the need for all intended handles to feature the same texture and colour.

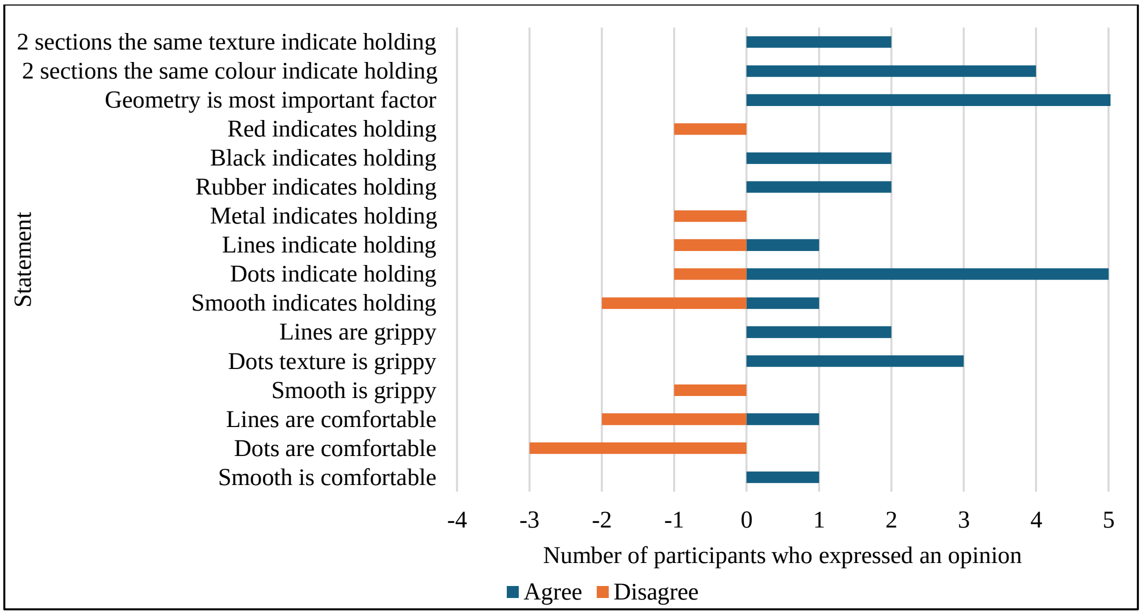

Figure 29: Verbal feedback provided during prototype testing

The prototype testing involved low and varied numbers of participants which limits its validity. These results should be used to inform and encourage the repetition of the experiments on a larger scale in order to definitively determine the optimal textures and colours of the handle. Additional colours and textures could also be explored for their influence on user behaviour; however, the results of this study can be used to design an initial prototype for a safer circular saw catering to users' perceptions of risk.

Discussion

A combination of existing literature findings and first-hand testing were used to inform the resulting prototype of this study. Due to the prevalence of power saw injuries found by Loisel et al. (2014) and Judge et al. (2018), this project focussed on improving the safety of a power saw. A circular saw was selected as this tool is portable and can be obtained in consumer hardware stores at budget prices making it an attractive and accessible power tool for novice users. Novice users were the target group of this project due to the prevalence of injury during DIY (Jain et al., 2023) which is often the only setting in which a novice user will have used power tools. Due to their limited knowledge of power tool use and safety, novice users may be injured through ignorance of the dangers posed by power tools and subsequently employ insufficient safety precautions or dangerous behaviours. Conversely, experienced users may instead sustain injuries due to complacency or wilfully engaging in risky behaviour. As they are not the focus of this project, methods of influencing the behaviour of experienced users were not explored in this report however future research may be conducted to inform this topic.

Incorrect hand placement (Judge et al., 2018) and atypical hand position (Frank et al., 2010) cause many power tool injuries suggesting safety could be improved with more robust handling guidance for users. This concern was further explored with primary research including, the Online Power Tool Usage Survey and In-depth Circular Saw Interviews. Participants largely agreed handle area 1 (Figure 12) should be held in the right hand which aligns with the manufacture's recommendations. However, the position of the left hand on the saw was more varied with participants generally preferring to hold the areas further away from the blade as depicted in Figure 23. This was against the manufacturer's recommendations as the position provided less control of the tool. As incorrect hand position decreases user safety, correcting this behaviour may reduce injury rates. Lapes in concentration (Judge et al., 2018) and distraction of attention (Frank et al., 2010) were also identified as risk factors suggesting injured users were looking away from the tool or workpiece when the incident occurred. Therefore, safety measures to influence user behaviour must not rely on visual factors. As a result, texture was identified as the key variable for investigation in this project. Although textures may not address all causes of injury during power tool use, this method should be studied due to its versatility of application to various tools with minimal impact on function and cost.

Textures were considered useful to mitigate errors from lapses in concentration causing the user to deviate their hand from a safe area. The user would be alerted by the change in texture and encouraged to re-focus on the saw and correct their grip. Participants revealed that the texture of area 1 should indicate the other intended gripping areas as the location of the trigger mechanism makes it clearly identifiable as a handle. This prompted the decision for only two textures to be present on the tool handle, one preferred texture covering the intended grips (areas 1 and 4), and one covering the non-gripping areas of the tool. The textures tested for their influence on user behaviour included Smooth, Dots, Lines, Squares, and Knurl.

The entry level circular saw adapted during this project had a unique handle shape (Figure 30) presenting more holding possibilities than most circular saws. This was exploited to investigate how users may hold the tool differently based on different variables and draw insights applicable to other handle shapes. In the instruction manual, only two areas of the handle are designated for normal use (the main and front handles – areas 1 and 4), and the curved section (area 5) is designated for operating the saw at an angle (Figure 30). However, many participants tested held the curved section prompting the testing of the ability of different methods to guide the user's hands to the correct areas.

A total of 42 participants engaged in experiments in-person (excluding additional online survey participants) completing up to 2 of the tests each. The majority of these participants (36/42) studied at the University of Bath in a stem field for degrees ranging from undergraduate to PhD. The remaining 6 participants interviewed were professionals. This limits the applicability of the results to a narrow demographic and age range, highlighting the need for testing to be repeated with larger more diverse populations to validate the results. Nevertheless, the findings of this study remain valuable in providing preliminary insights into the influence of texture on user behaviour and risk perception.

Testing revealed that overall, geometric textures were more often avoided (10 times) in favour of the smooth base texture than they were preferred (8 times). This suggested that Smooth is the generally preferred surface texture of a power tool handle when presented with physical options. However, this conflicted with the Grip Comfort Data which suggested smooth handles appeared less comfortable to users than textured ones. There was also concern that Smooth handles may appear neutral to the user when surround by textured areas causing them to assume the existence of a texture must indicate an area should be held. Therefore, Smooth and Dots received additional testing on the prototype to determined which was more effective at guiding the users' hands to the intended grip locations. The results suggested the application of Dots texture to intended gripping areas of the circular saw handle was optimal to positively influencing hand placement, potentially improving user safety through the elimination of atypical hand positions.

In most tests, Lines were largely ineffectual to participant holding preferences; however, one participant was so affected by this texture, they moved their right hand away from area 1 which was considered an extreme reaction. In addition, the Grip Comfort Data suggested when viewing the tool prior to operation, participants assumed the Lines to be uncomfortable to hold. 'Smooth and Lines' were the 2 most recognisable textures in the experiments, closely followed by 'Dots and Lines', and both combinations were highly distinguishable. 1 participant noted that the presence of 2 textured surfaces ('Dots and Lines') made it difficult to determine which texture was indicative of holding. This problem was not present with 'Smooth and Lines' as the Smooth surface was not textured, however participants were also divided as to whether the Smooth area was indicative of holding or not. Ultimately, the testing concluded that Dots were more commonly associated with gripping than Smooth, so 'Dots and Lines' was selected as the texture combination of the final circular saw handle. The goal these textures was to increase the user's perceived risk of holding the Lines textured areas and decrease the perceived risk of holding the areas with Dots. This would influence users' behaviour to prefer holding the areas which are designated as safe by the manufacturer.

The testing conducted was restricted to only 5 textures (including Smooth). This study shows that textures of a handle are useful to influence user behaviour suggesting benefit from an expanded study to identify specific features of a texture preferable or undesirable to hold (for example, shape or sharpness). In tests with multiple textures to be identified (e.g., the texture differentiation test) participants may have improved their ability to differentiate or recognise textures throughout the test due to increased familiarity with them. This was mitigated by presenting the test pieces in a different randomised order for each participant. This method was deemed sufficient for the preliminary testing conducted in this project. To maintain the texture focus of the tests, all test textures were 3D printed in the same plastic to allow for consistent surface roughness. In future studies, different materials should be tested (e.g. rubber or fabric) to inform the effect of surface material on holding preferences.

This study failed to consider the active user experience of holding each texture. Although participants were instructed to hold the tool and push it as though cutting wood on the edge of a table (for tests involving the saw mock-up or prototype), this action did not sufficiently emulate the forces required to use to tool. In addition, circular saws vibrate during use which was not considered by participants when commenting on the influence of each texture. This may have effected control and comfort related results. To mitigate this omission in future testing, the participants should complete the tests while the saw is actively in use with additional safety procedures in place (e.g. a fake blade) for their protection. This would require additional time and resources which were not available during this initial concept study.

The real-world hazards posed by the circular saw were also absent during texture and prototype testing. This was to ensure the participants' safety but may have affected the test results. Although participants were instructed to behave as though the blade was in use, participants ultimately felt safe while handling the tool possibly causing them to neglect safety factors in favour of comfort. This error was difficult to identify as it relied upon participants' self-assessments of their actions and understanding of the situation presented to them. Inconsistencies in the understanding of how the circular saw functioned could have led to over- or under-representation of safe behaviour. The results were nevertheless still useful as participants who underestimated the safety required when operating the saw observed a lower perception of risk implying a correction to their behaviour would be particularly beneficial to their safety.

Based on the results of Zuo et al. (2016), non-gripping handle areas were made of shiny hard plastic and ideal grip locations were made to appear softer with matte paint. The addition of rubber should be included in further testing as participants commented that this material would be indicative of gripping. All interview participants and many prototype study participants recognised the influence of the colours on the tool. This aligned with the findings of Williams and Noyes (2007) and Wexner (1954) who demonstrated a correlation between risk perception and colour. Therefore, colour was used on the prototype as a secondary measure of influencing user behaviour. Red was used to suggest hand positions to avoid, and black was used for areas that should be held.

The test results in this project culminated in the handle prototype pictured in Figure 31. This prototype should be rigorously tested and optimised for maximum effect on user behaviour. Due to participant feedback regarding the discomfort of the dots (described as 'spikey'), the final prototype featured wider, less protruding dot features than the test piece used in prototype testing to reduce their perceived sharpness. Only the metal components of the original circular saw were used in the final model with the plastic components adapted and replaced by 3D printed parts. These parts were filled, sanded, glued, and painted to closely match the original saw handle's production quality. The original motor was inserted into the printed motor housing and additional weight was added around it (with sand-cement mix) to replicate the mass and balance of the original saw. These factors all contribute to the user's perception of the prototype encouraging a more accurate representation of their risk perception. A functional prototype would increase this further; however, the resources were not available to produce this in the time frame of the project.

Future testing must be conducting with due regard for participants' safety. Initial testing should be conducted in a controlled environment supervised by professionals. A range of demographics should be tested to expand the research of this study including older, less mobile, and left-handed participants. This would expand the population able to benefit from the enhanced power tool safety.

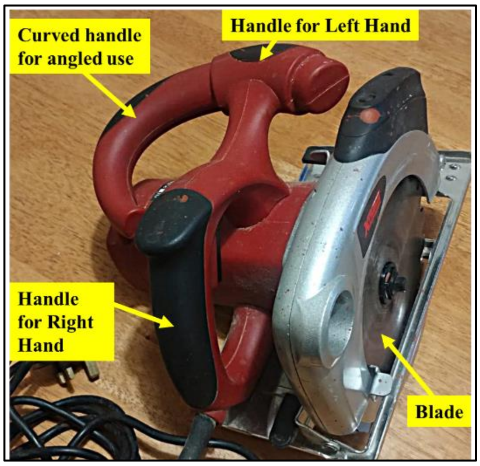

Figure 30: Circular saw with manufacturer's recommended hand positions and blade labelled

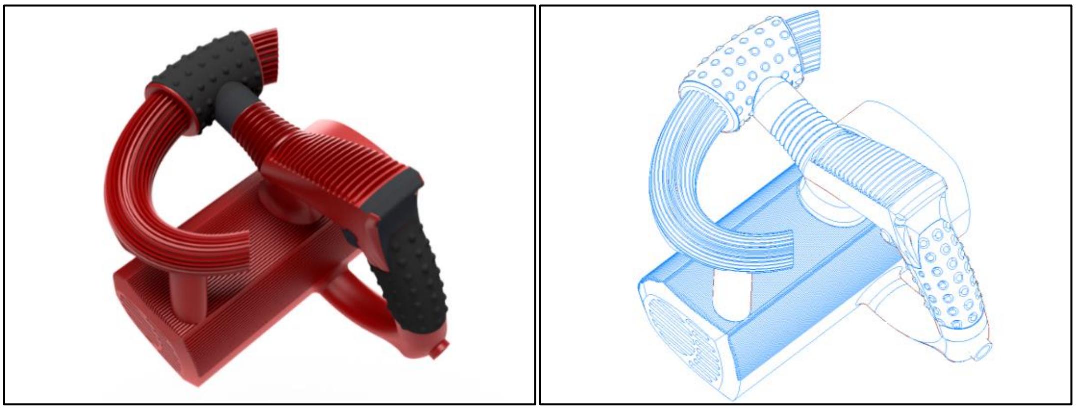

Figure 31: CAD render (left) and wireframe drawing (right) of the final circular saw prototype handle

Conclusions

This project proposed the application of textured to power tool handles to calibrate users' perceptions of risk and influence their behaviour. Novice circular saws users were identified as a key target group due to the high rate and severity of injuries. Testing concluded that applying textures to a circular saw handle influenced user grip location and behaviour, with the potential to improve safety by reducing risk. The study found handles with a Dot texture were perceived as indicative of intended grip areas and preferred by users, while Line texture discouraged gripping in unsafe locations. Colour was also found to enhance user perception of the safety, with black indicating intended holding locations and red indicated unsafe areas.

This study was limited by a narrow demographic of testing participants and boarder testing should be conducted to validate the results across diverse user groups. Furthermore, the hazards of real-world circular saw use were not adequately represented during the prototype testing, such as operational forces and vibration. Although the data is still valuable to determine users' assumptions and initial interpretations of various textures, further testing should simulate the working function of the circular saw. Overall, this preliminary proof-of-concept study suggests that textured and colour-coded handles can effectively influence safer user behaviour. Further research is recommended to optimise this approach and evaluate its impact in more realistic operating conditions. Once applied successfully to circular saws, the finding of this projects may be adapted to also benefit and increase the safety of other power tools.

Future work

To further develop this work, more extensive testing should be done using the prototype to enforce the accuracy of the data collected during the project. The prototype should be directly compared with the original circular saw to prove causation of the grip texture affecting the user's hand position. To broaden the project, additional textures or texture layouts should also be explored. This would allow for an optimised balance between behaviour influence and ease of manufacture. Further investigation into the influence of the colour of power tool handles on risk perception would also be a valuable addition to this research. This data could be compared to existing, more general studies discussing the effect of colour on risk perception to formulate an ideal power tool colour scheme that improves user safety. The material of the handle may also be investigated in the same manor to inform design from a risk perception perspective.

As previously mentioned, the power tool handle central to this project was chosen to allow for versatile testing to inform the design of a wider range of applications. Work should be conducted to determine other power tools and machines that may benefit from additional handle texture suggested in this report. Tools with high a severity of injuries would benefit most and should be prioritised. Since many power tool manufactures produce a wide range of tools, once optimised handle textures are applied to an OEMs most hazardous tools, the same design modifications can be extended to other products as manufacturing capability increases.

Production feasibility should be explored regarding adding texture to existing handle geometries. In order to be marketable to OEMs, adaptations to current handle design should have minimal impact on manufacturability. Any financial impact the design change has on the sale of the tool should be compensated by an expansion of marketing capabilities towards safety conscious novice users. To enable this, research should be conducted to determine a balance between behaviour influence effectiveness and cost. Targeted user groups should be consulted, and the specific tool of interest should be the focus of the experiment. The textures applied to existing power tool handles should also be tested for their structural integrity and longevity in high force and vibrational situations. This is paramount to ensuring users safety is maintained as a handle which fractures during use may itself cause injury or cause a loss of control of the power tool potentially leading to sever injury.

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Appendices

Appendix I: Online Power Tool Usage Survey Questions

1. What is your age?
2. What handedness are you?
3. What is your gender?
4. Which of the following best describes how often do you use power tools? (e.g., powered: drill, sander, saw, etc)
5. In which settings have you used power tools? [At work] [DIY at home] [DIY at someone else's home] [Hobby]
6. Have you used a handheld circular saw before?
7. *[Participants who have used a circular saw before]* How many times have you used a circular saw?
8. *[Participants who have used a circular saw before*] How (if any) did you conduct research into how to use a circular saw safely (or at all) before using one? (tick all that apply)
9. *[Participants who have used a circular saw before]* Did you read the instruction manual before using the circular saw?
10. *[Participants who have used a circular saw before]* Do you notice and comply with safety/warning stickers on power tools? [I notice safety/warning stickers] [I comply with safety/warning stickers]
11. *[Participants who have not used a circular saw before]* How (if any) would you conduct research into how to use a circular saw safely (or at all) before using one? (tick all that apply)
12. *[Participants who have not used a circular saw before]* Would you read the instruction manual before using the circular saw?
13. *[Participants who have not used a circular saw before]* Do you notice and comply with safety/warning stickers on power tools? [I notice safety/warning stickers] [I comply with safety/warning stickers]
14. What is the most dangerous part of a circular saw? Also list any other parts that may be considered dangerous.
15. How might that part of the tool injury you?
16. During which activities could this part of the tool injure you? Lists many as you can think of.
17. Might this part of the tool injure other people? How?
18. What action from the user might increase the risk of injury?
19. What safety features are currently on the tool to mitigate the risk of injury from this part of the power tool?
20. What PPE would you use to protect from injury from any part of the circular saw?
21. Could the workpiece (the wood you are working on) cause the user any injury whilst it is being cut by the circular saw? If yes, how could the workpiece cause the user injury?
22. How could the user prevent injury from the workpiece?
23. What methods can be used to hold the workpiece still whilst using the circular saw on it?
24. Where would you place your hands to hold and control this circular saw while using it (in reference to Figure 1)? [Left Hand] [Right Hand]
25. Why have you chosen the option above? Tick all that apply.
26. Where would you avoid placing your hands to hold and control this circular saw while using it (in reference to Figure 12? [Left Hand] [Right Hand]
27. Why have you chosen the option above? Tick all that apply.
28. Rank the following grips in terms of comfort level based on your past life experience (in reference to Figure 26). [A] [B] [C] [D] [E] [F] [G] [H]
29. What injuries may be associated with cleaning the circular saw blade?
30. How can injuries whilst cleaning the blade be avoided? What precautions can be implemented?

Appendix II: In-depth Circular Saw Interview Questions

1. Age
2. Height
3. Handedness
4. Gender
5. Power tool experience
6. Circular saw experience
7. Please give your initial opinions about the saw and how it feels to hold.
8. Would you wear any PPE whilst using this tool?
9. Would you be safer wearing these gloves whilst using the tool?
10. Might there be any issues with wearing gloves whilst using the tool?
11. Do you think colours are supposed to indicate anything?
12. Do you think the varying material is supposed to indicated anything?
13. Where would you place your hands to use this circular saw? Please demonstrate. (Cutting with the blade close to you.)
14. Why have you put your hands where you have?
15. Is there any scenario when you would hold the saw in a different way? (Cutting with the blade away from you?)
16. How would you turn the saw on? (Saw is not connected to power.)
17. Where would you keep your hands away from whilst using the saw? Why?
18. Would this saw ever need cleaning?
19. How would you approach cleaning the blade safely?
20. (Point out the two levers and push lever on the saw.) What do these levers do?
21. What does this third push lever do?
22. Why might you need to lock the blade in place?
23. With a piece of card as a work piece on the edge of the table. Imagine this piece of card is the work piece. How would you secure the work piece and hold the saw to begin cutting?
24. Please demonstrate how you would cut the workpiece.
25. Are there any other ways you could secure the workpiece?
26. Are there any other ways you could hold the saw?
27. Is the way you are currently using the saw dangerous?
28. Do you like the placement of the handles on the saw? Could the placement be improved?
29. What do you think about the texture of the handles? Is it comfortable? Does it help indicate where you should hold the saw?
30. What risky behaviours might lead to injury with the saw?
31. How would you avoid these behaviours?
32. Would you avoid these behaviours?
33. What parts of you might be injured by the saw or workpiece? How?
34. How could blade become damaged?
35. How could blade be damaged after a drop?
36. Additional comments?
37. Additional information provided while discussing survey answers.

Appendix III: Texture recognition test Tile Example Technical Drawings

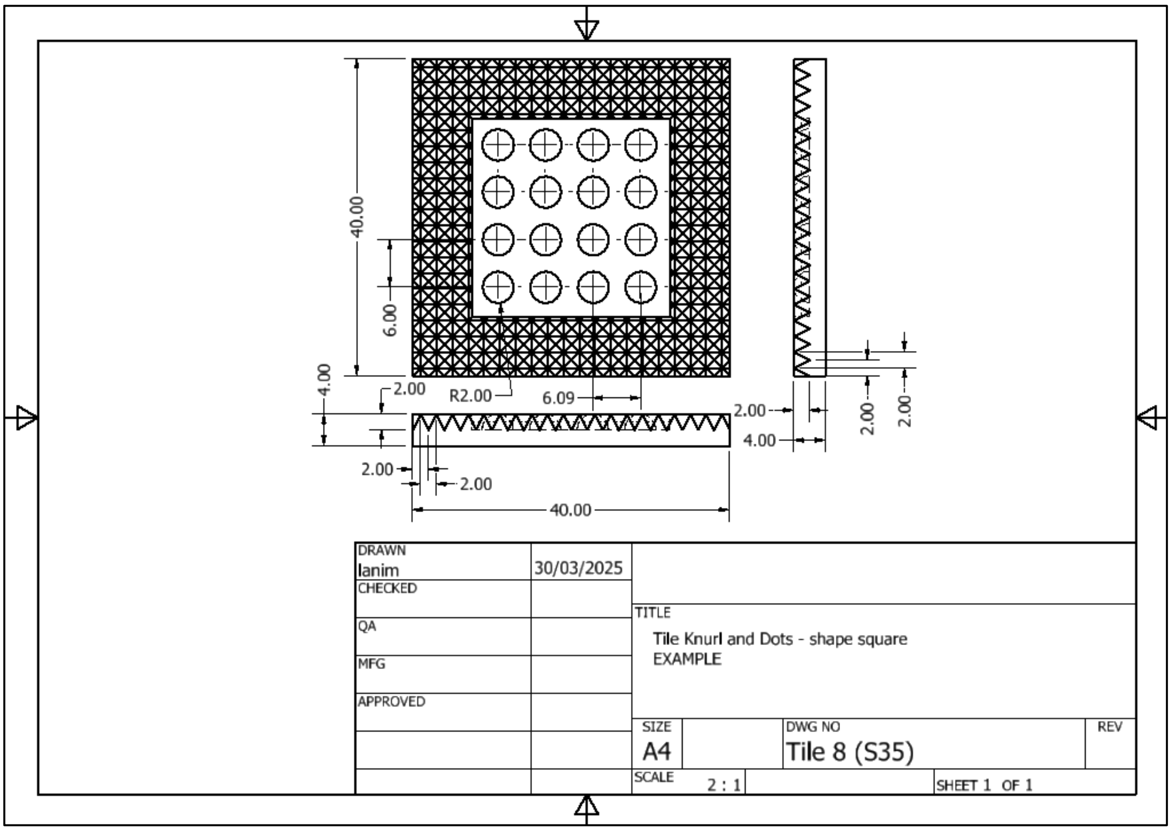


Figure 32: Tile Differentiation Test: Tile with knurl and dots in square shape Technical Drawing Example.

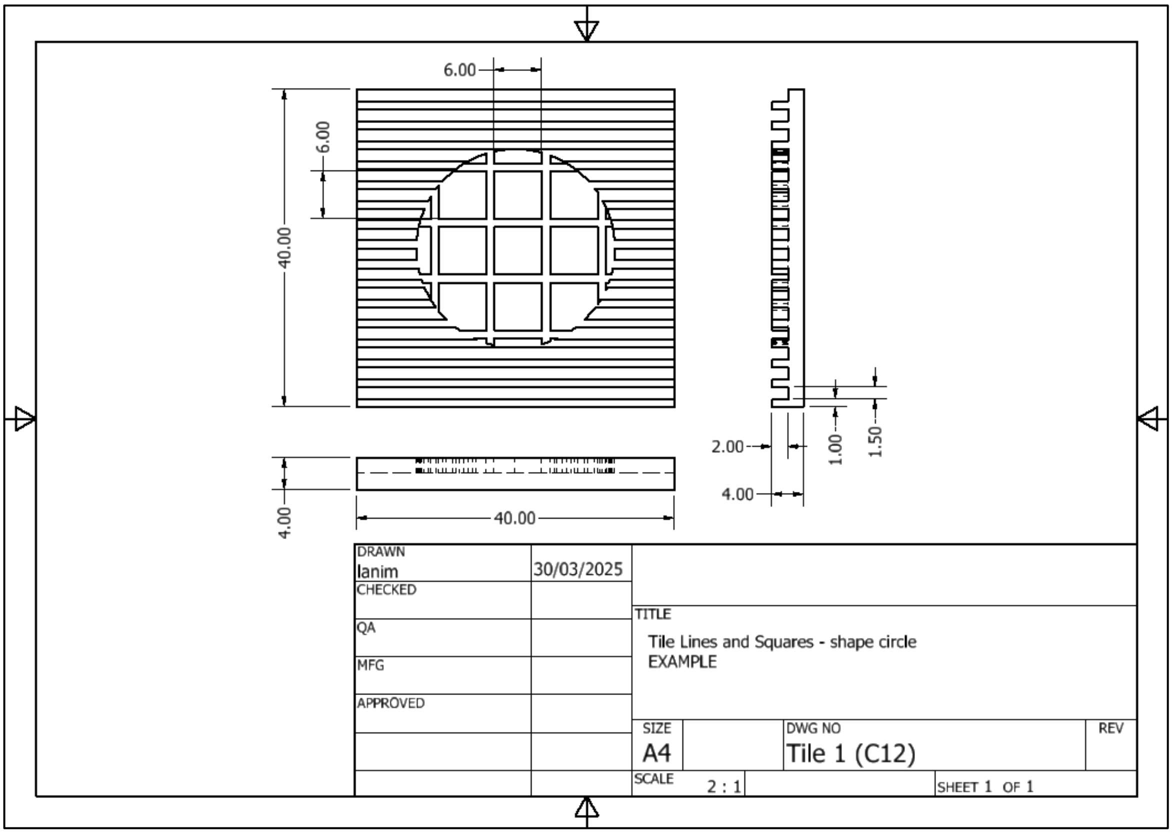


Figure 33: Tile Differentiation Test: Tile with Lines and Squares in circle shape Technical Drawing Example.

Appendix IV: Complete data collected from all novice and experienced users' Online Power Tool Usage Survey responses.

Table 16: Previous power tool experience of the Novice Survey Group.

Experience	Frequency
More than once a month to Daily	1
Rarely to more than once a year	13
Never to 6 times	7

Table 17: Frequency of settings in which the Novice Survey Group have previously used power tools.

Location	Never	Rarely	Sometimes	Often	Always
Work	13	2	3	1	0
DIY at home	2	3	6	5	3
DIY at other's home	10	4	3	2	0
Hobby	12	4	2	1	0

Table 18: Novice Survey Group responses to the question of whether they would read the instructions/manual of a circular saw before using it for the first time.

Read instructions	Frequency
Yes	11
No	5
If they are short	1
Quick Glance	2

Table 19: What type of research the Novice Survey Group would complete before using a circular saw for the first time.

Research type	Frequency
No research	1
Research how to use tool	7
Research how to use tool safely	7
Watch a video	13
Read a book/leaflet	5
Ask a professional	2
Ask a hobbyist	8
Ask someone else to do the job	1

Table 20: Responses of the Novice Survey Group when asked whether they comply with safety warnings/stickers on power tools.

Safety/warning stickers	Never	Rarely	Sometimes	Often	Always	Other
Notice	0	2	4	0	13	2
Comply		2	6	0	9	1

Table 21: Novice Survey Group responses when asked if they think the workpiece could injure them whilst using a circular saw.

Could the workpiece injure you?	Frequency
Yes	17
No	0
Maybe	2

Table 22: Frequency with which the Novice Survey Group would place their hands on positions on the circular saw labelled on Figure 12.

Position they would put hand	Left hand	Right hand
1	2	2
2	2	1
3	2	3
4	2	3
5	14	3
6	0	3
7	0	0

Table 23: Frequency with which the Novice Survey Group would not place their hands on positions on the circular saw labelled on Figure 12.

Position they would not put hand	Left hand	Right hand
1	2	2
2	3	0
3	6	2
4	4	3
5	1	1
6	12	12
7	12	18

Table 24: Novice and Experienced Survey Groups results comfort ratings for grips specified in Figure 26..

Handle	Ranking (1st - 8th most to least comfortable)	Frequency
A	1	12
	2	4
	3	6
	4	1
	5	0
	6	1
	7	1
	8	1
B	1	4
	2	12
	3	1
	4	3
	5	2
	6	0
	7	2
	8	1
C	1	4
	2	2
	3	6
	4	4
	5	3
	6	3
	7	2
	8	3
D	1	1
	2	0
	3	0
	4	6
	5	5
	6	6
	7	3
	8	5
E	1	3
	2	3
	3	4
	4	4
	5	4
	6	3
	7	4
	8	0
F	1	1
	2	3
	3	2
	4	3
	5	5
	6	3
	7	3
	8	5
G	1	0
	2	1
	3	1
	4	3
	5	3
	6	4
	7	9
	8	3
H	1	2
	2	2
	3	6
	4	2
	5	3
	6	5
	7	1
	8	5

Table 25: Previous power tool experience of the Experienced Survey Group when asked how often they use power tools

Experience	Frequency
More than once a month to Daily	7
Rarely to more than once a year	4
Never to 6 times	0

Table 26: Setting of power tool use of the Experienced Survey Group

Location	Never	Rarely	Sometimes	Often	Always
Work	3	2	3	2	1
DIY at home	0	4	1	3	3
DIY at other's home	5	1	4	1	0
Hobby	4	3	1	2	1

Table 27: What type of research the Experienced Survey Group completed before using a circular saw for the first time.

Read instructions	Frequency
Yes	1
No	10
If they are short	0
Quick Glance	0

Table 28: What type of research the Experienced Survey Group completed before using a circular saw for the first time.

Research type	Frequency
No research	4
Research how to use tool	0
Research how to use tool safely	0
Watch a video	0
Read a book/leaflet	0
Ask a professional	4
Ask a hobbyist	5

Table 29: Responses of the Experienced Survey Group when asked whether they comply with safety warnings/stickers on power tools.

Safety/warning stickers	Never	Rarely	Sometimes	Often	Always	Other
Notice	0	2	5	0	3	1
Comply	1	1	7	0	2	0

Table 30: Novice Survey Group responses when asked if they think the workpiece could injure them whilst using a circular saw.

Could the workpiece injure you?	Frequency
Yes	10
No	0
I don't know	1

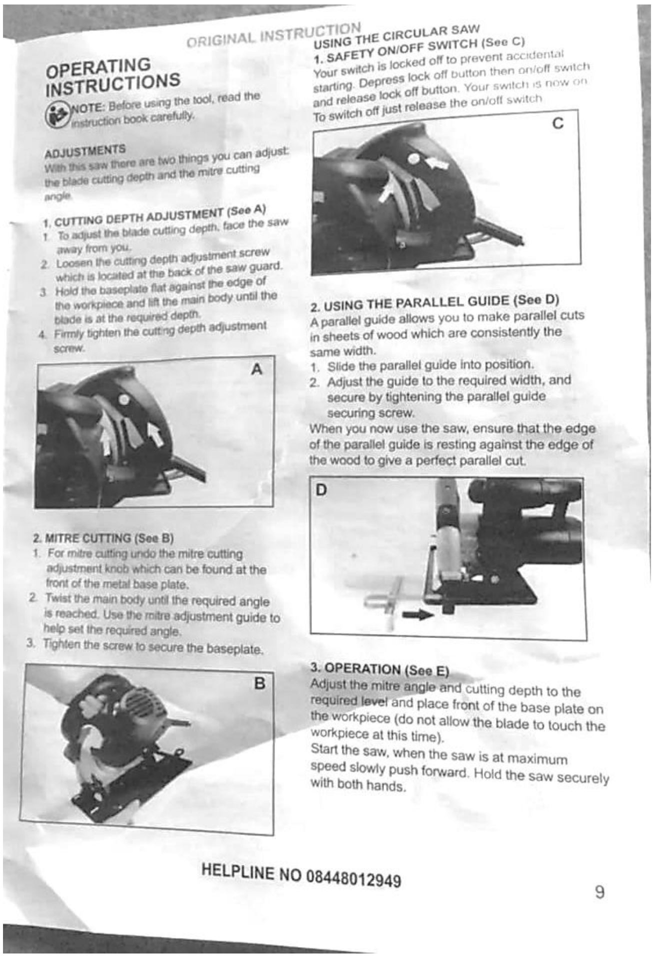
Table 31: Frequency with which the Experienced Survey Group would place their hands on positions on the circular saw labelled on Figure 12.

Position they would put hand	Left hand	Right hand
1	1	5
2	1	2
3	0	1
4	7	0
5	3	2
6	1	0
7	0	0

Table 32: Frequency with which the Experienced Survey Group would not place their hands on positions on the circular saw labelled on Figure 12.

Position they would not put hand	Left hand	Right hand
1	1	2
2	2	2
3	4	3
4	1	2
5	0	0
6	9	5
7	5	10

Appendix V: Circular Saw Instruction Manual Relevant Pages


ORIGINAL INSTRUCTION

OPERATING INSTRUCTIONS

NOTE: Before using the tool, read the instruction book carefully.

ADJUSTMENTS
With this saw there are two things you can adjust: the blade cutting depth and the mitre cutting angle.

1. CUTTING DEPTH ADJUSTMENT (See A)
1. To adjust the blade cutting depth, face the saw away from you.
2. Loosen the cutting depth adjustment screw which is located at the back of the saw guard.
3. Hold the baseplate flat against the edge of the workpiece and lift the main body until the blade is at the required depth.
4. Firmly tighten the cutting depth adjustment screw.

A

2. MITRE CUTTING (See B)
1. For mitre cutting undo the mitre cutting adjustment knob which can be found at the front of the metal base plate.
2. Twist the main body until the required angle is reached. Use the mitre adjustment guide to help set the required angle.
3. Tighten the screw to secure the baseplate.

B

USING THE CIRCULAR SAW
1. SAFETY ON/OFF SWITCH (See C)
Your switch is locked off to prevent accidental starting. Depress lock off button then on/off switch and release lock off button. Your switch is now on. To switch off just release the on/off switch.

C

2. USING THE PARALLEL GUIDE (See D)
A parallel guide allows you to make parallel cuts in sheets of wood which are consistently the same width.
1. Slide the parallel guide into position.
2. Adjust the guide to the required width, and secure by tightening the parallel guide securing screw.

When you now use the saw, ensure that the edge of the parallel guide is resting against the edge of the wood to give a perfect parallel cut.

D

3. OPERATION (See E)
Adjust the mitre angle and cutting depth to the required level and place front of the base plate on the workpiece (do not allow the blade to touch the workpiece at this time).
Start the saw, when the saw is at maximum speed slowly push forward. Hold the saw securely with both hands.

HELPLINE NO 08448012949

9

Figure 34: Circular Saw Instruction Manual Page 9.

Appendix VI: Risks and Safety Behaviour Written Responses

Novice Survey Group

1. **Most dangerous parts of the circular saw identified:**
   The blade was universally seen as most dangerous part of the tool. Base plate, power cord, and guards were also mentioned.
2. **Identified mechanisms of injury:**
   Cuts (18), amputation (6), eye injury (2), electrocution (1), guards/levers crushing or pinching (1).
3. **Dangerous activities identified:**
   Cutting wood (18), moving saw while unpowered (4), projectile shrapnel (2), accidental start (2), leaving saw exposed unattended (1), sawdust in eyes, mouth, nose (1), wood or blade slipping (1), removing blade before it stops spinning (1), Unsafe electric plug (1), lack of PPE (1), kickback (1), hand too close to blade (1), Cutting small items (1), electric shock from wet environment (1).
4. **Actions which increased risk of injury:**
   Improper grip/hand position (6), lack of concentration / distractions (4), less practice / understanding of the tool (3), lack of correct PPE (3), lack of attention to safety and risks (3), retracted/unsecured guard (3), putting fingers in front (2), rushing (1), incorrect clamping/set-up (1), alcohol/drugs (1), leaving the tool in an unsafe position (1), holding it in the air (1), use in wet environments (1).
5. **Safety features identified:**
   Blade cover/guard (18), on/off trigger (4), base plate (2), rubber power cord (2), cut-offs (1).
6. **Appropriate PPE identified:**
   Gloves (17), eye protection/goggles/glasses (16), safety shoes (5), safety trousers / other clothing (4), mask (1), face shield (1), hard hat (1).

Experienced Survey Group

1. **Most dangerous parts of the circular saw identified:**
   The blade was universally seen as most dangerous part of the tool. The power cord, lower guard, triggers, and 'whole tool' also mentioned.
2. **Identified mechanisms of injury:**
   Cuts (10), electrocution (3), amputation (2), eye injury (2), guards clamp finger (1), kick back (1), shrapnel (1)
3. **Dangerous activities identified:**
   Distraction / lack of concentration (1), cutting wood (9), transporting or passing the saw (2), measuring workpiece during cut (1), cutting small pieces (1), cutting at angles (1), turning on and off (1), cleaning (1), blade getting jammed (2), Holding wood by hand (1), shrapnel in eyes (1).
4. **Actions which increased risk of injury:**
   Putting hand in blade path or near blade (2), lack of PPE (2), leaving tool on which not in use (2), misuse (3), cutting improper materials (1), incorrectly supported workpiece (1), excessive force on saw (1), throwing the saw (1), disregard for safety instructions (1), moving tool from workpiece before the blade stops spinning (1), lack of concentration (1).
5. **Safety features identified:**
   Blade guard (9), Nothing (1), blade lock (1), safety cut-off (1), riving knife (1).
6. **Appropriate PPE identified:**
   Goggle/glasses/eye protection (7), visor (1), gloves (2), gloves with conditions (2), apron (1), none (1), wooden push tool (1), ear protection (1), mask (1).

Appendix VII: Texture recognition test Results

Table 33: Texture recognition test Correct Answers. KEY: L=Lines, S=Squares, K=Knurl, D=Dots, N=None/Smooth

Tile 1	Tile 2	Tile 3	Tile 4	Tile 5	Tile 6	Tile 7	Tile 8	Tile 9	Tile 10
L + S	L + K	L + D	L + N	S + K	S + D	S + N	K + D	K + N	D + N
Circle	Square	Triangle	X	Triangle	X	Circle	Square	Triangle	X

Table 34: Texture recognition test Results.

Participant		**Tile 1**		**Tile 2**		**Tile 3**		**Tile 4**		**Tile 5**		**Tile 6**		**Tile 7**		**Tile 8**		**Tile 9**		**Tile 10**		
		L	S	L	K	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	
1	Textures identified	L	K	L	L (perpendicular)	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	L + K hardest to tell apart, Dots and none where easiest
	Shape identified	Circle		Square		Triangle		X		Triangle		X		Circle		Square		Triangle		X		
2	Textures identified	L	K	L	K	L	D	L	N	S	K	L	D	S	N	L	D	K	N	D	N	S on outside makes the inside shape hard to tell because the boarders aren't clear or are cut off
	Shape identified	Circle		Square		Triangle		X		X		X		Circle		Circle		Triangle		X		
3	Textures identified	L	K	L	small bumps	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	
	Shape identified	Circle		Square		Circle		X		Circle		X		Circle		Triangle		Triangle		Square		
4	Textures identified	L	K	K	L	L	D	L	N	S	K	S	K	S	N	L	D	K	N	D	K	
	Shape identified	X		Circle		Triangle		X		Triangle		X		Circle		Square		Triangle		X		
5	Textures identified	L	Pass	L	L	L	K	L	N	L	N	Pass	Pass	L	N	L	D	L	N	D	N	
	Shape identified	Circle		Square		Triangle		X		Triangle		X		Circle		Circle		Triangle		X		
6	Textures identified	L	K	L	K	L	S	L	N	L	N	S	K	K	N	K	S	K	N	S	N	Thickness different helps
	Shape identified	Circle		Circle		Triangle		X		Circle		X		Circle		Square		Triangle		X		
7	Textures identified	L	K	L	L	L	D	L	N	S	N	S	D	S	N	K	D	S	N	D	N	
	Shape identified	Circle		Square		Triangle		X		Triangle		X		Circle		Square		Triangle		X		Hates squares texture, hard to tell, could be smooth or knurl and its confusing
8	Textures identified	L	K	L	D	L	D	L	N	S	K	N	D	K	N	K	D	K	N	D	N	
	Shape identified	X		Circle		Circle		X		Triangle		X		Circle		Square		Triangle		X		
9	Textures identified	L	S	L	L	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	
	Shape identified	Circle		Circle		Triangle		X		Triangle		X		Circle		Square		Triangle		X		
10	Textures identified	L	S	L	K	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	
	Shape identified	Triangle		Square		Triangle		X		Triangle		X		Circle		Square		Triangle		X		
11	Textures identified	L	K	L	K	L	D	L	N	S	K	S	D	S	N	K	D	K	N	D	N	
	Shape identified	Circle		Square		Triangle		X		Triangle		X		Circle		Circle		Triangle		X		
12	Textures identified	L	N	L	K	L	D	L	N	S	K	N	D	S	N	K	D	D	N	D	N	
	Shape identified	X		Square		Triangle		X		Triangle		X		Circle		Square		Triangle		X		

Appendix VIII: Texture Influence Test Results

Table 35: Participant 5: Texture Influence Test Results

Participant: 5							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	**Dot**	Smooth	Smooth	Smooth	**Dot**
		Hand position		RH		LH	
	Step 4	Texture	Smooth	**Dot**	**Dot**	**Dot**	Smooth
		Hand position	RH				LH
	Comments	***MOVED HANDS AWAY FROM DOT TEXTURE***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	**lines**	Smooth	Smooth	Smooth	**lines**
		Hand position		RH		LH	
	Step 4	Texture	Smooth	**lines**	**lines**	**lines**	Smooth
		Hand position	RH				LH
	Comments	***MOVED HANDS AWAY FROM LINES TEXTURE***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	**Squares**	Smooth	Smooth	Smooth	**Squares**
		Hand position	RH			LH	
	Step 4	Texture	Smooth	**square**	**square**	**square**	Smooth
		Hand position	RH				LH
	Comments	***MOVED LH AWAY FROM SQUARES TEXTURE***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	**knurl**	Smooth	Smooth	Smooth	**knurl**
		Hand position	RH			LH	
	Step 4	Texture	Smooth	**knurl**	**knurl**	**knurl**	Smooth
		Hand position	RH				LH
	Comments	***MOVED LH AWAY FROM KNURLD TEXTURE***					

Table 36: Participant 6: Texture Influence Test Results

Participant: 6							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH		LH		
	Step 3	Texture	Dot	Smooth	Dot	Smooth	Smooth
		Hand position	RH		LH		
	Step 4	Texture	smooth	Dot	smooth	Dot	Dot
		Hand position	RH			LH	
	Comments	***Moved LH towards Dot texture***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position					
	Step 3	Texture	lines	Smooth	lines	Smooth	Smooth
		Hand position	RH			LH	
	Step 4	Texture	smooth	lines	smooth	lines	lines
		Hand position	RH			LH	
	Comments	***Hand position unchanged by lines texture, 'don't like it sticking out'***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position					
	Step 3	Texture	square	Smooth	square	Smooth	Smooth
		Hand position	RH		LH .5	LH .5	
	Step 4	Texture	smooth	square	smooth	square	square
		Hand position	RH		LH .5	LH .5	
	Comments	***Hand position unchanged by squares texture, 'like the corner'***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position					
	Step 3	Texture	Knurl	Smooth	Knurl	Smooth	Smooth
		Hand position	RH		LH		
	Step 4	Texture	smooth	Knurl	smooth	Knurl	Knurl
		Hand position	RH		LH.5	LH.5	
	Comments	***Moved left hand to be partially over knurl***					

Table 37: Participant 7: Texture Influence Test Results

Participant: 7							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Dot	Smooth	Smooth	Smooth	Dot
		Hand position	RH				LH
	Step 4	Texture	Smooth	Dot	Dot	Dot	Smooth
		Hand position	RH			LH	
	Comments	***Moved LH towards Dots texture***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Lines	Smooth	Smooth	Smooth	Lines
		Hand position	RH				LH
	Step 4	Texture	Smooth	Lines	Lines	Lines	Smooth
		Hand position	RH			LH	
	Comments	***Moves LH towards lines texture Texture guides you, more secure***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Square	Smooth	Smooth	Smooth	Square
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Square	Square	Square	Smooth
		Hand position	RH				LH
	Comments	***Moves LH away from Squares texture***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Knurl	Smooth	Smooth	Smooth	Knurl
		Hand position	RH				LH
	Step 4	Texture	Smooth	Knurl	Knurl	Knurl	Smooth
		Hand position	RH				LH
	Comments	***Knurl has no effect on hold position***					

Table 38: Participant 8: Texture Influence Test Results

Participant: 8							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Dot	Smooth	Smooth	Dot	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Dot	Dot	Smooth	Dot
		Hand position	RH				LH
	Comments	***Moves LH towards Dot texture, prefers where dots are (said).***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Lines	Smooth	Smooth	Lines	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	Lines	Lines	Smooth	Lines
		Hand position	RH				LH
	Comments	***Lines have no effect on hand position***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Square	Smooth	Smooth	Square	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	Square	Square	Smooth	Square
		Hand position	RH				LH
	Comments	***Squares have no effect on hand position***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Knurl	Smooth	Smooth	Knurl	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	Knurl	Knurl	Smooth	Knurl
		Hand position	RH				LH
	Comments	***Knurl has no effect on hand position***					

Table 39: Participant 9: Texture Influence Test Results

Participant: 9							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	dot	Smooth	Smooth	dot	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	dot	dot	Smooth	dot
		Hand position	RH			LH	
	Comments	***Moves LH away from Dot texture***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Lines	Smooth	Smooth	Lines	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Lines	Lines	Smooth	Lines
		Hand position	RH			LH	
	Comments	***Lines feel like hold part, feels like the handle 1 should dictate the texture of the other hold parts***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Square	Smooth	Smooth	Square	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	Square	Square	Smooth	Square
		Hand position	RH				LH
	Comments	***Square texture has no effect on hand position***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Knurl	Smooth	Smooth	Knurl	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Knurl	Knurl	Smooth	Knurl
		Hand position	RH				LH
	Comments	***Moves LH towards knurl texture***					

Table 40: Participant 10: Texture Influence Test Results

Participant: 10							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Dot	Smooth	Smooth	Dot	Smooth
		Hand position	RH				LH
	Step 4	Texture	Smooth	Dot	Dot	Smooth	Dot
		Hand position	RH			LH	
	Comments	***Doesn't like the dots texture, uncomfortable, shouldn't touch***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Lines	Smooth	Smooth	Lines	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Lines	Lines	Smooth	Lines
		Hand position	RH			LH	
	Comments	***Lines texture has no effect on hand position***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Square	Smooth	Smooth	Square	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Square	Square	Smooth	Square
		Hand position	RH		Maybe LH	LH	
	Comments	***Likes the texture that matches the handle. Squares feel grippy, likes this one***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Knurl	Smooth	Smooth	Knurl	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Knurl	Knurl	Smooth	Knurl
		Hand position	RH			LH	
	Comments	***not a fan of knurl, grippy but uncomfortably spikey***					

Table 41: Participant 11: Texture Influence Test Results

Participant: 11							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Dots	Smooth	Smooth	Smooth	Dots
		Hand position	RH				LH
	Step 4	Texture	Smooth	Dots	Dots	Dots	Smooth
		Hand position	RH			LH	
	Comments	***Moves LH towards dots texture***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Lines	Smooth	Smooth	Smooth	Lines
		Hand position	RH				LH
	Step 4	Texture	Smooth	Lines	Lines	Lines	Smooth
		Hand position	RH				LH
	Comments	***Lines texture has no effect on hand position***					
Squares	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Squares	Smooth	Smooth	Smooth	Squares
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Squares	Squares	Squares	Smooth
		Hand position	RH				LH
	Comments	***Moves LH away from squares texture***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH				LH
	Step 3	Texture	Knurl	Smooth	Smooth	Smooth	Knurl
		Hand position	RH				LH
	Step 4	Texture	Smooth	Knurl	Knurl	Knurl	Smooth
		Hand position	RH				LH
	Comments	***Knurl texture has no effect on hand position***					

Table 42: Participant 12: Texture Influence Test Results

Participant: 12							
Texture	**Stage**	**Column1**	**1**	**2 or 3**	**4**	**5 upper**	**5 lower**
Dots	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Dots	Smooth	Smooth	Dots	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Dots	Dots	Smooth	Dots
		Hand position	RH			LH	
	Comments	***Dots texture has no effect on hand position***					
Lines	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Lines	Smooth	Smooth	Lines	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Lines	Lines	Smooth	Lines
		Hand position	RH			LH	
	Comments	***Lines texture has no effect on hand position***					
Squares	Steps 1-2	Texture	Knurl	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Squares	Smooth	Smooth	Squares	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Squares	Squares	Smooth	Squares
		Hand position	RH			LH	
	Comments	***Squares texture has no effect on hand position***					
Knurl	Steps 1-2	Texture	Smooth	Smooth	Smooth	Smooth	Smooth
		Hand position	RH			LH	
	Step 3	Texture	Knurl	Smooth	Smooth	Knurl	Smooth
		Hand position	RH			LH	
	Step 4	Texture	Smooth	Knurl	Knurl	Smooth	Knurl
		Hand position	RH			LH	
	Comments	***Knurl texture has no effect on hand position***					