Chainsaw Safety: Design for Risk Reduction and Injury Prevention

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STATEMENT OF AUTHENTICITY

This is to certify that to the best of my knowledge, the content of this report is my own work. This report has not been submitted for any subject or for other purposes. I certify that the intellectual content of this report is the product of my own work and that all the assistance received in preparing this report and sources have been acknowledged.

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AI USE STATEMENT

I have used Generative AI in this report. ChatGPT and Otter.AI were used in various ways. My general approach when it comes to AI was to use ChatGPT to help refine my writing and check for grammar. I'm fond of my writing style and I do enjoy creative writing so often the tasks I assigned to the program were aimed at small changes to one or two sentences at a time or to help with structural cohesion between sections. AI has not been used in the creation of any figures. Specific instances where I used are AI are listed in the appendix.

Name: D'Arcy Hodgson
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EXECUTIVE SUMMARY

This report explores chainsaw safety. Accidents involving chainsaws are severe and preventable. The objective of this research is to understand why risks persist. The research explores the Australian chainsaw user landscape through literature review, product benchmarking, stakeholder interviews, and video observations. Three interlinked forces shape the problem space: psychology, hardware, and usage. The report explores chainsaw safety holistically through these categories, each of which yielded unique insight into use groups, product ecosystems, and the specific challenges of varied use case contexts. This research establishes the foundation for a forthcoming design intervention aimed at addressing the following question:

How can I use emerging technology to develop a non-passive safety solution to improve chainsaw safety for a range of users?

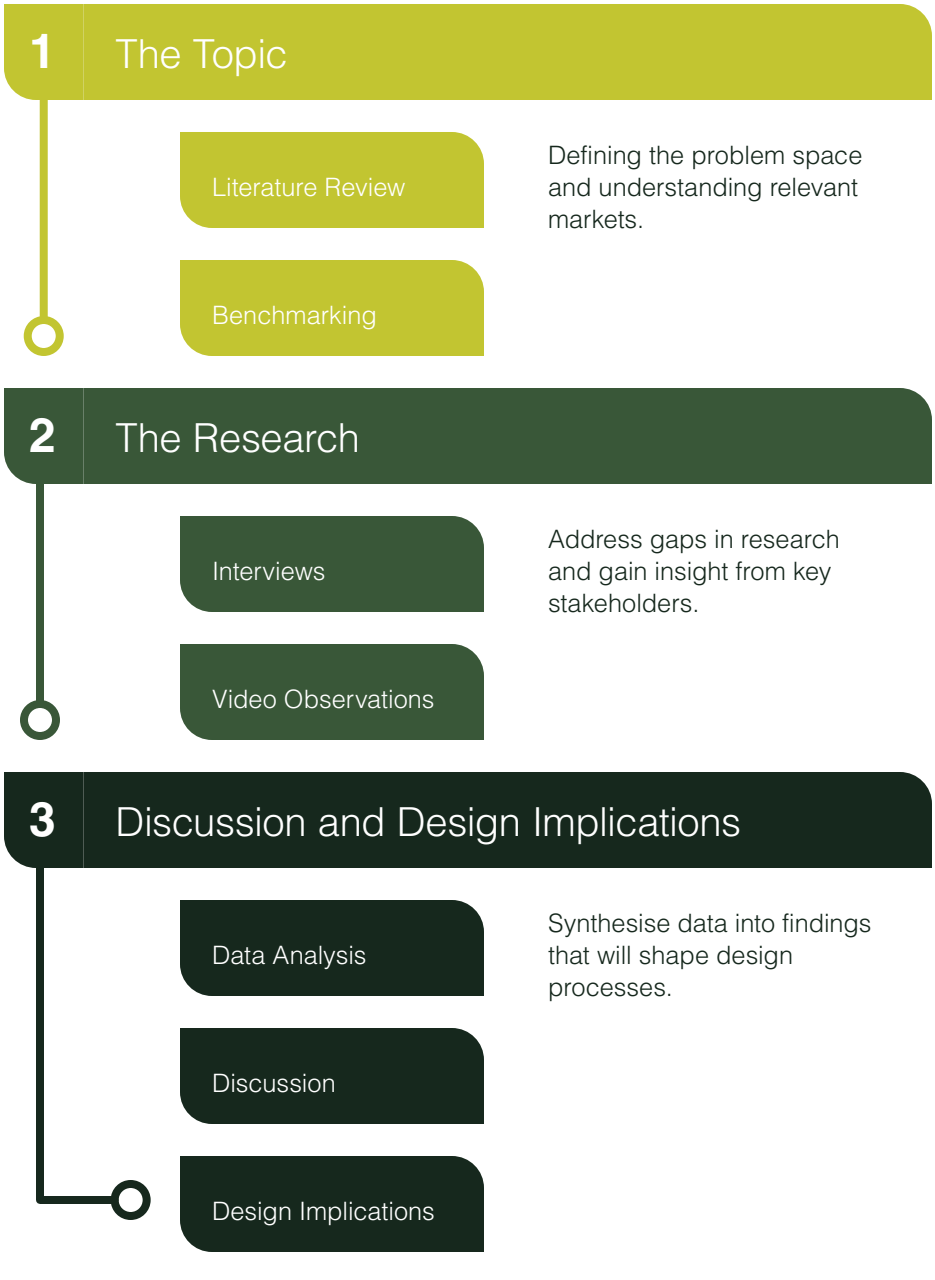


TABLE OF CONTENTS

Statement of Authenticity 2
AI Use Statement 2
Executive Summary 3

Section 1: The Topic 5

Introduction 6
- Overview 6
- Project Aim 6

Background 7
- Literature Review 7
- Amateur Users 7
- Professional Users 7
- Industry Standards 7

Benchmarking 8
- Introduction 8
- Chainsaw Market Analysis 8
- Chainsaw Product Analysis 8
- PPE Market Analysis 9
- Emerging PPE Technology 9

Section 2: The Research 10

Research 11
- Strategy 11
- Methodology 11
- Interviews 11
- Sourcing Participants 12
- Demographics and Bias 12
- Video Observations 12

Analysis and Findings 13
- Introduction 13
- Methodology 13
- Psychology: Masculine Overconfidence 14
- Psychology: Experience and Training 15
- Hardware: Chainsaw Design 16
- Hardware: Maintenance and Safety 16
- Usage: Chainsaw Operation 17
- Usage: Arboriculture and Pruning Saws 17
- Usage: Felling and Rear Handle Saws 18
- Usage: PPE 18

Section 3: Discussion and Design Implications 19

Discussion 20
- Epicentre of Risk 20
- Psychology - Usage 20
- Psychology - Hardware 21
- Hardware - Usage 21

Design Implications 22
- Introduction 22
- Tailored Design Intervention 22
- Design for Novices 22
- Design for Intermediates 22
- Design for Experts 22
- Task Consideration: Design for Arborists 22
- Task Consideration: Design for Felling and Logging 23
- Task Consideration: Design for Non-Professional Use 23
- Conclusion: Balanced Design 23

Conclusion 24
References 25
Appendix 27

Section 1

The Topic

Word Count: 1116

INTRODUCTION

Overview

Chainsaws are motorised, handheld saws. They utilise a rotating chain with teeth, and are primarily used to cut timber. Early patents for the tool arose in the late 19th century as the productivity ceiling of hand axes was eclipsed by the ever-demanding modern industrial landscape. Today, its role has matured beyond its early use as a tool of dominion over the natural environment. In the arboriculture industry, for example, chainsaws are indispensable for mitigating the hazards unmanaged trees pose in urban settings, while preserving their immense ecological and aesthetic value. *Figure 1* describes further use cases.

Across all tasks, a critical paradox exists which plagues chainsaw use: the same powerful efficiency that makes chainsaws indispensable to society also makes them unforgiving and extremely dangerous.

Project Aim

The aim of this project is to explore chainsaw safety holistically; moving beyond incident statistics with the goal of understanding greater systems at play. The report seeks to challenge the assumption that chainsaws are inherently dangerous. Literature on the subject, product benchmarking, and primary research sheds light on the underlying psychology, hardware, and usage patterns of the tools. It explores these broad chainsaw safety systems with intent to inform a design intervention aimed at reducing risk and preventing injury in chainsaw use.

1 Pruning refers to management of tree limbs. The primary purpose is to ensure the health of the tree and reduce unwanted interference with built environments. It is a core function of the Arboriculture industry.

2 Felling is the process of tree removal. The hazardous task is the core function of the logging industry.

3 Bucking is the processing of converting a felled tree into logs by removing limbs and processing it into manageable lengths.

4 Chainsaws are useful for processing felled timber into firewood, planks, sculpture, and more.

5 Storm debris poses a hazard on private property and in public areas such as bushwalking trails. Cleanup often necessitates the use of a chainsaw.

Figure 1. Common Chainsaw Use Cases. 3D asset created in Blender.

BACKGROUND

Literature Review

Existing literature on the topic of chainsaw safety largely explores the problem space through assessments of external factors that, when controlled, can mitigate risk. In any scenario where a chainsaw is involved, the risk is embodied by the tool. Existing literature takes for granted the danger of chainsaws, choosing instead to explore factors such as environment, education, training, personal protective equipment (PPE), and cognitive dynamics of chainsaw users. Whilst there is something to be said for the advancement of chainsaw safety through development of these topics, they neglect to frame the tool itself as the root cause. Robb (2022) stipulates that equipment malfunction is not amongst the leading causes of chainsaw accidents. Is it not so that every chainsaw accident can be blamed on the shortcomings of chainsaw safety features? Is an accident caused by a lack of training not symptomatic of poor industrial design? As designers, our job is to think critically of product ecosystems and to identify the deeper roots of problems such as these.

Amateur Users

Current chainsaw designs overestimate the extent that amateur users apply up-to-date knowledge and training when operating the tools. In doing so, safe practices and the safety features of chainsaws elude them. Professional users often, but not always, benefit from training and knowledge of regulations and proper operating procedures. Educational programs are proven to be effective (Dozier & Machtmes, 2005), but cannot resolve safety issues across the board due to limited reach, memory biases, and inconsistent application. It is infeasible for homeowners and DIY enthusiasts to operate the tool with a level of professional expertise. The lack of enforced education and screening during the buying process plays a role here (Hammig & Jones, 2015). Homeowners infrequent use renders frequent education and training as infeasible. The novice user groups are most at risk for these reasons (Robb et al., 2022; Singh et al., 2024).

Professional Users

Chainsaw injuries afflicting professional arborists can be attributed to advanced environmental challenges related to advanced working contexts. Such challenges include reduced footing stability while in trees (Blocher et al., 2025), leaves and branches hindering spatial awareness (Staněk, 2022), undesirable positioning in relation to targeted branches (DGUV, 2014; Robb & Cocking, 2014), collisions with falling objects (Staněk, 2022), and reduced ability to communicate with supervisors. Interestingly, supervisors were found to be at a greater risk of stress than operators due to their lack of situational control. (Abramuszkinová Pavlíková et al., 2024). It is clear that fatigue from long work hours also plays a role for professional users (Robb & Cocking, 2014).

Industry Standards

Australian minimum industry standards asserts that a chainsaw operator should be stable-footed and PPE-clad. Proper use requires the user to only make cuts on stable targets that are below shoulder height and not too close to the ground (Arboriculture Australia, 2020). This limited prescribed range is at odds with contexts that arborists encounter on a day-to-day basis. Ground-based tree felling work frequently requires tools to be operated horizontally, which also contradicts prescribed use cases to some extent, although this contradiction is unavoidable given the form of chainsaws. In order to design for chainsaw safety, the realistic motions that chainsaw users perform will need to be taken into account. A closed loop exists whereby product design is dictated by industry standards, which is in turn constrained by the products designed to be operated within its bounds.

BENCHMARKING

Introduction

Two key markets must be benchmarked in order to understand chainsaw safety from an industrial design perspective. First, we must understand the danger itself through analysis of the chainsaw market. Next, we must understand the defence-oriented personal protective equipment (PPE) market. Analysis reveals stagnation in both markets, although PPE is on the cusp of disruption.

Chainsaw Market Analysis

Stihl and Husqvarna oversee somewhat of a duopoly, especially amongst professionals. Growth-inspiring competition does exist, but innovations and growth are more closely tied to power and efficiency improvements that have come with development of battery electric systems with brushless motors (IMARC, 2025). Dan Holliday of ClimbingArborist.com (n.d.) suggests that particular models remain sought after long after production has ceased. Dan reiterates that reliability is a motivator here. Subjectivity makes it difficult to come to a conclusion on whether the market is catering toward users who resist change, and how this may impede safety innovations. Primary research will explore this further. Regardless, technological inertia in this field comes at the expense of the health and wellbeing of thousands. In the US an average 23,179 emergency visits per year can be attributed to chainsaw injuries (Hammig & Jones, 2015).

Chainsaw Product Analysis

Chainsaw designs diverge along two major pathways: rear handle saws (*Figure 2*), and top handle pruning saws (*Figure 3*). Other variants are pole saws and smaller one-handed pruning saws. The project covers only the two main configurations.

Figure 2. Stihl MS 362 C-M Petrol Chainsaw. (STIHL, 2025).

Figure 3. Stihl MSA220 (The Australian Arbor Age, 2023).

The safety implications for these saws are quite different because of their separate use cases, but built-in safety features are consistent across them. *Figure 4* describes core safety features in more detail, and *Figure 5* plots the saturation of these features across several relevant models.

COMMON CHAINSAW SAFETY FEATURES

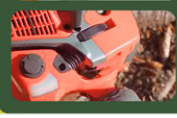
	Feature	Image	Description	Pros	Cons
1	Kickback and Inertia Brake		Mechanical brake system actuated by the wrist or fingers. Designed to shut off the blade in the event of kickback.	• Mature technology. • Instantaneous response. • Full market saturation.	• Buildup under the sprocket cover can clog the mechanism • No feedback system
2	Kill Switch		A switch that shuts off the blade. It is generally positioned within reach of the right thumb. The feature differs depending on if the system is petrol or battery electric.	• Ergonomic position is sensible. • Second line of defence behind the kickback brake.	• Requires logical thought to actuate, which might be absent in emergency situation.
3	Two Points to Activate		The right hand has to press two levers to use the tool. Generally positioned above and below the handle.	• Requires deliberate thought to activate the blade, reducing accidental use.	• One-handed use is not ruled out by the lever placement.
4	Anti-Vibration Handle System		Handles of modern chainsaws are isolated from the engine housing. Springs dampen vibration to drastically enhance user experience.	• Great for usability. Targets a critical point of fatigue in chainsaw users.	• Vulnerable to wear and tear. • May diminish perception of engine faults.

Figure 4. Chainsaw safety features. Images show these systems on the Stihl MSA220 (Stihl, 2025), Husqvarna T540XP Mark III (Husqvarna, 2025).

DISTRIBUTION OF SAFETY FEATURES IN THE CHAINSAW MARKET

Safety Feature	STIHL MS261 C-M	STIHL MS201 TC-M	Husqvarna 592 XP	Husqvarna T525	Bosch GKE 18V-40
Kickback and Inertia Brake	✓	✓	✓	✓	✓
Kill Switch	✓	✓	—	✓	✓
Two Points to Activate	✓	✓	✓	✓	—
Anti-Vibration Handle System	✓	✓	✓	✓	—
Smart Engine Sensors (temperature, speed control)	—	✓	✓	—	✓

✓ Feature Present in Tool — Feature Absent in Tool

Figure 5. Common Chainsaw Safety Features.

PPE Market Analysis

PPE products exist purely to fill in the gaps left behind by inadequate safety features of the wood cutting power tools themselves. Industry standard products protect users passively by relying on thick, multi-layered materials (***Figure 6***). Fibres choke the drive sprocket (***Figure 7***). Whilst products such as chainsaw chaps are effective at stopping blades (Sullman, 1999), Australian minimum industry standards only require operators to wear chainsaw protective pants. They do not require users to wear jackets, gloves, arm chaps, or gaiters with blade stopping capabilities (Arboriculture Australia & New Zealand Arboricultural Association, 2021). Whilst it may seem counterintuitive to recommend below the maximum protection available, it is widely accepted that such items are woefully unsuitable for hot weather and can cause heat-induced fatigue (Robb et al., 2022; Coca et al., 2012). Cognitive effects such as perceived security can also increase the likelihood that users will take risks (Klen, 1997).

Figure 6. Chainsaw Protective Fabric (STIHL NZ, 2020).

Figure 7. Choked Chainsaw Blade (STIHL, 2025).

Figure 8. Emerging SPPE Technology (Blocher et al., 2025).

Emerging PPE Technology

Emerging technologies for injury prevention include development of smart PPE (SPPE) (Dolez et al., 2022) and IoT-driven product ecosystems. SPPE solutions include utilising smart textiles with proximity detection capabilities (***Figure 8***) in combination with modified chainsaws to halt a moving blade (Blocher et al., 2025). SPPE products actively deter injuries by shutting off the blade pre-emptively. It is here that we arrive at a key divergence between existing and emerging PPE; active and passive protection. The core difference being whether the danger can be negated before or when the danger occurs (Blocher et al., 2025). Electrical driven active protection systems will negate the heat-related drawbacks of traditional passive solutions because of the reliance on electrical components rather than layers. This has huge implications on the future of chainsaw safety. IoT product ecosystems take a stance more in line with advanced monitoring and supervision. Real-time monitoring and hazard detection are key areas where AI will be utilised going forward (Zhang et al., 2024). Supervision-oriented systems are applicable to broader safety contexts. As such, improvements to AI integration in tangential fields such as the construction industry (Rabbi & Jeelani, 2024) will have flow-on effects to chainsaw safety. Drastic future changes could include deploying robotics to eliminate the need for human risk (Jebelli et al., 2022).

Section 2

The Research

Word Count: 1566

RESEARCH

Strategy

The existing literature and relevant markets demonstrate contextual drawbacks to safe chainsaw operation and shortcomings in product innovation. User input is required to help us understand deeper cognitive reasoning and behaviour. The research question, '***How can I use emerging technology to develop a non-passive safety solution to improve chainsaw safety for a range of users?***', is formulated on the assumption that professional and amateur users are both at risk when operating a chainsaw. Thus far, much of the findings build toward an accusatory stance on chainsaw and PPE product markets. I felt as if the literature was framing key user groups. Whilst the literature may have been using respectful language, it seemed necessary to get to the bottom of the umbrella term 'user error'. As such, the primary research approach was developed to temper these criticisms with personable input and insights from key users.

Methodology

Qualitative research questions were tailored to examine the following topics:

- Whether chainsaws are used in accordance with Australian minimum industry standards.
- Whether Australian minimum industry standards for chainsaw use are feasible in real world contexts.
- Correlations between safety and experience amongst chainsaw operators.
- Training and development amongst Australian chainsaw professionals.
- What factors drive innovation in the chainsaw market.
- Factors driving user preferences in the chainsaw market.
- Correlations between chainsaw maintenance and safety.
- The role of user demographics in safe chainsaw operation.
- PPE culture amongst Australian chainsaw users.

Interviews

Five semi-structured interviews were conducted with professionals from across several relevant industries and backgrounds. Each interview further informed the content of subsequent interviews. Information for these can be found in *Figure 9*.

PARTICIPANT AND INTERVIEW DATA

Participant Codename	Age	Location	Roles and Relevance	Total Experience	Interview Duration	Interview Date and Location
P1	25	Greater Brisbane	Former climbing arborist, now working as an arborist consultant in Brisbane.	8 Years	1:01:18	In person (New Farm) on 09/08/2025
P2	63	Benalla, Northern Victora	TAFE educator on chainsaw safety, administrator for seven online chainsaw Facebook communities, sales experience, semi-professional firewood cutting experience.	30+ Years	48:15	Phone call on 15/08/2025
P3	64	Yandoit, Victoria	One decade of experience as a climbing arborist following on over two decades doing tree felling.	30+ Years	45:15	Phone call on 18/08/2025
P4	N/A	Coastal New South Wales	Semi-professional chainsaw user with experience cutting firewood, conducting tree work around powerlines, chainsaw racing sport, limited climbing experience.	20+ Years	54:55	Zoom call on 18/08/2025
P5	42	Moonie, Queensland	Various roles predominately in the logging industry, but also ripping fenceposts and chainsaw milling.	26 Years	1:10:49	Phone Call on 18/08/2025

Figure 9. Participant and Interview Data

Sourcing Participants

P1 is a lifelong friend of the researcher, and had expressed eagerness to play a role in the primary research process from the project's inception. It was hoped that additional arborist participants would be enlisted through word of mouth at P1's workplace. This did not come to fruition. As an alternative, social media callouts were deployed to a plethora of chainsaw related Facebook groups. These groups ranged from buy swap sell communities to climbing groups. Seven people expressed interest, but two of these fell through and did not make it past the consent form phase. All of the potential participants were slow to reply here which prompted consent criteria to be modified to be achieved verbally over a call, or implied through participation itself.

Demographics and Bias

The Facebook-sourced participants are inherently biased towards viewing chainsaw safety favourably. Their demographic data is also representative of the platform, but the depth of experience and ability to plot longer term trends in their respective fields is an asset to the research. Generalisations made by experienced participants were treated with a grain of salt, and the data analysis approach favoured participants direct experiences over retold stories. Corroboration across participants lend credence to generalisations. At this stage of the research process there were concerns that the demographic similarities of the interview subjects would impede the findings.

Video Observations

Interview participants often described use cases and scenarios that were vague, subjective, or insufficient on their own. Supplementary data from video observations was necessary to support these findings. Findings relating to specific chainsaw use behaviours was especially lacking. A worded description does little to describe the dynamic three-dimensional scenario of ascending and pruning a tree. In order to rectify this, three videos were taken and assessed. Videos were chosen to inject diversity back into the primary research, which was disproportionately focused on arboriculture. *Figure 10* explains the individual purpose of each video.

VIDEO OBSERVATION DATA

Codename	Author	Title	Published	Relevance to Project
Video 1	Jack of all Trees (YouTube)	TREE OF A THOUSAND CUTS ep.11	30/03/2024	This was recommended by P3, who holds the Victoria-based author in high regard. The 19 minute video sheds insight into the methodology and workflow of arborist climbers. It was chosen primarily to supplement the interviews conducted on P1, P3, and P4.
Video 2	Guilt of Treeson (YouTube)	Chainsaw Review! Logging Redwoods With The Husqvarna 592xp!	11/08/2022	This video was chosen to supplement interviews conducted on P4, P5, and P2. This video demonstrates chainsaw use in tree felling situations and interactions with other workers and skidder operators. Visual data was needed to support findings relating to other contextual factors such as tree behaviour, chainsaw starting techniques, and operator positioning.
Video 3	Peek-a-Lake (YouTube)	STIHL MS291 chainsaw maintenance - Routine Maintenance	11/10/2023	The third video observation gives visual insight into maintenance. It shows the individual tasks as they exist within a broader start-to-finish sequence. Interview participants did not discuss maintenance in terms of a chronological order of operations. Nor did they specify cleaning products and tools. There were limited insights into the practicalities and accessibility of mechanisms.

Figure 10. Video Observation Data

ANALYSIS AND FINDINGS

Introduction

The primary research succeeded at shedding light into the cognitive and behavioural phenomena that hold chainsaw users back from safe practice. Much of the data confirms the working hypothesis that advanced contextual challenges impeded chainsaw professionals from operating the tools safely. The research failed to gain direct insight from non-professional chainsaw users, but perspectives from chainsaw educators do support the idea that chainsaw designs overestimate the extent that all users apply up-to-date knowledge and training when operating the tools. A theme that exceeded all expectations in the data pool was the influence of masculine risk-taking attitudes.

Methodology

As early as the second interview key findings emerged that support findings from secondary research. As further interviews occurred the data became increasingly compelling and an overall narrative became clearer. Data also became increasingly difficult to manage. Codifying it proved challenging due to the interconnectedness of ideas.

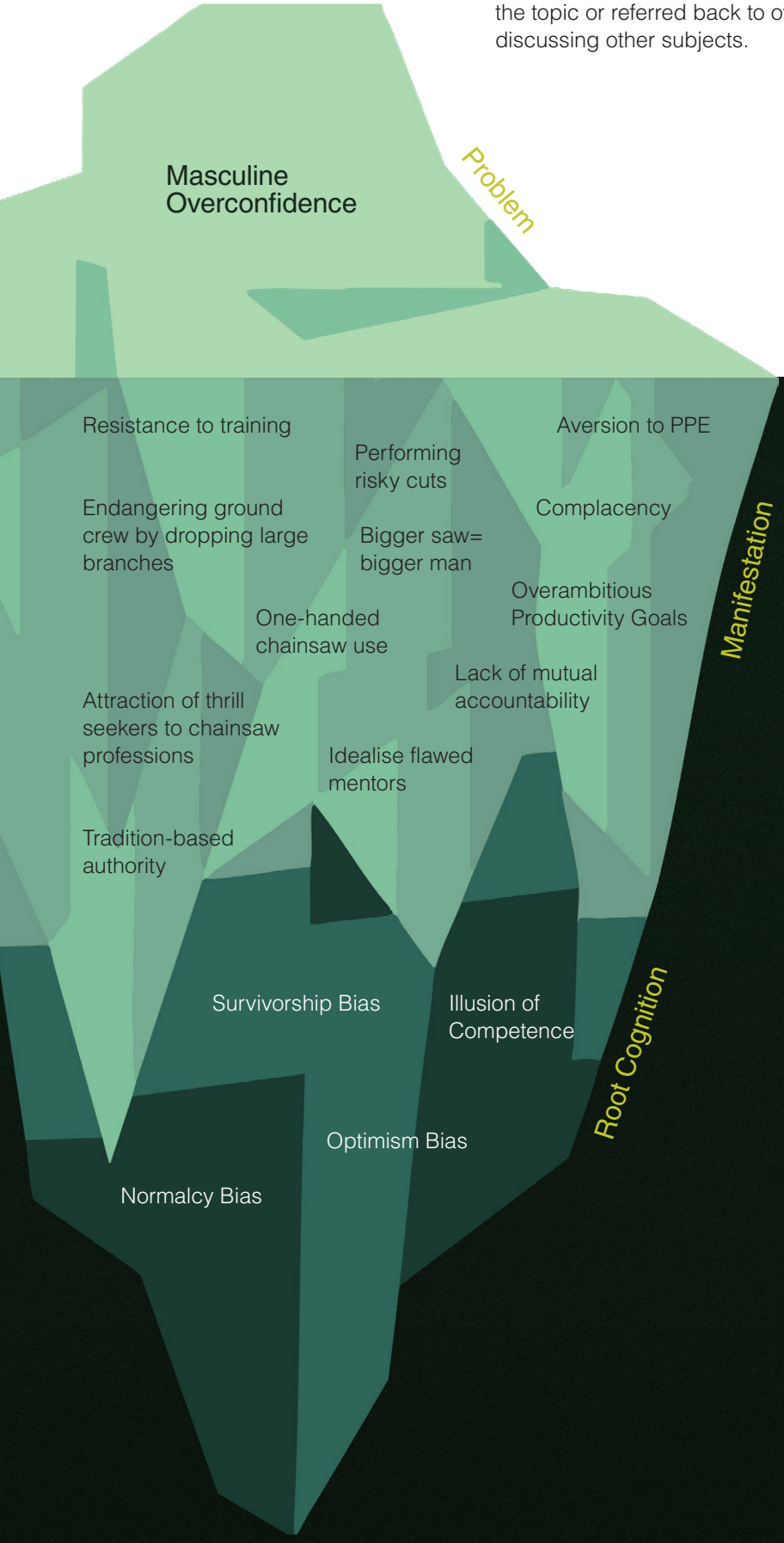
Rewatching the lecture on qualitative analysis helped significantly, as did plotting topics and their connections in a mind map. The categorisation structure was refined four times with purposeful intent to restrain the project's ballooning scope. The finalised system allowed all relevant data to be positioned concisely in relation to a three key categories: psychology, hardware, and usage. *Figure 11* is the finalised structure.

Category	Code	Subcode	Example
Psychology	Socio-Cultural	Demographics	Masculine overconfidence.
		Culture	Impacts of personality.
	Development Dynamics	Training Motivators	Seeking employment credentials.
		Mentorship	Experiential learning.
		Capability	Impact of experience on safety.
		Purchase Point Dynamics	Advice from sales associates.
		Training Programs	TAFE programs vs. informal training.
	Work Conditions	Work Hours	How long hours impacts safety.
		Productivity Demands	Impact of rushed labour and pressures.
		Jobsite Factors	Preservation of the built environment.
		Physiological Response	Impact of stress on the operator.
Hardware	Chainsaws	Top Handle-Specific	One handed use to control falling limbs.
		Rear Handle-Specific	Burdensome weight of large tools.
		Universal	Battery electric vs two-stroke petrol.
	PPE	Enforcement	Lack of supervisors on private property.
		Availability	Ability to purchase PPE.
		Industry Standards	Impact of industry standard guidelines.
		Usability	How well PPE is suited to users.
	Other Objects	Climbing Gear	Interaction between hardnesses and tools.
		Felling Tools	Plastic wedges used for felling.
		Heavy Machinery	Skidders, mulchers, and vehicles.
Usage	Arboriculture-Specific	Climbing	Impact of this specific environment.
		Pruning	Motions required to perform this task.
		Rigging	Detriment to productivity, but safer.
		Environmental Interaction	Communication, passing gear up the tree.
	Logging and Felling	Tree Behaviours	Tension release and fall path control.
		Terrain Impact	Impact of uneven or sloped terrain.
		Perception	Reliance on visual cues when felling.
		Environmental Interaction	Interaction with skidders.
	Timber Processing	Firewood Cutting	Managing safety during repetitive tasks.
		Chainsaw Milling	How the chainsaw rig impacts use.
		Chainsaw Racing	Competitive techniques.
		Bucking	Techniques and posture for the task.
	Maintenance	Planned Maintenance	Regular sharpening of the blade links.
		Unplanned Maintenance	Replacement of clutch springs.
		Modification	Additional layers on top of the air filter.

Figure 11. Code structure used to categorise qualitative data

Psychology: Masculine Overconfidence

The interviews on chainsaw safety consistently highlighted the theme of masculine overconfidence. All five participants explicitly acknowledged this phenomenon, and it was further evidenced implicitly across much of the discourse. *Figure 12* maps the far reaching implications of this demographic-driven phenomenon. The annotations represent instances where interview participants spoke directly on the topic or referred back to overconfidence, egotism, and recklessness whilst discussing other subjects.



> *"The hardest people to teach when we were teaching these courses were not complete beginners. It was the bloke saying, I've been cutting firewood on the old man's farm for the last 20 years, but I've always done it this way."*
>
> P3

> *"We had a lot of women come through the course and I think the majority of them were open to be told how to do things properly and a lot of them picked it up a bit quicker than the blokes because I think the blokes had preconceived ideas on how they should be doing it."*
>
> P2

> *"The way I was brought up was that you aren't a log cutter unless you had a 3120 or 84 or 88 you know what I mean and that was the attitude my father had."*
>
> P5

Figure 12. The masculine overconfidence Iceberg.

Psychology: Experience and Training

There were several interesting findings relating to training and development of chainsaw operators. A recurrent theme was complacency toward formal training, driven by deference to mentors and the prioritisation of experiential authority over standardised safety protocols. Insight from P2, a TAFE chainsaw safety educator, suggests participation in training programs is commonly a formality motivated by a desire to attain a qualification necessary for employment, rather than a reaction to past experiences or perceived self-risk. P1 expressed that employers are motivated to up skill their staff to reduce insurance premiums. Participants were outwardly critical of course duration and pacing.

"You can't teach somebody to fell a tree in a one day course" P3

"You can't instill in three days, twenty-five years of experience." P5

Another factor at play was online misinformation. Often, information coming out of North America is inappropriate for Australian chainsaw operators.

"There's a there's a lot of really good Americans who talk about this stuff too, but there's also a lot of rubbish on YouTube. P3

I think YouTube is the biggest curse to new operators" P5

Knowledge of specific tree behaviours appears to be the crucial area where knowledge gaps can impede chainsaw safety.

"Comb the internet and you will not find a bloke talking about the characteristics of an Ironbark tree as it leaves the stump." P5

"The only kind of time I didn't really feel safe was when I was uncomfortable with the tree that I was climbing." P1

The key takeaway from all of this is that experience is the path to safety.

"Once you've got experience and you know how each kind of tree or branch reacts to the way you cut it, it will determine how you use the chainsaw." P1

"If you don't get the right experience straight up then you won't get the experience because you'll probably end up dead." P2

"They've got to be confident and moving fluidly and safely… before you get them doing things like plunge cuts or tree felling" P3

Hardware: Chainsaw Design

Implementation of chainsaw brakes and anti-vibration handles have been a given since the 90's according to P2 and P5. There were no findings relating to newer safety systems. This explains why operators place emphasis on preventing user error.

The primary research did relatively little to explain the market dominance of Stihl and Husqvarna. Participants 3, 4, and 5 all used an identical 'Ford vs. Holden' analogy in reference to the dominance of Stihl and Husqvarna. P4 referenced light-hearted division and banter between 'Stihl guys' and 'Husqvarna guys'. This sentiment is corroborated by a two minute segment of Video 2. P1 was indifferent and stated that in his experience the employer's ownership of the tools left him with no say in the matter. What participants could agree on, however, is that the history and extensive research and development is what separates these brands from the rest of the pack. Chinese knock-offs are an emerging alternative, according to P2 and P5.

Design for disassembly is important to chainsaw users. P1 cites availability of consumables as a primary motivator to invest in the leading brands. Recently, a shift in the market has occurred. P3 explains that,

> *"A lot of people are switching from Stihl the Husqvarna at the moment, because Stihl spare parts have been priced through the roof so that you can't rebuild a saw anymore."*
>
> P3

P5 added to this by alluding to a broader market strategy. It is his assumption that the brand is more focused on selling saws and is pursuing planned obsolescence as a means to achieve this.

Hardware: Maintenance and Safety

There are significant correlations between chainsaw maintenance and safety. In *Figure 13*, some of the most critical maintenance tasks are described. Omitted are tasks that have a limited impact on safety.

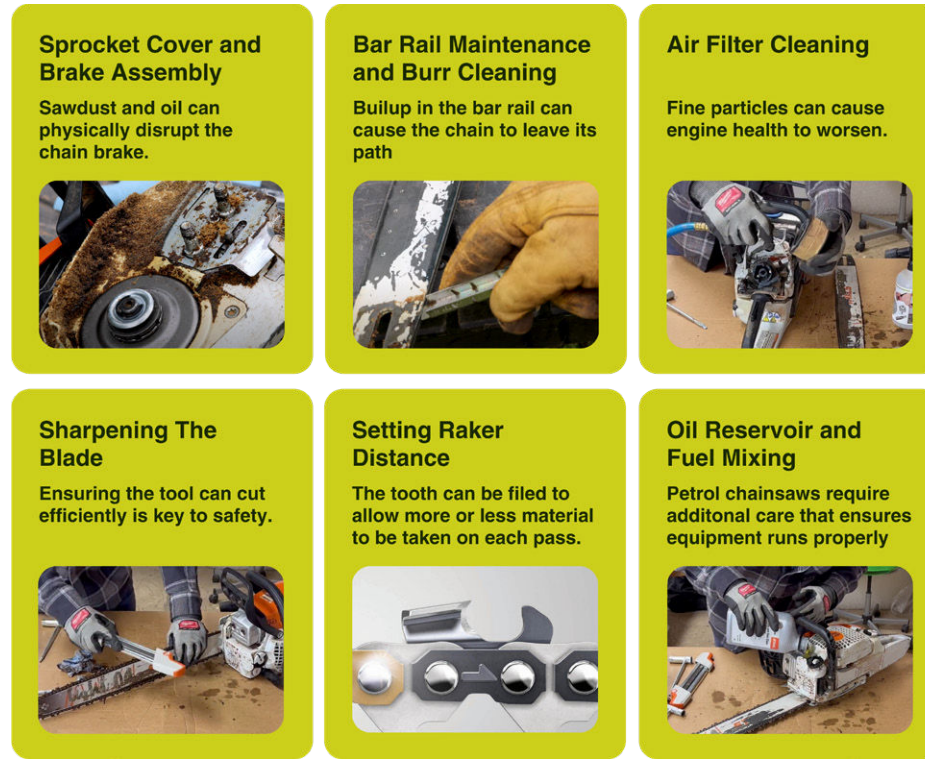


Figure 13: Chainsaw maintenance tasks. Images 1, 2 (Endurance Kennels LLC, 2020). Images 3, 4, 6 (Video 3). Image 5 (The Australian Arbor Age, 2023).

Usage: Chainsaw Operation

Training and development dynamics were reflected in the data tied to chainsaw usage. Each participant had unique methods of ensuring safe chainsaw operation. Their opinions on beginner mistakes reflected these takes.

Participant	Subjective Safety Principles	Perspective on Beginner Mistakes
P1	P1 stressed the importance of positioning. His methodology was most in line with Australian industry standards. his is likely due to his age and having been through modern training programs.	P1 stated that beginners fail to hold the chainsaw to the right of their body, instead holding it front on and putting themselves at risk of kick back. Underutilisation of the chain brake between cuts was also cited.
P2	P2's work as a chainsaw safety educator forms the basis of a style predicated upon procedural adherence. He advocates for the use of neglected PPE styles, such as chainsaw protective sleeves.	P2 encounters beginners drop starting the chainsaw, which is an advanced technique that requires experience to control. His focus on promoting PPE culture is the product of having seen beginners use it too infrequently.
P3	P3 had a trifecta of specific usage techniques to prevent kickback and misuse. This was developed over the course of his career. His stance strategy was borrowed from martial arts, firearm safety informed usage, and he completed the trifecta of safety principles with a more textbook chainsaw grip strategy.	P3 echoed P1's sentiment regarding the use of the chain brake. His safety methodology reflects his belief that beginners frequently have a poor foundation of body positioning.
P4	P4's mentor had a significant impact on his development, as did his exposure to the chainsaw racing community. Through these sources, he developed a well-rounded and informed approach to chainsaw safety. Progressing from lower powered saws to high powered saws is a critical approach for beginners.	P4's community knowledge is reflected in his criticism of masculine overconfidence impacting a beginners willingness to learn.
P5	P5 had exposure to chainsaw use from a young age due to his father's profession. He viewed his teachings with a critical eye rather than blindly following his advice. Experiential learning played a large role in his development as a chainsaw user.	P5 reiterated P4's sentiment on masculine overconfidence, and stressed the importance of learning through experience rather than learning vicariously through internet content.

Figure 14. Subjective Safety Principles and Beginner Mistakes

Usage: Arboriculture and Pruning Saws

Arborists face situational challenges whilst performing tree work. Ensuring a limb can fall into a designated drop zone is crucial to ensuring the safety of ground crew and preventing property damage. To achieve this, arborists remove one hand from the top handle pruning saw in order to guide the fall path (***Figure 15***). The alternative, rigging branches, is not a feasible alternative in most situations. Arborists are also impeded by challenging limb angles ***(Figures 16, 19)***, and the tight confines of the arboreal environment (***Figure 17***). Video 1 was highly insightful regarding habits of climbing arborists.

"Every single decent climbing arborist who, you know, wants to get the job done by the end of the day is one handing a saw."
P3

"If they're a climber they're using a top handle, so a one handed saw, holding the branches back with one hand and cutting with the other arm."
P2

"(Pruning saws) are more or less designed to be used with one hand. I probably shouldn't say that, but that is that is why I've got one"
P5

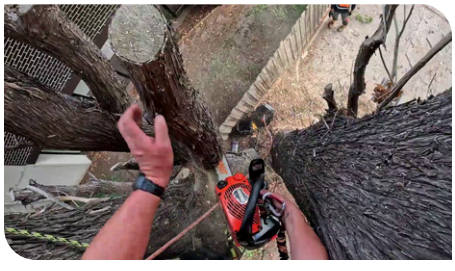


Figure 15: Video 1, 5:58. Using a pruning saw with one hand.

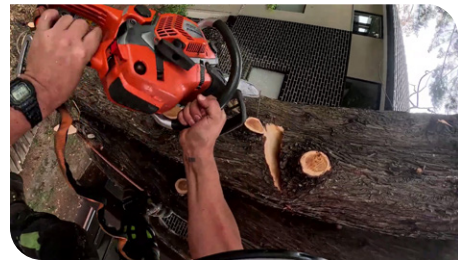


Figure 16: Video 1, 7:21. Kickback occurs, saw held with inverse grip.

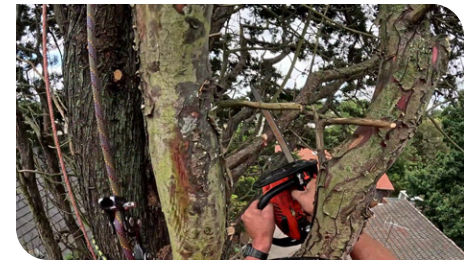


Figure 17: Video 1, 13:31. Visual obstruction while pruning a limb.

Figure 18: Video 1, 11:06. Falling object collision.

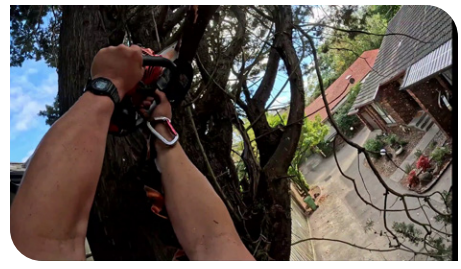


Figure 19: Video 1, 5:54. Pruning at maximum reach.

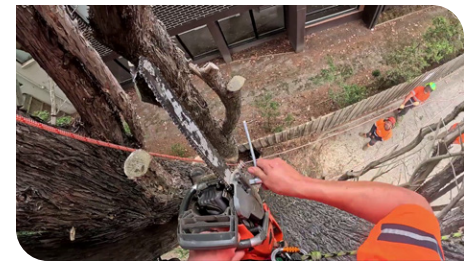


Figure 20: Video 1, 6:55. Correcting chain tension while in the crown.

Usage: Felling and Rear Handle Saws

Traditional back handle chainsaws used for felling are cumbersome, heavy, and can induce fatigue to a greater extent than the nimble pruning saws used by climbing arborists. All interview participants cited fatigue management as a key self-preservation strategy.

Fellers are more likely to be able to operate a chainsaw the way a manufacturer stipulates. Once again, realistic scenarios present environmental hazards that prevent this. Uneven terrain prevents secure footing (***Figure 21***), P5 cites sloped terrain as particularly hazardous. P3 indicated that users have very little control when holding the saw on its side (***Figure 24***), This action is necessary for scarf cuts and back cuts- which are the two main cuts that are performed to fell a tree.

V2 yielded many insights relating to habits within the logging industry.

Figure 21: Video 2, 02:29. Fallers traverse ground littered with sticks,

Figure 22: Video 2, 09:10. Faller using one hand to operate a saw.

Figure 23: Video 2, 7:53. Cut diameter demands a faller to use a weak grip.

Figure 24: Video 2,12:38. Horizontal use projecting debris toward the user.

Figure 25: Video 2, 02:58. Dangerous drop starting technique is used.

Figure 26: Video 2, 10:04. Reliance on visual cues when evacuating.

Usage: PPE

PPE is unpopular with chainsaw users for a range of reasons. Heat, weight, interference, and poor enforcement were all cited by participants. For this reason, PPE will not be focused on in later design stages. Multiple participants spoke highly of New Zealand-based brand Clogger, which produces protective pants that exhibit breathability atypical of PPE norms.

"We had to wear chaps when I was logging and yeah, in the middle of summer that was absolute bloody torture."
P5

"You couldn't have cut protection on your fingers, because then you wouldn't be able to work in them."
P3

"Theres not really any protection in Australia that will cover your torso just because of how hot it is. You don't want to be climbing a tree in 40 degree heat and have an extra 10 kilos of six-layered Kevlar on. It's just not practical."
P1

"Well, (PPE is) recommended but it's not like someone's coming around and policing it. You can climb a tree without chainsaw pants on. Its personal preference."
P1

"Where (chainsaw chaps) fall down is they're hot, so people don't like wearing them. They add a lot to the heat. If you're wearing trousers underneath them, their straps get caught in branches and things."
P3

"A lot of people don't use PPE so cuts to the left leg. Upper left leg injuries are quite common."
P2

Section 3

Discussion and Design Implications

Word Count: 1739

DISCUSSION

Epicentre of Risk

There were strong correlations between the literature and the primary research findings. Analysis of the literature, benchmarking, and primary research all points toward a common narrative; chainsaw safety is a system. Any number of factors can be at play in a scenario when the safety of a chainsaw user is jeopardised.

The interlinked nature of categories is visualised below in *Figure 27*. Safety is a two way street; each one of these facets can be detrimental or positive to overall safety. The most unsafe scenarios occur when there is a safety hindrance in all three categories simultaneously.

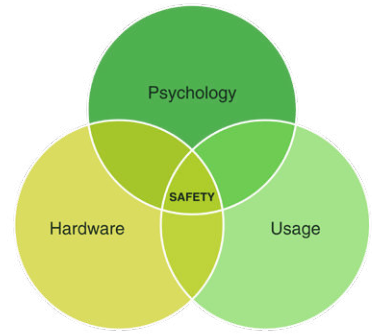


Figure 27: Chainsaw Safety Venn Diagram

Psychology - Usage

Safety implications in this space are where psychological impactors impede or improves usage behaviours.The Dunning-Kruger Effect (*Figure 28*) is a cognitive bias which explains overestimation of confidence amongst people with a low level of experience, and the inverse underestimation common amongst those with experience. Chainsaw user archetypes are plotted along the diagram. The risk profiles give insight into how the cognition of users can impact the way they operate a chainsaw. Cognitive biases shape risk-taking usage behaviour such as shortcutting, and resistance to training. Conversely, it demonstrates how experience and hindsight benefit experienced users. From this figure, we can begin to see how design solutions could be tailored to the needs of diverse users.

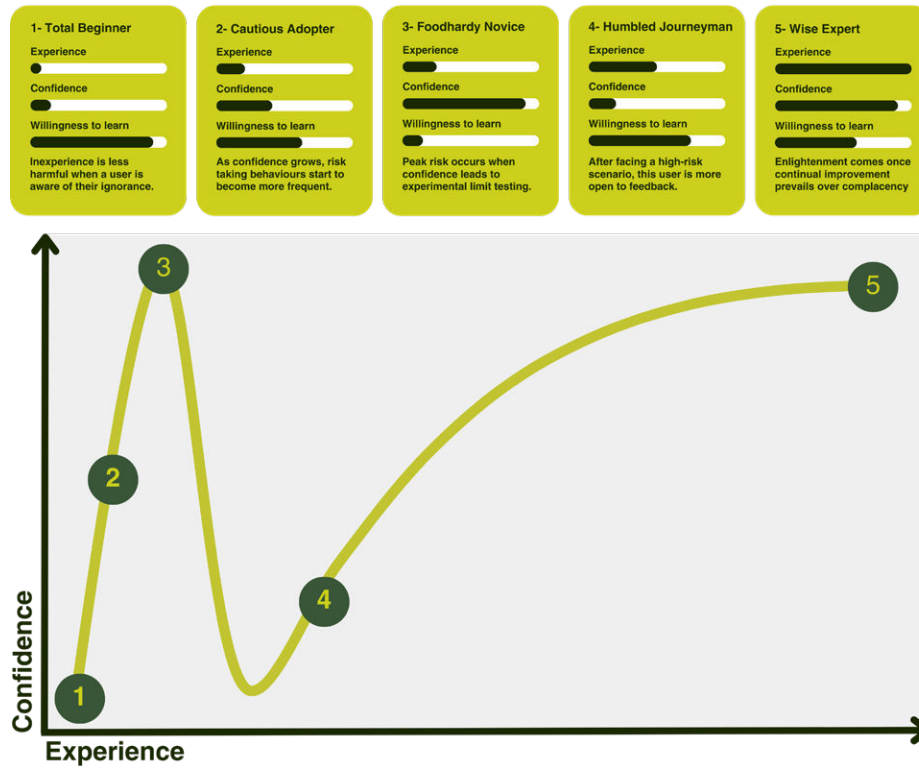


Figure 28: Risk profiles plotted along the Dunning-Kruger Effect.

Psychology - Hardware

Interplay between psychological factors and hardware is the space within which safety is reduced through the act of compromise.

- Productivity demands from the employer cause psychological stress. This leads to the user forcing a blunt blade through timber, rather than take the time to sharpen the blade.
- Overestimation of skill leads to a user purchasing a tool that is far beyond their capacity to operate safely.
- Proper maintenance of tools can lead to reduced psychological stress.

Hardware - Usage

This is the realm of product-centric findings. The main principle that drives these findings is the concept of affordance: where hardware characteristics determine how a product can be used or misused.

The characteristics of top handle chainsaws suggest that one handed usage is proper and correct. This is not the case. Intended use suggests two handed grip at all times. In reality, the size, weight, and placement of interactive components allow for users to operate the tools with only their right hand. This greatly benefits arborists who can significantly increase productivity by using their left hand to interact with other aspects of the environment. The starting mechanism can also impede safety for beginner users due to the affordance of the advanced technique called drop starting, which, according to P2 and P5, is easy to perform but difficult to do safety.

Conversely, the weight and cumbersome form of large felling saws makes them poorly suited for use over long periods of time. This is at odds with usage patterns- all participants voiced the importance of fatigue management over long work hours, citing chainsaws as being a factor in this equation.

DESIGN IMPLICATIONS

Introduction

Chainsaw safety cannot be effectively improved through solutions tailored to one of the three core facets. The interlinked nature of the categories suggest that in order for a solution to be effective, it must address the problem holistically. An effective solution must target at least two of the core categories that make up the chainsaw safety equation. Solutions that satisfy two criteria may be effective at preventing niche safety hazards. Peak impact can only be achieved if all three are considered simultaneously in a design solution.

Tailored Design Intervention

The diversity of tasks which chainsaws are used for predictably demands that tailored design solutions are explored, lest features be stretched too thin in an attempt to bridge diverse markets. Tailored solutions should be designed with consideration of both user experience level and the task at hand. Because of Stihl and Husqvarna's dominance, user demographics, and the similarities between popular chainsaw models, there is limited utility in defining more niche categories to tailor design interventions to.

Design for Novices

Novices need structured training, and products which strongly encourage technique-driven, low-risk application. Minimising the products ability to be used outside of the most foundational use cases is crucial to preventing misuse by users who, according to literature and data, lack the expertise to perform complex operations safely. Users in this category are likely to be more receptive to radical design solutions since they have no preconceived ideas regarding chainsaws or related products such as PPE. Designing for these users does present some challenges, since the safety features of a product must compensate for a lack of knowledge and training.

Design for Intermediates

Intermediate users know enough to be confident, but not enough to be safe at all times. The psychological aspect is critical for these users. As such, solutions tailored to them should seek to disrupt masculine overconfidence through accountability measures, technology-enhanced feedback loops, and inclusion of hardware that nudges them toward safe use. Users in this category are prone to risk-taking behaviours but do not possess deeply ingrained ideas about how products should behave or function. Products for these users could be somewhat radical in their approach to improving chainsaw safety.

Design for Experts

Experts require solutions that combat complacency, and are adaptable enough to perform in scenarios where contextual challenges stand in the way of textbook operation. Users at this level are most likely to appreciate continuity of features that already exist on the market. Solutions that fail to do this will falter on account of them neglecting existing product knowledge and intertwined professional expertise. Designing for these users is most challenging, as the research indicates these users are the least receptive to disruption. Retraining users at this level without addressing underlying cultural factors is an exercise in futility. At this level, task consideration plays a larger role as the application depends on profession of the user.

Task Consideration: Design for Arborists

Arborists utilise a wide range of gear in their line of work, all of which could foreseeably be redesigned to improve safety while climbing, pruning, and felling. The focus of this project is the latter two categories. Environmental circumstances significantly hinder the safety of arborists when operating a chainsaw. Solutions for climbers can alleviate safety risks by giving them greater control over their environment or reducing the likelihood that the pruning saw will come into contact with them whilst they perform tree care amidst the tight confines of a tree's crown. Products should not interfere with harnesses, ropes or PPE, and must prioritise ergonomics and handling.

Task Consideration: Design for Felling and Logging

Chainsaw safety is secondary in felling situations due to the extreme danger that can result from a tree leaving the stump. Despite this, there are design opportunities within this space which are still within the scope of this project. Interventions targeting chainsaw designs could improve control when making horizontal cuts, and reducing fatigue from long usage. Other interventions could target PPE; making garments that are more suitable for working in hot weather and less prone to getting caught on branches.

Task Consideration: Design for Non-Professional Use

The most common tasks for these users are firewood cutting, storm cleanup, and general property maintenance. Key locations are on private property or in outdoor recreational environments such as bushwalking trails and national parks. Non-professional use cases are not necessarily limited to an inexperienced user group. Storm season occurs every year, and firewood cutting is a recurring activity in colder environments. Users may accumulate a wealth of experience using a chainsaw non-professionally, but this may accrue much slower than in professional environments. Cost effective solutions will be more attractive to these users. Designs that succeed at appealing to these users also retain safety functionality after long periods of disuse.

Conclusion: Balanced Design

In general, a design that improves user safety for one category will not be detrimental or unappealing to other users. This is especially true when it comes to basic things like cost and durability. For example, a semi-professional users doing yearly storm season cleanup on acreage would also benefit from a product built to endure routine use in a professional environment. In this case, it would be about managing product cost to keep it competitive in relation to competitor products besite it on the shelf. A design solution should cover as many bases as possible.

It only really becomes a detriment when a niche use case alienates a user from a particular design. For example, an arborist would be alienated by a design that is too basic and heavily targeted towards a complete beginner due to the tool having a presumably lower power output. Once again, it comes back to the idea of affordance.

The design process which becomes of these research findings will, foreseeably, be a direct intervention within the chainsaw market itself. In terms of user-centred design, it will need to find a balance between being suitable to professionals whilst retaining appeal to semi-professional users. Beginners were not part of the research, and as such are less likely to be the focus of the design process.

CONCLUSION

The problem of chainsaw safety is a complex system. At any given time, the safety of a chainsaw operator hangs in the balance amidst phenomena both within their control and beyond it. The trifecta of psychological factors, hardware and design traits, and usage contexts can impact safety in nuanced ways—both advantageously and as hindrance. It is in the interplay between these factors that things can go wrong or right for a chainsaw operator.

The body of research revealed dramatic and relevant tendencies within the predominantly male user group. It is the view of the researcher that overcoming the challenges of masculine overconfidence and egotism will be of paramount importance to the forthcoming design intervention. This cultural phenomenon has a tangible connection to risk-taking behaviour.

In some ways, hardware itself affords risk-taking behaviour. The ability to operate chainsaws with one hand directly contributes to accidents. Removing this ability, however, would severely hinder the potential of a design solution, as one-handed tool use is crucial to workflow patterns and necessary to meet productivity demands. This is especially true for arborist climbers but also relevant to felling and bucking scenarios. The takeaway here is that one-handed tool use is not inherently wrong- rather, tools are designed in a way that allows this behaviour to occur unsafely.

To respond rhetorically to the research question, "*How can I use emerging technology to develop a non-passive safety solution to improve chainsaw safety for a range of users?*" the approaching design phase should strive to produce a solution with broad safety improvements that benefit a wide range of operators. This includes professionals as well as semi-professional and frequent users, whose insight has informed the research.

Ultimately, the challenge is not simply to make chainsaws safer, but to make safety inseparable from the act of using them.

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