HIHO

It’s off to create, make and play we go.

Designing smarter tools for the future

An Industrial Design Honours year project
by Lisa Fu

With thanks

Selby's table
For those long group table discussions in semester one and keeping each other on our toes.

Sarah R
For helping me get through the year in general and always staying positive (not to mention the interesting knick knacks and nachos)

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To everyone who has helped throughout the year, for giving me the time of day, for quality feedback and helping me to continually think critically about this project.

Thanks.

“ If we knew what it was we were doing,
it would not be called research, would it? ”

— Albert Einstein

CONTENTS

[1.0] INTRODUCTION

1. 01

About the project

Initial interest in the methods and tools people use to create, make and build, sparked the start of this project. At first I looked towards the past with great interest. Where once ones kitchen mixer was also ones power drill. Where the line between the domestic tools of the kitchen and those of the workshop were blurred. I also looked at the 6-in-1 combination machines that efficiently ran off one motor and were so prominent around the 60's - 80's.

I found that many today also shared this interest towards the multiple use of motors, in the kitchen and in combination with other tools. But I was careful to not to undertake a project that would romanticise or recreate the past. Instead I sought to capture and distill the appeal of this era, and carry it through this project: The convenience and blend between kitchen and workshop.

It wasn't until I began researching the Share Economy that this research project's purpose began to unfold:

How tools might evolve for makers of the future?

From the past: An EMCOSTAR 6-in-1 combination machine

From the present: A power drill being utilised as a kitchen mixer

From the present: A drill press being utilised into a bobbin sander

Central issues:

" **The Sharing Economy** is a socio-economic ecosystem built around the sharing of human and physical resources. It includes the shared creation, production, distribution, trade and consumption of goods and services by different people and organisations. "

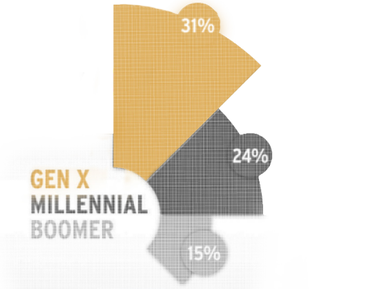
The Sharing Economy that has begun, is changing the landscape for products and will continue to affect more. It is changing the way people will interact with, use and access products, and because of this there are many factors and problems to consider:

Designing to share, not designing to own

Many products used by companies within the Share Economy, such as Uber and Zipcar, currently use products that were made to be owned by a sole proprietor. Moving into the peak of the Share Economy in the future, companies such as Google and Ford have begun to create products that were made for sharing. This has begun in the automotive world, and should also be followed through with products to come.

More users, better UI/UX

The Share Economy gives people access to products that they might otherwise be unable to access or need to pay an upfront cost for. This also means there will be more users per product. With more users means a greater variety of users with different skill levels, and because of this the interface and user experience of a product within the share economy should be accessible and easily understandable.



A national US study shows Gen X to be leading the Share Economy

Google's development of a self-driving car that is capable of becoming a share service

" **This trend is no longer emerging, it's here. And the marketplace should accommodate a consumer wanting nimble access to things instead of outright ownership of them.** "

Lynn Franz, Campbell Mithun's director of strategic planning.

1. 01

About the project

Central issues:

More users, better maintenance

With higher demand for products to be shared within the Share Economy, comes a need for proper maintenance of these products. This means that products should be designed for fast maintenance to ensure the product is continually circling the economy. Desining for durability also ensure that tools will spend less time in maintenance and repairs.

Access Economy

Convenience and efficiently being able to access goods and services is also another rising factor. Hand in hand with the what is termed the Share Economy is also the Access Economy, where easy and fast access is pinnacle.

Brunswick Tool Library's Tool Maintenance area

Undertaking the task

I used a combination of primary research, secondary research and professional advice from designers within the field. A vast amount of my primary research was ethnographic, focussing on user experiences with tools. My secondary research explored many possible trends that could affect tools. What tools are on the market and where they benchmark at was not the only research focus here. I also looked at what social movements could affect the design and context of my project.

The final outcome of my research is a community based system for renting tools. I designed a power drill as an example of what future tools might look like. It highlights the potential to incorporate many technologies into the drill to bring it into line with a future filled dwith many other smart devices. It is part of the transition to automation. But most importantly, this project seeks to take you into a narrative of what the future may hold for products, especially the tools people will be using to create and make.

1. 02

Objectives & Outcome

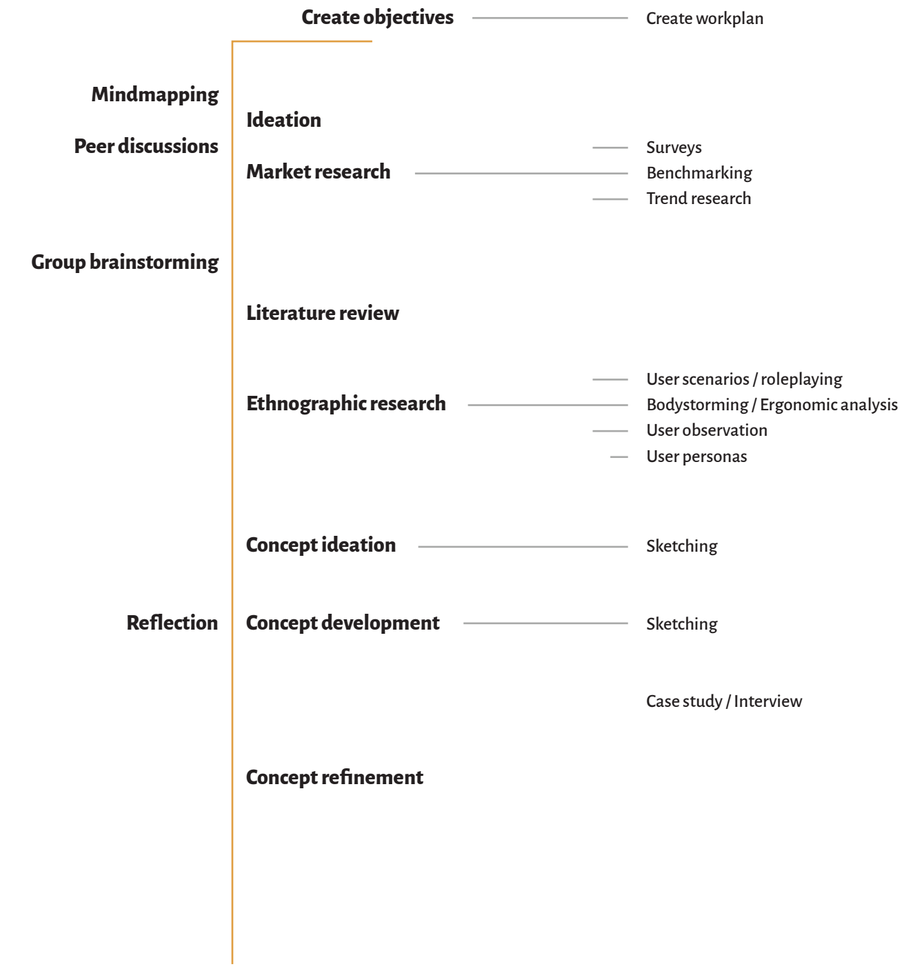
The intended outcome of this project is to produce a power tool that is smart and intuitive. One that might displace the norm of otherwise owning a power tool.

1. **Sharing is caring**
   To create a power tool that embraces a rental system where tools are shared rather than developed for sole ownership.

2. **Accessibility**
   Because this is a tool to be used by differing demographics and experience levels, the tool must have an interface that is accessible and easy to use, as well as be something the user is able to obtain and access with ease.

1. 03

Research methods

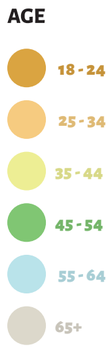


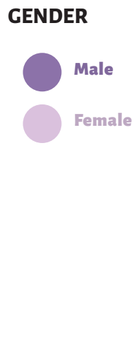
[2.0] RESEARCH

Task Clarification: Statistics and the market

2. 01

Survey results & statistics

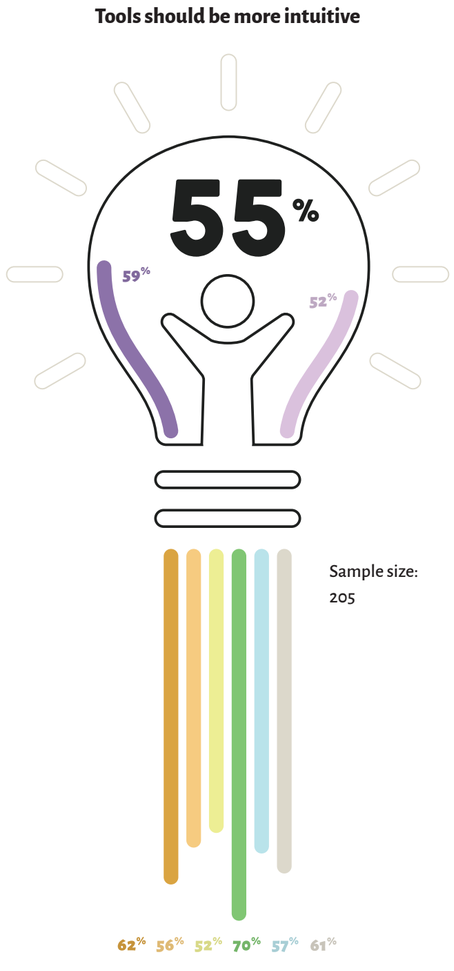


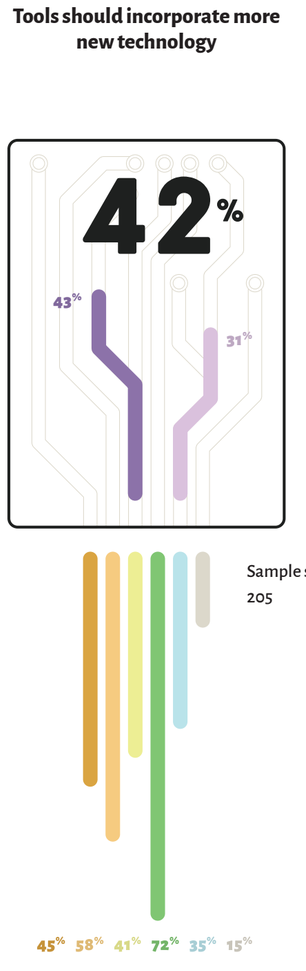


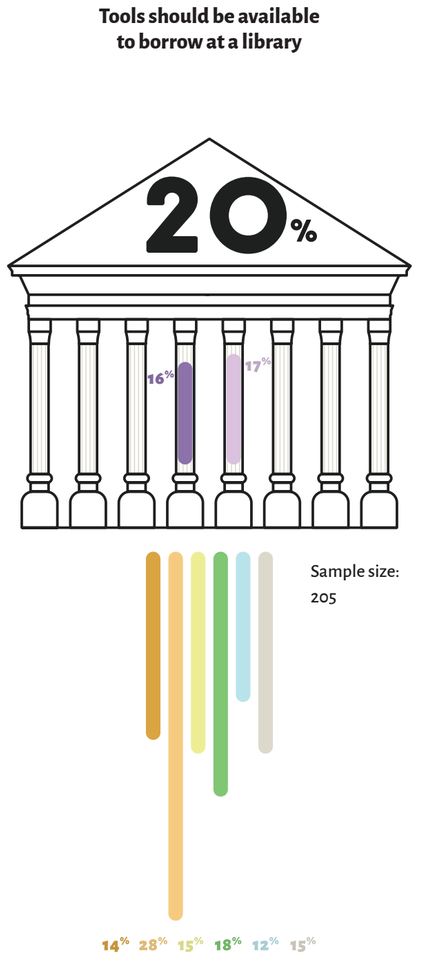
A Google survey was conducted towards the beginning of the research phase to explore potential market gaps. The survey pool consisted of 200 people, from both Australia and America.

The results of the surveys indicated that tools should be more intuitive to use. Usability is an issue that many companies attempt to solve through design. Some cater to users that aren't experienced, by using pictographs, others cater to more experienced users by offering more power options and additional settings.

It is interesting to note also that women (consisting of 25% of the total pool) greatly preferred more gender neutral styling over male participants. While female users may be a minority, the gender imbalance may soon equalise in the future with gender equality discourse and more women moving into sectors previously male dominated. (ch 2. 11)







Survey results & statistics

AGE

- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65+

GENDER

- Male
- Female

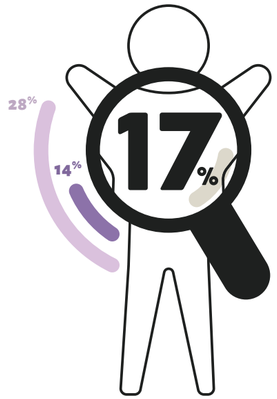
USED TOOLS

- From a young age
- Later on in life

Many of the options available on the survey are all important to the progression of the design in this research project, however in the given time frame it is not possible to focus on all of them. The results of the survey have indicated a focus towards developing a more intuitive power tool. Extensive User Experience research should be undertaken as a response to this. As well as this, gender neutral styling is also perhaps needed to cater for the rise in female users.

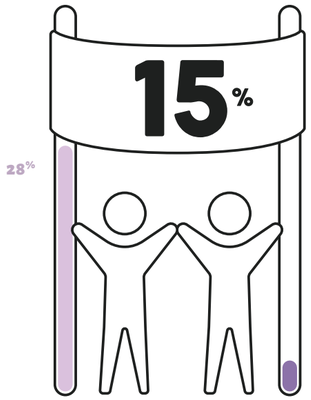
An additional survey was also completed with a sample size of 100 people. This looked at the correlation between users working in the trades and using tools from a young age. The results show a clear relationship between users using tools from a young age and becoming a trades-person later on.

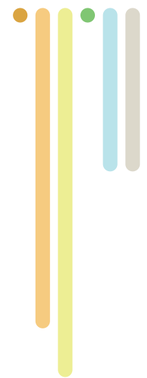
Catering to body proportions



Sample size:
205

More gender-neutral styling





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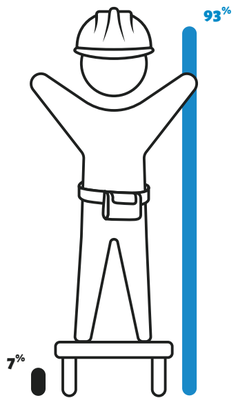
Trades-people that used tools from a young age



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2. 02

Whistle Design studio: consultation with Paul Connor

19 / 03 / 2015

Early on in the research stages, I met with Paul Connor, an Industrial Designer who works at Whistle design. Whistle design specialises in designing power tools, power tool storage solutions and point of sale packaging.

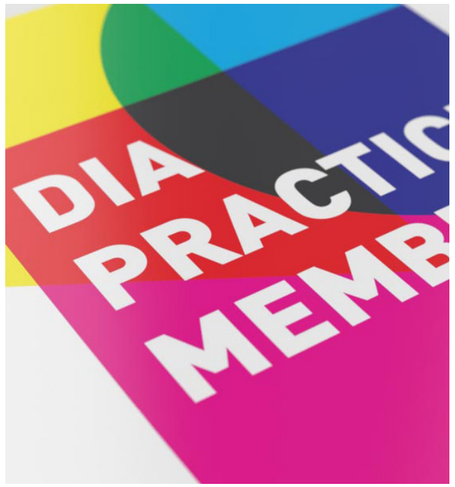
As someone who has been in the industry for over a decade, Paul provided some valuable insights into the power tools market and the design decisions put forward by current products.

We began talking about current modular power tools on the market and discussing their advantages and drawbacks. My early project direction was focused on this area, because of the size and convenience advantages of creating a modular power tool set. However, as Paul highlighted, the restrictions and drawbacks of this feature meant compromising on the interface and motor by homogenising them. To say that one interface layout, or one motor was suited to all tasks was not something I was seeking to achieve with my project in terms of efficiency and ergonomics.

To delve into ergonomics further, we discussed the progression of technology, and its role in enabling batteries and motors to continuously evolve into smaller hardware. How this was driving the prices of high-end power tools down, and making them more accessible.

We explored the idea of adjustable ergonomics within a power tool that is able to cater to all power tool users, much like an adjustable gaming mouse. We also looked at ergonomics that could conform to a task such as working to reach tight spaces, where a normal tool would have trouble fitting.

Paul highlighted the value of a good handle in a power tool, and the importance of both material choice when designing for a power tool as well as the shape of the handle. Analysing a Dewalt driver as an example, he went on to explain design details such as the design of the surfaces around the grip area being paramount to the balance of the tool. Dewalt's aims in their power tools were to balance the product at the lip of the trigger in order to achieve perfect balance. It also features filleted cutaways on either side of the forefinger knuckles to prevent the tool digging into the users skin. Also mentioned was the placement of the 5th digit (pinky) finger



being a problem area on a lot of power tools, where often the circumference around that area would not be small enough to be ergonomically comfortable. Power tools in the past would compromise on the shape of their batteries in order to meet ergonomic quota's such as these.

Moving onto material choice, he added that first impressions of a power tools tactile quality would differ from its long term use. While rubber overmoulding often felt good to grip with the hand at first, in common areas of hand movement, such as around the trigger, the friction of the rubber could also cause blisters from frequent rubbing. The use of hard plastics combined with rubber overmoulds, and careful material breaks will be important when designing for hand comfort and endurance in a power tool.

We briefly discussed styling within the tooling industry, with Paul noting that a house style amongst power tool families were generally determined by the handle grips. We also looked at power tools within the house, how easy they are to access and whether consumers would ever display them the same way kitchen appliances are featured.

It was an insightful talk, and some extra avenues of exploration certainly opened up after our discussion that will be explored in later research.

2. 03

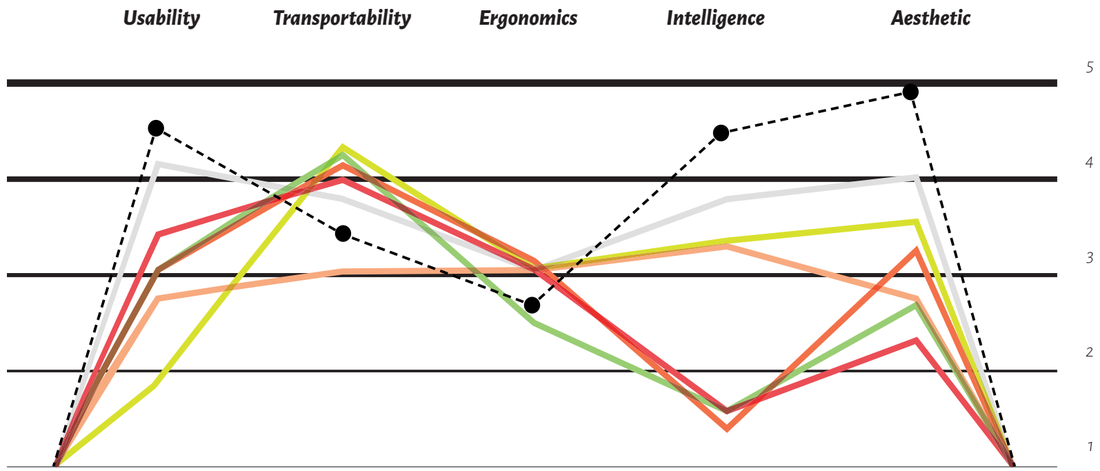
Evaluation: potential market offering

Key innovations from competitors in the power drills market were observed through product analysis and market trends. At this stage of the project, there appears to be potential in developing a mid to high end product. One with a focus on ergonomics, intelligence aided usability, and featuring a gender neutral styling.

While many tool companies undertake extensive studies and research into improving ergonomics, this is an area that is perhaps be more difficult to improve on given how extensive the ergonomics research is within the market. The science and level of user testing, as highlighted by Paul (ch 2. 02), would be difficult to beat against years of professional and validated research. Looking at ergonomics that will fit almost any user, and looking at how the grip of the power tool could perhaps be adjustable is a key feature that could separate this tool from the market and may be explored later on in the project.

It would also seem that the power tools market attempts to style its products with a more masculine tone to give the power tools a sense of sheer power and durability. Many drills have over-stylisation and ornamentation that give it a durable aesthetic. This project will look at how the same durable feeling can be achieved with an elegant form driven approach.

While keeping the physical design components of both ergonomics and styling in mind, this design will also look at ways in which power tools (which are a consumerist purchase), move into a Collaborative Consumption society. How the design will be affected by users who do not directly own a product, and how the usability of the product may change because of this new societal factor. The market analysis of tools follow on from this page.



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2. 03. 1

Modular tools: Black & Decker Matrix system

Sander

Trim saw

Router

Impact driver

Jigsaw

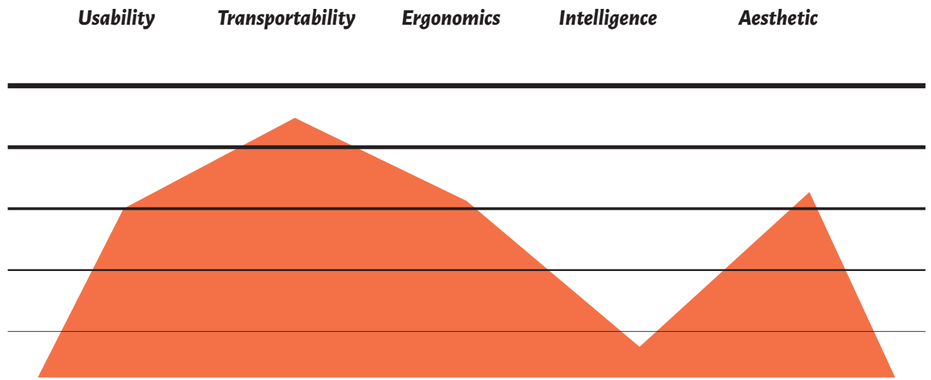
Drill hammer

Overview

Black and Decker's Matrix tooling system uses interchangable head attachments to a power drill. These attachments mean that one motor can be used for multiple tools, such as routing, sanding, and cutting. Users are about to purchase attachments as they need and don't have to give up valuable space at home when undertaking DIY projects.

Specifications

Price: $359 with all parts; $126 for drill
Material: Plastic
Dimensions: 31.75 x 10.6 x 24 cm (drill)
Weight: 1.9 kg (drill), 6.5 kg (total pack)
Battery: lithium ion
Voltage: 20V
Approx release date: 2012



The interchanging attachments on this unit increase usability as changeovers between tools are easy, as well as lightweight. While it would be classified as above average, Black and Decker's 'one size fits all' motor and interface for its Matrix range means they are only sufficient for the task at hand and rather than ideal. The overall ergonomics of the Matrix system is well-received, based on consumers that primarily use this tool in low duty tasks such as an at home DIY tool. This tool is not suited for heavy duty work and not evaluated for in this instance.

The Matrix system features filleted contours that soften the aesthetic of the tool, while the striped material breaks add emphasis to the tool. Black and Decker's Matrix tool has a reasonably balanced aesthetic compared to the rest of the market.

Pros

- Versatile range of tools
- Easy swapping between tools
- Very compact
- Lightweight
- Good value for money

Cons

- Not very heavy duty
- No LED
- No battery gauge
- Only 1 speed, no gearbox change
- One motor is not always most compatible

2. 03. 2

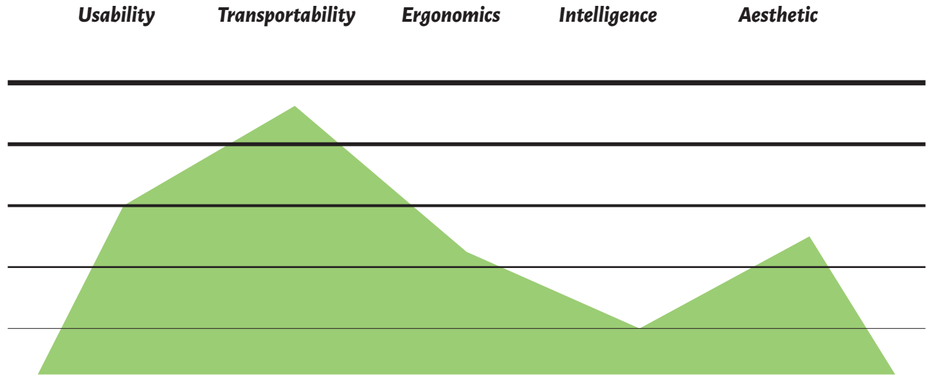
Modular tools: CEL Power 8 Workshop

Overview

Cel's Power 8 Workshop kit is a cordless workstation that transforms its stainless steel carrying case into a worktop bench. While similar to Black & Decker's Matrix series, Cel chooses to utilise the interface and battery as interchanging modular components, whereas the Matrix series chooses to use the motor, interface and battery. These differences in modularity allow for slight variations in attachments and their functions. E.g. Looking at the Matrix series router to Cel's drill press.

Specifications

Price: $440
Dimensions: 31 x 12 x 10 cm (drill)
Weight: 14kg (total pack)
Battery: lithium ion
Voltage: 18V
Approx release date: 2011



As with Black & Decker's Matrix system, the usability of Cel's system is increased by its modularity, but using the same interface as a power drill for a sander or jigsaw may not always be the most compatible option.

While heavier than the Black & Decker series, the Cel series includes a designated multifunction storage box with wheels for increased transportability ease.
Cel makes the claim of the Power8 tools being the "smallest 8 function tool box". The tool box size denotes the work bench surface area, which appears to be smaller than a regular work bench. While the tools may be ergonomic to use, the workbench that some tools such as the drill press or saw interact with may not be able to cater to a more varied demographic. The aesthetics of the attachments and interface pack seem slightly disjointed, while the storage box is robust looking with strong, sharp lines and chamfered edges.

Pros

- Versatile range of tools
- Very compact
- Workbench

Cons

- Workbench may be too small
- One set interface may not be suited for all tooling tasks

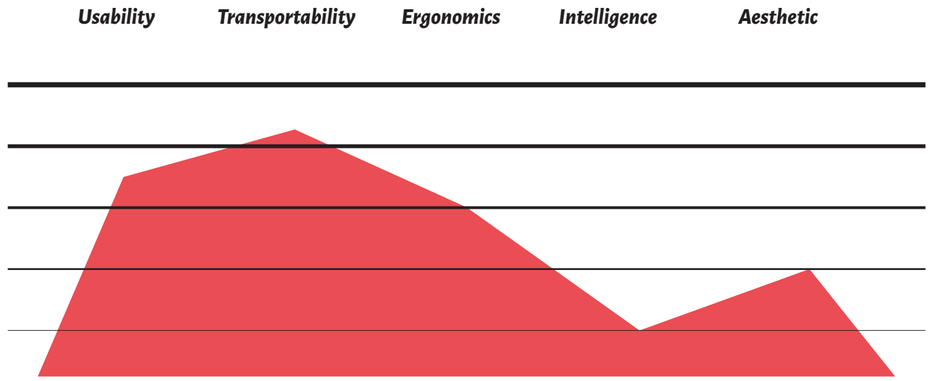
Modular tools: Milwaukee's 4-in-1 drill / driver kit

Overview

Milwaukee's 4-in-1 kit comes with modular attachment heads. It functions as a cordless screw driver fundamentally, but includes modular attachment heads that convert this screw driver into a drill. The tool includes offset and right angle attachments for easy maneuvering in tight or difficult to reach spaces.

Specifications

Price: $140
Dimensions: 20 x 12.7 x 40 cm
Weight: 0.5kg
Battery: lithium ion
Voltage: 12V
Approx release date: 2014



Milwaukee's 4-in-1 drill/driver modular kit sets out to accomplish a few simple tasks and accomplishes them well. With offset and right angle attachments helping the user to reach difficult places when working in a variety of scenarios.

Being a small kit, the Milwaukee set is easy to transport, with carefully thought out rubber and plastic material breaks to prevent hands slipping.
Milwaukee's kit features sharp, angular lines, which seem quite intense, but perhaps quite masculine styling. The dull shine to textured plastic cues hard wearing, and insusceptibility to dirt build up.

Pros

- Straightforward use
- Versatility when working
- Easier to reach difficult places

Cons

- For light duty jobs primarily

2. 03. 4

Intelligent tools: Ryobi phone works

Noise canceling earphones

Infrared thermometer

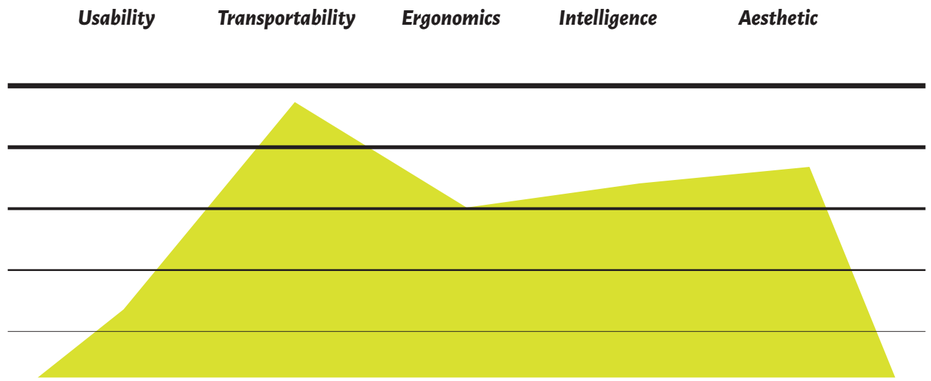
Stud finder

Overview

The Ryobi Phone Works series is a set of sensors that attach to the phone, allowing it to become an interface for the user to operate and receive information. These attachments include: Inspection scope, noise canceling earphones, infrared thermometer, moisture meter, stud finder, laser distance measurer, laser or cross-hair level and laser pointer.

Specifications

Price: app [free], Inspection camera [$100],
IR thermometer [$50], earphones [$20], moisture meter [$30],
stud finder [$20],
laser measurer [$80], laser level [$40],
Laser [$15], case [$20]
Weight: 20 - 200 grams
Battery: AA or AAA
Voltage: 12V
Approx release date: 2014



This range of sensors that interact with a consumers smart phone is below average for its lack in performance expectations, mainly due to the technology needing some fine tuning. With part of the tool component being a smart phone, transportability is quite above average, as most users will already transport their smart phone on a regular basis.

Simple shapes echo the shape of the phone, giving the user something they expect to feel when interacting with the tools.

With smooth fillets and chamfers for comfort from any hard edges. A connected app makes these tools smarter. With the noise suppressing earphones allowing users to make calls, and selectively block noises such as conversations and phone alerts. Its simple, clean and fairly gender neutral styling makes for a balanced aesthetic.

Pros

- Component sharing modularity
- Large LCD interface
- Smart
- Lightweight
- Good value for money

Cons

- Technology needs to catch up - performance lacking
- Relies on phone battery
- Only supports iPhone currently

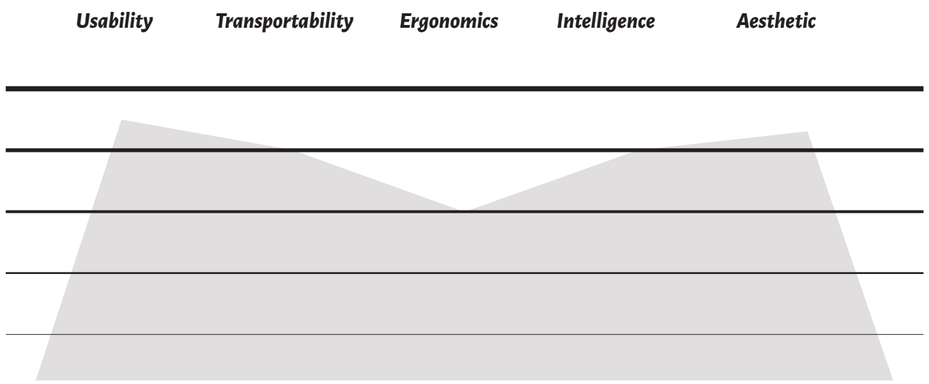
Intelligent tools: EasiDrive electric screwdriver

Overview

The EasiDrive by Alastair Warren is a runner up from the Core77 Student Design Awards. It is marketed towards those who are unfamiliar to DIY and power tools, looking to perform essential home tasks such as hang a painting or assemble a table. It features functional enhancements such as an alignment tool for drilling/screwing straight, and catching debris from working around the house.

Specifications

Concept piece
Dimensions: 14.4 x 13 x 4.1 cm
Approx release date: 2012



This electric screw driver features very accessible interface, that makes it clear to understand without prior knowledge. Though this product's purpose is to be used at home, it is easy enough to transport for due to its light weight.

EasiDrive features a number of aids to the user that makes it smarter than the average tool. These include depth markers for drilling, and the ability for the drill to guide the user at the correct angle when drilling or driving a screw.

The aesthetic is clean, with subtle curve treatment. Smooth surfaces and monotone colours keep the design simple, and shy away from giving the tool an aggressive aesthetic.

Pros

- Component sharing modularity
- Large LCD interface
- Smart
- Lightweight
- Good value for money

Cons

- Technology needs to catch up - performance lacking
- Relies on phone battery
- Only supports iPhone currently

2. 03. 6

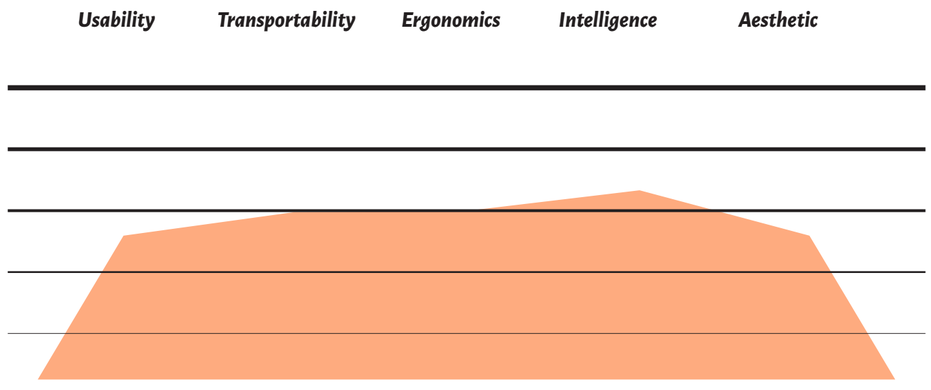
Intelligent tools: Black & Decker's Smart Select range

Overview

Black & Decker's Smart Select tooling series features an interface with pictorials to guide users that are unfamiliar with changing settings such as torque or speed to suit the task. In tools like the power drill, the interface is simplified further by removing interactions with the gearbox, and allowing the user only to change speed settings via pictorials.

Specifications

Price: $150
Dimensions: varying, 34.5 x 10 x 25 cm (drill)
Weight: 2.3kg
Battery: lithium ion
Voltage: varying, 20V (drill)
Approx release date: 2014



This is a range that, while attempting to create a better user experience with power tools for those who are unfamiliar, actually lessens the usability for more experienced tool users. Some new users will still need time to adapt to the pictorials and decipher them.

Overall this series seems quite standard in transportability and ergonomics, fitting most peoples needs. It attempts to be more intelligent to the user by allowing the tool to guide the user, rather than the user needing to decipher torque and speed settings.

This is a product range that is aimed at consumers that are less experienced, and likely not requiring a professional and/or high strength tool. The aesthetics match this, with softer curves and fillets applied to material breaks and form.

Pros

- Component sharing modularity
- Large LCD interface
- Smart
- Lightweight
- Good value for money

Cons

- Technology needs to catch up - performance lacking
- Relies on phone battery
- Only supports iPhone currently

2. 03. 7

Current concept drills

Pictured here are some examples of concept drills used as inspiration throughout the project. I found a wide variety, ranging from highly stylised to clean and simplistic forms.

Dust collector and 90 degree alignment tool. with retracting power drill head.

A drill for drilling onto radial surfaces, an interesting feature to address in a power drill.

Uses a flex shaft to give the drill rotary power.

The battery takes on a different form, as well as attaching to the power drill. Streamline, ribbon aesthetic.

E-ink display and interface, gives one place to view all information. Optimum for viewing outside, in bright lighting conditions.

Case study: Festool power tools

Festool is a German based brand which is known for its quality and safety focus in power tools. Most of its products come at a significant price compared to the market, but most users who are willing to invest in their tools find the investment to be worth it.

Design aesthetic

Festool separate themselves from the market in many ways, such as its use of a clean aesthetic. The tool utilizes sensible material breaks and sweeping lines while avoiding knurling, ridges and overly-ornate style. The use of bright colour is present in areas of interaction, such as buttons or release mechanisms. Internal Industrial designer at Festool describes their aesthetic as: "Form follows function. Which is really an old and much used term... still applies very perfectly to us." At Festool, the focus is on the "use of the machine, on the ergonomics and the functionality of it all".

Ergonomics

While ergonomics are hard to cater and test for in a research project such as this, it is still worthwhile taking cues from an area that a top brand such as Festool has managed to excel in. Where other brands are claimed by users to be "top heavy" or just plain "heavy", Festool has developed tools that are balanced in weight, with a centre of mass almost exactly in the niddle of the handle.

In some models, this could be attributed to the placement of the battery in relation to the main components of the drill. For example: Festool's CXS drill (Figure A) features a battery that inserts into the front portion of the handle. This not only ensures that the weight of the battery can be slightly shifted towards the front (balancing out the motor and handle), but also allows the handle to be a smaller size. Many drills without

Figure A

Figure B

a "D" handle feature batteries that extend into the handle itself, making it difficult to reduce handle size for comfort. These batteries can also be clunky, wider, and potentially upset the centre of mass.

Figure C

Figure D

Figure E

Functionality

Belt clips: Festool features some of the longest belt clips on the market across their numerous drills. Not only will it fit snuggly on a belt and won't run the risk of slipping off due to its length, it is also able to be taken out, and installed onto the otherside of the drill for personal preference (See Figure B).

Fastfix: The fastfix range pictured in Figure C, show an array of interchangable drill chucks that can be used on a number of selected drill models. Most of these feature a release-ring mechanism (Figure D), where the cover only needs to be pulled back to separate the chuck. Other types feature a simple, short twist motion around the base ring to fasten the chuck onto the drill. The Fastfix components offer a lot of useful attachments, in particular:

- Figure C, 2nd from left: the right angle chuck, which allows the right angle to be attached at any orientation in relation to the drill. Although it can only be used on the CXS drill.
- Figure C, 5th from the left: the offset chuck, can be used to drill closer to edges, without marring surfaces.
- Figure D or Figure C, 7th from the left: an extremly lightweight drill chuck. This however, only takes hex shank drill bits, and not cylindrical shank bits.

Electronic speed control: Figure E looks at Festool's electronic speed control, it allows users to gradually change the rpm while in motion allowing for better control over the tool.

[2.05] RESEARCH

Task Clarification: User research & trends

2. 05

Trends: DIY trending downwards, Injuries trending upwards

DIY is a trend that has risen to much prominence, and is predicted to be on a downwards trend(Will 2014), especially amongst younger households as they are shown to be spending less on DIY projects. Contrary to this, older homeowners such as baby boomers continue to be a growing part of the DIY market.

This is due to a multitude of reasons, such as those buying property later in life, and increased instances in renting. As a result, people are renting flats which they are less likely to renovate (bradley 2014). Bradley also quotes Leigh Sparks in the article, who questions whether the decline is due to the change in education system, where "people no longer learn the skills they would have previously got from school and those skills are being lost."

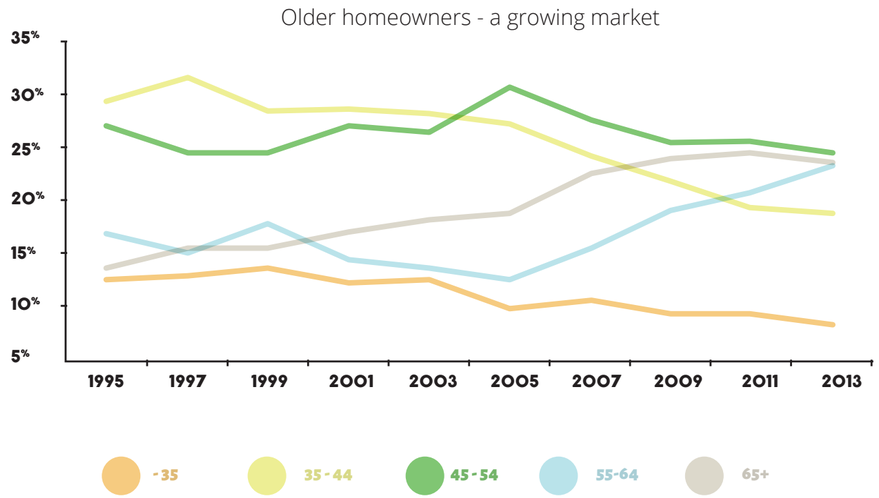
The lack in skill and knowledge, can perhaps be attested to the increase in injuries amongst DIYers (The West Australian 2014, Keene 2013). Consequently, users may feel a lack in confidence towards being able to complete a home improvement project, resulting in the homeowner resorting to professional help instead (Will 2014).

(Lowe's Home Improvement 2015)

A: "Went to Lowe's, the gave me a few tips. Pointed me to the right fertilizer and... Voila"
B: "Well it made a huge difference"
A: "And it made me feel like I can do anything."

Much of the current generation would rather pay a professional rather than DIY due to feeling a lack of capability when it comes to relying on their own skill. These have been answered with the rise of the 'Do it for me' or the DIFM market (Riha 2013), where professionals complete DIY projects instead. This is further supported by home improvement companies such as Lowe's (similar to Bunnings in Australia), where advertisements attempt to empower consumers to take on DIY projects (Lowe's Home Improvement 2015). By trying to make DIYers feel like they "can do anything" with a bit of advice from some home improvement employee's.

Even though DIYing is on the decline, and estimated to be non-existent by 2040 (Daubney 2015), it is still a large market, worth £7.3 billion per year in the UK, and it makes sense for power tool stockists to want to keep this trend going for as long as possible.



" Serious accidents are frequently blamed on 'human error.' Yet careful analysis of such situations shows that **the design** or installation of the equipment has contributed significantly to the **problems.** "

— Don Norman, *from The Design of Everyday things*

2. 06

Work flow scenario

A work flow scenario was explored in relation to power tool users who may choose to borrow from a tool library. This scenario in particular, caters for tool users with limited knowledge or resources when using power tools, who are perhaps on the brink of the tool users spectrum.

The user depicted here is one with limited resources but has some basic knowledge of using a power drill. The task is to drill a set of collinear holes in order to join two pieces of pine together using dowel.

After printing out a template for the holes, the user first starts with inserting a drill bit into the drill chuck. This serves as a pilot hole to help guide the 6mm holes later.

Smaller drill bits sometimes get caught in the drill chuck prongs, and can take slightly longer to install than larger drill bits.

Using the printed guides, pilot holes are drilled.

As a user with limited access to tools, this includes limited access to tool accessories such as clamps. This makes the job of steadying the work piece more difficult for the user, and increases the time spent on pilot holes.

After finishing pilot holes, a larger drill bit for the final holes is placed into the chuck. Using masking tape, the maximum depth of the hole is indicated, allowing the user to engage how far down they are drilling.

To be critical of this work flow, the drilling of the final holes were onto a workpiece that was not only without a clamp (possibly hazardous to the user), but also not entirely perpendicular either (resulting in holes that are at slight angles).

In addition to this, the masking tape indicator on the drill bit, while simple and resourceful, was not perfect either. When relying on the human eye, some holes were too shallow, resulting in the wooden dowels being too long for the drilled holes. While the printed guides helped guide the drill bit placement before drilling holes, they ultimately were slightly off centre, and not completely collinear.

Conclusively, it seems improvements are needed to reduce the human error within the work flow of a novice power tool user.

> In my experience, **human error usually is a result of poor design**: it should be called system error. Humans err continually; it is an intrinsic part of our nature. System design should take this into account.

— Don Norman, *from The Design of Everyday things*

2. 07

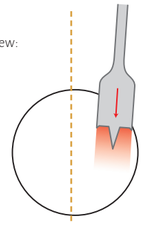
User observation: common errors and qualms using power tools

The activity:

A Design study was conducted, where 3 participants of varying demographics were asked to complete a DIY project by themselves from start to finish. The requirements of the DIY project were to make something that the participant would find useful and improve their living space. The participants had no prior experience using power tools. This was a self-directed task, in that the participants were asked to conduct this with only the aid of the resources they had available and could source themselves. With as little as possible help from the researcher supervising the design study.

Featured on this page are some key discoveries from the design study that all participants had trouble with, and will give insight to the design in the concept development stage.

Participant 3 liked doing things on the fly, not paying heed to working out measurements. Though she would often drill into wooden dowel on an angle, and often struggled to drill perpendicular to the tangent of the dowel.



Participant 1 opted out of safety glasses, due to the lack of aesthetic appeal.

Participant 1 & 2 both felt more confident testing power tools for the first time on a scrap piece of material.

Participant 2 chose to maintain minimal contact with the drill when changing bits.

She was apprenhensive towards the power tool, and found this part fiddly and hard to deal with.

The workpiece was too high for participant 2, resulting in drilling on an angle & poor balance of the power tool. One discovery all participants had trouble with was difficulty maintaining speed of the drill and jigsaw.

While participants understood that the speed was proportional to the finger pressure on the trigger, they didn't have the muscle memory to achieve the appropriate speed they desired.

Eventually, the effects of the poor ergonomic positioning, which led to drilling another pilot hole at an angle, led to the nail being hammered through the side of the undertable by participant 2.

2. 07. 1

Participant 1: Computer monitor stand

07/04/2015 - 09/04/2015

Gender:
Male

Age:
late 20's

Occupation:
Paramedic student

Located:
Suburbs

Skill level:

- No power tools experience
- Has used some hand tools
- Maths and science tutor

Before DIY:

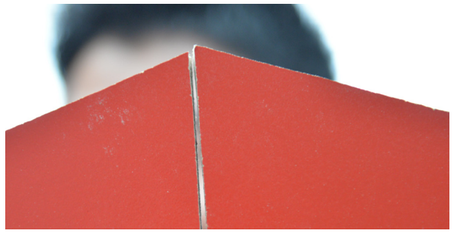
- Enthusiastic
- Wanted to make his own design, something "unconventional" instead of simply following a tutorial
- Had never heard of borrowing power tools

After DIY:

- "I will consult you [about] upgrades"
- "I definitely need LEDs"
- "It was fun"
- Would like to do more DIY in the future

Observations

- Constantly needed to double check measurements and each step, was not confident in his workmanship.
- Participant quickly realised that it would be economical to complete all the cutting tasks before joining.
- The user felt better testing out tools and techniques on scrap wood before using them on his new parts.
- It was hard for the participant to detect which resources he would be needing for the entirety of the project.
- The participant would often need a second set of hands to stabilise material while he was cutting.
- Was not eager to consult with any sales people at the stores he visited.



Because the participant could not tell how far down he had drilled, there were gaps between the two pieces he was attempting to join where some of the holes were too shallow. He decided to drill some holes further before gluing, but ultimately, the join still left a small gap.

The participant placed dowels in the adjacent holes to check the angle of the holes he had drilled

The participant had a difficult time maintaining an appropriate amount of torque on the drill when completing this task. Without a guide or a jig, the participant became wary of the angle at which he had drilled at, how far down he had drilled, and how far apart he had drilled.

Eventually progressed from using hard measurements and measured his work off existing pieces he had cut away from that already had the correct measurements.

2. 07. 2

Participant 2: Small side table

03/04/2015 - 12/04/2015

Gender:
Female

Age:
Early 20's

Occupation:
Medicine student

Located:
Suburbs

Skill level:

- No power tools experience
- Self-proclaimed trouble with following instructions

Before DIY:

- "This is scary"
- "I can't build an IKEA cabinet, let alone this"
- "How hard could it be, you just get 4 sticks?"

After DIY:

- "This is not for me"
- "DIY is way harder than med"
- The participant would not like to attempt DIY on that level again.
- "With IKEA, I hate that nothing is built, I just want them to come to my house and build it" that remark aside, the user did mention upon further inquiry that she wouldn't mind customising something to the extent where she could choose her own paint colour. "That seems doable"

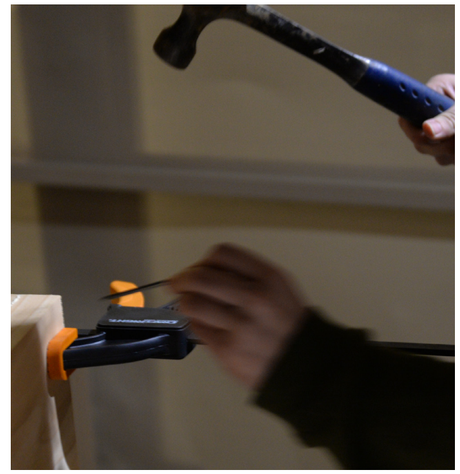
Observations

- Participant could not adapt well if measurements were missing from the tutorial, needed to ask for help.
- The user was not sure where to travel to in order to purchase materials.
- Was not sure on the difference between timber and wood. Was after some "regular" wood (referring to pine)
- Was not sure how to approach painting, and preparing surfaces for painting.
- Participant needed a hard copy of the tutorial.
- Was unsure of whether to glue pieces first, or nail pieces before gluing first.
- Clamp placement often not optimum, causing the workpiece or clamp to move out of position.
- Was often retracing her steps and unprepared.

Instead of opting for joining smaller pieces together, the participant decided to use some plywood instead. Was unsure of how to transport the material around the store, until the researcher suggested a trolley.

While at Bunnings the participant realised:

- That she did not have a list of measurements from the tutorial.
- That material could not be bought in the exact size needed
- That the tutorial was in inches, and Australian stores used mm
- That she would need to recalculate everything according to the materials that were available at the store and calculate material yield. This took a considerable amount of time.
- Had trouble converting inches to mm



The participant was unsure of how to insert a nail horizontally, eventually realising that the workpiece should be rotated so that the nail could be hammered in vertically.

2. 07. 3

Participant 3: Standing clothes hanger

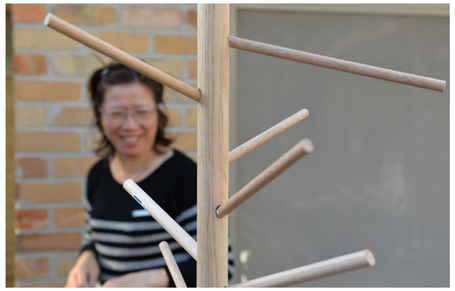
07/04/2015 - 12/04/2015

Gender:
Female

Age:
mid 50's

Occupation:
Accountant

Located:
Suburbs



Skill level:

- No power tools experience

Before DIY:

- Reluctant to do research
- Believed it would be easy
- Went in with no plans

After DIY:

- Discovered it was more difficult than she thought
- Enjoyed DIY, as it made her feel capable
- Was proud she could use power tools
- Wouldn't mind attempting another DIY task

Observations

- Participant was reluctant to use measurements, but opted instead for taking measurements by eye or off her hands.
- The user was not sure where to travel to in order to purchase materials
- Was reluctant to ask for directions when looking for materials, and also reluctant to ask for any advice when unsure of what to do.
- Did not want to follow a tutorial, but instead opted to make measurements off of pictures found online.
- The participant lacked the mechanical/muscle memory to control the speed of the power tools.

The participant asked for help from her husband in completing the task.

The participant had some trouble figuring out joinery and how the structure would support itself. With no plans and no tutorial, the participant had trouble putting the structure together. As a result, participant 3 required assistance on many occasions from multiple people.

" Don't think of the user as making errors; think of the actions as approximations of what is desired. "

Don Norman, from The Design of Everyday things

User profiling: Novice

Arnold Stanton

Age:
32

Located:
Suburbs

Occupation:
Software developer

Current situation:

- About to be married
- Looking at what kind of a home lifestyle he wants to have with his future wife.
- Wants some practical items on the wedding registry, such as power tools they might need for fixing things around the house in the future.

Experience with power tools:

- Little to none with power tools.
- Was never taught how to use them by his father, and has avoided or never been in a situation where he would need to use them

Wants power tools to help achieve:

- Some DIY around the house to save money like replacing a toilet
- Not wanting to resort to having to pay a professional to do work he could do using power tools
- Add a garden feature

Value Opportunity Analysis: Novice

Emotion
Arnold does not want to be adventurous, and would rather have a tool tell him what to do, as he lacks confidence in tools. He is happy with a tool that will give him more confidence.

Ergonomics
Arnold does not know much about tools, so is concerned with safety and how difficult it will be to use them.

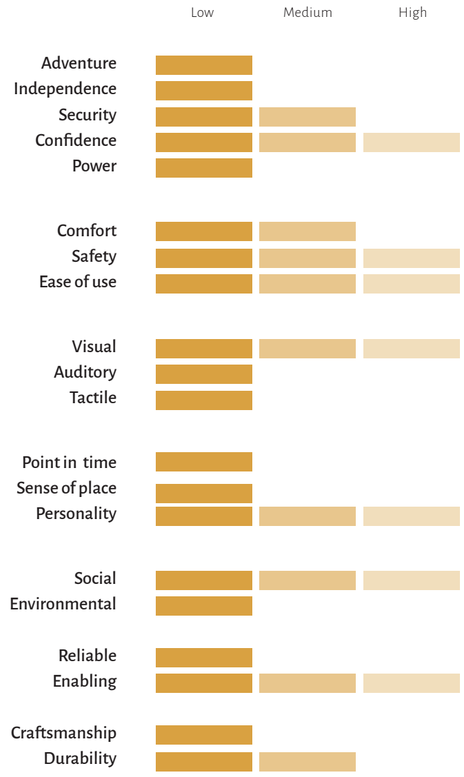
Aesthetics
Arnold is most drawn to a friendly looking tool, but not something that will attribute itself to his lack in skill.

Identify
Arnold is not very familiar with the specifications of tools, and so is more drawn to how a tool might sell itself to him.

Impact
Cares more about social movements than the environment

Core technology
Just wants the tool to enable him to get the job done easily.

Quality
Not much care for craftsmanship. Feels that durability of a tool might help him, but overall is unsure of how much durability he will need.



User profiling: Apprentice

Marcy Kern

Age:
23

Located:
City

Occupation:
Studying

Current situation:

- Studying at TAFE
- Relies on tools at the TAFE tool library workshop space
- Not enough money to provide own power tools

Experience with power tools:

- Surrounded by tools from a young age
- Her grandfather was a Cabinet Maker, but parents have office jobs in the city
- Quite competent with power tools, but wanted to go to TAFE to get a formal education and take some design classes

Wants power tools to help achieve:

- Starting up a business in making furniture
- Making a dining table set for her parents when she graduates
- Fixing up some odd ends for the landlord in the apartment complex they reside in

Value Opportunity Analysis: Apprentice

Emotion
Marcy values being able to place confidence in her tools, and feels that while the "smart" features do take away some independence, they give her more security in her work.

Ergonomics
Possessing smaller hands means the comfort and ease of use is very important to Marcy.

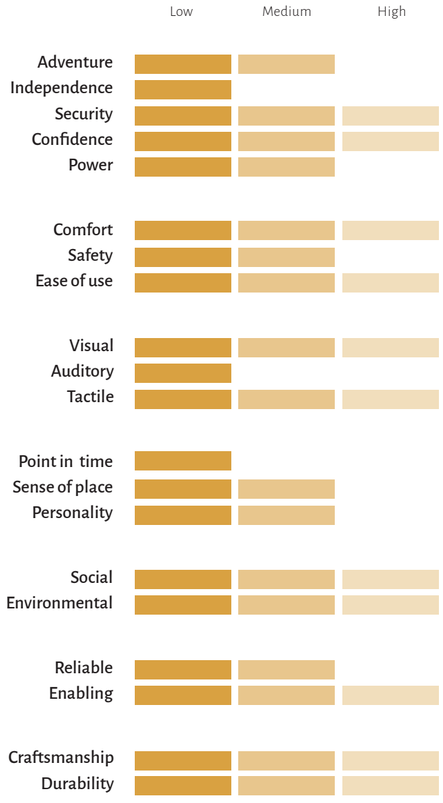
Aesthetics
Marcy is not bothered by noise, but appreciates tools with tactility that look reliable

Identify
Marcy does not mind how this product compares to others on the market, and would rather a tool that is right for the job.

Impact
Cares about environmental and social ramifications

Core technology
Is happy with a tool that enables her to be better

Quality
Enjoys well crafted tools that will last a long time. Does not often encounter these at the TAFE tool library.



User profiling: Professional

Phillip Bayley

Age:
42

Located:
Rural

Occupation:
Professional handyman

Current situation:

- Practicing handyman, with a personal workshop of tools
- Sometimes does contract work for company's, but generally works for his own clients
- Enjoys projects around the house
- Wants to teach his children some tricks of the trade but they are often on their computer or phone all day

Experience with power tools:

- Apprenticed to a Cabinet Maker when he finished high school
- Has always enjoyed practical tasks
- Uses a range of tools for plumbing, electrical and general woodworking tasks

Wants power tools to help achieve:

- Speeding up working progress
- Making his working progress more efficient

Value Opportunity Analysis: Professional

Emotion
Phillip enjoys being independent with his tools, being able to modify them when needed and using them skillfully.

Ergonomics
Phillip is willing to sacrifice comfort for a tool being safer and easier to use.

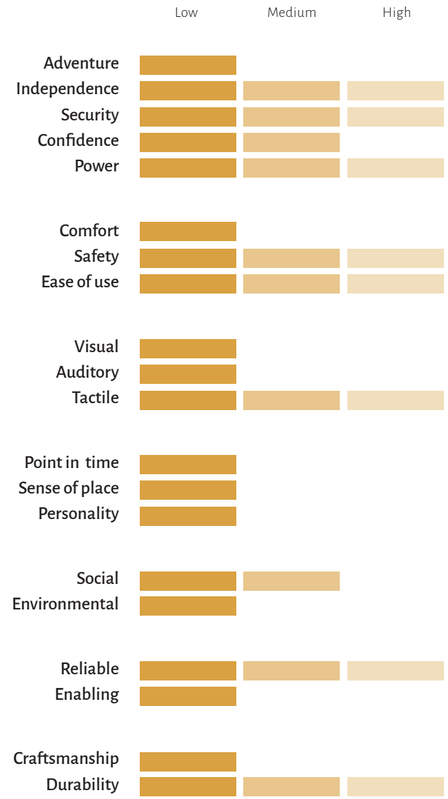
Aesthetics
Phillip leans towards tools with a more tactile quality.

Identify
Phillip cares more about the specifications of a product rather than how well the product fares on the market or its identity

Impact
Is less concerned with the bigger picture, but does place some importance on a tools impact in the community,

Core technology
Is confident his seasoned skills will enable him to do anything, just needs the tool itself to be reliable.

Quality
Enjoys something durable that gets the job done.



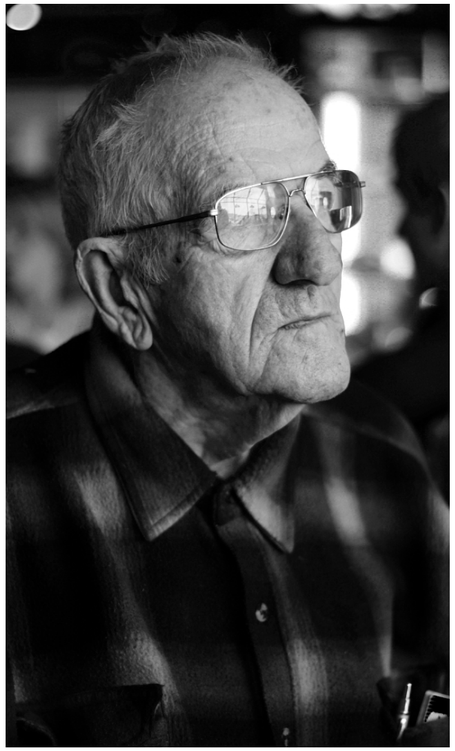
User profiling: Limited mobility

Peter Roman

Age:
75

Located:
Suburbs

Occupation:
Retired



Current situation:

- Living out his retirement
- Still likes doing DIY projects in his spare time
- Has arthritis
- Is both long and short sighted

Experience with power tools:

- Has years of experience working with power tools, and is quite comfortable around them
- With the development of his long and short sightedness as well as arthritis, his progress working with tools has slowed down

Wants power tools to help achieve:

- Finishing DIY projects
- Making a rocking horse for his grandson
- Being able to fix up the house without the need for a professional or technician, occasionally asks for help from a friend or his son

Value Opportunity Analysis: Limited mobility

Emotion
Peter is not as agile as he used to be. He still wants to be independent with his tools, but is not as confident with his muscle memory and is not sure if the tool's power will make him lose control.

Ergonomics
Peter is looking for something that is very clear to use, but is not expecting anything to be comfortable with his arthritis.

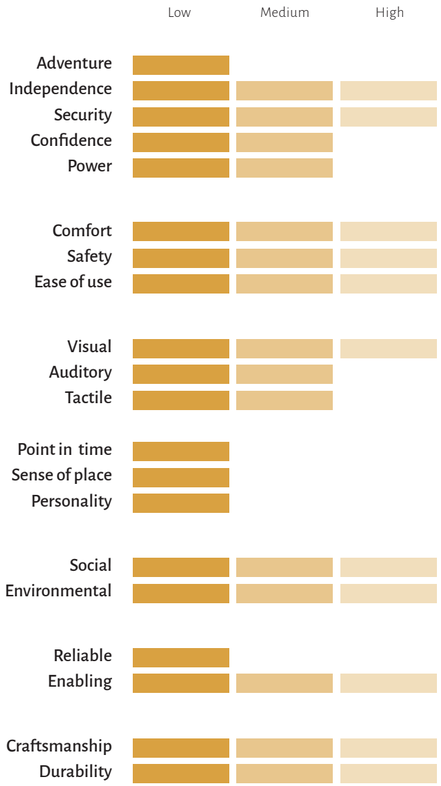
Aesthetics
Peter would like something with a visually clean interface, something he can understand easily.

Identify
Peter does not keep up with the latest products, nor is he drawn in by the personality of products. He only hopes that he will be able to understand any new technologies that come his way.

Impact
Peter is quite environmentally and socially conscious.

Core technology
Using tools can be more difficult for prolonged periods, Peter just wants a tool that will enable him to work better.

Quality
Peter has an appreciation for good craftsmanship, but feels less of the younger generation are getting into trades.



2. 09

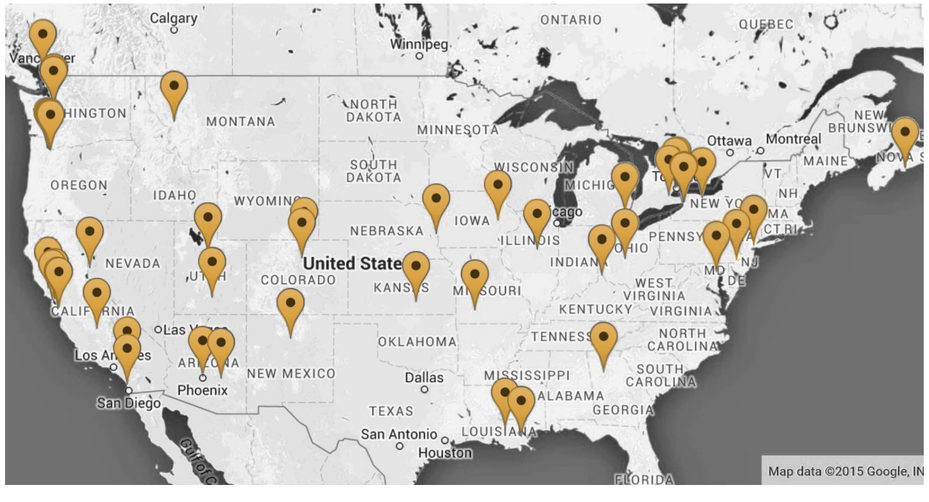
Trends: Collaborative consumption, Share Economy

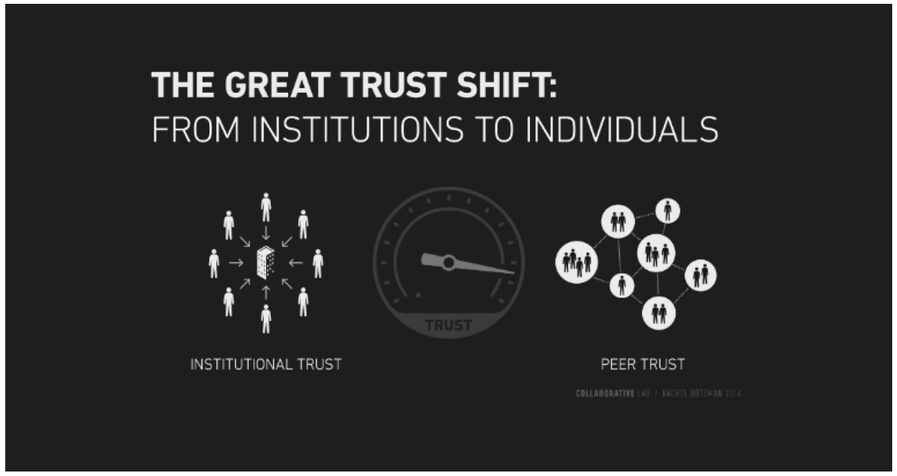
The digital age has been around for a good few decades, and its effect can be seen in almost everything nowadays. Libraries are an example of something that has changed and adapted greatly to meet growing users needs. From providing users with e-books and audio books, to providing 3D printing services (Library.gleneira.vic.gov.au 2015).

The landscape of local libraries, and the way that users interact with the library in relation to what they can offer is changing. The previous methods of borrowing books were quite rudimenetary, involving every book to be hand scanned by a librarian. It is evident to have come a long way though. Checking out books to borrow is now as easy as putting a pile of books onto a modern looking LED lit clear acrylic surface. After swiping ones library card, all the books are scanned simultaneously, and a receipt is given to the user. Easy, quick and simple.

What does this new age of borrowing mean for the humble power tool user?

The last decade or so has seen a rise in the addition of tool libraries. Which are as they sound - libraries that lend out tools to users. This is not just happening as an addition to traditional libraries that lend books, but has also been propelled forward by the creation of makerspaces such as the tool lending library created by Makeshift Society (core77, 2015),and Brunswick tool library in Melbourne, Australia. These libraries not only lend tools to DIYers, but also serve to help freelancers and small teams grow. They also look at providing creatives with cameras, light kits, audio equipment and other high upfront cost tools.





This consumerist shift from ownership to access is based on the concept called Collaborative Consumption. Localtools.org asks: “Do you want to own a saw, or do you want a board cut or carved? Do you want the drill, or the hole that the drill can create?”

Time magazine's ‘Today's Smart Choice: Don't Own. Share’ article further highlights this, and looks at other areas this is happening in. Music ownership was one of the earlier consumer models that became influenced by the notion of Collaborative Consumption. Instead of purchasing a track individually, users enter a product service system, and could then have access to an unlimited amount of music through a subscription basis.

Collaborative Consumption is particularly powerful for items with a high-idling capacity, like the power drill or a car. Which on average costs $8,000 a year to run, but sits idle for 23 hours a day. This trend looks at improving sustainability, where hyper-consumption is negated by purchasing and using only what we need.

Power tools have traditionally been developed for consumer ownership, and the influence of this rising trend questions how power tools would be different if they were to be developed for user access.

2. 09. 3

Collaborative consumption, Share Economy: the effect on makers

The rise of the so called, Share Economy, has not only allowed users to share and exchange objects, but information regarding these objects as well. This has produced alternative ways of using products, contrary to the object's designed intent.

To give an example, hacking IKEA furniture is a development where people use different IKEA furniture, parts of furniture, or IKEA fixtures to create something new or modify something existing. It has risen to popularity mainly due to its consistency of parts on a global scale. Where someone in one country could complete a tutorial posted by someone in another without the parts don't differing from country to country like many traditional furniture stores might do. As explored in a previous observational study. Some of the most frustrating and time-consuming parts of completing a DIY project would often be sourcing the parts. Many times, the participants' sourced parts would differ slightly to the ones specified in the tutorial, causing them to expend unnecessary time on the project at hand.

Figure A shows a bike rack made from a STOLMEN post originally meant to be used in a wardrobe furniture set. Combining these with two fixtures and four hooks, separate to the furniture set the STOLMEN post was from, produces a completely different product.

Figure B and C shows an IKEA table being hacked to transform into twin high chairs. The chair silhouettes were cut out using a jigsaw, and slot fit in, enabling them to be removable, and allowing a separate board to be placed on top to turn it into a regular table again.

Figure A

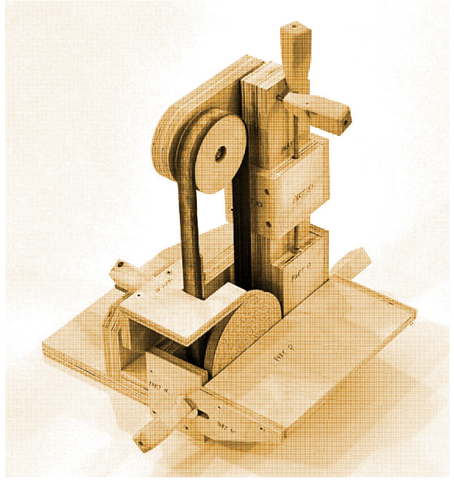
Figure B

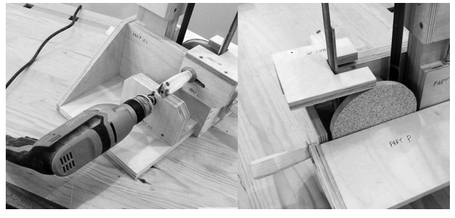
Figure C

The modification of tools is one that has grown more and more popular with more and more makers choosing to post their thoughts and creations online. Online, a power drill is not just a tool for creating holes and affixing screws. It's also used for planting bulbs, making art, peeling fruit, spinning yarn, making rope, making cables, making combat robots, cracking pepper, just to name a few.

Similarly, others choose to develop the drill into another tool in itself. By using the rotational power of the drill, many users create tutorials for transforming the power drill into lathe's, bobbin sanders or makeshift drill presses, and these are abundant on the Internet.

It is important to consider, and perhaps even cater towards, these alternate uses for the power drill that are becoming more widespread. Users are no longer commonly learning how to use a drill from their predecessor's.





Collaborative consumption, Share Economy: the effect on makers

More and more individuals, particularly experienced users, are getting their say in how a product should or could be used, and these users now have further capability (by reaching large audiences online) to educate new users on how to use tools in a way that might stray from traditional methods.

Many tutorials and tips by seasoned users mention adding components to the tool to make the task easier. Winner of Australia's National Cabinetry Apprentice of the Year Adam Bredhauer, talks about modifying the power drill to make tasks easier as well. Such as using masking tape to mark how far down a drill bit might need to go. Or alternatively using a hack saw to mark a line on the drill bit as well.

Jimmy Diresta, a well known youtuber and an experienced power tools user who has a large audience. Diresta gives tips like bringing more drill bits than needed to job sites in case they break, (Figure D) or switching into first gear for better battery conservation. He describes all these tips as:

"Just a trick, you learn the hard way".

Figure A

Figure B

Figure C

Figure D

Figure E

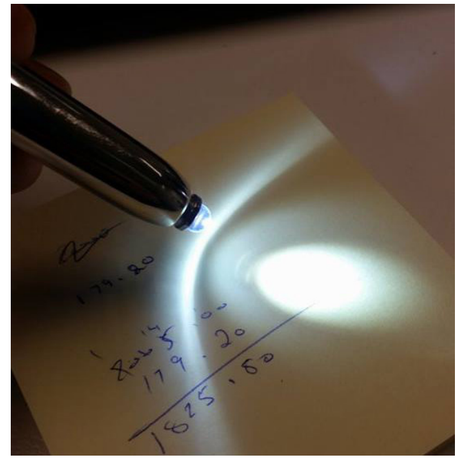


Figure F

Figure A: Diresta also voices his opinion about the design of the drill in itself, criticising companies for their aesthetic styling: "Drills should not be designed to look like basketball sneakers, they should actually follow the function of what they're meant to do."

Figure B, Figure C: He then follows on with some suggestions for design improvement, (something that will be taken into consideration in this research project) explaining that designing a drill with functional flat surfaces meant that the drill could be incorporated into an on-site drill press using the rig shown in Figure B. Additionally, in Figure C, he demonstrates that this would not only be beneficial when drilling "parallel to the floor" but also in corners as well.

In figure E he suggests using a pre-drilled hole to guide a faucet bit to ensure the workpiece does not become damaged when needing to re-drill a hole, or even a new hole.

Figure F: A friend talking to a local tradie sent this picture as a tip. Using a light to determine how far off from perpendicular the drill was driving at.

While these add-ons are usually cheap and easy, these elements require exploration and discovery from the novice user; in some ways this struggle becomes an initiation into becoming a more experienced user. I observed great difficulties in the projects of my participants (ch 2.07) due to this lack of knowledge and understanding, which begs the question of whether this initiation is really necessary. Rather than the user being forced to discover how to use the tool through trial and error, perhaps the tool should facilitate the learning from the start.

“ Do you want the drill,
or the **hole the drill can create?** ”

— Rachel Botsman in
The Case for Collaborative Consumption

Pictured above: Karleng Lim at the front desk.

2. 10

Interview: President of Brunswick Tool Library — Karleng Lim

So how long have you been a part of this library?

2 years.

And do you live close by?

I used to, but at the moment no. It's sort of my day trip into Melbourne, so I try to pack it in.

Do most of the customers live around here?

Yeah most people live around here.

I know you're a not-for-profit, so is this library completely run by volunteers?

Yep, completely volunteers, so we're still growing on our own. We're hardly making enough to cover our rent and insurance. We did apply for a grant and we got a 3 year grant from Malvern Council. So that helped us build the library, not to run it. But it does help us grow, and hopefully get more members... So hopefully in 3 years time we'll be able to stand on our own feet and be sustainable. But hopefully in 3 years we can hire someone to run the library on their own.

- Went to go serve a customer -

You were saying before, your role differs to other people in terms of your experience?

I am the president... We have a board of directors, uh, but most of the people that are volunteering here are on a more permanent basis, like me, do have a place on the board. It helps, being a volunteer, you know the library better than other people.

So what does your typical shift as a volunteer involve?

Staffing the library? Uh, as a staffer, just basically sign people up, show people around, check out tools. You know do the accounting at the end of the day. Quite, very... librarian. It's basically like a librarian.

2. 10

Interview: President of Brunswick Tool Library

What about being on the board and managing it?

They also staff the library. We have a volunteer coordinator, a workshop coordinator, marketing. I oversee how it all kind of works. What improvements need to be made. But we're also looking for roles in marketing and media to get the word out there. Which at the moment I am filling, but I am looking for someone who could do a better job than me... So it's basically someone to... radio advertise, advertise on Facebook, get the newsletter out. That sort of thing.

- Went to go serve a customer -

What would be some of the more difficult aspects of your job as a volunteer, or as president?

The volunteering, is easy, staffing the library is really no that difficult. I suppose. For me personally, because I'm running it. The most difficult would be finding and retaining the right people. People who have specific skill-sets, or who are very passionate... But like most organisations, we can't expect everyone to stay on. When it comes time for people to leave... it's hard, it's a bit scary. That's my headache. Other than that, look, I reckon it's kinda fun. So it's not that hard.

Do you get many inexperienced users coming in and borrowing tools?

We do, uh, as best as we can we do ask, like if they've used it. But if they're oozing confidence we just assume that they do. We do ask if they're taking something out dangerous, we ask if they have the proper safety equipment, or if they've used it before... We can't stop them from borrowing the tool, but we do ask that they get someone to teach them or supervise them.

So if they get hurt, will they be protected?

So they are protected under insurance, and we are too. But if they lend it out to someone else, then they are not protected.

I saw before with one of your members, he just went into the library, got to see the whole range of tools and picked out what he was after.

So yeah, most people have a plan, they know what they need to execute it. Or they don't have a plan, they speak to us and we work it out together.

What's your process for maintaining all the tools?

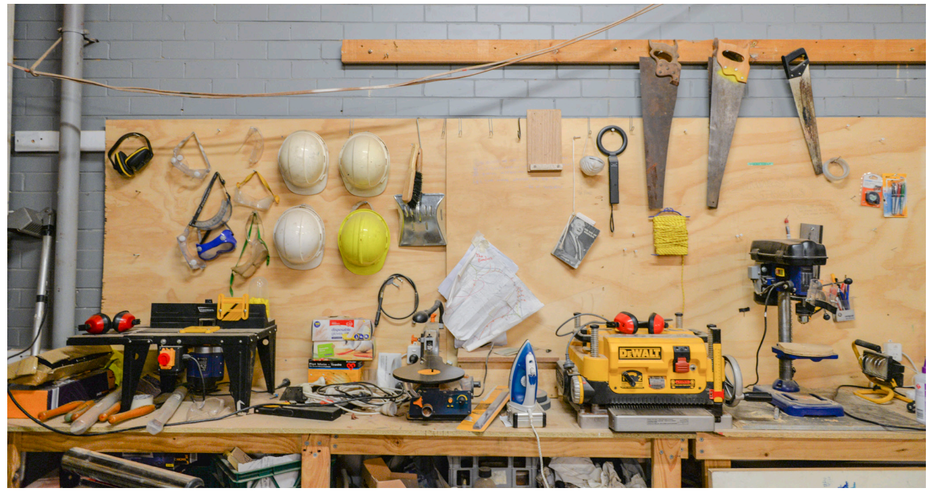
We have a tool guru. His name is Jeff Lawson... He tests and tags all the tools... every few months. But he does keep it up to date, making sure everything works. If something is broken we take the tool out of service, we have a software that allows us to keep track of the tool. If someone reports a tool, then we'll send it over to Jeff to fix it.

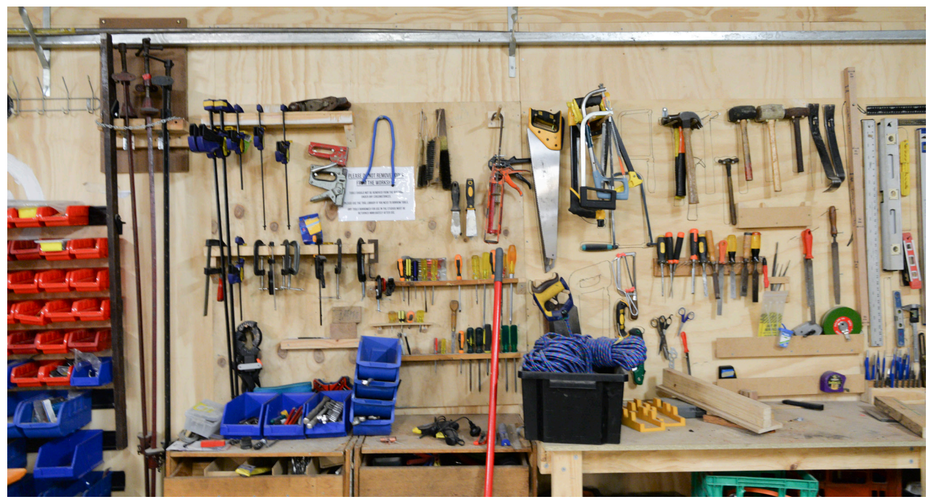
So the tools are fixed when Jeff has time to fix them?

Yeah, or if someone who knows how to fix the tools can fix them. If we can't fix it, then we ascertain whether it is worth sending the tool out to get fixed. Or whether it will be a whole bunch of problems, which means it will cost us more money to replace it. So we weigh the situation up.

It takes a while for the tool to be fixed?

It depends on the problem, and whether we can fix it in-house.





2. 10

Interview: President of Brunswick Tool Library

Do you sometimes buy tools yourselves?

Yeah, it's part of the grant money. The grant allows us to acquire new tools. A lot of our tools are donated, so inevitably due to wear and tear, every tool will break down.

- Went to go serve a customer -

This question is a bit more broad. How do you think the library will develop in the future?

Big space with big shiny lights! Nah I'm kidding. No, um. My best hope for it is that after the 3 years [of grant money], it will be sustainable... It will keep going on, it will outlive, us. It's a great community resource, so we're all working very hard to keep it alive. And we're developing systems to ensure that it works. So I suppose where I want it to go, is more members and a lot more variety of tools.

What do you think of a community based tool library compared to some of the more commercial renting systems out there? Do you think there is more room for community library spaces to pop up? Or do you think commercial renting spaces will be...

The go?

Yeah.

Um, look I think there's a real, undercurrent, like a movement of community based... anything. That's sort of, still very grass-roots at the moment. But it's part of the whole bigger, like, share economy. Where, it just makes more sense. It's sort of anti-excessive. Cutting that down, the things we don't need, just being more aware of now we consume... I think more and more people are aware... and also does make a lot of sense to save some money. A lot of people, before a tool library, would either rent commercially, which is expensive anyway, or go and buy a tool that they will use once or twice. You buy your tool like that, and it just sits under the bed or in the shed, and it just...

Doesn't get much use and is thrown away.

Yeah. Exactly. I mean everyone is guilty of that at some point. Right?

Not even with tools, just with other items.

Exactly, exactly. Like, uh, a blouse or something.
So uh, I reckon this is only a small part of a much larger, sort of movement, or just spirit of the times.

Is that perhaps one of your main motivations for helping run this library?

I joined up quite early. Like a few months in. So I didn't start this. Jolleen started this, but now she's moved back to the states and is the treasurer. I've stepped up to become president... So... Margot, who's also on the board, was giving a talk at a fair. And I was like: "Oh my god, that's a great idea! Where have you been all my life?" You know? That sort of thing, and I joined up, and the rest is history. I just came in here, fell in love with the whole concept. And I also wanted to be a little bit more handy... I don't think I was very handy.

2. 10

Interview: thoughts and analysis

I cross referenced this interview with a "Tool Libraries in Australia" report in made in 2003. While the data in this report seemed quite informative and very telling of the tool library situation and the culture of tool lending, it was however conducted over a decade ago. I sought to confirm whether anything had changed from the report 12 years later.

Pictured above: A collection of tools that need fixing

Some conclusions that appear to be quite similar between the 2003 report and my interview were:

Tool maintenance is difficult

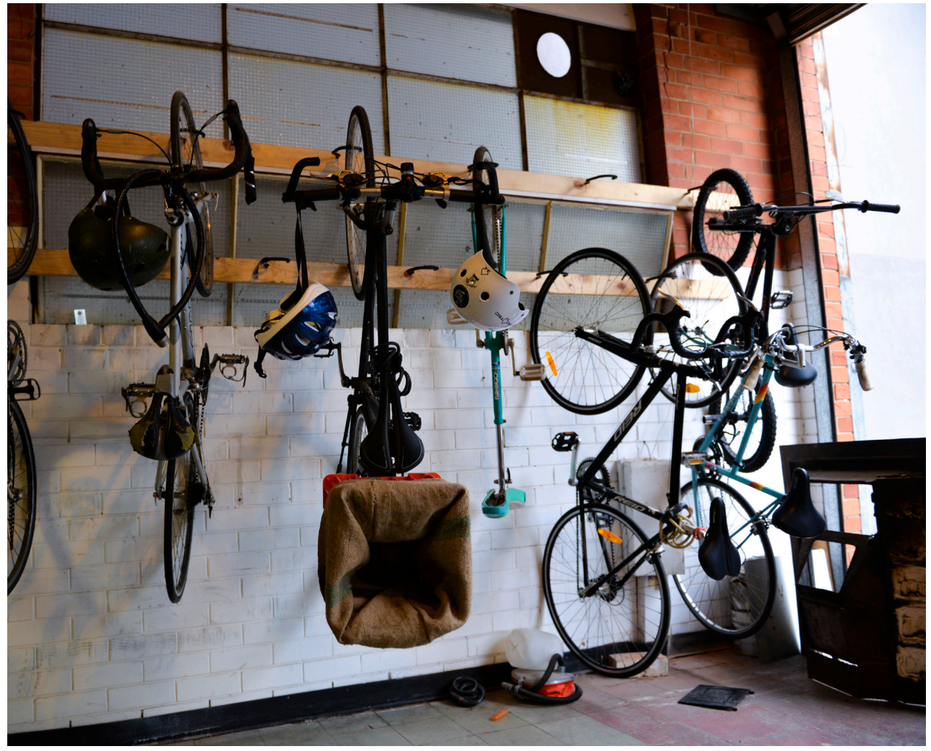
- While not every tool is going to be in circulation all at once, tools being maintained perhaps every few months might impact the systems efficiency. While it might not be critical in small libraries, in a large system with high circulation, long maintenance times could lead to system failure.
- The tools being donated and, less frequently, bought by the libraries are not designed for a rental system.
- Although the community aspect of the Brunswick library rental system seems to encourage people to treat the tools with respect, this type of attitude is not guaranteed and may vary in other systems that lack the community aspect.

Customer instruction

- Both the 2003 report, "Tool Libraries in Australia", and Karleng Lim from the Brunswick Tool Library stressed the importance of the user having some knowledge of tool operation and safety requirements. This means that in all current systems it is crucial to have interaction with a person or access to a user manual/guide. In the case of the Brunswick tool library where many tools are donated, this is something that is often missing from the tools.
- In all current systems it is crucial to have a person or user manual/guide provide knowledge. But in systems with donated tools, these sources of information are not always available.

Renting is here to stay

- Both Karleng Lim and the 2003 report agree that tools are an item that people are very willing to borrow rather than own.



2. 11

Trends: social roles

(Dewalt 2015)

Daubney (2015) furthers the insights into the decline of DIY by looking at the feminist movements that have happened in approximately the last century. With movements such as 'Heforshe' encouraging gender equality, men and women have begun taking on roles previously regarded as being exclusive to the opposing gender (HeForShe 2015) (Bavman 2015). Working with power tools in the past was regarded as being a masculine task, and brands marketed toward this demographic (Dewalt 2015). However, Daubney (2015) argues that men are not eager to associate themselves with power tools in this manner, especially with the topic of gender equality in constant flux and power tools being marketed as male-oriented products (Bosch Power Tools 2015).

Women themselves are also moving into different roles, as the demographics of home buyers changes. Within a dozen years, from 1985 to 1997, the amount of female homeowners doubled, and was predicted to continue increasing. Which in turn leads to a sequential progression of women taking on DIY tasks for the homes they own (Stevens 2000), with an admitted 60% of women claiming to carry out DIY projects over their partners, and considering themselves to be better skilled in comparison (Daily Mail Australia 2015).

Andreas Bergström, 39 years, Senior Probation Officer.
About to start 6 months parental leave. (Bavman, 2015)

When it comes to power tools, men and women have typically looked for different things (Stevens 2000). Advertisements typically targeted to a male-centric audience tend to show off sheer power by demonstrating the tool boring through material countless amounts of times (Dewalt 2015). Ryobi's Andrew Miller highlights that the macho domain of power tools is more concerned with "owning a big grunt tool" (Moses 2011) at the sacrifice of ergonomics, as the bigger the tool, the greater the power it seems. Women on the other hand, suggested by both Stevens (2000) and Moses (2011) are concerned with functionality and ergonomics:

"I look for tools, such as grinders, that have a smaller hold as this enables me to get a better grip and I can work longer. Unfortunately, there are not a lot around and often these tools have less power, which can be frustrating"

— Moses, 2011

[2.15] RESEARCH

Task Clarification: Ergonomic &
Anthropometric studies

2. 12

Ergonomic Analysis: Current market snapshot

This study was conducted in order to gauge what trends and notable features were available on the market. It took place at Bunnings Warehouse in South Oakleigh.

2. 12. 1

Ergonomic analysis: Ryobi ONE+ / $199

1

4

2

5

3

1, 2. Finger space is uncomfortable - can't really balance drill very well as drill is prone to slipping if not gripped horizontally.

3. Protruding, sharp part-line - After long wear, this would no doubt be abrasive and uncomfortable.

4, 5. Very clear pictorials.

2. 12. 2

Ergonomic analysis: Ozito / $149

1

2

3

1, 2. Basic numbers, no pictorials.

3. Forward and reverse indicator lights - unclear.

4. Recessed part-line, better than Ryobi, still protrudes and still could cause rubbing and abrasion.

5. Widely spaced dots on rubber over molding are different compared to most other brands.

6. Kind of a short grip, uncomfortable due to wide pinky area diameter.

4

5

6

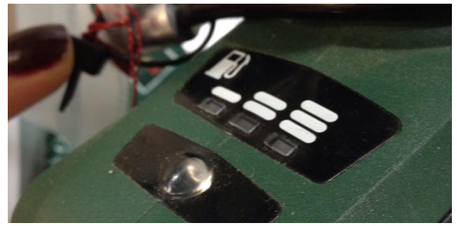
2. 12. 3

Ergonomic analysis: Bosch / $198

1

3

2



4

5

1. Integrated gear shift is simple and understandable.

2. Hard to read front pictorials due to rubber texture and reflectivity of material.

3. Person opening a book icon - unclear of what purpose it serves.

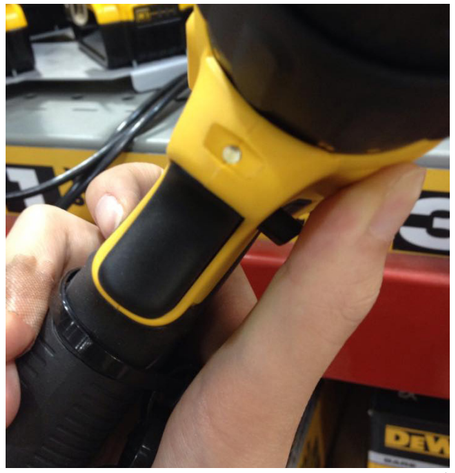
4. A battery gauge is useful, but a fuel icon does not fit on a battery powered device.

5. Another shot of the drill's interface. Very clean, simple and user friendly.

2. 12. 4

Ergonomic analysis: Dewalt / $199

1



2

3

4

1. Handle size is snug and also leaves enough space for a larger hand.

2. LED under motor.

3. Beautiful “part-line”, seamless and smooth to touch.

4. Texture break line is recessed giving a comfortable grip.

2. 12. 5

Ergonomic analysis: AEG / $250

1

3

2

4

1. The graphic is difficult to discern on a rubber surface that is so close to a material break that overhangs. At certain angles the shadow will cloud the text and decrease readability.

2. Strong lines, and very defined knurling.

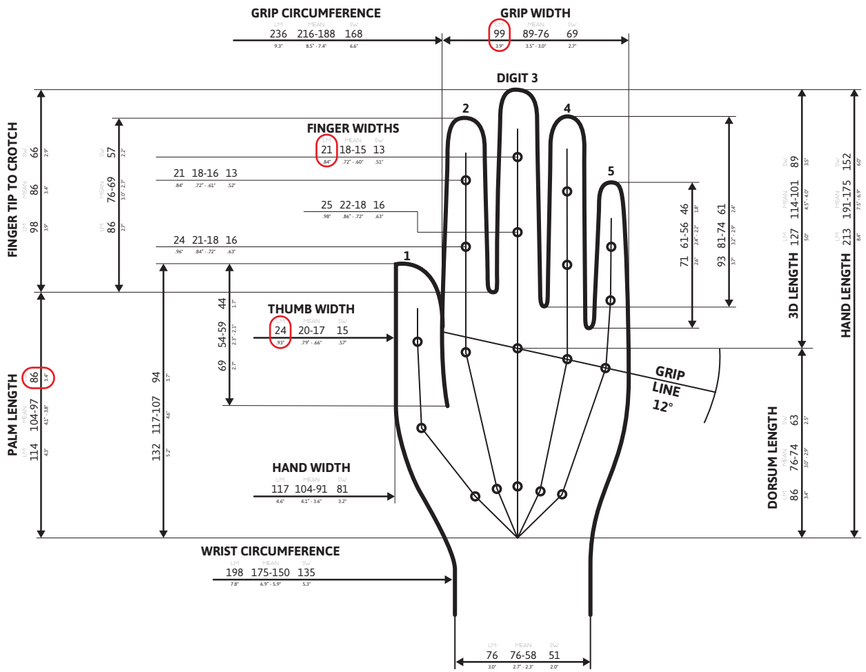
3. Vents are not usually this large in most power tools, given that it is an 18V cordless drill with similar specs to the others, it can be assumed it is not for functional reasons, but perhaps aesthetic reasons.

4. Exposed nails. Contribute to a sturdy, durable aesthetic.

“ The tool must be **fitted to man**...
Not the man to tool. ”

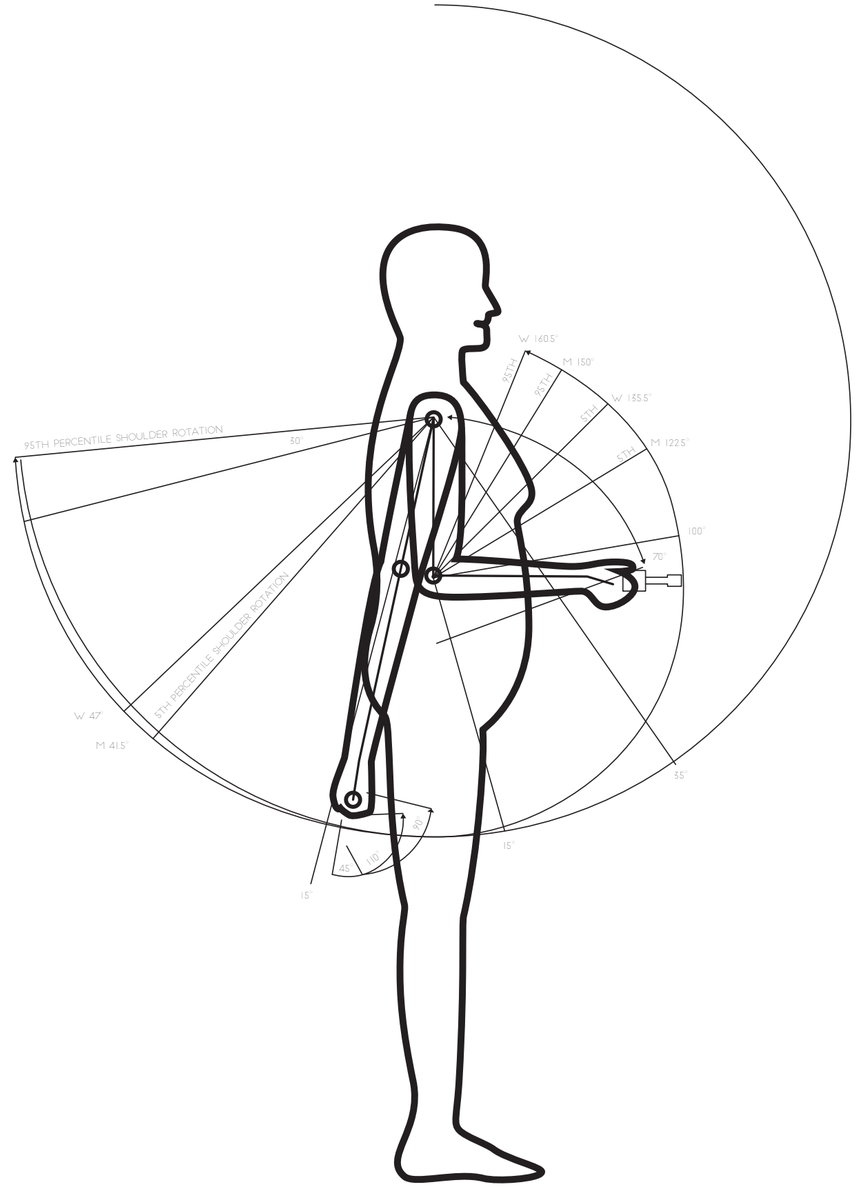
— Robert Bosch ‘*The influence of ergonomics on the design of power tools*’ *(1987)*

Ergonomics & Anthropometrics: Hand + interface data

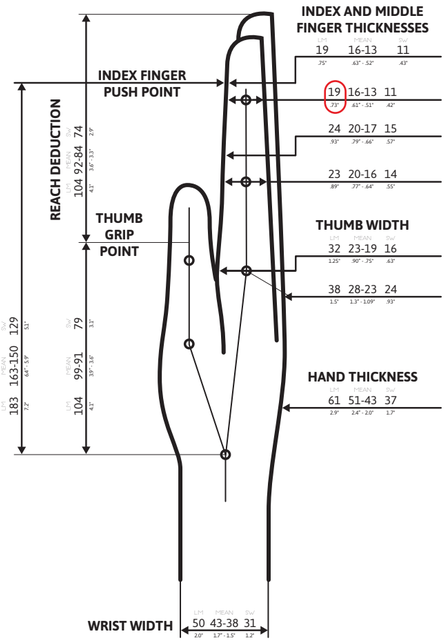


Recorded on this page are the hand measurements of the 99th percentile male and the 1 percentile female, in hopes that this will give a solid indication of a reasonable range of measurements to begin developing the ergonomics of the power tool.

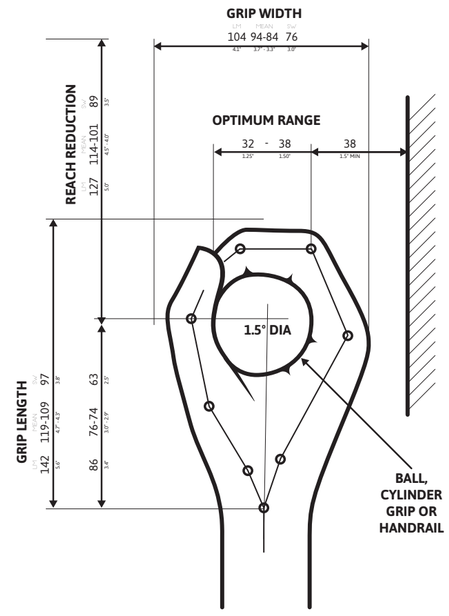
The grip width will be used to determine the handle's length, and the thumb width will be used to determine the length of the trigger area.



Ergonomics & Anthropometrics: Hand + interface data



Index finger width is important for the trigger width and the length of it is important for determining trigger area diameter



It is important to note that when using a power tool, the angle of the whole arm, and its relation to the body, can be a deterrent to maintaining a neutral hand position while working. While my project so far looks at the ergonomics around handle grips in power tools, such as drills, it is also important to study the anthropometric body data and to relate back to the positions in which people put themselves in while working with a power tool. Because adding weight or pressure to push the drill in further, or saw cut faster is all part of a whole body movement.

2. 13. 1

Handle ergonomics

Gripping in neutral position

Extensive documentation exists in relation to the neutral position of the wrist, and its benefits in both preventing injury and providing the greatest operating potential for the user. A neutral position for the wrist, is one where the grip and the forearm maintain an angle of 100-110°. This is something that has been used at an advantage when designing for tools.

In figure 1, by redesigning pliers to accommodate a neutral hand position, greater grip strength is achieved, which consequently enables the user to provide greater torque strength when using the pliers. In turn, helping prevent any repetitive strain injuries that are commonly associated with using pliers in a professional environment. (Mital and Karwowski 1991)

In figure 2, it is apparent that the angle of the saw handle allows the user to maintain a neutral position while working. The carpal bones in the palm are of different lengths, providing the angle of the neutral position. These should be taken into consideration when designing for other tools using a similar gripping technique (Pheasant and Haslegrave 2006)

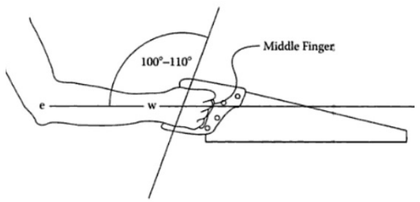
When designing a handle, the index finger must be able to react quickly, and be able to feel where all the controls are. The user should not be feeling around "blindly" for any controls. A slight angle must be maintained that is close to the neutral postiion of the hand. In addition, no harsh or tight curves should dig into the users hand.

Fig 1.

Conventional and redesigned pliers

Fig 2.

The neutral position of the wrist is preserved if the axis of the grip of the tool makes an angle of 100 to 110 degrees with the axis of the forearm



2. 13. 2

Handle ergonomics: bodystorm

" The grip shape should be such that maximizes the area of contact between the palm and the grip. Maximizing this area of contact leads to better pressure distribution and reduces the chances of forming pressure ridges or pressure concentration points. This is particularly important for tools that require a power grip. "

(Mital and Karwowski 1991)

Further study into grip size in relation to the shape of the hand is undertaken in a body storming exercise with a number of household cylindrical objects ranging from 20mm to 75mm in diameter. This ergonomic test was undertaken to better understand the importance of size and shape in relation to the hand. It is not applicable to all hands in terms of looking at exact measurements, as everyone possesses different measurements. However, understanding the effects of what is too small, what is too large, and how this affects the neutral hand position for a user will hopefully lead to a better understanding of how to design for demographics where this is commonly the case in hand power tools.

2. 13. 2

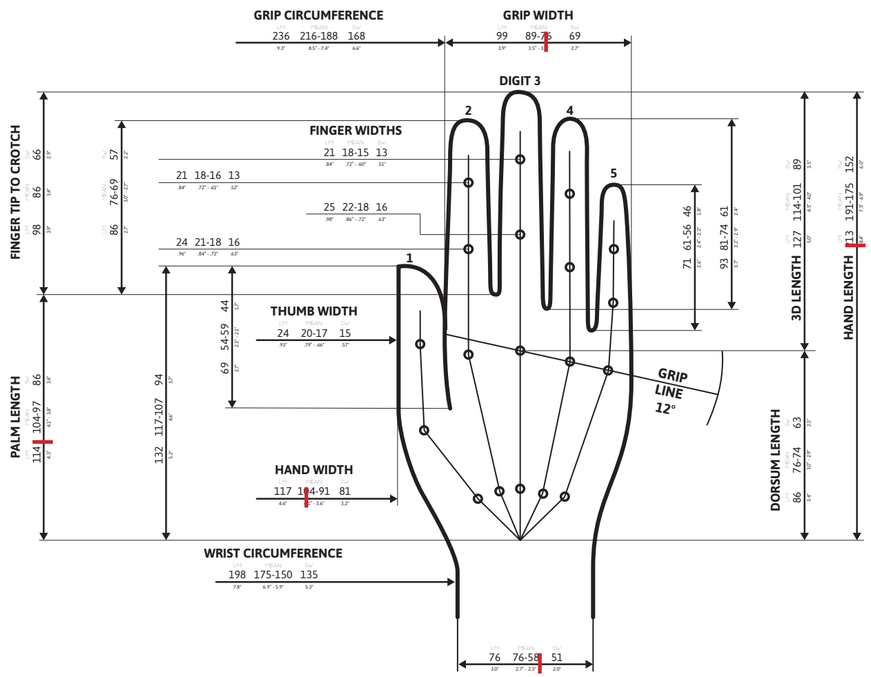
Handle ergonomics: bodystorm & analysis

Note: Some of the findings from this exercise were quite self-evident, but nevertheless provide a further understanding of the hand and its anatomy.

I measured my hands, for my own reference, to determine what percentile I was approximately at in terms of grip width, hand width, wrist width, hand length and palm length. These are indicated on the anthropometric ranges for female hands below:

When completing this ergonomics exercise, and studying the different cylindrical sizes, two key elements were analysed:

1. How much area of contact there was between the palm and the grip
2. How close the shape of the grip deviated from a neutral position across a variety of sizes



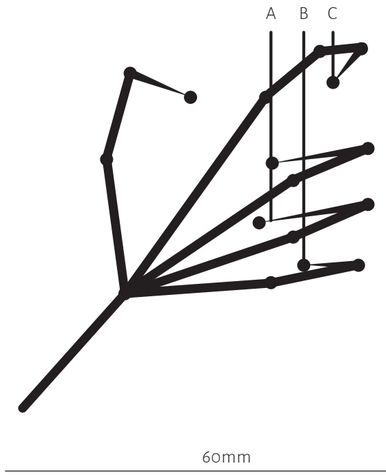
Findings:

- 20-37mm: At small diameters the fingers would crowd over each other, and nails dig into skin of the palm. Thumb overlaps.
- 52mm: Full palm coverage. The most comfortable range for my hands. With 50mm being the minimum range stated by Mital and Karwowski (1991).
- 60-72mm: The misalignment away from the neutral position looks and appears more prominent.
- 64-74mm: A brief look at a deviating diameter of a cylindrical object.

Comfortable, but why? The comfort comes down to the purpose of the object, the ergonomic aim of this thermos was to pivot at approximately where the red line is indicated. This means, the pressure put onto the fingers by the ergonomic aim of the product is focused on primarily the third digit finger, with the second and fourth digit finger there to stabilise the third digit finger. The fifth digit finger, rarely comes across any real pressure/strain, making it a strong, comfortable grip.

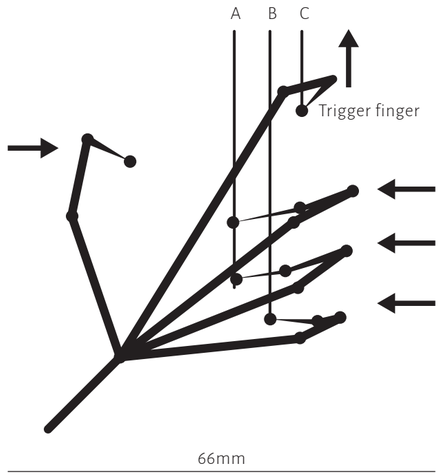
2. 13. 2

Handle ergonomics: bodystorm & analysis



After studying the findings of the experiment more closely, I mapped out the structure of the hand's anatomy to look closely at the deviation in the fingers. It was found at larger diameters that the fingers needed more pressure in order to maintain a firm grip onto the object. The second digit (forefinger) and fifth digit (pinky), strain themselves more compared to the third digit and fourth digit fingers. This is because the weight/pressure of the grip had been transferred to the ends of the fingers (digital phalanx and middle phalanx). These areas of the fingers are commonly used for pinch grips (Patkin 2001) and should be used sparingly as they wear the hands out faster (Mital and Karwowski 1991).

This explains the need for a smaller diameter towards the fifth digit finger in power tools, whilst the second digit finger is left to provide pressure vertically to help stabilise the tool, instead



of horizontally to wrap around the tool. As the forefinger will be busy navigating the trigger, this leaves the horizontal pressure of the grip to 3 fingers and a thumb instead of the hole hand. Which makes it even more important for power tools to be able to cater for a smaller diameter around the fifth digit finger, in order to reduce the effects of hand strain over long term use in such a position.

[2.19] RESEARCH

Task Clarification: Technology & trends

2. 14

Trends: Technology and sustainability of craft

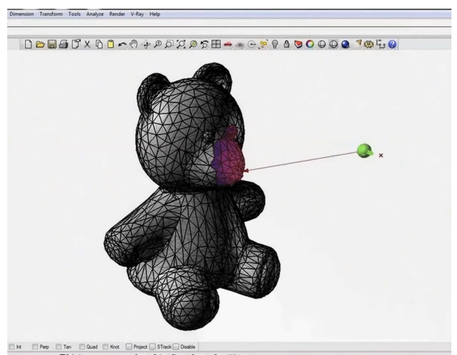
Innovations in power tools have traditionally been led by improvements in technology, such as a motors efficiency, speed, or size. Technology will always be a trend that power tools will follow, as it is something that continuously improves. Common products used in an abundance of applications, such as batteries, are constantly undergoing technological innovations to become more efficient, with researchers repeatedly looking at methods to make them smaller, more powerful, and longer lasting in product lifespan (Condliffe 2013).

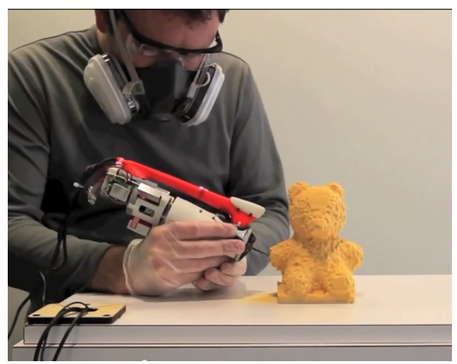
A longer lifespan to products as a whole is important for sustainability, in a shift away from a wasteful, consumerist society. Technology is now beginning to embrace and aim for concepts such as Cradle to Cradle (Gizmodo 2013). In some instances, developers and manufacturers aim to improve the longevity of hardware by introducing modularity to easily swap out broken components instead of disposing of the whole product that still contains working parts (Hakkens 2013).

(Hakkens 2013).

With the rise of cheap manufacturing through the aid of intelligent machines, such as additive manufacturing, one must question how long crafted goods made by either hand or power tools will remain attractive. Researchers at MIT are finding a way to blur the distinction between the hand-made and machine made, by creating computer assisted tools (Chandler 2013). Pictured below is a sculpting device for amateurs, to overcome the barrier of learning a new trade, using intelligence of the computer to help sculpt an object. Tools such as these may be commonly referred to as “Computer Augmented Power Tools”, as they look at connecting the feeling of a hand held power tool with the control of an automated machine (Taktia.com 2015, Handibot.com 2015).

This growing trend to merge power tools with technology is seen further with developers engaging smart phones to interact with power tools as well. Such as Ryobi Phoneworks, which incorporates sensor technology with smartphones (Ryobitools.com 2015), or with the Kickstarter project, “powerisite”, where a user can recharge their smart phone on a construction site from a power tool battery (Sparkfactor products 2014). Smartphones, in many ways, are the new interface to interact with a growing number of components in the world around us (Consumerphysics.com 2015). Technology, in its many forms, is a constant propelling factor to the innovation of new or existing products, and is something the hand power tools industry should be looking to incorporate seamlessly to improve the user experience of tools.





2. 15

Batteries and Wireless Power Transfer

Batteries can be quite expensive, and for power tools they are essential to its operation. Battery capacity can often increase a tools price range, and due to this, in some cases are highly sought after theft items in relevant workplaces (Panasonic Corporation, 2014). Current batteries also produce the additional problem of adding significant weight to the tool in cordless varieties for some users. This can hinder on maneuverability and ergonomics for weaker users. Batteries are also vary amongst tool models within brands, and only recently have started to become homogenised for ease of use. Current batteries also run into problems such as deterioration over time by running less efficiently and requiring time to charge, often overnight. To counteract this, many frequent tool users will purchase multiple batteries or drills to swap out when the other runs out.

The development of research towards more efficient sources of power and energy is one that has been ongoing, and will see benefits in portable electronic devices, electric vehicles, implantable medical devices and other tools (Chan et al., 2007). While there are many theoretical, hypothetical, prototypical and upcoming market solutions, they all glaringly boast to improve on what is currently on the market. It is but a natural route for hardware to improve on efficiency with further technology developments. Some viable options for incorporation into this research project are as follows:

Silicon nano-tube lithium ion batteries
300% longer
More efficiency - smaller batteries
Currently at 99% efficiency, just short of 99.9% to be viable for the market.

Aluminium graphite batteries
Flexible, thin
Fast charge - 1 minute
Although half the holding power of current batteries

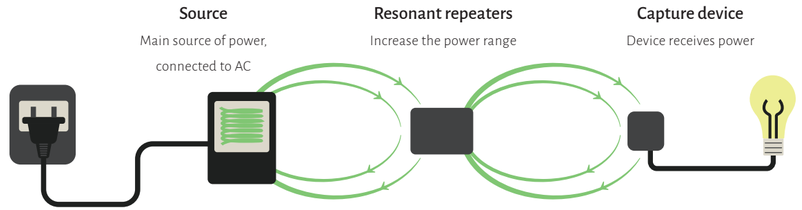
Storedot
Biological semiconductors
Fast charge - electrical car in 3 minutes
2017 release

Lumopack
Charges in 6 minutes
Battery itself charged in 30 minutes
2015 release

Wattup
Power via radio waves
Harvests energy up to 6m away
2016 release

Ryden dual carbon battery
Utilises current lithium ion battery factories
Sustainable - uses carbon
x20 faster charge rate

NTU fast charging battery
x10 longer life
70% in 2 minutes
On the market



Witricity
Using passive repeaters to extend the range of the wireless energy transfer.
On the market

30 second rechargable batteries
Uses supercapacitors
No loss of capacity
2014 release

Semisolid lithium ion batteries
Bendable and foldable
Suitable for high-density usually larger batteries
Improvement in manufacturing batteries
On the market

Concluding decisions and thoughts
For the purposes of this project, Witricity seems best as a charging option. It features the longest range out of all current wireless charging technologies, and can extend its range of wireless charge by using passive repeaters. It is the most efficient when compared to other methods, such as radio waves, as it does not require further amplification. The illustrations on this page depict the extending of Witricity's charge range.

Choosing a battery on the other hand, is perhaps more arduous due to the sheer volume of different types of new and improved versions upon the lithium-ion battery now on the market, or soon to be. Many boast applications in portable consumer electronics, and all claim to be more efficient, safer, with faster charging times, and more sustainable than its predecessor. No power drill on the current market has released a model utilising these new battery technologies, and so no matter which battery is chosen for this project it will stand to be an improvement upon the current market. Using time frame to narrow the technology choices down to current market releases, and taking into account the need for a battery to be dense and small, the chosen battery is a semisolid lothium ion battery, developed originally at MIT.

Illumination

Placement

LED's are present on almost all power drills nowadays, and they are commonly situated underneath the drill chuck. Some are placed near the battery (Figure B), and others are placed as close as possible to the chuck, usually near the trigger, (Figure A) to provide the best possible illumination to the workpiece being drilled into. It is often a priority for designers to be able to position a light where it will best illuminate the end of the chuck, so that it is as clear as possible where to aim the drill. Other drill designs have attempted to be better at this by situating light sources on the end of the drill chuck, as close as possible to the drill bit itself (Figure C), while definitely better, this is not yet a common occurance in drills currently on the market.

Some Festool drills (Figure D), a quality high-end tools brand, do not include inbuilt lights, but instead give the user the option of attaching a light onto the chuck of their drill. This also doubles up as a headlight when needed. The headlight option is an interesting choice, as it gives the user the flexibility of moving the light to an angle they desire, without being restricted to the fixed placement of the light on the drill. Below, a diagram illustrating the placement of light on a drill and how this may affect visibility.

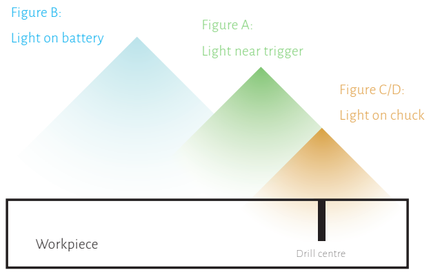


Figure A

Figure B

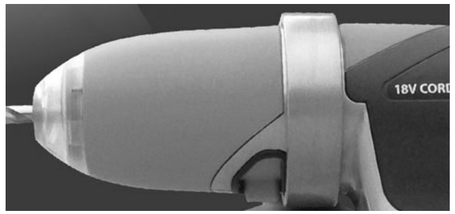


Figure C

Figure D

Types of light technology

LED's are a commonly used light source in almost every drill, as well as many other consumer products, including car headlights. However more recent developments in lighting technology have introduced laser lights as a possible smaller and more efficient alternative to LED's.

Laser light benefits

- Light up long distances better than LED's
- More efficient than LED's, uses 2/3 power
- Smaller than LED's, 300 micrometers
- More durable than LED's
- Able to produce patterns and pictographs (See Figure E, F) thanks to a digital micromirror device (See Figure H). This feature could engage a further level of user experience, especially applied within this project.
- While typically the lasers used would not be safe to the eye by themselves, the use of fluorescent phosphur material enables the light to be converted from a beam, to a spread of even light (See Figure G)

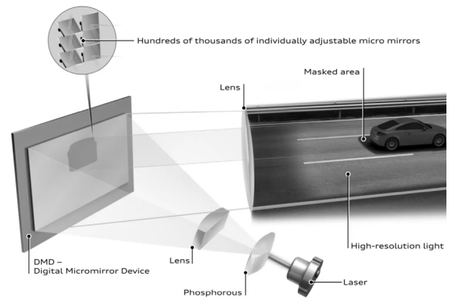


Figure H

Figure E

Figure F

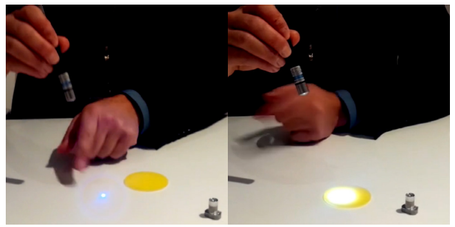


Figure G

er-

2. 17

Interface

There are many different types of displays on the market, from e-ink displays to flexible OLED screens.Typically for power tools, a combination of lights, icons/pictorials (See Figure A) and interface mapping allow the user enough information to properly interact with the tool. In designing a smarter power drill that assists the user on another level, with more complex user experience possibilities may mean that the introduction of a screen may be necessary (See Figure B, a smart drill featuring an E-ink screen). Screens should require little power, and be able to relatively withstand shock.

Figure A

Figure B

E-ink / E-ink backlit displaly

- Requires very little power, only uses power when switching between images
- Can be flexible in shape
- Suitable for outdoors conditions, and the backlit display will assist in low lighting conditions
- Colour saturation may be a problem, colours have the potential to appear dull.
- Matte finish means glare isn't an issue

OLED display

- Lower power than LCD screens, but uses more than an e-ink display
- Can be flexible
- Excellent for low lighting conditions, as well as during the day. May have trouble in direct sunlight.
- Usually with a gloss finish, though a matte cover could provide adequate prevention against glare

LED Matrix

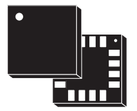
- Excellent colour definition, bright and easily recognisable
- Limited resolution means designs and interface are limited to simplicity

There are many other factors that make up an interface, from sound to button tactility. This segment looks at the possibility of incorporating a digital screen, where information can be seamlessly relayed to the user. This research project will consider an E-ink backlit display. While colours saturation may be less pleasing to the eye for some users, it is a screen that will always remain visible to the user, no matter the environmental conditions it is in, and this is a crucial factor to ensuring usability amongst a wide variety of users in the design of this product.

2. 18

Gyroscope

The gyroscope is commonly used in many consumer products, from smart phones to cameras. They have now started to sruface in power tools, making them smarter, more responsive and intuitive to the user. There are many different types of gyroscopes, but the one most commonly used in consumer products is the Vibrating Structure Gyroscope, which uses vibrations to sense rotation and the direction at which it is being moved. Useful information to assist the user in refining their experience with the product.



LGA-16 (4x4x1 mm)

Advantages

- Small (See example on right)
- Cheap
- Readily available
- Shock resistant
- Able to withstand harsh environment conditions
  E.g. from -40°C to 85°C
- Commonly also include temperature sensors

2. 19

Infrared Spectrometer

Breakdown

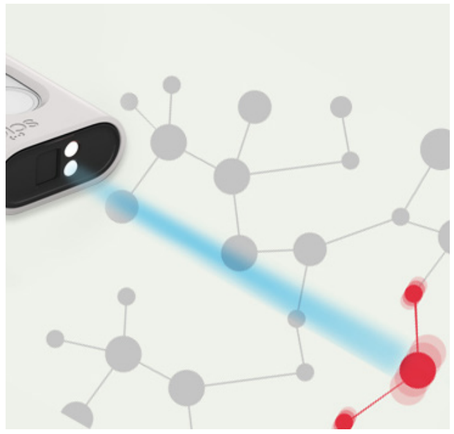
Infrared Spectroscopy is based on the method that each molecule vibrates in its own unique way, and when light is introduced can produce a different optical signature. Through this method, it can detect and differentiate compounds.

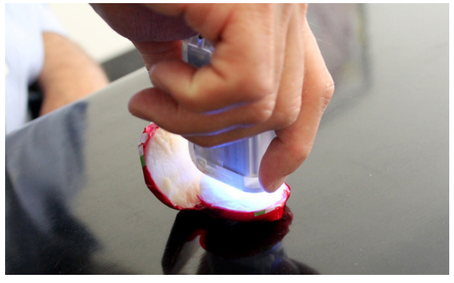
Traditionally, Infrared spectrometers are found in scientific laboratories and can be quite expensive, butthe technology is now being developed for consumer use. An example of this currently on the market is called “SCiO” (see below pictures), and is a low cost alternative that connects to a cloud network with software developed to help analyse and determine different compounds.

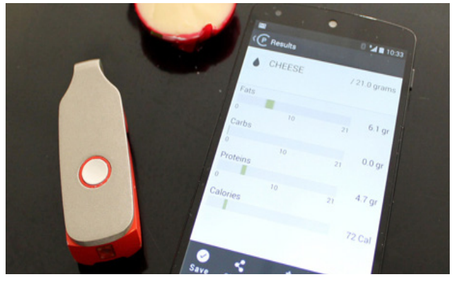
There is no current database for identifying materials and their unique optical signatures, and SCiO's kickstarter campaign in 2014 was the beginning of building such a database by allowing the vast amount of users buying the device to develop its library. While it is uncertain whether the Infrared Spectrometer within this project will be connected to a cloud database, it will be a potential requirement to establish at least a preliminary database of likely materials to be used.

Features

- Close range scan
- Short scanning time - 1 second
- Sensor type: near IR spectroscopy
- Organic an inorganic compounds can be scanned
- Non-destructive to sample being scanned
- Safe around eyes
- Small tech packages have been developed







2. 20

Proximity sensor

Breakdown

Proximity sensors are incorporated into much of everyday life, smart phones use them to detect a persons head as they take a call and turn off the screen accordingly, whilst other applications may use them as a hidden pushbutton. While there are many different types of proximity sensors, each with their own limitations on range and size, the types that are being considered for this project are:

Infrared proximity sensor

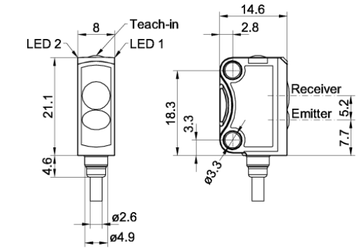
- Accurate
- Capable of reaching appropriate measuring range
- Affected by external conditions like dust particles, rain, or dark objects
- Affected by reflective/clear objects

Sub-miniature laser proximity sensor

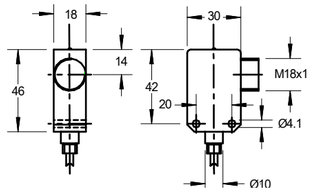
- Accurate
- Capable of reaching appropriate measuring range
- Not affected by uneven surfaces
- Affected by external conditions like dust particles, rain, or dark objects
- Affected by reflective/clear objects
- Small technical package size (see right)

Ultrasonic proximity sensor

- Accurate
- Capable of reaching appropriate measuring range
- Not affected by uneven surfaces
- Not affected by reflective/clear objects
- Small technical package size (see right), although can come in miniature sizes



Sub-miniature laser sensor current market example measurements



Ultrasonic sensor average current market example measurements

The Ultrasonic proximity sensor is one that will be considered due to its advanatge in being able to withstand external conditions such as dust particles, something that will be a common occurrence in power tools.

It is also uncertain what types of materials the users will be working with, and if reflective would undoubtedly skew infrared/laser proximity readings.

2. 21

Self-healing & smart materials: Vitrimers

Vitrimers

Vitrimers are a new class of polymers that are known for their self-healing capabilities. Vitrimers are able to re-organise the bonds between molecules. Molecules can change their binding partner but the amount of bonds among molecules stays the same. This enables it to maintain its form and strength integrity. It is reshapable at will, and can be repaired and recycled using heat. Because of this property, this new polymer is said to be able to produce shapes that are difficult or even impossible to obtain by traditional mould manufacturing methods.

Benefits:

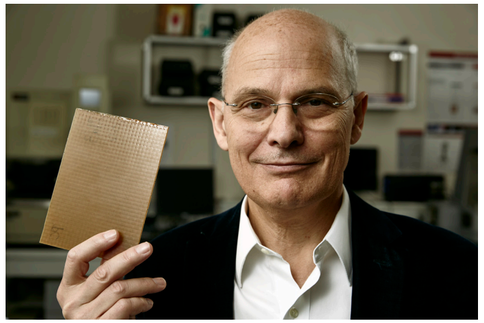
- This polymer can be processed at a wide range of temperatures, making it adaptive to different manufacuring techniques.
- The plastic is self-healing, which means that consumers are able to repair their plastic goods instead of paying for replacement costs.
- This is also beneficial to the environment, and has the potential to reduce waste on the planet significantly.

Attributes:

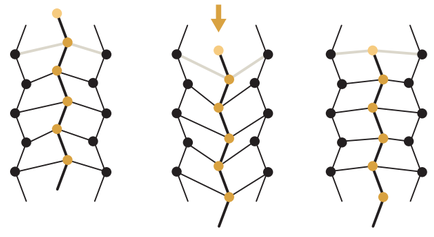
- As hard as metal, while still being recycleable & repairable.
- It is tough, but as lightweight as composite materials.
- When an additional layer is applied vitrimers can also protect from paint scratches when heat is applied.

Applications:

- Aircraft construction
- Bicycle helmets
- Wind turbine blades
- Automotive industry
- Smart phones



Ludwik Leibler, the research lead in the team who discovered this new class of Polymers

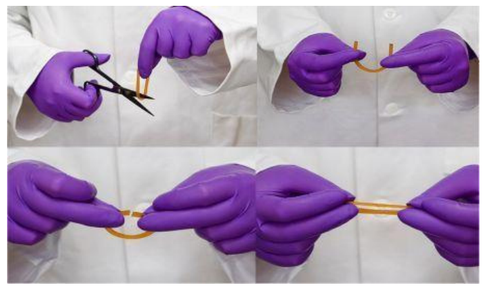


Above: an illustration depicting the flexible bonds within the Vitrimers network of molecules

> " It makes it **possible to produce** shapes that are **difficult or even impossible to obtain by molding** or for which making a mold is too expensive for the envisaged purpose. "
>
> *Priscilla Dacher, CNRS press release*

2. 22

Self-healing & smart materials: Supramolecular rubbers & Nano coatings



Nano coatings

Nano coatings can be used to give additional properties to the objects they are coated in. Nowadays nano coatings with properties like hydrophibia, water repellance, are becoming increasingly popular in the consumerist market. Nano coatings can also be customised, allowing manufacturers to apply a custom set of attributes to products. These can be properties like:

- Hydrophilia
- Hydrophobia
- Fire retardancy
- Scratch resistance
- Electronical and magnetic properties

Self-healing Supramolecular rubbers

Rubbers with similar properties to Vitrimers, and and are able to reverse the effects of small cracks and scratches in the material. Many industry applications are being explored, such as:

- Conveyor belts
- Impact protection
- Shock absorbption layers
- Industrial gloves.

Parametric Modelling & AugmentedReality

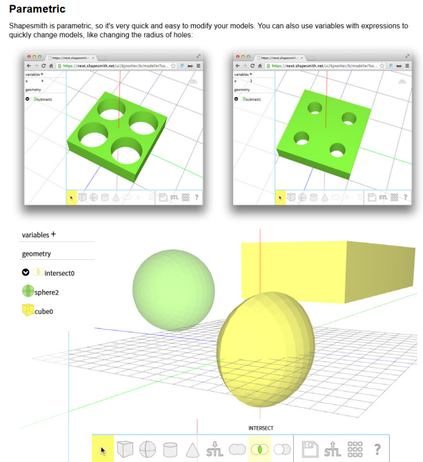
After conducting a thorough observational research task, some problem areas within the DIY work flow concerning project management and organisation surfaced quite clearly. When beginning projects participants often:

- Participants could often never find the right tutorial for what the task they envisioned would be.
- Some of these tutorials required the user to convert measurements from imperial to metric, as they may have been made by someone in a different country.
- Often a list of parts needed or the type of part would be hard to find. In fact a lot of time was consumed simply trying to find parts that the participant had not come across before. Often the user would not know how to begin finding a part. Gathering parts was agreed upon by all participants to be one of the most tedious tasks within the DIY work flow.
- Often the parts found would be slightly different from the ones specified. The ones specified would not be available, as parts may differ from country to country
- Participants often had trouble visualising what their product would look like and the scale it would be after they finished as well.
- Participants also enjoyed modifying tutorials so that their individuality showed through in the finished piece.

To help users undertaking DIY projects, a library of parametrically modelled objects will be available for customisation by the user. This will be completed through a web browser, a medium that has become a growing trend for customising 3D modelled objects.

Shapesmith.net

An open source web browser 3d parametric modelling program, using primite shapes as a basis, and then transforming these shapes using subtract, intersect, and union techniques. Models can be saved or exported as .stl files directly. While this may not be as efficient as other modelling programs, it is very accessible and easy to learn.

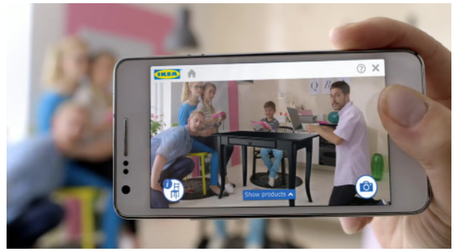


Nervous System - Cell Cycle jewelry

Parametrically modelled jewelry where users may choose a base model, and then subtract, and add elements. Data is reflected in realtime, such as the price of the item. Colour highlights areas where the user may modify and work on.

Tylko furniture

Tylko is a company that gives its customers the option of high-end customisable furniture. Like the Nervous System jewelry, Tylko furniture starts from a base model and allows the user to change parts of it to their liking. Tylko furniture also incorporates Augmented Reality into their sysem, giving users the opportunity to visualise their creations amongst their living spaces.



IKEA furniture & Augmented Reality

IKEA changes its catalogue to be interactive and include an element of Augmented reality. Enabling customers to more easily personalise their living spaces with IKEA furniture. Augmented Reality through the use of smart phone or tablet devices show items from IKEA's catalogue in the context of the users own living space.

Analysis

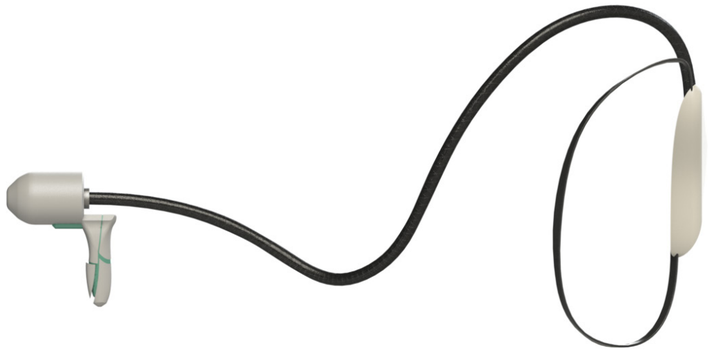
Through ethnographic research such as user observation as well as studying the trends of DIY, it would appear that the companies of today have also drawn similar conclusions to the problems associated with DIY. By providing a platform through which the user can more easily customise the objects in their lives, these services have responded to the needs of the modern day DIY-er. Who, by generalisation and statistical research (please see ch 2), have shown to be lacking in skill compared to previous generations yet still striving towards the personalisation of living spaces and goods.

[2.22] RESEARCH

3 Concepts

2. 22. 1

Concept 1

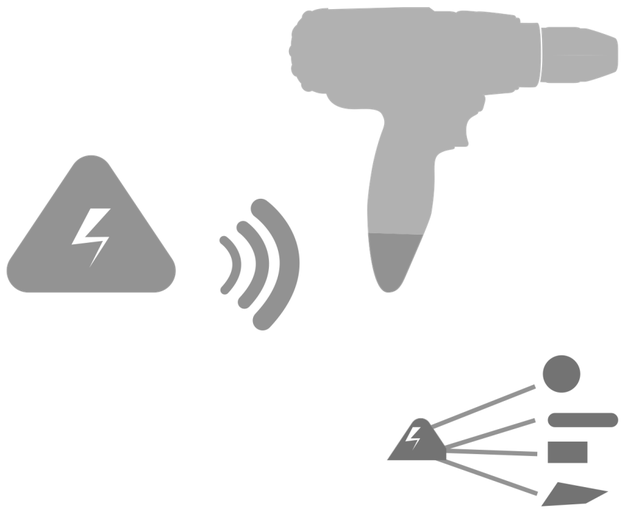


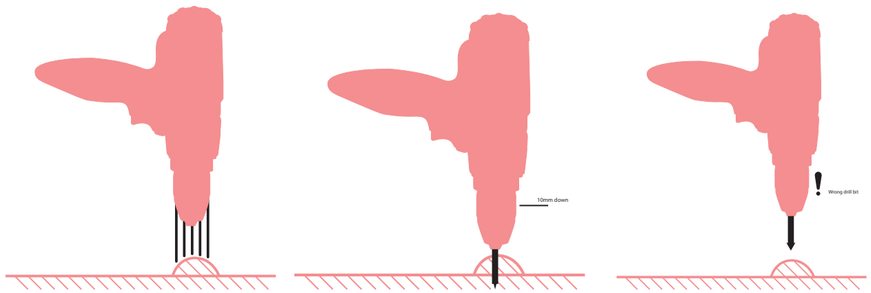
Concept 1 looks at the design specifications by alleviating the weight of the tool from the user's hand, and moving it somewhere better supported. Such as the hips or the shoulders (See mockups on the right). The weight of the motor and battery is taken out of the power drill, and connected via a flex shaft. With the battery and motor to the side, navigation of tools with heavier motors that need more power should be less cumbersome.

Its handle grip is one that adjusts to the users hand shape, and uses pressure sensors to determine an even weight distribution across the hand. Laser guides, when needed, help the user drill at proper angles. The laser guides projected change in shape and colour, and the OLED interface also alerts the user to how well they're doing. Green as a positive colour means the angle is accurate, and yellow and red sequentially indicate a poor angle, or to stop working.

2. 22. 2

Concept 2





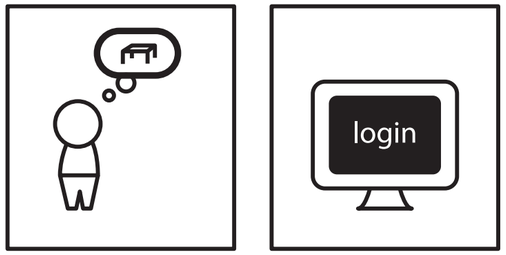
The second concept looks at how the drill can be smarter, and lighter as well while remaining completely cordless. The power drill still features a battery within the drill, although smaller in size. A larger battery, able to be attached onto a work belt, or placed within the vicinity of the power drill uses witricity to wirelessly charge the battery inside the drill at any level of energy depletion. The advantage of having a battery that transfers power via witricity, is that it can be used not only amongst power drills, but also other hand power tools that are cordless.

It uses physical guides to help guide the user in drilling at the right angle, a proximity sensor to detect how deep a hole is, prompting the user to stop drilling if commencing through a programmed tutorial, and an infrared spectrometer for detecting material to drill bit compatibility. A programmed tutorial can be inserted into the drill via a disposable micro usb, or sd card. This then allows the user to be directed by the power tool's commands, and allows some level of automation from the power tool to take over. For e.g. When drilling a hole, the power tool might stop at a certain depth, and switch to reverse whilst telling the user to pull out of the hole.

2. 22. 3

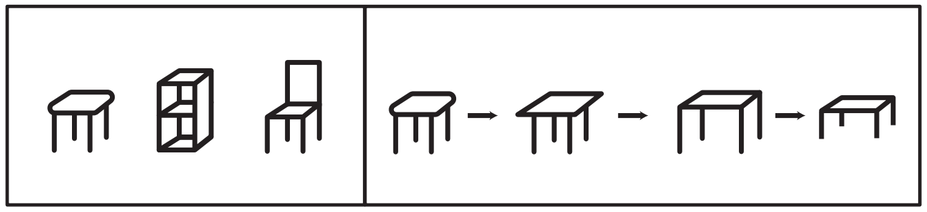
Concept 3

The third concept is most compatible with a system, although this system can be applied to the previous concepts mentioned as well. The system looks at the process of making, and the work flow around a power tool. By improving the work flow around using power tools, the process of making something with a power tool becomes easier.



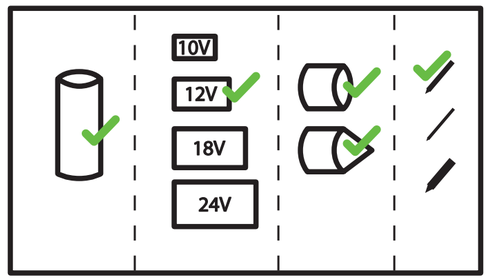
The user wants to make a table

Logs into library system

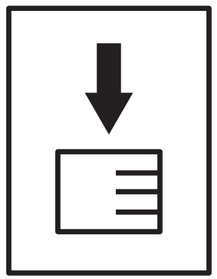


This system has a DIY section that allows users to customise parametrically modelled objects. Designs will need to be updated periodically to ensure trends are met

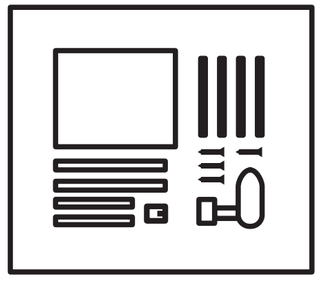
They begin with a base structure, and then modify the furniture using the system.

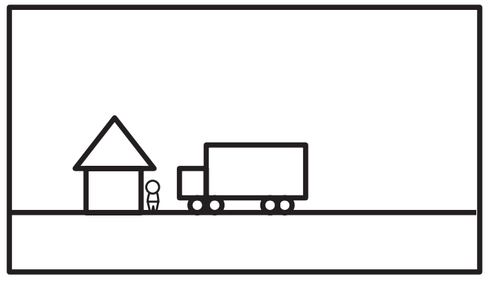


The system then determines what type of tool is needed for the job and assembles a tool best for the job. The advantages of splitting up a tool into different components is that it makes servicing and replacement of parts easier. In addition, it allows a tool to be made custom for a job, instead of using a tool that one might have lying around that will just 'get the job done'.



It downloads the assembly method onto a disposable memory device. This will be in the form of a paper usb or paper micro sd card





A kit is assembled of materials and tools needed for the task. The amount of tasks needed to assemble this piece of furniture depends on the degree of difficulty they have selected. The easiest level involves the parts cut, sanded, all dimensionally correct, with the user only needing to put the kit together. A harder level might allow greater, further customisation, and may ask the user to manually cut pieces. This kit is then delivered to the person's door. Once finished with the tool, the user can return it to their local home hardware store or post office.

2. 22. 4

Concept evaluation & decision making

Following the week nine presentation, the lecturers and class gave feedback to the three concepts. This feedback would determine the direction for the final concept refinement.

Feedback

- A wide variety of ideas
- Technology exploration was interesting, particularly in terms of making the drill “smart”
- Explore modularity more
  Decide which parts should be modular and which parts are better off left as they are
- Look at how the aesthetics and styling might convey project objectives
- Look at combining some of the key features from concepts 2 and 3

Decision making & Evaluation

- A combination of Concepts 2 and 3 will be explored, looking at the relationship between system and product
- Sensors are great for making the power drill “smart”, but careful considerations and decisions must be taken to ensure it bears little ressemblance to a swiss army knife
- Develop power drill’s interface

[2.23] RESEARCH

[PDS] Product Design Specification

2. 23. 1

Functional & performance requirements

Objective
Sharing is caring: to create a power tool that embraces a sharing system where tools are shared rather than developed for sole ownership.

Definition
This project looks at the future of what product interaction may be. In line with the market and trends research, it is highly likely that products will begin to be designed for the Sharing or Access Economy. This means that the product designed should be designed to be shared rather than for sole ownership. Designing a product to be shared means that many more people will be in contact with the one product. Due to this, the product must be durable, and able to withstand the misuse of many different users within many different scenarios.

Product performance requirement

- The product must be durable

System performance requirement

- The product takes into consideration the Sharing/Access Economy and places itself within this context.

Means of Assessment

- Technical research/exploration, market research into new materials and technologies
- Trend research
- Interviews
- Roleplay
- Surveys

Objective
The tool must have an interface that is accessible and easy to use, as well as be a product that is able to be accessed with ease.

Definition
Embracing a Sharing and/or Access Economy means preparing for an increased variance and number of users. Ergonomic considerations must also be made. These users will come from different demographics and skill levels. Using power tools can often be more difficult for novice users, who often lack the mental and/or physical muscle memory knowledge associated with using power tools. Creating an interface and user experience that is accessible to the user and easy to understand is the aim of this objective.

A product is not alone. This power tool may be involved in many processes, such as the creation of an object. The power tool should be easily accessed so that the process can be completed with minimal effort. But the other articles within this process must also be accessible if the product is to be seamlessly integrated into a system.

Product performance requirement

- The user interface should assist the user in performing their desired task.
- Intuitive, making the task at hand easier

System performance requirement

- The product and the processes it may be involved in should be easily accessible, in understanding with the Access Economy.

Means of Assessment

- Bodystorming
- User observation
- Field research
- Trend research
- Ergonomic Analysis
- Design Ethnography

2. 23. 2

Regulations and standards

Given the future context of this project, some regulations and standards may no longer apply. They most likely will be updated, as well as the possibility arising of new regulations and standards being established for various new technologies. The regulations and standards outlined here serve as an unconstrained basis in designing this project. But possible need for regulations and standards for the project in the future may include:

- Lighting (see ch 2.19)
- Smart device management where automation may be an issue (standards and guidelines such as ISA108 have already emerged to begin to address this)
- Emergency stop measures that are addressed in the design of safety related parts of control systems such as AS 4024.1604-2006 (Emergency stop – Principles for design)

AS/NZS 60745.1:2009
Hand-held motor-operated electric tools & their safety
7.2, 8, 9.1, 14, 18, 19, 21, 22, 24, 25, 27, 30

AS/NZS 60745.2.1:200
Hand-held motor-operated electric tools and their safety
Part 2.1: Particular requirements for drills and impact drills
8.1, 8.12.1.1, 19, 19.1, 10.101

AS/NZS 3160:2009
4.1, 5

AS 4024.1901-2006
Ergonomic requirements for the design of displays and control actuators: General principles for human interaction with displays and control actuators

AS 4024.1904-2006
Requirements for visual, auditory and tactile signs

AS 4024.1907-2006
System of auditory and visual danger and information signals

AS/NZS CISPR 22, EN 55022, CISPR 22
Electromagnetic compatibility regulatory arrangement

2. 23. 3

Technical & other recommendations

Workspace, Equipment And Tool Design.
By Mital, Anil, and Waldemar Karwowski

Bodyspace
By Pheasant, Stephen, and C. M Haslegrave

A Check-List For Handle Design
http://ergonomics.uq.edu.au/eaol/handle.pdf.
By Michael Patkin

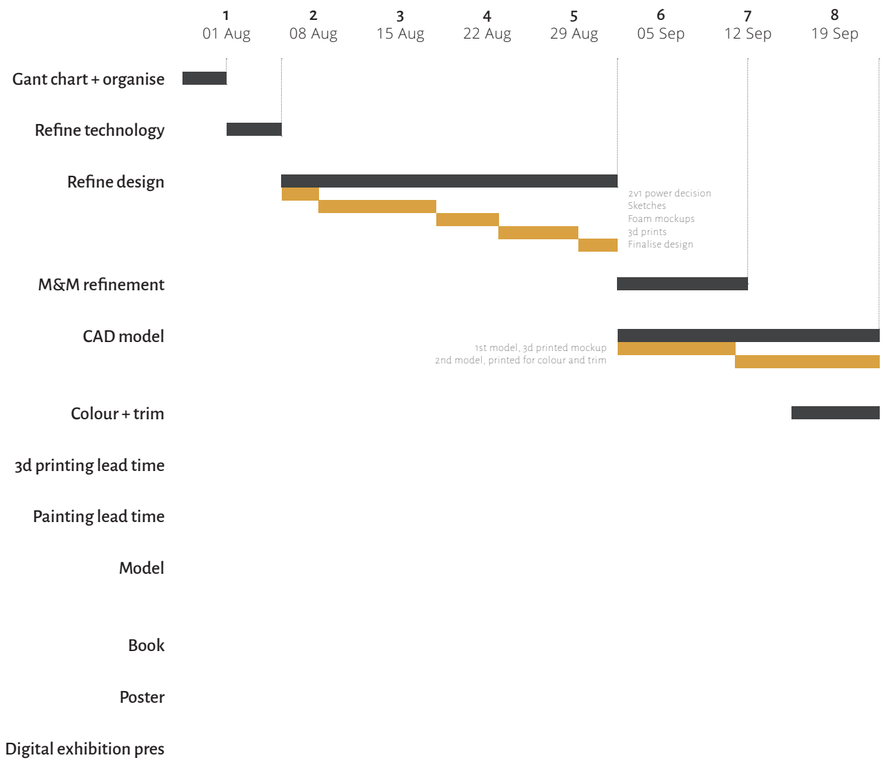
The influence of ergonomics on the design of power tools
By Robert Bosch

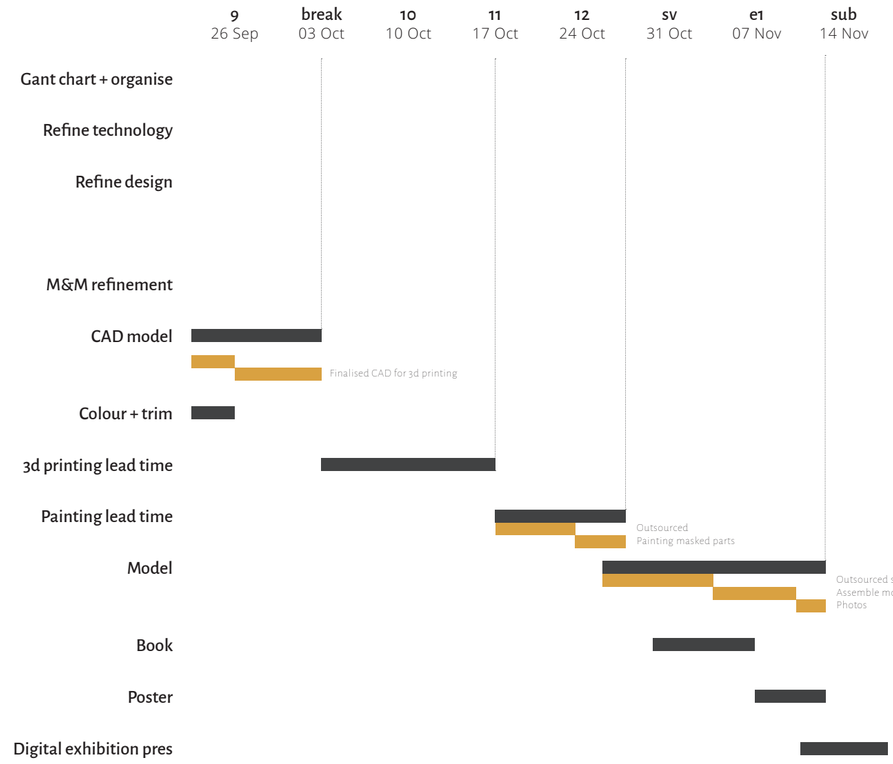
[3.0] DESIGN

Schedule for semester 2

3. 0

Gant chart: semester 2



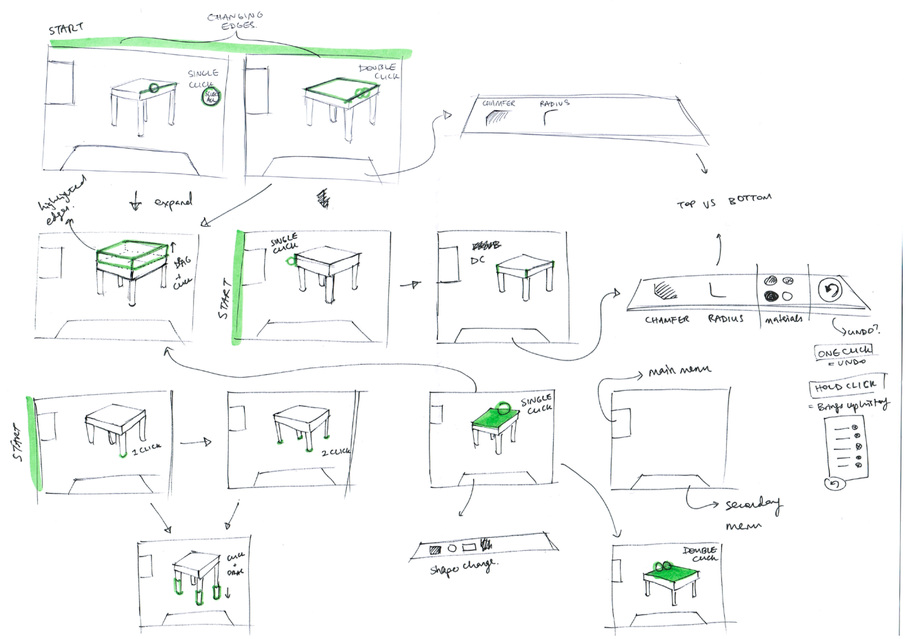


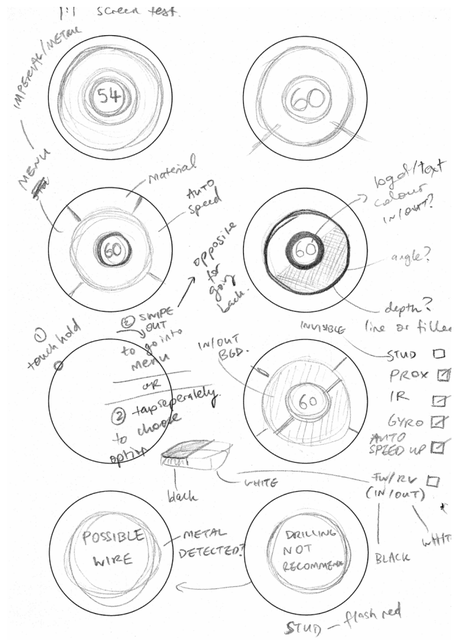
[3.1] DESIGN

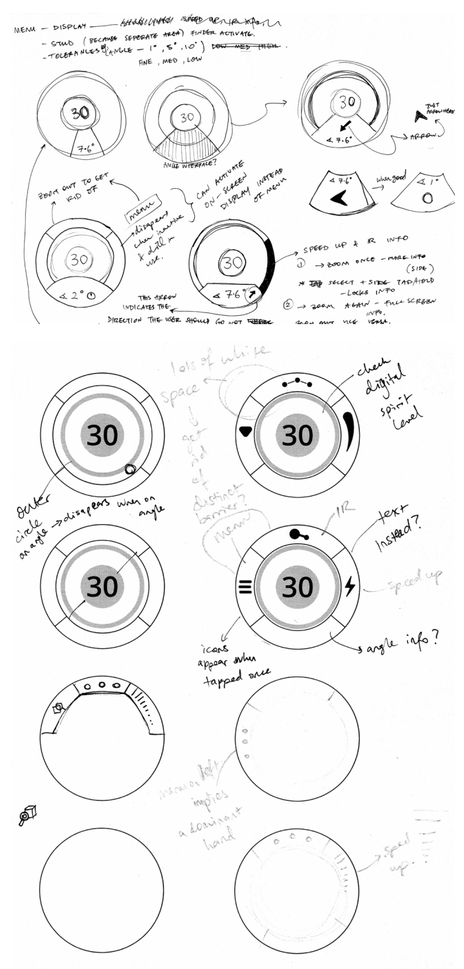
Development & Refinement

3. 01

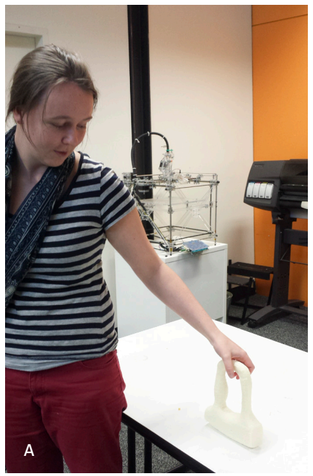
System development

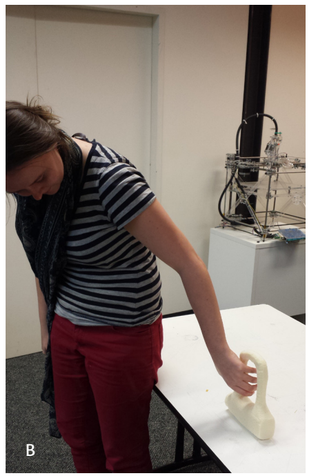


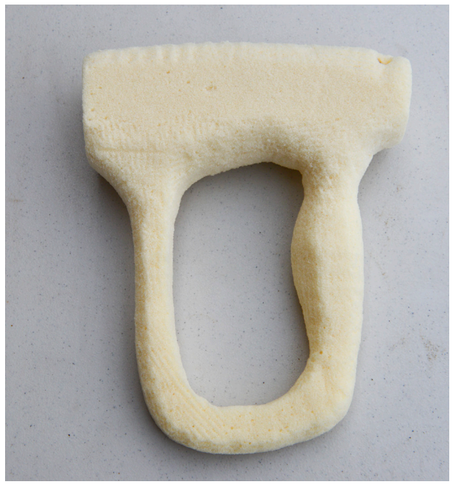




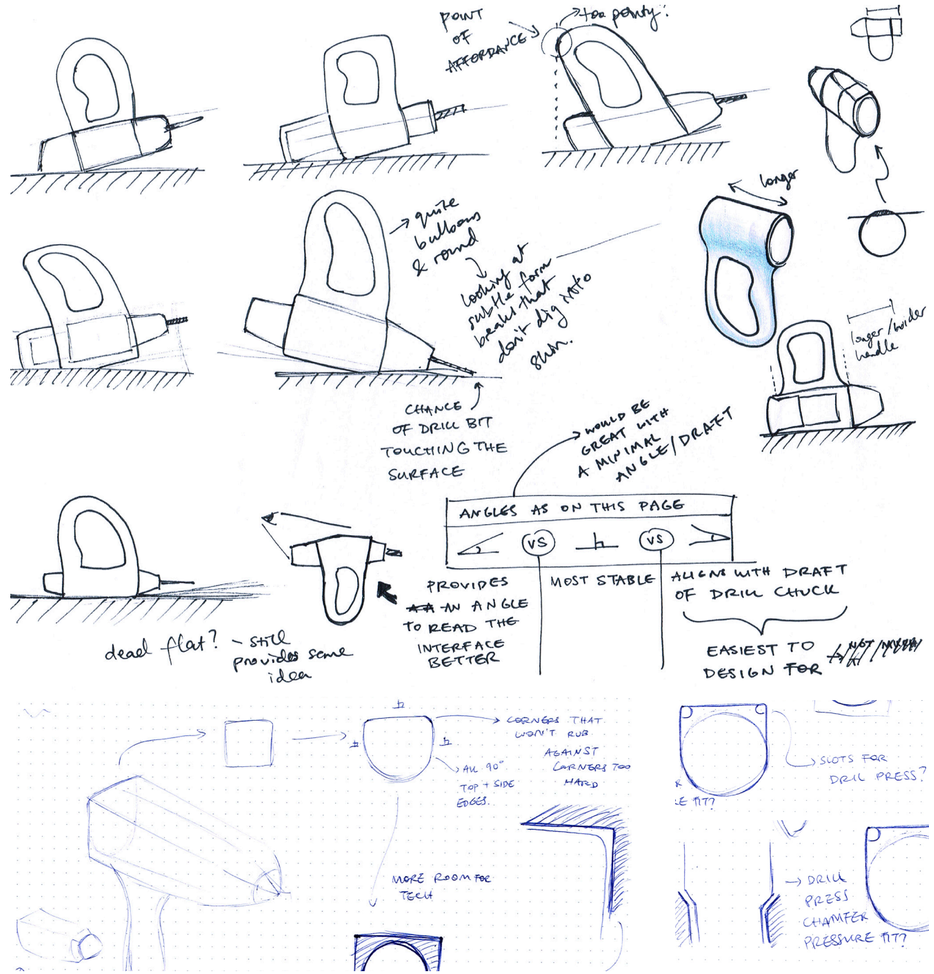
Form development





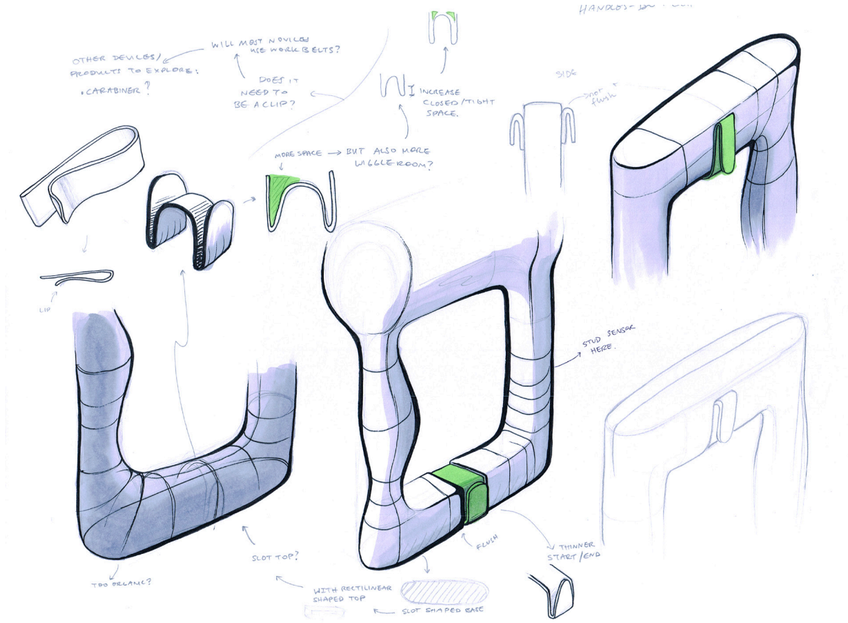


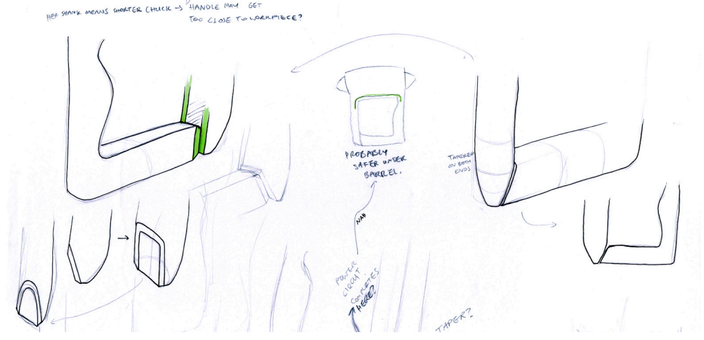
This is an exploration in how a user may interact with approaching a power drill, and how this could be perhaps made easier for the user. Here, the designer attempted to utilise the top heavy mass, by turning it upside down and experimenting with a handle that may “present” itself to the user in a friendly way. After completing a mock-up and bodystorm analysis, Figure B shows an uncomfortable arm stance in the process to picking up the tool, it was decided that a flat bottom instead might be of better use.

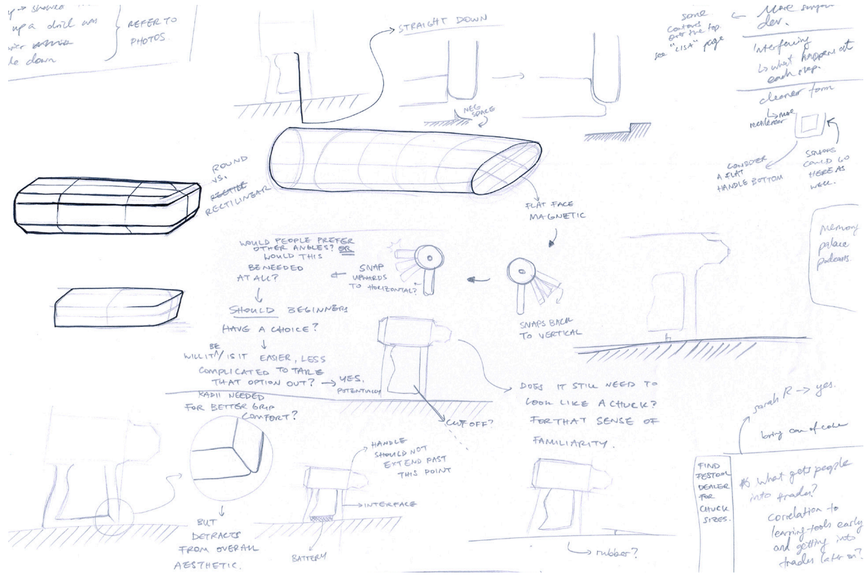


3. 02. 1

Form development

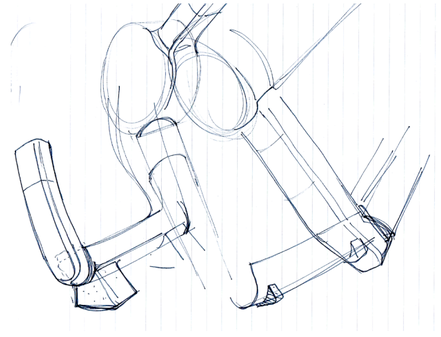




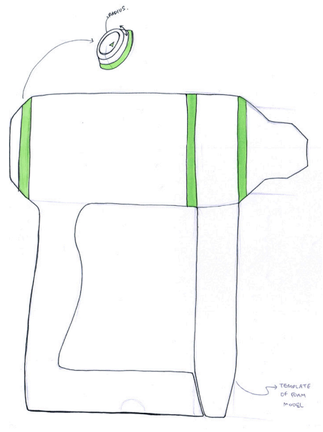


While the flat topped barrel featured on the previous page may have allowed for more room to fit the various sensor components into, the secondary handle at the front could also serve this purpose. In this design iteration, the fore-handle is seperated from the main body, allowing the user to steady the drill when needed.

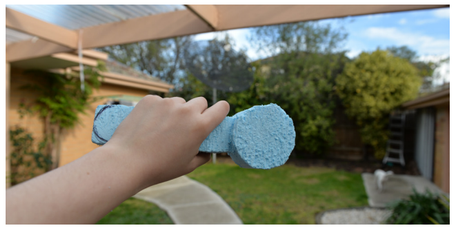
With this in mind, the material break between the fore-handle and the main handle must be dealt with in a seamless manner, but also affording the user with the information on how to use it, while at the same time remaining ergonomic. This iteration also looks at developing a flat-bottomed drill, and how the top-heavy nature of it could perhaps be alleviated.

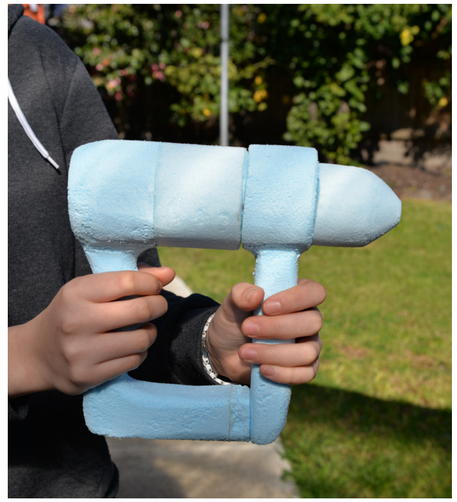


Form development: Mockup & Bodystorming



The inspired sketch for the basis of this mockup



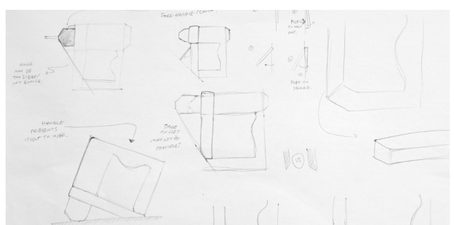


From the sketches, a rough foam model was constructed, allowing the designer to gauge where certain fillets or curves were necessary for ergonomic purposes, and looking at how the different surfaces might flow into each other.

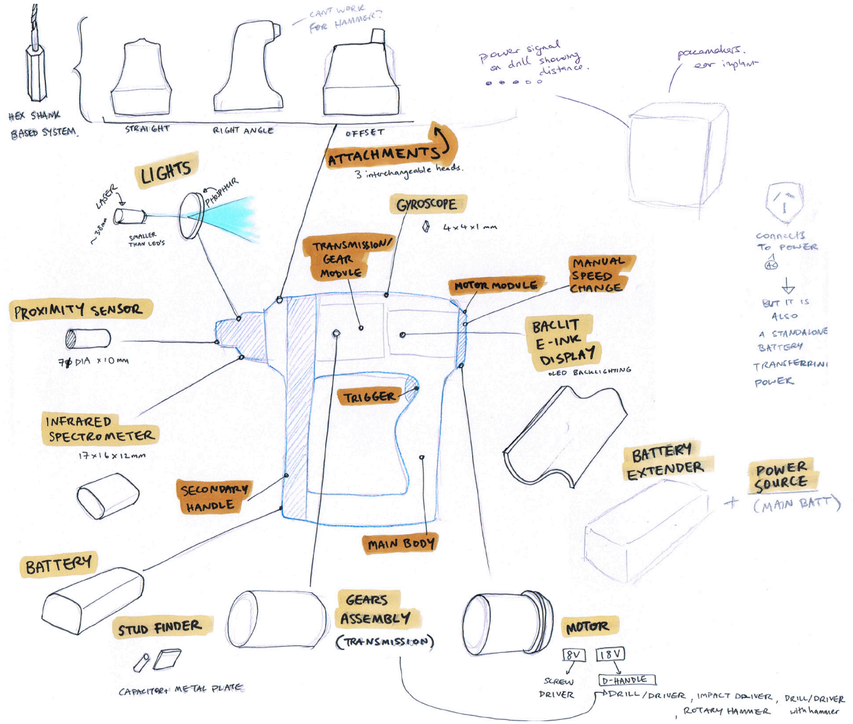
After the model was completed, the user body stormed with it, noting how easy or difficult interactions came. There was particular focus on the two handles, which would become the basis for developing a digital model.

Form development: Mockup & Bodystorming

A small bodystorming exercise looked at how the user interacted with placing and picking up the tool. It was observed (and is often the case with current D handle power drills) that from a standing (or taller) position the user must bend their wrist and arm at a slight uncomfortable position to put the drill down. From this, a sketch was made that instead proposed having an angled face on the front handle to allow for an angled placement of the drill.



Final technology requirements



A list of parts were compiled for clarity purposes, and making sure all the components had been sorted and researched properly. Some parts such as the power source and battery extender needed form given to them still, as well as the chuck add-on's needing further form exploration.

3. 03

Form development: Interaction

> " An electronic device comprising: a processor; a sensor in communication with the processor; a protective mechanism in communication with the processor and configured to **selectively alter a center of mass** of the electronic device; and an enclosure configured to at least partially enclose the processor and the sensor. "
>
> **—(King, 2011)**

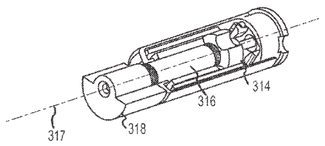
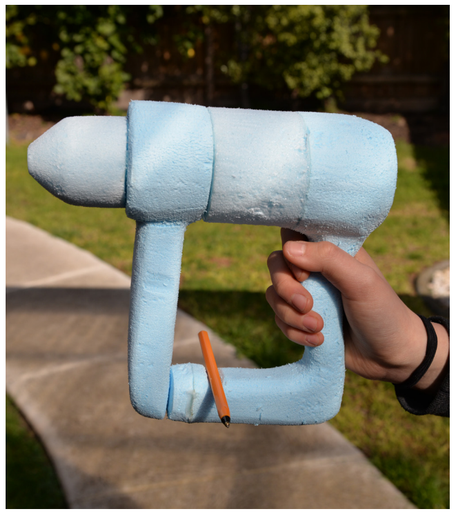
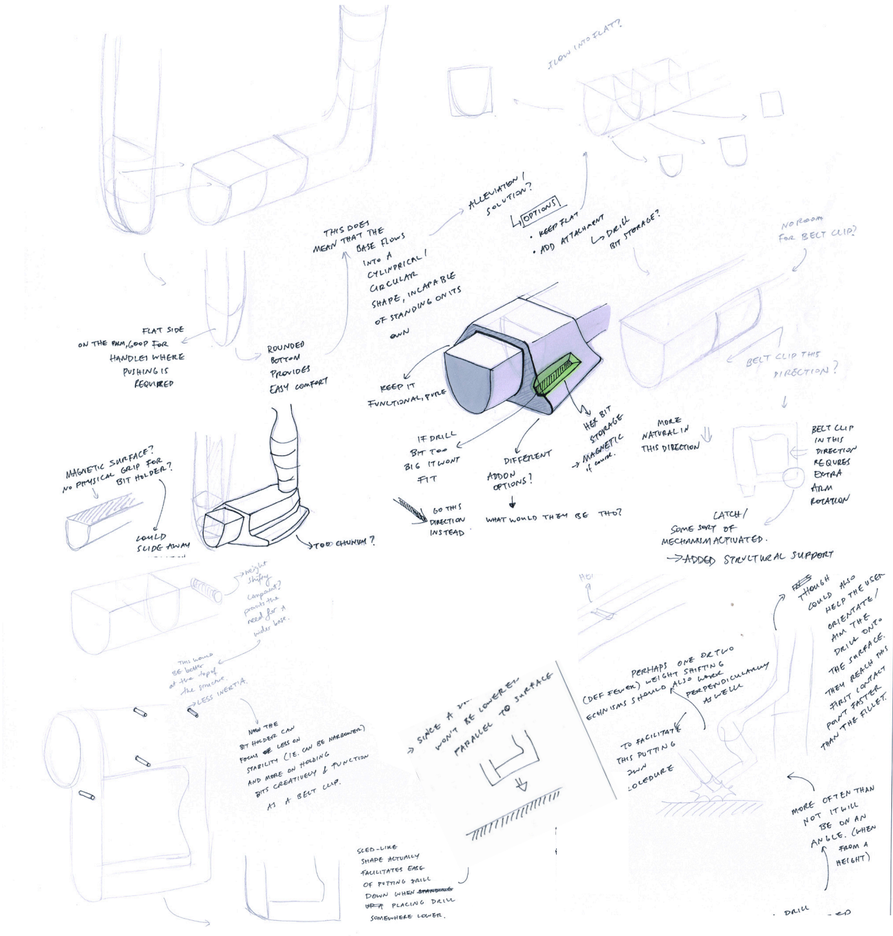


FIG.5A



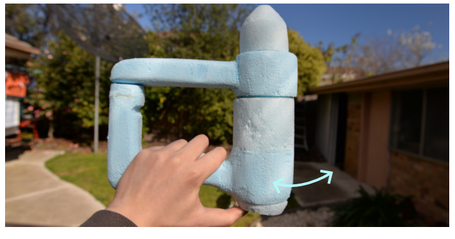
This initial mockup looked at how the model could incorporate efficient features such as drill bit storage. It looked at creating a magnetic hexagonal recess for bits to sit in. One concern about this was the potential for longer drill bits to interfere with the workpiece or perhaps damage it.

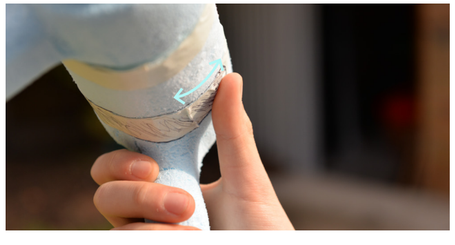
Another concern about the model was towards its stability given its thinner base and top heavy form. Some additions to the base were explored in relation to this, shown in the sketches on the opposite page. Upon discovering a patent for a mechanism that could shift a device's weight when falling to protect its vital components. I applied it to this project by using it to stabilise the product, so that the risk of toppling over could be counter-balanced by the electronic device's capability to alter a center of mass



3. 03

Form development: Interaction

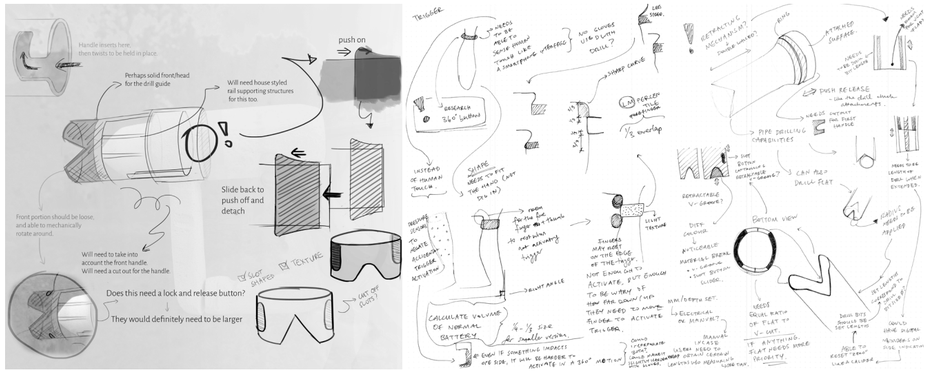




I explored initial Interface ideas here. Looking at gestures, reach, and how some work flow movements might be made more seamless. I was particularly interested in the maximum reach of the areas of the mockup. In these initial stages I was quite focused on the barrel of the drill becoming a basis for interaction, incorporating lots of rotations and semi-rotations into the interface.

While body storming I looked for places that would be the most intuitive and easiest to use. Requiring the use of both hands was decided to be only used for stability purposes. Needing to use two hands all the time may prove inefficient in some cases. Thus it was decided that any major interface control points should be reachable by the users dominant hand operating the tool.

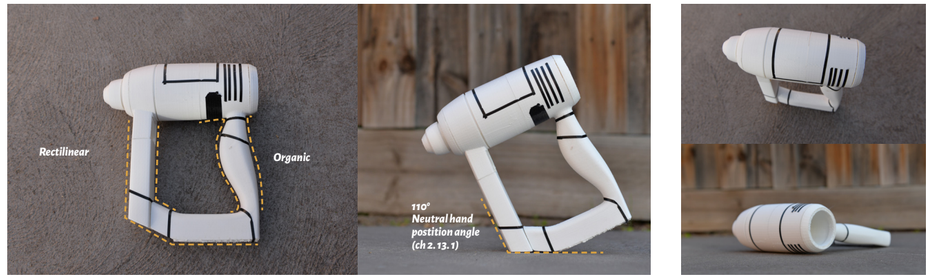
Project & form refinement



A brief exploration into a drill press / drill guide add-on was explored with a few pages of sketches.

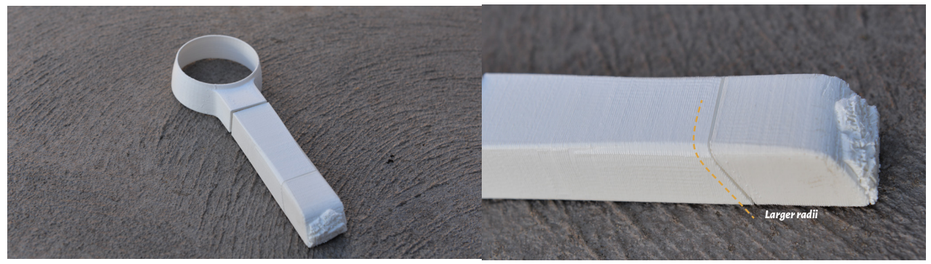
1

A preliminary handle was made as a digital model and then 3D printing to determine how ergonomic it might be, and what surfaces might need to be changed. Various iterations followed thereafter.



2

Changes to the handles shape were made, as well as changes explored in previous sketches such as the angled base. Black tape was used to begin exploring colour and trim options, as well as mock up the interface. In this iteration the handle shape was still a bit too thin, but what was perhaps in need of addressing was the overall form. While the drill sat at an ergonomic angle for users to access, the form was a seemingly clash between organic and rectilinear form language.

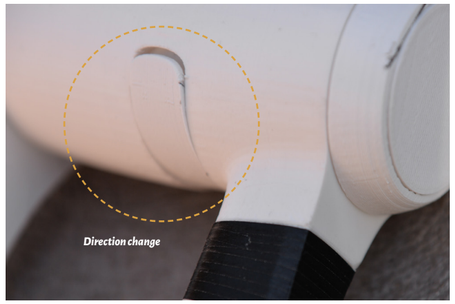


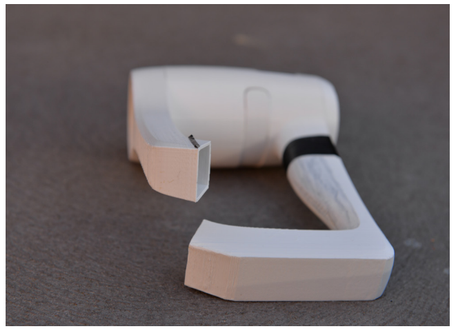
3

There was some attempt to alleviate this issue by giving the forehandle some larger radii and have it curved more. But this would also make the overall product less stable when sitting on an angle, due to having less of a flat surface to lean on. Before going back to the drawing board, the main handle was remodelled to a more optimum ergonomic shape.

3. 04

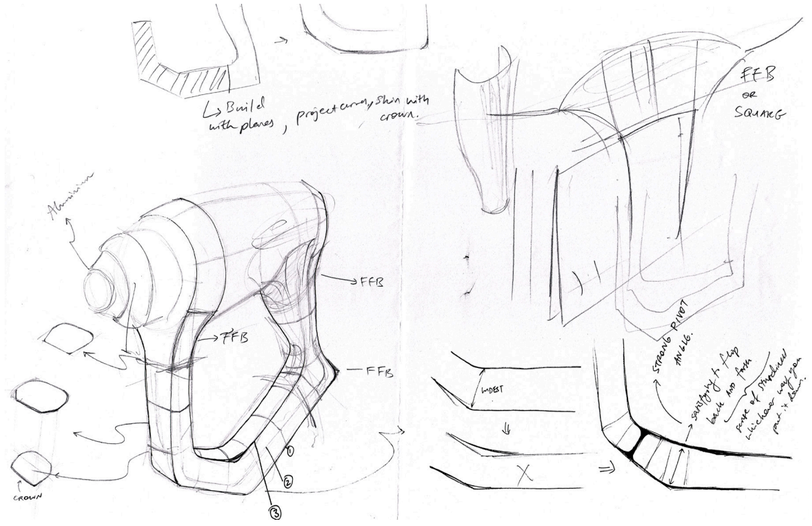
Form refinement

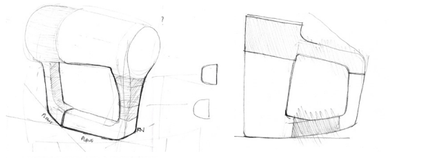


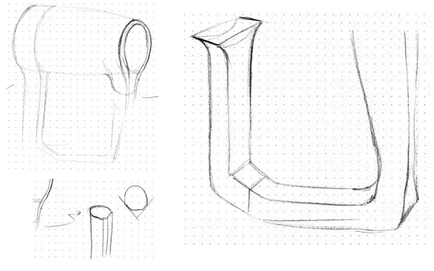


4

For the form to become more cohesive and unanimous, some compromises to the main handle were made. By becoming more rectilinear the main handle's ergonomics were not optimum. Despite this, being able to feel the edges of the form enabled the user to better feel what angle the drill was being held at. One sweeping chamfer throughout both handles (see dashed line) ties both handles in together. The chamfers in combination with crowning of flat surfaces allows the handle to remain comfortable, while still showing crisp edges. This was the final 3D print, and allowed for testing of physical interface. After testing it was found that the direction change button was not working out, and was more awkward than convenient. This was then changed for the next iteration. Some modifications to the interface and colour breaks are shown with black tape.



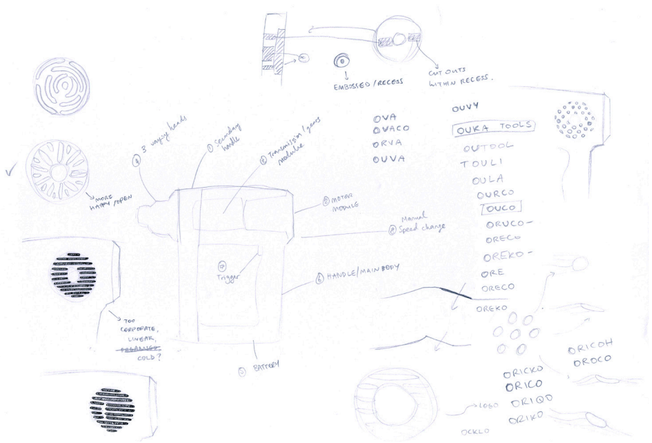


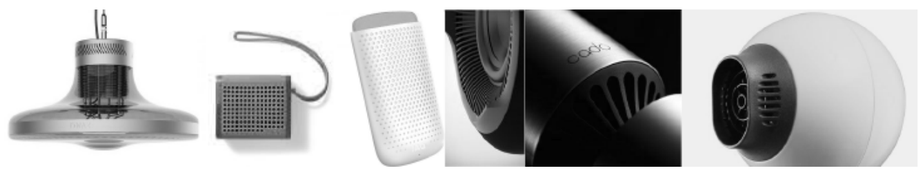


These rough sketches were the beginnings of determining the final form. They looked at exploring how the product may lay, and how the shape of the main handle could still be comfortable if a rectilinear route would be taken. As well as refining the shape break around the forehandle and main handle area.

3. 04. 1

Refinement: vents

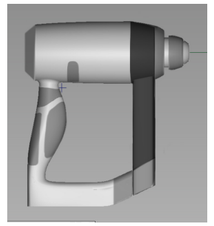


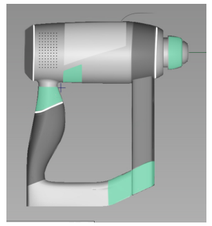


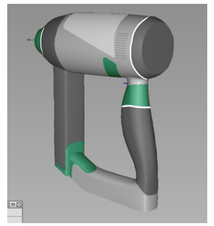
Detailing the air ventilation was something necessary as it was vital to running the machine well, but it was also important stylistically. The vents I studied back in ch 2. 01. 5 were quite angular, and from a styling point of view I was looking to achieve something that said simplicity. Upon creating a moodboard for vents, I was quite drawn to including roundness in the pattern. Looking at dot matrices and slot patterns.

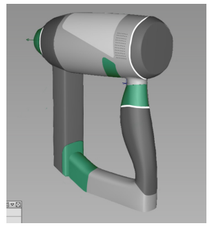
3. 05

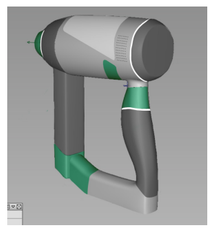
Colour and trim

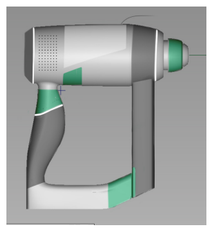












Above are a few early iterations of colour break options, using a bright colour to highlight function. Initial colour and trim ideas looked to separate from what was currently on the market and take a softer approach to styling. It wasn't until the colour and trim influences themeboard that the colour and trim began to come together. However, my initial thoughts on colour and trim are as follows:

Colour ratio

Most drills tend to use 3-4 colours, with 1 non-neutral colour. Looking at material breaks, areas of interaction are highlighted in a non-neutral colour, whilst material changes (e.g. plastic to rubber) are displayed in a neutral colour.

Colour follows function

Primary functions will be highlighted in a non-neutral colour, as these need to be immediately clear to the user. Whilst secondary (perhaps more obvious) functions, will be highlighted on a neutral colour.

Clarity: too much, too little

Colour is not to be applied so liberally that the function it is highlighting is lost, or so little that it is not visible.

3. 05. 1

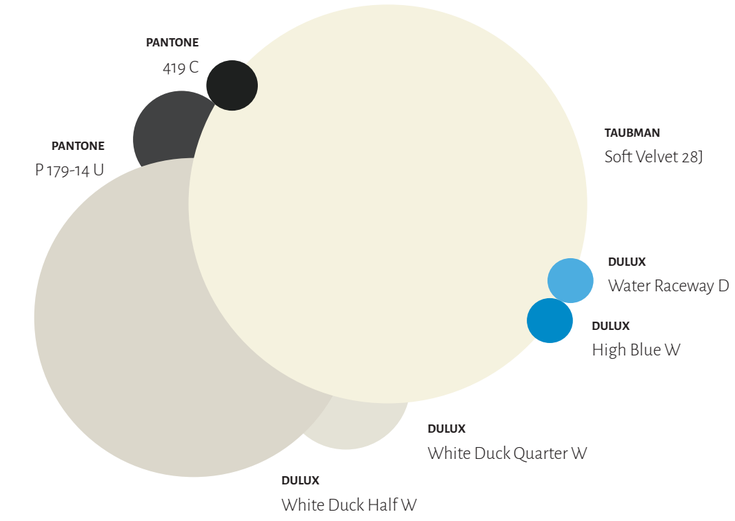
Colour and trim inspiration themeboard

3. 05. 2

Colour and trim themeboard breakdown

From previous page: main sources of inspiration

My theme board was inspired by products that were the adverse to the norm of styling power tools. In line with a clean, simple and accessible aesthetic I chose an analogous colour theme that combined using very minimal amounts of blue led lights and black to define certain areas. My colour theme differentiates itself from current power tools as many choose to use contrasting colours. Usually two neutral colours and one bright primary colour. This extreme contrast of colours only adds to the intensity of the overall product. I wanted to reduce over-stylisation and so carried this through with my colour and trim.

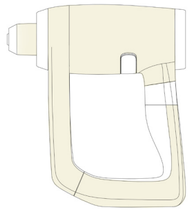


3. 05. 3

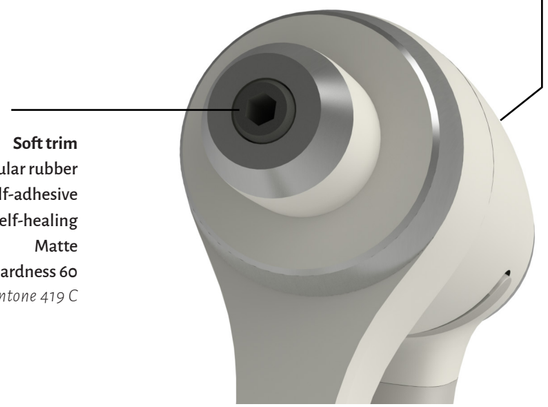
Colour and trim

While many power tools give texture to their plastic surfaces to alleviate the disruptive appearance of scratches, dirt and grim. Being able to use smarter materials and coatings with self-healing properties and customised nano-coating, mean that the the product can be better maintained and protected. A smoother, more-refined and subtlety can be given to the materials being used as trim. This means there is less visual noise for the user, and falls in line with aims to create a clean, simple and accessible aesthetic.

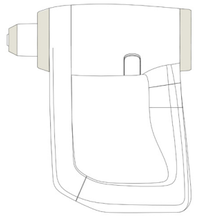
On this page are a breakdown of colour and t rim choices, with their locations shown on adjacent diagrams.



Hard trim
Vitrimer plastic
Self-healing
Smooth texture
Satin-matte finish
Nano hydrophobic coating
Taubman Soft Velvet 28J



Soft trim
Supramolecular rubber
Not self-adhesive
Self-healing
Matte
Shore hardness 60
Pantone 419 C



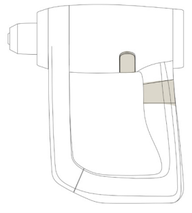
Hard trim
Anodised Aluminium
Smooth texture
Satin finish
Dulux White Duck Quarter W

Hard trim
Graphene
- Non reflective
- Conductive (touch screen)

Smooth texture
Clear
Satin finish
Custom Nano-hydrophobic coating

Soft trim
Supramolecular rubber
- Not self-adhesive
- Self-healing

Matte
Low spark texture
Taubman Soft Velvet 28J



Soft trim
Supramolecular rubber
- Not self-adhesive
- Self-healing

Matte
Low spark texture
Dulux White Duck Half W

3. 06

Final form

Following colour and trim feedback, slight tweaks to the form were made to improve ergonomics and further refine sensor placement within the technical package.

3. 07

Model making process snapshot

[3.10] DESIGN

Features, drawings, rationales

3. 08

Product

The developed product is a smart power drill that intelligently supports and guides the user through their task at hand. The future focused design incorporates many emerging and new technologies, allowing the drill to be more intuitive and easy to use. Ergonomic and Ethnographic research has also aided in realising form factor, as well as in relation to user interaction with the product.

This product is designed to be shared, made for disassembly allowing quick replacement of parts ensures this. Its materials make it durable, allowing for its product life cycle to be long and efficient, in what will be the peak of the Sharing and/or Access Economy.

Product: physical features

Battery

Making a lighter tool is more accessible to users as it is less reliant on strength and stamina. The battery has been made significantly smaller in volume. This does mean a shorter battery life, but this is negated through wireless charging technologies like Witricity. Witricity is able to charge objects from as little as a few centimetres away, to a few metres. This means that the the battery, despite lasting a short while by itself, is able to be continually topped up with power. Leaving the potential for this power tools battery to last even longer than larger power sources on conventional tools. (ch 2. 15)

Crowned surfaces

These allow the drill to maintain its sleek, sharp lines, while remaining ergonomic. The crown minimizes the pressure points placed on the hand, with small fillets aiding in this as well. The angular changes in surface can still be felt by the user, as was the designed purpose.

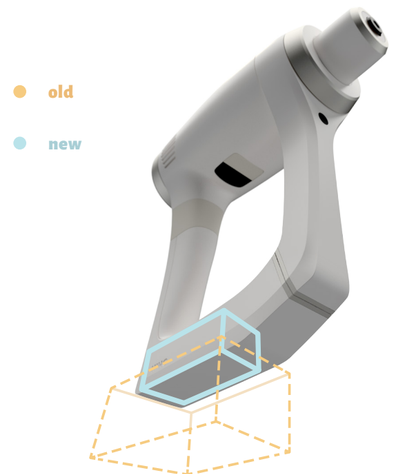
Many novice users may not be spatially aware with the tools they are unfamiliar with. This can lead to misalignments and ultimately a lower quality project than they may have hoped for. Including delicate surface changes that are tactile for the user, gives them a better understanding of how they are using their tool.

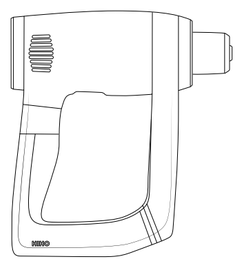
Modularity

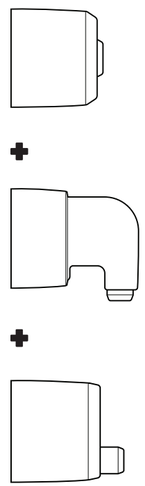
The whole model is part of a modular system. This ensures that parts are easily replaceable, without needing to replace the whole product. The drill chucks and other attachments can be changed for different functionalities and purposes, while internal components such as the gearbox / transmission are swapped to provide different performance capabilities.

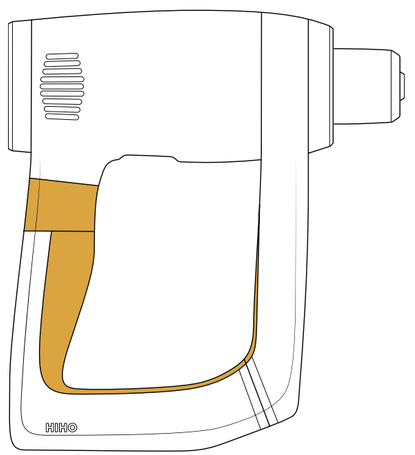
Plastic to rubber ratio
(i.e. Low friction to high friction)

Rubber, or similar materials with friction, are important for the user gain a sense of comfort through a soft touch material, as well as a sense of security that their grip won't slip. While maintaining good grip through a soft friction material is important and may initially lend to comfort, areas where the users skin is likely to rub against frequently pose possible painful side effects such as chaffing. Hence the forefinger area is left plastic, as a lot of movement is often produced there. A balance between immediate comfort and longterm comfort aims to be maintained with these ratios.









Product: physical features

Handle shape and formation

The handle is a D shaped handle, which can provide extra stability and weight distribution. Weight distribution of a tool is important in preventing early fatigue. The handle also splits into two, with the forehandle providing users with the comfort and increased control. This is also useful for interactions with other modular components that may be applied to the drill.

Drill orientation

Drill orientation gives users more options to work with. Traditional: The drill is still able to stand in its traditional orientation, this flat based standing position is ideal for completing sitting down tasks. (See left)

Stable: Sits flat with the screen, protects the screens frame, but also providing stability through the weight of the barrel.

Versatile: The drill presents itself to the user on an angle, and is more ergonomic when working while standing at a workbench. As the drill is usually quite low in comparison to the user, this allows the users wrist to remain in a healthy neutral position. (Please refer to the Design Research and Ergonomics chapter)

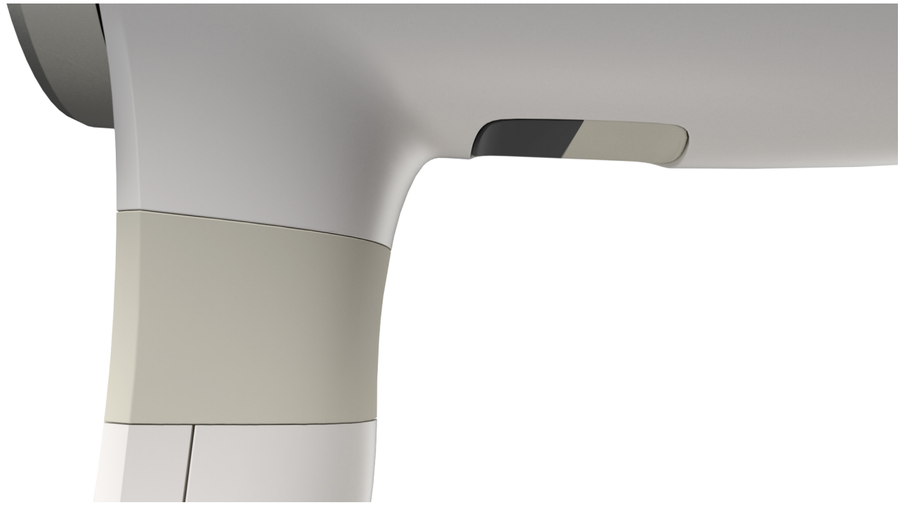
Trigger

The trigger features a tangible part-line, and material and texture change. According to Bosch (1987), as the trigger is such a key element to the drill, it must be highly accessible to the user and they should be able to use it without needing to visually confirm what they are pressing.

The trigger wraps completely around the handle and may be activated from all angles. This provides long term ergonomic support against problems such as “trigger finger”, allowing the user to balance pressure distribution better.

Direction change

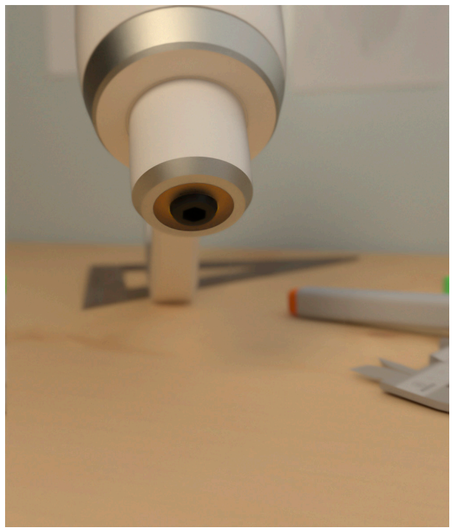
While many of the functions are automated on this drill, careful consideration towards automating the direction change switch into yet another invisible function was taken. With the trigger form changed, the usual place for this switch would need redesigning. Instead of enlisting yet another part to jut out of the form (as is so common amongst other drill designs), a minimal approach was taken instead. Where a cavity was subtracted from the form to create an affordance for the user to place their forefinger.

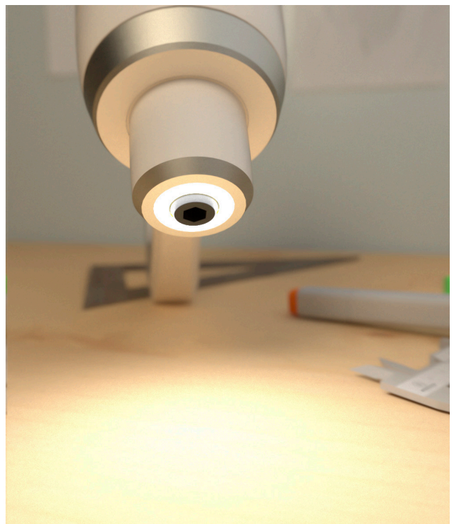


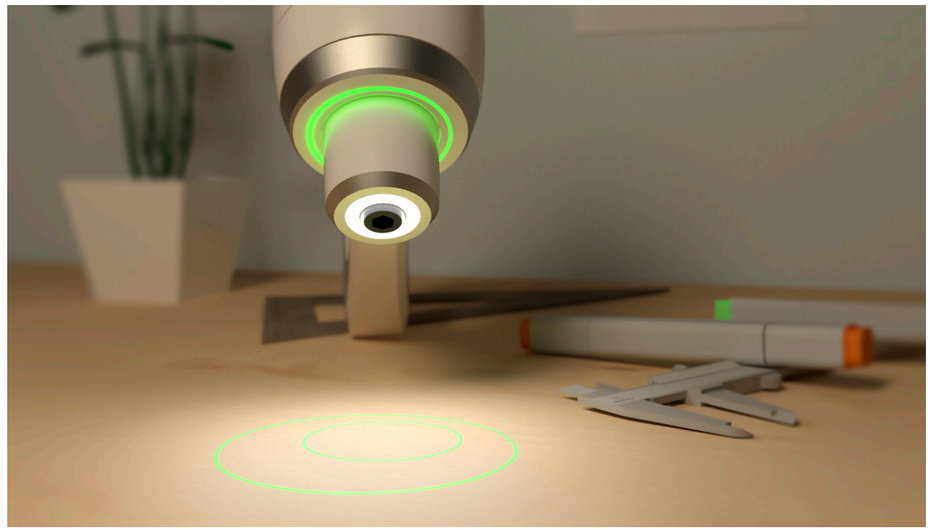
Product: physical features

Matrix laser light

The small technical package of the Matrix laser light technology (ch 2.16), 300 micrometers, enables this light to be situated inside the chuck. Placing a light as close as possible to the drill bit provides the optimum angle of illumination for the user. The phosphur panel at the front of the chuck assists in dispersing the concentrated laser light. This allows for bright, even lighting from a package size much smaller than the typical LED's used in this application. A light sensor responsively adjusts the the chuck light according to the surrounding environment.








menu
material
speed
0
180°

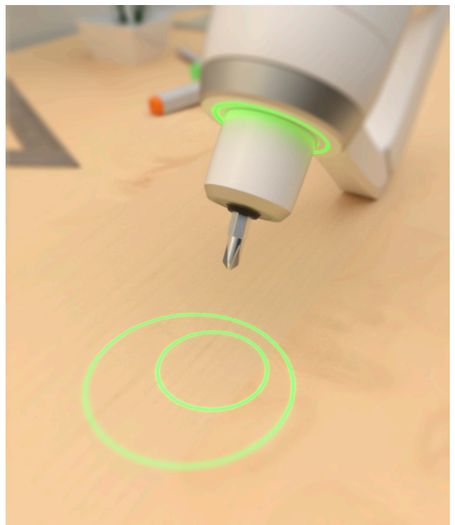
Product: Intelligent features & interface

Auto-stabilising

Weight shifting mechanisms in the drill enables it to stabilise itself, despite being top heavy with a smaller base. The gyroscope senses the angle of movement and the weight shifting mechanisms act as a counterbalance. The user can place the drill down with comfort, knowing that it will stabilise itself. The weight shifting mechanisms increase the durability of the tool and are also useful in protecting vital parts when in free fall. By shifting weight around, the angle of impact can be changed and less durable parts are protected.

Laser guides

At the front of the drill behind the chuck Is a laser projection device that provides a heads up display of the angle and depth. The laser projection is displayed onto the workpiece, and circle around the drill bit. The green rings are a highly discernable colour, and are visible even with the chuck light activated (See previous page). While there are no numbers to provide depth drilled or exact angle, the immediate feedback is provided within the users typical viewpoint and easily allows for appropriate reaction to any errors.



LED's

A set of three blue LED's are present on the side of the drill. These are used to indicate the wireless charging effciency. The further away the user is from the power source, the less lights there will be. This immediate indiactor lets the user know where they can set up their work in relation to the power source. No measuring, and no scrolling through menu systems on the OLED screen required.

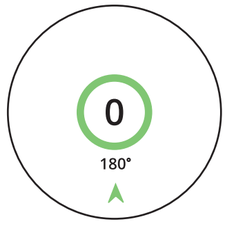
This is not included in the OLED interface system because it is an element unrelated to the main functions of the drill. It also deserves its own point of interaction because when the user needs this information, it will be most efficient when accessed directly. In addition to this, the charge interface is mapped next to the battery so that the user may relate the location of this information to its function.

Product: Intelligent features & interface

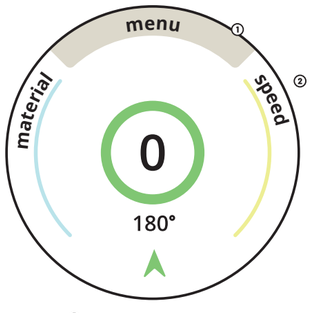
OLED screen and touch interface

Using a screen to relay information to users is important, because, when encountering a tool without prior experience, a user will often be unaware of many relevant or important factors. A screen is able to control information output, and prevent new users from becoming confused at the vast selection of buttons and switches they are greeted with immediately compared to conventional drills. The screen is the primary source for information. This was purposefully designed to reduce confused interaction with other parts of the drill.

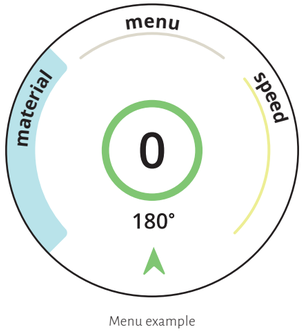
While the OLED is touch screen, minimal function has been applied here to prevent stray contact. The main touch interface is available through the frame which houses the screen. A combination of taps and slides are used to navigate through the menu system. The interface interactions were carefully considerd, to prevent any stray or accidental activations of elements.



① Tap and hold frame/screen to bring up menu

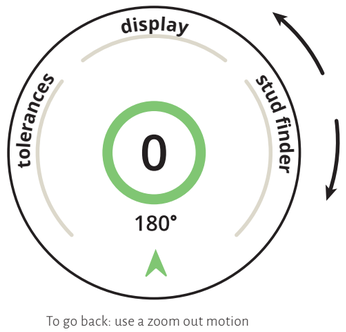


① Tap choice ② Tap anywhere to select choice



Menu example

1:1 scale

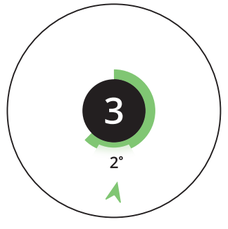


To go back: use a zoom out motion

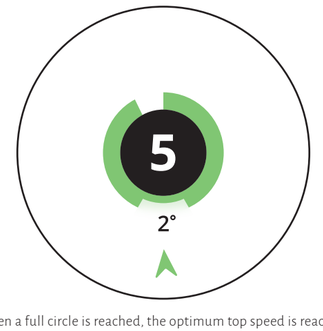
When at main menu, this also clears the menu premature to fading out

Trigger

Primary ethnographic-based research revealed that many users had trouble controlling the trigger pressure. The trigger pressure is proportional to the rotational force outputted from the drill. It is a muscle memory skill that not every novice user is able to achieve initially, which is why the trigger is semi-automated. It can be activated with pressure, but the amount of pressure applied will not change drill speed. Instead, data from the drill's sensors (such as the infrared spectrometer and proximity sensor) will inform the correct speed settings.



① The travelling circle indicates the rate of speed increase.

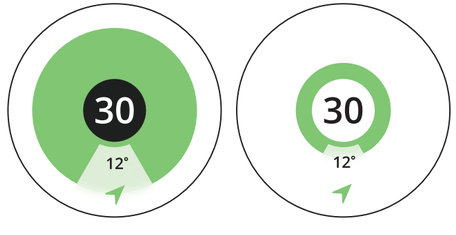


② When a full circle is reached, the optimum top speed is reached.

The rate of speed increase can be adjusted in the speed menu.

Direction change

Many drills refer to the direction change functions as "forward" and reverse", or "anticlockwise" and "clockwise". These ultimately means "in" and "out". Extra learning steps are nulled for a highly accessible interface for novice users. There is reduced chance for users to confuse "forward" with "reverse". Instead the drill indicates "in" or "out" as the interface language for direction change. The interface functions are mapped to suit this. A sideways switch between left and right for anti-clockwise and clockwise movement, is replaced with a touch button moving perpendicular to previous movements. This shadows the "in" and "out" direction the drill would naturally make. A slight prolonged touch changes the direction, with stark colours used to differentiate between forward and reverse.



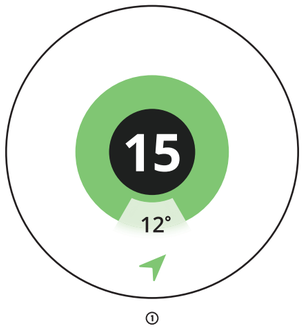
Black indicates moving in

White indicates moving out

Product: Intelligent features & interface

Proximity sensor

Calculates distance so the user can obtain feedback in relation to their actions. Such as how far down they have drilled. This information is displayed realtime to the user, using responsive graphical animations that communicate the users movement.



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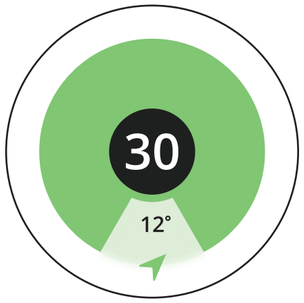


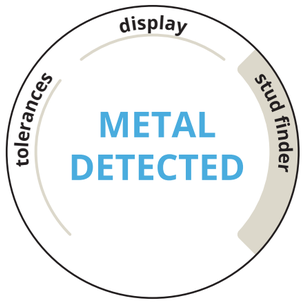
②

Green circle moves outwards to indicate an increase in depth

1:1 scale

Stud sensor

The flat angle added to the form contains a stud sensor that can be used to locate objects the user may not be able to see from the outside. These can be objects hidden behind a wall that a user is drilling into, without knowledge of what may be embedded inside it or behind it. Objects like hidden screws/ nails or wires that may be damaged if drilled into.



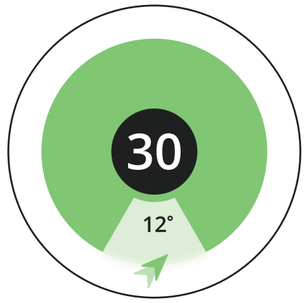
①

②

Angle detection

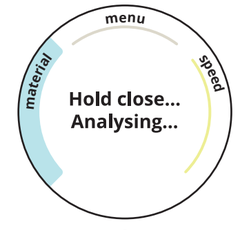
Angle detection and feedback is important for the user to be able to adjust their actions accordingly. Using a gyroscope sensor and laser guides that display themselves onto the workpiece, the user is able to easily gauge their movements from all angles.

When drill is active, green arrow will motion back and forth to the direction the user should angle towards to straighten out.



Material detection

The automated speed up function of the trigger is possible due to the data received by an Infrared Spectrometer sensor. It is able to detect material compositions and analyse, assign and translate these compositions into different materials. Different materials require different speed and torque settings. The Infrared Spectrometer sensor is able to inform and control the motor and gears of the drill without the need to increase the learning curve for novice users.



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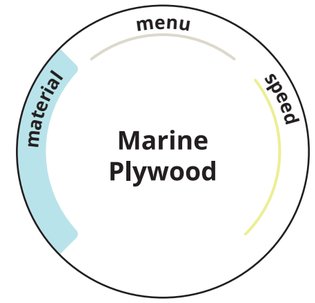


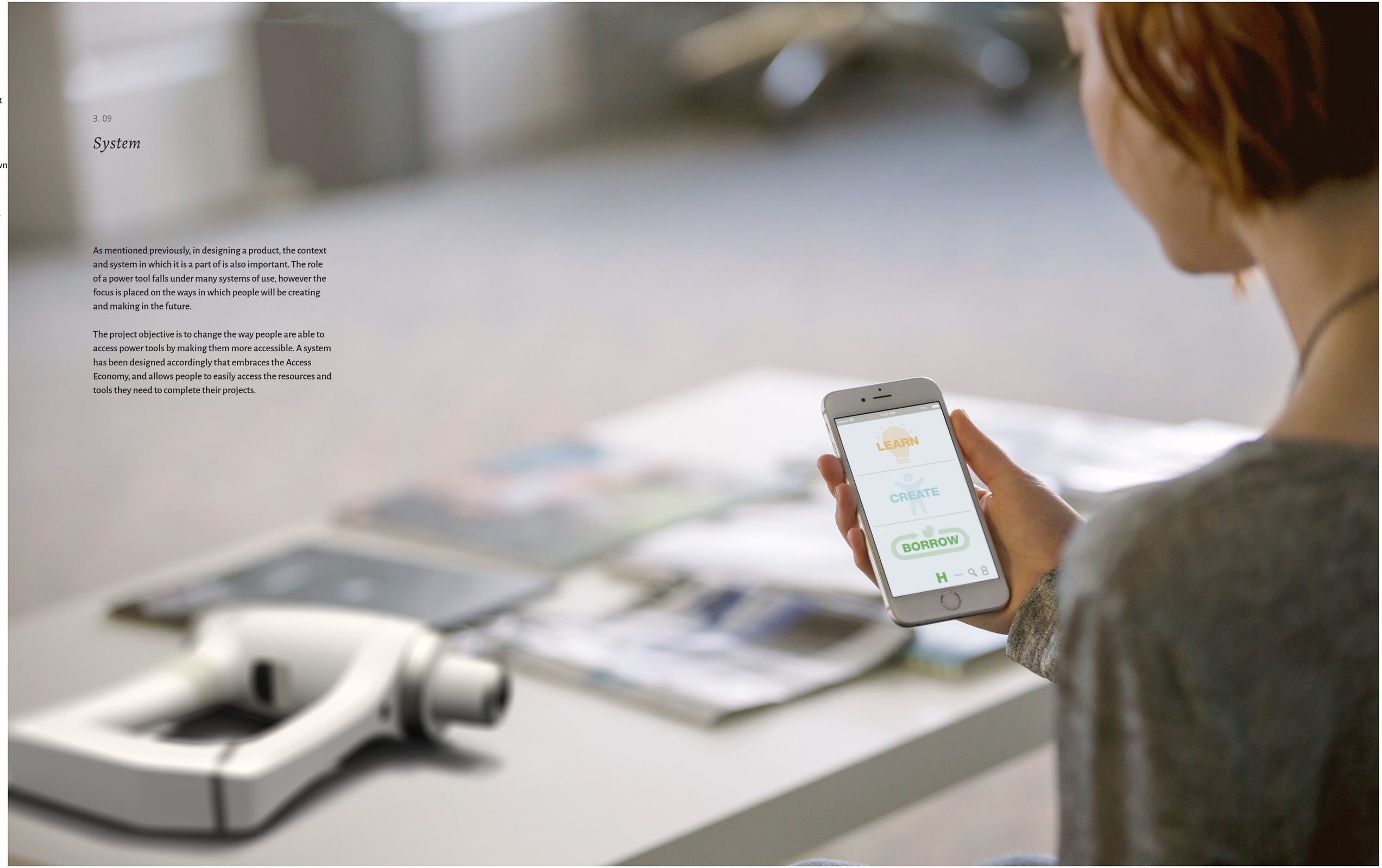
②

3. 09

System

As mentioned previously, in designing a product, the context and system in which it is a part of is also important. The role of a power tool falls under many systems of use, however the focus is placed on the ways in which people will be creating and making in the future.

The project objective is to change the way people are able to access power tools by making them more accessible. A system has been designed accordingly that embraces the Access Economy, and allows people to easily access the resources and tools they need to complete their projects.



3. 09. 1

Final concept: system work flow

The system is catered around being able to access tools efficiently. Thus, many processes leading up to the interaction of the tool has been designed within this system. This system is based around three main trends:

① **Learn**

People want to learn how to make and use new tools they're unfamiliar with.
From 3d printers to quilting, classes and tutorials are on the rise, especially within community driven circles.

② **Create**

People want to put a personal touch to their objects, and are seeking this through making their own or modifying existing products.
Parametric modelling, IKEA hacking, personalised orders online... Everyone from the average person to large companies are seeking to add that extra level of personality objects.

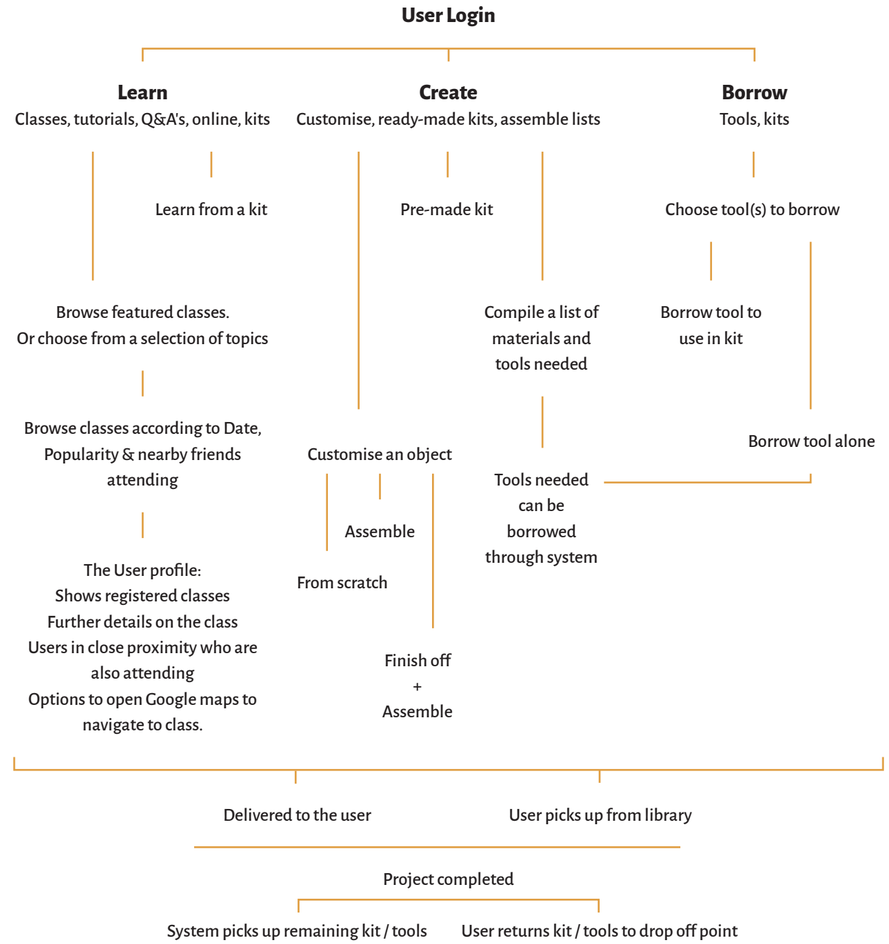
③ **Borrow**

People want better access, tools included.
The Sharing Economy has only made obtaining the benefits of products cheaper. Community Tool Libraries have proven to be increasingly popular, as have the rapid rise of 3d printing services opening to the public through libraries.

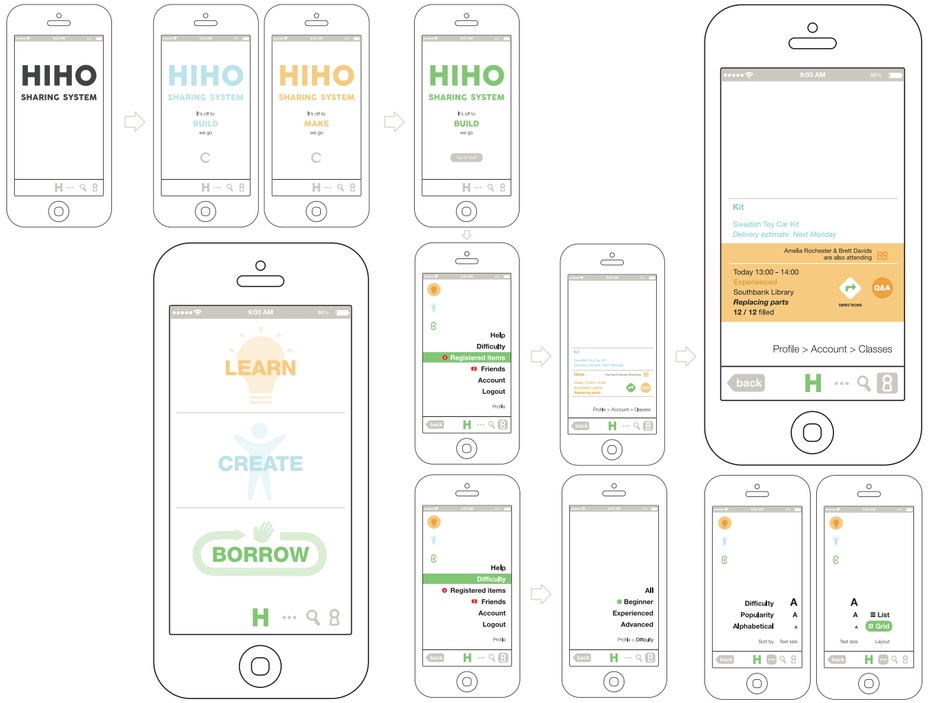
Ideally, this system would be supported through a community driven library network in partnership with leading innovators. It is the next step up from existing tool libraries, maker labs and places for peer production. HIHO belives that building, making and creating can be an explorative learning process, serious expedition or playful adventure. HIHO seeks to encourage users of all ages and skill levels to learn something new. The HIHO system looks at what the next generation of creating and making entails. It aims to provide an approachable service to a variety of users that want easy accessibility to tools, creating, and learning.

HIHO

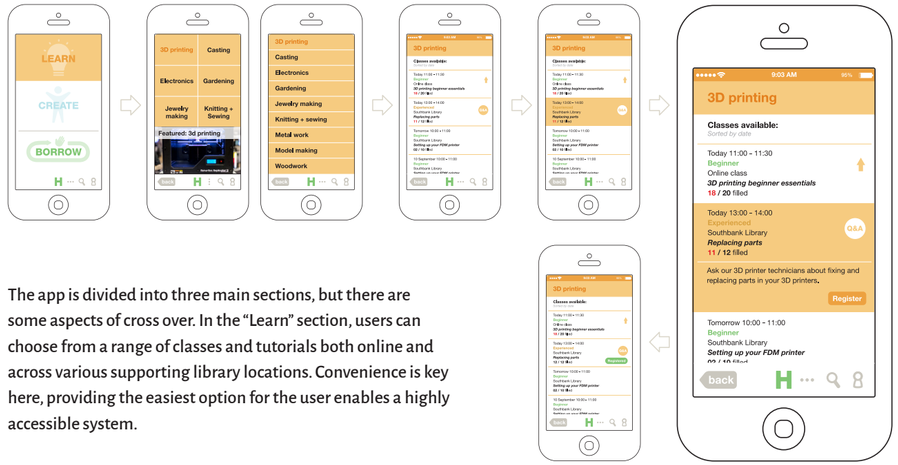
It's off to create, make and play we go



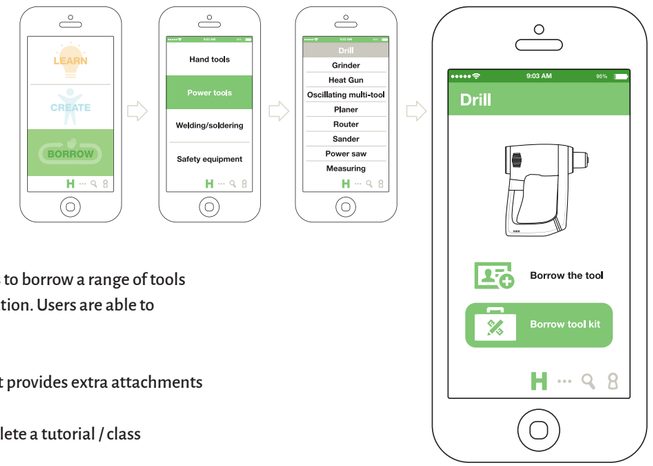
System: App features



HIHO seeks to engage its users from all aspects of the system. The app opens up to a loading page that flicks through the three main theme colours. The user choose an overall colour theme to their preference before they enter the app. Users can login with their library ID and view classes they have registered for or kits and tools they may have on loan. As well as change various display settings and features of the app.



The app is divided into three main sections, but there are some aspects of cross over. In the “Learn” section, users can choose from a range of classes and tutorials both online and across various supporting library locations. Convenience is key here, providing the easiest option for the user enables a highly accessible system.

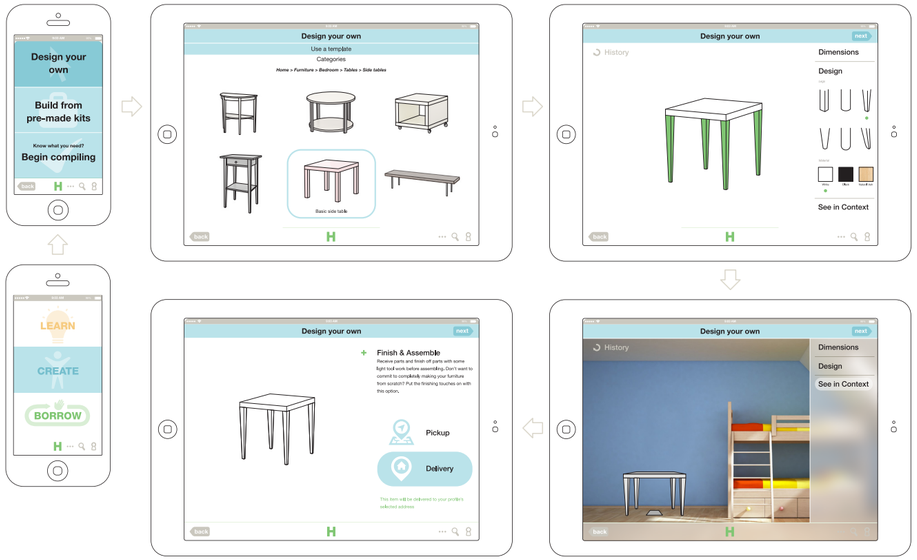


The “Borrow” section allows users to borrow a range of tools designed to be in constant circulation. Users are able to choose from:

- Borrowing the tool alone
- A kit to go with the tool that provides extra attachments and helpful guides
- Borrowing the tool to complete a tutorial / class

3. 09. 2

System: App features

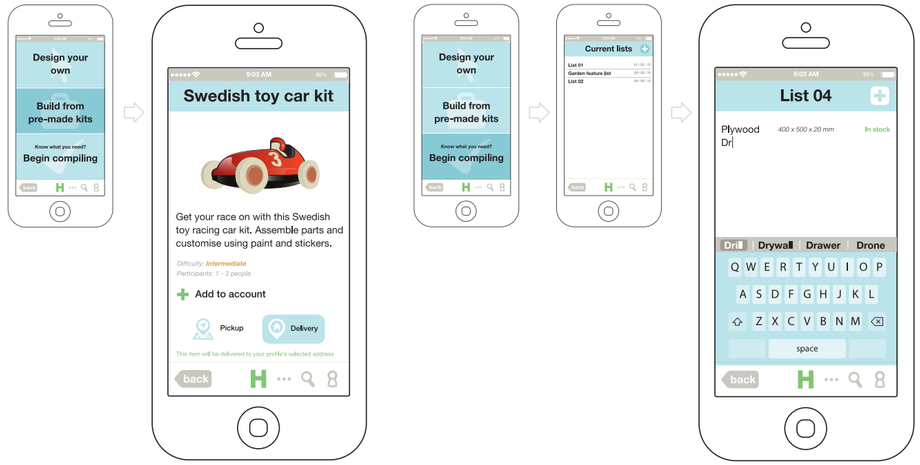


In the “Create” section users can choose to design their own items. These range from decorating a pot plant to home decor. The main focus is the improvment of living spaces. Users can choose from a range of starting designs, and then begin to modify these through the use of parametric modelling. They are then able to view their designs in their desired living area through Augmented reality.

Ensuring the user is able to easily access the customised object they have just designed is fulfilled through delivery and pickup options.

The “Design your own” option allows uers to choose their level of commitment / effort towards their project:

- From scratch: Material can be bought cut to size, or sources are recommended to the user. Tools may be borrowed through the app or a local library in person.
- Finish & Assemble: The parts come rough and ready for assembly. Finishing details like varnish, sanding, or drilling holes may be required.
- Assembly: Assembly is the only requirement for implementing this piece into a users living space.



The “Pre-made kit” option allows users to create simple objects that do not require parametric modelling to customise. The kits are designed for a variety of skill levels, with some kits giving users the option to choose their level of commitment towards the project.

In completely self-directed projects, sourcing the materials and tools to begin the project can often be the most time consuming of tasks. (See User Observation research) Often online tutorials will contain confusing information such as region-specific measurements. The “Compile” option is a place where users can create their own lists for projects they wish to undertake. Whether measurements entered are imperial or metric, the users selected default settings will automatically homogenise all units and items.

Materials & Manufacturing rationale

Vitrimer self-healing plastic:
Multi-shot Injection moulded (to rubber)

A

Multi-shot Injection moulded with retractable core (to rubber)

B

Multi-shot Injection moulded (plastic only)

C

+

Supramolecular self-healing rubber:
Multi-shot Injection moulded

The plastic shell, using present day methods, would be most suited to injection molding. This method would require the addition of ribs and bosses internally to strengthen the structure. However, the properties of this Vitrimer polymer opens opportunities to manufacture pastic parts not available using current manufacturing methods. (ch 2. 21) Similar opportunities also apply to the supramolecular rubber material.

A

Anodized Aluminium:
Low pressure die cast, anodized custom colour

Rotational symmetry as well as the non-ferrous, low melt temperature attributes of aluminium makes this method optimal. An anodized layer gives durability against wear and tear, while adding to a clean aesthetic.

A

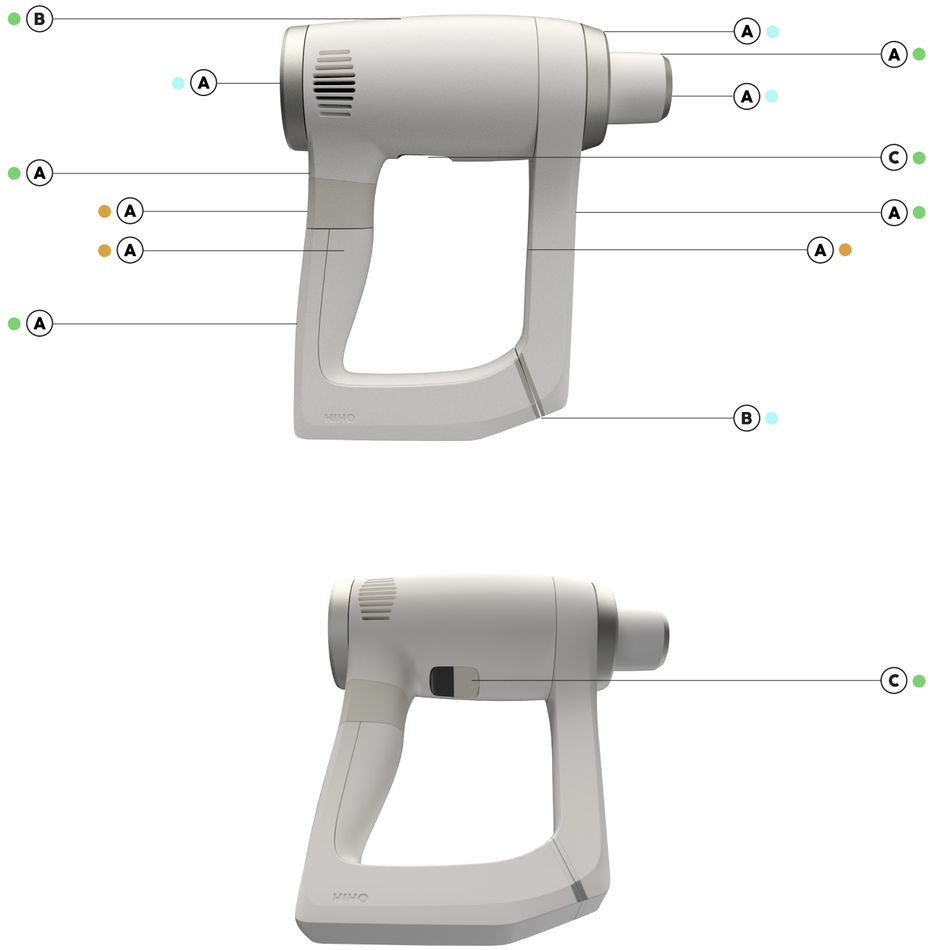
High pressure die cast, anodized custom colour

High pressure die casting is used for smaller, intricate parts where wall thickness may be thinner. Fine surface detail can be achieved here, despite increased detail. This part is not rotationally symmetrical and must be manufactured in this manner.

B

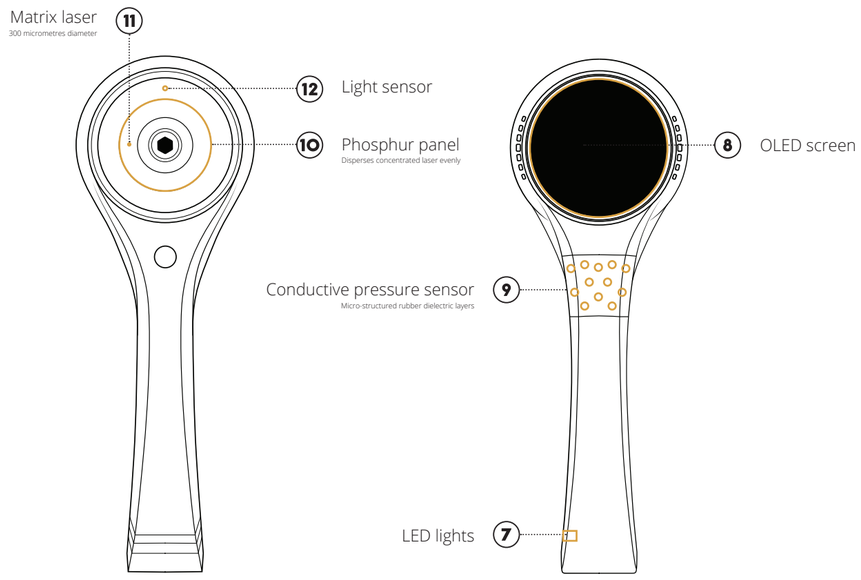
Nano coating & microscopic surface modification:

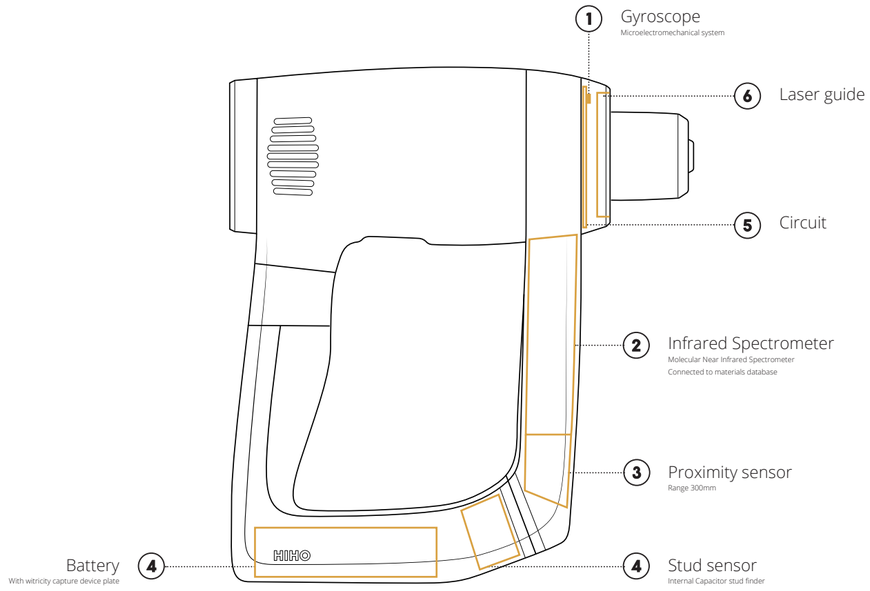
While the self-healing materials enable durability against physical impact and scratches. Nano-coatings and microscopic surface modifications can increase durability against solvents, grease and other chemicals that may be involved throughout a users project. Adding hydrophobic effect may also also assist in this as it ensures dry particles like dust are easily cleaned off the product. This helps maintain a clean surface, ultimately providing an approachable object everytime for the next user.



3. 11

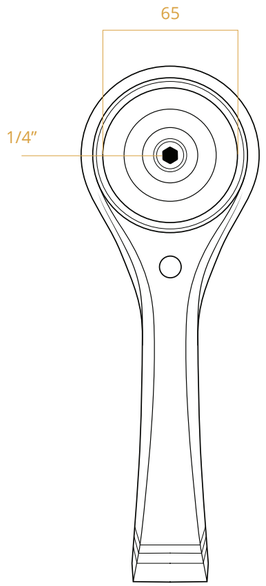
GA

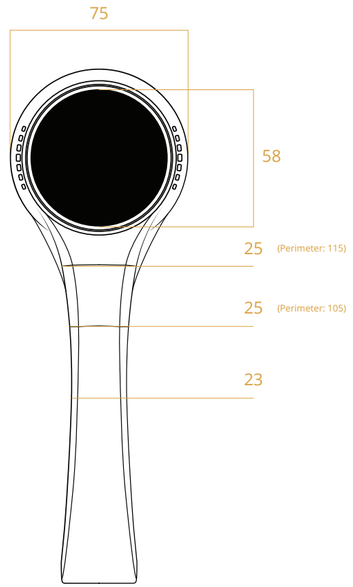

Matrix laser
300 micrometres diameter
11
12
Light sensor
10
Phosphur panel
Disperses concentrated laser evenly
8
OLED screen
Conductive pressure sensor
Micro-structured rubber dielectric layers
9
LED lights
7

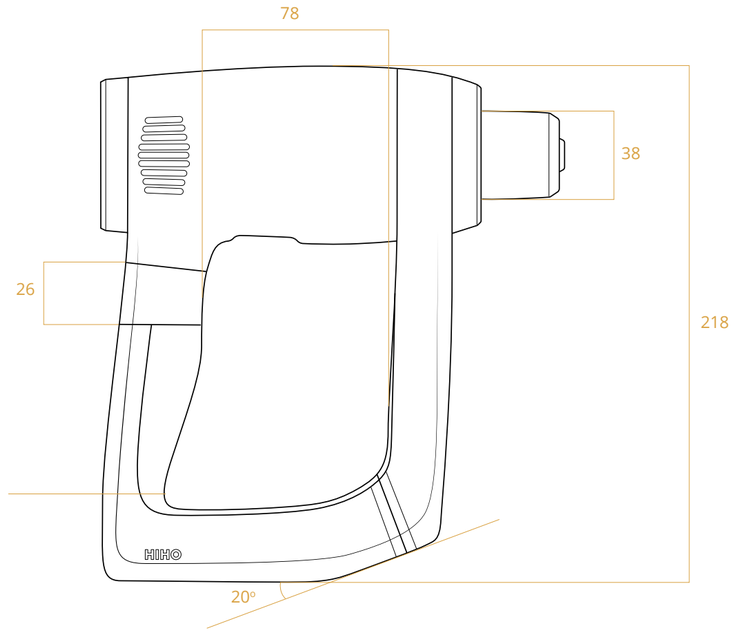

1
Gyroscope
Microelectromechanical system
6
Laser guide
5
Circuit
2
Infrared Spectrometer
Molecular Near Infrared Spectrometer
Connected to materials database
3
Proximity sensor
Range 300mm
Battery
With witricity capture device plate
4
4
Stud sensor
Internal Capacitor stud finder

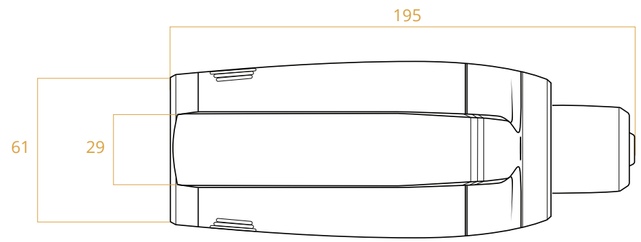
3. 12

Detailed drawings









All measurements in millimetres

3. 13

Conclusion

Objective review

The intended outcome of this project is to produce a power tool that is smart and intuitive. One that might displace the norm of otherwise owning a power tool.

Incorporating new technologies, such materials and appropriately chosen sensors, conributes to the design of a smarter tool. While these technological additions can make a more intuitive tool, extensive ethnographic research revealed many user experience insights that helped inform appropriate use of these technologies. The norm of owning a power drill and its design are displaced by approaching the motivating factors for designing a drill in a different way.

To create a power tool that embraces a rental system where tools are shared rather than developed for sole ownership.

This project looks at not only the design of a product, but also explores the context that the power drill will reside in. The system and product complement each other. A system where users may access the power tool has been developed. It encourages users to partake in the Share / Access Economy. The product has been designed to accompany the system, where easy and efficient maintenance of parts through a modular design ensures system sustainability and perpetuity.

Because this is a tool to be used by differing demographics and experience levels, the tool must have an interface that is accessible and easy to use, as well as be something the user is able to obtain and access with ease.

An accessible looking design is reflected in the clean form language and neutral colour and trim aesthetic. The user experience is made accessible for a variety of users by developing a power drill that is responsive and smart. The power tool has been made easy to access by developing a system where users can easily obtain the tool through channels that complement their own work flow.

During project conception the initial research directions were broad. There were many opportunities for the project to head in, and not every route could be explored and realised. I ultimately decided what to design based on my interests throughout the year:

- Futurology - technology, the role of design in the future
- Systems & service design - user experience

There were many successful areas of the project:

- The D handle design of the drill. The form factor and the material ratio / breaks are quite refined.
- The ethnographic research was thorough and detailed
- The different approach taken with colour and trim to create something different from the market.

There are also many opportunities for further research and development:

- Developing a complete power tools range with the same aim of being smart, accessible and intuitive.
- Designing the users experience within the library if they were to collect or drop of tools / kits.
- Developing a more indepth user interaction within the app, as well as across platforms.

While some of the add-on features like the modular components and battery pack were not completely realised, these were secondary to the design of the drill and the system. The final outcome of the project is still well-rounded, demonstrating a system and product that complement each other. I hope this project changes the way users and designers think about product design in the future, as it certainly has for me.

Glossary

Access Economy
"Systems that enable people to pay for access to the benefit of goods rather than needing to own them outright."

(Rachelbotsman.com 2015)

Collaborative Consumption
"Systems that reinvent traditional market behaviors—renting, lending, swapping, sharing, bartering, gifting—in ways and on a scale not possible before the internet."

(Rachelbotsman.com 2015)

Cradle to cradle
"This framework seeks to create production techniques that are not just efficient but are essentially waste free. In cradle to cradle production all material inputs and outputs are seen either as technical or biological nutrients. Technical nutrients can be recycled or reused with no loss of quality and biological nutrients composted or consumed. By contrast cradle to grave refers to a company taking responsibility for the disposal of goods it has produced, but not necessarily putting products' constiuent components back into service."

(Sustainabilitydictionary.com 2015)

Sharing Economy
"Systems that facilitate the sharing of underused assets* or services, for free or for a fee, directly between individuals or organizations."

(Rachelbotsman.com 2015)

Trigger finger
"Trigger Finger, also known as stenosing tenosynovitis or flexor tendonitis, is a condition where one of the fingers or thumb of the hand is caught in a bent position. The affected digit may straighten with a quick snap, similar to pulling and releasing the trigger on a gun, hence the name trigger finger."

(Handsurgery.com.au 2015)

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