Deline

DIRECT-TO-FABRIC BESPOKE GARMENT PATTERN PRINTER

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10 Page Summary

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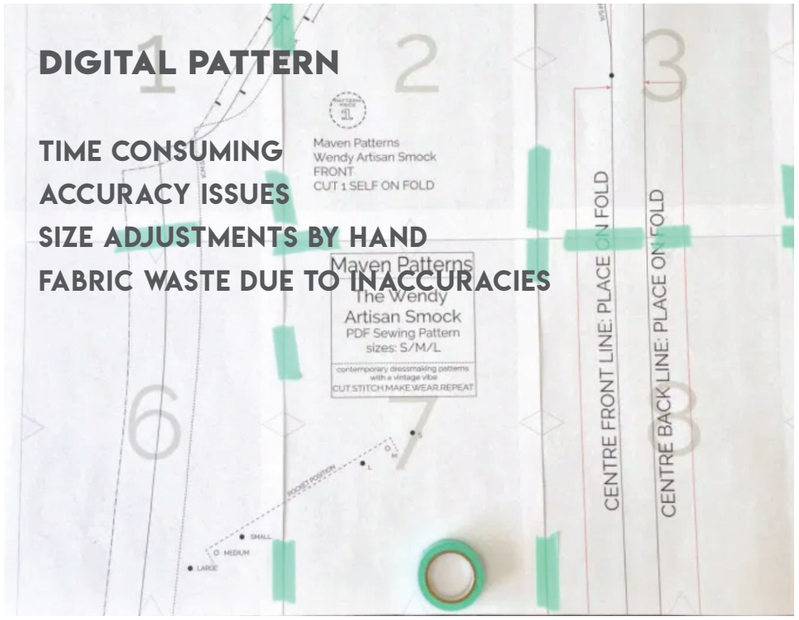
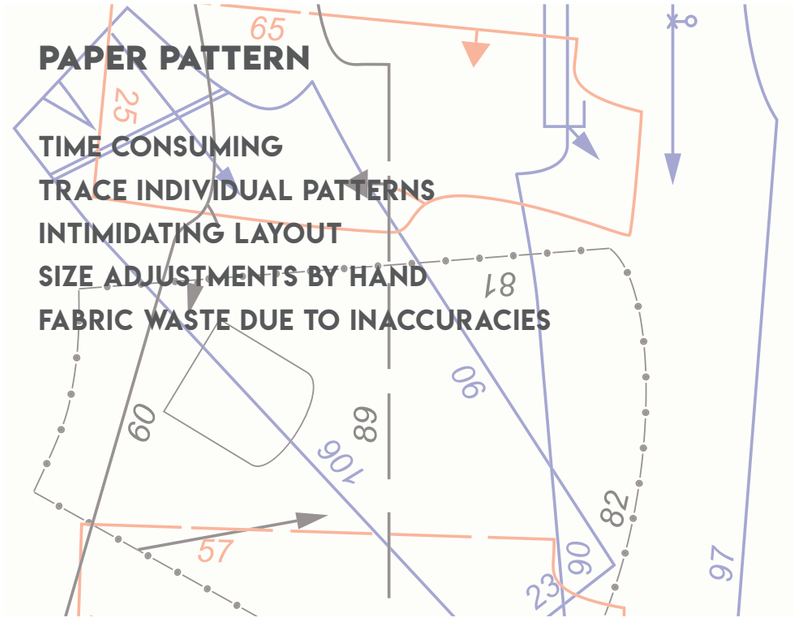
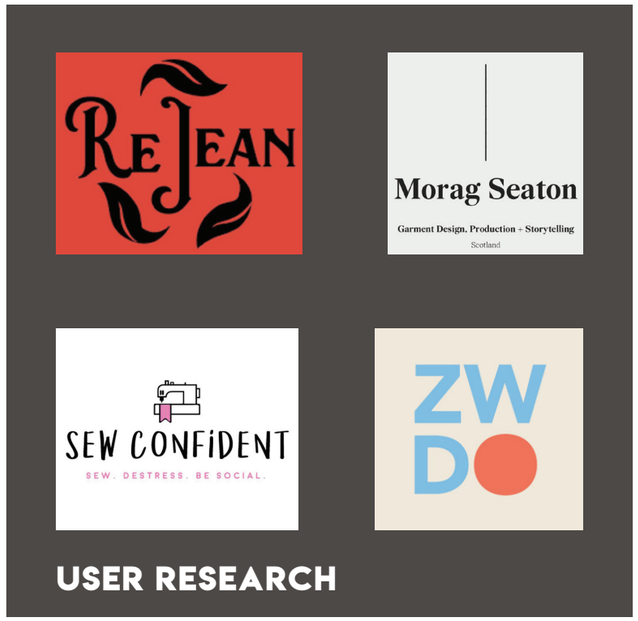
PROBLEM...

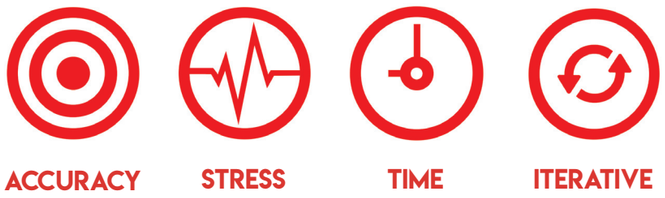
DELINEATE:

1. PORTRAY SOMETHING PRECISELY
2. INDICATE THE EXACT POSITION OF A BORDER









Users are required to print digital patterns and connect the individual sheets together to construct the full pattern. Precision is required to maintain overall pattern accuracy which I found to be challenging to achieve during my sewing lesson. A0 printing can be outsourced but it is expensive and isn't immediately available.

Patterns bought in books are stacked on the same page and must be traced on specialised A0 tracing paper which is expensive. Again, if A4 tracing paper is used, it must be stuck together accurately. People can choose to use the pattern to create one of the garments but the others will be lost once it is cut out. Additionally, having several patterns stacked creates a complex set of geometries that are difficult to follow.

@ SEWING & PATTERNS UK CHAT

"Need someone to explain this if they can please..."

"Help! I'm stuck and I can't for the life of me work it out... bear with me... I don't understand the instructions."

"Hello all. Can someone please help me, I think I am going mad. I'm struggling to make this waistcoat and it's really challenging my strength and temper..."

"Anyone made Oliver+S patterns? I can't work out the sizes, they seem big..."

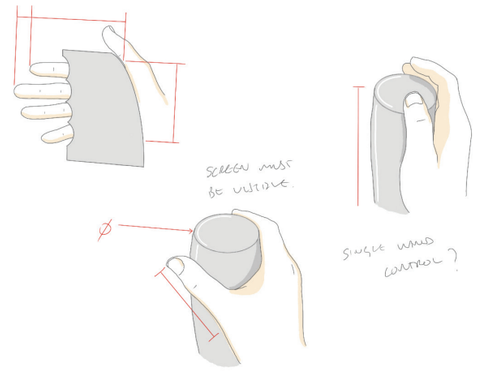
"My local printer has quoted me £50 to print two A0 patterns, are there cheaper options?"

"I'm a little confused; I'm usually a size 14 however the measurements are saying 20, how does this work?"

"Can someone recommend a UK pattern printer company for A1 & A0 patterns?"

"Where can I buy super cheap cotton to make a mock up of a dress and jacket so I don't waste my lovely wool fabric?"

USER PROFILE



Anyone can make clothes so this product had to be as inclusive as possible to people with varying physical and cognitive abilities, and prior technical experience. By considering users at the lower end of this spectrum first, it ensured that the product would be accessible to the vast majority of potential users. This led to key user criteria that had to be met:

- The product had to be **intuitive** and **easy to use**; whatever technology was used had to be as transparent as possible.

- The product had to be **compact**; user research highlighted that many users have limited space to prepare patterns.

- The product had to be **light**; users with limited mobility or strength had to be able to use the device with ease.

- The product had to be **ergonomic**; it was designed to be comfortable to users between the 5th and 95th percentile of hand dimensions.

		18 - 65 years					
	dimension (in mm)	P1	P5	mean	P95	P99	SD
hands	hand length	161	169	189	209	217	12
	hand breadth	67	72	83	94	99	6,9
	hand thickness	20	22	27	32	34	3,2
	thumb breadth	13	15	20	25	27	2,8
	forefinger tip breadth	12	13	16	19	20	1,7

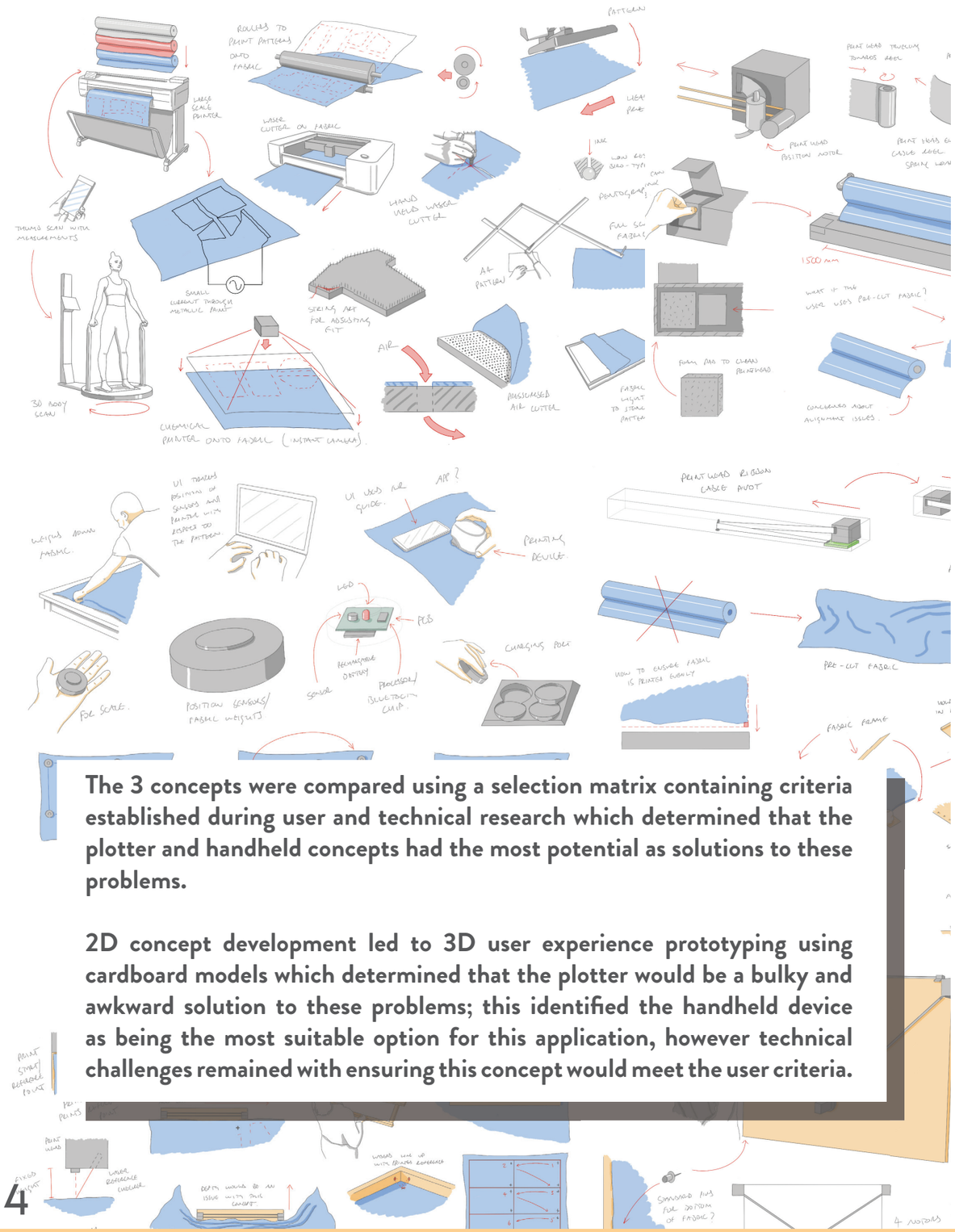
PRINT MEDIUM

DESIGNED TO USE EXISTING, LOW-COST FABRIC MARKERS

THESE PENS ARE READILY AVAILABLE AND THE FAMILIAR TO THE END USER

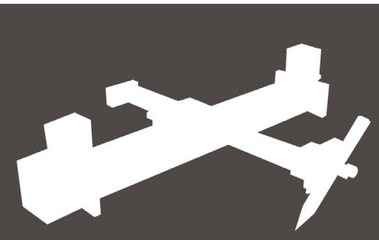
THE PRODUCT HAD TO ACCOMMODATE VARYING SIZES

CONCEPT DEVELOPMENT



The 3 concepts were compared using a selection matrix containing criteria established during user and technical research which determined that the plotter and handheld concepts had the most potential as solutions to these problems.

2D concept development led to 3D user experience prototyping using cardboard models which determined that the plotter would be a bulky and awkward solution to these problems; this identified the handheld device as being the most suitable option for this application, however technical challenges remained with ensuring this concept would meet the user criteria.



PLOTTER CONCEPT

HIGHLY ACCURATE

FAST PRINT TIMES

FAIRLY BULKY

REQUIRES USER REPOSITIONING DURING PRINT

HANDHELD CONCEPT

HIGH POTENTIAL ACCURACY

COMPACT AND LIGHT

TECHNOLOGICALLY COMPLEX

REORIENTATION REQUIRED IF PRINT IS INTERRUPTED

PRINTER CONCEPT

HIGHLY ACCURATE

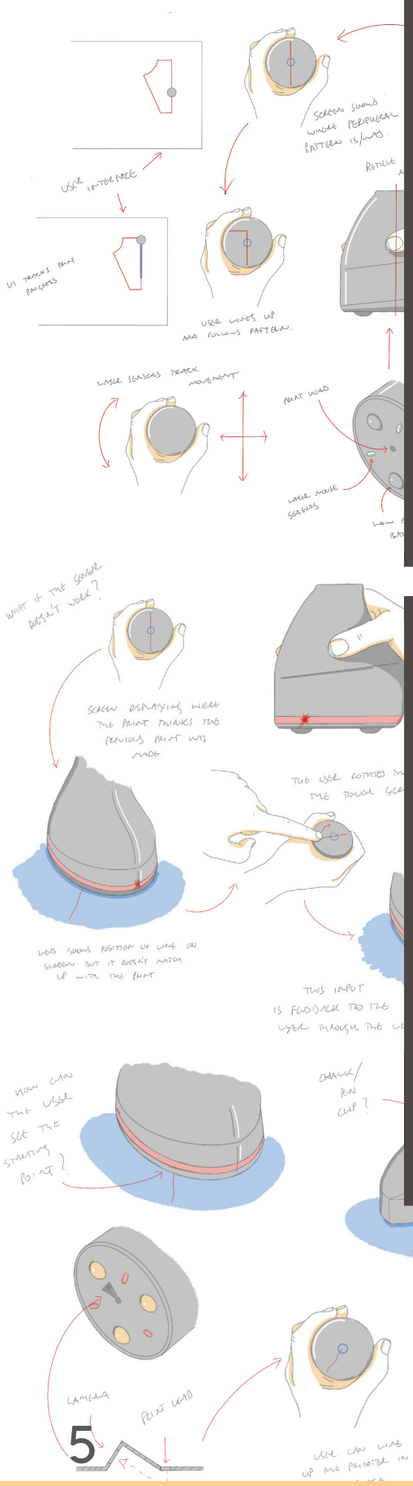
COMMON EXISTING TECHNOLOGY

VERY BULKY AND HEAVY

INEFFICIENT PRINT TIME

3D USER EXPERIENCE PROTOTYPING

CONCEPT REFINEMENT



ULTRA WIDEBAND RF

TRANSMITTERS TRIANGULATE THE POSITION OF THE RECEIVER BY CALCULATING THE DISTANCE USING THE SPEED OF THE WAVE AND THE TIME OF ARRIVAL

RF WAVES TRAVEL AT THE SPEED OF LIGHT AND REQUIRE EXTREMELY HIGH RESOLUTION CLOCKS TO REMAIN SYNCHRONISED, WHICH ARE VERY EXPENSIVE FOR THIS APPLICATION

FOR 1MM RESOLUTION

$t = \frac{d}{c} = \frac{0.001}{300{,}000}$

$= 3.33$ PICOSECONDS REQUIRED

$c = 300{,}000\ m/s$

$d = 0.001\ m$

$t = ?$

ROTARY ENCODER

REQUIRED TO HAVE A VERY HIGH RESOLUTION FOR ACCURATE REORIENTATION OF PATTERN

THE TRANSPARENT AND OPAQUE PATTERN DISRUPTS THE IR LIGHT REACHING THE SENSOR LEADING TO A CHANGE OF SIGNAL THAT IS USED TO TRACK POSITION AND MOTION OF THE ROTATION

MAX PULSES PER REVOLUTION ON CODE WHEEL = 900

$\theta = \frac{360^\circ}{900} = 0.4^\circ$

MAX. LENGTH OF REMAINING PATTERN TO ENSURE RESOLUTION OF 1MM

$x = \frac{0.001}{\tan(0.4)} = 14.3cm$

ACCELEROMETERS/GYROSCOPES

HIGHLY SENSITIVE AND CAN MEASURE STATIC AND DYNAMIC ACCELERATIONS AND CHANGES IN PITCH

DOUBLE INTEGRATION OF ACCELERATION CALCULATES THE CHANGE IN POSITION; SMALL ERRORS ARE CARRIED THROUGH AND INCREASE IN SCALE

$\iint \frac{d^2x}{(dt)^2}\,dt = x \quad \therefore \iint ERROR\,dt$ LARGE!

$= \int ERROR\ t\,dt = \frac{ERROR\ t^2}{2}$

LASER SENSOR

EXTREMELY ACCURATE LINE-OF-SIGHT TECHNOLOGY

EXTREME ACCURACY CAN CAUSE NOISE AND JITTER; THIS APPLICATION REQUIRES A RELATIVELY LOW DPI RATING

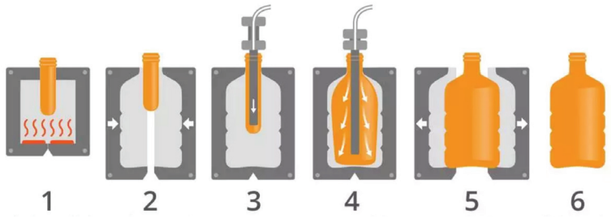
SMALL RANGE REQUIRES PRECISE MANUFACTURE WITH LOW TOLERANCES

SAFETY CONSIDERATIONS FOR THE END USER

PRODUCT OVERVIEW

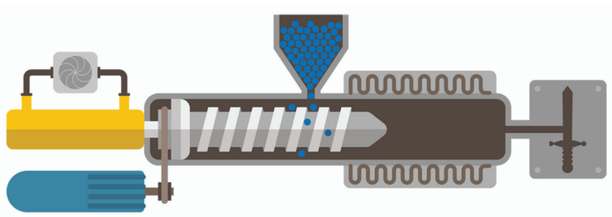
BLOW MOULDING

DUE TO INTERNAL CAVITIES CAUSED BY GEOMETRY



INJECTION MOULDING

ALL OTHER PARTS INJECTION MOULDED



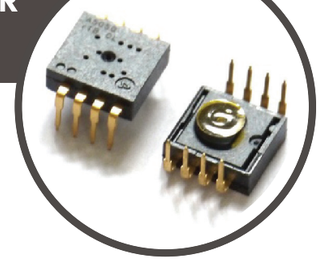
480P TOUCHSCREEN OLED DISPLAY

SPRING LOADED PEN MOUNT

LI-ION 5V 2.2AH RECHARGEABLE BATTERY

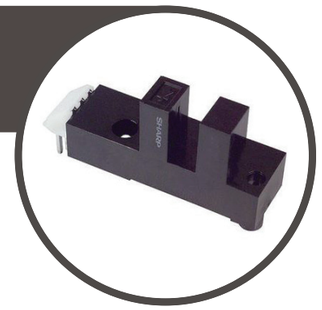
USB C PORT FOR CHARGING

400DPI ADNS-9500 LASER MOUSE SENSOR



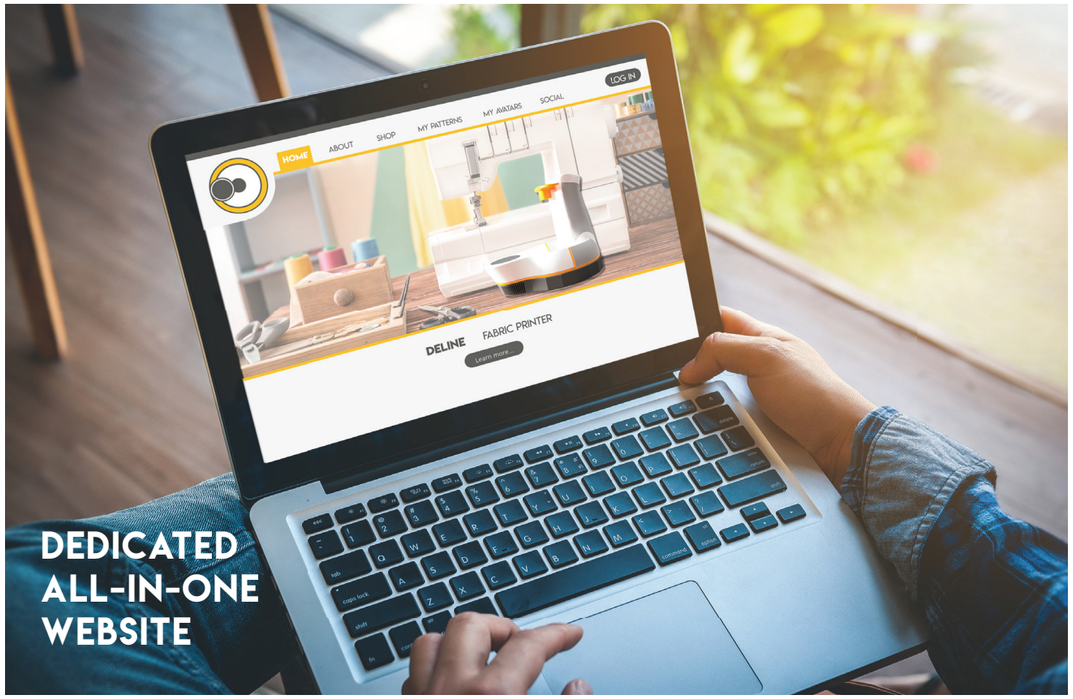
PCB'S FOR ELECTRONICS

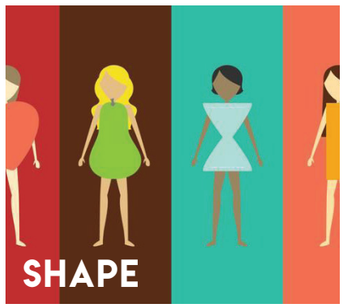
IR PHOTOELECTRIC ENCODER



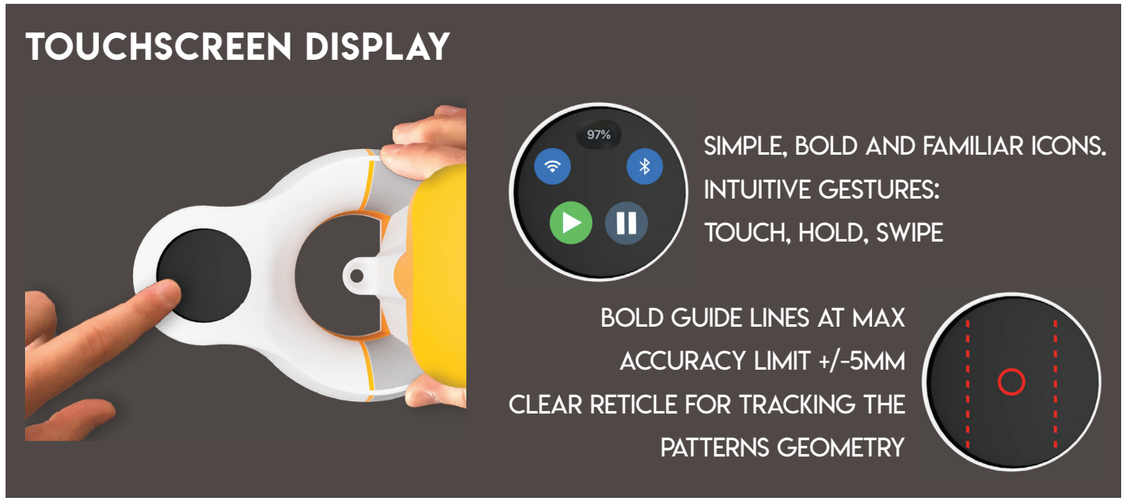
LOW FRICTION STEEL CASTERS

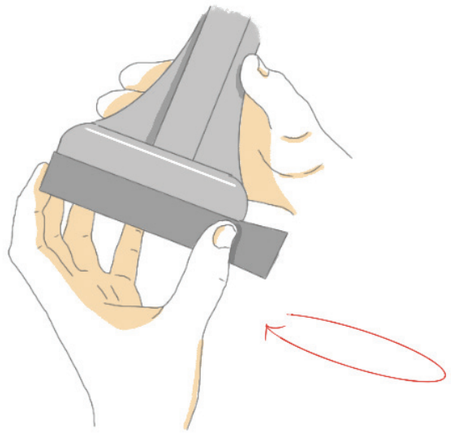
USER INTERACTION POINTS





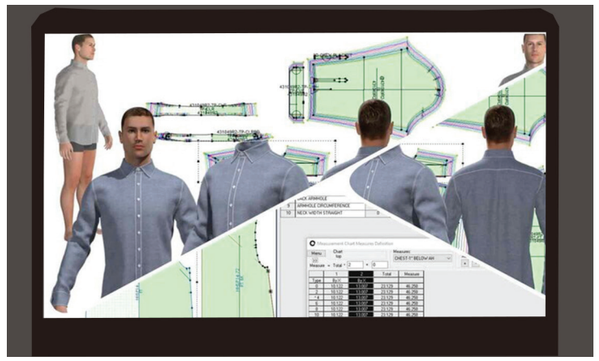
The user interface provides all necessary functions from shopping for a pattern, automatically adjusting the pattern to fit the users body avatar, to finally accurately guiding the user through the printing process. The touchscreen display is designed to be intuitive and familiar, controlled using common smartphone gestures. The reticle complies with the anthropometric data and can be rotated using one hand. The base has a polygonal cross section for added grip when rotating with two hands. The pen mount is design with finger and thumb grips and its shape clearly informs the user how it is operated.





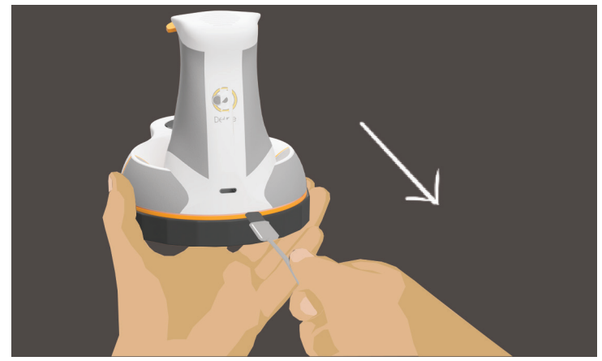
USER JOURNEY

1. THE USER BUYS A GARMENT PATTERN THROUGH THE USER INTERFACE

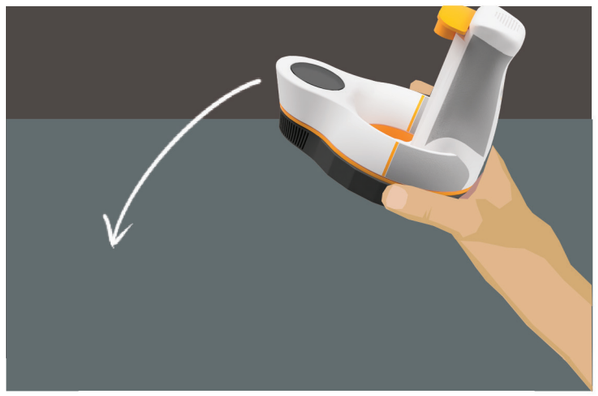


2. THE INTERFACE AUTOMATICALLY ADAPTS THE PATTERN TO THE USERS SIZE

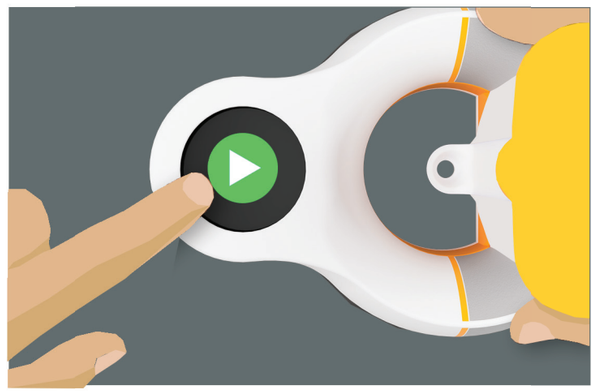
3. THE USER SELECTS THE STARTING PATTERN AND STARTING POINT ON THE PATTERN



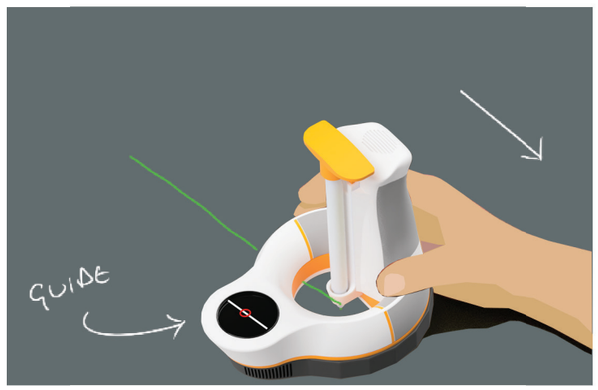
4. THE USER UNPLUGS THE DEVICE



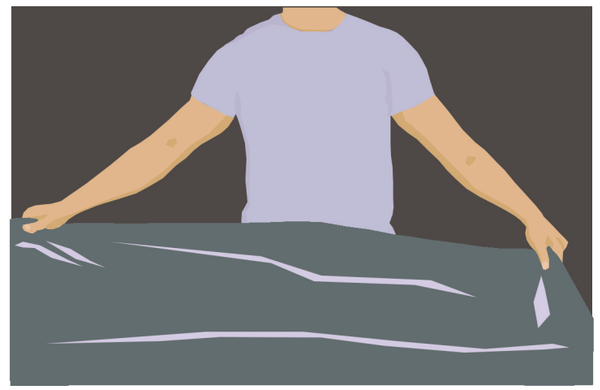
5. THE USER PLACES THE DEVICE ON THE CHOSEN STARTING POINT



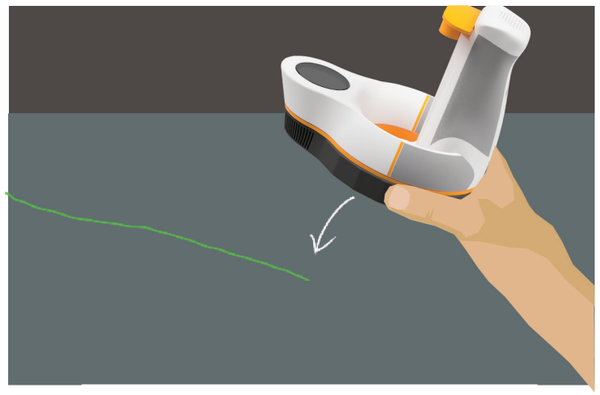
6. THE USER STARTS THE PRINT PROCESS USING THE TOUCHSCREEN DISPLAY



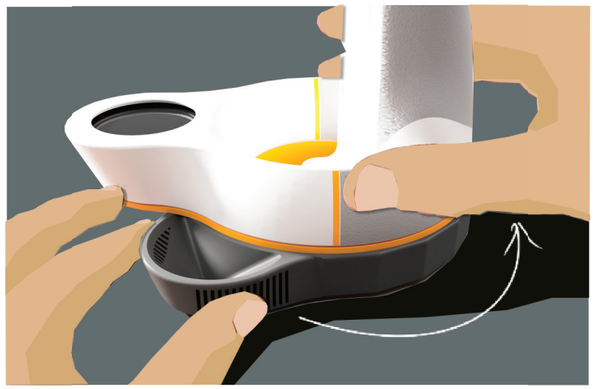
7. THE USER PRINTS THE PATTERN BY FOLLOWING THE GUIDE ON THE DISPLAY



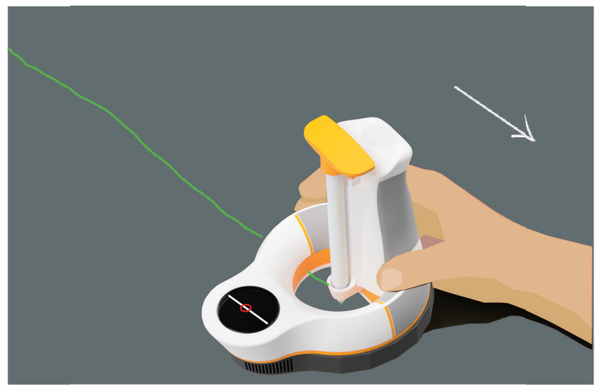
8. THE USER ADJUSTS THE FABRIC TO ACCESS THE FINAL SECTION OF THE PRINT AS REQUIRED



9. THE USER LINES THE PRINTER UP WITH THE END OF THE PREVIOUS PRINTED LINE



10. THE USER ROTATES THE RETICLE TO MATCH THE PREVIOUS LINE WHICH REORIENTATES THE PATTERN



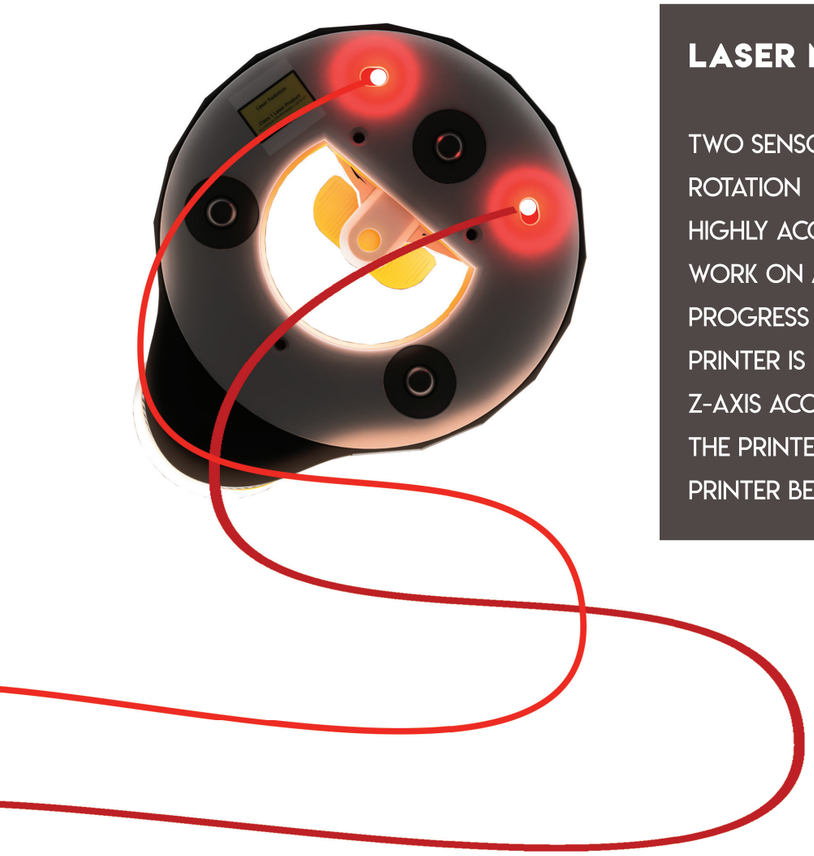
11. THE USER COMPLETES THE REMAINING SECTION OF THE PATTERN

STAGES 8-11:

THIS FUNCTION IS INTENDED FOR USERS WITH LIMITED SPACE AND MOBILITY WHO AREN'T ABLE TO COMPLETE THE PRINT IN ONE CONTINUOUS PROCESS.

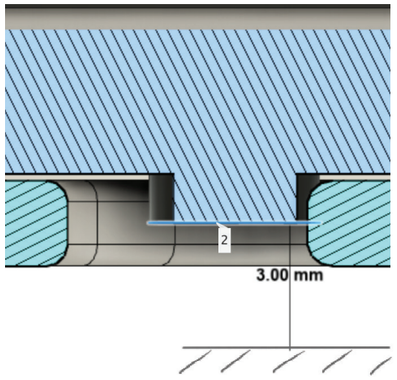
THIS FUNCTION MAY NOT BE REQUIRED FOR MOST USERS WHICH WOULD LIMIT THE USER JOURNEY PRESENTED HERE TO STAGES 1-7.

POSITIONING TECHNOLOGY



LASER MOUSE SENSORS

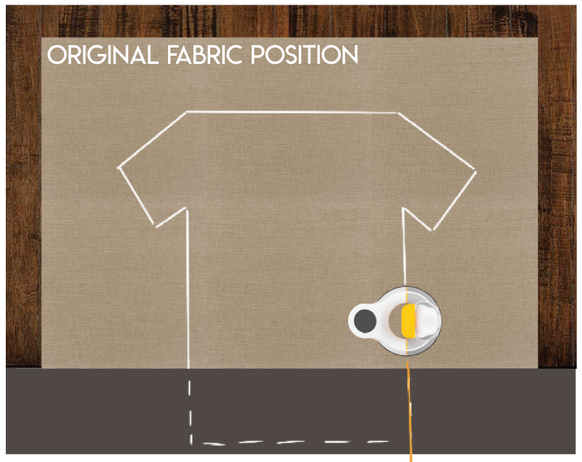
TWO SENSORS TRACK TRANSLATION AND ROTATION
HIGHLY ACCURATE
WORK ON ALL SURFACES
PROGRESS AUTOMATICALLY PAUSED WHEN THE PRINTER IS REMOVED FROM FABRIC
Z-AXIS ACCELEROMETER DISTINGUISHES BETWEEN THE PRINTER BEING STATIONARY AND THE PRINTER BEING REMOVED FROM THE FABRIC

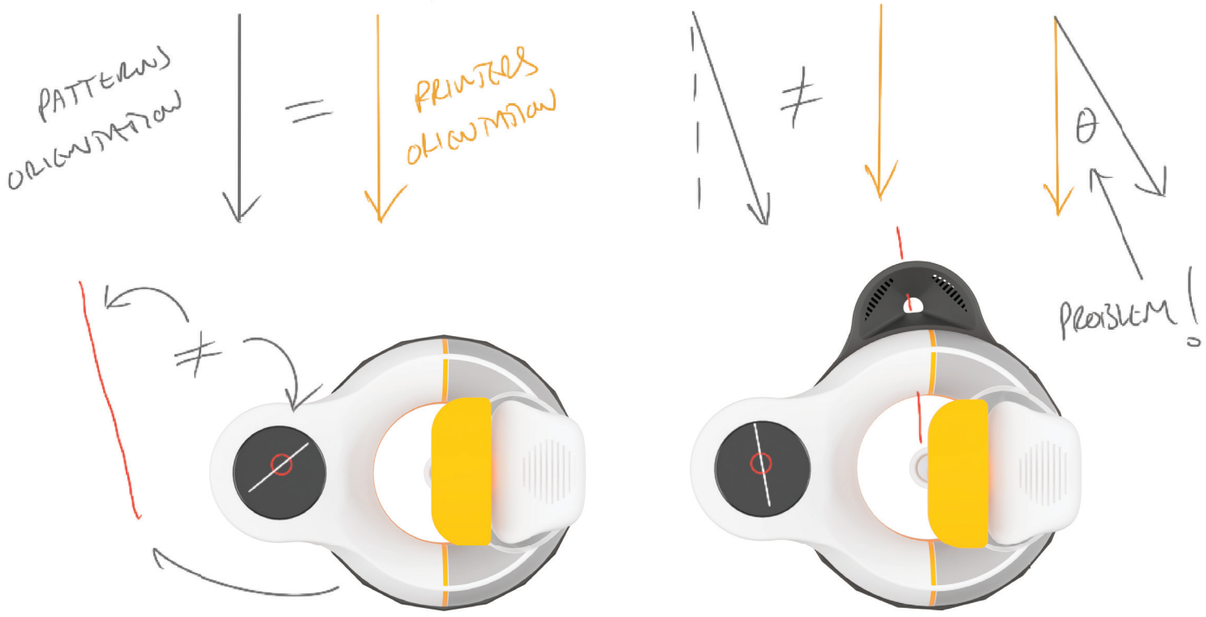


Having two laser mouse sensors allow the device to record translation and rotation accurately during printing. Laser mouse sensors have a very limited range which informed the overall geometry of the product; the sensors have to be in range of the fabric to work.

The reticle is used to reposition the digital pattern with the physical pattern. As the fabric is readjusted, it will rotate to a new orientation. By lining the pen up with the end of the last print, the reticle is rotated in line with the previous pattern; these two points inform the user interface where the pattern is and in what angular orientation.

REPOSITIONING RETICLE

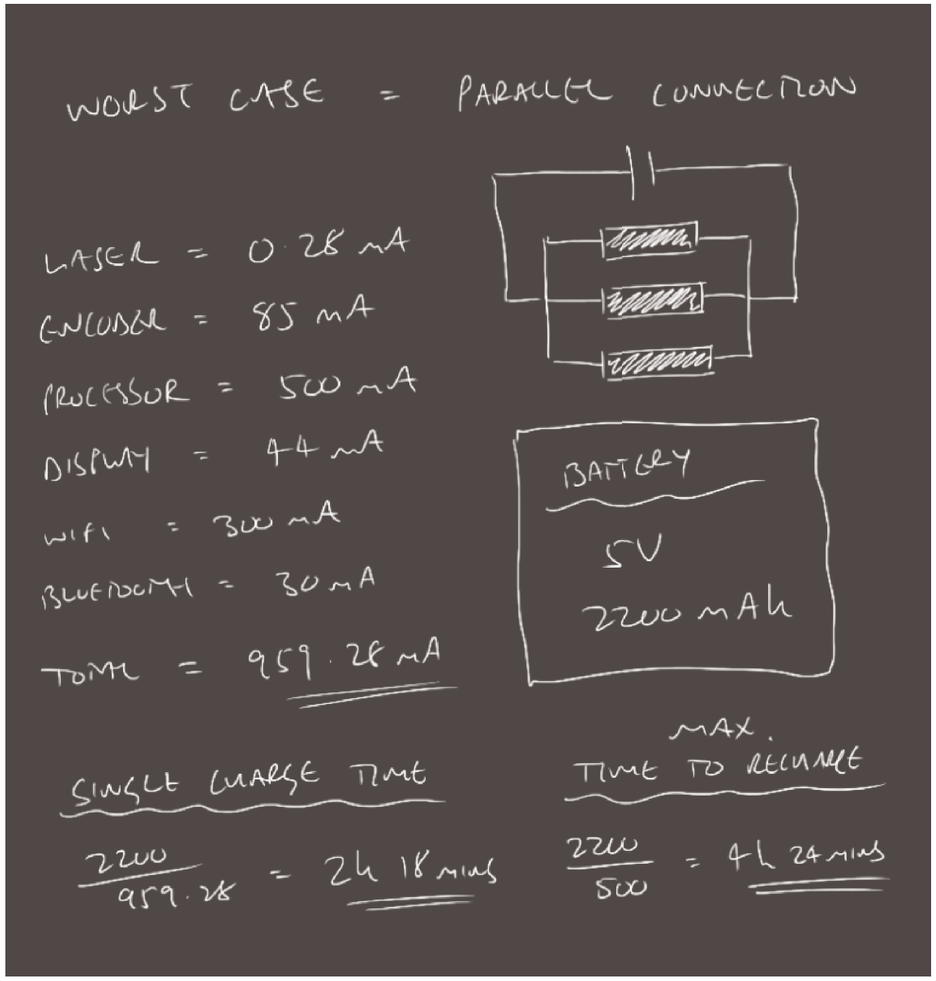




1. PEN LINED UP WITH END OF THE PREVIOUS PRINT

2. THE RETICLE IS ROTATED TO LINE UP WITH THE PREVIOUS PRINT.

POWER AND DATA TRANSFER



STREAMLINED DEVICE TO DEVICE COMMUNICATION
SHORTER RANGE = MORE SECURITY
LOW POWER
LOW BITRATE: MAX. 0.99MBPS

HIGH BITRATE: CAN EXCEED 100MBPS
FOUNDATION OF INTERNET OF THINGS
IP ADDRESS REQUIRED PER CONNECTION
LESS SECURE

"BEST OF BOTH" COMMUNICATION

STREAMLINED DEVICE TO DEVICE COMMUNICATION
SHORTER RANGE = MORE SECURITY
HIGH BITRATE

MAKES INITIAL CONNECTION

TRANSFERS DATA

Specification	Maximum Voltage	Maximum Current	Maximum Power
USB 2.0	5 V	500 mA	2.5 W
USB 3.0 and USB 3.1	5 V	900 mA	4.5 W
USB BC 1.2	5 V	1.5 A	7.5 W
USB Type-C 1.2	5 V	3 A	15 W
USB PD 3.0	20 V	5 A	100 W

Type	Video Bitrate, Standard Frame Rate (24, 25, 30)	Video Bitrate, High Frame Rate (48, 50, 60)
1440p (2k)	16 Mbps	24 Mbps
1080p	8 Mbps	12 Mbps
720p	5 Mbps	7.5 Mbps
480p	2.5 Mbps	4 Mbps