

# Smart-Drying Booth | Airbrushing Miniatures

MSC PDE - Major Project

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# Design Process Journal Rundown



## 1. Background

- a. Showing what is my *topic* (airbrushing figure customization)
- b. Demonstrating *how airbrushing* figures is normally done

## 2. Initial research – user experience

- a. By *showing how* would *the interviewees do for the whole airbrushing process* to **observe & discover insights**
- b. **Comparing** similar products which is useful to the project → so that I can identify *problems* & what are the *opportunities*

## 3. Concept development

- a. Showing the research throughout the project → demonstrating
  - i. what, why are *the product-user requirements* & functions
  - ii. How to accomplish them

## 4. Deliver

- a. Showing the **result** – the *final product* created for this project with detail explanations

## 5. Technical challenges

- a. Showing:
  - i. *Engineering* calculations and theories inside the product
  - ii. Used materials and manufacturing process
  - iii. *Mechanisms*
  - iv. *Product assembly*

## 6. User journey

- a. Demonstrating *how* the product is being *used*
- b. Demonstrating the *user-product interactions*

## 7. User scenario

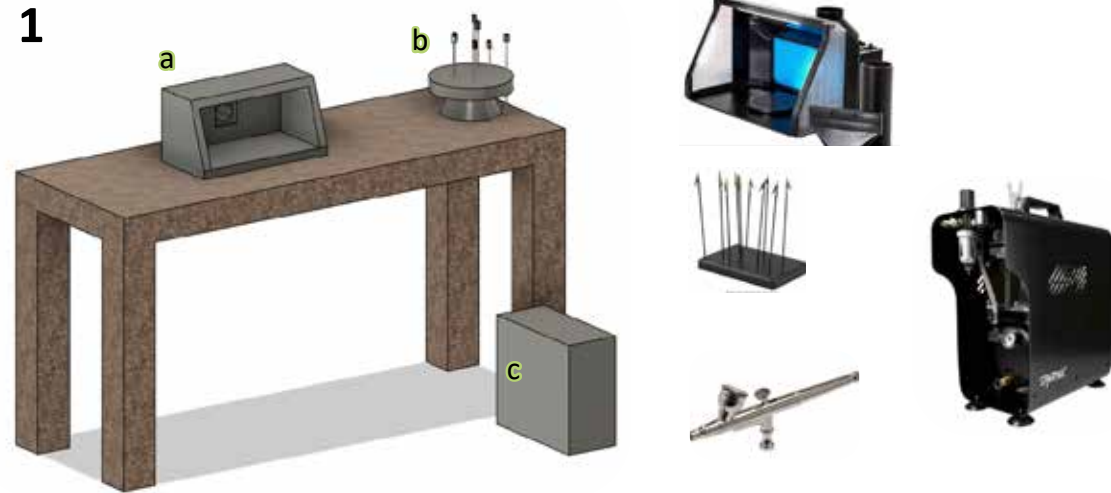
- a. Showing *where* the product is being used

# Discovery

## Background

### Project Introduction & Background - What is airbrushing?

Essentially, airbrush can be used for multiple usages, and this project focus on using it to undergo figure customization. The typical steps can be understood as:



Pictures above showing an example of how the airbrushing set up might look like

**a:** A spray booth – this is the area where the user is holding their “to-be sprayed” parts and start spraying. A spray booth can suck out the smell and the excessive paint from indoor to outdoor

**b:** A tray storage – usually this is the place where the user places their sprayed parts

**c:** An air compressor and airbrush pen – the air compressor is an electrical machine that provide air source and it can control the air pressure. As for the airbrush pen is the pen which carries the paint and allowing them spraying out to the figure part

## 2

### Types of Paint



#### Oil-based

- Takes around 8-24 hours to fully cure
- Quick-dries paint takes 15-20 minutes to dry



#### Water-based

- Toxic
- Takes around 1-2 hours to dry
- Non-toxic & non-flammable

### Best

	Temperature in F	Humidity %
Oil-based	40 to 90 (room temperature)	40 to 70
Water-based	50 to 85 (room temperature)	40 to 70

## 3



Pick up a figure part for spraying

## 4



spraying the figure at the spraying booth

## 5



open up the cover of the tray storage



place the sprayed part into the tray storage



close the cover and continue the same process, which is step 3 & 4

## 6i



when the spraying process is finished, some people prefer leaving the storage in a place without the cover as the parts can dry faster

## 6ii



and some people prefer placing the cover on to protect the parts

# Initial Research - User Experience

## Motivation



Many **airbrush hobbyists** customize or spray their figure components nowadays (including myself). There are no products specifically designed to help improve the finish during the curing process, which is necessarily needed during and after spraying process. Any careless treat could ruin the whole finish.

Moreover, there are **many collectors** who collect high quality and expensive collectables, which many of them have high expectations to their collections. How good the paint finish on the figures/models is one of the key factors determining if the collectors are satisfied, being amazed and impressed by **the collectables**. **And who's going to responsible for making high class figures – the professional airbrush painter/ businesses**. A good tool for them will help them create better masterpiece.

### Targeted User Group



## Project Goal

Therefore, I wish to make a product that helps and **benefits both the collectables buyers and the airbrush painters**.

## User Experience & Observations



Following the correct way



DOESN'T following the correct way

Pick up a component:



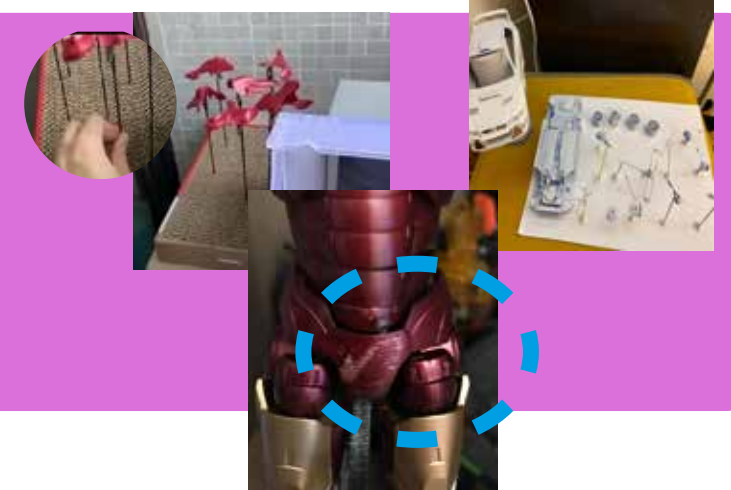
Observations:

The spraying process is smooth and easy because of not following the normal steps. But in exchange, the sprayed parts are **left exposed in an unsecure area to let dry**.

Spray the part(s):



Store/Collect:



- The paint finished got damaged by **dust** & due to accidentally **drop on the ground**  
 - One of the interviewees said he will leave the parts at the balcony --> **paint** got **defects** due to sun's UV light

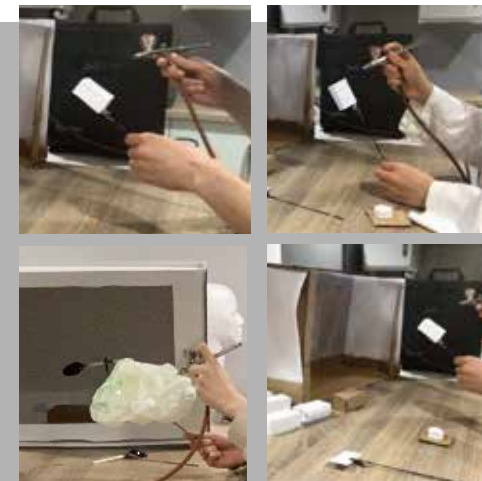
Pick up a component:



Observations:

Open and store and close --> too **annoying** and **clumsy**

Spray the part(s):



Drying the parts without cover might be risky. Paints could be ruined by dust or accidents. **Having a cover protection makes the user feel safe**.

Store/Collect:



The paint **dries slower** when the box container is fully covered the parts

**Self reflection** - By observing the interviewees and myself performing the whole spraying process, I **discovered more issues** during spraying. I can also confirmed that many users are willing to **risk ruining their creations to avoid clumsy & correct spraying procedures**.

# Initial Research - User Experience

## Problems

### Drying Problem

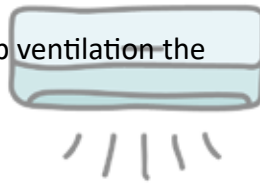
- **Paint finish** takes long time to get harden (especially for oil-based paint/ having poor ventilation).
- Usually the component can be sprayed for **2nd** or **3rd** coats after **10 – 20 minutes**.
- Without proper protection, the finish can be **ruined accidentally**.



### Ventilation Problem

A good ventilation for sprayed components:

- **Will benefit to human's health** (oil-based paint are toxic. We should keep ventilation the components to suck out as much VOCs – toxic chemical as we can)
- Aid the drying process

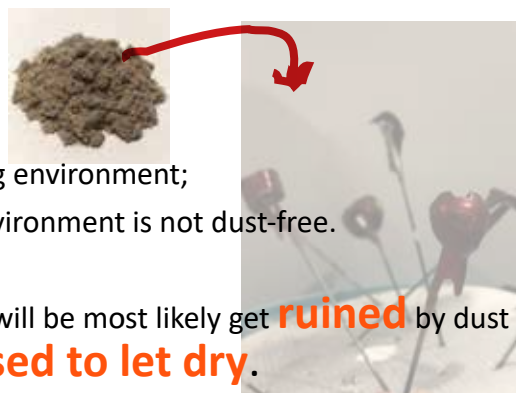


### Noise Problem

- Too much noise generated from the extractor fan causing discomfort

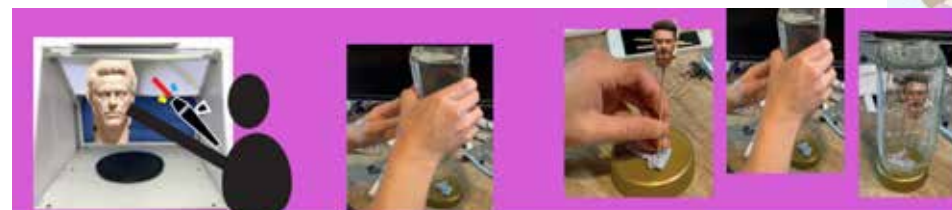
### Dust Control on Paint Surface

- This depends on the dust level of the user's working environment; **==>** therefore it is fair to say that normal working environment is not dust-free.
- Under this circumstance, if the component's finish will be most likely get **ruined** by dust sticking on its surface **if they are left exposed to let dry**.



### Clumsy Spraying Procedures

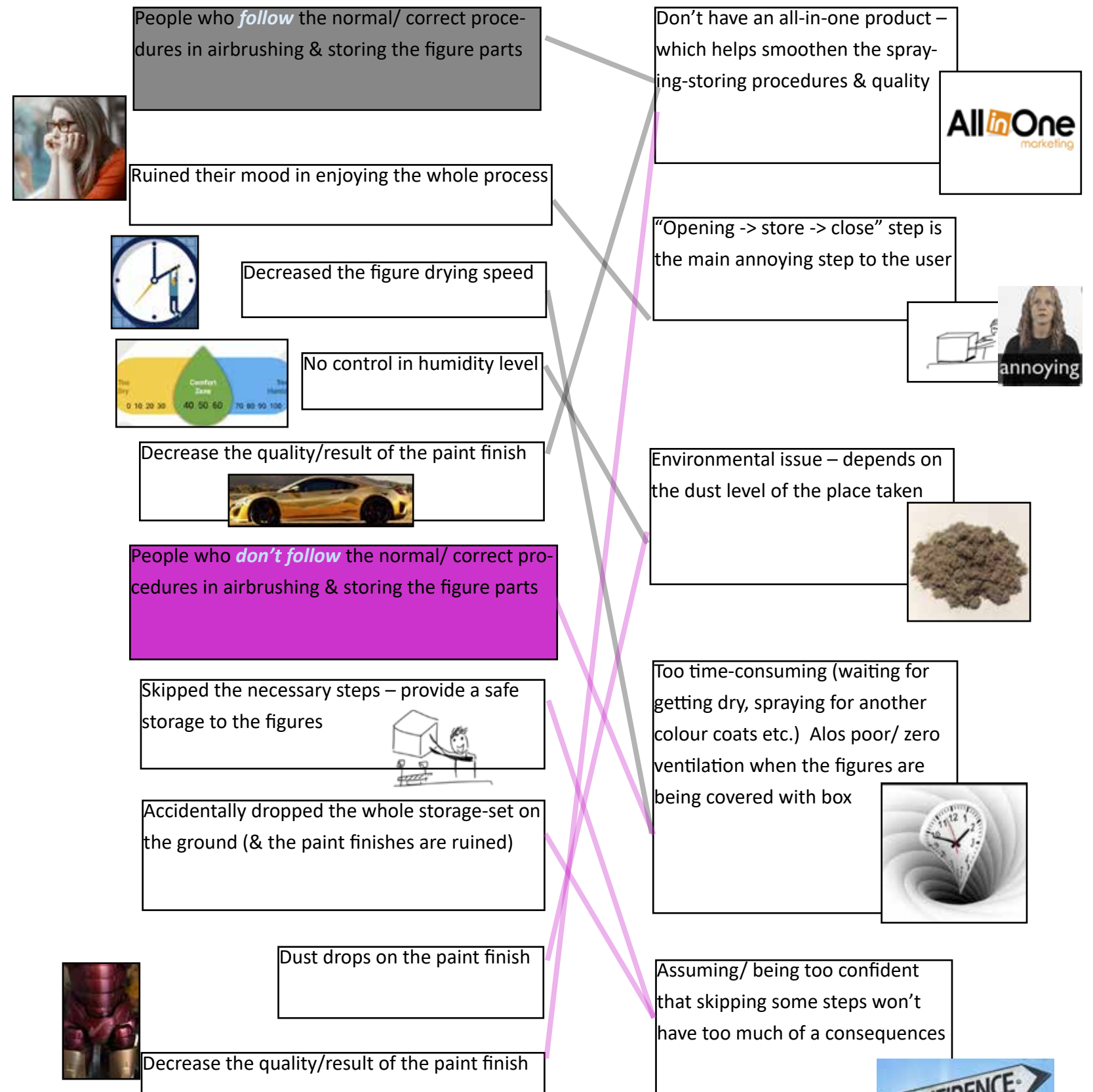
- Annoying or clumsy process **resulting many users are sacrificing** the finish's **protection** and just leave them exposed.



## Key Insights

Following the correct way

DOESN'T following the correct way



**Self reflection** - Identifying the problems and insights at the start of the project helps me clear my mind in knowing what the product requirements are, how should the user interact with the product and how/what types of technology I might need to use throughout the project.



# Initial Research - User Experience

## Parallel products

My project will create a new product and it is specifically designed for airbrushing models. Therefore I cannot find an exact same product to compare and analyse. What I did here is to take certain similar products as reference and tackle their key points.



### Feedback based on User Experience

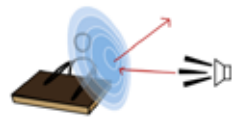
#### Positive

- Efficient
- Have enough light source for the operation  
-> ensure the figure itself won't have colour difference after spraying
- Reasonable price
- Ventilation performance = quite satisfied

#### Negative

Quite noisy – 47 dB

*\*Noise below 35-40 would be consider low level*



- Very efficient
- Quality = Professional level

- Very expensive
- Very noisy – 66-77 dB

- Occupy so much space – **not** meant to be **domestic usage**



- User-friendly
- Won't occupy too much space
- Reasonable price

- Don't have too much storage space

- Weight balance issue (the sprayed parts might fall due to imbalance weight)



The chosen products have many positive inspirations, such as having effective extractor fan to create ventilation; user-friendly and price reasonable. But there are also negative discoveries among them such as the noise created during operation is too loud or the human factors were not well considered and designed for the product. these information guided me to understand what are the “product-operation-side effects” I should avoid or what are the good elements I should include.

## Opportunities

Can use one hand finished the changing process - one hand put down and store and collect at ease and quick



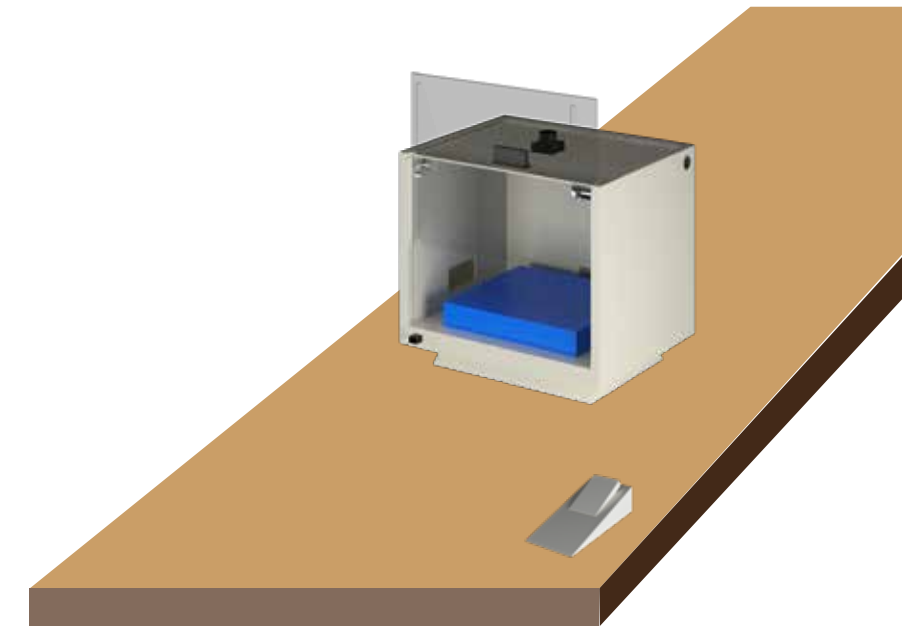
Automatically “collect” & “able to withdraw”?

For my product itself, it will include/be:

- Humidity control
- Smell control
- Anti-dust
- Protection from unexpected paint spilled into the finish

- Easy cleaning
- Esay assessamble & disassemble
- Low noise level

- Anti UV
- Space saving/portable



## Solutions

**What:** a price reasonable, space saving smart drying booth that its primary function is to help smoothen the spraying process by making the store-and-collect procedure easier and its secondary functions are providing extra functions to help the paint dries faster.

**Where:** in a workshop or a room at home that can provide large working space as figure custom with airbrushing is an activity requires many space.

**Who:** professional hobbyist; people who demand high quality finish for their collectables; people who do business with figure custom.

**When:** during and after airbrushing the figure parts

**How:** applying simple materials, manufacturing methods and mechanisms.

**Self reflection** - By comparing the similar products related to my project, I can understand what are the pros and cons of each product. **Using these data to identify opportunities x solutions and be a reference guide** for me when developing my ideas.

# Concept Development

## Product requirements

Must be able to perform the targeted tasks and goals:

- VOCs resistance (paint chemical)
- Space saving – when not using
- Attractive appearance
- Durable to use/ easy to repair
- User-friendly & easy to assemble
- Anti-UV for the drying area
- Low noise level
- Good ventilation
- Temperature control
- Help Smoothen the spraying, store-and-collect process

## Ergonomics

Table 2. Anthropometric Data of Hand, Foot and Ear for Female

Parameter	Percentile			Standard Deviation	Standard Error
	5 <sup>th</sup>	50 <sup>th</sup>	95 <sup>th</sup>		
Age (Years)	19	24	28	1.1	.11
Foot Breadth(cm)	8.0	9.0	10.0	0.59	.06
Foot Length (cm)	23.0	25.0	27.0	1.4	0.14
Foot Height (cm)	4.3	5.4	6.4	0.68	0.07
Hand Breadth(cm)	8.1	9.5	10.5	0.75	0.08
Hand Length (cm)	17.4	19.0	21.5	1.21	0.12
Hand Thickness (cm)	2.7	3.5	4.1	0.41	.04
Ear Height (cm)	3.2	5.5	6.2	0.88	0.09
Ear Breadth (cm)	2.5	3.0	3.4	0.23	0.02

Table 1. Anthropometric Data of Hand, Foot and Ear for Male

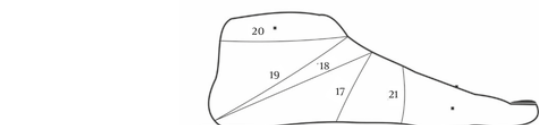
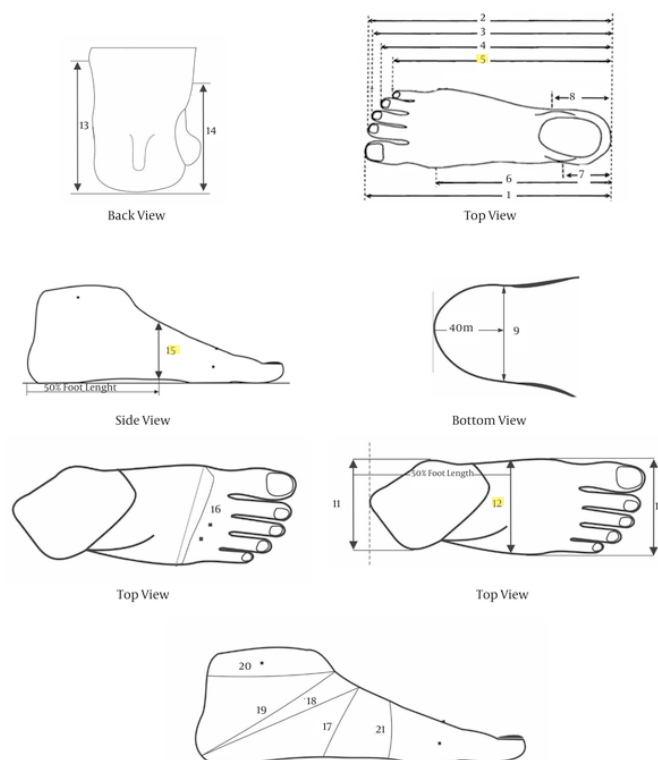
Parameter	Percentile			Standard Deviation	Standard Error
	5 <sup>th</sup>	50 <sup>th</sup>	95 <sup>th</sup>		
Age (Years)	20	25	28.7	1.25	0.13
Foot Breadth(cm)	7.9	8.6	9.5	0.55	0.06
Foot Length (cm)	24.8	26.4	27.5	1.2	0.12
Foot Height (cm)	5.2	5.9	6.7	0.54	0.05
Hand Breadth(cm)	8.8	9.6	10.0	0.49	0.05
Hand Length (cm)	18.5	19.5	20.1	0.59	0.06
Hand Thickness (cm)	3.0	3.4	4.0	0.39	0.04
Ear Height (cm)	5.1	5.5	6.2	0.32	0.03
Ear Breadth (cm)	3.1	3.4	3.8	0.28	0.03

Ergonomics research results help understand the dimensions such as what are the table size, height are; what are the dimensions are human hands and soles dimensions etc. These data help provide a guidance or an idea to estimate how large the product was or what are the limits should set (for example, if the product can occupy too much space otherwise the sash might not have enough spare space to open and close).

Table	L (cm)	W (cm)
Large Table	107- 137	244 - 305
Standard	76 - 91	152 - 183
In Workshop	/	60 - 75

Chair	L (cm)	W (cm)
Standard	46	38

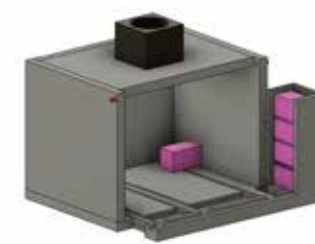


**Self reflection** - Based on researches such as usability testing and human factors helped me to understand what are the best User-Product interactions and the sizes dimensions for the final concept.

## User requirements

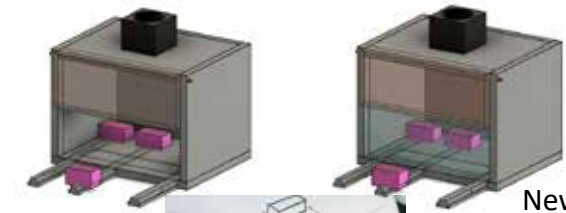
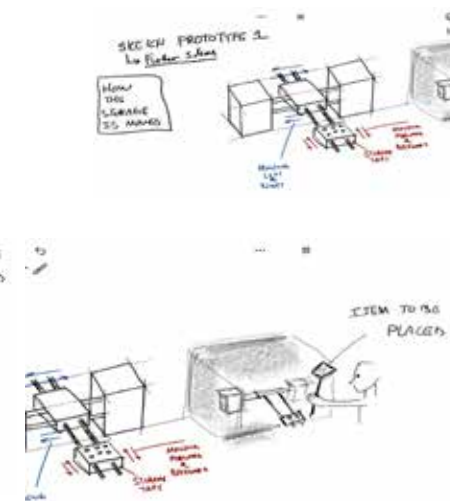
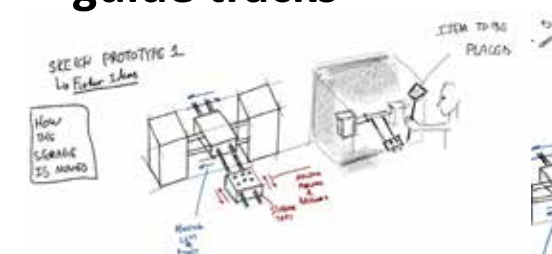
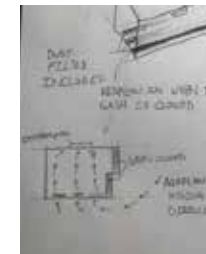
- Have a working desk for airbrushing (to make a setup)
- Reasonable price
- Understand how to assemble/disassemble

## Concept Development - Sketches, Prototypes



### Tray Storage

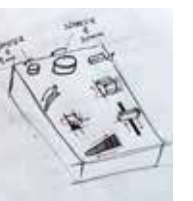
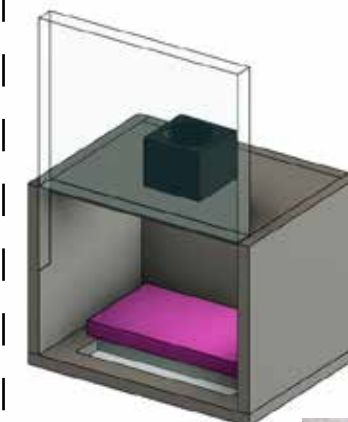
### x-y axis and its guide tracks



Axial actuator and its guide tracks

New way to store

New sash opening design



## Final product



Object	Dimensions (cm) L x W x H
<b>Drying Booth</b>	
External area	39 x 48 x 45
Internal - Drying area	35 x 45 x 35
<b>Tray Storage</b>	
Assembled	33.2 x 29 x 5
Individual	8.3 x 7.25 x 5
<b>Footstep Controller</b>	22.3 x 10 x 6.4

## Interaction Requirements



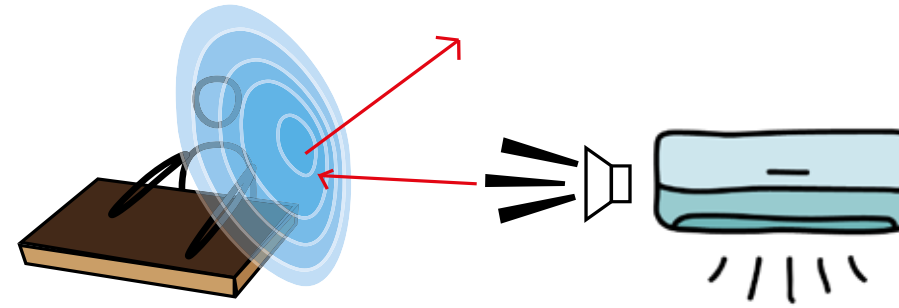
The user needs to press the On/Off switch to control the power of the booth



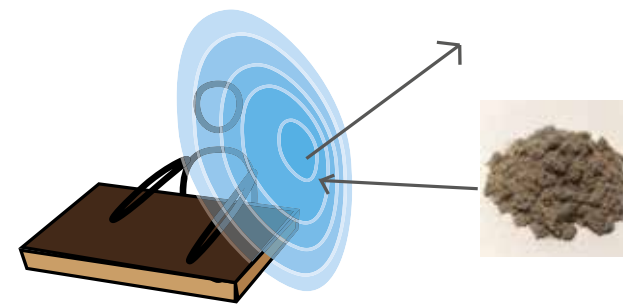
The user needs to step on the footstep controller to control the opening and closing of the door of the drying booth.



## Product Functions & Features



**Low Noise Level Ventilation**



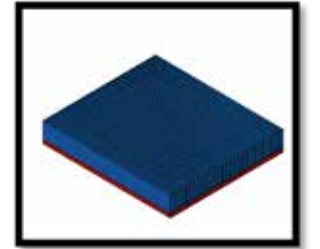
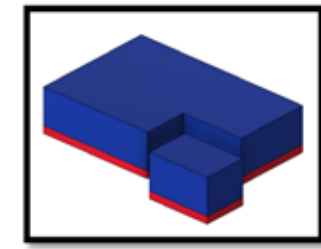
**Dust-Proof**

The dust filter limits the dust from entering the drying area.



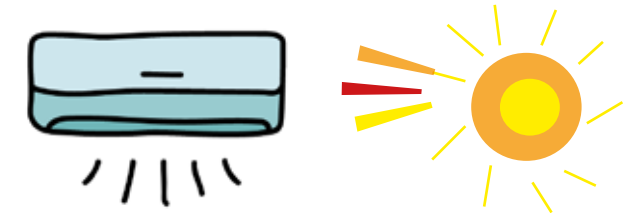
**Modular Storage Assembly**

Modular design - the drying booth can be disassembled when it is not in-use. This helps space saving for domestic use.



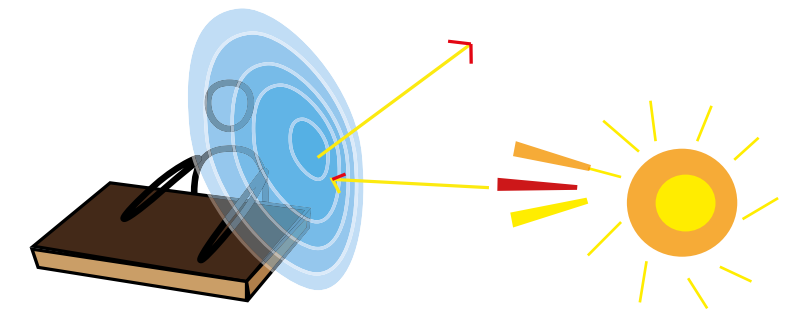
**Modular Booth Assembly**

Depends on how many parts are required to spray. Let's say there are only 5 parts to spray then the user can unplug one of the storage to save the rest for future use.



**Temperature Control**

When the drying area's temperature drops below 26 °C (room temperature) then the heater will turn on as 26 °C or above is the best temperature for paint to get dried.



**UV-Proof**

The sash has coated with UV-coat. Meaning that even when the booth is placed facing to the sun, the booth is able to block the UV ray and avoid the paint getting defects.



## Materials & manufacturing

The material selections were based on advice from the technical supervisor, articles and online resources' support, along with showing the appropriate manufacturing process. A table of the drying booth components with the corresponding material will firstly be shown. Following by the reason of choosing the material. Then lastly, the manufacturing process will be stated.

Components	Material	Manufacturing Process
Side panel (R)	Polypropylene	Injection molding
Sash	Clear acrylic	CNC
Wire rope (diameter: 1mm)	304 stainless steel	/
Rope-sash connector	Aluminium alloy	Forging
Motor connecting rod	Aluminium alloy	Extrusion
Side panel (L)	Polypropylene	Injection molding
Top panel	Polypropylene	Injection molding
Back panel	Polypropylene	Injection molding
Base panel	Polypropylene	Injection molding
Storage tray (top & bottom)	Polystyrene	Injection molding
Footstep controller	Polycarbonate	Injection molding

## Cost

### Material Cost (total £ required per materials)

Polypropylene: £3.34

Aluminium: £0.35

Acrylic (450mm×350mm5mm): £16.06

Polycarbonate (0.58/kg): £40.6×10<sup>-3</sup>

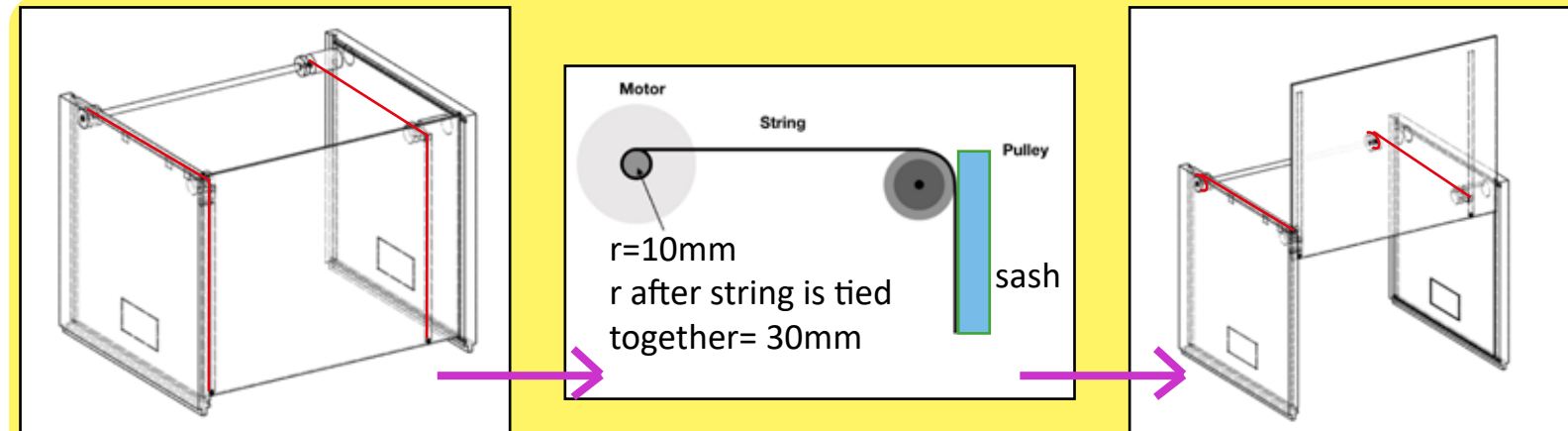
Polystyrene (0.07kg): £0.20

### Purchase component cost (in £)

- On off switch – 1.22
- Motor – 31.21
- Limit switch – 3.62
- Bluetooth chip – 4
- Force sensor – 24.67
- LCD display – 11
- Fan – 5.5
- G3 dust filter – 48.79
- LED – 3.25
- Heating wires – 10.2
- Thermometer – 16.09
- Rope – 18
- UV coat – 10.2

## Mechanisms

### Motor



For the **opening mechanism of the sash**, it will be operated by one single DC motor, which connects to one side of the bar rod. The bar rod connects to the pulleys and the straps which will be driven up and down when the DC motor is powered on. The motor will stop moving once the end of the sash hits the limit switch.

### Ventilations



**Calculations** – Given my *internal drying area has only a volume of 0.0551 m<sup>3</sup>*, which is far smaller than a moisture and big bathroom. Yet, it will also require a high air circulation rate to help the sprayed parts dry faster, as a result, an estimation was made and decided to use 60 as the change of air. Therefore, the required airflow can be obtained by using the “Air Change Method”.

Airflow (Q) = cubic feet × air changes per hour

0.0551 m<sup>3</sup> = 2 cubic feet

Air changes per hour = 60; which is = 60/60 = 1 air change per minute

∴ Q = 2 × 1

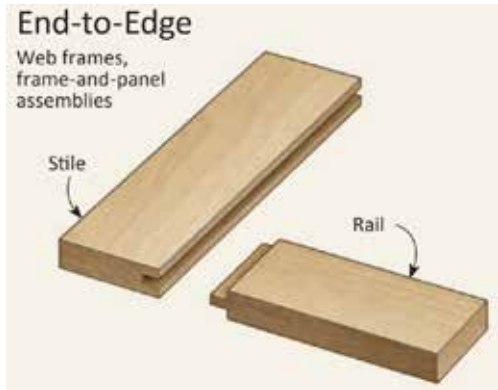
= 2 cfm

Therefore, for this product, a minimum of 2cfm airflow is required to *ventilate the drying area 60 times per hour*.

### Total cost

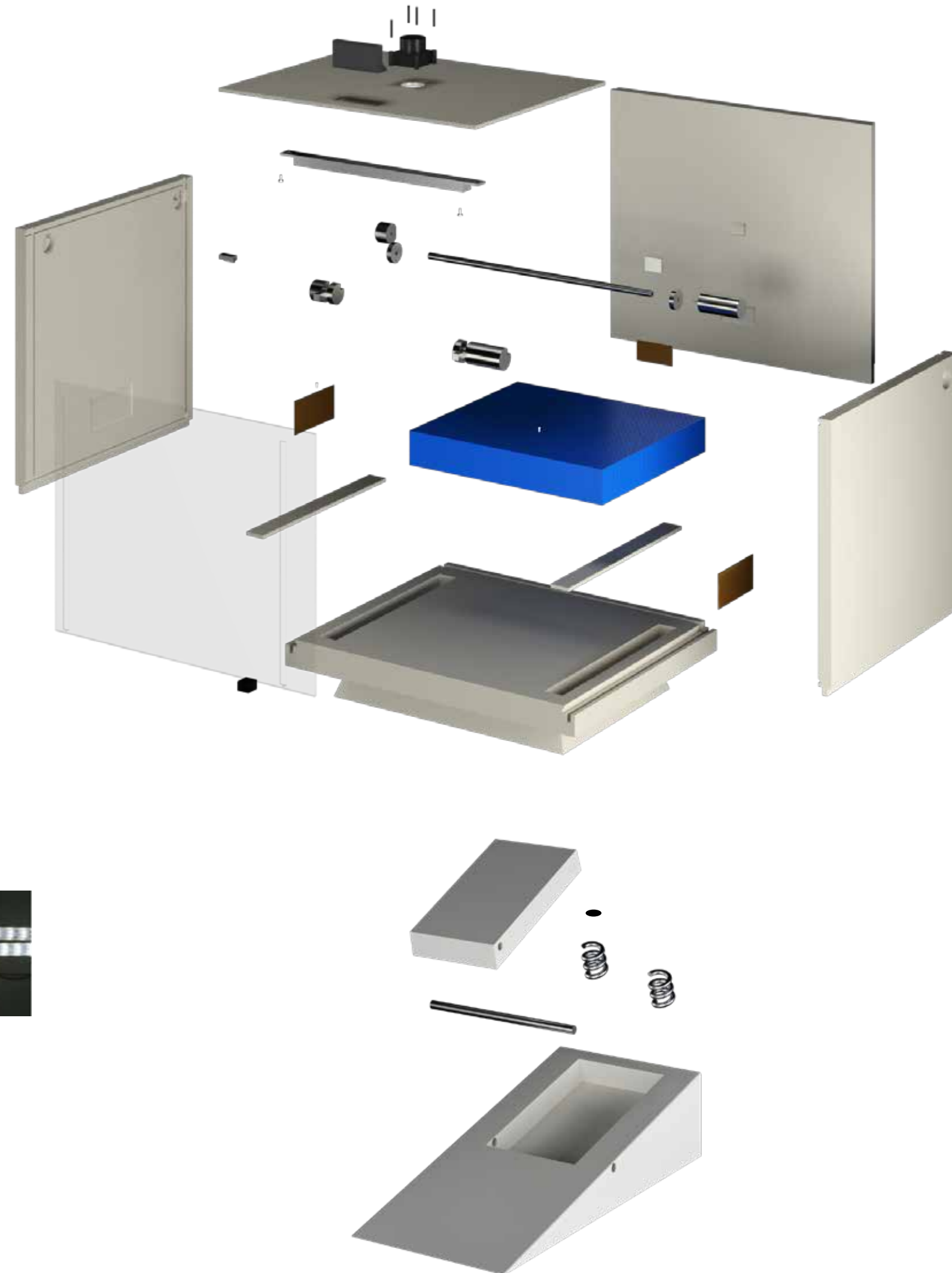
**Total cost = £207.74** – given the purchased materials are raw materials from manufacturer and the shipping cost are excluded; the components are purchased online (include VAT) and the manufacture cost are excluded. **The cost only means how much money is required for buying the material and the components for one product.**

## Assembly Design & Techniques

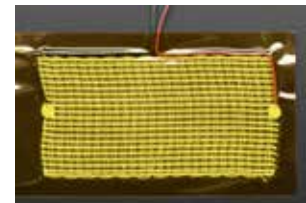


The booth boards are assembled using the Tongue-and-Groove techniques. This made the assemble process easy to do so.

And for the components (LCD screen, LEDs etc.), most of them can be slide/push into the pre-molded holes on the panels. and some of them such as LEDs are already pre-connected with screws.



## Assembly (electrical components & door sash mechanism)



Heating wires



on/off switch



Limit switch



DC motor



thermometer chip



G3 level - domestic level - dust filter



LCD display



Aluminium String



LED strap



extractor fan



Bluetooth chip



Force sensor

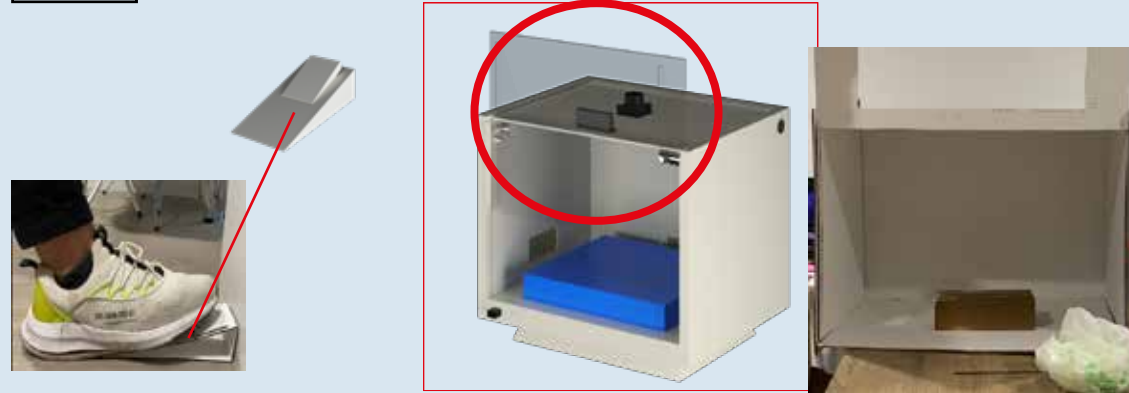
## Product demonstration - Product Interaction

1



I firstly picked up and spray the first model part. It can be seen the the sash of the drying booth is closed. In real life, the sash is a one piece clear acrylic. The hole I cut is just to show what is actually happening inside the drying area.

2



Step on the foot controller

Sash opens

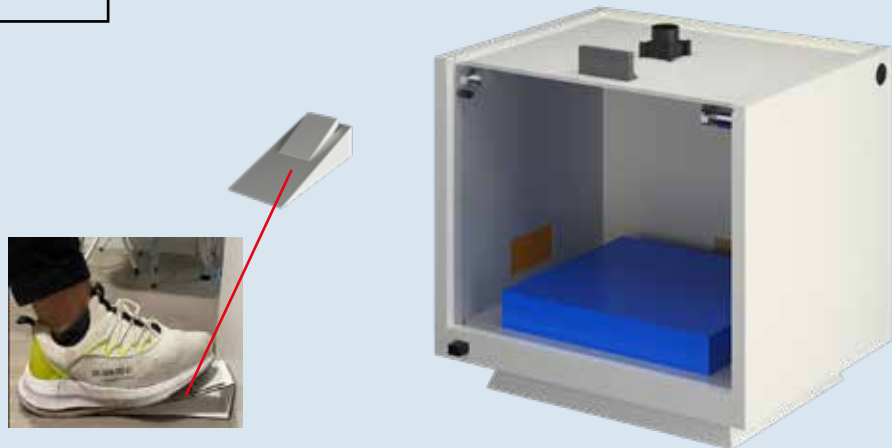
Once the model part is fully covered with paint, I stepped on the footstep controller to open up the sash. The sash is able to fully opened within 3 seconds.

3



I then placed my sprayed model part into the drying area.

4



Step on the foot controller

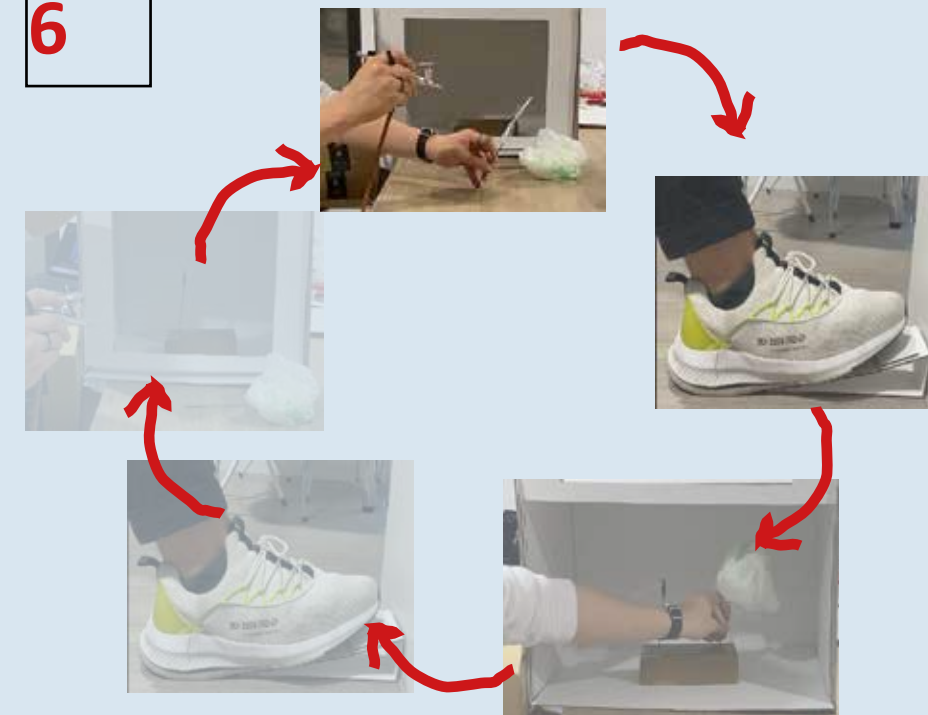
Once I have done placing the part, I stepped on the footstep controller again to notify the sash to close.

5

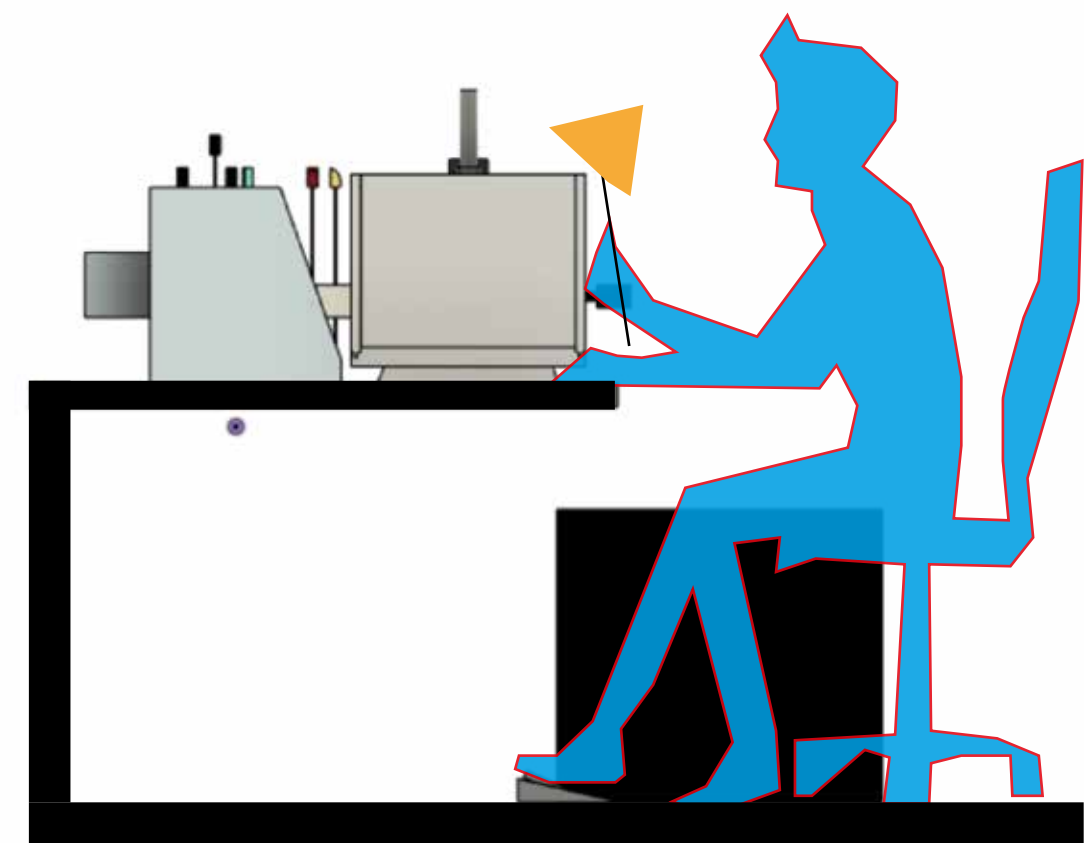
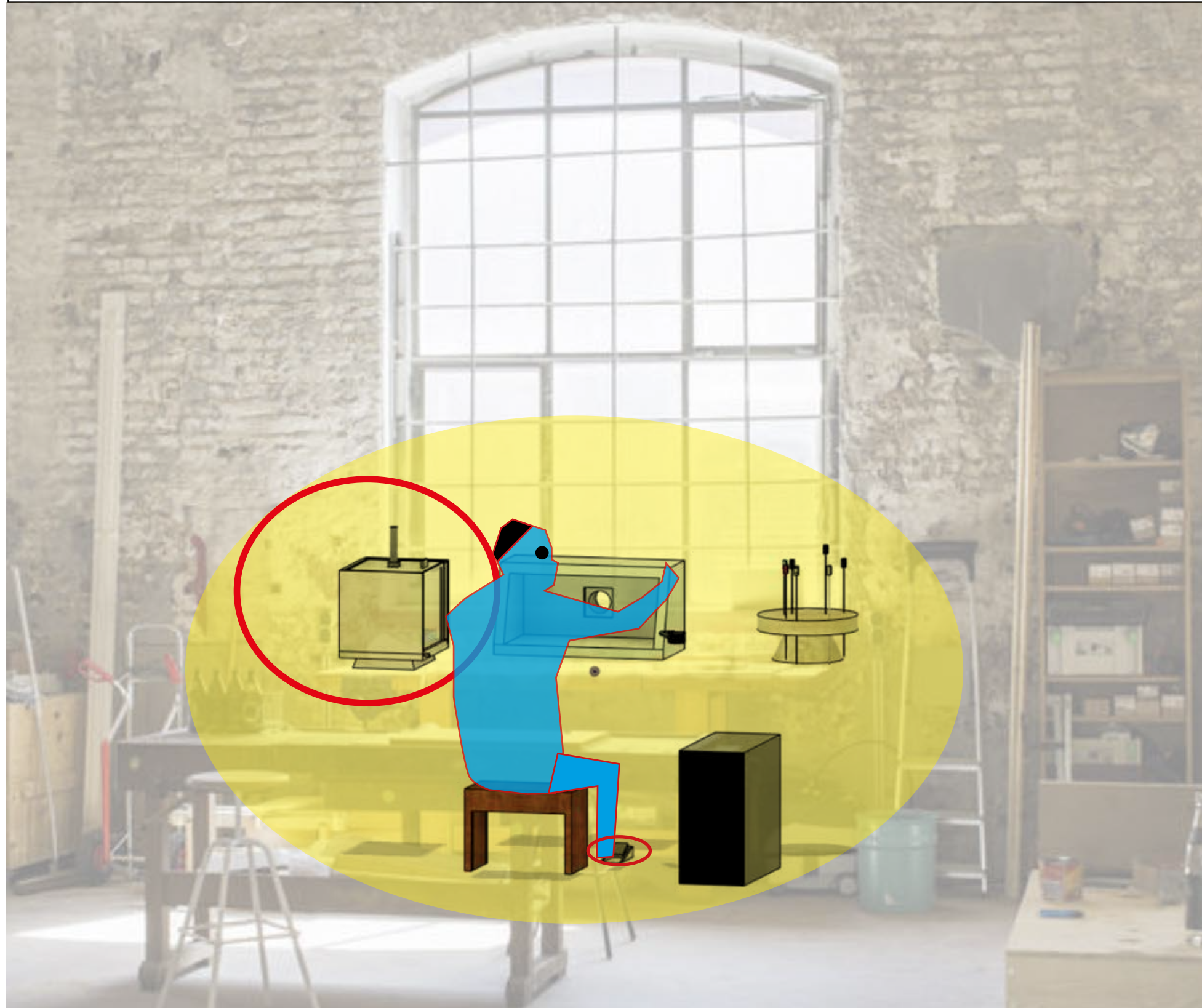


I could then continue spray the next part without having concern to the one which is getting dried as it is safely placed.

6

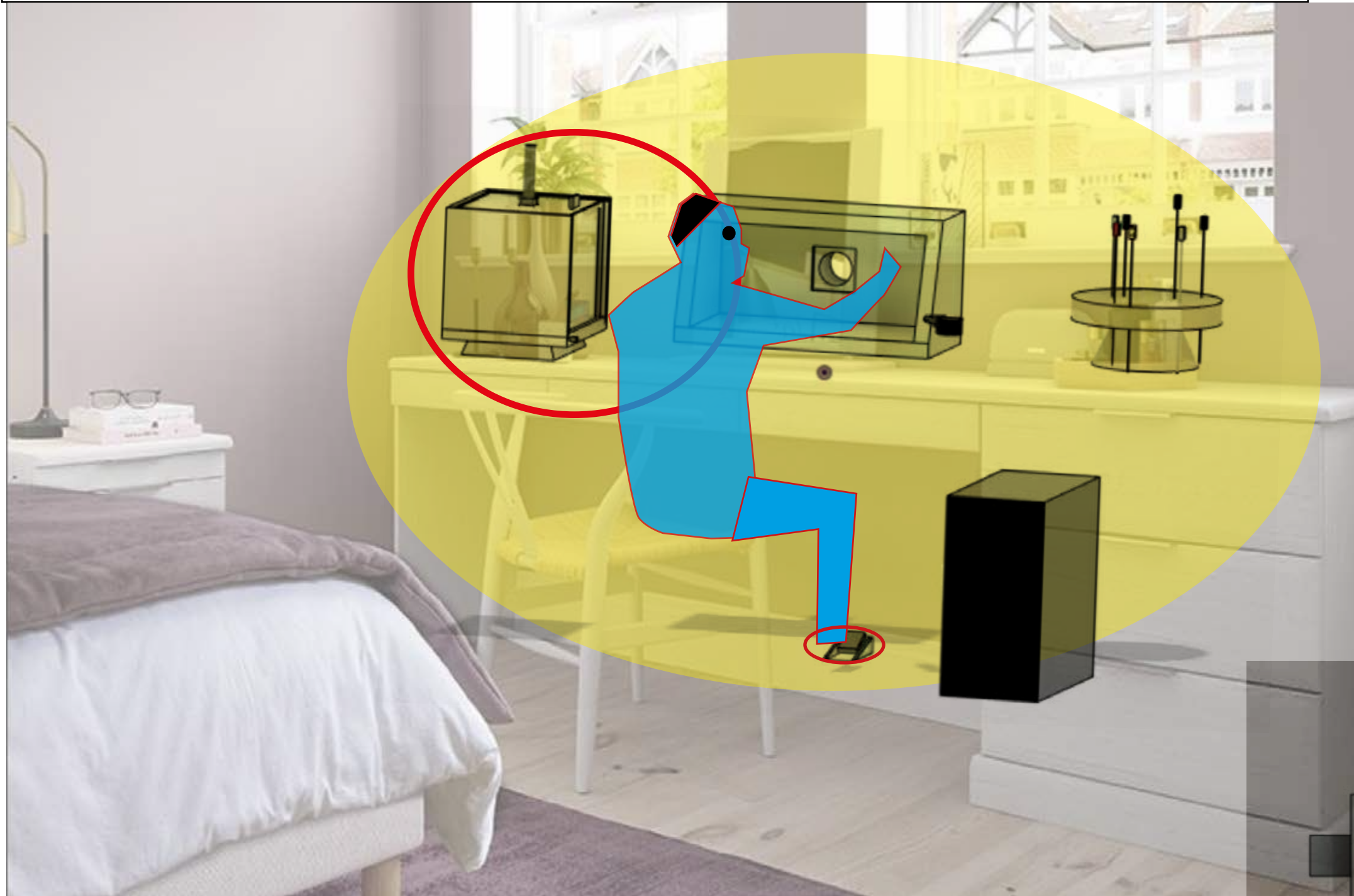


Repeat the same process again and again until all the parts are being sprayed.



This is a business user who is doing figure custom commission work for his clients.

Product demonstration - User Scenario **b**



This is a professional hobbyist who is doing figure custom in his working room/ bedroom.