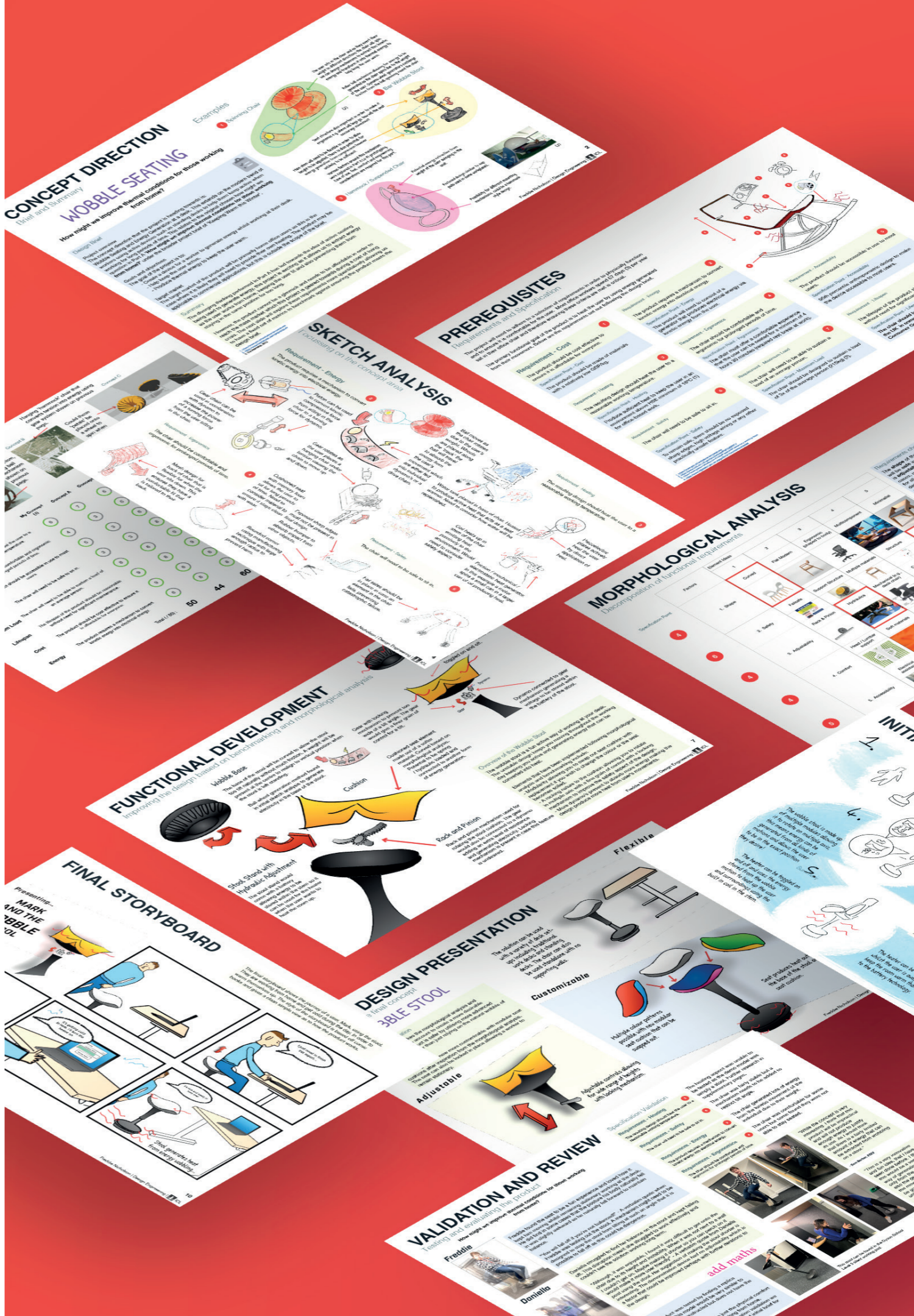


# KEEPING WARM THIS WINTER

Introduction to Design Engineering - Part B



# CONCEPT DIRECTION

## Brief and Summary

### WOBBLE SEATING

How might we improve thermal conditions for those working from home?

#### Design Brief

##### Project overview

The concept direction that the project is heading towards is: Wobble Seating and Energy Generation at a desk. This extends on the modern trend of workers using active devices such as standing desks to help them keep active when working for long periods of time. This relates to the original chosen 'how might we' question in Part A **'How might we improve thermal conditions for those working from home?'** under the broader project brief of 'Keeping Warm this Winter'.

##### Goals and objectives

The goal of the project is to:

- Create a device for a worker to generate energy whilst working at their desk.
- Help keep the user active.
- Produce thermal energy to keep the user warm.

##### Target market

The target market of the product will primarily be home office users as this is the case where it is likely they will need to provide their own heating. The product may be applicable to commercial applications, but this is outside the scope of the brief.

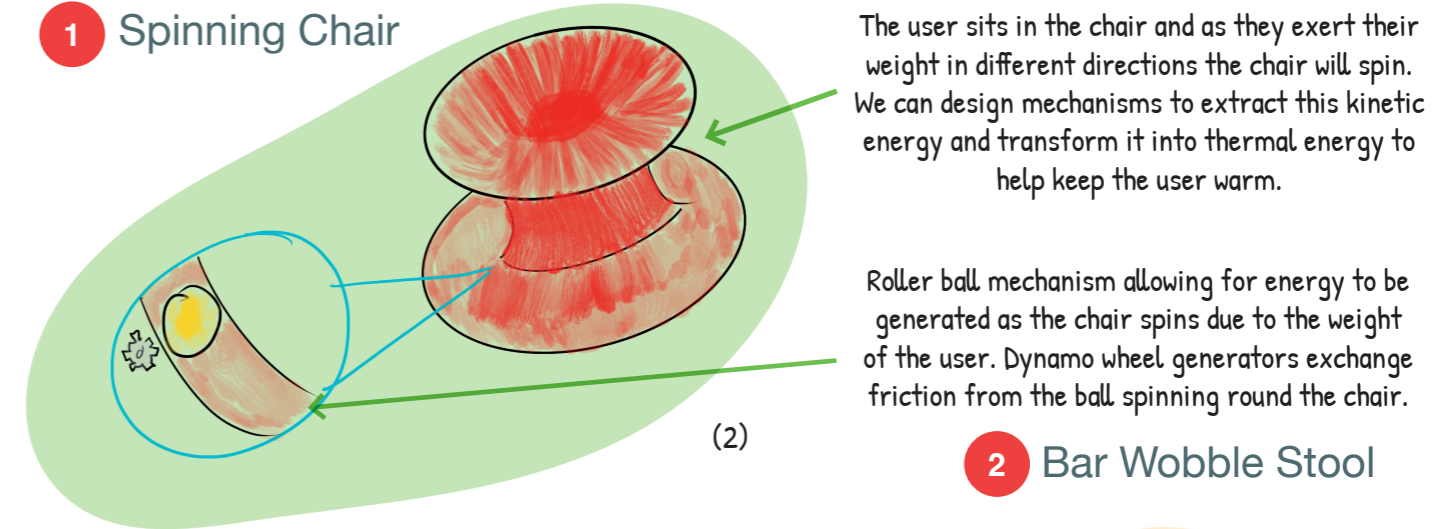
#### Summary

The diverging thinking performed in Part A has led towards the idea of active seating being used to generate energy, this project is exciting as it allows us to extract energy as the user works from home, keeping the user fit and also preventing them from staying in the same position for too long.

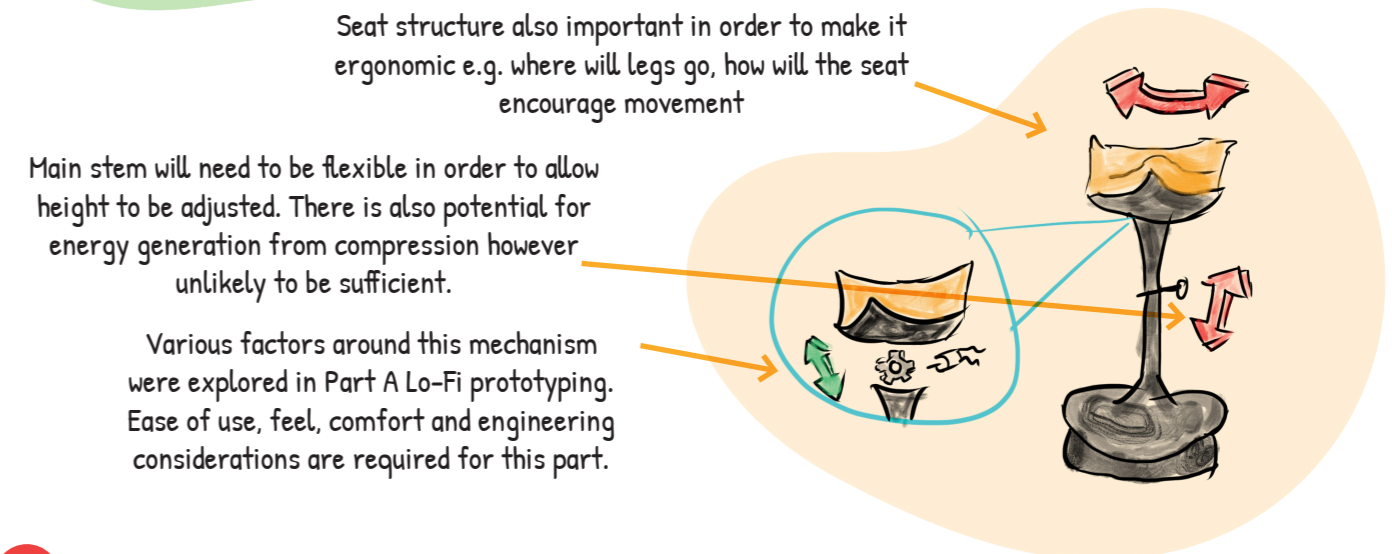
However, the product cannot be a gimmick and needs to be affordable in order to reach the mass market which this project is geared towards during a cost of living crisis. The next slide will explore these requirements more quantitatively allowing us to have a fixed set of metrics to benchmark against ensuring the product meets the design brief.

## Examples

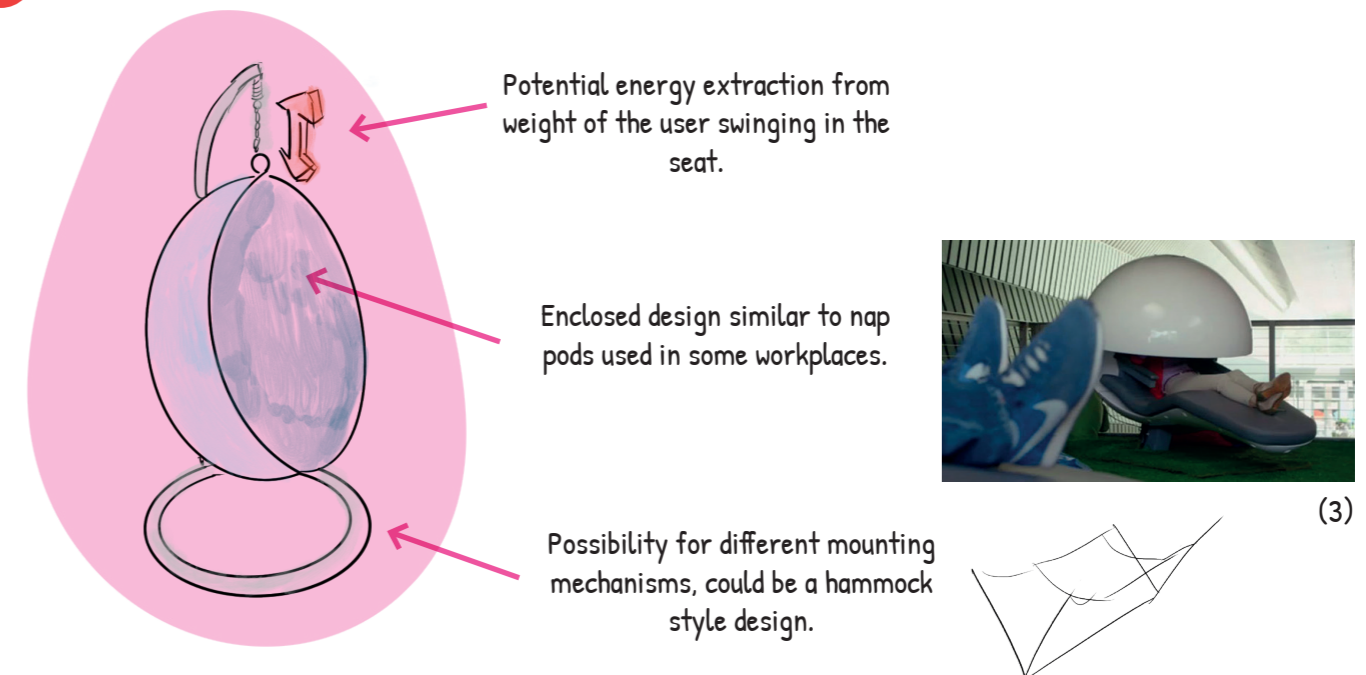
### 1 Spinning Chair



### 2 Bar Wobble Stool



### 3 Hammock / Suspended Chair



# PREREQUISITES

## Requirements and Specification

The project will need to adhere to a selection of requirements in order to physically function and to ensure it is comfortable for the user. Most office workers spend 67 days (3) per year sat in their office chair and therefore ensuring these criteria are met is critical.

The primary functional goal of the product is to heat the user by using energy generated from their movement. Below are the requirements set out following the design brief.

In rank order  
→

1

**Heating**

The resulting design should heat the user to a reasonable working temperature.

Produce sufficient heat to keep the user in an environment above HSE minimum of 16°C (1) for office-based work.

2

**Ergonomics**

The chair should be comfortable and ergonomic for prolonged periods of time.

The chair must offer a comfortable experience that the user can be seated for a minimum of 4 hours 30 minutes (required rest break at work).

3

**Energy**

The product requires a mechanism to convert kinetic energy into electrical energy.

The product will need to consist of a generator that produces electrical energy via kinetic energy from the user.

4

**Safety**

The chair will need to be safe to sit in.

To remain safe, there should be no exposed sharp edges, high voltage wiring or any other practically unsafe feature.

5

**Maximum Load**

The chair will need to be able to sustain a load of an average person.

The chair should be designed to sustain a load of 3x of the average person (215kg) (2).

6

**Lifespan**

The lifespan of the product should be reasonable without need for significant maintenance.

The chair should last at least 6 years which in the UK in some cases is required under the Consumer Goods Act 2015.

7

**Cost**

The product should be cost effective to ensure it is affordable for everyone.

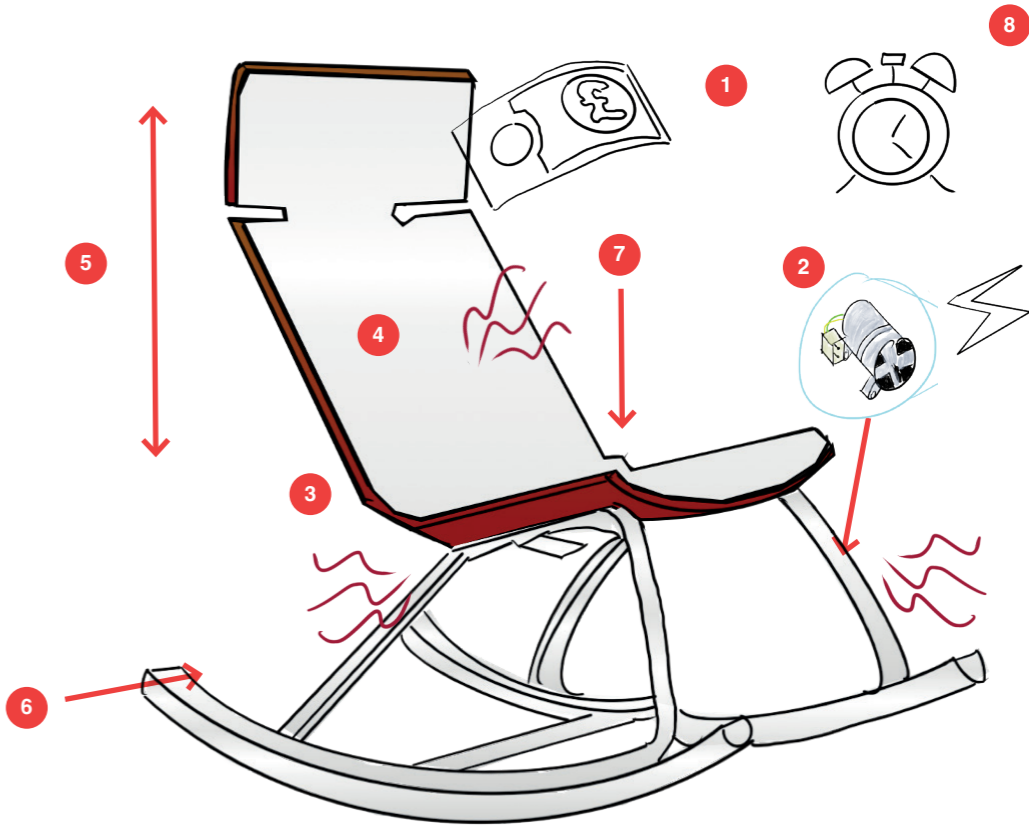
The product should be made of materials with a relatively low GBP/kg.

8

**Accessibility**

The product should be accessible in use to most users.

95th percentile anthropometric design to make the device accessible to most users.



Legend



Requirement

Specification

1. <https://www.gov.uk/workplace-temperatures>  
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3408371/>  
3. <https://www.personneltoday.com/hr/staff-spend-67-sedentary-working-days>  
4. <https://www.legislation.gov.uk/ukpga/2015/15/contents/enacted>

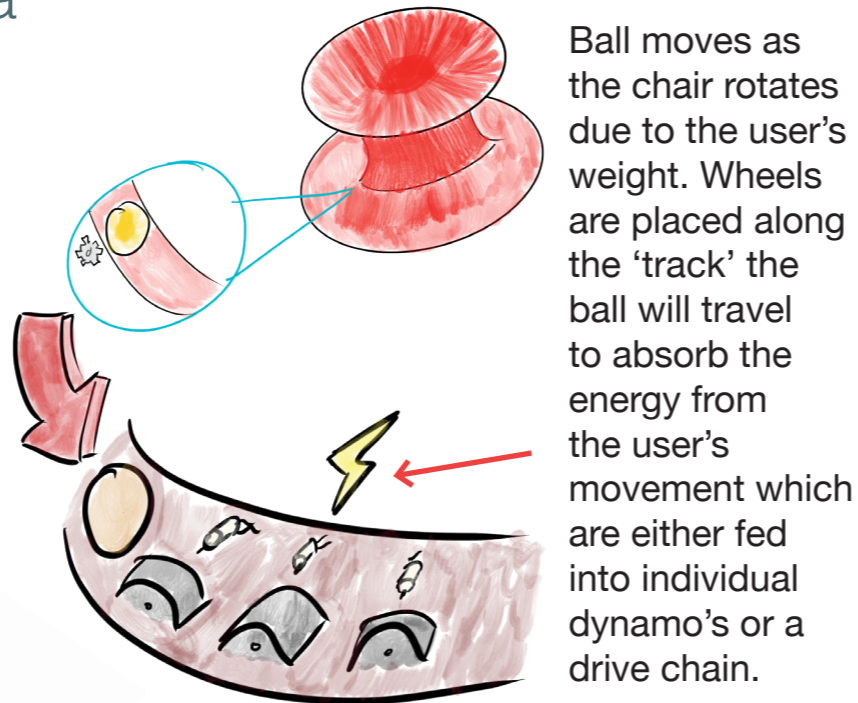
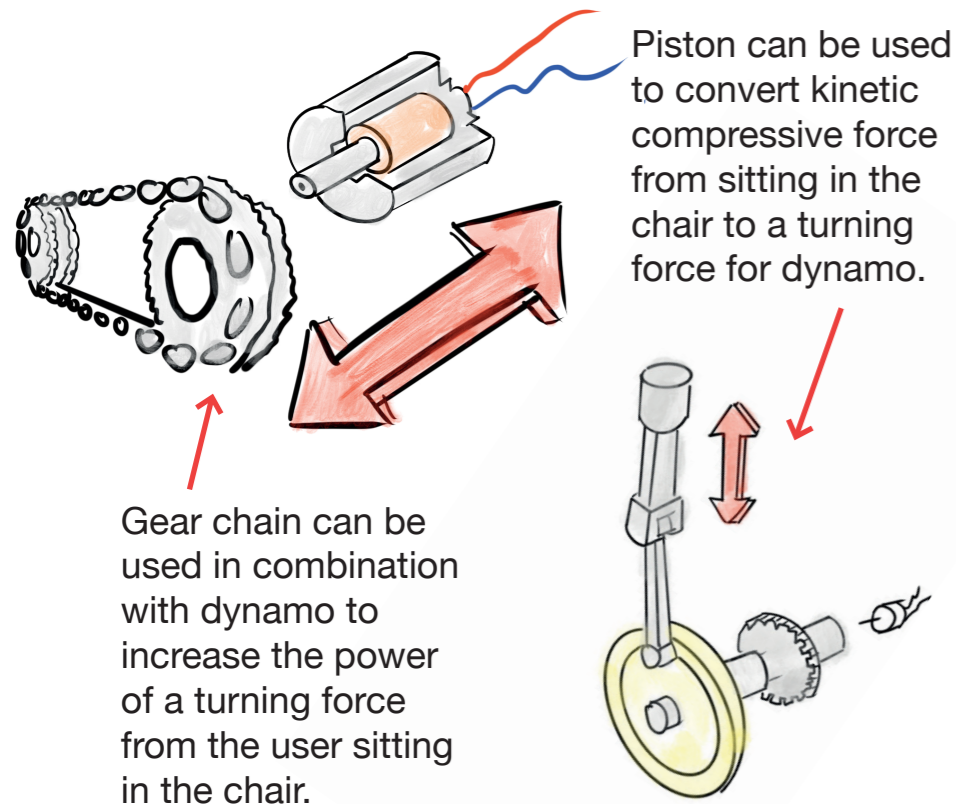
# SKETCH ANALYSIS

Focussing on the concept area

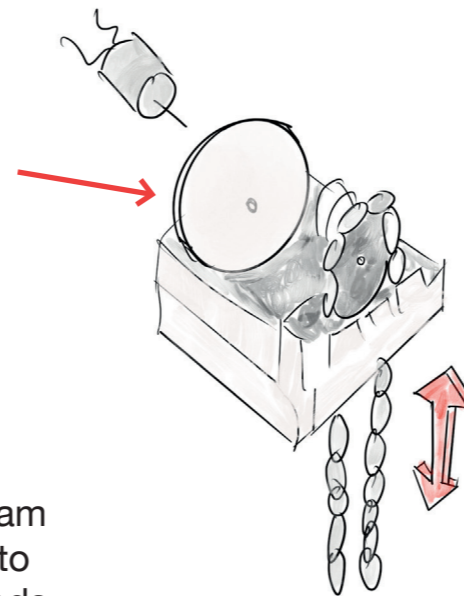
## Energy

The product requires a mechanism to convert kinetic energy into electrical energy.

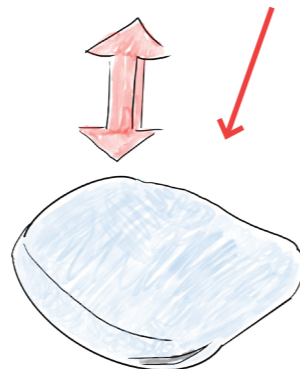
3



Gear rotates as the user places a hanging chair under tension causing the chain to move up and down.



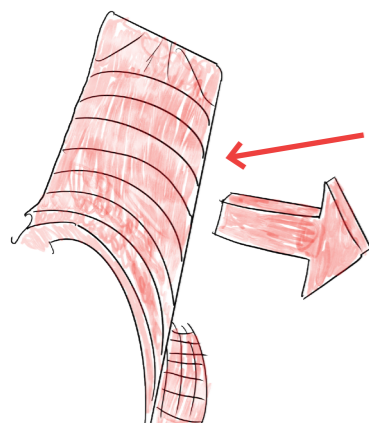
Cushioned seat with memory foam allows the user to sit for long periods of time. Need to consider material to ensure it stays clean with wear.



## Ergonomics

The chair should be comfortable and ergonomic for prolonged periods of time.

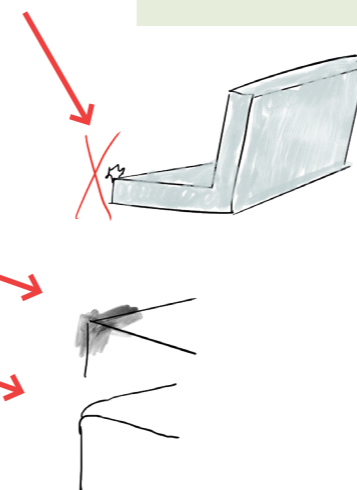
2



Exposed sharp edges must not be present in final design.

Rubber bumper to absorb impact from other objects.

Rounded corner using manufacturing technique with large enough radius to prevent harm.

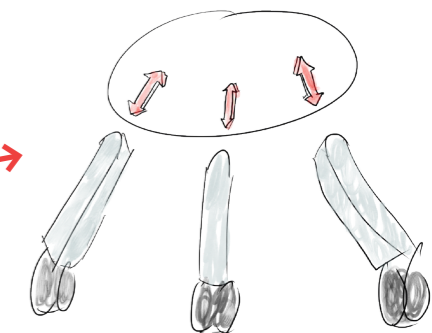


## Safety

The chair will need to be safe to sit in.

4

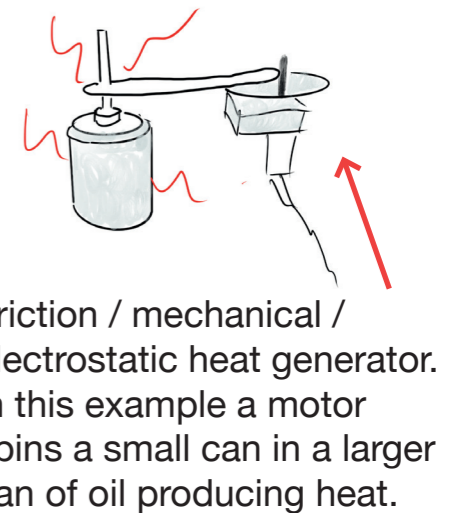
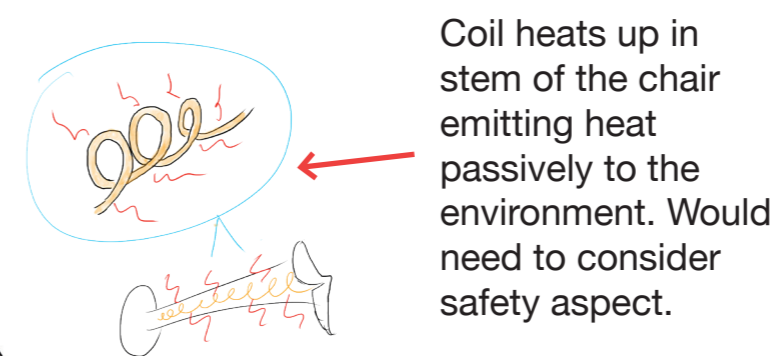
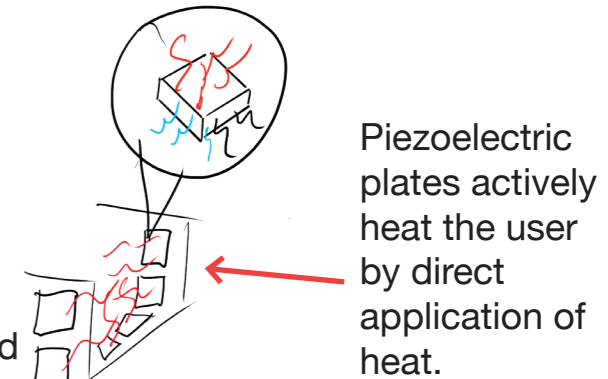
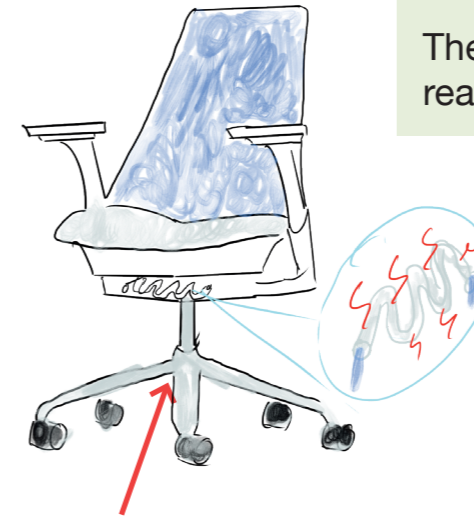
Fail safes should be in place in case an element in the chair fails, preventing catastrophic failure.



## Heating

The resulting design should heat the user to a reasonable working temperature.

1



# BENCHMARKING

Exploring methods of energy generation

My Concept

Generating from tilt



Generating from Rocking



Concept A



Generating from Tension



Concept B



Generating from Rotation


















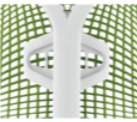













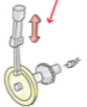

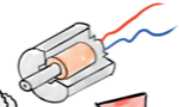

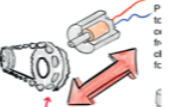


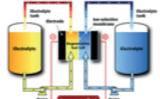

Concept C



Requirement		My Concept (1)	Concept A	Concept B	Concept C	Description of Metric	<div>Summary</div> <p>This benchmarking analysis has highlighted that my initial wobble stool idea has some areas where it could be improved. I will use these strengths, as highlighted by the rating wheels, to merge the ideas.</p> <p>In the charts, I was specifically targeting the components of the design and how energy could be generated rather than the product itself as shown by the annotations above.</p> <p>Overall, using the internet to find interesting chair ideas (even without the energy generation aspect) has been valuable to gain creative insights into new solutions that could be used to generate energy.</p>
Heating	The resulting design should heat the user to a reasonable working temperature.	6	7	6	7	This metric describes how efficiently a design was able to generate heat. This relates to the energy generated.	
Ergonomics	The chair should be comfortable and ergonomic for prolonged periods of time.	4	3	6	5	Relating to the comfort, cushioning, ergonomic design and anthropometric features are considered for this score.	
Accessibility	The product should be accessible in use to most users.	5	3	6	3	Considering how the design appears to cater to all users. Lack of support and adjustability are detrimental.	
Safety	The chair will need to be safe to sit in.	3	3	8	8	How much structural support, materials the product is made out of and other safety factors considered.	
Maximum Load	The chair will need to be able to sustain a load of an average person.	8	6	9	9	Relating to the support structure of the chair, materials and the mechanisms used.	
Lifespan	The lifespan of the product should be reasonable without need for significant maintenance.	9	8	9	9	Materials, mechanisms, quality of production are all considered to predict how long the product will last.	
Cost	The product should be cost effective to ensure it is affordable for everyone.	9	6	8	8	Primarily the materials used and the expected manufacturing process are considered to predict the cost.	
Energy	The product requires a mechanism to convert kinetic energy into electrical energy.	6	8	8	7	Linked to the heating requirement, considering the size of movement and the mechanisms to produce energy.	
Total ( / 80 ) :		50	44	60	56	<b>Analysis:</b> My concept has some aspects that could be improved from benchmarking the other ideas. I will explore this in the functional development.	5

# MORPHOLOGICAL ANALYSIS

Decomposition of functional requirements

Specification Point	Factors	Element Ideas				
		1	2	3	4	5
2	1. Shape	Curved 	Flat Modern 	Ergonomic (shaped to body) 	Multicomponent 	Minimalist 
4	2. Safety	Failsafe 	Support Structure 	Multiple materials 	Structure 	Smooth 
2	3. Adjustability	Rack & Pinion 	Hydraulics 	Mechanical (e.g., deck chair) 	Cushion Size 	Interoperability 
2	4. Comfort	Head / Lumbar support 	Soft materials 	Reclining 	Swinging 	Rocking 
8	5. Accessibility	Electrical assistance 	Anthropometric design 	Levels of control 	Modular system for additional assistance 	Easy reach controls 
1	6. Type of Heating	Coil 	Water 	Friction 	Piezoelectric 	
3	7. Energy generation mechanism	Piston 	Tension 	Dynamo 	Wheel 	Gear Chain 
3	8. Energy Storage	Battery 	Mechanical 	Chemical 	Kinetic 	

## Requirements chosen

The **shape** of the chair, how the chair will be **safe** in use, ensuring the product is **adjustable** to different users and use cases, making the product **comfortable** for all users and having an **accessible** design are all critical requirements I decided to use for my morphological analysis. I also considered **heating** and **energy**. These cover 5 of the 8 requirement areas in depth.

## Summary

From the morphological analysis a broad range of ideas were displayed. This helped expand my diverging thinking around the concept area and focussed on the HMW of '**How might we design a wobble chair that is comfortable for the user?**'

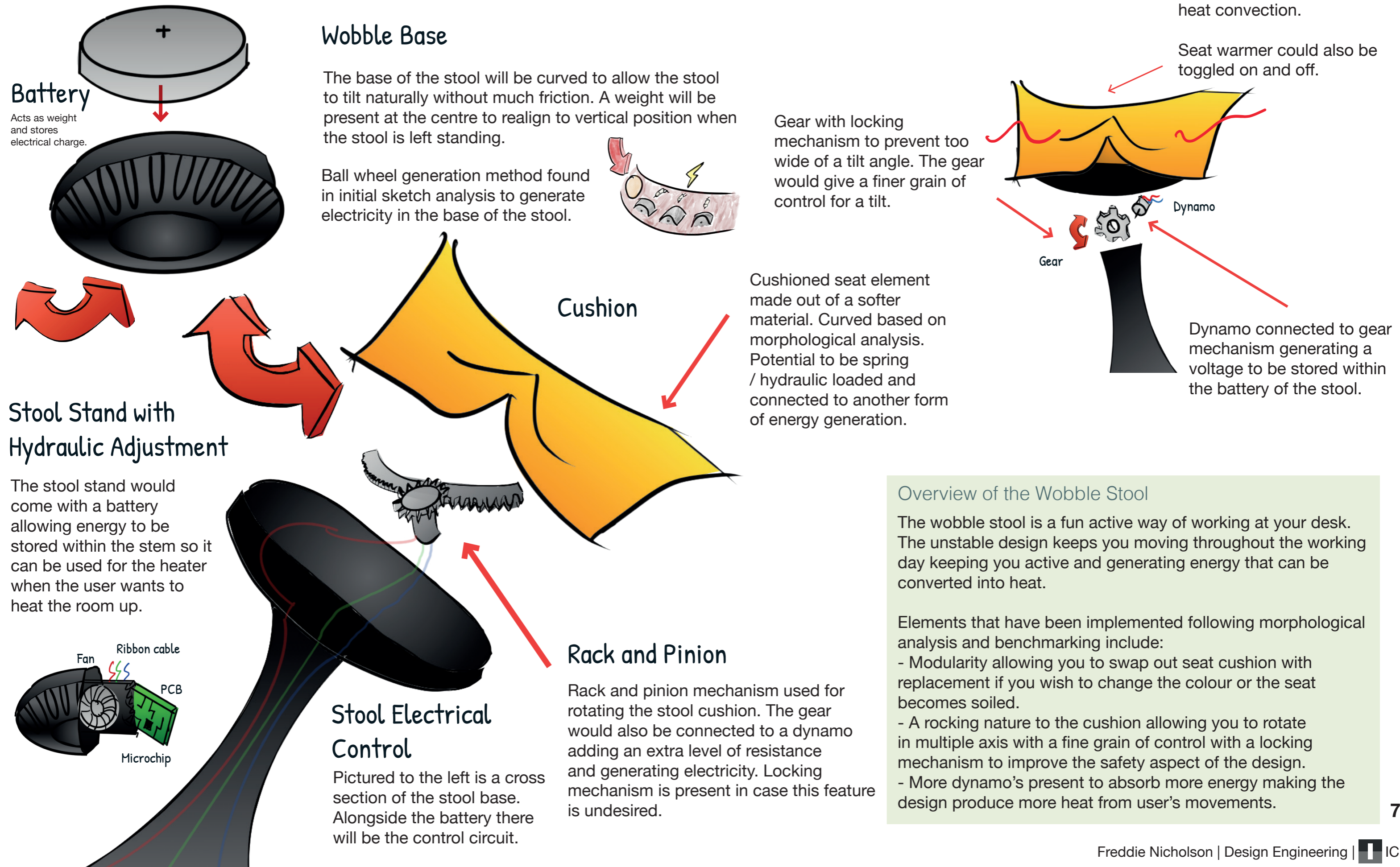
Particular analysis from the morphological process to highlight would be **accessibility** and **adjustability** as these both relate to inclusive design which is crucial for the audience that the product would be marketed towards as it allows as many people as possible to have the best experience.

Whilst this explores the functional requirements of the chair, it does not explore in depth the functional requirements of the mechanisms to generate electricity this will be explored in the functional development section.

The highlighted ideas show ideation that I will make a particular focus on within my final design concept.

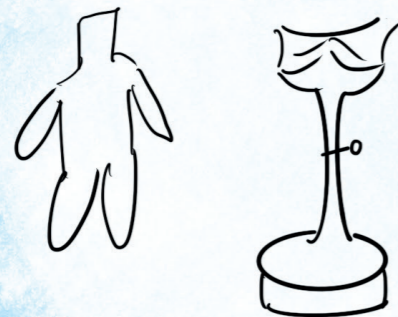
# FUNCTIONAL DEVELOPMENT

Improving the design based on benchmarking and morphological analysis



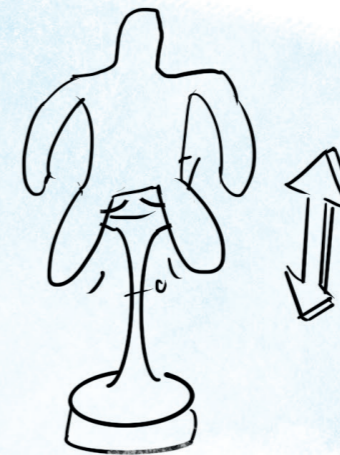
# INITIAL STORYBOARD

1.



The wobble stool is a unique solution to generating energy whilst working from home.

2.



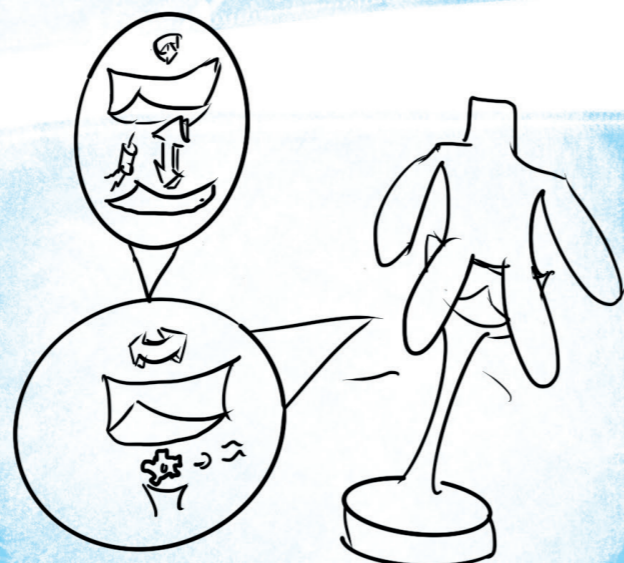
The wobble stool is fitted with a hydraulic mechanism allowing it to fit to the height required by the user.

3.



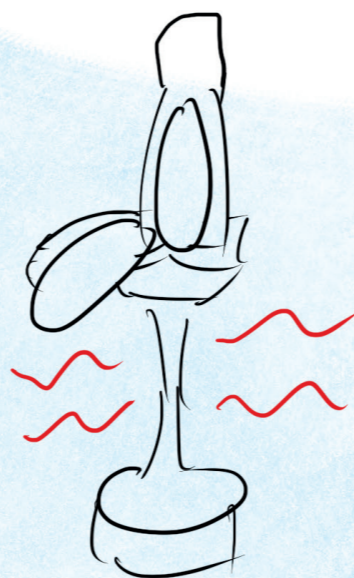
As the user works, they can wobble with a controllable side to side motion to generate electricity for the heater.

4.



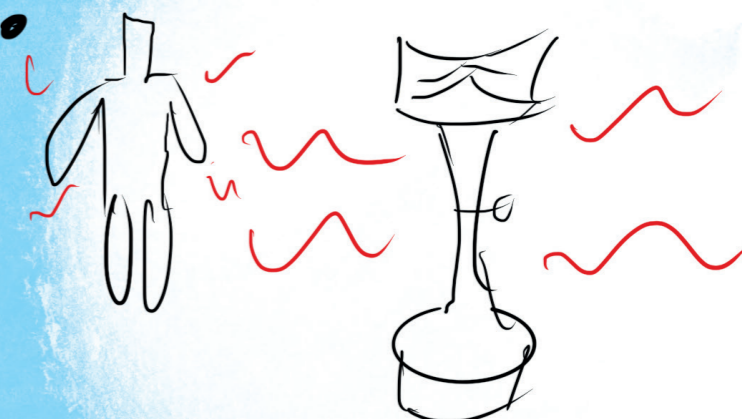
The wobble stool is made up of multiple modules allowing it to rotate on multiple axis, this means energy can be generated from all kinds of motions and allows the user to be in the exact position they desire!

5.



The heater can be toggled on and off and uses the energy stored from the wobble motion to heat up the user and surroundings using the built in coil in the stem.

6.



The heater can be left on whilst the user is away to keep the room warm thanks to the battery technology.

## Summary

The storyboard was great for giving a clear direction towards where the concept was heading and illustrating to a peer at a glance the general idea. As this is the initial storyboard, simple sketching techniques and structures were used which will be further developed in the final storyboard.

# FINAL DESIGN PRESENTATION

Presenting the final concept

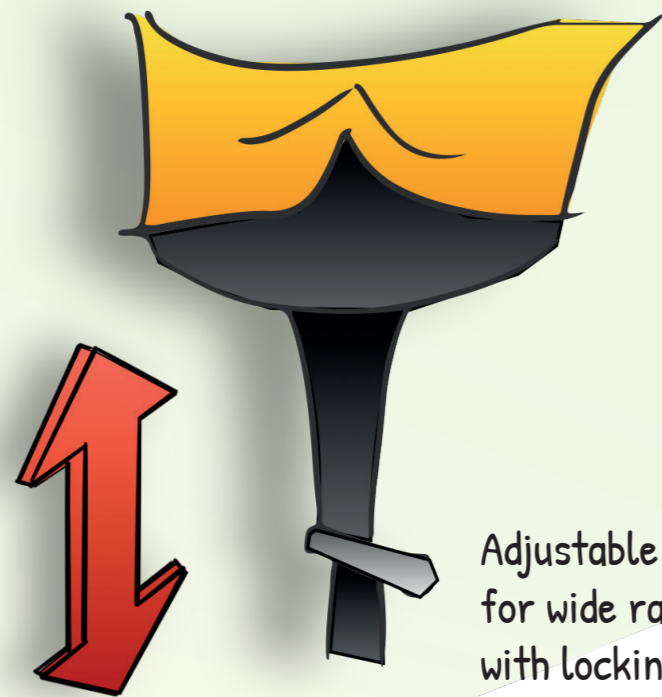
## WOBBLE STOOL

### Summary of Iteration

The final design takes the morphological analysis and benchmarking into account to create a more desirable product. The product is safer by utilising more advanced mechanisms rather than just relying on the natural wobble of the curved base.

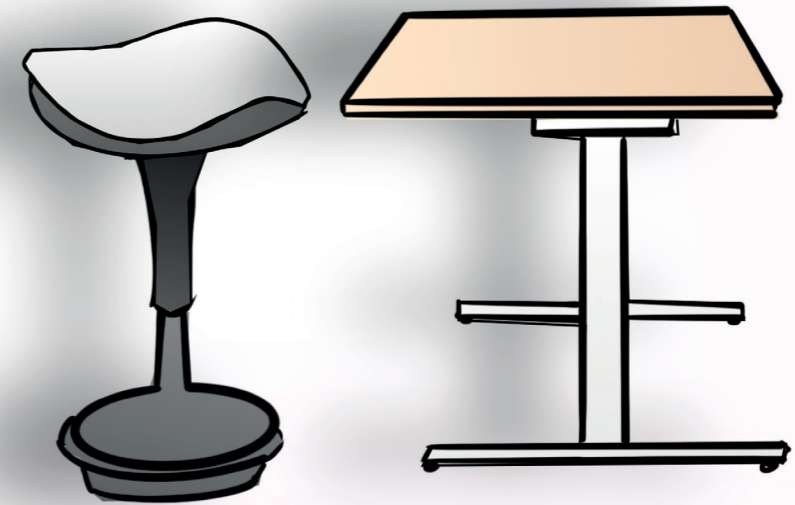
The design is also now more customizable with modular seat cushions after inspiration from the morphological analysis. The seat can also be locked in place allowing a worker to remain stationary.

### Adjustable



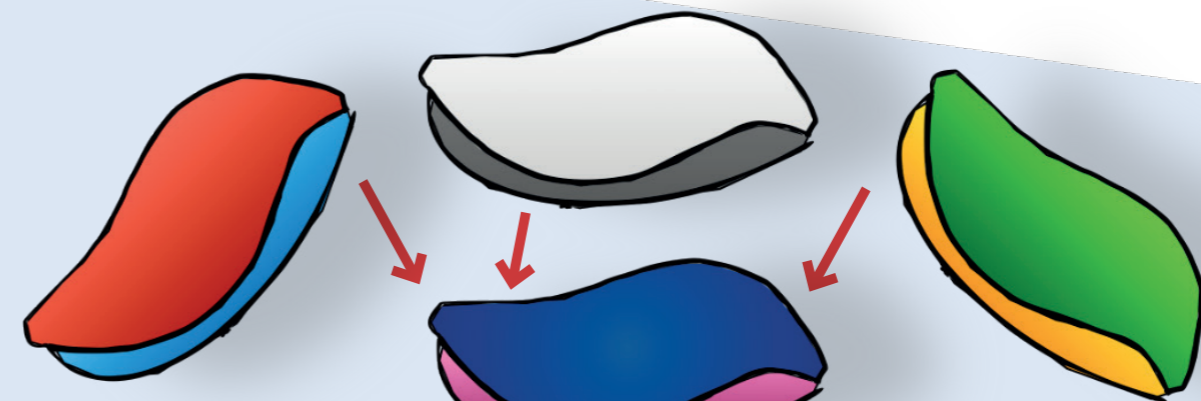
Adjustable controls allowing for wide range of heights with locking mechanism.

The solution can be used with a variety of desk set-ups including traditional work desks and standing desks. The chair can also be used standalone with no supporting walls.



### Flexible

### Customizable



Multiple colour patterns possible with new modular seat cushion that can be swapped out.

Seat produces heat out of the base of the stool and the seat cushion.

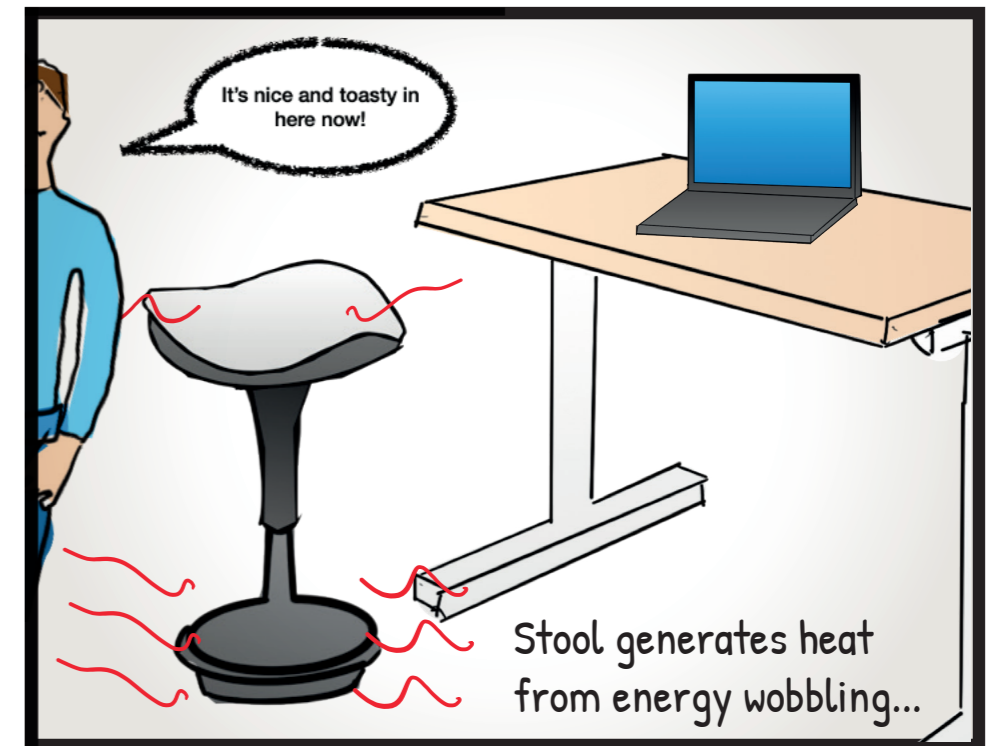
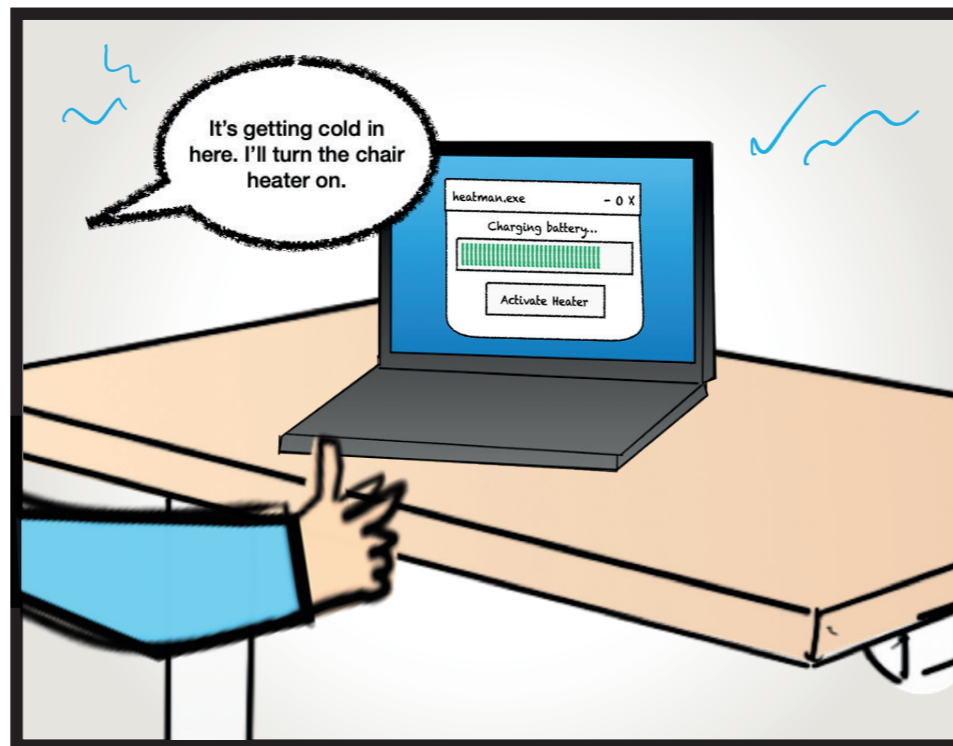
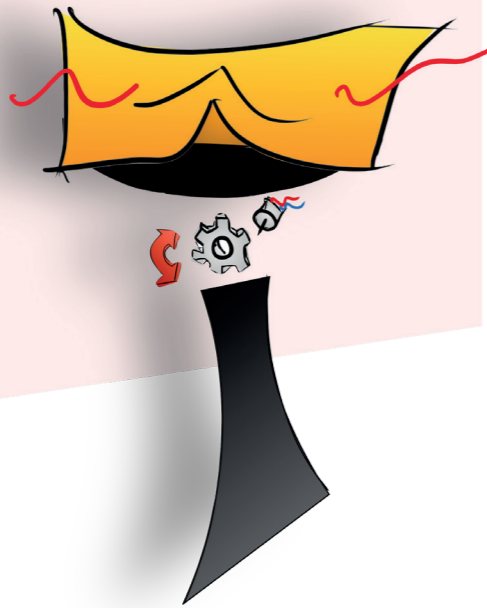


# FINAL STORYBOARD

The final storyboard shows the journey of a user, Mark, using the stool. They are working from home and get cold during the day and use the stool in order to warm themselves up. The style of the storyboard is based off comic books and gives a clean simple view as to how the product works.

Presenting...

## MARK AND THE WOBBLE STOOL



# VALIDATION AND REVIEW

Testing and evaluating the product

How might we improve thermal conditions for those working from home?

Freddie



Freddie found the seat to be a fun experience and loved how it kept him moving whilst remaining stationary working at the desk. He did find in some cases that the posture his body naturally fell in was slightly awkward as he naturally fell forward to maintain balance.

**“You will fall off if you’re not balanced!”** - A verbatim quote when Freddie was testing out the stool. In the final design a mechanism will need to be designed to stop the stool from tilting at such an angle that it is possible to fall off as this could be dangerous.

Daniella



Daniella struggled to find her balance on the stool and kept falling off. This disruption meant she struggled to work effectively and couldn’t see the solution working long term.

**“Although, it was enjoyable, I found it very difficult to get onto the chair due to its height and instability. When it was not next to a wall I couldn’t get on. Maybe making it shorter so you can perch on it would make it more user friendly”** - A verbatim quote from Daniella post using the stool. Her suggestion of making the stool shorter is interesting. The demonstration device had no adjustability which is a factor that could be improved perhaps with further iterations to the design.

## Summary

The physical design of the product was tested by finding a replica model within the Dyson school.

Therefore the in person testing was limited to just the physical comfort and practicality of using a wobble stool for working from home. However from the end user feedback and specification validation we can see that the product meets most requirements and initial brief for keeping warm this winter however the energy generation mechanism is not sufficient.

1. <https://www.sust-it.net/energy-calculator.php>



## Specification Validation

### Safety

The chair will need to be safe to sit in.

4

The chair was fairly stable but a mechanism needs to be added to restrict tilt angle.

### Heating

The resulting design should heat the user to a reasonable working temperature.

1

The energy calculation below suggests that the stool would not be able to fulfil the heating requirement.

### Ergonomics

The chair should be comfortable and ergonomic for prolonged periods of time.

2

The chair was comfortable for some users but some found they were not able to stay seated.

### Energy

The product requires a mechanism to convert kinetic energy into electrical energy.

3

$$E = KE + GPE$$
$$\frac{1}{2}mv^2 + mgh$$

Power = Force x distance / time  
Avg. UK weight: 85.4 kg  
 $\frac{1}{2} \times 85.4 \times 0.1 \times 0.1$   
 $= 41.89 J$   
 $P = \frac{E}{t} = \frac{41.89}{1.5} = 27.9 W$

Select tariff:	UK: Energy Price Guarantee (October 2022)	Or: Enter tariff
Energy Calculator		
Energy consumption:	27.9	<input checked="" type="radio"/> Watts (W) <input type="radio"/> Kilowatts (kW)
Time in use:	8	<input type="radio"/> Minutes <input checked="" type="radio"/> Hours
Cost of electricity:	£0.08 per 8 hours £0.075888 per 8 hours	

I found that in its current form the energy generation would not be sufficient enough only producing £0.08/day worth of electricity with a constant wobble of distance 10cm.

6. How would you improve the design of the wobble chair?

More Details

Insights

13

Responses

Latest Responses

"make the wobble adjustable (change btw high and low gear ratios)."

"Add back support?"

"why don't you just have a heater by itself instead of mixing the heater wit.."

4 respondents (31%) answered support for this question.

adjustability/footrest support Height adjustabilityseat cushion  
Sth form of back support support heater instead of mixing  
smaller motions Maybe add footrest No back support  
gear ratiosheight people Add back support support would be great  
change btw flawless design Maybe include

This stool can be found in the Dyson School Level 3 silent working pod.

A survey was also run to gauge opinion. The results can be found in supplementary pages.

These results show that the audience would prefer more support on the stool.

# SUPPLEMENTARY PAGES

Introduction to Design Engineering - Part B



# THINKING THROUGH SKETCHING

Making my ideas come to life through digital tools



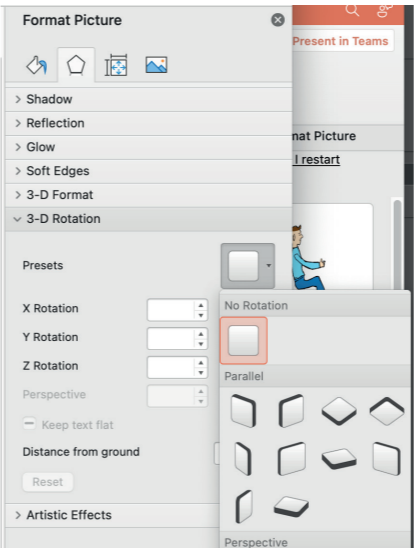
## Peer feedback

Peer feedback was gathered in a tutorial session on my Part A ideas. We used post-it notes to annotate ideas on to each other's concepts.

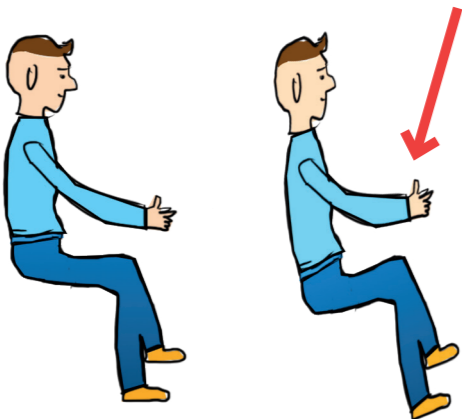
Suggestions around my main concept direction included:

- 1 Improving posture
- 2 Making sure to keep the user healthy long term
- 3 More indepth sketches of mechanical elements
- 4 Having an effective power storage mechanism

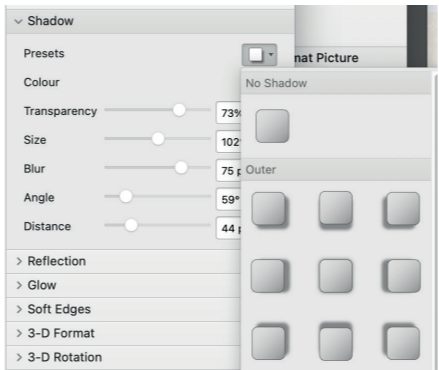
To help get to grips with drawing people, I also utilised stock images off the internet to give a template for different positions.



Powerpoint 3D rotation effect



Google image prompts such as 'cartoon man sitting on chair' were used to find examples.

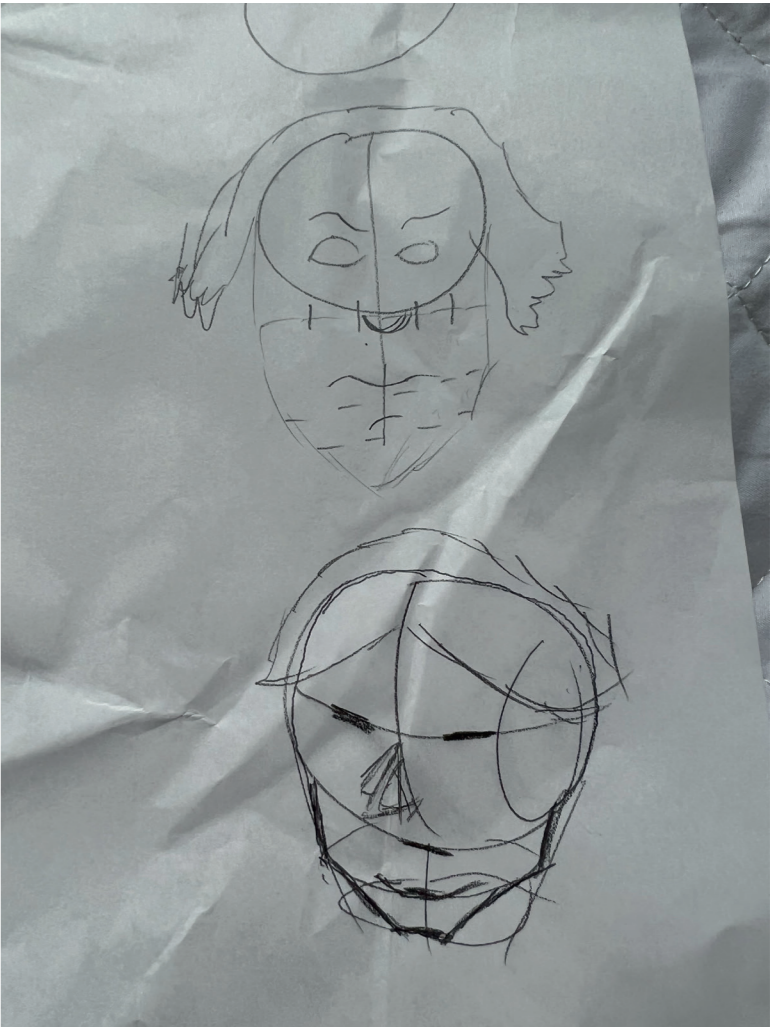


## People Drawing Skills

We practiced people drawing skills within the final tutorial sessions. Splitting the head into 8 sectors and working from divisions within this gave me a structured face shape that gave a realistic proportion for the face.

We took it a step further by moving to 3D and using a sphere shape to base our initial sketch off and then built out with the chin and hairstyle.

I initially struggled with getting hair correct but found through my storyboard development it was much improved.

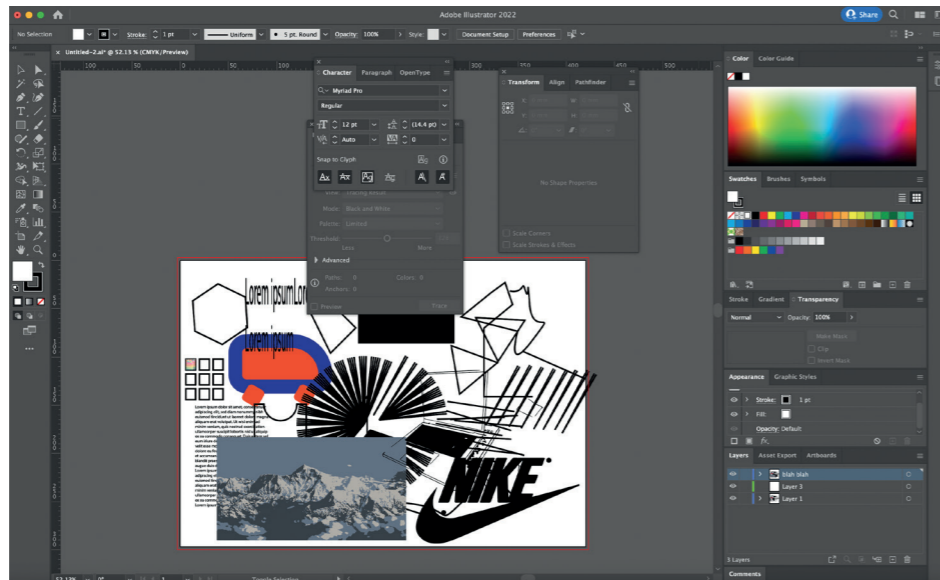


# ILLUSTRATOR DEVELOPMENT

Trying out illustrator and other vector manipulation tools



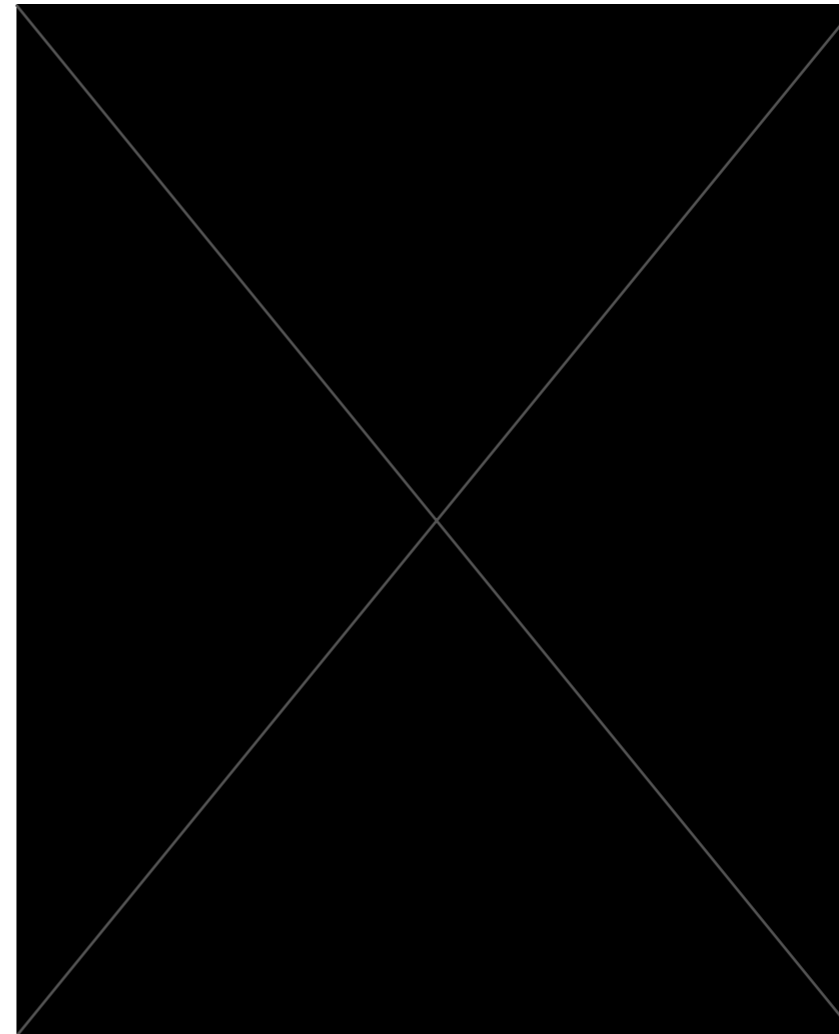
VECTOR



## Illustrator

I completed the Illustrator training given by Ahmed Patel. In this session we learnt about basic vector shapes within illustrator and how to use the fill and stroke tools with these. We also learnt about more advanced geometric operations such as rectangular and radial patterns. In addition, we performed tracing using the trace tool and the various different types of trace that could be used from a simple black and white logo to a unique limited colour effect to create a more artistic look. I also completed the vector pen exercise.

I used the illustrator trace tool to create the below image using the 6 colour preset. This and other tools were used throughout the project to create a more modern unique look and to 'unify' the images slightly so they looked sketched / artistic within the project to make it appear they were drawn in similar styles.

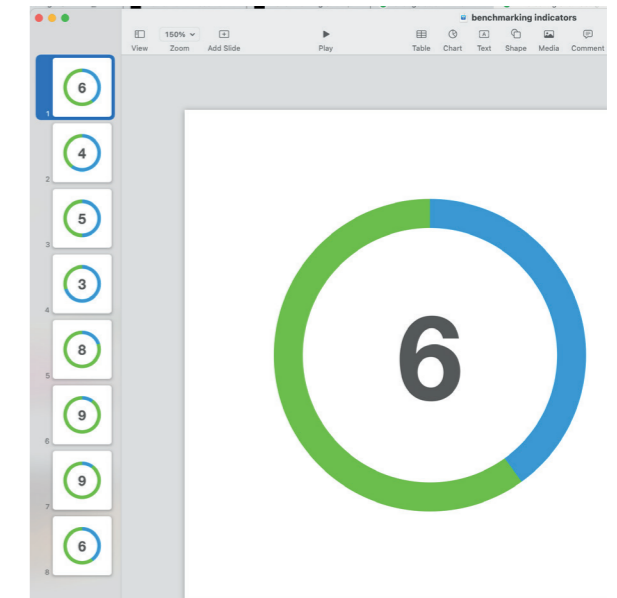


## Keynote

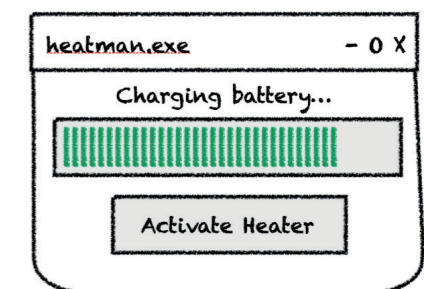
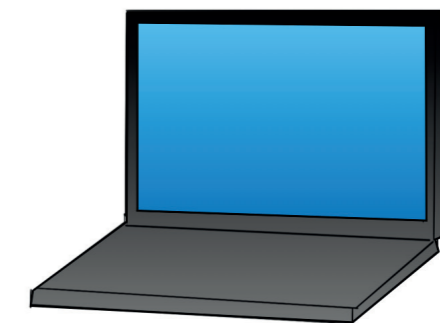
Keynote is another particularly powerful application that I find is less well known. It offers a great way for creating simple vector graphics and bringing to life great slides.

These vectors can then be exported into InDesign or Powerpoint to apply more transformations.

features that were used within this project: Pen tool, Vector Operations (unite, intersect, subtract, exclude), Advanced Image Masks, Instant Alpha / Remove Background, Advanced Gradients, Image Colour Correction and more.



Benchmarking indicator made using custom pie chart and text indicator in centre.

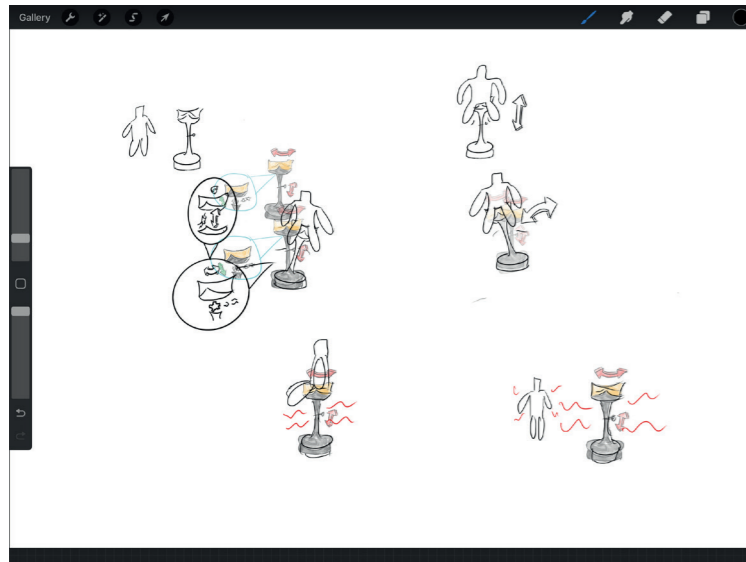


I created a quick UI mockup using keynote to display on the laptop within the storyboard. In order to make sure it looked correct, I used powerpoint to get the right rotation to make it appear on the laptop in 3D.

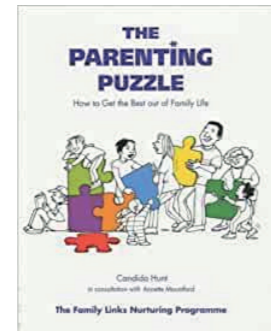
# SKETCHING AND STORYBOARD

Concept Idea to a planned story

4 December 2022 at 22:42



Low poly blob characters inspired my initial storyboard. Colour is used where the focus matters as is shown in the above book cover.

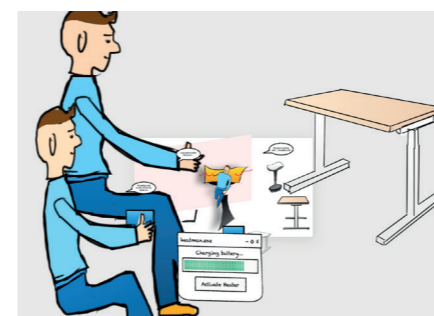


Stationary stool and laptop person walking up to try it  
 Person sits on chair, it compresses down - I just need to complete this report...  
 Person wobbles backwards on chair - My back is becoming stiff..  
 Chair produces heat - It's getting cold in here. I'll turn the heater on.  
 Person leaves and room is left warm - It's nice and toasty in here now!

I took notes before drawing anything in the final storyboard. This helped give me some structure to work off and saved time by avoiding any change of storyline.

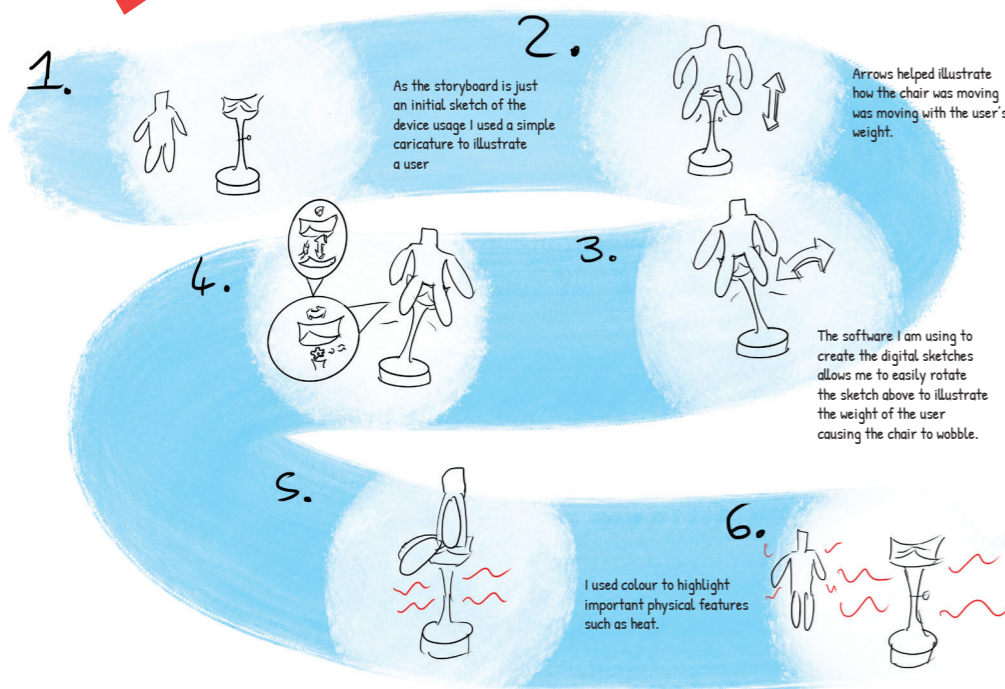
## FINAL STORYBOARD

The final storyboard shows the journey of a user, Mark, using the stool. They are working from home and get cold during the day. In order to warm themselves up. The style of the storyboard is based off comic books and gives a clean simple view as to how the product works.



I used Powerpoint to apply 3D rotation effects as a time saving technique for showing the character in different positions.

These graphics were imported from Illustrator / Keynote and then saved as PNGs to import into InDesign. The drawings were done in Procreate with the gradients / graphics in Keynote.

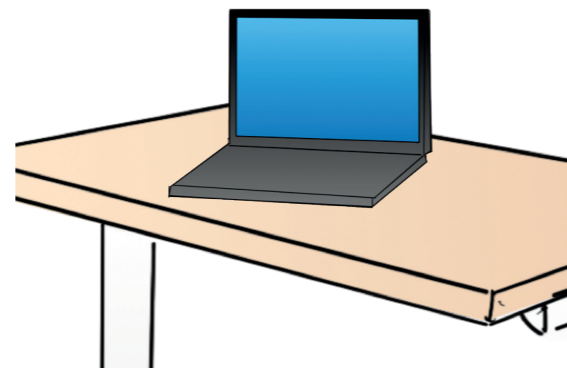
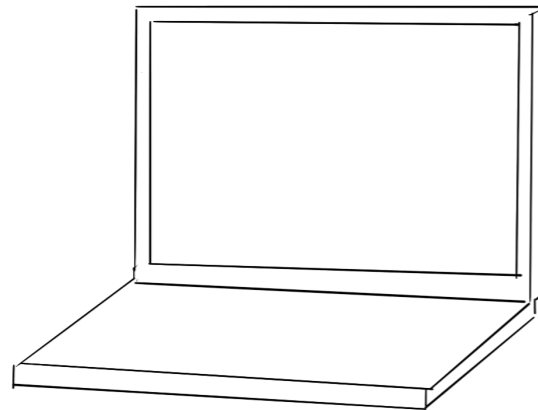
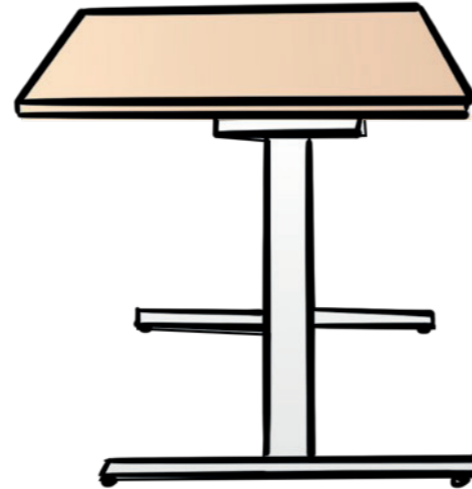
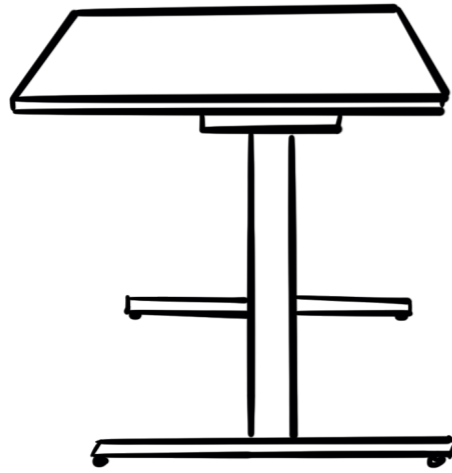


# ADDITIONAL SKETCHING

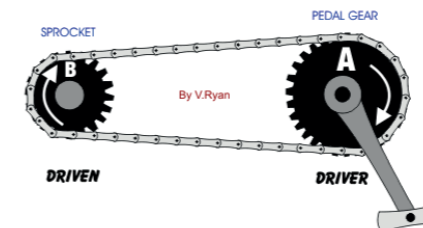
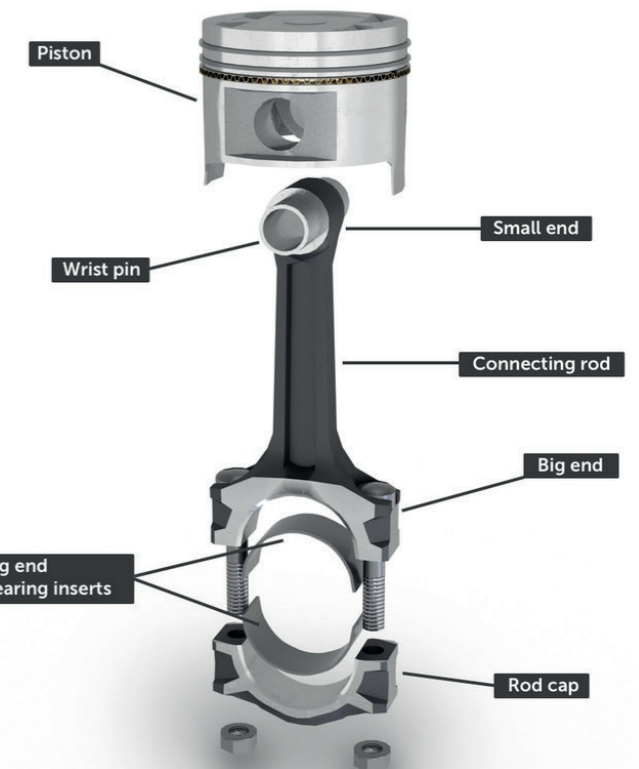
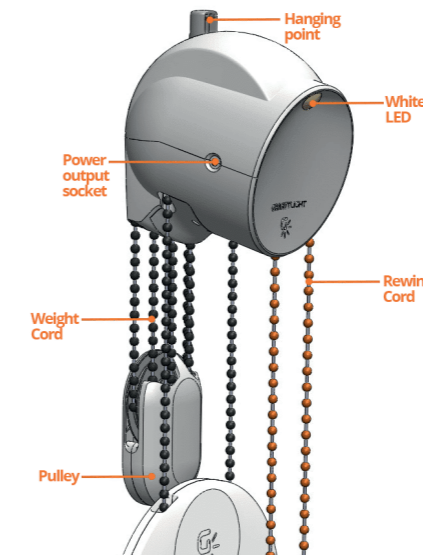
1 Reference

2 Procreate

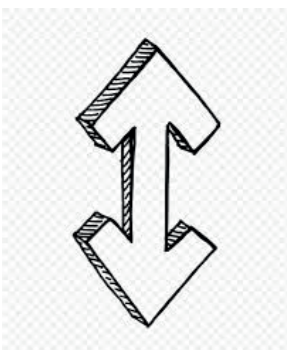
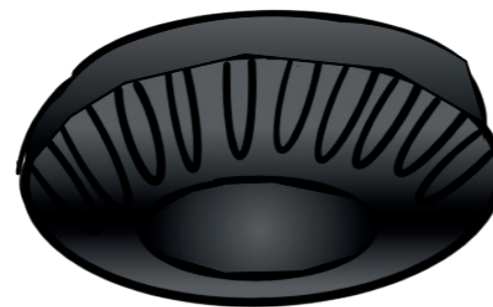
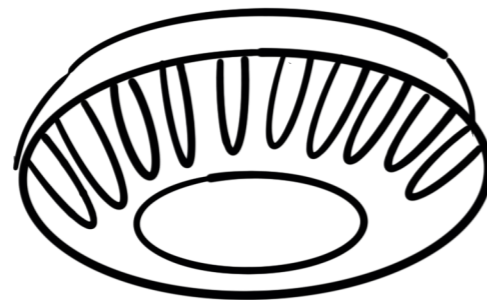
3 Gradient



## Mood Board for Mechanisms

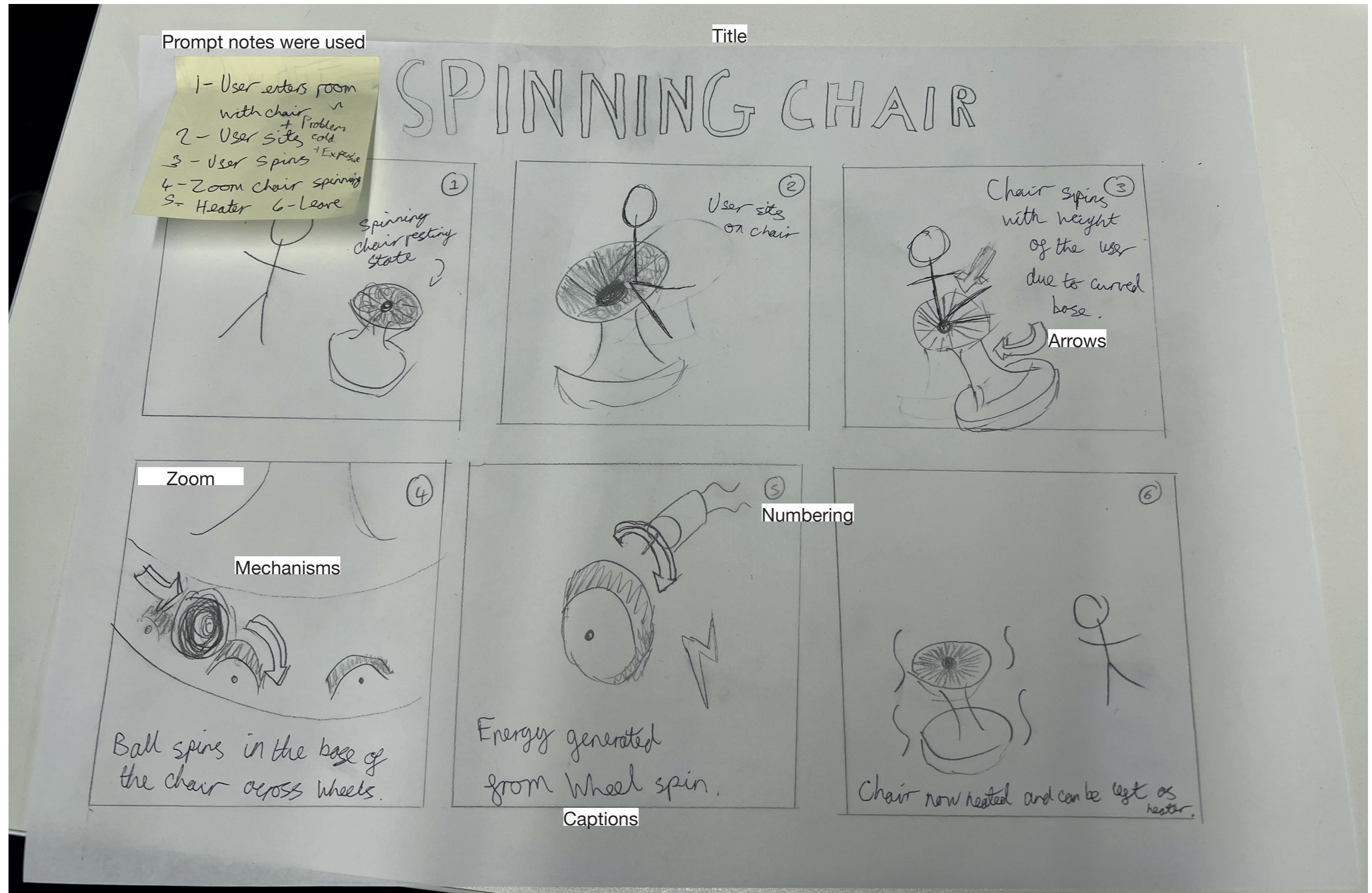


Shadow effect gave a 3D look and feel.



# INITIAL STORYBOARD

A sketch of my initial storyboard drawn in a tutorial session with a completely different product concept using a spinning chair that rolled on its base.



# SURVEY

## Guaging user opinion

1. Have you ever sat at a desk in an active way (e.g. standing, wobble chair)

[More Details](#) [Insights](#)

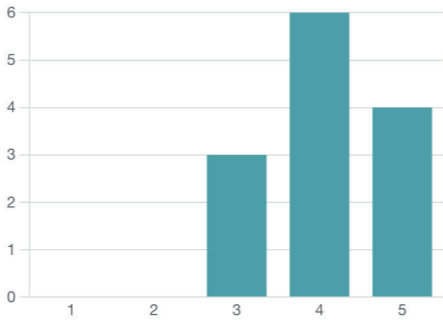
Yes 6  
No 7



2. What would you rate the above product in terms of ergonomics?

[More Details](#) [Insights](#)

4.08  
Average Rating



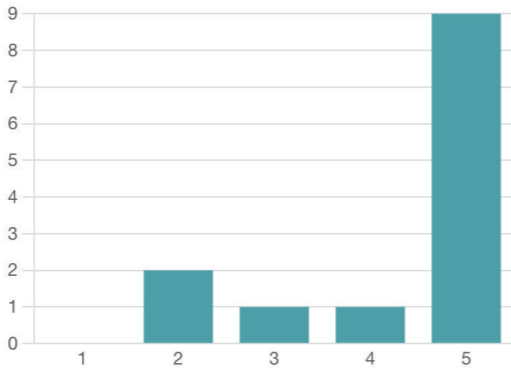
“While the concept is very interesting. I think that this product will be impractical and will not produce enough energy to justify its use. As I would think that there is a fairly limited amount of energy that can be extracted from wobbling on a stool.”

- Sam Barber, 2022

3. Does this chair look fun to use?

[More Details](#) [Insights](#)

4.31  
Average Rating



“This is a very innovative and fun idea, that I have not seen done before. I think this would be a very good way of generating heat not only from the exercise but also the generation from the movement. It would be good to aim this at university students and other people who find it difficult to sit still”

- Daniella Garces Beavis, 2022

4. What do you interpret from the storyboard?

[More Details](#) [Insights](#)

11  
Responses

Latest Responses

“your mouvement in the chair are used to heat it up.”  
“Mark has a bad back and the chair helps to fix it”  
“he wobbles the chair and then it gets hot”

5. After seeing the storyboard have your thoughts changed in anyway?

[More Details](#) [Insights](#)

11  
Responses

Latest Responses

“no”  
“Yes, see it more as for people who have bad backs”  
“no”

### Summary

The user survey responses were generally positive.

Participants felt that the product would help improve the user’s posture and stop them from getting a bad back. This was an unintended positive due to the prompt around the user being stiff.

Update

9 respondents (82%) answered **chair** for this question.

wobble chair heat

Update

5 respondents (45%) answered **No** for this question.

heating Not sure break user Nope  
bad backs No wobbling people  
alot of heat clearer fun