48240 Design Brief

Tutorial: 11

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Executive Summary

This Design Brief has been prepared for consideration from the DIF.Co Project Review Board and proposes the LuxChair as an innovative office product and viable solution to promote healthy sitting posture for sedentary workers including university and high school students, office workers and home office users. The LuxChair is an ergonomic office chair which detects users' poor posture through detecting and measuring light with a lux meter and sends alerts via vibrations to the chair. The increased need for social distancing and work from home measures due to the COVID-19 pandemic has created a growing demographic of home office users on top of an increase in sedentary workers due to the changing nature of work and shift to technology related jobs.

This report presents our product design, prototypes, innovative features and defined requirements as well as our proposed manufacturing, assembly, usability, maintainability, sustainability, safety and optimization measures. We also explore the market potential of our product and present calculations and findings from our conducted financial and break even analysis.

From our findings we recommend to the Project Review Board to go ahead with the LuxChair as it is both an inventive solution which addresses an essential need amongst the student and sedentary worker demographic and shows promising market and business potential for DIF.Co.

Introduction

This report offers a comprehensive look at our team's proposed product: the LuxChair. It introduces the problem opportunity we aim to address, and provides a description of our product, its design and innovative features and stakeholder requirements. Within this brief our team presents our rejected designs and product features as well as improvements and justifications towards our design. Additionally, the considerations towards our product design features including manufacturing, assembly, usability, maintainability, sustainability, safety and optimization has been explored and justified. The market potential of our product is analyzed to determine whether our product is feasible given market size and rival products. Lastly a business plan is outlined which includes our development budget, break even analysis and the time frame as well as sales volume in order to break even.

Product Overview

Problem Opportunity

"The shift to online delivery for universities has led to tertiary students learning from home. At-home study environments have caused students to neglect proper office ergonomics and adopt poor study habits which has led to drawbacks ranging from physical discomfort to long lasting pain and injuries."

In mid-March 2020, the risk of contracting COVID-19 was increasing globally, which led the Australian government to enforce restrictions with the main aim to keep social distancing in all public spaces, including educational institutions. In accordance with these restrictions, university learning was moved online without any face-to-face interaction. Hence, students switched their study space to be at home, which is usually not equipped for long periods of sitting or using computers.

The proposed product aims to target the primary market of university students and a secondary market of home office users and sedentary workers and perform as both an ergonomic office staple and assistive tool to correct users' posture in order to prevent long term physical discomfort and injuries. (Gate, 2020) states that appropriate posture can eliminate pressure from joints, strain from muscles, pressure from the spine and decrease lower back, shoulder and neck pain. Overall, healthy posture is a significant factor in promoting better health, reducing stress and increasing productivity.

Product Description

The LuxChair is an ergonomic office chair with an integrated lux meter which detects and aims to correct poor user posture. The major components of the chair include:

- A light meter sensor integrated into the mid-upper back of the chair which measures and detects light levels based on how far the users' back is from the back of the chair
- A 12-24 volt vibration motor positioned in the bottom back of the seat which will trigger when the lux meter detects high levels of light exposure or when the user is leaning too far forward in their chair
- A circuit board placed in the base of the seat which connect the electrical elements
- The chair body - assembled from outsourced nylon, foam and fabric materials, i.e. chair frame, base, wheels, moulded foam back, fabric chair covering, etc.

Innovative Features

Lux Meter to Detect User Sedentary Posture

The main innovative feature of the LuxChair is the integrated lux meter. No other product, whether office furniture or posture trainer, uses light sensor technology to aid physical health. The lux meter feature provides a constant and non-invasive reminder of users to straighten their backs unlike market competitors which can require users to wear the gadgets on their bodies.

Stakeholder Requirements

The Stakeholder Requirements have been outlined in Appendix A and have formed the basis for the product features and design decisions. Basic requirements include those regarding the physical build of the chair such as requiring orthopedic chair cushioning, adjustable height and armrests, wheels and the capability to support a static user weight of up to 120kg with a safety factor of 1.5 applied. As well as this it was required that the chair be comparable to market competitors with a lifespan of 7-8 years. The team agreed that our product should serve as a mid-high range quality ergonomic office chair as well as a posture detection tool.

The main requirement for the lux meter was for it to have an 8-hour rechargeable battery life and for the meter to prioritise battery and product life over accuracy of the lux meter as a low-mid range quality lux meter is sufficient to detect varying room light levels of 0-1000 lux. Lastly it was deemed important that the vibration motor be strong enough to alert the user but not be a disturbance to the user. Our proposed test strategy across all requirements is to test the beta prototype with a range of volunteers to gauge their preferences in terms of comfort and usability as well as the chair's ability to pass static load and abrasion testing and provide correct feedback to user posture.

Product Design Features

At the very basic level the primary function of the product is an office chair. Hence the product will have all the basic needs of a competitive office chair on the market. The appeal of the LuxChair comes from its secondary function which will elevate the product above all other competitors in the office chair market. The chair will have a lux meter placed in the back of the chair detecting light levels. Theoretically if a user has the correct posture there will be very little light entering detected in the lux meter. If the user has bad posture at a certain point of time, light will begin to enter the lux meter. If light levels in the lux meter go above a certain point the lux meter will send a signal to a circuit board which will in turn turn on a vibration motor placed underneath the seat of the chair alerting the user to their poor posture. The user will be aware of their poor posture and can then return their back against the back of the chair.

Manufacturability

The bulk of the materials will constitute the product will be outsourced to specialty suppliers around the world to maximise quality and minimise cost. The lux meter as the innovative component of the product will be designed and produced in Australia. As it is the innovative component of the design, communication with the supplier is critical to ensure that the lux meter design satisfies the specific needs of the product.

Assemblability

Many office chairs on the market are able to be assembled by the users by themselves with the aid of a manual. However the LuxChair has an electrical component that other office chairs on the market do not have. User participation often leads to sub-par assembly of products which may be negligible in most products such as the IKEA catalogue, however with the LuxChair comes an inherent risk of electrocution if assembly is not done properly. Due to this, the assembly of the product will take place prior to the sale without user participation.

Usability

An office chair is quite manageable in terms of use and comes naturally to most users. However users will need instructions regarding how to utilize the lux meter to help improve their posture. Therefore the product will be delivered with a manual that describes the necessary details regarding maintenance, warranty and instructions for use. In addition a video tutorial will be filmed demonstrating the use of the chair for sensorial assistance.

Maintainability

Maintainability was the catalyst for the biggest changes in the product design and how to minimise the need for it. The lux meter will be designed to maximise the lifetime while sacrificing the accuracy typically observed in lux meters present on the market. This is to create a lux meter lifecycle that is analogous to the chair itself. The LuxChair does not require a lux meter with precision accuracy and hence this design decision can be made without losing functionality. The design will incorporate one centralised vibration motor over several smaller vibration motors. This reduces the circuit board demands and therefore maintenance needs.

Sustainability

As previously mentioned the decision to employ a single vibration motor over several smaller ones reduces the number of parts included in the design enhancing sustainability. In addition, the design of the product will maximise the use of recyclable and environmentally friendly materials where possible with regard to price.

Safety

Safety is a crucial aspect of the product design especially as there are electrical components involved. As is standard, there will be insulation placed around electrical components as well as waterproofing points where exposure of electrical components is possible, eliminating the risk of electrocution. Furthermore, the amount of moving parts are minimised, the vibration motor will be encased and the use of lighter materials will reduce the extent of injuries in the case of mishandling.

Optimization

Design Improvements

- Centralised vibration motor
    - Simplifies circuit system increasing long-term reliability and reducing cost
    - Fewer parts increases sustainability
- Day & Night Mode
    - Changes light threshold required for vibration motor to launch depending on the environment
    - Allows consistent and convenient usage in darker light settings
- Generalising basic features
    - Avoiding elaborate designs for basic components such as wheels, arm rests etc.

    - Focuses innovation and resources on the prominent component of the product

Rejected Design Features

- Bluetooth Notification
    - Feedback from solution pitch revealed that users would prefer vibration as the form of notification instead of bluetooth
    - Implementing bluetooth as the form of notification would make the product dependant on external devices for its functionality, therefore vibration was more appealing as the product could function independently
- Several small vibration motors
    - More components would decrease sustainability
    - Would increase demands on the circuit board and therefore reduce maintainability as well as increasing cost
- Battery
    - A battery to facilitate function in environments where power-supply is not available
    - Highly improbable that users will buy an office chair for use in environments where power supply is not available for example a backyard
    - Hence this feature would not be effective at attracting customers relative to its cost and repercussions on warranty and reliability
- Adjustable height for lux meter
    - Will use a set height that will allow 95% of users to be able to maximise functionality
    - Height will be decided based on samples of normally distributed heights of the population and the mean will be taken. This height will be to allow approximately 2 standard deviations of the population to maximise the benefits (95%)
    - The cost to create a product with an adjustable lux meter (considering space, safety etc.) will be greater than the potential revenue lost from 5% of potential customers
    - Similar principle used to determine height of seats in automobiles

Design Iterations

Version 1

Note: See Appendix A for Version 1 design

- Basic chair components include adjustable height, swivel base and chair wheels
- Electrical components include lux meter, circuit board and vibration motor

Version 2

Note: See Appendix B for Version 2 design

- Accounts for nylon chair frame and use of polyester fabric
- Improved design includes insulation and waterproofing of electrical components
- Ergonomic chair design including back foam design and components are minimised while adjustable armrests are added

Prototype

Note: See Appendix C for design prototype

Market Potential

In the present technological age, the education system and workforce has shifted to become more accommodating towards remote and online work. This shift has become even more apparent following the impact of COVID-19 on Australia and the world. Almost all companies and industries have two solutions to maintain their business: cutting down employees or having their labourers work from home. Moreover, all students have to study online in the world because of the threat of the COVID-19 pandemic. Therefore, the Luxchair will appear in many markets such as students studying online, home offices, small business owners, classroom environments and work from home employees which is a potential market in the future. Global lux meter industrial production is currently dominant in five regions: North America, Europe, Asia Pacific, Middle East and Africa, as well as South America, (Transparency Market Research, n.d.) which creates a significant opportunity for expanding the Luxchair market and production all over the world.

Market Demographic and Size

According to Australian Bureau of Statistics (2021), almost a year after the 100th COVID-19 case was registered in March 2020, Australians are operating from home more than before the pandemic, and they expect this trend to continue. In the new Household Impacts of COVID-19 Survey, which was conducted from February 12 – 21, 2021, two out of every five people with a job (41%), worked from home at least once a week in February 2021, relative to 24% in March 2020. (Australian Bureau of Statistics, 2021). Additionally, Zojceska (2020)

stated that there are 64% of U.S. employees working from home. Since the COVID-19 outbreak in Australia and the world the number of employees working from home has increased rapidly. According to a recent Gallup study (Brenan, 2020), three out of every five (59%) U.S. employees who worked from home during the COVID-19 pandemic would want to continue working remotely as much as possible.

Market Competitors

Standard Office Chair

Standard office chairs assist sedentary workers with maintaining a healthy posture through features such as adjustable seat and armrest height and orthopedic back design. The LuxChair innovates upon these pre-existing features with the integrated lux meter which detects poor user posture and encourages users to straighten their backs and use the office chair structure as intended to optimise posture.

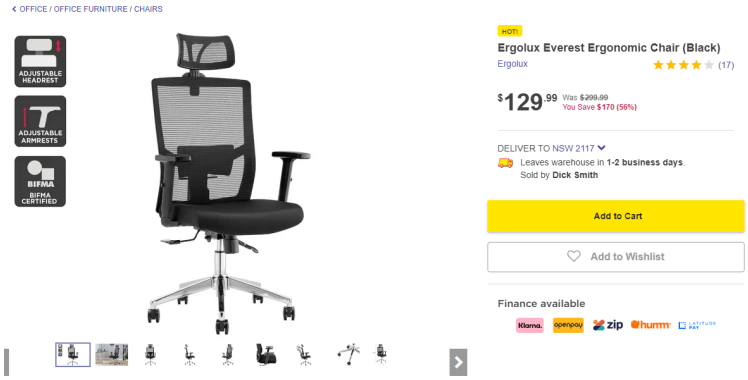


Figure 1: Ergonomic Office Chair

Upright Go

Upright Go is a posture trainer which uses biofeedback technology to vibrate when the user slouches. This product deviates from our proposal as it is a gadget-based tool which requires the user to apply the product to their upper back using adhesive or straps. Additionally its small size can make the product easy to misplace. Our product on the other hand is a non-invasive, all-in-one orthopedic chair and posture detector.

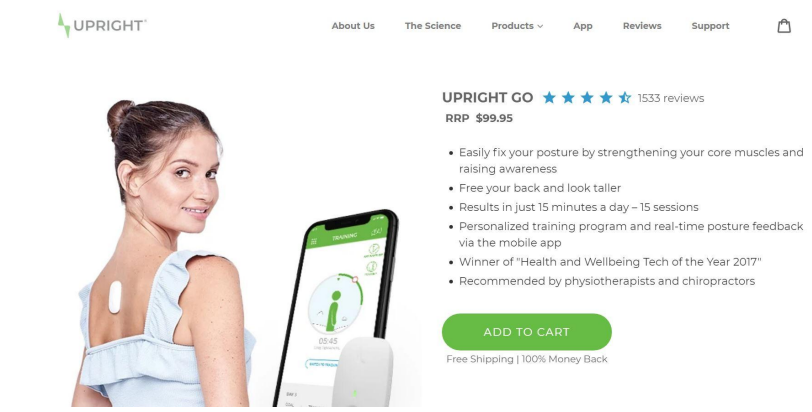


Figure 2: Upright Go

Product Business Plan

Fixed Costs

Table 1: Fixed Costs

Design Engineers	$21,170.83
Manufacturing Set-Up	$14 500.00
Training	$1 100.00
Packaging & Pre-production Marketing	$2 800.00
Total	**$39,570.83**

Table 1 covers the upfront fixed costs for commencing production and development of the LuxChair. Development costs include total design team costs and pre-production costs which encompass prototyping, manufacturing set-up, training, packaging and pre-production marketing.

Variable Costs

Table 2:

Product Components	$86
Labour Costs	$53.27
Distribution Costs	$4.86

Total	**$144.13**

Table 2 displays the variable costs of production per unit including product component, labour and distribution costs.

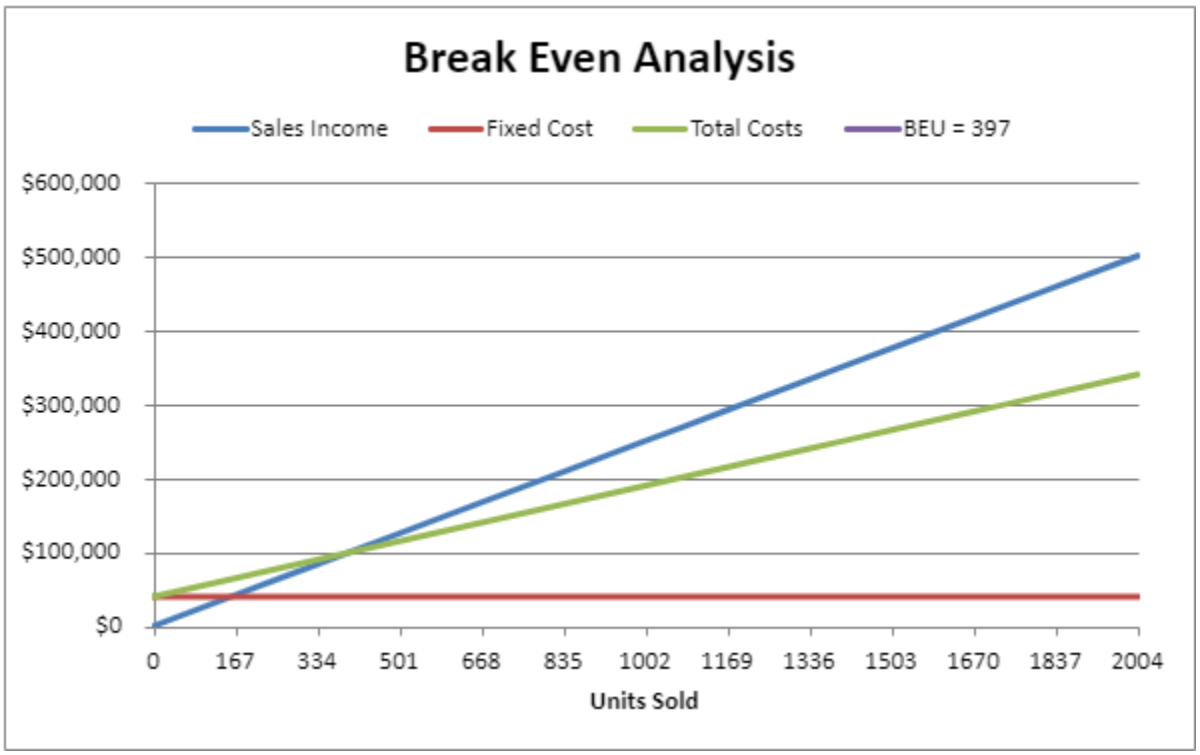
Wholesale Product Sale Price

The selling price of the LuxChair will be set at $250 AUD per unit. This is based on the costs of competitor mid-range ergonomic office chairs which are priced from approximately $200-300.

Estimated Sales Volume

Bolton (2020) stated for the Financial Review that 14 669 students in NSW have applied to start university in 2021. For our product to capture 10% of this market, 1 467 units would need to be sold. Our team aim is to sell 2000 units per year accounting for the secondary market of home office users and sedentary workers. We propose to sell the product at this sales volume for two years before reassessing market growth and increasing manufacturing costs and DIF.Co investments for following years. Based on these figures, DIF.Co would sell 4000 units in the first two years.

Break Even Analysis



Break Even Units	Break Even Sales	Label
397	$99,250.00	BEU = 397

Break even analysis was conducted using estimated fixed cost, sales price and variable cost figures. From breakeven calculations (see Appendix G: Break Even Calculations) it is indicated that the LuxChair will break even after 374 units sold and $93 500.00 generated in break even sales. Based on these figures and estimated sales volume, the LuxChair would become profitable after 2 months of sales. In the first year of sales the product will produce a net income of $214 512.03. This profit would allow for further improvements to the product design and increased company investment in market share and development costs.

Conclusion and Recommendations

Our team strongly recommends that DIF.Co invests in our proposed product, the LuxChair and proceeds to the next stage of product development. Our solution places innovation at the forefront of our design, featuring lux meter technology as a new method of posture detection, and aims to stand out in a market of conventional office chairs and invasive, appliance-based posture trainers. Our product aligns with DIF.Co's focus on social responsibility and prioritises sustainability through use of recyclable materials and minimised product components.

Moreover the LuxChair shows great potential to succeed in a growing market of sedentary workers and students, especially given the shift to online work during the coronavirus pandemic. Our findings on the product market potential, business opportunity, break even analysis and estimates highlight that the product would be highly profitable for DIF.Co to invest in. Our team has the following recommendations to DIF.Co for the next stage of product development:

Product Testing

The product will be tested by 30 volunteers from ages 14-70 for 2-3 months. The test team should consider a diversity of heights, body types and weights and physical disabilities. Within this test period DIF.Co should test the comfort, practicality and usability of the product before mass production, marketing and distribution.

Feedback and Altercations

DIF.Co should collect volunteer feedback from product testing to correct product defects as well as to redefine product requirements such as vibration motor and lux meter strength.

This will reduce post production costs and ensure that a product is released which aligns with the preferences of the general public.

Market Launch

Once the project has been launched, the DIF.Co team should continually gather feedback from customers and review data every 6 months to determine product modifications.

Future Improvements

Based on customer feedback, the product should undergo continuous and regular improvements to design features. Potential improvements to the design could include the ability to adjust the height on the lux meter on the back of the chair to account for different heights.

Expanding Distribution

The first release of the LuxChair accounts for New South Wales, Australia however once the company breaks even and begins to generate profit, there is potential to expand production and distribution of the product across Australia as well as major manufacturing countries such as China, the US and Japan.

References

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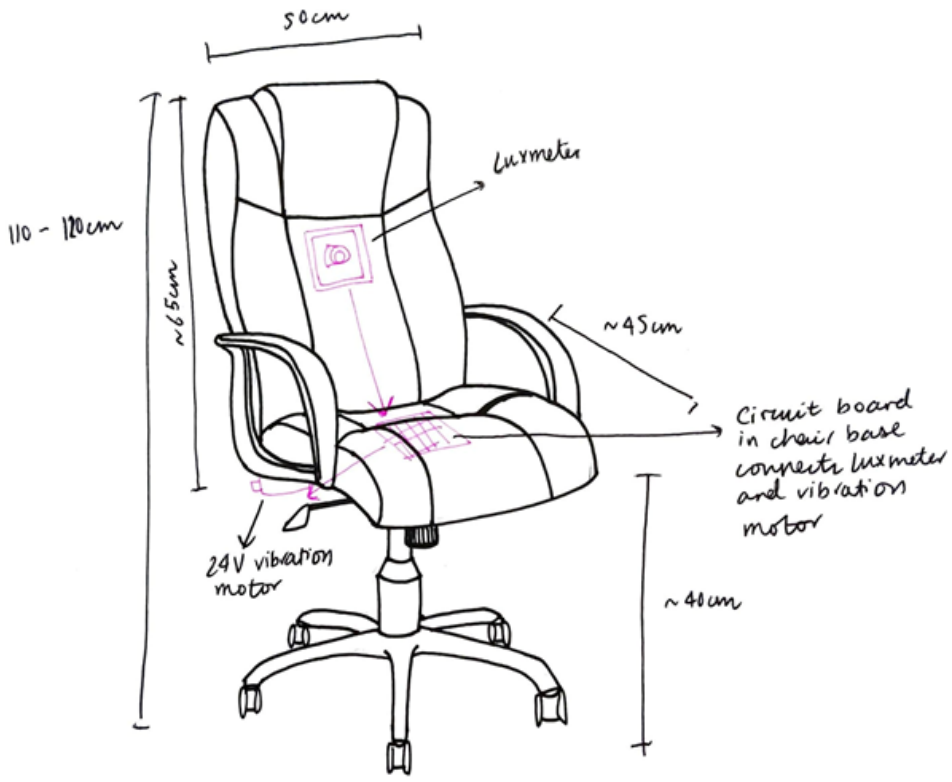
Appendices

Appendix A: Stakeholder Requirements List

ID	Requirement	Source	Verification/ Test Strategy	Priority
R001	Vibration motor needs to be noticeable but not disturb the user	End User Need	Test beta prototypes with volunteers with motors with different power output (12-24V); conduct survey to gage volunteer preferences	8
R002	Lux meter should prioritise battery and product life over accuracy yet be able to differentiate between darkness and normal room light levels (0-1000 lux).	End User & Manufacturing Need	Test lux meter feedback with varying light intensities and ensure that correct feedback is given	8
R003	Lux Meter requires an 8-hour rechargeable battery life	End User Need	Test beta prototype with volunteer pass if working for 8 hours or longer	8
R004	Chair must have a lifespan of 7-8 years	End User Need	Test upholstery using martindale abrasion testing and test seat with repeated robotic discotinuous loads applied	8
R005	The chair should be able to support static user weight of up to 120kg and moving load with a safety factor of 1.5 applied (Basic Need)	End User & Manufacturing Need	Test beta prototype with seat static load test	10
R006	Orthopaedic back support cushioning and bottom seat cushioning (Basic Need)	End User Need	Test with volunteers that chair meets their comfort level and meets ergonomic requirements for lumbar back support	10
R007	Adjustable chair height (0.3m-1m from the ground) and armrest (30cm range)	End User Need	Test with different volunteers that chair can be adjusted to suit their comfort level and is	10

	(Basic Need)		ergonomically safe, e.g. both feet resting on the ground, etc.	
R008	Wheels for portability	End User Need	Test with volunteer in simulated study space that user can move around office and chair is easily transported and moved	6

Appendix B: Design Sketch 1



Chair Components:

- Nylon base, wheels and gas lift
- Nylon seat base and gears /or metal, e.g steel
- Nylon chair frame
- moulded back & seat foam
- Fabric or mesh seat covering
- Nylon arm rests

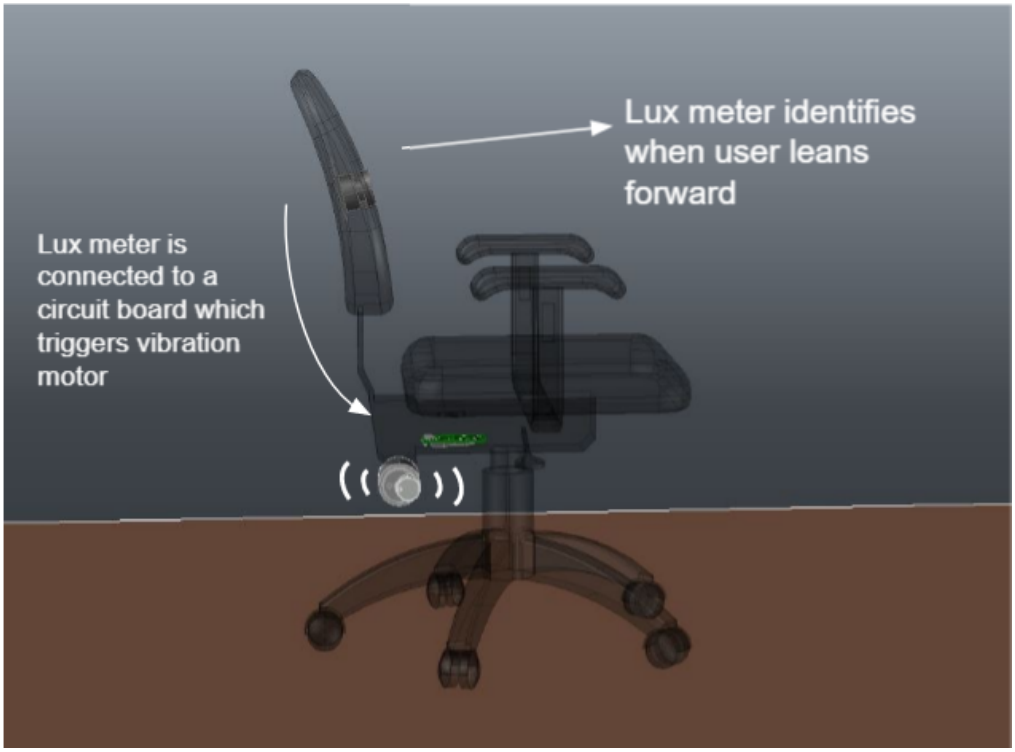
Appendix C: Design Sketch 2

Design changes:

- Luxmeter placed in insulated & waterproof casing in chair upper back to prevent electrical damage and harm

- Chair back design and overall design simplified to reduce outsourcing cost of components and minimise parts
- Adjustable armrests added for user comfort

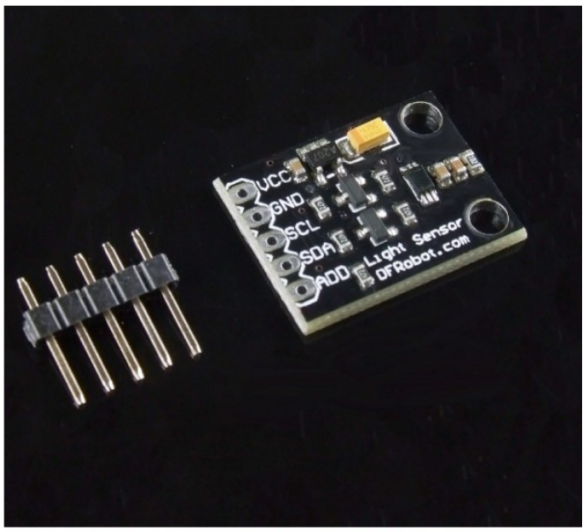
Appendix D: AutoCAD 3D Prototype



Appendix E: Outsourced Components

The outsourced components listed below have the cost calculated as 30% of the retail price.

Light Sensor



Light Sensor-BH1750

SKU: SEN0097

$25.91 AUD, inc GST

$23.55 AUD, exc GST

Quantity Discounts:
10-50 $22.373 (exc GST)
50+ $21.673 (exc GST)

In stock, ships same business day if ordered before 2PM
Delivered by Tue, 1st of Jun

ADD TO CART

Quantity: 1

ADD TO WISHLIST

Brand: **DFRobot**

Share a project for this product

Shipping:

- **$6+** Standard (2-6 days*, tracked)
- **$10+** Express (1-2 days*, tracked)
- **$3+** Stamped Mail (5-9 days*, no tracking)
- FREE Pickup (Newcastle only)

- Supplier: Core Electronics
- Cost: $25.91x 30% = $7.77 per unit

Chair Seat Base

STAPLES OFFICE CHAIR PARTS SEAT PLATE BASE REPLACEMENT 6" x 10.15" Mount #SP-610

Condition: **Brand New**

Quantity: 1 More than 10 available
955 sold / See feedback

Price: **$43.95**
Approximately AU $56.77

Buy It Now

Add to cart

♡ Add to Watchlist

- Supplier: Staples
- Cost: $43.95 x 30% = $13.19 per unit

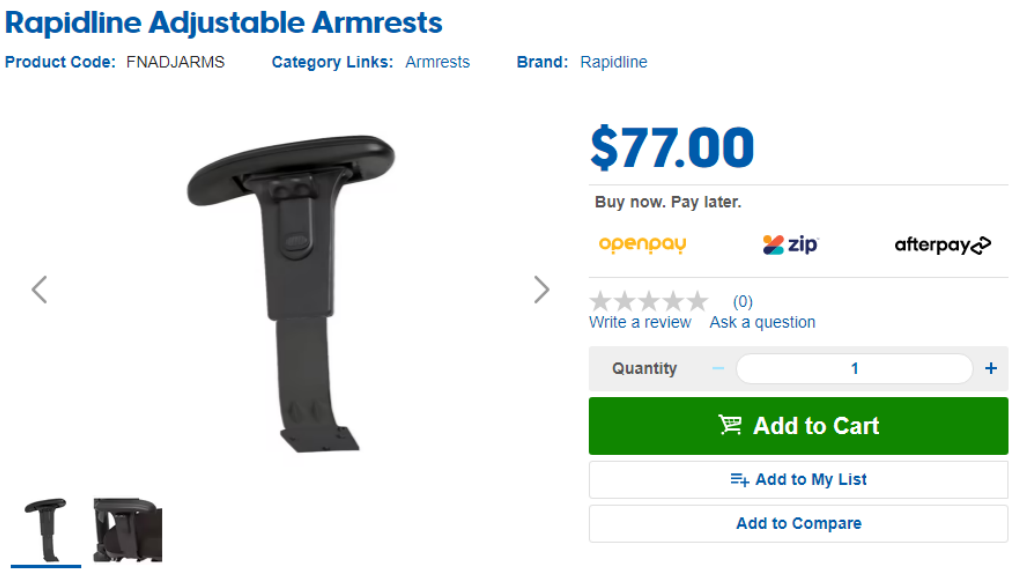
Moulded Foam Back and Seat

Grade	Description	Price (ea)	Price (total)	
HR36-100	Commercial High Density SEAT FOAM (Soft/Medium) - FR	$41.04		Select
HR36-130	Commercial High Density SEAT FOAM (Medium) - FR	$41.04		Select
HR40-230	Commercial High Density SEAT FOAM (Firm) - FR	$48.96		Select

Based on quote from custom cut foam supplier:

- Supplier: Home Upholster
- Cost:
    - Back Foam (HR36-100): $41.04 x 30% = $12.31 per unit
    - Seat Foam (HR40-230): $48.96 x 30% = $14.69 per unit

Adjustable Armrests



- Supplier: Officeworks
- Cost: $77.00 x 30% = $21.10 per unit

Gas Lift

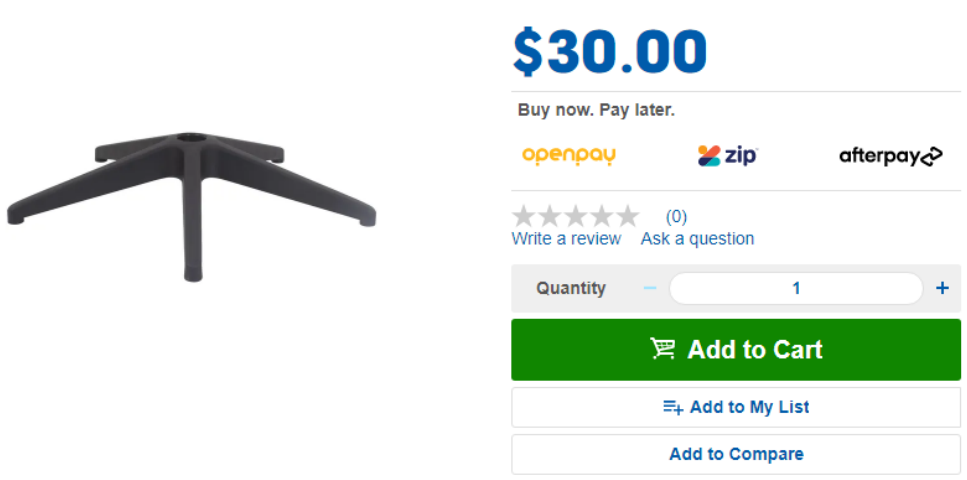
Office Chair Gas Lift with Cover

Product Code: JBGASLIFT **Category Links:** Chair Gas Lifts **Brand:** J.Burrows

- Supplier: Officeworks
- Cost: $19.90 x 30% = $5.97 per unit

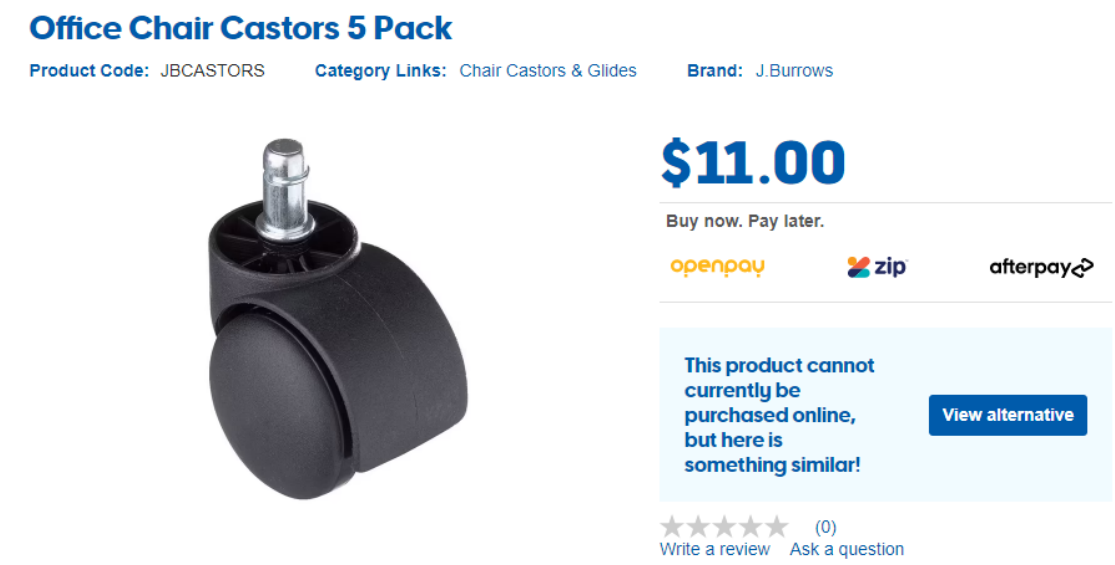
Nylon Spider Chair Base

Product Code: JBNYLOSPBS **Category Links:** Chair Bases **Brand:** J.Burrows



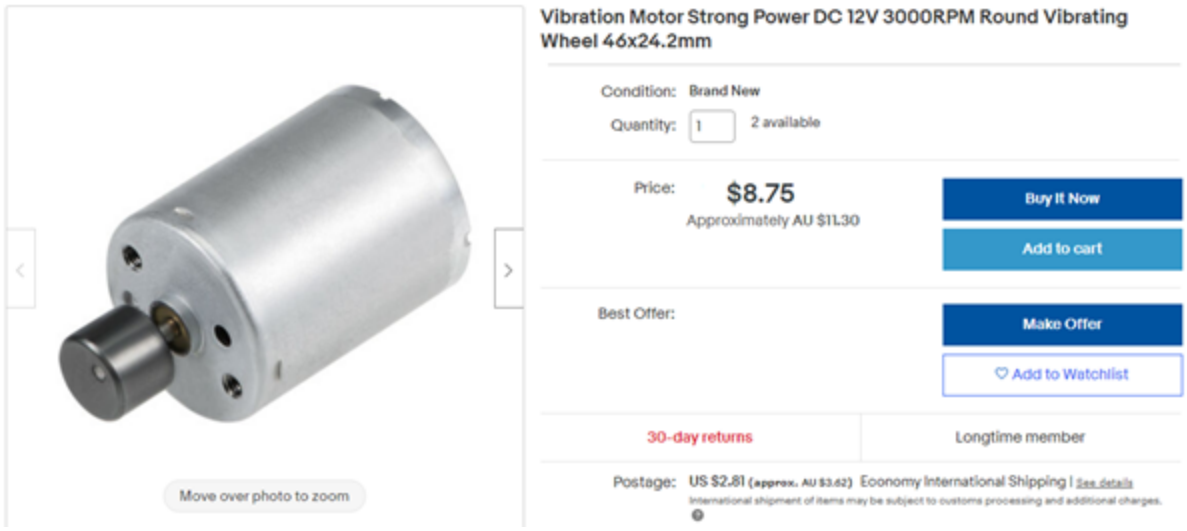
- Supplier: Officeworks
- Cost: $30.00 x 30% = $9.00 per unit

Chair Wheels



- Supplier: Officeworks
- Cost: $11.00 x 30% = 3.30 per unit

12V Vibration Motor



- Supplier: Vevor
- Cost: $8.75 x 30% = $2.63 per unit

Appendix F: Product Components Costs

Product components	**Price per unit**
Light Sensor-BH1750	$7.77
reaVibration Motor	$2.63
Moulded foam seat	$14.69
Moulded foam back	$12.31
Chair Base	$9.00
Chair Wheels (5/unit)	$3.30
Gas Lift	$5.97
Adjustable Armrests (2/unit)	$23.10
Seat Base	$13.19
Total	**$91.95**

Appendix G: Breakeven Calculations

Sales Assumptions			
Sales / Month	Sell Price	Unit Variable Cost	Total Fixed Costs
167	$250.00	$150.09	$39,570.83

Break even units = BEU = $\frac{Fixed\ Cost}{Sales\ Price - Variables\ Cost} = \frac{39\ 570.83}{250-150.09}$ =396.06 which rounds to 397 BEU.