2017

Final Design

&

Product Specification

Report

DNH603 – INDUSTRIAL DESIGN 6

PETER FORRER – N9135065

FORRERHOME DESIGN | peterf26@dodo.com.au

TABLE OF CONTENTS

1 INTRODUCTION

In conjunction with Philips Healthcare, ForrerHome Design worked to create an innovative interactive product which would help senior peoples engage with their health and wellness through personal devices. With the aim of designing a device which helps senior people gain more control over their health and wellbeing, by producing a product that responds to tangible interaction which can become a part of the senior person's everyday routine. Furthermore, improving awareness and engagement of the targeted medical condition.

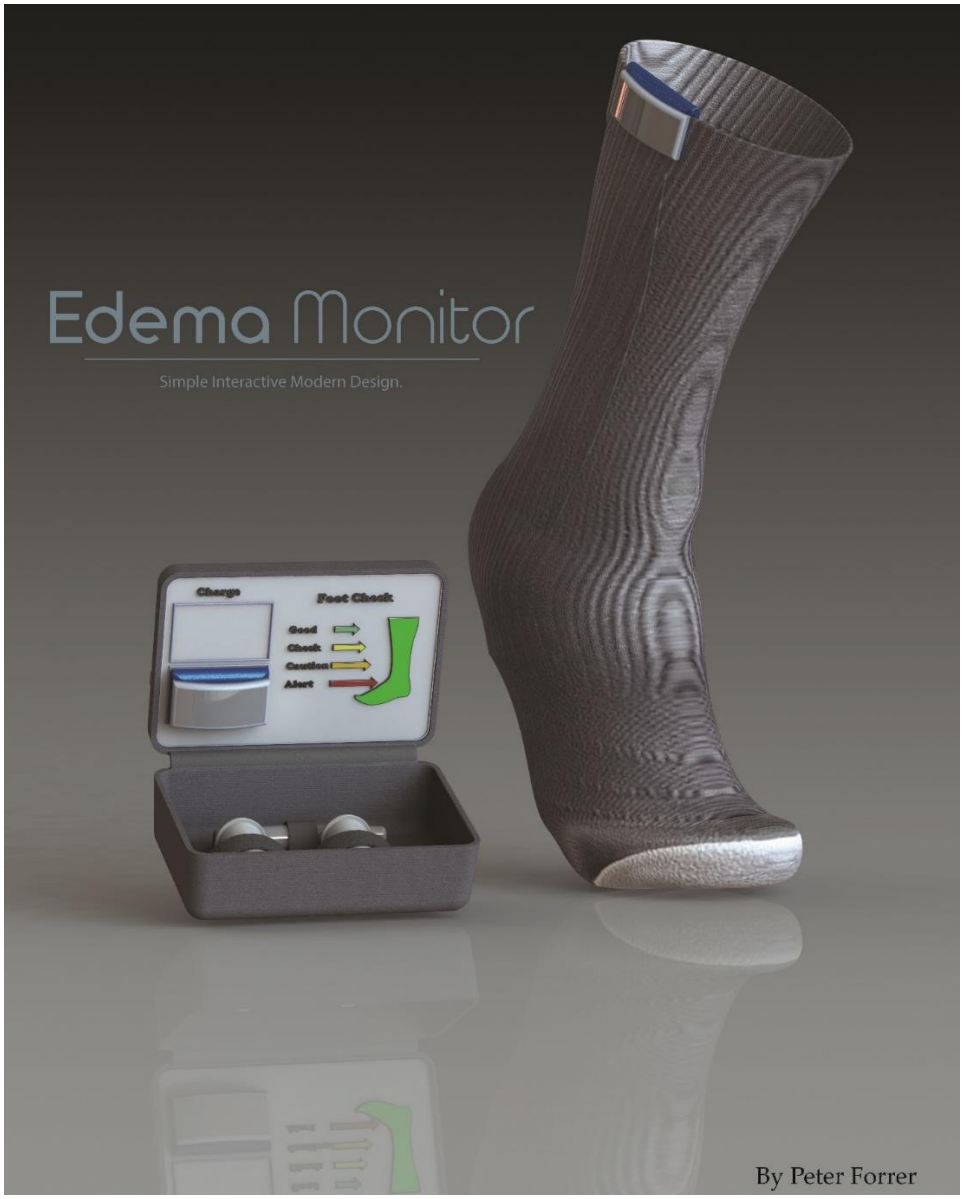
The focus of this project is type 2, Diabetes in senior people 65 year and older who were recently diagnosed. Research showed that people over 65 years of age who have been diagnosed with type 2 diabetes are looking for better ways to manage their condition while still being able to live a full life. It was also found that senior people find it difficult to understand the new medications being prescribes, which has caused them to make mistake or not take the medication at all. These issues are greatly enhanced by the limited time spent with doctors and specialists, effecting their ability to understand the information given to them and the ability to manage the new health condition effectively.

An important part of managing diabetes is the daily feet inspections, to check for swelling. Fluid build-up in the feet and ankles causes them to swell and reduce blood flow. The swelling can be brought on by long periods of standing and commonly affects the ankles and feet(diabetes.co.uk, 2017). This is difficult to manage as most problems are not found till after it has become serious or ignored due to embarrassment. To treat this problem medication is used to remove fluids from the body reducing swelling(diabetes.co.uk, 2017).

From the research collected opportunities were found in both monitoring the swelling of the user's feet and the management of the medication being taken for the condition. By pursuing this opportunity an interactive product solution was designed, the Edema Monitoring system. This interactive product provides a real-time status updates of the user's feet. Giving the user a fast and easy way to monitor their feet throughout the day and giving them, the information needed to manage the condition easily and improving their quality of life.

2 FINAL PRODUCT DESIGN

Edema Monitor, is an interactive device for the management of feet edema for the intended use by senior type 2 diabetic people. The Edema Monitor has three main functions; monitoring and tracking the swelling of the user's feet and ankles. Supporting the user to actively care for their feet and enabling remote interaction for collection of feet swelling data and status with down time monitoring. To help determine the best course of treatment for the medical professional and support services. The Edema Monitor interacts with the user through gestural interactions for active monitoring of feet swelling and with the use of a text bases spreadsheet, assist people by recording time and date of problems detected and down time.



2.1 Description

Presenting the Edema Monitor, it is a new to the world feet edema monitoring system, designed to changing the way senior type 2 diabetics manage the condition. It incorporates modern technologies and interactive design to produce a reliable way to monitor and track feet swelling and gives the person active monitoring throughout the day and provide easy visual status updates of their feet. Additionally, the Edema Monitor remotely connects with medical professionals, for better management and support with the condition.

The Edema Monitor is an interactive concept design which helps monitor and remotely track the swelling of the foot and ankle, to support the daily checks a diabetic person needs to perform before taking medication. It accomplishes this by giving the user a way of monitoring the statue of their feet, without the need for removing their shoes. The Edema Monitor is comprised of three parts, the compression sock, the sock monitor and the diabetic medicine case with each working together as a system to produce an innovative interactive product.

Figure 1: Sock Monitoring System

The Edema Monitor concept, will provide the user with the ability to monitor their feet statue while being able to go about the day as normal. It will do this in Three ways, first the monitor is attached, it reads the sensors in the sock at all times, checking for swelling of the feet and ankles. When swelling is detected three stages of feedback are given to the user through a vibration motor. The vibrations will increase in intensity till the monitor detects critical swell at which point an alarm will sound alerting the user to the seriousness of the problem.

Second, once the user notices the vibration they can check the severity of the condition by opening the medicine case, which has a build in charging station and visual readout. The case automatically connects wirelessly to the sock monitor and gives the user a

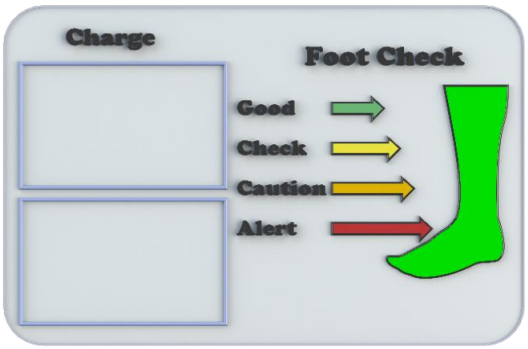


Figure 2: Visual Readout for Edema Monitor

visual readout of the foot status. The checks can also be performed during the time a user tests their sugar levels. Giving the user status updates throughout the day allowing for further action to be taken if needed and better medication control.

Third, the Edema Monitor track and stores the daily information each time it connects to the medicine case giving the user, a record of the day's events. As well the Edema Monitor connects with the user doctor or specialists through email, to help keep them informed of the patience situation so as to provide improved patient care.

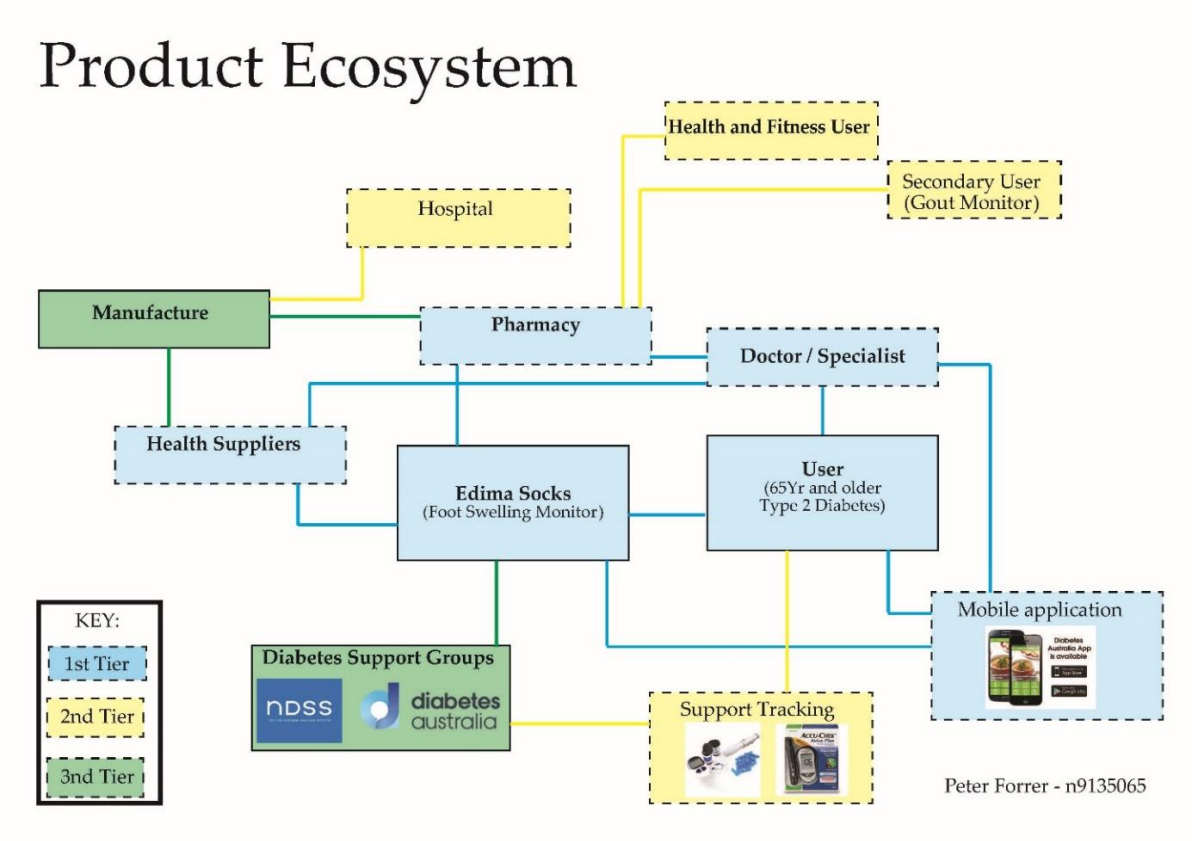
3 VALUE PROPOSITION

The Edema Monitor, is designed to build upon the existing daily treatments of the diabetic and improve the user's capabilities to manager the condition. It does this by removing the challenges surrounding the routine checks associated with feet oedema's and embarrassment associated with checking their feet for swelling throughout the day.

Aimed at the tech aware user; the daily management of diabetes thought the use of technology is seen more as a tool, to assist them in managing the condition with the goal of maintain their health. This user is prone to disengagement from a product as the novelty wears off or the product is seen as a burden. Taking this in to consideration the Edema Monitor is designed to promote engagement in two ways, an easy to understand interactive design and remote monitoring. To further reduce the user's disengagement of the product a built-in tracker helps support continued use by allowing for doctors and health specialist to setup alerts, informing them of any disengagement and providing active support to the user helping them re-engage with the product.

3.1 Product Ecosystem

To enhance the product and user value, the Edema Monitor fits in to a large already established ecosystem of product designed to support diabetics with their daily checks. Building on this ecosystem of product gives the Edema Monitor recognised value to both the user and the market place. By seamlessly adding to the capabilities of the user to self-manage their health condition, while providing the market with the ability to provide better support for the patients. With all of this aimed at enhancing the diabetic user's health and wellness by promoting more independence and a more enjoyable lifestyle.



4 DESIGN JUSTIFICATION

The aim of this project was to successfully design an interactive product, for the elderly diabetic user to improve their health and wellbeing. To do this, a list of requirements and objectives were constructed from research and will be used to evaluate the new product design. The new design can be broken down in to three areas usability, ergonomics and the quality of interaction. These aspects are discussed in detail below.

4.1 Usability

As the elderly were the target user for the Edema Monitor, it was important to the final design that usability would play a central part to a successful design. As the ability to use the product with no instructions and minimal training, would help the elderly user adopt the new technology effortlessly. Thus improving the implementation of the new product and supporting the continued use of the Edema Monitor, while reduce technology rejection due to poor understanding (Peek et al., 2014). Additionally, the Edema Monitor is designed to become a part of the already used diabetic testing kit. As these kits are an essential part of supporting the condition, joining them with the new product would reinforce the users

continued use of the product as a part of their daily routine. Furthermore, the Edema Monitor utilises clever interactive design to help the elderly to interpret the information being conveyed improving the user experience and usability.

4.2 Ergonomics

The Edema Monitor will be worn on the ankle clipped to the top of sensor sock. Because of this it was important for the design to ensure the user could wear the product without it becoming an issue. It was also important the design take in to account the multiple environment the sock and monitor will be exposed to and design accordingly for these extremes.

To accomplish this the monitor, it made slim to hug the side of the leg and reduce outward protrusions. The monitor is held in place with three pins that press in to the sock and prevent it being knocked off during use. To help support the monitor, the sock is a reinforced compression sock with built-in rubber inserts which help hold it in place. Allowing for maximum flex and improved comfort for the user.

4.3 Interaction

Integrated in to the design, the Edema Monitor uses metaphorical interactions to support the user in monitoring their medical condition. These interactions have been designed to provide the user with a quick way of identifying any concerns, which assist in determining the best course of action. This is important as it ensures the user can manage the medical condition promptly, giving them greater control and improving their health. To produce tangible interactions a combination of sound, motion and light were used to represent three functions feedback, status and alert as shown in the table below. This has been incorporated into both the sock monitor and the case display to give the user a complete interactive experience.

Using motion and sound the sock monitor interact with the user by utilises vibration to give the user status updates on the feet condition and a buzzer to produce feedback to indicate activation as well alerts if a problem is detected. The case uses light in the form of RGB LEDs to show the user a visual status of the monitors reading, while a sound from a buzzer gives the user feedback to indicate activation of the display.

4.4 Quality of Interaction

Action	Reaction	Functionality	Problem/Issues/Negatives	Comment – Possibilities of quality interaction
Inspect feet for swelling in the morning	Look at feet	Check for Difference in Shape	Swelling not checked regularly	
Pull Socks on to feet	Slide sock over feet	To cover feet	Placing sock on the right way	Look at sock orientation
Clip Monitor to sock band	Clip monitor to sock	To activate monitor	Position and placement	(Switch) to activate
Open Medicine Wallet	Unzip and open wallet	To get to medicine and test equipment	Person will need to carry with them daily	(Switch) Opening wallet activates process and test sequence
Check Monitor Status	Look at display	See level of displayed	Understanding display readout	(LED) Visual display of status
(Throughout day) Foot Swells	Foot Feels Sore	Stop activity	Must remove shoes to check foot/ not bothered to check foot	(Strain resistor, vibration motor) Resistive bands on key areas to check swelling and feedback when swelling sensed
Take medicine	Find medicine wallet	Take prescribed dose	Unknown dose of medicine	(LED bar graph) Visual indicator of swelling

4.5 Design Interaction Metaphors

Action	Goal	Metaphor	Metaphorical Actions	Sensors	Output from the system	Output Action
Inspect feet for swelling in the morning	Look at feet for swelling					
Pull Socks on to feet	Slide sock over feet					
Clip Monitor to sock band	Turn on monitor	Good to Go – Green Light	Colour displays for set time	Switch On/Off	Green LED – turns on/off to show active	Status
Open Medicine Wallet	Unzip and open wallet	Fridge Light	Lights up to show active	Switch On/Off	Green LED – turns on/off to show active	Status
Check Monitor Status	Look at display	Volume	Changes colour to show intensity	Stretch Resistor	RGD LED – As resistance increases it lights up more LEDs	Status
Proceed to do morning check	Perform Blood test					
(Throughout day) Foot Swells	Sense if foot has swelled	Balloon inflating	Stretching	Stretch Resistor	Vibration Motor, LED & Buzzer	Feedback & Alert
Open Medicine Wallet	To take Edema Medicine		Open a Book	Switch	Green LED	Status
Take Medicine	Judge amount of medicine to take				Visual LED Graph	Status

5 TECHNICAL DOCUMANTS

5.1 Technical Specification

To manufacture the Edema Monitor it requires three main part, the sensor sock, monitor clip and the case display. Because of this, three areas of manufacture were needed to produce each component of the design.

5.1.1 Monitor

The monitor is made from ABS-PC polymer as this was the best choice for skin contact. To produce this part the housing is made in three parts by injection moulding, then electronics are fitted on to a custom PCB board and seal inside by use of sonic welding. This produces a IP67 rating which gives the monitor a waterproof design.

5.1.2 Case

The case is an off the shelf part from Philips designed to their specifications. Fitted to this is the interactive visual display. The display is injection moulded in ABS-PC. With the electronics mounted on the back. The electronics are potted in place and glued in to the case. The USB port is left inside the case and is accessible by pulling back the side allowing for connections to a computer, standard Mini USB socket used as connection point.

5.1.3 Sensor Sock

The sock is an off the shelf compression sock, this if circular knitted, the sensors are glued in place, ready for the final addition of the conductive rubber. The conductive rubber is added by injection moulded on to the surface of the sock to help keep moveability. The final product is tested with detergent and long-term water exposure to produce a long life wearable product.

5.1.4 Technical Components

Edema Monitor System	Monitor	Case	Sock
Description	3-part plastic housing	Nylon Case with plastic display insert	Nylon cotton, rubber reinforced Compression sock
Manufacture Technique	Injection moulded, with sonic welded joins	Injection Moulded, Glued	Circular knitting - rubber moulded insert
Materials	ABS-PC – Silicon	ABS	Cotton, Nylon, Rubber
Electronics	Arduino Pico custom Vibration Motor Buzzer LiPo Battery RF Transmitter Induction coil Red LED	Arduino WeMos mini RGB LED X 3 RF receiver SD Card Reader Wi-Fi Adaptor Induction Coil LiPo Battery USB Port	Strain/Stretch sensor Conductive rubber
IP Rating	67		

5.2 Materials

The main part of the Edema Monitor is manufactured to be worn on the ankle and used every day. This area of the body can receive a lot of punishment, from knocks and scrapes and other environment factors. This Made it important to produce a product with characteristic of durability and longevity, to withstand the rigors of constant use. Because of this ABS-PC polymer was chosen for the sock monitor, as it meets these requirements while safe for direct contact with the skin.

5.3 Product Standards

AS/NZS 4268:2008	- Radio equipment and systems - Short range devices - Limits and methods of measurement
ISO/TR 17522:2015	- Health informatics - Provisions for health applications on mobile/smart devices
AS 60529—2004	- Degrees of protection provided by enclosures (IP Code)
ISO9241	- Ergonomics of human-system interaction
ISO/TR 17522:2015	- Health informatics - Provisions for health applications on mobile/smart devices
ISO 13485:2016	– Medical Devices – Quality Management Systems – Requirements for regulatory purposes
AS/NZS 4417.2:2009	- Marking of electrical and electronic products

5.4 Bill of Materials

Bill of Materials

FORRERHOME Design

Phone: 0412302419

E-mail: peterf26@dodo.com.au

Statement

Statement #: 0.001
Date: October 15, 2017
Customer ID: 1001

Bill To: Health Management Corporation
Philips Healthcare
3000 Minuteman Road
M/S 109
Andover, MA 01810

Emema Sock

Photo	Part	Order Volume	Description	Amount	Units	Balance
	Arduino Pico	10000	Main Computer	$ 6.21	2.00	$ 12.42
	Vibration Motor	10000	Motor Interaction	$ 0.75	2.00	$ 1.50
	Strain Sensor	10000	Sensor, stretch and strain	$ 1.01	4.00	$ 4.04
	Buzzer	10000	Sound, Interaction	$ 0.20	2.00	$ 0.40
	Contact sensor	10000	Switch, Turns on and off monitor	$ 0.80	2.00	$ 1.60
	Transmitter	10000	Transmitter, Relays data to main computer	$ 0.50	2.00	$ 1.00
	Housing	1000	Housing, ABS	$ 2.10	2.00	$ 4.20
	Custom Socks	1000	Compression sock, inlay of conductive rubber and sensor points	$ 5.50	4.00	$ 22.00
	LiPo Battery	10000	3.7v 250mAh	$ 2.20	2.00	$ 4.40
					Total	**$ 51.56**

Bill of Materials

Sock Monitor

Photo	Part	Order Volume	Description	Amount	Units	Balance
	Arduino WeMos Mini	1000	Arduino WeMos Pica, controller for the sensors and IoT	$ 4.59	1	$ 4.59
	SD card reader	1000	Storage for data collected	$ 1.00	1	$ 1.00
	LED Gauge	1000	Display colour range	$ 0.50	1	$ 0.50
	Buzzer	1000	Sound and Noise	$ 0.20	1	$ 0.20
	Reciever	1000	Wireless data connection	$ 0.50	1	$ 0.50
	Wireless/BT tranciever	1000	IoT Connection	$ 1.20	1	$ 1.20
	Case	100	Housing for devices	$ 2.50	1	$ 2.50
	Reed Switch	1000	Turns of the Arduino	$ 0.20	$ 1.00	$ 0.20
	Magnet	1000	10mm X 2 mm	$ 0.80	$ 1.00	$ 0.80
	LiPo Battery	100	3.7v 2000mah	$ 2.10	$ 1.00	$ 2.10
	Plastic Incert	100	mount for electronics inside case	$ 3.40	$ 1.00	$ 3.40
					Total	**$ 16.99**

6 REFERENCES

Diabetes.co.uk. (2017). Swelling and Diabetes - Swollen Legs, Ankle & Feet, Peripheral Edema. Retrieved October 13, 2017, from https://www.diabetes.co.uk/diabetes-complications/edema-and-diabetes.html

Peek, S. T. M., Wouters, E. J. M., van Hoof, J., Luijkx, K. G., Boeije, H. R., & Vrijhoef, H. J. M. (2014). Factors influencing acceptance of technology for aging in place: A systematic review. *International Journal of Medical Informatics*, *83*(4), 235–248. https://doi.org/10.1016/j.ijmedinf.2014.01.004

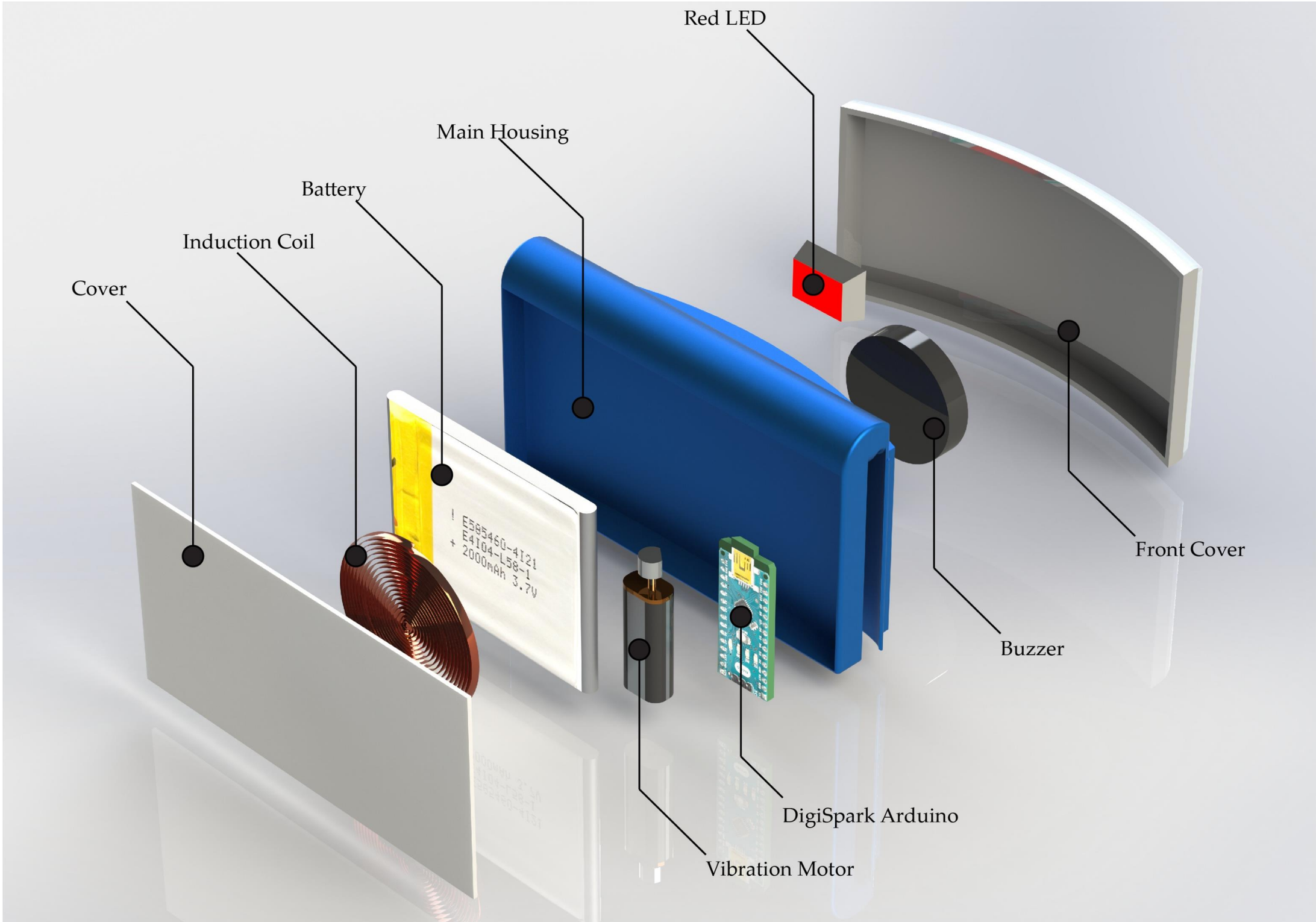
Saiglobal.com. (2017). SAI Global, the compliance and risk experts. - SAI Global. Retrieved October 18, 2017, from https://www.saiglobal.com/

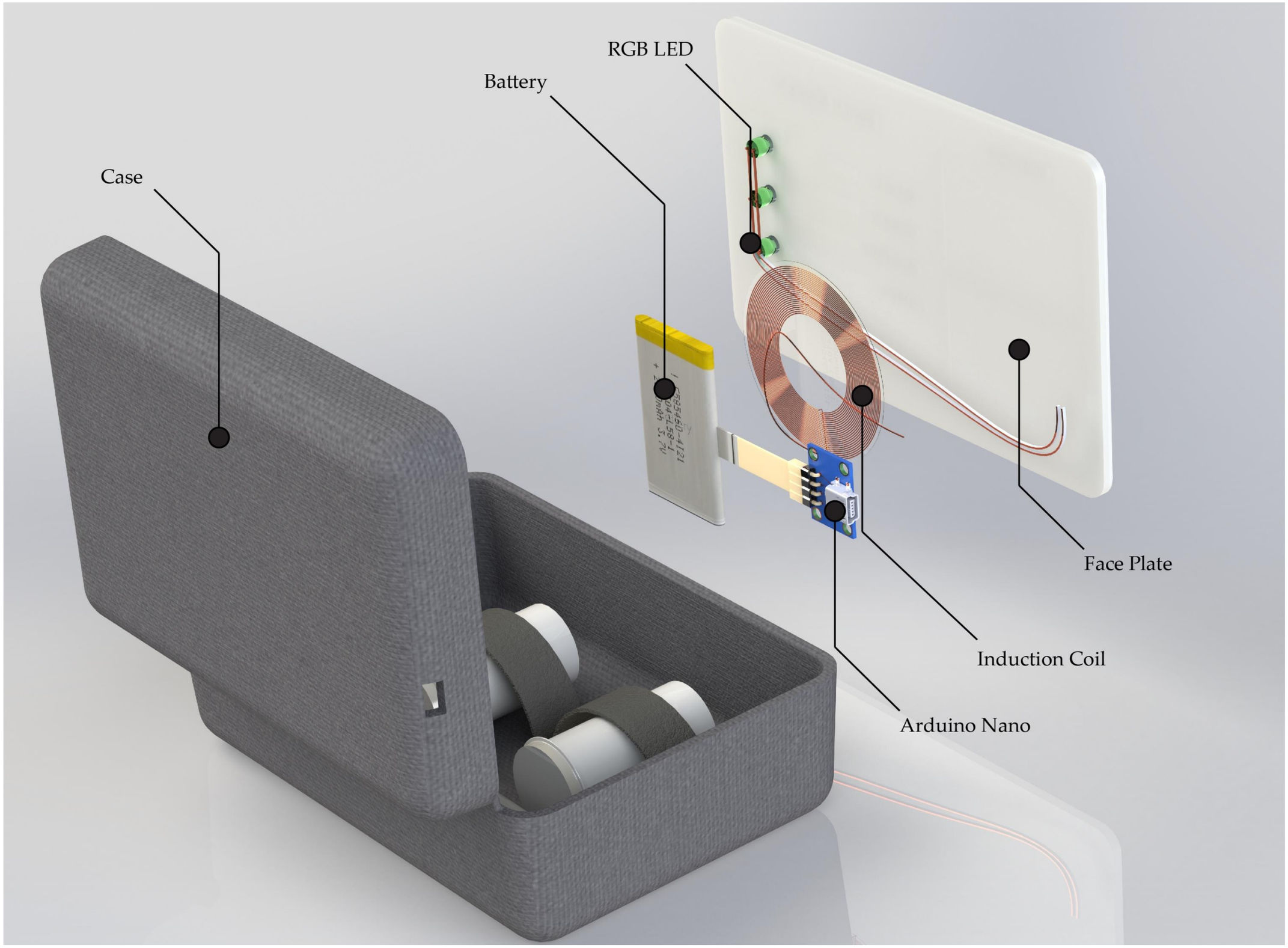
Yusif, S., Soar, J., & Hafeez-Baig, A. (2016). Older people, assistive technologies, and the barriers to adoption: A systematic review. *International Journal of Medical Informatics*, *94*, 112–116. https://doi.org/10.1016/j.ijmedinf.2016.07.004

7 APPENDIX

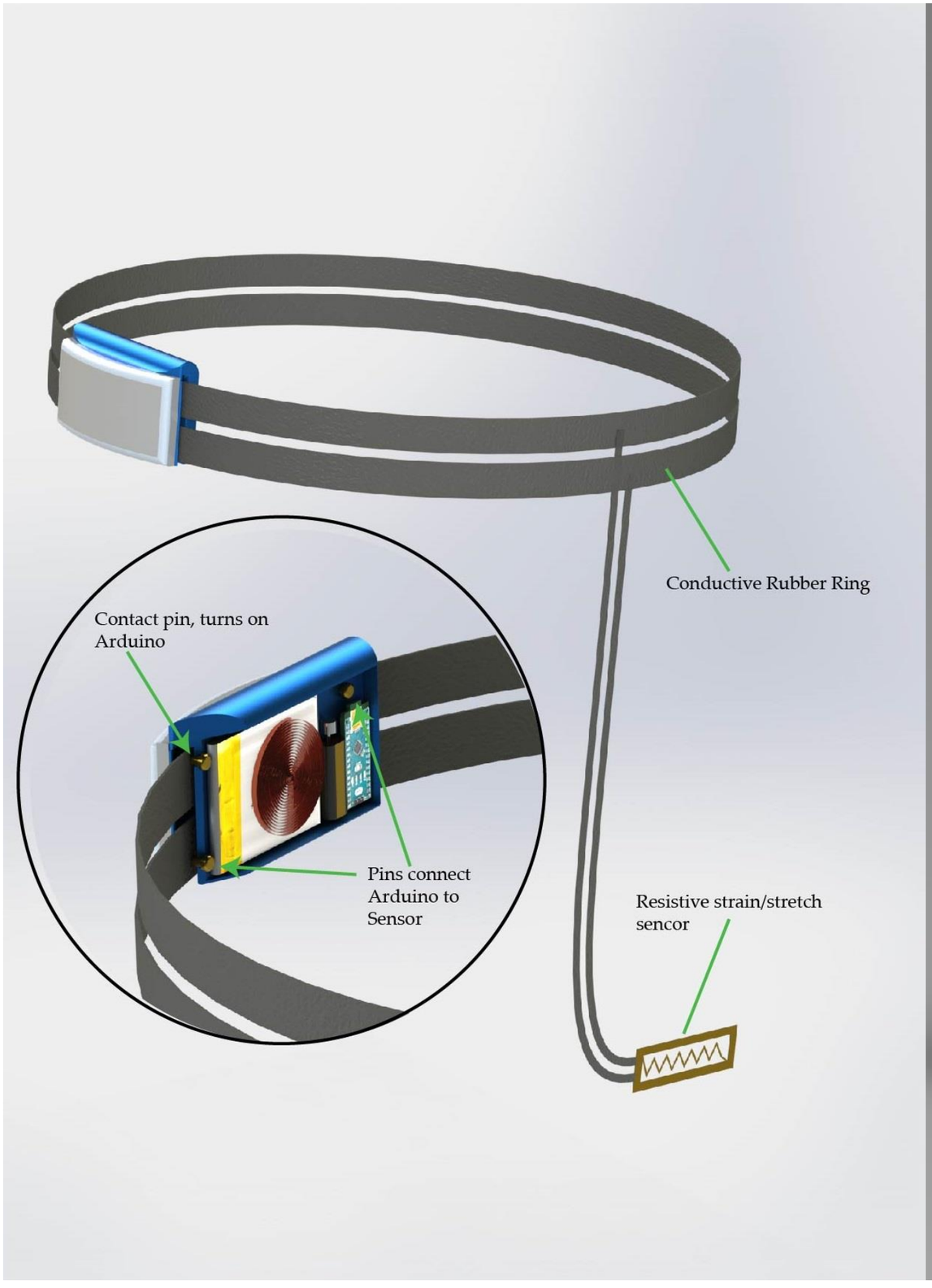
Final Renders


Charge
Foot Check
Good
Check
Caution
Alert


Red LED
Main Housing
Battery
Induction Coil
Cover
Front Cover
Buzzer
DigiSpark Arduino
Vibration Motor

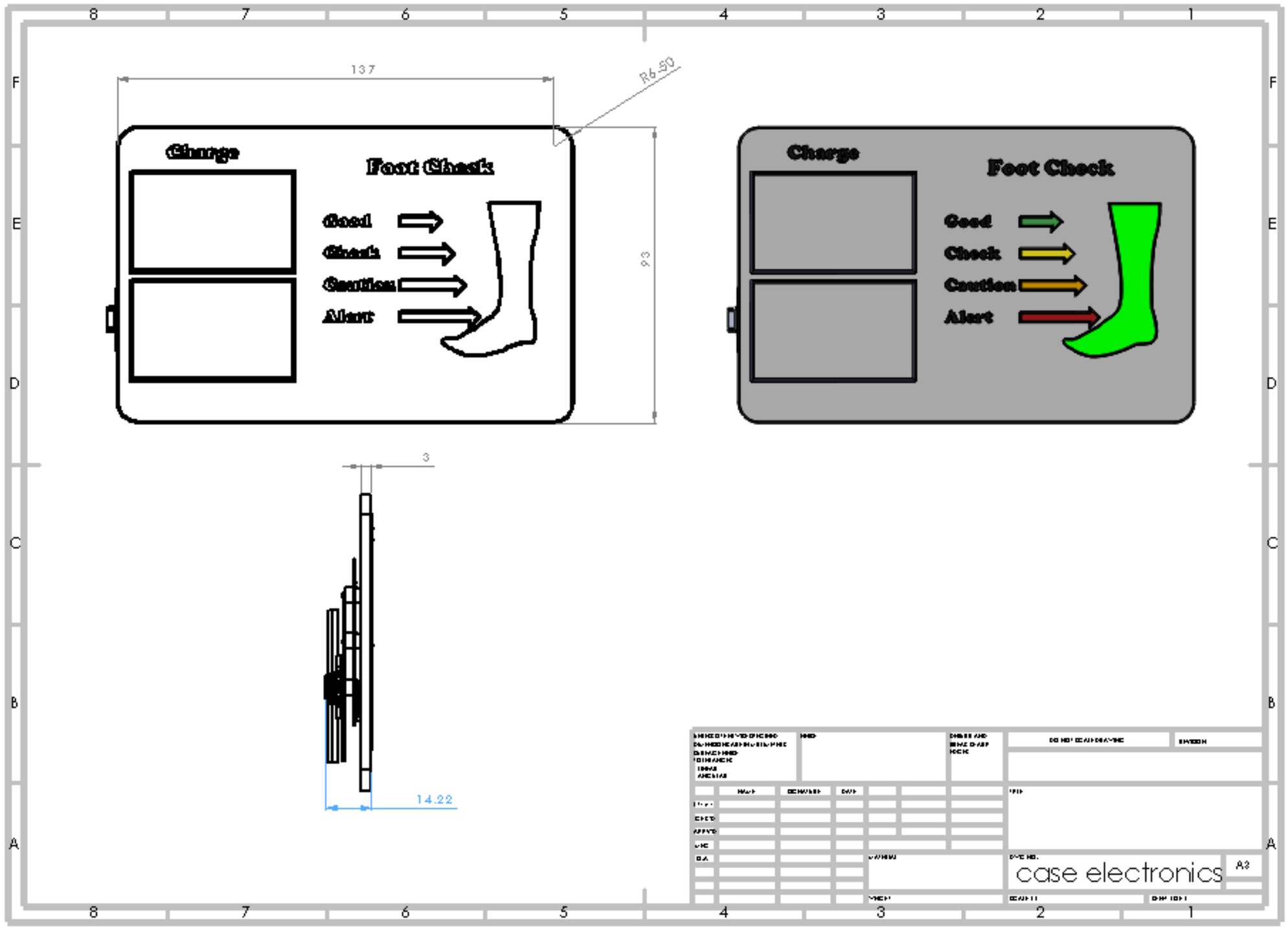


ForrerHome Designs

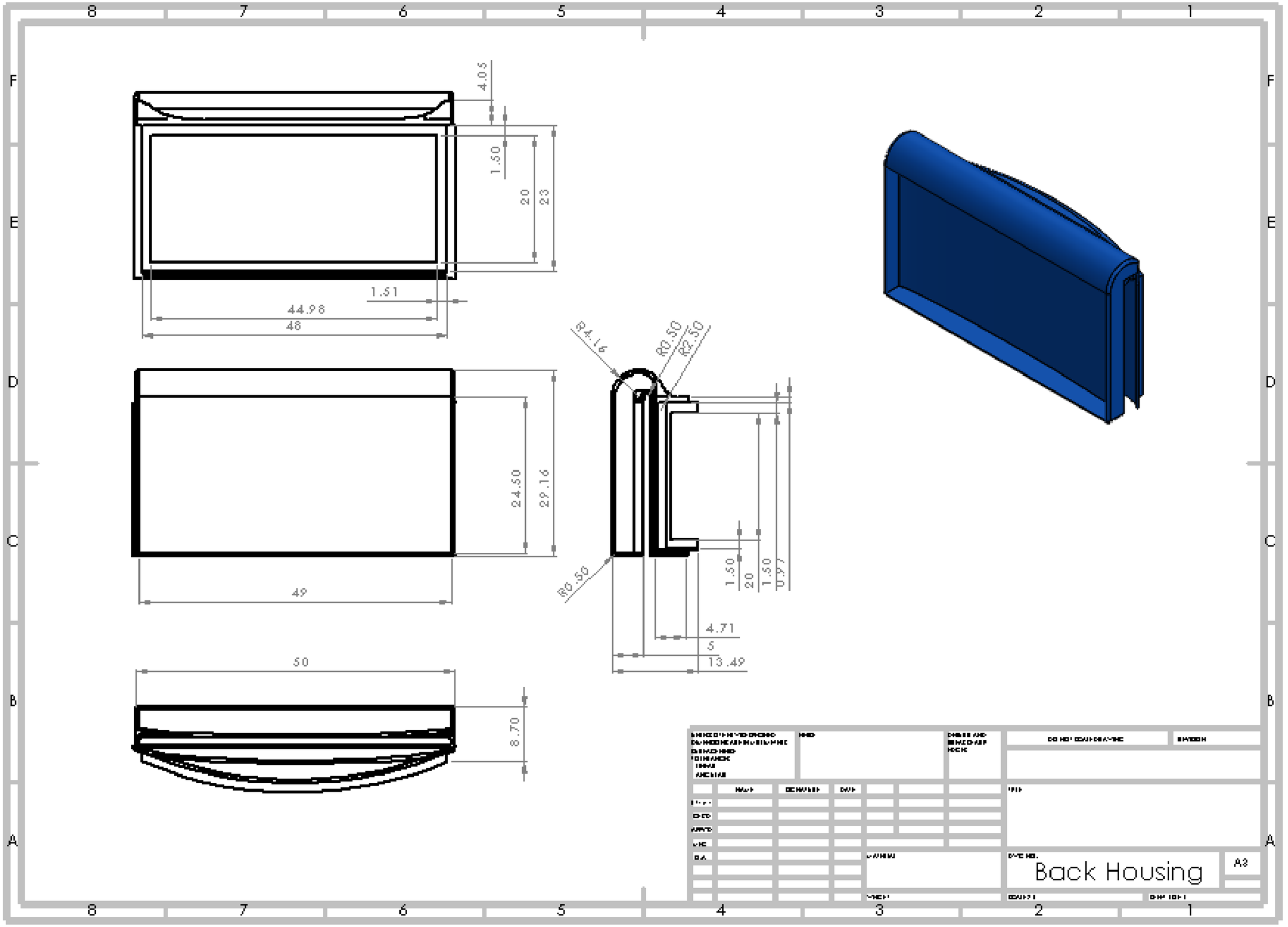


ForrerHome Designs

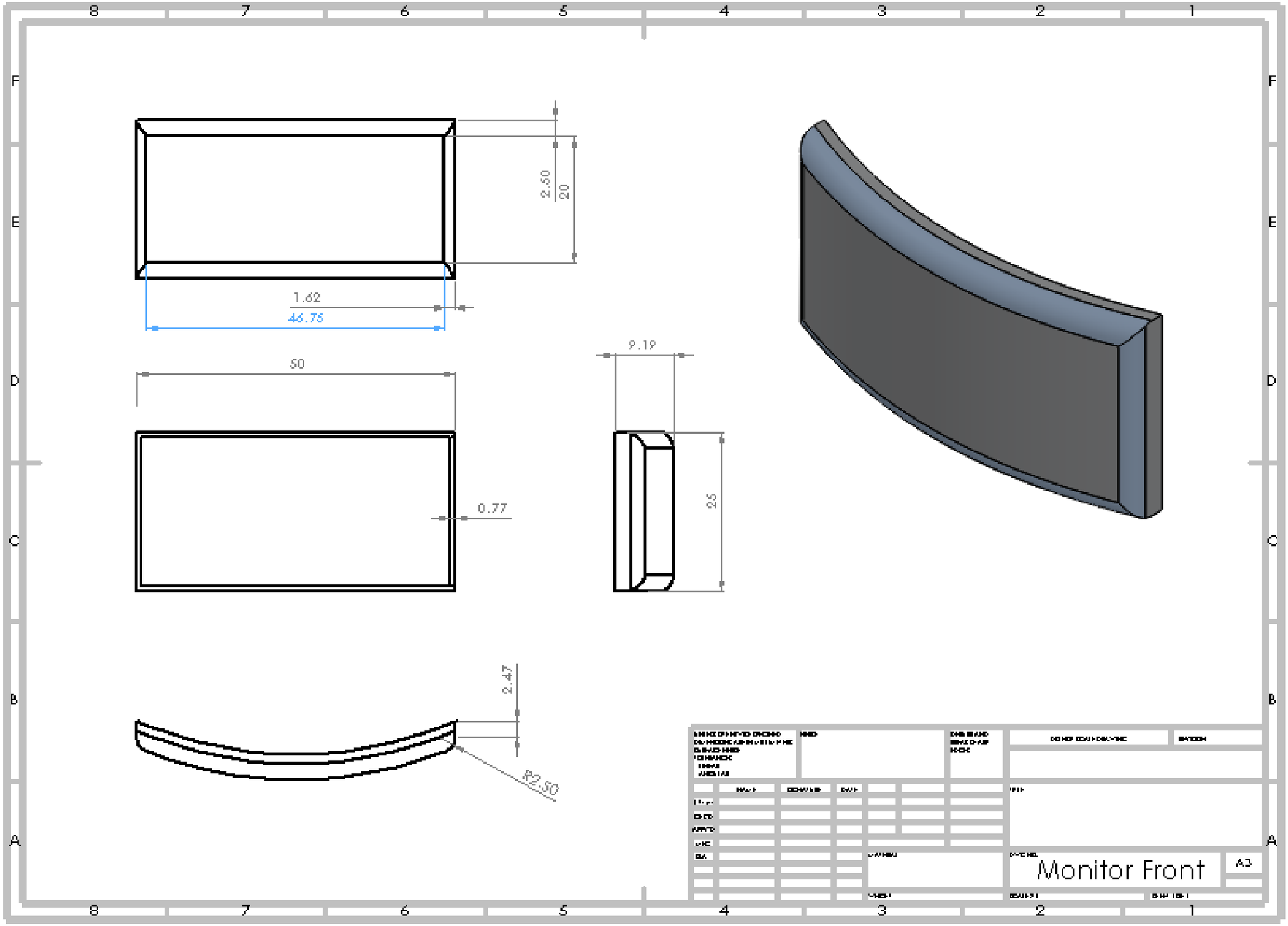
5.8 Technical Drawings

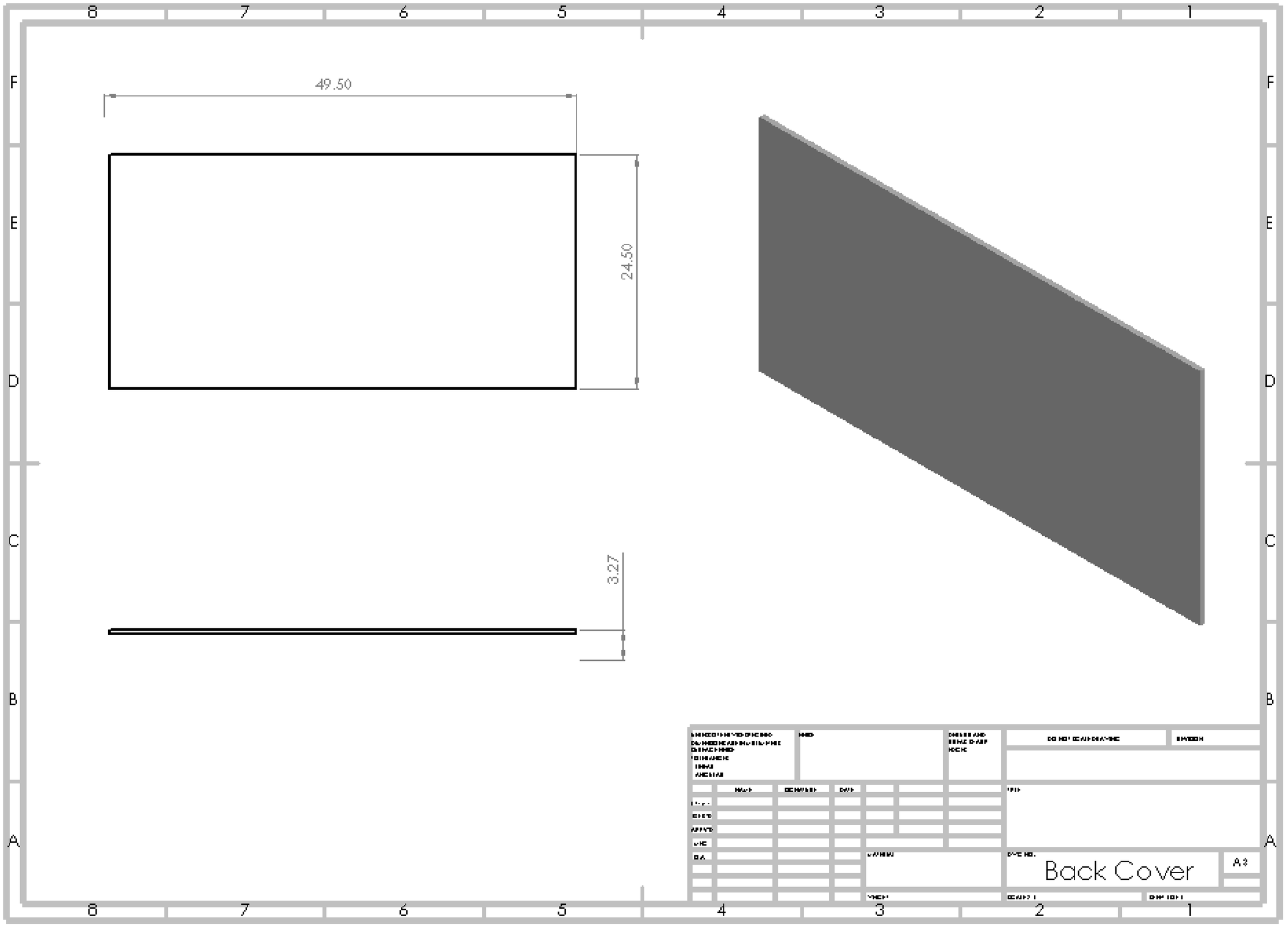


ForrerHome Designs



ForrerHome Designs





ForrerHome Designs