DESIGN PROPOSAL AND FEASIBILITY STUDY

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Background

Augmented reality is a recently new technology which allows the superposition of computer rendered images and 3D objects in the real world all controlled by the user. They interface most of the time with the augmented reality (or AR) world using a type of HUD headset (heads-up display) which allows the users to map virtual objects to real physical spaces [1]. The objective of AR is to display computer generated objects into the real world which only the user can see.

The name of this technology was derived through the word *augmented*, which means to add something. Augmented reality transforms our natural environment by adding graphics, touch, and sounds feedback. It modifies user's natural environment by overlapping virtual information on top of it, while a VR (virtual reality) demands user to occupy a complete virtual environment. Although both realities can coexist, users prefer a new and better world in the shape of AR [6]. Most AR devices in the market are autonomous, meaning they do not need cable or desktop computer to work. The principle behind the AR headset is that it uses head tracking technology as well as real world object detection to produce a mix of reality and virtual reality: this is known as augmented reality [1].

The most advanced augmented reality devices on the market as of now are the Google Glass as well as the Microsoft HoloLens, which both already have commercial applications. For example, the HoloLens is used in medical simulations for training doctors and nurses alike, but can obviously be adapted to almost any application due to the project being open source. Finally, there are several categories of augmented reality such as marker based AR, marker less AR, projection based AR, superimposition based AR [6]. They all differ from each other based on their objectives and user's application.

Problem Statement

AR technology has evolved over the past few years, but it still faces some hiccups before it can completely dominate the market. There are many challenges and constraints when it comes to the use of augmented reality. The biggest issue concerning augmented reality technology is its cost, for example, the Microsoft Hololens costs around $3999 [2]. Due to its high cost, certain people may hesitate from purchasing the device. There are other issues, such as the challenges concerning the successful interaction between virtual and physical materials which can hinder the device's overall performance [3].

Furthermore, AR headset devices have very narrow fields of view which restricts user interactions. For instance, the HoloLens has a 34 degree of diagonal field of view that is by far not immersive and does not engage user's natural perceptions [5]. In order words, the HoloLens, which is one the best AR headset in the market as of now, is not well suited for human-computer interaction that's ideal for users. There is also the problem regarding the hardware in the device since they must be light and compact enough to prevent ergonomic related problems while also maintaining its efficiency [3].

Another major concern AR industries are facing is privacy. There are hopes that AR devices will can get information of a person by simply pointing the device at that person, but many don't wish to share their personal information without them knowing it. Although most of us do not hold back to upload anything about ourselves online, many believe that they do not want stranger to easily access their personal information. These are some of the problems that the augmented reality industry is currently facing.

Literature Review

One of the most anticipated technology of this generation is the Augmented Reality headset/goggles (AR technology). This can be defined to connect the digital world with the physical world depending on the user's needs and settings. More specifically, by adding digital information into reality through codes and algorithms which enables the user to do so [4]. One of the main characteristics of this technology is that it does not enable the creation of a spatial location but simultaneously adds digital information into the physical world via headset or goggles [4]. This digital information may include static data such as 3D models of objects or even dynamic ones depending on the user's inputs into the device [4]. This technology enhances a person's view of reality with the help of images, texts or other type of medium that are integrated into the real world through the device. This gives the impression that they are part of the physical world. Another aspect is that the user can willingly alter the physical world, making AR technology interactive by changing the information present to his suiting [4]. For example, this can be done by importing something from the digital plane into the physical world allowing the user to interact with his surrounding. Everyone wearing an augmented reality device has their own perspective of the physical world that is being altered and the material being projected depends on the user's current position [4]. For instance, when something is being changed in a specific area of the real world, this change will remain in that location even if the user looks and moves to a different direction with the headset. In short, these are the traits which makes Augmented Reality different from similar technologies.

Currently, there are many companies who have created their own augmented reality technology but the two largest companies which have created tools that utilizes this technology are Google with their application Tango and Microsoft with their Hololens [7]. For instance, Google has created and incorporated augmented reality into two mobile phones [8]. Some of the features included are the ability to interact with virtual objects into reality and with information appearing through the mobile phone that appear as to be part of the environment which can all be done by simply pointing the mobile device's camera at a certain location [8]. Then there is the more advanced AR headset technology: Microsoft Hololens. This device combines both the digital and physical world together through their headset which enables an interactive environment to be created where holograms can be generated [2]. Microsoft Hololens would be the device that would revolutionize Augmented Reality.

Design Criteria and Scope of the Problem

Earlier in the report, a few high-level problems with the current augmented reality industry were stated. In fact, the most important issue associated with current augmented reality headsets is the extremely high purchase cost which essentially prevents most people to have access to this technology. The main objective of our capstone project is to completely redesign and improve an existing student-made augmented reality headset while respecting a set of constraints set by our team and our capstone professor. These constraints will be defined in greater detail later in the report. In addition, we want to ensure that the entire headset uses only open-source technology and easily purchasable parts so that it can be re-created by anyone in the world following a set of instructions. However, there are several problems/challenges with the existing headset setup which we set to improve during our capstone. These problems are:

- Lack of ergonomics/Uncomfortable: the current headset device is entirely 3d printed with a lack of padding around the device. The device is printed in a general cube shape which does not sit comfortably against the user's forehead. The straps used to attach the headset around the user’s head are not very elastic which causes the device to be forced into the user’s head.

- Not upgradable: the current device operates using a HUD material, a screen to project the image, a raspberry pi 3 and an accelerometer. However, with the existing setup, there is no way to interchange/upgrade the hardware to other configurations such as using your phone as the projector or using a more powerful computer chip (Odroid XU-4) which can incorporate a depth sensor.
- Poor thermal management: since the current headset operates on raspberry pi 3 which has limited computing power. The device quickly overheats while the AR software is running and, ultimately, throttles to prevent heat damage to the computer chip which causes the software to crash.
- Inefficient cable management: the AR headset requires several cables to be connected between the raspberry pi, the accelerometer and the screen. It also requires cables for a mouse and keyboard which is poorly managed and there are several cables sticking out of the device.
- No portable power source: the device requires a power cable to be connected to an outlet to power the raspberry pi and the screen.
- Poor heads-up display material: the headset currently is using a thin transparent plastic wall as the heads-up display where the screen projects. However, the HUD bends easily and isn’t sturdy enough for everyday use.

In terms of design criteria, there are several essential features we must make sure to incorporate into our augmented reality headset to ensure that our device can deliver a similar experience when compared to industry leading devices such as the Microsoft HoloLens. As such, the essential features we've determined necessary in our headset are:

- Appropriate weight distribution: since the headset will be intended to be worn for long periods of time, the headset should have appropriate weight distribution close to 50-50 front/back so that there is no discomfort caused by most the weight being on one side. Furthermore, the weight of the device should be supported by the user's head instead of the weight being on the user's nose and ears.
- Adjustability: the headset should be able to fit a variety of head sizes by having a mechanism that allows the internal diameter of the headset to be adjusted.
- Appropriate thermal management: the augmented reality headset should not overheat causing unnecessary discomfort on the user.
- Reliability: the headset should be sturdy enough to not break under normal everyday use.
- Self-contained: the headset should not be tethered by any wires or external devices. It should be able to run without being plugged into a power source (battery).

Finally, the constraints set by our team and our capstone professor are the following:

- Affordability/Accessibility: the headset should primarily be made of easy to access and inexpensive material to keep the fabrication cost as low as possible.
- Open source and Upgradeable: the AR headset should be extensible by adding more sensors and different computer boards. It must contain standard hardware that anyone can purchase/access and it must use only open source software as it's platform.

Evaluation of Potential Solution Methods

Realistically, many different solutions could be used to give our headset the necessary functionality as well as meeting the constraints we have been given. However, given the budget and the limitations of the constraints between each other, only a few solutions will be viable for our specific application. As for the ergonomics and comfort level of the headset, a few options present themselves:

- Creating the headset frame to resemble a helmet design, meaning that the weight of the headset will be evenly distributed over the user's entire head and this should limit the headset sagging forward or the risk of it falling off the user. However, this does introduce a size constraint, as it will be harder to make a solid helmet design fit many different head sizes
- Having the headset be more like a pair of goggles, where the screen and mirror assembly will be situated all on the front of the user's head, secured to the back of the head through straps that run from front to back and attach themselves to a hub. This gives more variability towards the size of head and adjustability of the headset, but compromises in the sense that this design will probably be less secure on the user's head.
- Designing the headset in such a way where it will be almost like a pair of glasses (like the Microsoft HoloLens for example) where the entire design is solid (no straps) and the majority of the components are once again found on the front of the user's head.

As for the issue with the headset being able to support multiple hardware configurations, two options present themselves to us:

- Leaving enough room so both of our hardware configurations (this includes the default setup and the cell phone setup) can be stored in the headset at once. This means that you will not need to physically modify the headset to change configurations, but also means that more space will be needed and the weight will be increased
- Having easily interchangeable hardware, where you can swap out components on the fly. This option will be lighter and probably a bit smaller, but will require more access to our components.

Regarding the overheating issue of the AR headset, a couple solutions are possible for our situation:

- Leaving a lot of space between components as well as a lot of ventilation between the outside and inside of the headset, for a more ``natural convection`` based solution
- Having the components spaced normally, but focusing on a more ``forced convection`` type of solution. This means including fans to direct the air at a certain speed, managing the airflow (inflow and outflow) as well as the direction and the inclusion of a heat sink.

As for the wiring problems, two alternatives present themselves. Either:

- Having all the components localized in a certain area, most probably all situation at the front of the headset. This way all the wired will be contained inside the device
- Or having some components situated in the back of the headset, requiring a little bit of wire management by running the wired on the outside of the straps (which link the front and the back of the headset) and protecting and hiding them by placing a cover over the straps on the outside, and padding on the inside.

Another problem we are facing is regarding the power supply. To remedy this problem, any of the following could be done:

- Having the headset require being plugged in to the wall at all times. This would give us infinite usage time, but would greatly limit the mobility and range of our device.
- Having an external portable power supply, which the user could carry in his pocket. This would be a good compromise between duration and mobility.
- Having an internal, self contained power supply. This solution is the best mobility and range wise, but will add weight to the headset and given the space constraints, will probably be a smaller battery (thus leaving the device with less operating time).

Identification of the Preferred Solution & Alternate Solution

The preferred solution as for comfort and ergonomics would be to use the design which has straps. This allows for a good compromise between adjustability, flexibility, weight and structural soundness, and will also not be as hard to manufacture as the helmet style headset. However, the helmet would be our alternative solution, as it will be the most secure on the user's head and would evenly distribute the weight, leaving less risk of the headset sagging downward or falling of the user's head.

The ideal choice as for the multiple configuration problem would be to use the interchangeable component design. This would mean that you do not need to transport around the hardware for both setups in the headset at all times (as only 1 configuration can be used at a time anyway), reducing the weight of our device. Alternatively, the dual-purpose configuration could be a good backup plan, and has its own advantages such as not having to open up the headset and move around hardware to change configurations.

As for the overheating / heat transfer solution of the AR headset, the preferred choice would be to use a forced convection type of approach, where we will be able to do heat transfer calculations given specific data (component heat output, contact surface area of components to air, air speed, etc.) to determine if our solution will be sufficient. The alternative solution of a natural convection solution is not viable in our opinion, as we would not be able to control airflow and would also add other restrictions to our design. For this category, we believe the only realistic solution will be to use forced convection as in modern day computers.

When discussing the wire management of our headset, the best solution would be to have all the wires self contained in the front of the device. This will be easier for wire management, will limit the risk of damaging the connections and cables during use, and will give a nice clean look to the headset. Alternatively, having wires run from the front to the back through the straps would also be a possible solution, but involves a little more risk and wire management, which is why this will be the backup plan.

Finally, for the power source, the ideal would be to have a self-contained power source. This would mean no wires would be running out of the headset, and it would truly be a standalone device. However, the portable power supply is a very smart and interesting alternate solution, and will most probably be the solution used as first during the early prototypes and iterations of our augmented reality headset. Ideally though, the final device would have a self-contained power supply unit capable of delivering a decent amount of operating life to our device.

Statement of Work

As of today, Dr. Charles Kiyanda confirmed the hardware configuration which will be used in our device. The hardware components were chosen according to their physical dimension and their effectiveness to our device. It includes an Ordroid XU4, an Intel RealSense depth camera, and an Adafruit BNO055 orientation sensor. These parts will be bought in upcoming weeks so that the graduate student working with our team can start configuring the necessary codes. Based on the hardware components selected and its function, we designed our AR headset accordingly. The drawing of several parts of the device can be seen later in this report. For the HUD, we must change the current material used (thin transparent plastic) since it is not the best suited for our device. The material selected must be opaque than the one already fixed. This is necessary as the HUD is one of the most important parts of the device for the user.

In addition to the drawings, we also started 3D printing the parts of our AR headset. This will be done in couple of days as 3D printing takes time and special set-ups are required for each of the parts due to their design complexity. Once 3D printing is completed, we will assemble all the components to make the first iteration of our device. The printed parts will be attached to make our AR headset accessible to easily modify if needed. Several straps will be added to the device to distribute weight equally on the user's head.

The first iteration will not include the hardware components and one can guarantee that this design will not be our final version due to many tests that it will undergo. Once the coding is completed, we will combine the hardware components to the device and once more perform several tests to validate the design criteria set by Dr. Kiyanda. This will obviously lead to design modifications and hence improve our AR headset. We expect many iterations of our AR headset until we come up with the final version.

Expected results/contributions

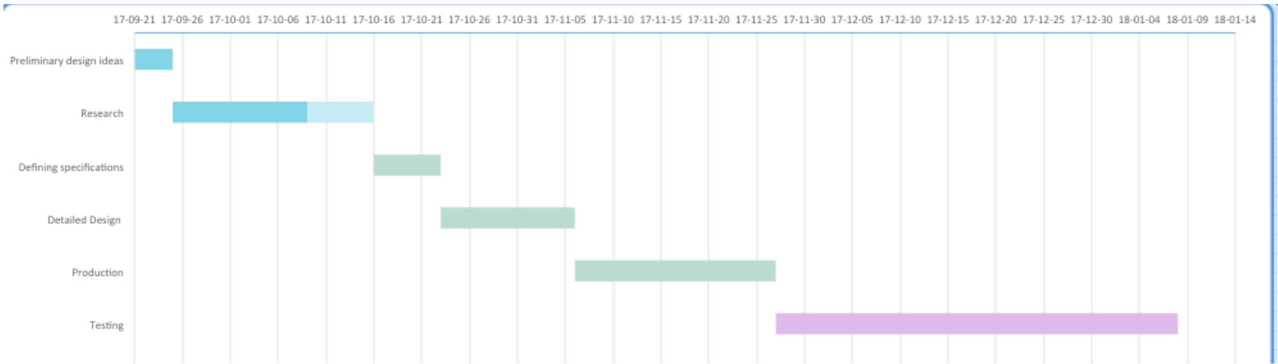
The final product will be a direct result of the team's contributions. All team members should evaluate the product throughout each iteration of the design. More constraints will be added throughout the design/manufacturing process and it is important to make the device as user-friendly as possible. Having a team of 7 members helps get many potential user reviews of the product and will help understand the points that need to be focused on for improvement. The goal for the final product is a design with the least possible flaws.

The final product should be a simple design that can easily be 3D printed, ergonomic, have great thermal management and be wireless with an internal battery for added mobility. The 3D printed design should be limited to parts no bigger than the standard printing size which is 7’x7’x7’ and will have to have an efficient way of fastening the parts together. The fasteners should not be too heavy to keep the headset from having an uneven weight distribution. The weight distribution is an aspect that will be a focus in the design because if the headset needs to be worn for multiple hours, it needs to be comfortable and not put any pressure on the neck or head area. Adding straps over the top of the head and on the sides will help the user be comfortable by adjusting it to his or her needs. The thermal management also needs to be well thought out for users to be happy with the experience and not worry about feeling hot and uncomfortable. The ideal solution for thermal management would regulate the temperature of the unit to around 35 to 45 degrees Fahrenheit. The last focus of the design would be to make sure the headset is completely wireless. No cables should be sticking out of the headset, there should be an internal battery pack for all the components to be contained within the headset. The battery should be able to ideally last at least five to seven hours. This will present the greatest challenge because it will add another thermal management aspect plus adding more weight and making sure the distribution is ideal for use. Putting all of this together, the final design of the headset should essentially be able to present augmented reality all by having the comfort of the user as the main feature of the product.

Preliminary Drawings

See the end of the report for all relevant CAD drawings.

Project Schedule/Gantt chart



Preliminary Test and Safety Procedure

Any product that enters the market has undergone some sort of preliminary test and safety procedure to prove the products design suitability and its practical application. For our Augmented Reality headset (AR), the team will perform several test and safety procedures. This will allow us to identify the limitations of the Augmented Reality headset and allow the team to better enhance the safety of AR headset. There are several tests which will be performed on the AR headset such as the vibration, thermal, spill and drop test. For each of these tests, the Testing, Safety, Procedures and Controls Document (TSPCD) will be filled and signed appropriately.

The following are the tests which will be performed on the AR headset as well as the expected ideal outcome:

Drop Test

The drop test will consist of dropping the AR headset with all its hardware (Raspberry Pi, r200, xu4, battery, etc.) from several different heights and observe what happens to the AR headset.

The ideal outcome of this test would be that the AR headset does not fail after being dropped repeatedly. If the AR headset does fail, this will indicate that changes in the design is still required.

Vibration Test

The vibration test will be used to ensure that all the hardware remains in place after being shaken repeatedly. To perform this test, the AR headset will be placed on a vibration table for a certain period and observe what occurs to the hardware. The outcome from this test would be that the hardware remains intact after being vibrated repeatedly. If the hardware does not remain intact, additional mounting holes for the hardware will be required.

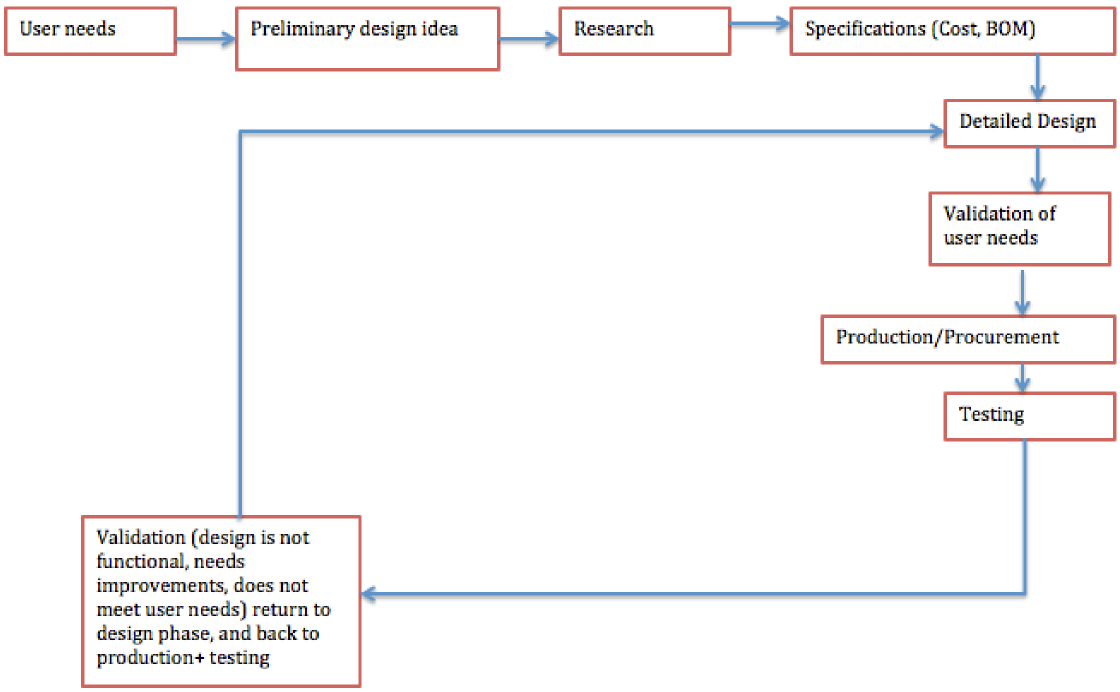
Thermal Test

The thermal test consists of utilizing the AR headset continually for several hours and noticing whether the headset overheats (from the hardware) and fails. If the AR headset overheats this will indicate that there aren't enough heat sinks within the headset and additional are required. Moreover, this will also indicate that the design is missing openings for proper ventilation of heat within the AR headset.

Spill Test

The spill test consists of placing the AR headset (without the hardware) in a water bath (depth of 2 cm) as well as splashing drops of water on the AR headset to mimic the effects of spilling liquid in a real setting. The ideal outcome of this test would be that no water infiltrates into the AR headset. If there is water damage on the AR headset, design changes would be required.

Validation System Diagram



Budget

Itemized Components	Purchased/Manufactured	Labour Hours	Cost ($)
Display			
5 in HDMI screen	Purchased		25
Display Visor lens	Purchased		10
Headset			
Headset Frame and cover	Manufactured	5	75
Headband cushion and padding	Purchased		8
Adjustable Headband	Manufactured	3	45
Reflector cover	Manufactured	2	30
Sensors			
Adafruit BNO055 Orientation sensor	Purchased		43
Processors			

Raspberry pi 3	Purchased		46
Odroid - XU4 (Heat sink + Fan incl.)	Purchased		107
Hardware			
Intel RealSense depth camera	Purchased		100
Thermal Management			
Cooling Kit for rsbp 3 (heatsink +fan)	Purchased		10
Power and Connectivity			
10000 mAh USB powerbank battery	Purchased		20
Other			
Wiring	Purchased		20
Velcro	Purchased		4
Fasteners	Purchased		7
Mirror	Purchased		6
		Total Cost ($)	556

References

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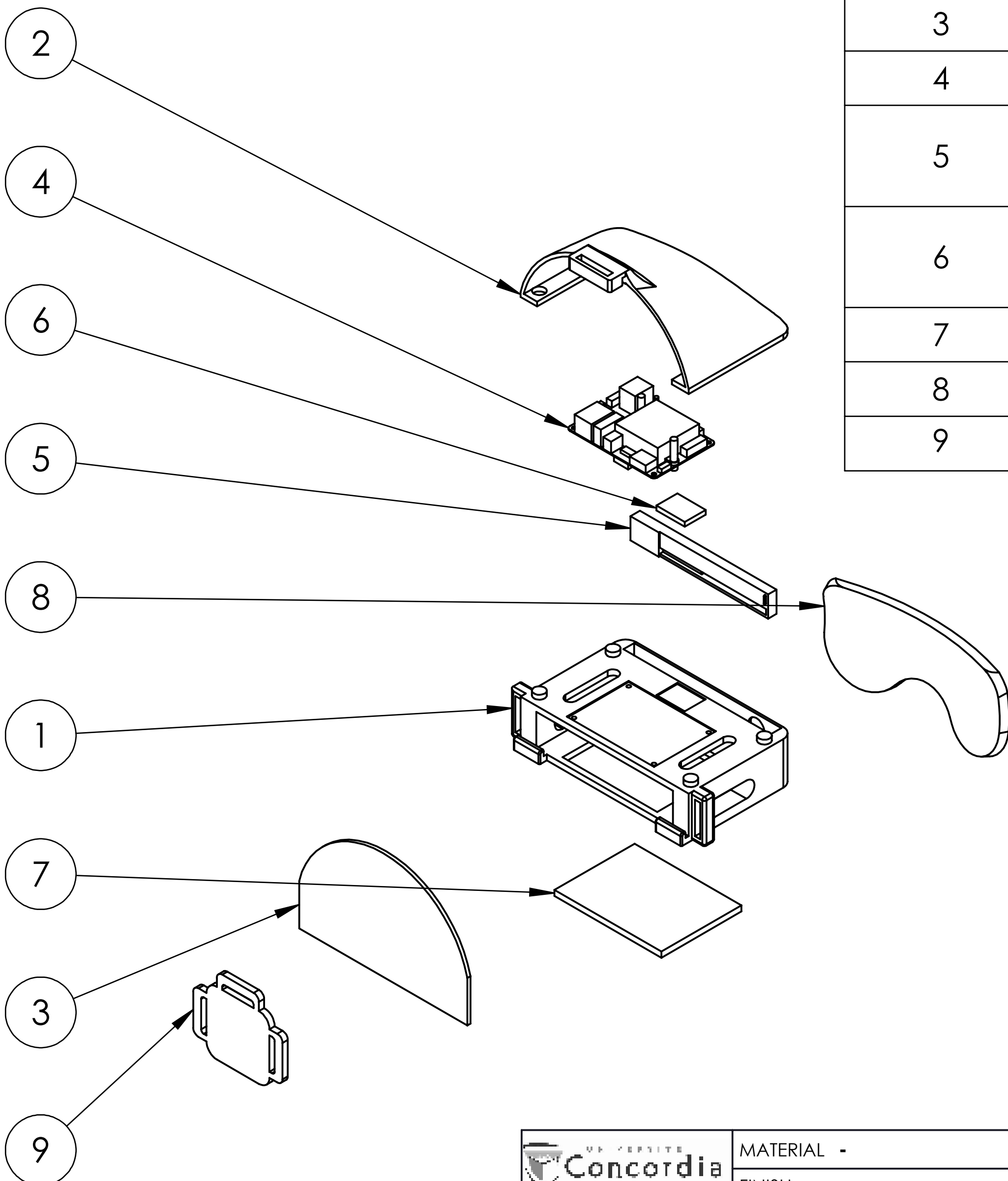
ITEM NO.	DRAWING NUMBER	DESCRIPTION	MANUFACTURED / PURCHASED
1	HS-01	Headset	MANUFACTURED
2	TC-01	Top Cover	MANUFACTURED
3	BC-01	Back Cover	MANUFACTURED
4	XU4-01	Odroid XU4	PURCHASED
5	IR-01	Intel real sense camera R200	PURCHASED
6	MS-01	Adafruit BNO055 motion sensor	PURCHASED
7	SC-01	Screen	PURCHASED
8	SV-01	Screen viewer	PURCHASED
9	BP-01	Back piece	MANUFACTURED



MATERIAL -		SURFACE ROUGHNESS	TITLE **Headset Assembly+ BOM**
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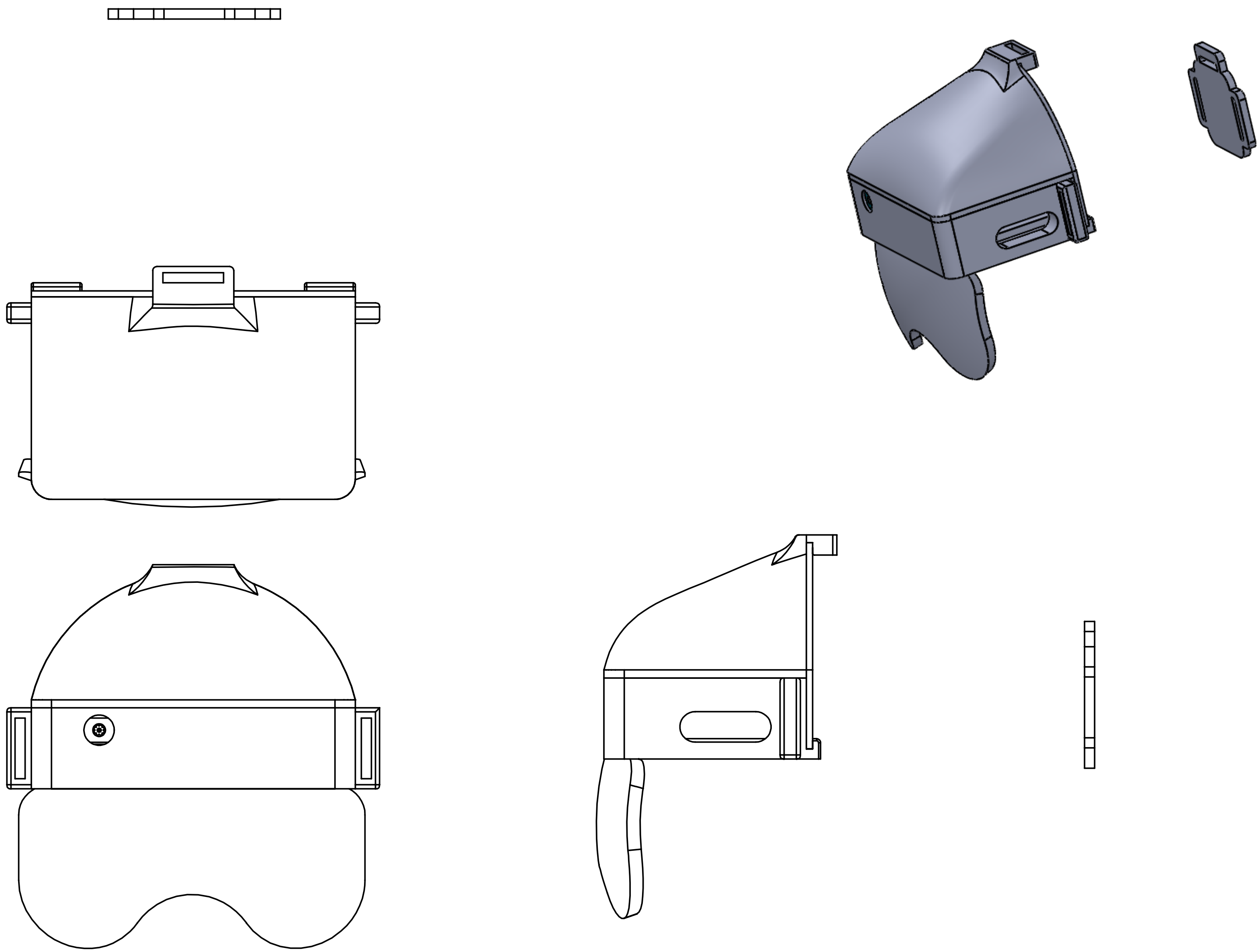
DESIGNER **TEAM**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED		
DRAFTER **TEAM**	APPROVED **TEAM**	SCALE **1:5**	SHEET **1 / 1** DWG NO. **BOM-01** REV NO. **01**

Concordia



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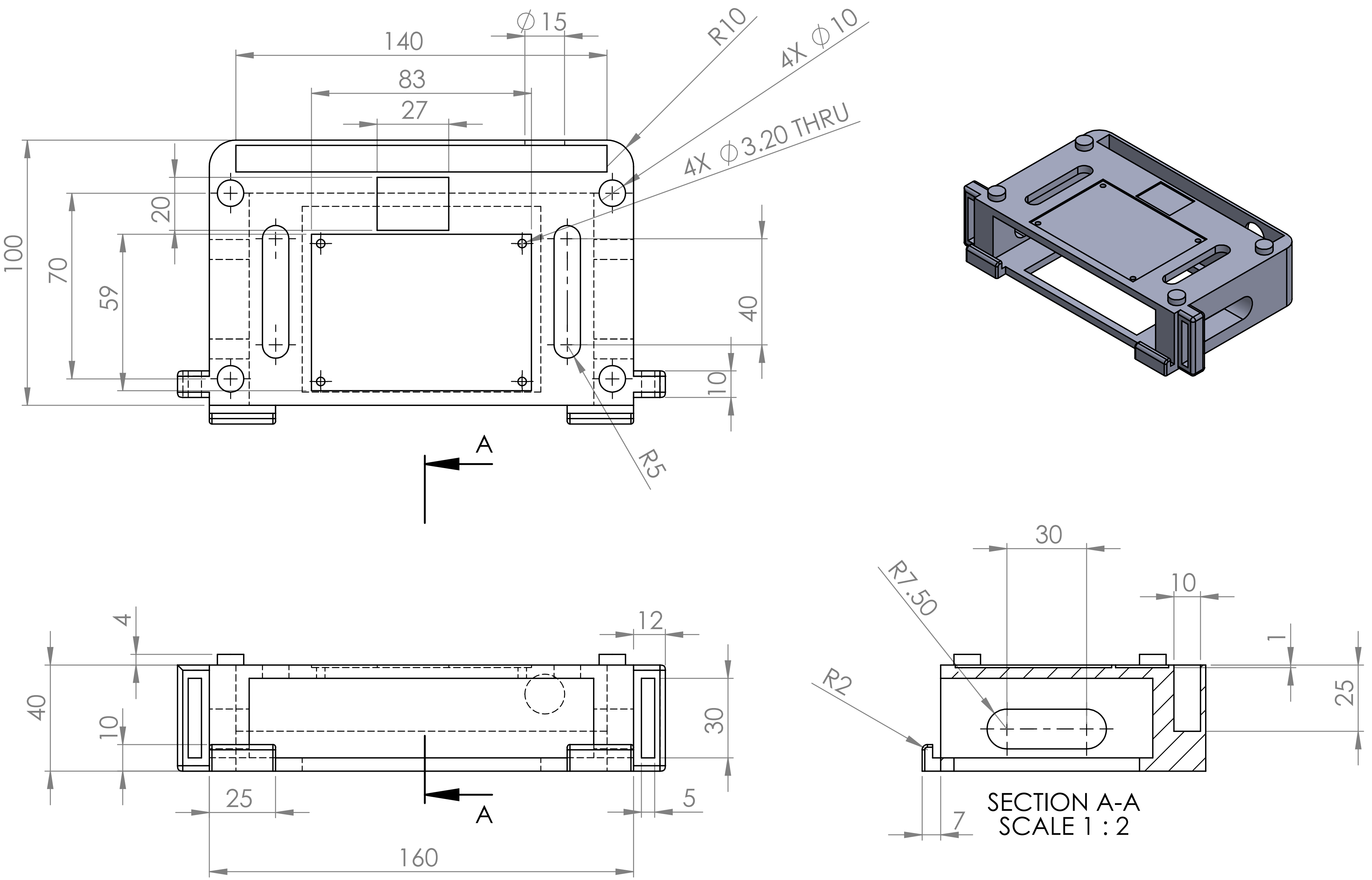
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED	A SIZE · DATE **10/8/2017** · USED ON **MECH 490**
	DRAFTER **M. A. YADAO**	APPROVED **R. PATEL** · SCALE **1:3**	SHEET **1 / 1** · DWG NO. **HS-A-01** · REV NO. **01**



SOLIDWORKS Educational Product. For Instructional Use Only.

Concordia	MATERIAL **POLYLACTIC ACID (PLA - 3D PRINT)**		SURFACE ROUGHNESS √	TITLE **Headset**	
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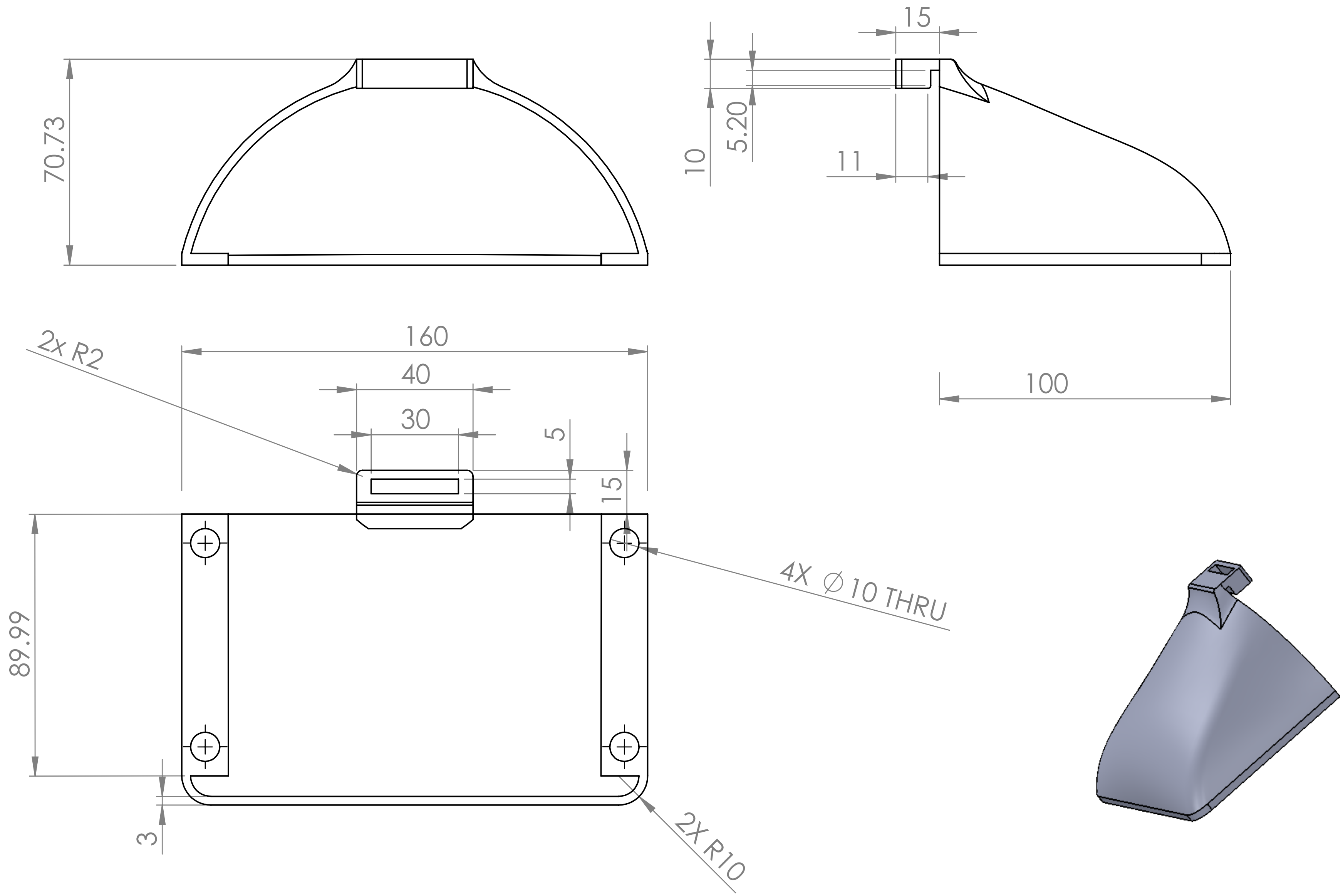
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED	A SIZE	DATE **10/8/2017**	USED ON **MECH 490**
	DRAFTER **M. A. YADAO**	APPROVED **R. PATEL**	SCALE **1:2**	SHEET **1 / 1** DWG NO. **HS-01**	REV NO. **01**



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UNIVERSITE Concordia UNIVERSITY	MATERIAL POLYLACTIC ACID (PLA - 3D PRINT)		UNLESS OTHERWISE SPECIFIED: SURFACE ROUGHNESS √; TOLERANCES X ± .1, .X ± .05, .XX ± .005, .XXX ± .002, ANGLE ± .5°	TITLE **Top Cover**
	FINISH -			
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED	A SIZE	DATE **10/8/2017** USED ON **MECH 490**
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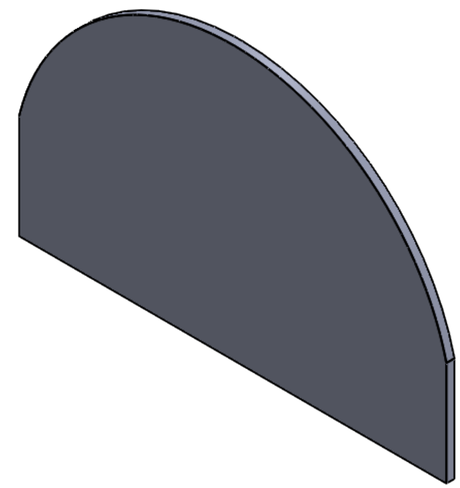

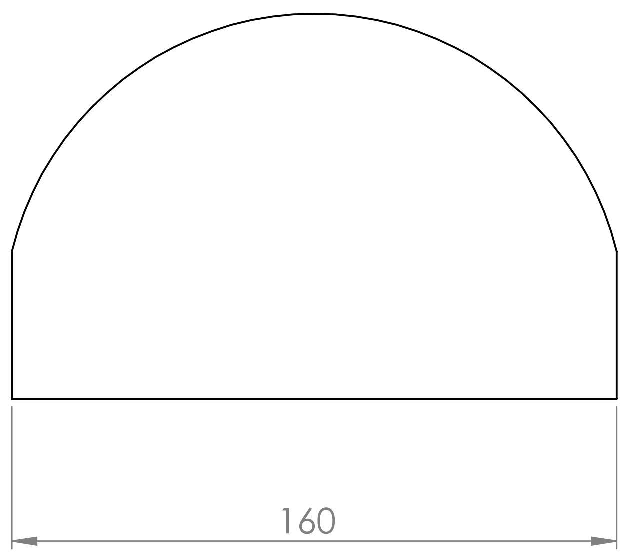

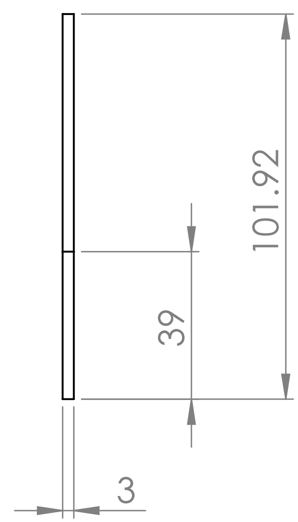

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Concordia	MATERIAL POLYLACTIC ACID (PLA - 3D PRINT)		UNLESS OTHERWISE SPECIFIED SURFACE ROUGHNESS √ -	TITLE **Back Cover**			
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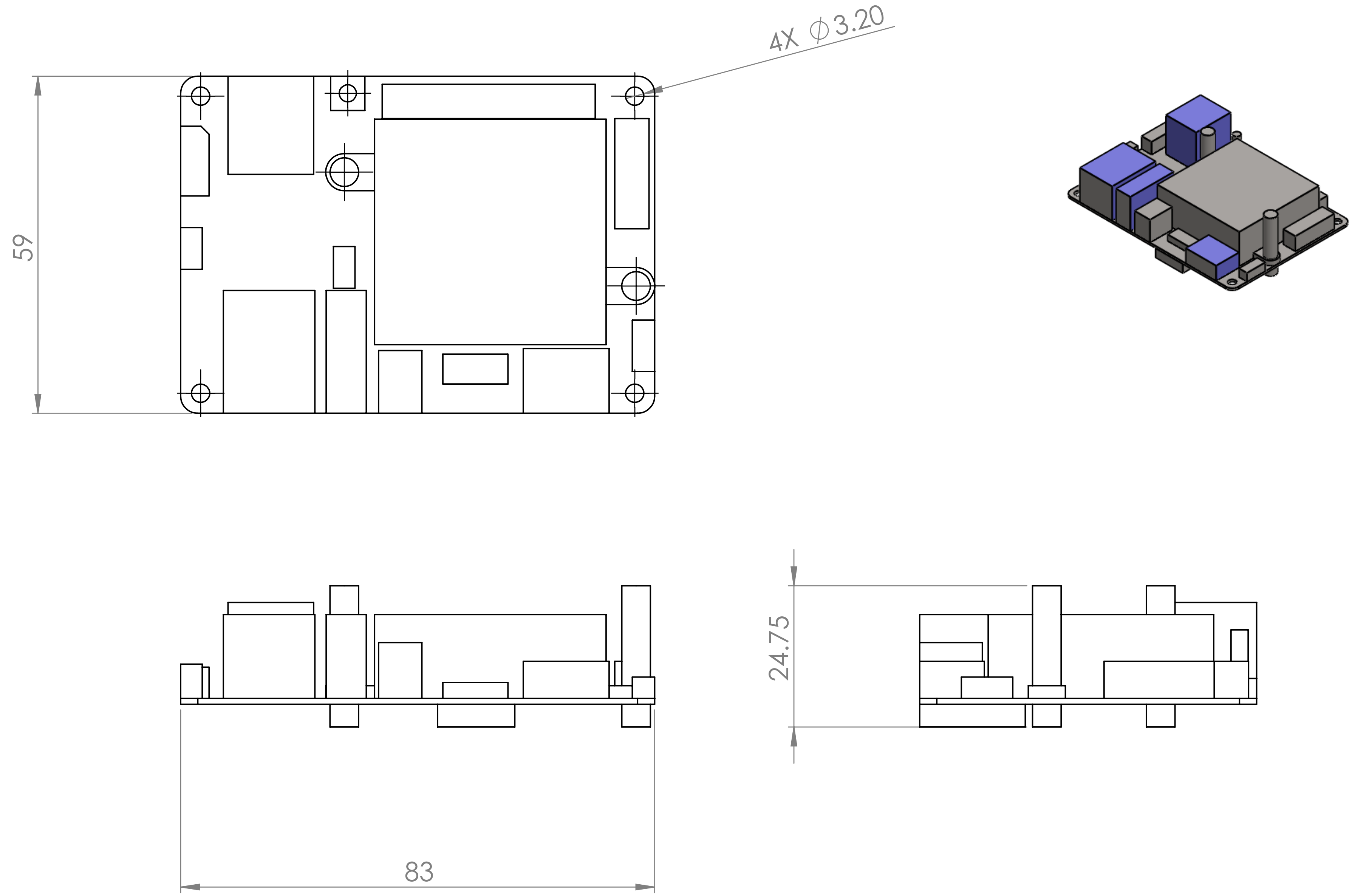
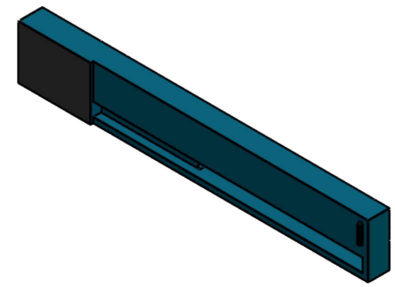
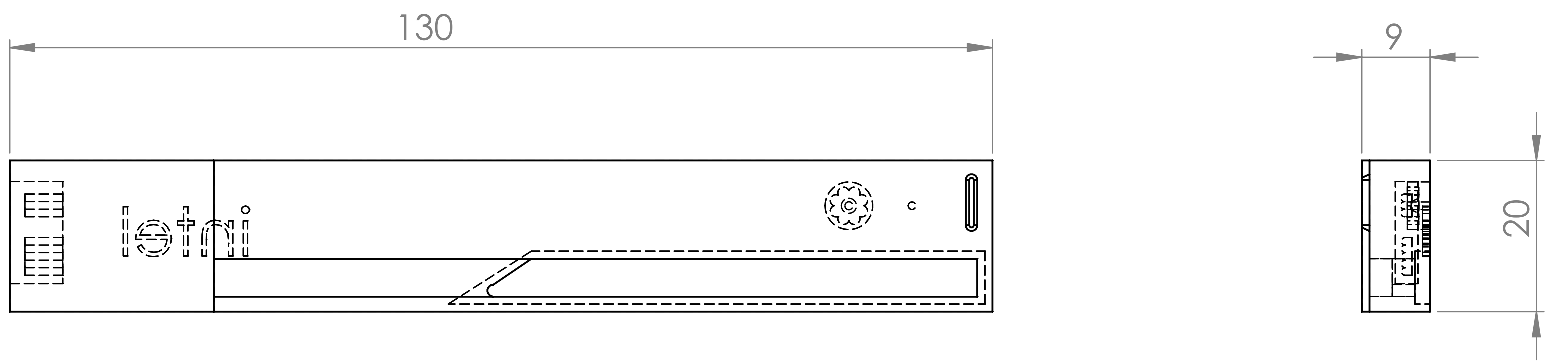
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED		A SIZE	DATE **10/8/2017**	USED ON **MECH 490**	
	DRAFTER **M. A. YADAO**	APPROVED **R. PATEL**	SCALE **1:2**	SHEET **1 / 1**	DWG NO. **BC-01**		REV NO. **01**

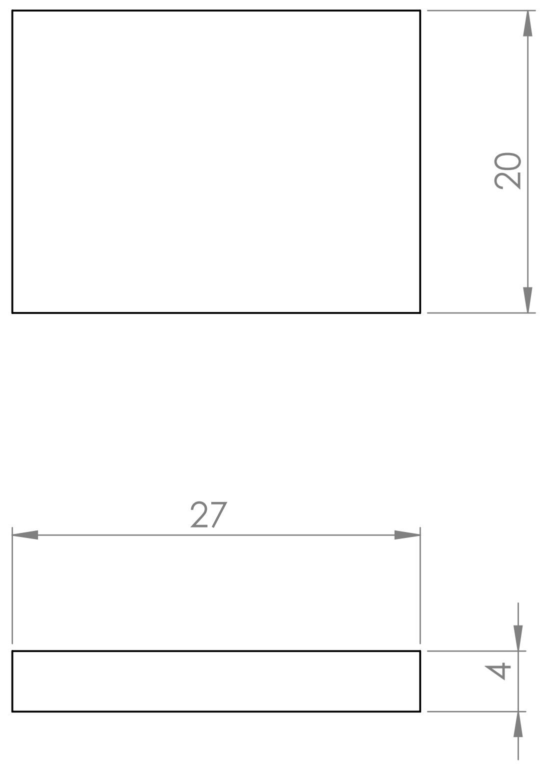


Concordia University	MATERIAL -		SURFACE ROUGHNESS	TITLE **Odroid XU4**
	FINISH -		UNLESS OTHERWISE SPECIFIED TOLERANCES X ± .1, .X ± .05, .XX ± .005, .XXX ± .002, ANGLE ± .5°	
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **ONLINE**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED		A SIZE · DATE **10/8/2017** · USED ON **MECH 490**
	DRAFTER **ONLINE**	APPROVED	SCALE **1:1**	SHEET **1 / 1** · DWG NO. **XU4-01** · REV NO. **01**

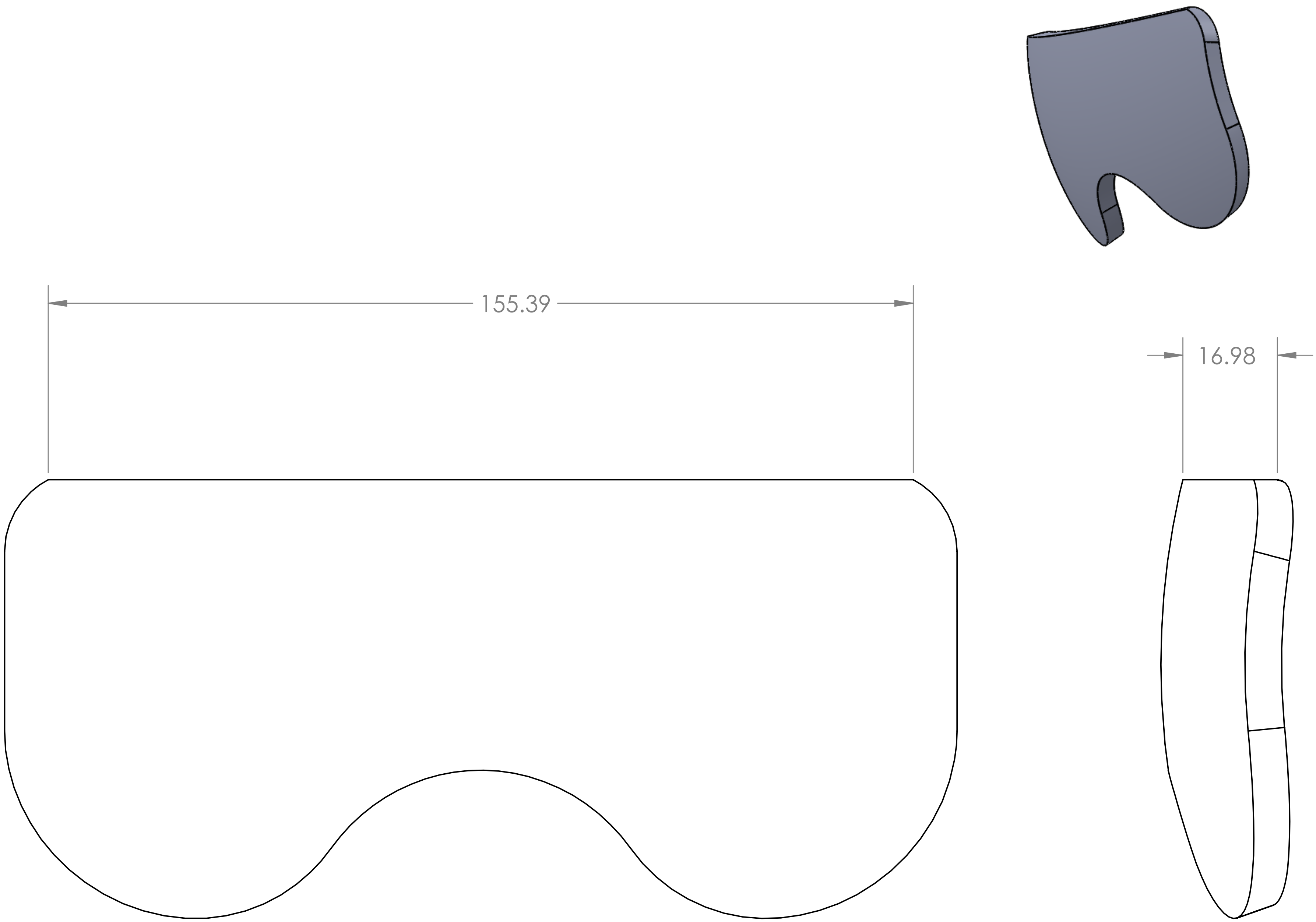




Concordia	MATERIAL -		SURFACE ROUGHNESS	TITLE Intel real sense camera R200
	FINISH -		TOLERANCES X ± .1 .X ± .05 .XX ± .005 .XXX ± .002 ANGLE ± .5°	
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER ONLINE	ALL DIMENSIONS IN METRIC UNLESS OTHERWISE SPECIFIED	UNLESS OTHERWISE SPECIFIED	A SIZE · DATE 10/8/2017 · USED ON MECH 490
	DRAFTER ONLINE	APPROVED	SCALE 1:1	SHEET 1 / 1 · DWG NO. IR-01 · REV NO. 01



MATERIAL -		SURFACE ROUGHNESS	TITLE **Adafruit BNO055 motion sensor**	
FINISH -		UNLESS OTHERWISE SPECIFIED TOLERANCES X ± .1 .X ± .05 .XX ± .005 .XXX ± .002 ANGLE ± .5°		
DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED	A SIZE	DATE **10/8/2017**	USED ON **MECH 490**
DRAFTER **M. A. YADAO**	APPROVED **R. PATEL**	SCALE **2:1**	SHEET **1 / 1** DWG NO. **MS - 01**	REV NO. **01**



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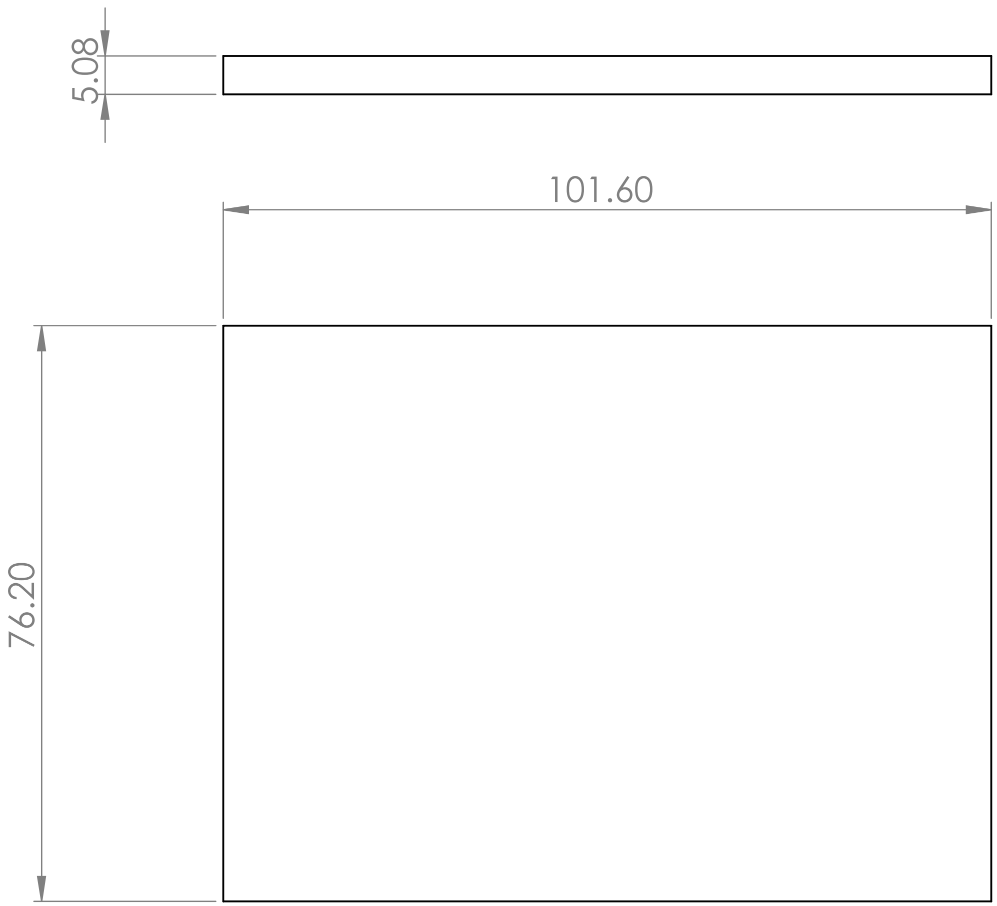
Concordia University

PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY

MATERIAL -		UNLESS OTHERWISE SPECIFIED: SURFACE ROUGHNESS √	TITLE **Screen viewer**
FINISH -		TOLERANCES X ± .1, .X ± .05, .XX ± .005, .XXX ± .002, ANGLE ± .5°	
DESIGNER **F. YUNUS**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED		A SIZE; DATE **10/8/2017**; USED ON **MECH 490**
DRAFTER **M. A. YADAO**	APPROVED **R. PATEL**	SCALE **1:1**	SHEET **1 / 1**; DWG NO. **SV-01**; REV NO. **01**



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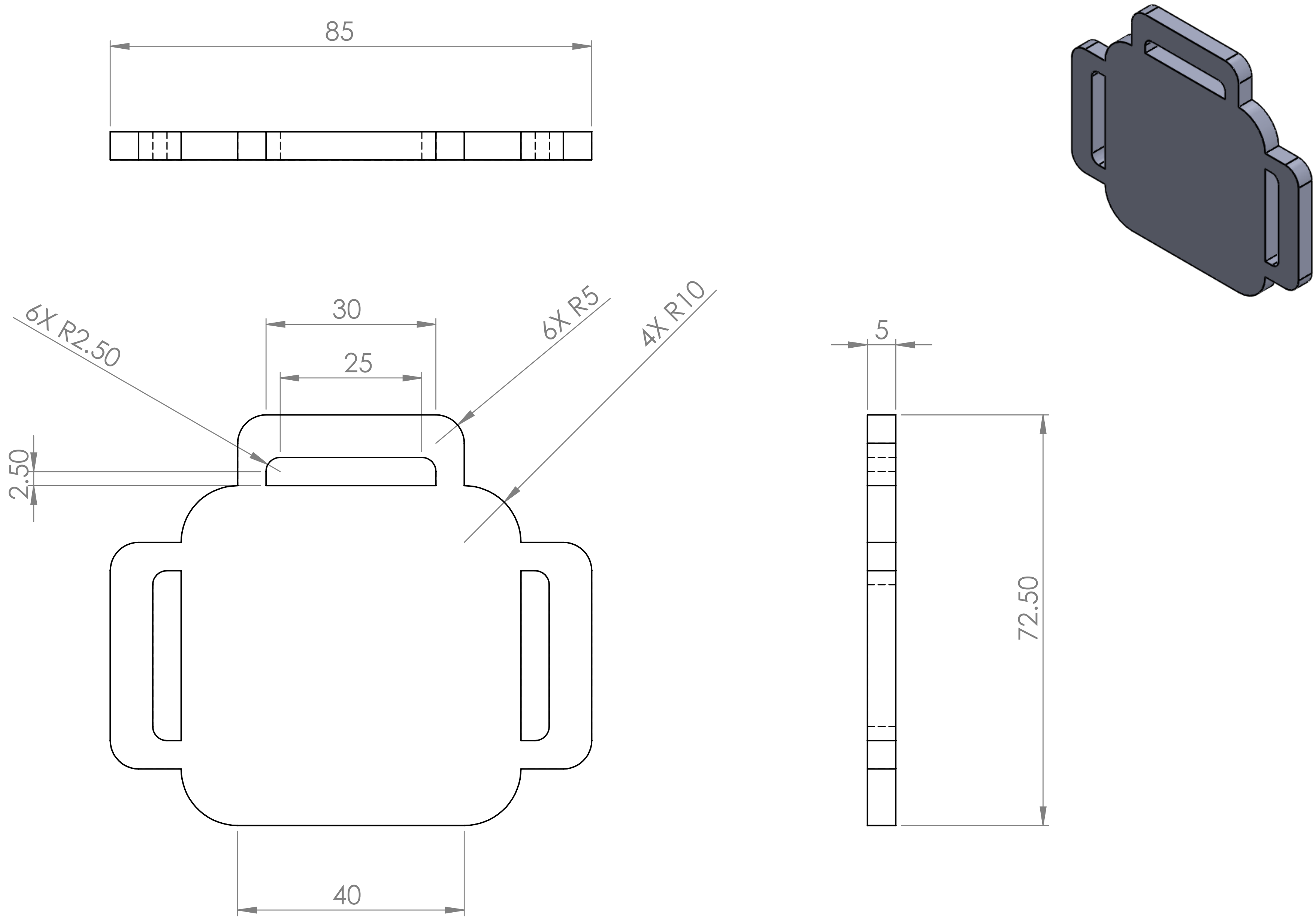
Concordia University	MATERIAL -		UNLESS OTHERWISE SPECIFIED SURFACE ROUGHNESS √	TITLE **Screen**
	FINISH -		TOLERANCES X ± .1 .X ± .05 .XX ± .005 .XXX ± .002 ANGLE ± .5°	
PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY	DESIGNER **A. SHAWWA**	ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED		A SIZE | DATE **10/8/2017** | USED ON **MECH 490**
	DRAFTER **M. A. YADAO**	APPROVED **R. PATEL**	SCALE **1:1**	SHEET **1 / 1** | DWG NO. **SC-01** | REV NO. **01**



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Concordia University

PROPRIETARY INFORMATION NOT TO BE RELEASED WITHOUT WRITTEN AUTHORIZATION FROM CONCORDIA UNIVERSITY

MATERIAL **POLYLACTIC ACID (PLA - 3D PRINT)**

FINISH **-**

DESIGNER **N. CIERSON**

DRAFTER **M. A. YADAO**

ALL DIMENSIONS IN **METRIC** UNLESS OTHERWISE SPECIFIED

APPROVED **R. PATEL**

UNLESS OTHERWISE SPECIFIED

SURFACE ROUGHNESS √

TOLERANCES X ± .1, .X ± .05, .XX ± .005, .XXX ± .002, ANGLE ± .5°

SCALE **1:1**

TITLE **Back piece**

A SIZE

DATE **10/8/2017**

USED ON **MECH 490**

SHEET **1 / 1**

DWG NO. **BP-01**

REV NO. **01**

Concordia University
ENCS
Engineering & Computer Science

Year	2017
Team	Group #9
Device	AR Headset

CODE						CASH	CASH	CAPCOIN	CAPCOIN	SPONSOR
	Item	Description	Drawing#/Part#	MNF/OEM/SPL	QTY	Material [$]	Labour [$]	CODE	Capcoin$	In Kind
	1	Screen	SC-01		1		-	-	-	Dr. Kiyanda
	2	Adafruit BNO 055 (motion sensor)	MS-01		1		-	-	-	Dr. Kiyanda
	3	Intel realsense camera R200	IR-01	TO BE PURCHASED	1	100	-	-	-	
	4	Odroid XU4	XU4-01	TO BE PURCHASED	1	107	-	-	-	
	5	Headset	HS-01	STUDENT (3D PRINT)	1		-	-	-	
	6	Top cover	TC-01	STUDENT (3D PRINT)	1		-	-	-	
	7	Back cover	BC-01	STUDENT (3D PRINT)	1		-	-	-	
	8	Back piece	BP-01	STUDENT (3D PRINT)	1		-	-	-	
	9	Screen viewer	SV-01		1		-	-	-	
	10									
		SUBTOTALS				207	0	0	0	0