Group 19
Lightweight Wireless Heart Rate Monitor

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Design Impact Statement

Public Health, Safety, and Welfare Impacts

A very evident public health impact is from the fact that the device my team and I are putting together as a direct tie to that aspect because it has to do with display heart rate which can be used by people to keep track of their fitness as well as other factors like stress and anxiety by comparing a person's normal resting heart rate to their current heart rate [1]. It also helps people to keep track of just how hard they're working by looking at their heart rate once they've done some exercise or strenuous work to see if they are hitting a high enough heart rate for their age/weight [1]. In addition, improved health tends to coincide with improved welfare and as for safety the biggest public safety risk this product could deliver is something that comes with any modern day battery power device in that if the battery is somehow damaged then it could lead to damage to persons or property. A negative health impact is in the recycling of devices like this where people can be exposed to the harmful materials inside these products[3]

Cultural & Social Impact

The main cultural impact a device like this tends to have is when it comes to the discussion of accuracy versus different skin colors as can be seen in articles like ones created by statnews.com[4]. Although they do reference a paper done in 2017 and published in the Journal of Personalized Medicine this seems to be a mute point with modern day sensors where there is no real significant difference in the accuracy of the heart rate reading between skin colors [2]. A societal impact this may have has to do with how we're attempting to price the product with the cost of components my team is using. That impact is that there may be some societal pressure and shaming due to using a cheaper product that can be sometimes seen in today's society with children being shamed by peers for not having certain products or access to certain items. There is not much that can be done for this negative impact as this is a problem rooted much more deeply in how society views people's wealth and access to items.

Environmental Impacts

Like most modern day electronics the environmental aspect where they have the most impact is during product's creation and disposal. A way that electronics like the ones we are developing can have environmental impacts during disposal is because of the harmful and poisonous materials that go into them that need to be dealt with during disposal. Even recycling can bring some environmental problems like previously discussed where recycling can result in the people doing the recycling being exposed to these harmful materials and bringing them home to their families [3] and this also likely means that these harmful materials are also being scattered around the local environment which is not good for those ecosystems. An impact that devices like these have in their creation is that these same harmful materials must be mined, gathered, and purified all steps that often lead to more and more harmful materials being dumped into environments around the world and especially in places of poverty as most often these are the places employed to gather these materials.
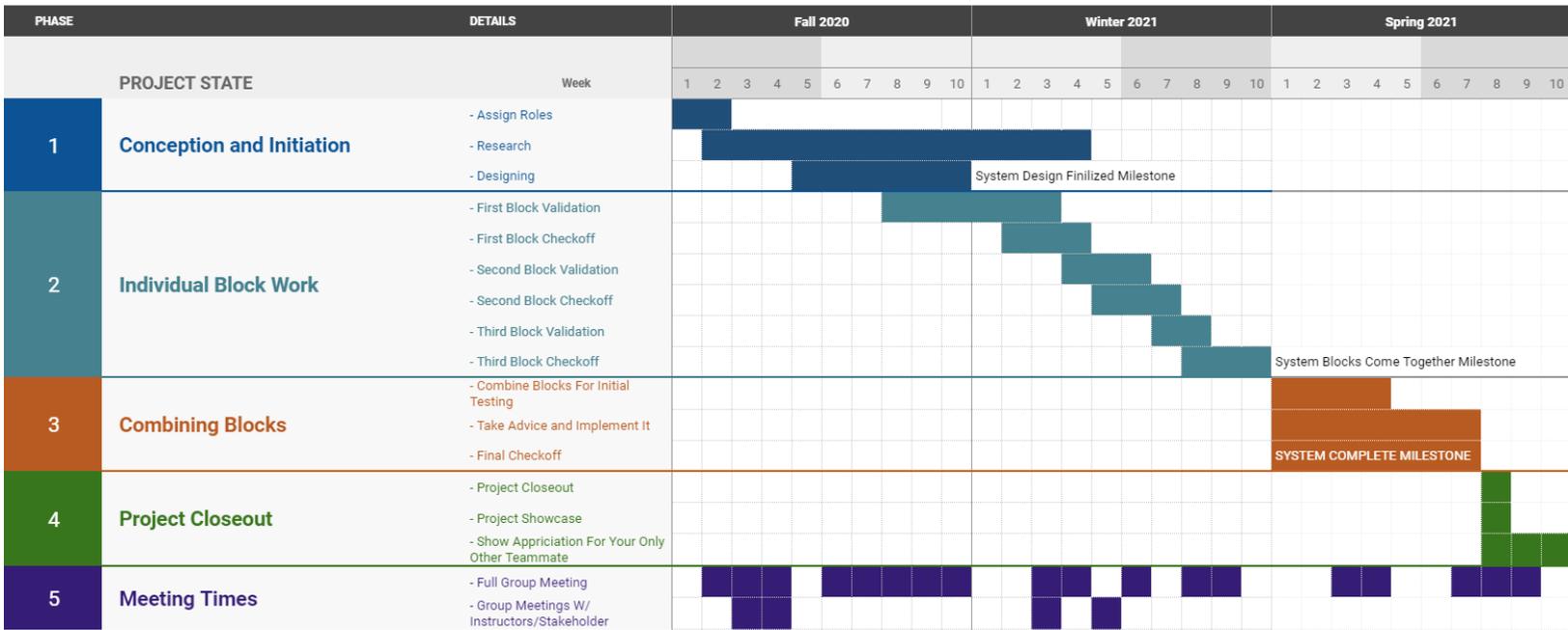
Economic Factors

An economic factor is of course cost, which in this case my team has tried to keep low by using off the shelf parts that are also being sold at low prices but are good quality as to reduce cost of the end item which is good for both our client and the end user as the cheaper the product is to manufacture and engineer generally the cheaper that item is then for the end user meaning that access to it is much greater. With that greater accessibility that allows the item to be more impactful and also generate more income for our client. Another economic impact that comes especially from using a lithium battery is that a lot of the materials mined for these devices come from third world countries where conditions are not the safest for both life and for the environment but it does introduce money into these communities although whether or not it's worth the environmental and health effects is touched on in the previous section [5]. Another economic factor is that this cheaper lightweight heart rate monitor may help improve the economy as people who are more fit tend to be more productive and a this device can help them workout and exercise in a more efficient way by knowing if they aren't working hard enough or if they're working too hard using their heart rate tell [6].

Project Timeline

PROJECT TIMELINE

PROJECT TITLE	Lightweight Wireless Heart Rate Monitor	Group	19
TEAM MEMBERS	Ivan Vargas, Mohammad Alshahrani	Start Term	Fall 2020
PROJECT STAKEHOLDER	Joshua Thelen		

PHASE		DETAILS	Fall 2020	Winter 2021	Spring 2021
	PROJECT STATE	Week	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
1	Conception and Initiation	- Assign Roles			
		- Research			
		- Designing	System Design Finilized Milestone		
2	Individual Block Work	- First Block Validation			
		- First Block Checkoff			
		- Second Block Validation			
		- Second Block Checkoff			
		- Third Block Validation			
		- Third Block Checkoff	System Blocks Come Together Milestone		
3	Combining Blocks	- Combine Blocks For Initial Testing			
		- Take Advice and Implement It			
		- Final Checkoff	SYSTEM COMPLETE MILESTONE		
4	Project Closeout	- Project Closeout			
		- Project Showcase			
		- Show Appriciation For Your Only Other Teammate			
5	Meeting Times	- Full Group Meeting			
		- Group Meetings W/ Instructors/Stakeholder			

Scope and Engineering Requirements

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link
Battery Life	Must have a comparable battery life to other products	The system must log data for at least 12 hours on a full charge.	Demonstration	1. Fully charge the system 2. Pair it with a phone 3. Wear the device for 12 hours. 4. Open the system app and view the data. Supply a full charge and time how long it takes to power down.	If the system is reporting heart rate at the end of the 12 hours, this requirement is met.	https://drive.google.com/file/d/1WlFiG58mI7fkuyKuFF5YmxwL4Hu_wad7/view?usp=sharing
Easy To Use Interface	Interface must be easy to understand and interpret	Systems output can be easily read and correctly interpreted by at least 9/10 people.	Test	1. Ask 10 people to use the phone application 2. After a small introduction to how to use the app ask them to try and use it on their own 3. Have the student sign a document stating they were able or unable to understand the phone application	If 9/10 people were able to understand and interpret the phone application, the requirement is met.	https://drive.google.com/file/d/1SEFNe7vLQ3_U3CozNk9G2FUVe1BNlRBR/view?usp=sharing
Lightweight	Must be lightweight	System must be between 20 to 120 grams.	Test	1. Turn on scale 2. Tare scale 3. Place system on scale 4. Record weight	System weighs between 20 to 120 grams.	https://drive.google.com/file/d/1sgYbnKP_S0klv7w2_a9keRbqC9IglTs4/view?usp=sharing

Rate Detection Accuracy	Heart rate detection must be accurate	The system will detect heart rate with at least 80% accuracy when compared to at least two similar products on the market	Demonstration	1. Subject will have our wearable component on one of their wrists 2. Subject will have competing wearable on their other wrist 3. Subject will remain still for 15 seconds of data collection 4. Repeat 1-3 for second or more similar products 5. The data collected will be averaged to determine if similar between both wearables from 5 second intervals 6. Compare averages	If the system averages 80% accuracy for 15 seconds of data collection compared to a competing system, the requirement is met.	https://drive.google.com/file/d/1CjyFAcaQeKHsMTxbdBp9OobTwGSSEZQJ/view?usp=sharing
Wireless Comm Range	Must be wireless	The system will communicate wirelessly up to 5 feet from the receiver.	Test	1. Connect receiver and transmitter. 2. Set up receiver and transmitter 5 feet apart with no obstructions between them (clear line of sight). 3. Begin transmitting data to receiver. 4. Check if the system communicates wirelessly up to 5 feet from the receiver this condition passes	the system communicates wirelessly up to 5 feet from the receiver	https://drive.google.com/file/d/19GufV5hCCYC1Pnji2nY2XWRNboGbAPWg/view?usp=sharing
Wireless Comm Reliability	system must be reliable	The system will maintain a 70% successful data transfer over its wireless connection within 5 feet.	Demonstration	1. Connect receiver and transmitter 2. Keep receiver and transmitter within 5 feet of each other with no obstructions between them (clear line of sight) for 15 seconds. 3. Wait for the app to alert when a malformed packet is received. 4. Count number of malformed packets versus correct packets	Ratio of correct over total received packets is at least 0.7	https://drive.google.com/file/d/18yxuYEpo4vGfs3N6bBNgDd48Bs4eXTbV/view?usp=sharing

Risk Register

RISK ID	Description	Category	Probability	Impact	Performance indicator	Responsible Party	Action Plan
R1	A member of the team contract COVID-19	Personnel	25 %	H	Teammate sick No longer in class	The team member who gets COVID	Avoid
R2	Project experiences a vendor related delay	Time	25 %	M	Products arriving late	The team member in charge of ordering	Reduce
R3	An unexpected design incompatibility occurs	Technical	50 %	M	Incorrect units Incorrect protocols	The team member who designed the block	Reduce
R4	A significant event occurs in someone's personal life	Personnel	25 %	H	Must leave class for term Occupied with other projects	The relevant team member	Avoid
R5	An unexpectedly significant price change occurs	Cost	25 %	M	Price change	The team member in charge of ordering	Retain
R6	The team goes a significant period of time without communication from a member or members	Personnel	10 %	H	Gaps in communication Possible group dynamic tension not being discussed	The team members who have not been communicating	Avoid
R7	A portion of the project takes longer than anticipated	Time	25 %	M	Part of project taking longer than anticipated	The team member responsible for this task	Reduce

Figure : Table that contains our groups risk register. A risk that occurred that was not anticipated was losing two teammates in the middle of the project during a point where

we were supposed to begin integrating our parts together. A lesson to learn is to always keep your artifacts up to date and in a clean state just so if something were to happen and you can no longer work on the project the rest of your team has an easier time either catching up with a new teammate or continuing where you left off.

Future Recommendations

1. Use smaller components
   Reason: It would be more comfortable for the person who would wear the wristband and it would satisfy the customer. A starting point would be researching nano components size, and look up what would be beneficial to the system without losing their main functionalities.

2. Build the enclosure by a 3D printer
   Reason: A 3D printer would be more accurate for the system and the components to be put on the enclosure. A starting point would be learning how to design 3D models and printing it on a 3D printer.

3. Water Resistant enclosure
   Reason: The current enclosure is fabric based which can easily get dirty and is not water resistant at all. This could pose a problem for more athletic oriented users so a water resistant enclosure would help mediate any problems this demographic may have with the system. A starting point would be researching what kind of materials could make water resistant enclosures and different levels of water resistance.

4. Include the SpO2 to the measurements on the system
   Reason: At the moment our set up has the capability of calculating and sending SpO2 data to the user but we currently don't partly due to time constraints. This could be nice for more medical focused reasons. A starting point would be looking up how to simultaneously update two numbers on the display at the same time in android.

5. Add history to the phone application
   Reason: At the moment there is no way of tracking what your heart has been like on previous runs for instance, which could be helpful for people attempting to keep track of their heart rate to get a better sense of just how hard they're pushing themselves. A starting point would be looking up how an app can save data to the phone and then how to retrieve and manipulate that data.

6. Add graphs to app
   Reason: Currently the app just displays a new line with the heart rate whenever it receives an notification from the bluetooth module which is not very user friendly. A graph would help users better visualize their heart rate. A starting point would be looking up how to draw images on a display on android.

7. Add iOS support
   Reason: Currently there is only android support for our project and so to open the project for more people to use it adding in iOS support would help. A starting point would be researching iOS development and the process needed to your app on the app store.

8. Have more regular meeting times
   Reason: The irregular meeting times made it hard at times to coordinate and keep up to date with who had what done. A starting point would be to set up weekly meeting times at the beginning of the project and try to make sure everyone always shows up.

References

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