Project Deliverable D: Conceptual Design

GNG 1103C
Team #7
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1. Abstract:

As part of the ideation phase of the design process for the opioid overdose device, a global concept must be developed from the ideas of the members that the group will strive to make a reality. The method for its development starts with individual concept drafting by all the members in the group - Abdel, Bilal, Ali, David, and Yazan - a crucial step. There then follows a detailed analysis of the pros and cons of the concepts on an individual basis, before they are mixed and matched into three global concepts of the subsystems. The same process completed with these three global concepts, until one global solution is reached, which is the result of this method. The following document goes through the details of this process, until the result is reached.

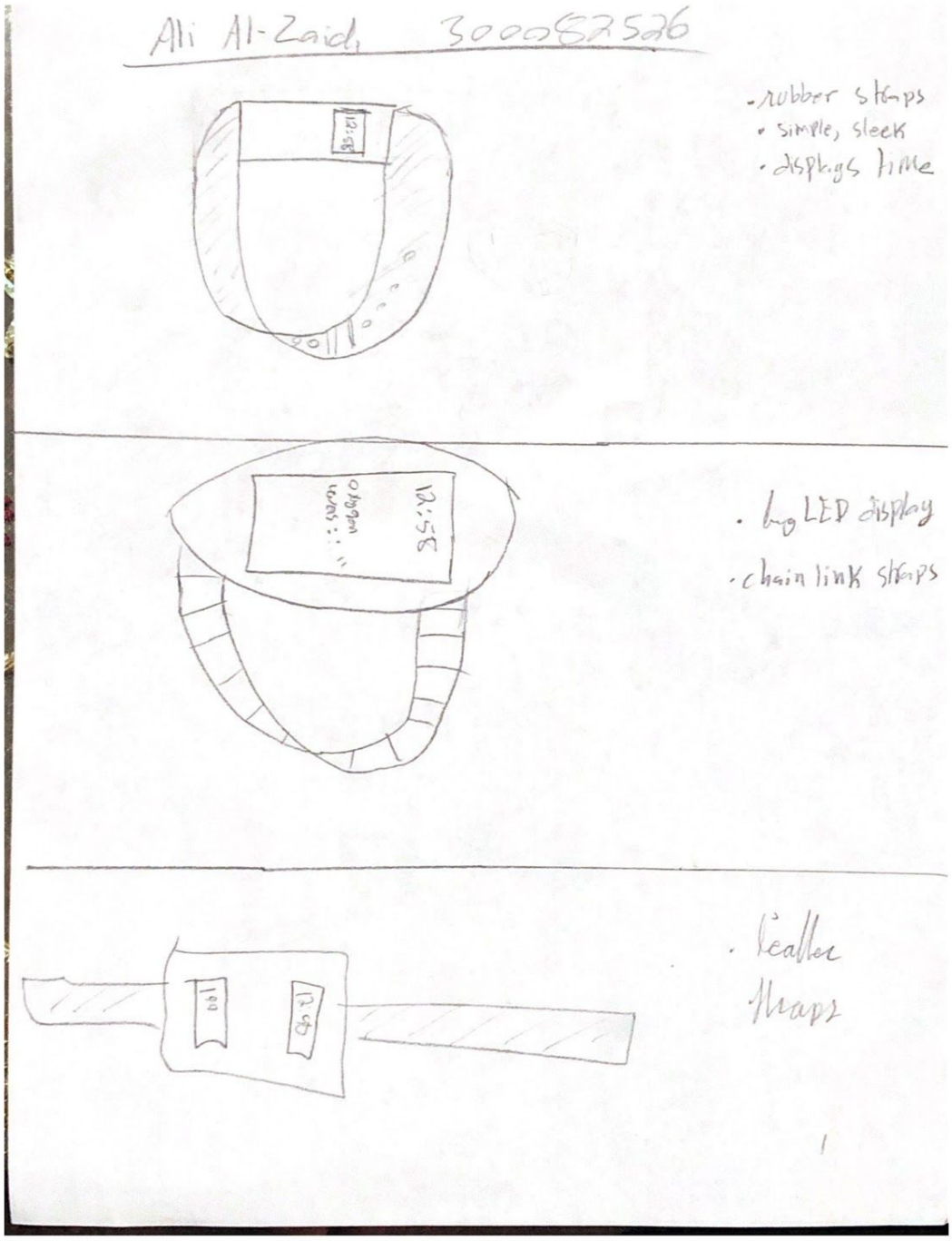
2. Introduction:

After having identified our user-interpreted needs and design criteria, it is time to develop a design concept which our group will aim to achieve. The process of formulating a single “global” concept involves the prerequisite consideration of as many concepts as possible. This process is important as it allows team members to record all of their ideas in an illustrative manner and discuss the pros and cons of specific features and ideas with other members. This consultation and feedback process followed by idea elimination lessens the likelihood of design flaws moving forward. The objective of this document is to be a record of the design process undertaken by our group with regards to the opioid overdose emergency response device, including the analyses which precede each decision made.

A week before our determined meet-up date, all members of the team were instructed to sketch three or more concepts and make a record of the ideas and specifications that they had in mind. The obligativity of this was stressed, since it is crucial that every member’s ideas are put forward and analysed during this process. These ideas were then mixed and matched to form three global concepts for the subsystems after detailed analysis of all design features proposed. These were then carefully benchmarked, and the team considered the likelihood that they will be able to achieve proposed ideas as well as their impact of the practicality of the device’s use. After this, a final global concept was agreed upon by all members individually then sketched. The details and documentation of this process can be seen in the following sections of this document.

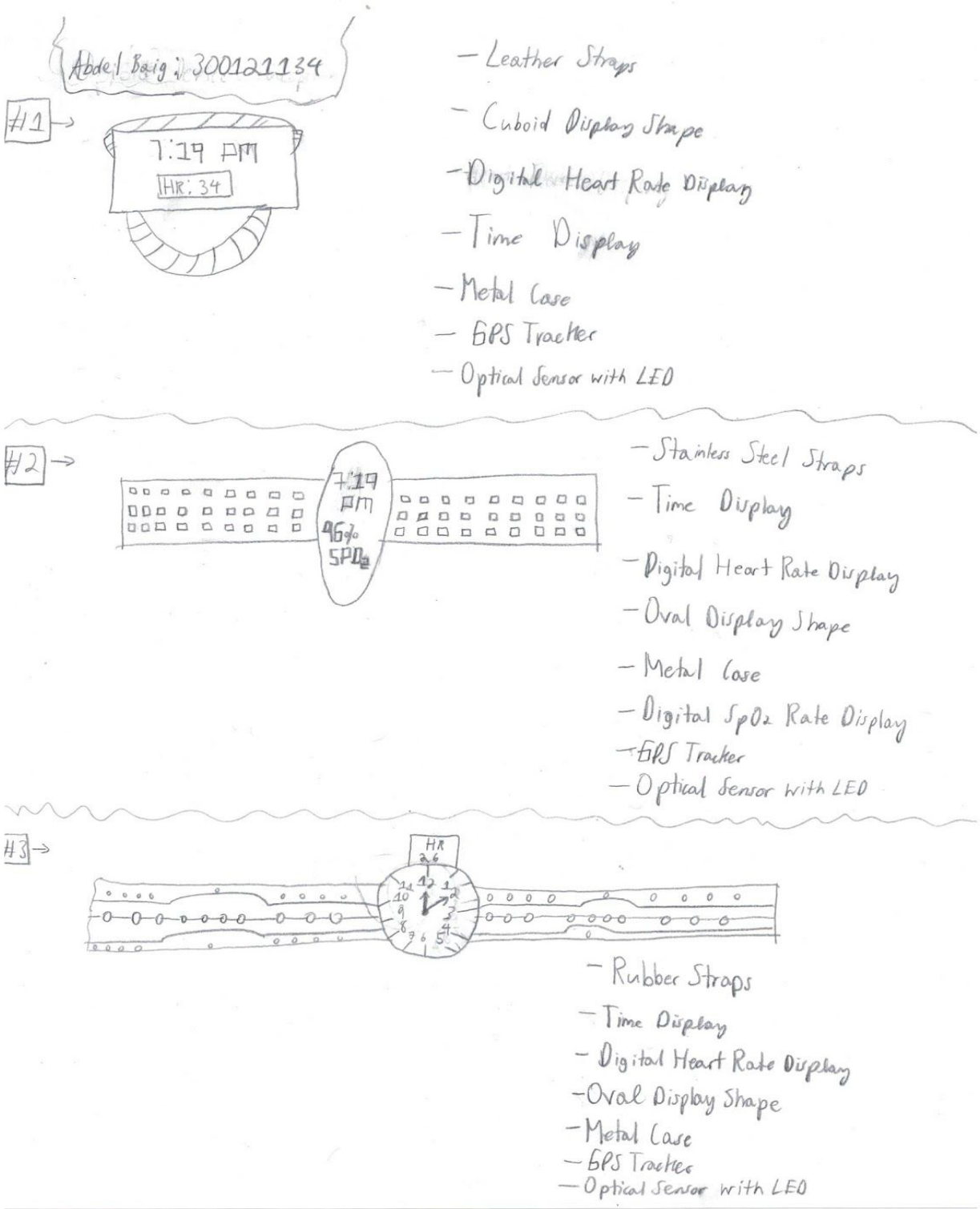
3. Design Concepts:

Figure 1: Ali's Concepts



- The first of Ali's concepts displays a sleek and minimalist design where the only user interaction is a digital clock on the top of the case. The case is to be made of plastic, and the straps of rubber.
    - Pros:
        - Ease of use as there is little user interaction
        - Discreet design that draws little attention to itself
        - Lightweight materials
        - Water resistant materials
        - Durable straps
    - Cons:
        - Plastic case may not be durable and may become damaged during labour work such as construction
- The second of Ali's concepts display a more bulky and flashy design centered around a big LED display. The casing is to be made out of metal and the straps also metal.
    - Pros:
        - Very durable metal material and can be made water resistant.
        - Can serve many functions thanks to the LED display
    - Cons:
        - The use of metal will increase the weight, thereby reducing its wearability
        - The large size may become irritating
        - One may grow tired of the more flashy and bulky look
        - With the added complexity of an LED display comes the increased chance of manufacturing defects and damage induced failure
        - Large displays are excessive when the functions of the device are taken into consideration and will unnecessarily increase cost, production time, and size.
- The third of Ali's concepts feature another simple case similar to that in the first one, except with an added screen displaying the heart rate of the user. The material of the case is plastic and the straps are leather.
    - Pros:
        - Ease of use
        - Discreet
        - Lightweight
        - Leather straps are classy but not flashy
    - Cons:
        - Leather may wear in water during rough tasks, and over time, reducing durability of the product
        - Plastic case may become damaged
        - The display of one's heart rate may cause others around the individual to ask questions and thereby draw unnecessary attention to the device

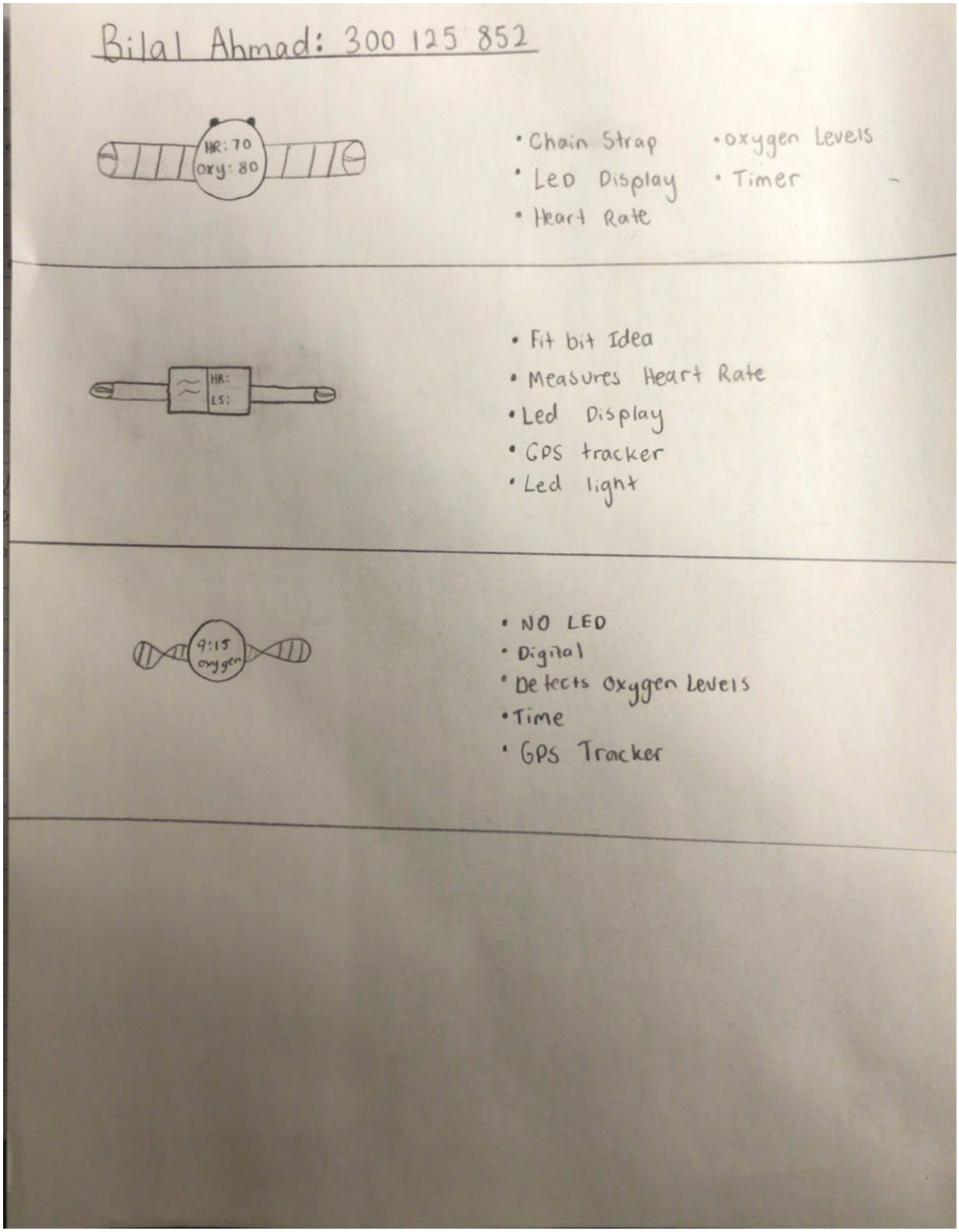
Figure 2: Abdel's Concepts



- The first of Abdel's concepts displays a bulky and minimalist design where the only user interactions are the digital time as well as the monitoring of the user's heart rate. This information is displayed through the use of an optical sensor which utilises an LED display. The display rests at the top of the case which entails a cuboid shape. The casing is to be made out of metal, and the straps of leather.
    - Pros:
        - Very easy-to-use as there is very little user interaction
        - Simplistic design with very little additional features present
        - Discreet design that draws little attention to itself
        - LED display that allows for heart rate display
        - Leather straps made for comfortability
    - Cons:
        - Leather is a somewhat heavy material thereby reducing comfort for the user
        - Elongated length of screen display may not look aesthetically pleasing to the user
        - Shortened length of leather straps which may reduce comfortability for the user
        - Little water resistance and might wear down overtime thereby reducing its durability
- The second of Abdel's concepts displays a fashionable and sleek design where the only user interactions are the digital time as well as the monitoring of oxygen saturation levels, commonly known as SpO2. This information is displayed through the use of an optical sensor which utilises an LED display. The display rests at the top of the case which entails an oval shape. The casing is to be made out of metal and the straps of stainless steel.
    - Pros:
        - Extremely durable metal material
        - Easy-to-use which means there is little user interaction
        - Water resistant materials
        - LED display that showcases SpO2 levels which is the best indication if one is undergoing an overdose
        - Steel straps have a medium length (not too big or too small) which will fit for many users
    - Cons:
        - Metal is heavier than rubber and leather, thereby reducing the wearability of the device
        - Screen length might be too large in which the user may have trouble reading what is being displayed
        - One may grow tired of flashy look of the steel straps which also reduce comfortability
        - Does not have a discreet design due to the SpO2 being displayed.
        - It's very difficult to test spO2 from the wrist

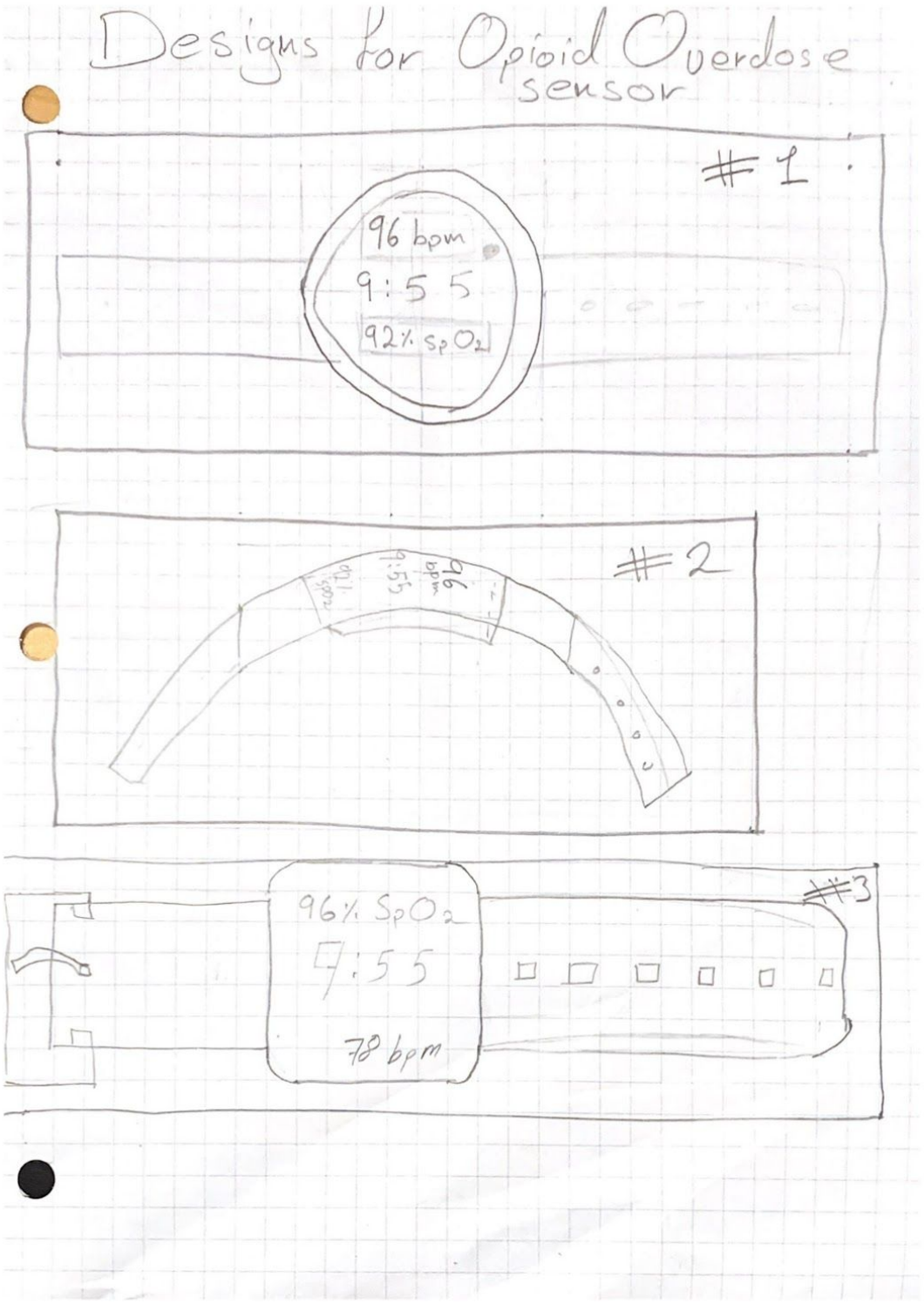
- The third of Abdel's concepts displays an opulent and rugged design feature where the only user interactions are the digital clock as well as the monitoring of the user's heart rate which makes it somewhat similar to that of the first design. This information is displayed through the use of an optical sensor which utilises an LED display. The display rests at the top of the case which entails a circular shape. The casing is to be made out of metal and the straps of rubber.
    - Pros:
        - Durable metal material
        - LED display that allows for heart rate display
        - Somewhat lightweight (lighter than leather but heavier than metal)
        - Water resistant
        - Rubber straps created to be classy and aesthetically pleasing for the user
        - Comfortable material for rubber straps
    - Cons:
        - Irregular shape of the case which means that it is not discreet due to the heart rate being displayed at the top of the case, separate from that of the digital clock.
        - Small circular holes present on the straps which expose the user's skin and may injure the user's wrists if they come into contact with other objects
        - Complex design due to the clock encompassing most of the casing's space, thereby making it troublesome for the user to read their heart rate level
        - Is not a one-size-fits-all watch because the straps are very long. Only tailored to specific users that can handle wearing this type of device.

Figure 3: Bilal's Concepts



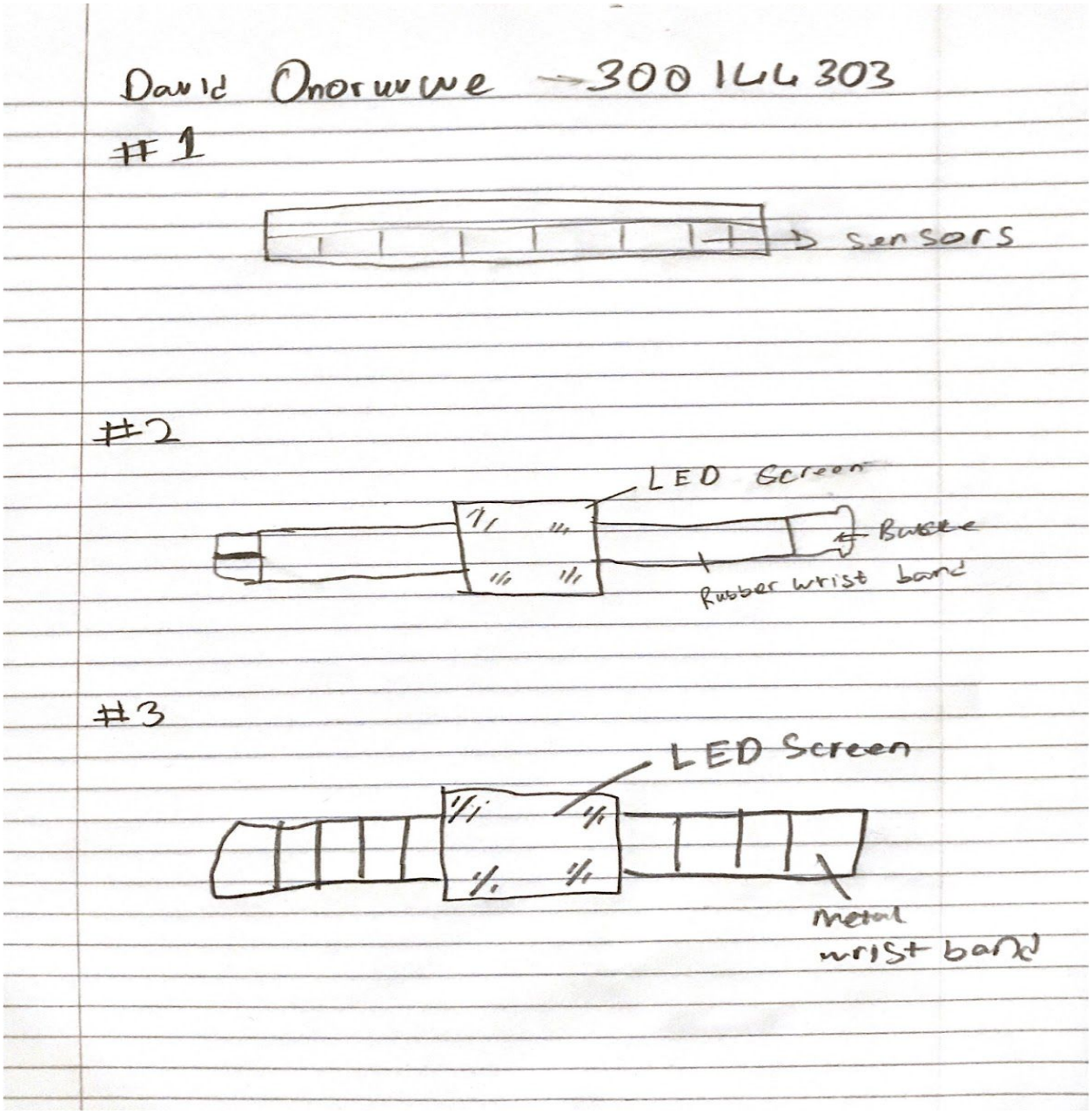
- In Bilal's first concept, the circular LED display is what the users will be interacting with when tracking their daily use of opioids. The watch has chain straps and displays the time which the user can look at to track the duration of the effects.
    - Pros:
        - Big display, easy to navigate the features
        - Measures oxygen levels and heart rate
        - Looks like a digital watch, very discreet
        - Durable (Chain Links)
    - Cons:
        - Very bulky, not the most comfortable design
        - Increased risk of manufacturing defect due to the LED display
        - Price ranges are quite high, considering it has metal links and round LED display
        - This device is not waterproof nor water-resistant
- In Bilal's second concept, the device includes a more sporty aspect as it is very similar to the typical design of "fitbits". This conceptual design was fueled by simplicity. In order to have a successful working device, it must be easy for the users to grasp. This device is made of rubber and includes an LED display
    - Pros:
        - Easy to use, specific features and small
        - Discreet and a similar design to "fitbits"
        - Measures heart rate
        - Water-resistant and waterproof
        - Comfortable, lightweight and can be worn at all times
        - Cheaper material, increased in affordability
    - Cons:
        - Small LED display, hard to see at times (e.g. cloudy, dark days)
        - Made of rubber, not the most durable material
        - Smaller compared to watches, can be lost easily if misplaced.
- In Bilal's final concept, the device has leather straps and displays a digital time and heart rate. The design is similar to the first concept in the sense that the displaying screen is round.
    - Pros:
        - Detects heart rate
        - Includes digital time
        - Discreet
        - Leather straps provides increased comfort
        - Easy to read the display and features
        - Durable
    - Cons:
        - No LED lighting
        - Old fashioned (e.g. Not a modern look for today's society)
        - Holes for the strap can be ruined over time if used recklessly

Figure 4: Yazan's Concepts



- The first of Yazan's concepts displays a wristwatch with a big circular LED display containing heart rate, time, and oxygen levels. It has leather wristbands for a more casual formal look.
    - Pros:
        - An abundance of information is displayed and available to the user
        - The device looks very advanced and modern
        - Easy to read and use
        - Touch display
    - Cons:
        - Is not discreet because it fully displays the SpO2 rate (takes about a third of the device's screen display)
        - Could be expensive to make
        - No buttons
        - Takes time to get used to the touch gestures
        - Could get worn out over time thus reducing its durability
- The second of Yazan's concepts displays is a more simple wristband that gives off a sports look. It displays the heart rate and time on a small LED screen and is mounted on a rubber wristband that is comfortable to the user.
    - Pros:
        - Easy to use
        - Straightforward
        - Cheap
        - Discreet
        - Long battery life
    - Cons:
        - Small LED screen (Hard to read)
        - Made of rubber
        - Could get worn out easily
        - Cheap looking
        - Pressure on the wrist could make it annoying to the user.
- The third of Yazan's concepts displays a modern watch with a round-edged square LED screen that displays a variety of information, has an adjustable wide rubber wristband, and an interactive touch screen.
    - Pros:
        - Display information clearly and accurately
        - Appears like a modern watch
        - Stylish
        - Very durable
    - Cons:
        - Not discreet
        - Expensive
        - Heavy weight
        - Short battery life

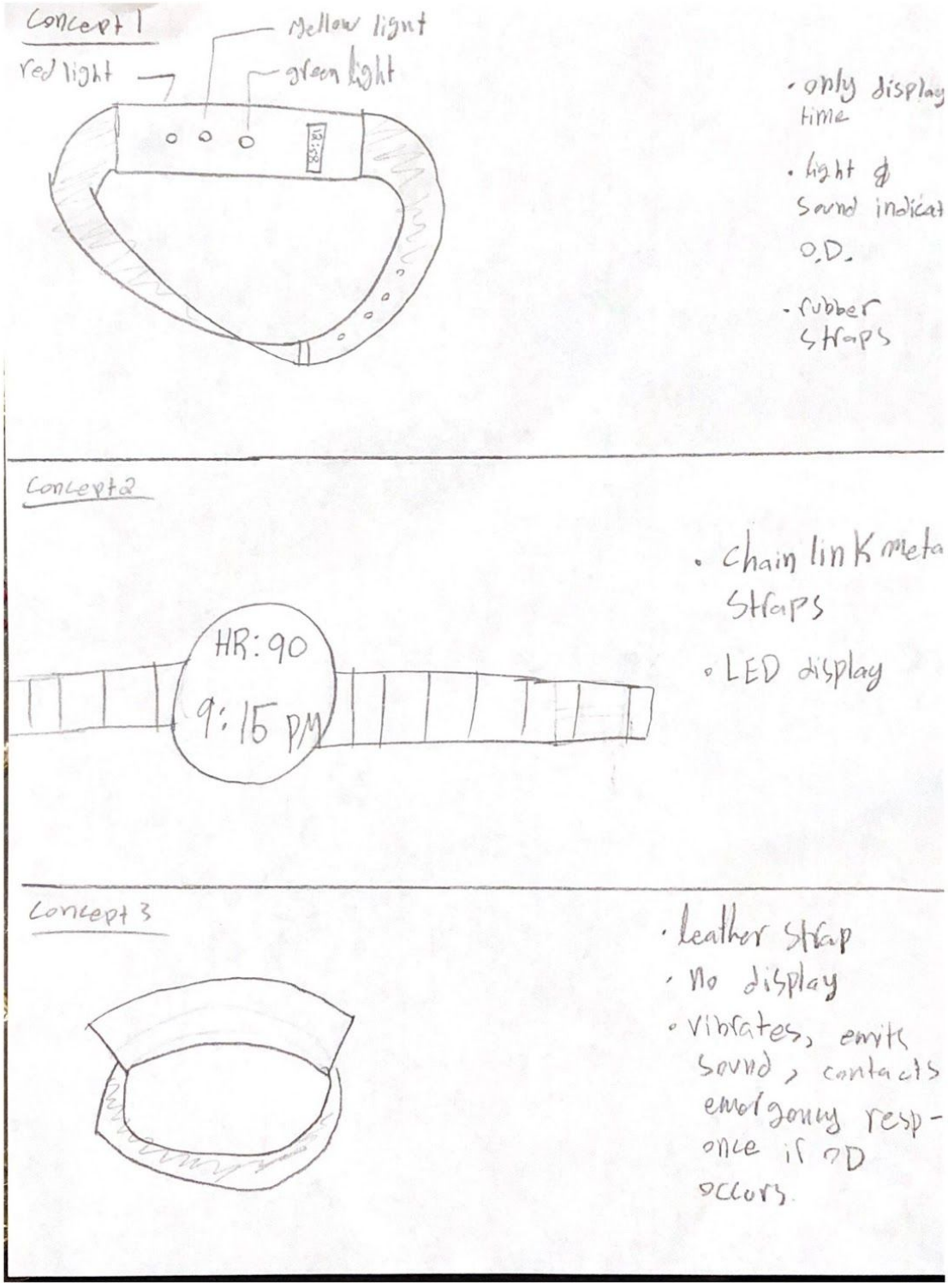
Figure 5: David's Concepts



- The first of David's concepts displays an all around metallic bracelet with an optical sensor that surrounds the device. This is a very minimalistic design with no screen display. The sensors' purpose is to measure the user's heart rate level and they create sound vibrations whenever the user has overdosed which then sends an alert to the nearby emergency response team.
    - Pros
        - Long battery life
        - Metal is a more costly material which means that it has enhanced durability as opposed to materials such as rubber
        - Very discreet because there are no additional features present on the device. It looks like a regular metallic bracelet which others will assume the same idea.
        - Very lightweight (lighter than rubber)
    - Cons
        - Troublesome to use because there are no features on the device
        - Metallic material may lead to decreased comfortability for the user's wrists
        - Expensive material
        - Restricted sizing of bracelet due to it having a fixed shape.
- The second of David's concepts displays a sleek rubber wristband. The device has an LED display placed on the front of the watch which showcases the current time and the user's heart rate. The device is made of rubber straps and there are optical sensors located on the back of the device which directly connect to the monitoring of the user's health rate. As noted in the first concept, whenever one has overdosed, the sound from the sensors will send an alert to the nearby emergency response team.
    - Pros
        - Easy to use
        - Long battery life
        - Very durable
        - Water-resistant
        - Discreet
    - Cons
        - Rubber might tear thus reducing the durability and wearability of the watch
        - Restricted hand-size (non-adjustable)
- The third of David's concepts displays is a modern watch with a squircle LED screen that showcases the current time and the user's heart rate. The device is composed of an adjustable metal wristband wristband, and an interactive touch screen.
    - Pros
        - Long battery life
        - Durable
        - Water resistant
        - Discreet

        - Stylish
        - Adjustable wristband
        - Easy-to-use
    - Cons
        - Expensive material
        - Metallic material may lead to decrease in comfortability for the user's wrists

Figure 6: Three Global Concepts



The first concept displays a modern design with rubber straps and cuboid shape which only displays the current time. Rubber is used for the straps because it is a very comfortable material for the user to wear and is durable as well. It does not have a digital heart rate or SpO2 sensor but instead, it has a LED light system that reflects heart normality. This is used on the basis of a colour scale in which green indicates a normal heart rate, yellow indicates an unusual heart rate, and red indicates a drastically low heart rate which means that the user is potentially suffering through an overdose. Whenever the red light flashes, this alerts the nearby emergency response team that one has overdosed. This method makes the device very discreet because there is no display of any rate and no one around the individual will question why there are lights present on the watch display.

The second concept displays a design akin to that of a standard digital watch. The casing has a circular shape to it and the LED display showcases the time as well as the user's heart rate level. The device also has chain link metal straps which make the watch look very sumptuous and extremely durable. All in all, this is a very simplistic design that users will find easy-to-use.

The third concept displays a rudimentary design but with very sophisticated functionality. The casing has a squircle shape to it with leather straps and no screen display. This means that there is no time, heart rate, or SpO2 sensor. Leather is used because it is a comfortable material for the user to wear thereby increasing its durability as well. The device uses a different method than that of the first two designs in determining if one has overdosed. When an individual overdoses, the device emits a sound and continuously vibrates, thereby contacting an emergency response team to come to the person's aid. Due to the functionality of the watch, it is very discreet because there are no features displayed on the device thus no user interaction occurs. All in all, this is a very minimalist design that users will find easy-to-use.

Table 1: Benchmarking of Three Global Concepts

Concept	1	2	3
Cost	$100 (CAD)	$100 (CAD)	$100 (CAD)
Estimated Weight (g)	145	125	175
Material of Case	Metal	Metal	Metal
Material of Straps	Rubber	Metal	Leather
Shape of Case	Cuboid	Cylinder	Curved
Pulse Range	25 bpm-250 bpm	25 bpm-250 bpm	25 bpm-250 bpm
Pulse Accuracy	+/- 2 bpm	+/- 2 bpm	+/- 2 bpm
Safety	Yes	Yes	Yes
Optical Sensor	Yes	Yes	No
Power	Replaceable Battery	Replaceable Battery	Replaceable Battery
Tracking System	GPS	GPS	GPS
Heart Rate Display	No	Yes	Yes
Display Time	Yes	Yes	No

The table below is color-coded with (green = 3, yellow = 2, red = 1). The purpose of this is to determine which of the three solutions best fits the user's needs based on the provided sketch diagrams.

Table 2: Continuation of Benchmarking of Three Global Concepts

Concept	1	2	3
Cost	$100 (CAD)	$100 (CAD)	$100 (CAD)
Weight (g)	145	125	175
Material of Case	Metal	Metal	Metal
Material of Straps	Rubber	Metal	Leather
Shape of Case	Cuboid	Cylinder	Curved
Pulse Range	25 bpm-250 bpm	25 bpm-250 bpm	25 bpm-250 bpm
Pulse Accuracy	+/- 2 bpm	+/- 2 bpm	+/- 2 bpm
Safety	Yes	Yes	Yes
Optical Sensor	Yes	Yes	No
Power	Replaceable Battery	Replaceable Battery	Replaceable Battery
Tracking System	GPS	GPS	GPS
Heart Rate Digital Display	No	Yes	No
Display Time	Yes	Yes	No
Sum of Values	35	33	27

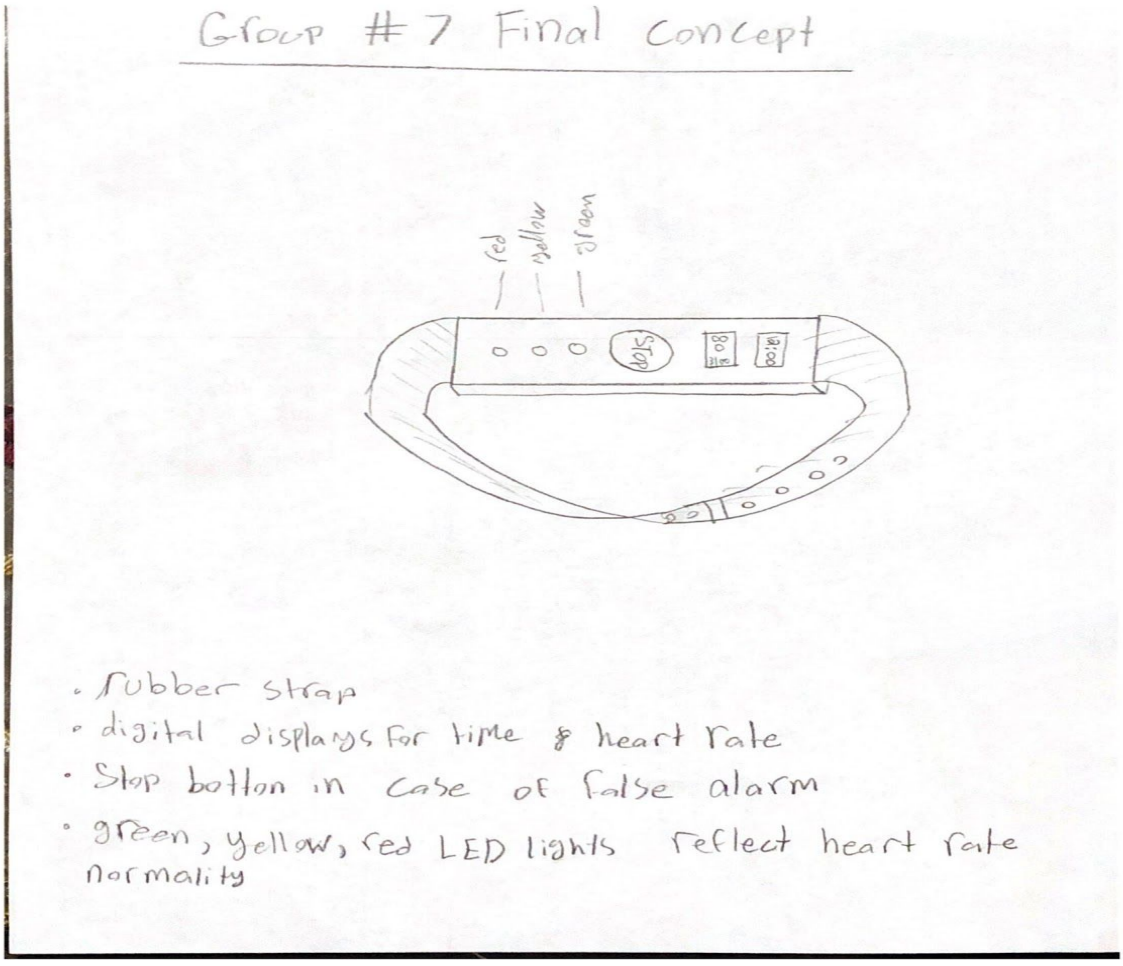
Concept 1
- Sum of Values = 35

Concept 2
- Sum of Values = 33

Concept 3
- Sum of Values = 27

Concept 1 wins as the user's most beneficial product when compared to the other concepts. This was done by utilising the design criteria's functional requirements as well as keeping the user's needs in check. The sum of values was calculated using the predetermined colour scale (green, yellow, red). We then use the design from Concept 1 to create a final concept for our opioid device which is displayed below.

Figure 7: Final Concept



The above sketch is the diagram for what the device that our group will create. This final concept is very similar to Concept 1 with the addition of a stop button in the event of a false alarm, which occurs when the user does not undergo an opioid overdose but the device mistakenly interprets that they are going through one. This is a very useful feature because the device cannot accurately determine whether one is experiencing an overdose at all times. One's heart rate can be less than the normal amount (frequent inhalation and slow exhalation) but that does not necessarily mean that they have overdosed. The other features of the device are that firstly, it has rubber straps because rubber is a fairly inexpensive material and these straps allow for more comfortability on the user's wrists. It is also lightweight and durable. Secondly, there are digital LED displays for both the time and user's heart rate. The displaying of time is a vital component of the device because it is the quintessential aspect of any watch. The heart rate is an integral part of the device due to the fact that one of the prevalent symptoms of an opioid overdose is that one's heart rate slowly decreases as time progresses. In some cases of

overdoses where the effects are gradual and prolonged, a person may notice his heart rate decreasing and start taking steps to obtain medical aid. In addition to this, there is a built-in LED light system which displays different coloured lights that reflect the heart rate normality. As aforementioned, green light indicates normal heart rate, yellow rate indicates questionable heart rate (less than normal), and red light indicates very low heart rate which means that the user is experiencing an opioid overdose, and will trigger the emergency response. This will start by the device emitting a loud noise and vibration to alert those around the opioid user of the situation, and also to gain the user's attention. In the situation where the emergency is a false alarm (which may occur with heart rate detection devices), the user may press the "stop" button to indicate that he is not having an overdose. The device uses replaceable batteries as some users may not have a place to safely charge the device by using a wire.

Of course, to every design there are limitations which must be kept in mind. With the global concept developed, there is an issue that, in some rare cases, a person may be experiencing an overdose but is in denial and wishes to not be disturbed. He may still have the ability and bodily control to cancel the emergency response, and in doing so, cancelling the medical aid he needs. However, there must be a system to prevent false alarms, which are much more likely to occur, and this is the best solution proposed, since infrared oxygen saturation levels are hard to do at the wrist. This drawback should be kept in mind during further development to lessen its probability of occuring. Another drawback is that some users may neglect to replace the batteries once their lifespan is ended, putting them at risk if they overdose. This can be potentially resolved by adding a "low battery" indicator to warn them ahead of time.

Conclusion:

Through combining our group members' sketches together into three conceptual designs, and then benchmarking these three solutions based on the design criteria requirements, one final design concept was formed for the device that our group will aim to produce. The first prototype will be as close as possible to the sketch presented above as we now move onto developing the project plan and creating cost estimates for the design of the watch.