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Team Discovery

Working in Space

Problems

Working in space has five main areas with problems, they are experiments, spacewalks, on board training, communication and on-orbit maintenance.

1. Astronauts spend years training for missions in space, however it is easy to forget how to do specific tasks. Also they need to train to know how you use new technology. So training has to continue on board.

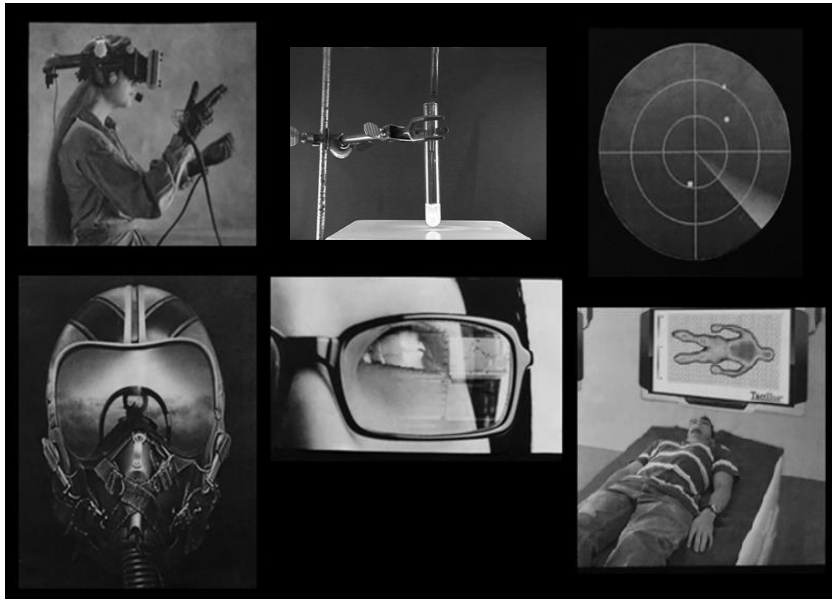
2. The challenges with conducting experiments is that objects and liquids floats in zero gravity, which makes it difficult for equipment to stay on the spot.

3. What causes the most damage to the space station is space debris and space debris can also hurt astronauts on spacewalks.

4. During spacewalks it is vital that the astronaut can communicate with the space station to report any problems or any changes to the mission. In space they use the communication carrier assembly which has problems, including the electronics being affected by the drinking and feeding tubes and any other liquid. The boom microphones are also too close to the astronaut's mouth, so the space station can hear a lot of breathing and the headphones move causing the astronaut not being able to hear properly and cannot be sorted once the helmet is on.

5. During spacewalks one of the challenges is the temperatures the astronauts endure. Depending on the position of the astronaut, they could face temperatures between 250 degrees Fahrenheit and -250 degrees Fahrenheit for between five to seven hours. To help solve this problem astronauts wear liquid cooling and ventilation garment (L.C.V.G.). The L.C.V.G works by pumping cold water through tubes close to the person's skin. However as the astronauts can feel too hot and too cold on spacewalks, the L.C.V.G. is not going to solve both problems.

Possible Solutions



1. A solution to training on board is a simulator that has different tasks to solve, like virtual gaming with different levels to pass. The simulator could also mimic the conditions in space for example by making the gloves change temperature.

2. A solution to conduct experiments successfully is to attach the equipment to a surface like a table, maybe by a nailed down test tube clamp stand.

3. The best way to solve the problem of space debris damaging the space station or hurting the astronauts on spacewalks is to detect the debris and avoid it. In space, radar can be used to detect the space debris.

4.1. To solve the problem of the feeding and drinking tubes affecting the communication carrier assembly separating the two can help. Also attaching the headphones to the helmet like a fighter pilot's helmet will solve the problem of headphones falling off. Astronauts will be used to the shape of the fighter pilots' helmets because they train on fighter planes.

4.2. Using other ways to communicate could solve the problems with speaking through a communication carrier assemble, such as texting. Texting in space is possible as the New York company Lone Signal sent texts into deep space.

5. A solution to finding out how cold or hot the astronauts are in their space suits is to have a temperature gauge, so the L.C.V.G. can be switched off if the astronaut is too cold.

Clay models

1. Visor for the virtual gaming training devise.

3. Handheld radar design to detect space debris.

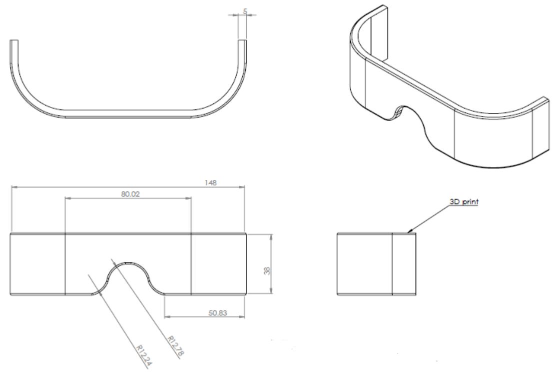
4.1. Helmet designed to look similar to a fighter pilot's helmet, which connects the microphone and headphone and gasmask together.

4.2. Arm cuff keyboard and cover to allow astronauts to text the space station.

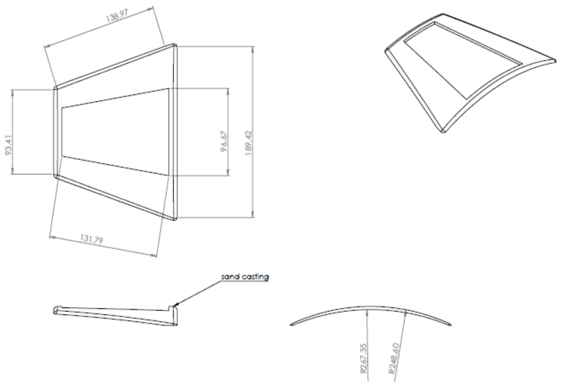
5. Handheld temperature gauge with a thermistor to get the skin temperature and a display to see the temperature.

Making the clay model made me realise what concepts had too many or too few components to them as I was making each part separate out of clay and attaching them together. I decided to make my clay models like that because I thought it would give me an idea how the actual product will come together. I have decided not to continue to develop the virtual training game concept because I felt that making a visor or screens to see the game and gloves or joystick to play the game would have too many components to them. Also I would have to make a prototype of the game too. I have also decided not to continue with the handheld radar device because it only had one component and wouldn't give me the chance to try multiple processes. As well as having too few components, I felt it would be too difficult to get the radar to work.

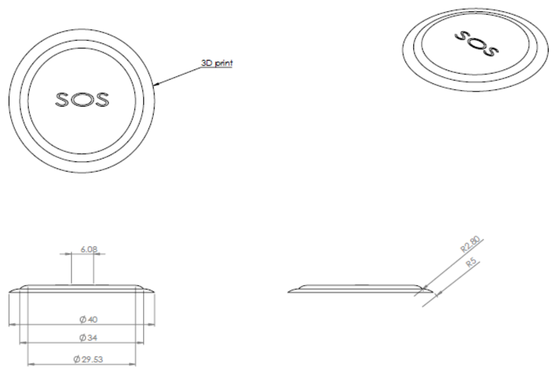
CAD Drawings



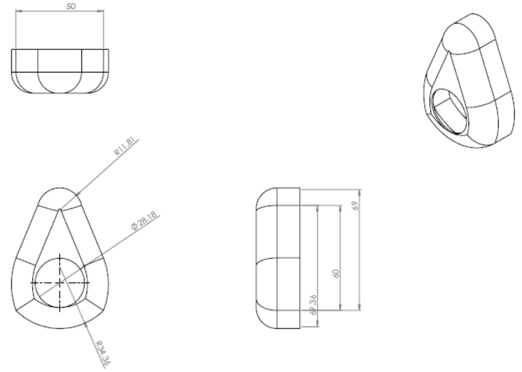
4.1. Visor for helmet



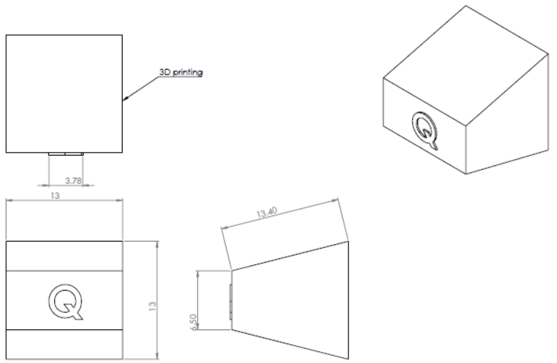
4.2. Keys' holder for text cuff



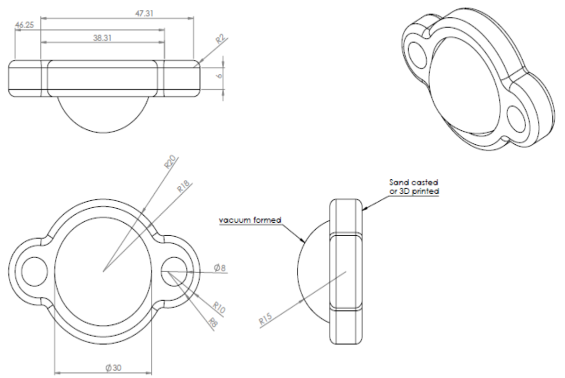
4.2. Buttons for text glove



4.1. Gas mask for helmet



4.2. Keys for text cuff



5. Temperature gauge design

Developing the ideas I decided to continue with on Solid Works I have come to realise what two ideas I would like to continue developing and creating. Even though there are flaws in the text cuff concept this allowed me to develop it into something better, for example making the keys look more modern on Solid Works. Also to make it easier to wear instead of the cuff the buttons can be on the astronauts glove. My last concept was to develop a helmet that makes communication easier however there would be a lot of components and difficulty assembling them all together.

Creating the temperature gauge concept the components were easy to create and assemble together on Solid Works. Also it looked compact and sleek, so I decided to keep with this idea.

Feedback

4.2. When presenting the text glove to my fellow students, they liked the concept, but they also gave me some suggestions to improve the product. One of the suggestions was that the text glove should be a secondary function, so the text glove was only used in emergencies. For example, when the communication carrier assembly was not working. This suggestion also meant a whole keyboard was not needed and could be replaced with a few buttons that are quicker to press. I took this suggestion into account and changed the text glove keyboard to four buttons: on/off, yes, no and SOS. The SOS button will be a great function for astronauts that end up in an emergency situation like astronaut Luca Parmitano, who nearly drowned in his spacesuit.

Another suggestion was to have a way to indicate if the buttons on the text glove have been pressed or not. This gave me the idea of a colour code indicator. When the glove is off the buttons are red, when switched on the buttons turn blue for standby and when a button is pressed the button pressed turns green for three seconds and then turns back to blue.

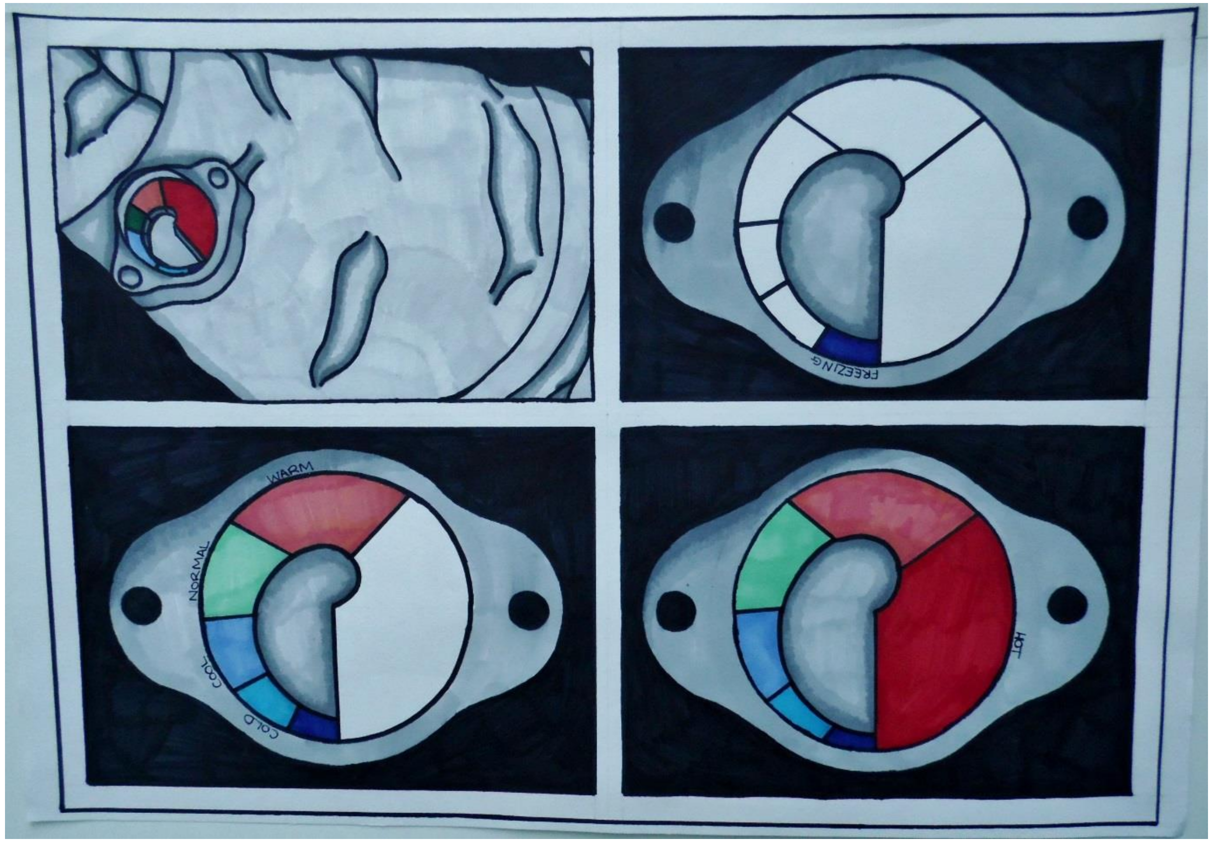
The final suggestion for the text glove was that it is harder to see the inside of your arm than the outside, however having the buttons on the outside would make it easier for them to be accidently pressed by objects. I've decided to have the buttons on the outside of the arm, but the buttons will need some pressure to be pressed to stop them from being accidently pressed.

5. When presenting the temperature gauge to my fellow students they gave me some suggestions to improve the product. One suggestion was that the colours that represented hot and cold should represent actual body temperature. I've changed the amount of colour sections so the colours represent body temperature between less than 34 degrees Celsius to more than 39 degrees Celsius, which is the temperatures of hyperthermia and fever.

The other suggestion was to make the temperature gauge part of the text glove as it will be easily seen on the glove and it will be close to the SOS button if the astronaut has hypothermia or a fever. The shape of the temperature gauge could attach on a glove, however I am not sure to have it on the same glove as the text glove or the opposite glove.

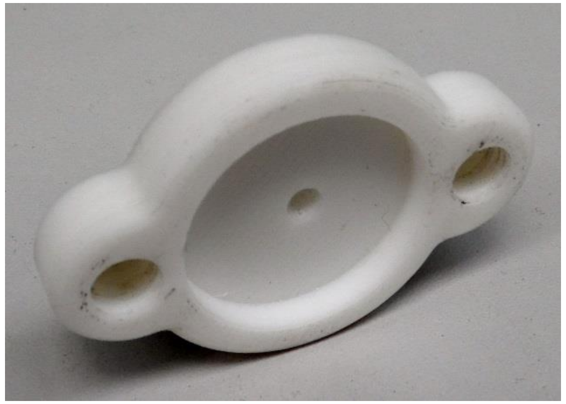
Interaction Drawings

- The buttons are red when the glove is off and blue when it is on.
- When you switch on the glove it tells the space station.
- The glove receives texts from the space station with a maximum amount of characters.
- The glove can answer yes and no questions.
- There is an SOS button to tell the space station about emergencies.
- When buttons pressed it goes green for three seconds to make the person aware it has been pressed.



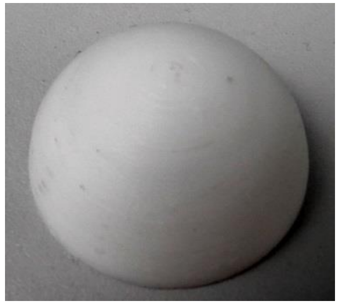
- The temperature gauge attaches to the glove by rivets.
- It lights up dark blue for freezing cold.
- It lights up mid blue for cold.
- It lights up light blue for cool.
- It lights up green for normal.
- It lights up orange for warm.
- It lights up red for hot.

Manufacturing the Prototype



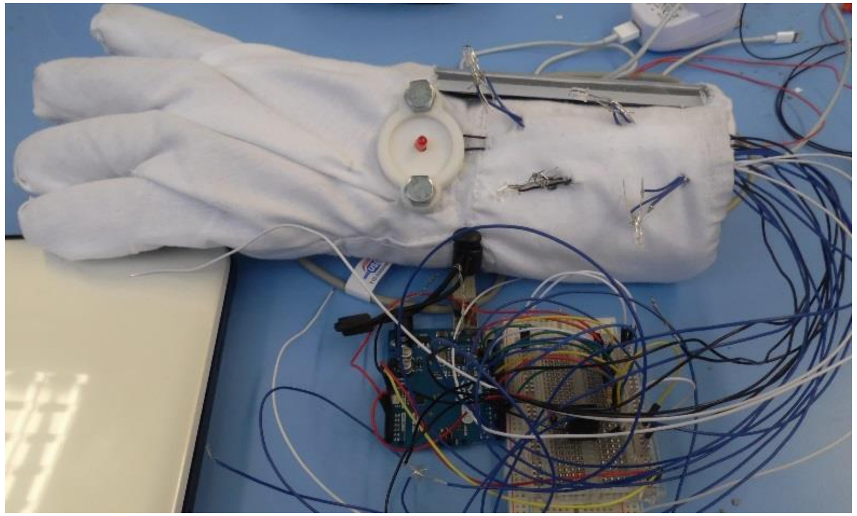
3D Printed Main Piece of the Temperature gauge

3D Printed Buttons



3D Printed Dome Mould

Vacuum Formed Dome



Hand Sewn Glove with Screen Prototype and RGB LEDs attached to an Arduino

Code for the Arduino:

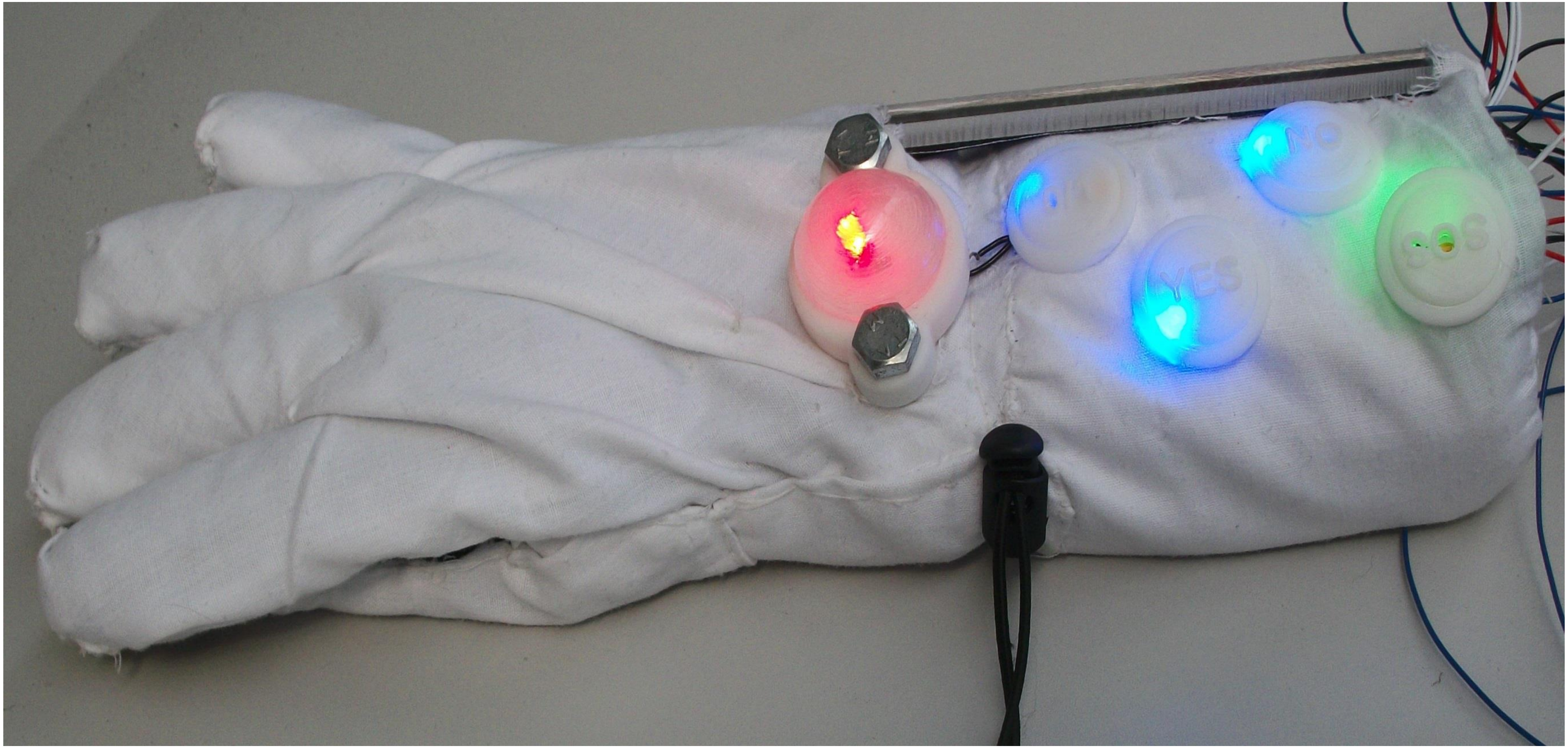
```
 pinMode(led4b, OUTPUT);
 pinMode(led2g, OUTPUT);
 //move this stuff later!
digitalWrite(led1r,HIGH);
digitalWrite(led2r,HIGH);
digitalWrite(led3r,HIGH);
digitalWrite(led4r,HIGH);
digitalWrite(LED,HIGH);
}
void loop()
{
 green_current = digitalRead(BUTTON2);

 if (green_current == HIGH && state == true)
  {
   digitalWrite(led1b,LOW);
   digitalWrite(led2g,HIGH);

   delay(5000);
   digitalWrite(led2g,LOW);
   digitalWrite(led1b,HIGH);
   green_current = LOW;
  }
 button_previous = button_current;    // the current state is now previous
 button_current = digitalRead(BUTTON);  // set the current button state

 if(button_previous == LOW && button_current == HIGH)
 {
  changeButtonState();
 }
// if state is true, turn LED on
// else turn LED off
if(state==true)
{
  digitalWrite(led1b, HIGH);
  digitalWrite(led2b, HIGH);
  digitalWrite(led3b, HIGH);
  digitalWrite(led4b, HIGH);
  digitalWrite(led1r, LOW);
  digitalWrite(led2r, LOW);
  digitalWrite(led3r, LOW);
  digitalWrite(led4r, LOW);
 }
 else
 {
  digitalWrite(led1b, LOW);
  digitalWrite(led2b, LOW);
  digitalWrite(led3b, LOW);
  digitalWrite(led4b, LOW);
  digitalWrite(led1r, HIGH);
  digitalWrite(led2r, HIGH);
  digitalWrite(led3r, HIGH);
  digitalWrite(led4r, HIGH);
 }
}
// function for flip state
// if the current state is true, change to false
// if the current state is false, set to true
void changeButtonState()
{
  if(state==true)
  {
   state=false;
  }
  else
  {
   state=true;
  }
}
```

Final Product



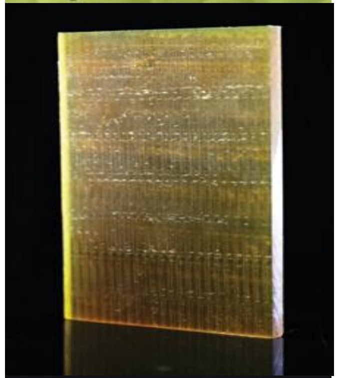
Materials for Real Product

4.2. The materials that will be used if the prototype went to manufacturing will have to be suitable for when the astronauts go on spacewalks. The text glove will be made out of the same fourteen layers of materials that other astronauts' gloves are made out of. The materials are: nylon tricot and nylon/spandex for the liquid cooling and ventilation inner and outer liner, urethane coated nylon for the pressure garment, Dacron for the restraint, neoprene coated nylon ripstop for the thermal micrometeoroid garment liner, multi-layered insulation-aluminized Mylar for the thermal micrometeoroid garment liner and ortho-fabric for the thermal micrometeoroid garment cover.

For the buttons I have been researching touch sensitive materials that are conductive which makes it easier to connect to a digital output such as a LCD screen and RGB LEDs. I found a material suitable called Interactive Senor. It is suitable as it is wearable, so it can be attached to the glove. Also the material is already being used for manufacturing fabric keyboards with.

5. The material for the dome on the temperature gauge has to be transparent to let the light come through. I found a plastic called Polyetherimide that is transparent. It also has a very high heat resistance that can with stand up to 422 Fahrenheit. As space only heats up to 250 Fahrenheit this plastic will withstand that temperature.

The material for the main piece of the temperature gauge will be made out of a light alloy, such as a magnesium alloy. This alloy is strong and is also heat resistant.



Product Developments for Earth

The text glove can be developed for occupations that are dangerous and could require a SOS button for emergencies. Also dangerous occupations most likely require to keep in contact with other people at all time and the text glove can be a backup for communication failure. The temperature gauge can be used for occupations that are in freezing or hot temperatures like artic explorers or firefighter to check their skin temperature.

Some of these dangerous occupations require safety gloves that the electronics can be fitted to, but other occupations do not. For these the glove can be changed into an electronic bracelet where the screen and buttons can either be on the bracelet or can be a skin sensor tablet. The bracelet can also be waterproof for occupations like trawling. Instead of texting other ways of sending messages can be used on Earth such as using Bluetooth or Wi-Fi.