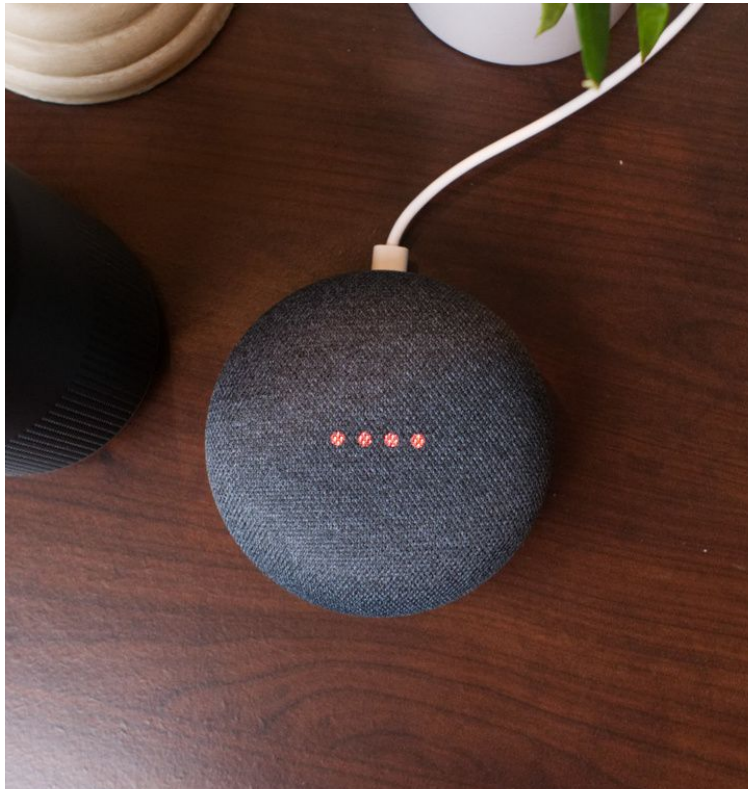# Design Project 4:
PRODUCT DESIGN SPECIFICATION

SUPER SYMPTOM SYSTEM
• *A Design Solution to Help Ms. Liu* •

Team 10

Elise Schwarz, schwae1

Madelyn Hogan, hoganm5

Sam Milicia, milicias

Faisal Khaleel, khaleef

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The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Signature:

Submitted by [Elise Schwarz, 400241480]

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Signature:

Submitted by [Madelyn Hogan, 400258666]

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Submitted by [Sam Milicia, 400244576]

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Signature:

Submitted by [Faisal Khaleel, 400251143]

Table of Contents

Background and Underlying Condition

The patient, Ms. Liu, suffers from an unknown condition causing pain, swelling, redness and burning in some of her joints. Specific joints causing pain include ones in her fingers, toes, and her hips. As a result of these symptoms, she struggles to open doors, open water bottles, walk far distances, take notes, and perform other fine motor movements. She takes a few medications at the moment, however the doctors struggle to help her as they are unable to diagnose her with a specific condition. Specifically, she takes immunosuppressants and cyclosporine (a specific type of immunosuppressant). These drugs are typically used for people after organ transplants to ensure that rejection doesn't occur [1]. However, they are also used for people with autoimmune diseases [1]. Immunosuppressants work by interfering with the synthesis of DNA for the immune system, preventing the cells from dividing [1]. Therefore, the cells of the immune system eventually die and the system's effectiveness is decreased [1]. Cyclosporine works by inhibiting the action of immune T cells [1]. However it can cause side effects that include swelling of the joints [1].

Ms. Liu does not have an official diagnosis, however there are some conditions that have symptoms similar to hers, and that are treated with the same medication and immunosuppressants. One of these conditions is lupus, a condition where the body attacks healthy tissue [2]. This can occur in the joints and cause swelling and pain [2]. Another condition is psoriasis, which is a skin condition that causes rapid buildup of skin cells that results in redness and inflammation. This condition is also treated with cyclosporine [3]. Lastly, there is also rheumatoid arthritis which also causes swelling and pain specifically in the hand and feet joints [4]. This is also an autoimmune disease commonly treated with immunosuppressants [4].

Currently, Ms. Liu goes to the hospital for monthly injections, which leave her in bed for the following few days. As a result, she struggles to keep up with university life and is dependent on others to help her during these times. Her symptoms are also very unpredictable at the moment, and she often does not know what she will be able to accomplish in a day beforehand, so she struggles to make plans and keep them. At the moment, the doctors ask Ms. Liu to record her symptoms so they may be able to find a pattern or cause of her symptoms. However, Ms. Liu struggles to remember to record her symptoms and she also struggles to use a pen and paper due to her joint pain. As a result, there is a lot of missing data that could potentially help her doctors diagnose her.

A Google Home is a well known device present in many households. Launched by Google in November 2016, this smart speaker is primarily designed as a vehicle for Google Assistant [5]. Google Assistant is Google's virtual helper activated by voice prompts and connected to the internet [5]. Google Home listens to its environment, but it won't interact with a person until they speak one of its preprogrammed wake words, such as "OK, Google" or "Hey, Google" [5]. Google Homes are highly customizable and can be tailored for a variety of

uses within the home. Some examples of its capabilities include recipe assistance, making phone calls, and playing music [5]. Google Homes can also store data such as grocery lists and can be customized to provide reminders or information at specific times throughout the day [5].

Google Assistants can be customized using a program called DialogFlow, a process referred to as building actions. DialogFlow is a cloud based software that runs on the Google Cloud Platform. It is powered by Google Machine Learning and can extract pre-set entries, such as the time, date, or a number from a spoken phrase [6]. DialogFlow can also be used with JavaScript to code more complex functions [7]. To build actions, firstly, training phases are set that will be used to identify when to start the program. The Google Home will listen for these training phrases and the program will be activated when a training phrase is heard. It can then store certain data and respond to the user. Using Google's machine learning, the software can identify phrases that are similar to the training phrases and also be activated that way, making the commands very flexible to the user. Additionally, DialogFlow allows for follow up intents, so the Google Home will ask a series of questions to the user, and collect data after each response. The program can also be activated at certain times of day, and DialogFlow can integrate with many other softwares to carry out tasks, such as Facebook Messenger, Slack, and more [8]. The data collected from each question can then be saved and exported to different platforms for use or analysis [8].

Need Statement

Ms. Liu needs a design solution that will make it easier and indelible to record her symptoms in order for her physicians to better understand and assist her with the condition(s) she faces.

Product Identification

- The purpose of the developed design solution is to assist Ms. Liu in recording data relevant to her condition over the periods of time in between visits with her specialists. In doing so, this solution also aims to help her doctors in treating her.
- The solution prompts Ms. Liu, via voice output through a Google Home, to enter data regarding her condition twice a day. Once in the morning immediately after Ms. Liu has woken up, and once in the evening at a user-set time. Data is then logged, saved, and displayed via a compatible mobile app where it is always accessible by her specialists.

- A defining feature of this solution is the easy-to-use, touchless, voice-based series of interactions between the user and the program which constitute the daily data collection.
- As well, a key feature is the program's AI-based dialog abilities, which allow the recognition of any phrase as well as the extraction of only the relevant information inputted. Furthermore, this means that the program could voice the same prompt in a variety of different ways.
- Another feature would be the program's ability to be downloaded onto any Google Home or other compatible Google devices and applications.
- An additional key characteristic of this solution is the mobile app compatibility, which allows a variety of unique features. These include, but are not limited to, reminder notifications, remote data logging, and a multitude of data display options.
- Furthermore, a final feature is that the program would work with the messaging service Twilio to send all raw data towards a cloud-based server for storage until use.
- The program itself would be a software downloadable on Google devices, but specifically designed for the Google home. Therefore, it would typically take the form of a Google Home, allowing it to remain light, user-customizable, and accessible around the user's house.
- The compatible app would include three main pages, consisting of a day-by-day logbook of raw data previously collected, a data-entry form for remote data input, and a summary of data collected within a user-specified time frame.
- The entire set-up would weigh roughly 1 lb.

Usage

- The program can be installed onto the user's Google Home through the Google Home app (not the compatible app previously mentioned) as a custom action.
- Once the program is set up, usage is kept extremely intuitive. At the time of each data collection session, all the user has to do is simply reply to the data collection voice-prompt to start the process. Then, they would answer the symptom/activity questions by voice in an appropriate manner until the program clarifies that they've reached the end of their conversation.
- The compatible app is similarly intuitive and easy-to-use. If the user is trying to view raw data from a specific date, they would be prompted to enter the date they are looking for. If the user is looking to summarize data from the past, they would specify a range of time and select from pre-established methods of data display. Finally, if Ms. Liu is trying to input data away from home, she would fill out a form consisting of the same questions she would have been asked by the program at home.

- Each data collection session should range from 3-5 minutes. This is done twice a day. On the other hand, the compatible app would be used whenever necessary but especially in the meetings Ms. Liu has with her doctors for a quick data summary and analysis.
- The Google Home would likely be stored in Ms. Liu's room, allowing the operating/service environment to remain dry and at room-temperature, free of risk.

Standards and Safety

- The main standards and safety issue is confidentiality of user information. Throughout the processes of information input, transfer, formatting, and output, confidentiality is at the forefront.
- Protections that will be in place include the user being able to control who is able to access the information from the app by authorizing who is allowed to log in, encryption of messages during transfer using the Twilio feature, and the database where the information is stored being inaccessible to anyone but developers outside of the app.
- The probability of breach is low since the process is very secure and only contains low-risk information about one person, rendering it an unlikely target for a data breach.
- In the event there's a breach, the severity is low since there is no critical information stored, only information about severity of symptoms and activity levels.

Life Cycle

- The life cycle of the program is essentially infinite, since it can be moved to new devices if an upgrade or repair is needed on the host device.
- Periodic updates will be required every few months or at a doctor's request, possibly to update questions asked or add a new method of data output.
- The product can be serviced or replaced by developers of the program, or anyone with access to the software.
- The Google Home can be cleaned by being wiped down with a cloth, and it can be fixed or replaced by the vendor.

Production Cost

- To produce this program, 2 Twilio accounts would be required, one to send the message from the Google Home and one to receive it in the database. Each message sent or received costs $0.0075, so the cost per month would be about $1.
- A Google Home would be required to run the application, which ranges from about $50 - $300 depending on the model and size, but even the cheapest one would be sufficient.
- A database would cost about $0.50 per month, since little storage is required for this product.
- The fee of publishing an app on the Apple App Store is $99 per year, the Google Play Store is a $25 one-time fee, and the Windows Store is a $12 one-time fee.
- It is assumed that the end users already have a method of accessing the app, (a cell phone, tablet, or personal computer with a WiFi connection). Overall, the program using an iPhone would be $50 up front and $10 per month, using an Android would be $75 up front and $1.50 per month, and using Windows would be $62 up front and $1.50 per month.

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[3] A. Rendon, K. Schakel, "Psoriasis Pathogenesis and Treatment," *NCBI,* March 2019. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6471628/. [Accessed: 04-Apr-2020].

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[6] "DialogFlow," *DialogFlow.* [Online] Available: https://cloud.google.com/dialogflow [Accessed: 04-Apr-2020].

[7] "The Dialog Flow Definition," *Oracle.* [Online]. Available: https://docs.oracle.com/en/cloud/paas/digital-assistant/use-chatbot/dialog-flow-definition.html#GUID-CE86A43E-286A-462C-8B80-0BA2666D80F7 [Accessed: 04-Apr-2020].

[8] "Integrations," *Google Cloud.* [Online]. Available:
https://cloud.google.com/dialogflow/docs/integrations [Accessed: 04-Apr-2020].

Appendices

Appendix A - Customer Requirements

- *Objectives*
  - Appealing
  - Portable
  - Easy to use
  - Durable
  - Intuitive
  - Ergonomic
- *Constraints*
  - Inexpensive
  - Pain-free
  - Does not require fine motor movements
  - Lightweight
  - Powered
- *Functions*
  - Receives input
  - Records symptom data
  - Saves recorded data
  - Results are accessible by physicians
  - Provides a periodic reminder to input data

Appendix B - Engineering Specifications

- Personal opinion of appeal (scale of 1 to 10)
- Personal opinion of ergonomics (scale of 1 to 10)
- Dimensions (mm)
- Number of steps (numerical value)
- Force device can withstand (N)
- Cost ($)
- Confirmation (Yes/No)
- Mass (g)
- Memory (Gb)

Appendix C - Quality Functional Deployment Chart

Quality Functional Deployment Chart

| February 28, 2020 |
| Design Project 4, Milestone 1 |
| Elise Schwarz, schwae1 |
| Sam Milicia, milicias |
| Madelyn Hogan, hoganm4 |
| Faisal Khaleel, khaleef |

Customer Requirements	Personal Opinion of Appeal (scale of 1 to 10)	Personal Opinion of Ergonomics (scale of 1 to 10)	Number of Steps (numerical value)	Dimesions (mm)	Force Device Can Withstand (N)	Cost ($)	Confirmation (Yes/No)	Mass (g)	Memory (Gb)
Appealing	●	▽		○			▽	○	
Portable		●	▽	●	○		▽	●	
Easy to use		▽	●				○		
Durable		▽	○		●			▽	
Intuitive		▽	●				○		
Ergonomic	▽	●		▽			○	▽	
Inexpensive						●			
Pain-Free		●					●		
Does Not Require Fine Motor Movements		▽	○				●		
Lightweight				▽			▽	●	
Powered						○	●		▽
Recieves Input			○				●		
Records Symptom Data							●		▽
Produces Accessible Results			●				●		▽
Saves Recorded Data							●		●
Periodic Reminder to Input Data							●		

Relationships		Weight
Strong	●	9
Fair	○	6
Weak	▽	3
No Relationship		0

Appendix D - Sketches of Proposed Design Solutions

Concept 1 - Amazon Alexa Mini-Program & Compatible App
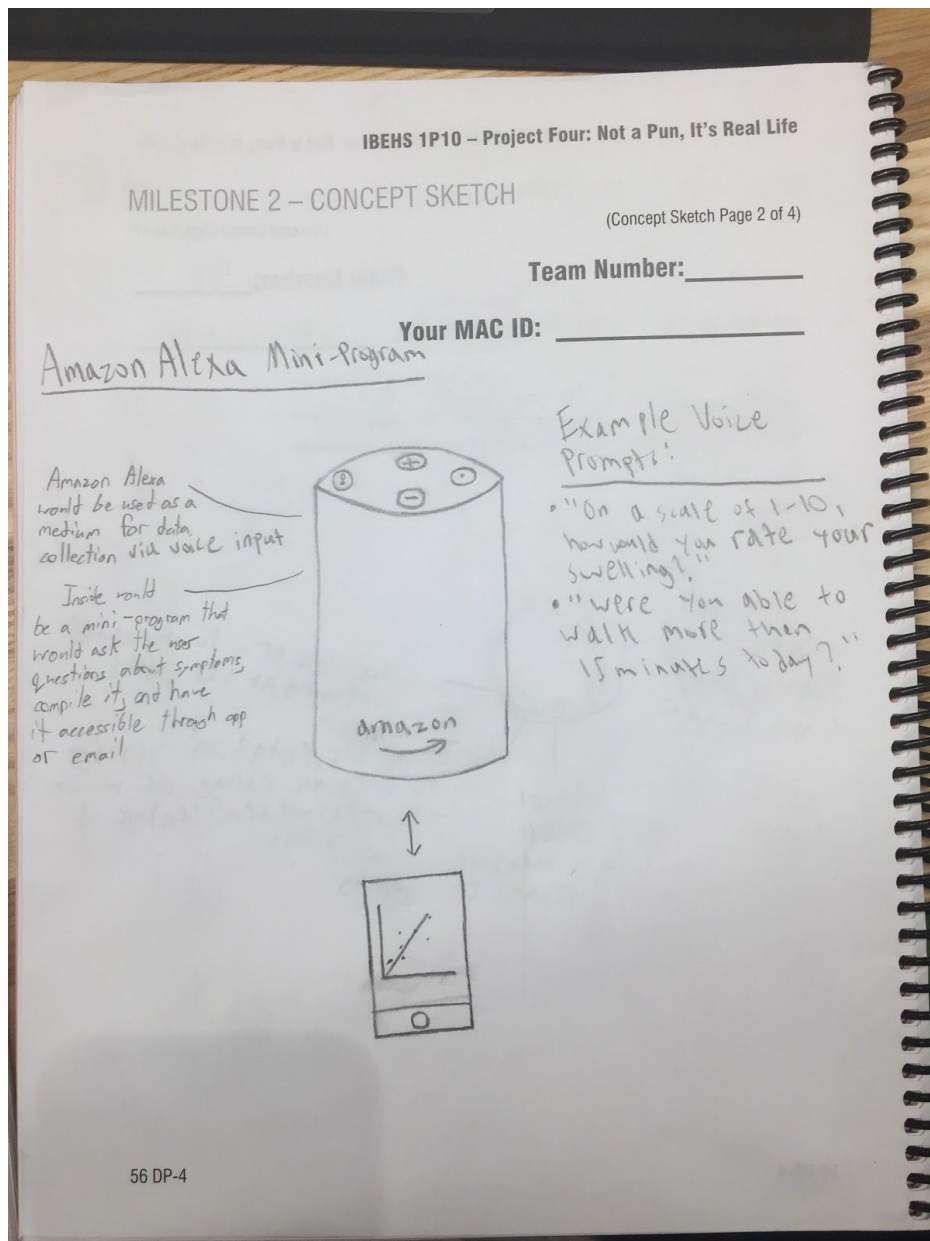
APP INTERFACE

Daily Logbook

app asks a series of questions, asking her to rate pain / symptoms / etc on a scale from 1-5.

→ app records data →

Symptom:

app summarizes & display average statistics
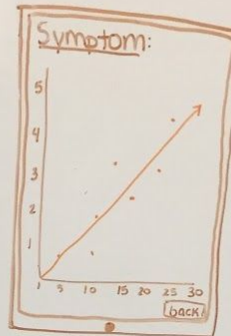
Activities Logbook:

app asks her to rate her ability to complete everyday tasks & abilities.

Activities:

Activities + Symptoms
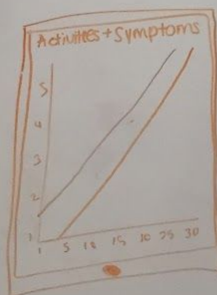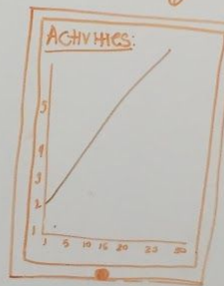
overlay the activities & symptoms graph to see correlation

Concept 2 - Symptom Scanner

MILESTONE 2 – CONCEPT SKETCH

(Concept Sketch Page 1 of 4)

Team Number: 10

Your MAC ID: milicias

Scanner

description of sensors

actual computational components (inside)

Joint is placed on top of sensors

sensors to detect symptoms (such as temperature, colour, force)

rechargable batteries

55 DP-4

15
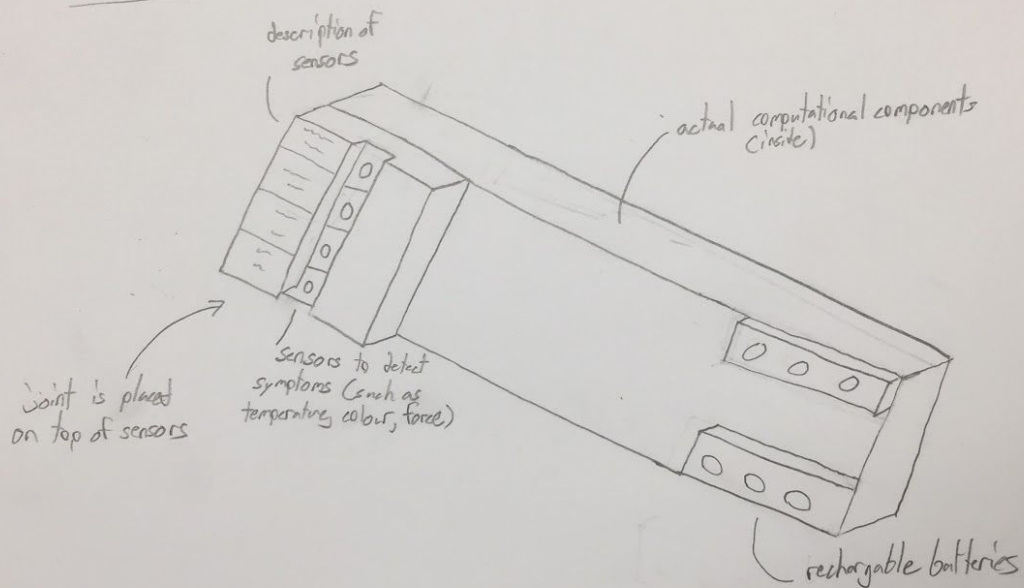
Concept 3 - Symptom-Monitoring Ring

MILESTONE 2 – CONCEPT SKETCH

(Concept Sketch Page 1 of 4)

Team Number: 47

Your MAC ID: 400251143

Symptom - Monitoring Ring

Embedded Replaceable Battery + Data Logger

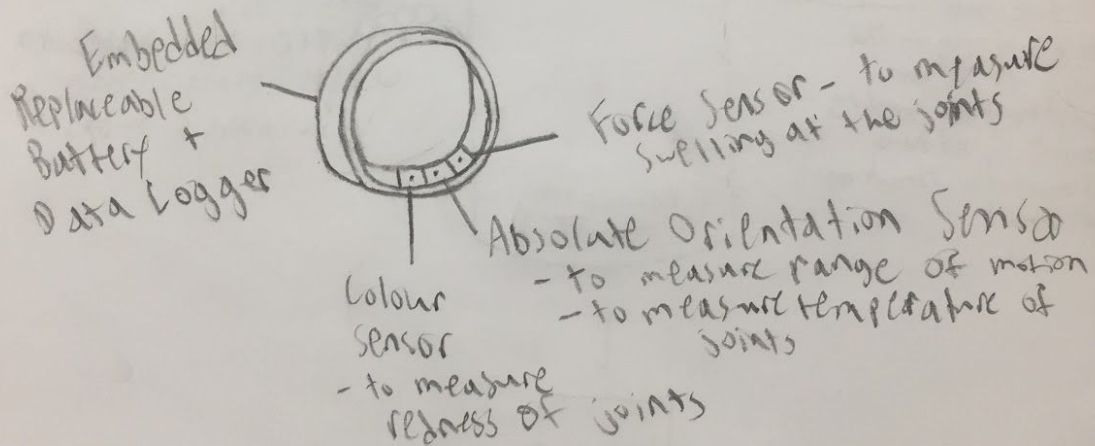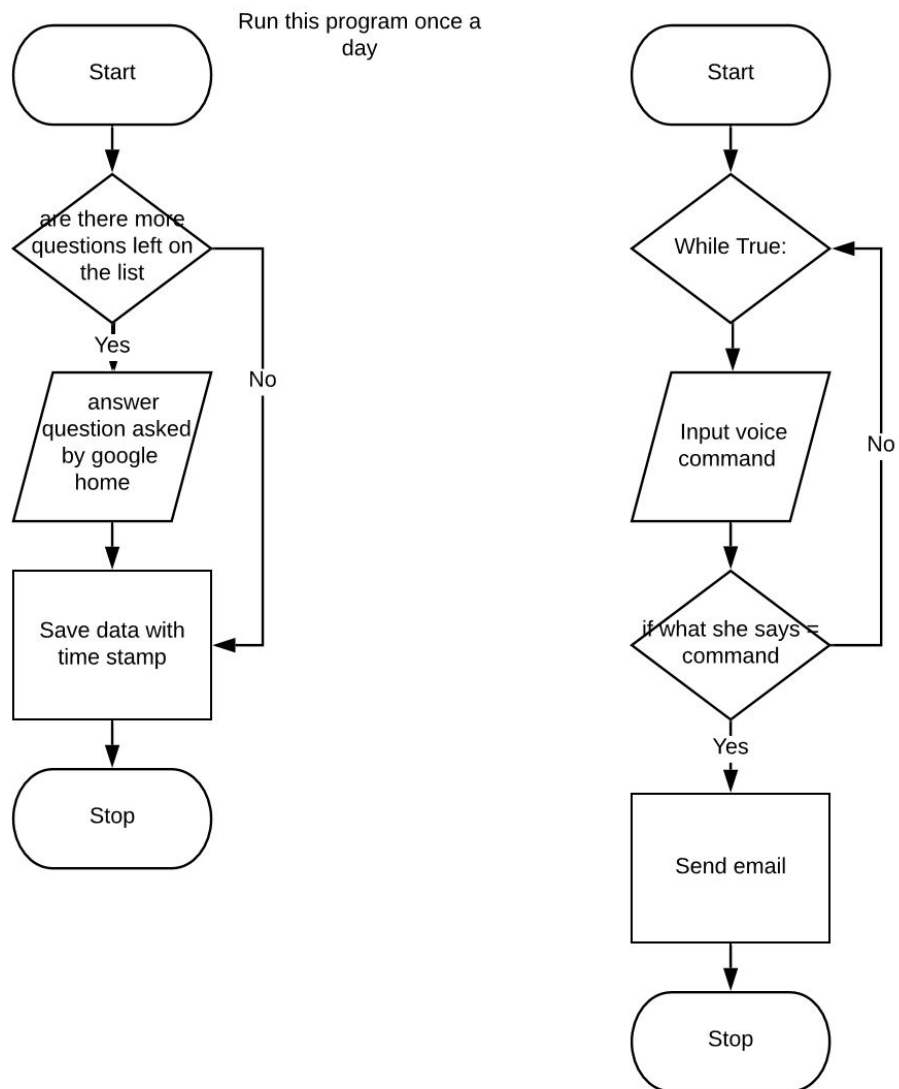Force Sensor - to measure swelling at the joints

Absolute Orientation Sensor
- to measure range of motion
- to measure temperature of joints

Colour Sensor
- to measure redness of joints

55 DP-4

Appendix E - Concept Evaluation

Design Project 4, Milestone 2				
March 5, 2020				
Elise Schwarz	schwae1			
Madelyn Hogan	hoganm5			
Sam Milicia	milicias			
Faisal Khaleel	khaleef			

Criteria	Weight (/5)	Concept 1 - Ring		Concept 2 - Scanner		Concept 3 - Amazon Alexa		Concept 4 - App	
		Rating (/5)	Weighted Rating	Rating (/5)	Weighted Rating	Rating (/5)	Weighted Rating	Rating (/5)	Weighted Rating
Appealing	2	5	10	2	4	4	8	4	8
Portable	2	5	10	1	2	3	6	5	10
Easy to Use	5	5	25	4	20	5	25	5	25
Durable	2	2	4	4	8	4	8	5	10
Intuitive	4	5	20	4	16	5	20	5	20
Ergonomic	4	3	12	4	16	5	20	3	12
Inexpensive	4	1	4	3	12	4	16	5	20
Pain-free	5	3	15	5	25	5	25	4	20
Does Not Require Fine Motor Movements	5	5	25	4	20	5	25	2	10
Lightweight	3	4	12	2	6	4	12	5	15
Powered	5	5	25	5	25	5	25	5	25
Recieves Input	5	4	20	4	20	3	15	2	10
Records Data	5	4	20	5	25	4	20	5	25
Saves Data	5	2	10	5	25	4	20	5	25
Results Accessible by Physicians	5	1	5	5	25	3	15	5	25
Provides Reminder	4	1	4	3	12	5	20	5	20
Total	325		221		261		280		280
Percentage	100.0		68.0		80.3		86.2		86.2

Conclusion: We have decided to pursue a combination of the Amazon Alexa and the app because these they have the highest rating in the most heavily weighted criteria.

The app makes the results really accessible and the Amazon Alexa makes the collection of data is very easy since you only have to use your voice, and there is no fine motor movements required.

The app would also have more room for storing data.

Appendix F - Documentation of Low-Fidelity Prototypes

Preliminary Flowcharts of Proposed Program

Run this program once a day

```
Start
  |
  v
are there more
questions left on  ----No----
the list                    |
  |                         |
 Yes                        |
  v                         |
answer                      |
question asked              |
by google                   |
home                        |
  |                         |
  v                         |
Save data with  <----------
time stamp
  |
  v
Stop
```

```
Start
  |
  v
While True:  <------------
  |                      |
  v                      |
Input voice             No
command                  |
  |                      |
  v                      |
if what she says =  -----
command
  |
 Yes
  v
Send email
  |
  v
Stop
```

Current Progress Achieved Towards Final Prototype

Shared with the prof1p10@mcmaster.ca email is our Google Actions console in which our program has been developed thus far. We have also developed a video demo explaining how to access and try our program at its current state, this is the link: https://youtu.be/y9Vw7FR79TI

Preliminary Code for Saving Data on a Cloud-Based Server

```
Saving Twilio Messages.py - C:\Users\faisa\Downloads\Saving Twilio Messages.py (3.7.4)
File  Edit  Format  Run  Options  Window  Help

from flask import Flask, request
from twilio.twiml.messaging_response import Message, MessagingResponse

app = Flask(__name__)
@app.route('/sms', methods = ['POST'])

def sms():
    number = request.form['From']
    message_body = request.form['Body']
    resp = MessagingResponse()
    symptoms = open('Symptoms.txt', 'a')
    symptoms.write(message_body)
    symptoms.close()
    resp.message('Hello {}, you said: {}'.format(number,message_body))
    return str(resp)

if __name__ == '__main__':
    app.run()
```