

# Design of a Device to Help Severely Mentally Ill Patients Quit Smoking

## Design Team:

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## Client:

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Emeritus Professor  
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Dartmouth College
- ✧ Joelle Ferron, Ph.D.  
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# Overview

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# Client

## **Prof. David H. Gustafson**

UW Madison

Department of Industrial and Systems Engineering



## **Mary F. Brunette, M.D.**

## **Joelle Ferron, Ph.D.**

Dartmouth College

Department of Psychiatry

# Background

- ▣ Tobacco addiction in SMI patients

(Brunette et al., *Psychiatric Services*, 2011)

- Cigarette smoking rates in SMI patients: 45%–90%
- Cigarette smoking rates in general population: 20%



# Background

- ▣ Diseases caused by smoking

*(National Cancer Inst., Smoking, June 5, 2012)*

- Lung and other forms of cancers
- Heart and blood vessel diseases
- Stroke
- Cataracts



# Background

## ■ Quitting smoking in SMI patients

(Brunette et al., *Health Education Research*, 2012)

- Difficulty: Not using the traditional resources
- Solution: Using a well-designed program for the SMI
  - Constant (24 hours a day) monitoring
  - Access to structured computer programs



# Problem Statement



To design **a case** (Pack Pal) for holding cigarettes to help a severely mentally ill (SMI) patient quit smoking via communication with a **smartphone**.

# Motivation



- ▣ Research shows: people with nervous disorders want to stop smoking.
- ▣ No successful program/therapy to aid quitting and prevent relapse.
- ▣ The Pack Pal = coach + data
- ▣ Travel to Chicago to visit patients and gain valuable insight



# Design Specification

## □ Case Requirements

- Always locked
- Open after a specified time delay
- Sense
  - Opening attempt
  - Actual opening
  - Number of cigarettes removed
- Transmit the data to the smartphone wirelessly

# Design Specification

- ▣ Smartphone Requirements
  - Analyze the data from the case
  - Deploy countermeasures to discourage smoking behavior
    - Picture of smoke damaged lung
    - Social media
    - Friends or Family
  - Record trigger and rate craving strength
  - Send weekly updates to the subject

# Design Options

- ▣ Cigarette Case
  - Cigarette Sensing
    - Accuracy and consistency
    - Low power consumption
    - Minimize components
  - Options
    - Separate IR LED/Sensor
    - Integrated IR LED/Sensor
    - Flex/Strain sensitive resistor

# Design Options

## ▣ Cigarette Case

### ■ Battery

- Reliability and efficiency
- Cost effective
- Size

### ■ Options

- Replaceable batteries
- Removable lithium-ion battery
- Wall-charge lithium-ion battery

# Design Options

## ▣ Cigarette Case

### ■ Locking mechanism

- Size
- Physical strength
- Reliability
- Power Consumption

### ■ Options

- Magnetic
- Linear Actuator

# Design Options

- ▣ Smartphone Application
  - Platform: iOS, Android, Windows
  - User interface
  - Data
    - Storage
    - Accessibility
    - Representation
  - Program design and implementation
    - Always running (background process)
    - Handling Bluetooth communication



# Design Matrices

<b><u>Cigarette Sensing</u></b>	<b>Separate IR LED/Sensor</b>	<b>Integrated IR LED/Sensor</b>	<b>Flex Resistor</b>
Power Consumption (.6)	3	3	4.2
Components (.4)	0.8	1.6	2
Reliability (.8)	4.8	5.6	0.8
Implementation (.3)	0.9	1.5	2.4
<b>TOTAL</b>	<b>9.5</b>	<b>11.7</b>	<b>9.4</b>

# Design Matrices

<b><u>Battery</u></b>	<b>Replaceable Batteries</b>	<b>Removable Li</b>	<b>Wall-Charge Li</b>
Initial Cost (.3)	2.1	0.9	0.9
Long-term Cost (.4)	0.8	3.2	3.2
Interaction (.2)	0.4	0.4	1.6
Convenience (.5)	2	1	3.5
Implementation (.6)	3.6	3.6	2.4
<b>TOTAL</b>	<b>8.9</b>	<b>9.1</b>	<b>11.6</b>

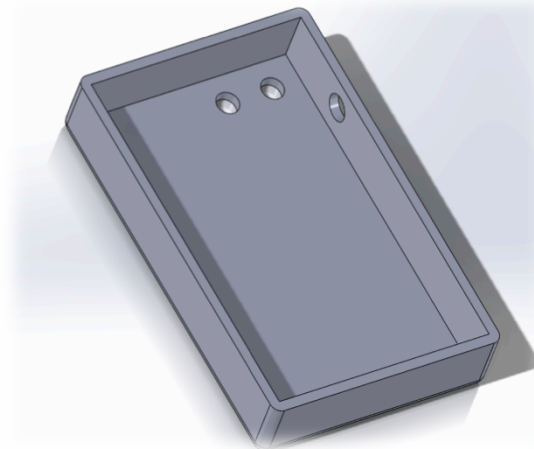


# Design Matrices

<b><u>Locking Mechanism</u></b>	<b>Magnetic</b>	<b>Linear Actuator</b>
Power(.7)	1.4	3.5
Cost (.3)	1.5	1.2
Strength (.6)	2.4	4.2
Implementation (.5)	1.5	2
<b>TOTAL</b>	<b>6.8</b>	<b>10.9</b>

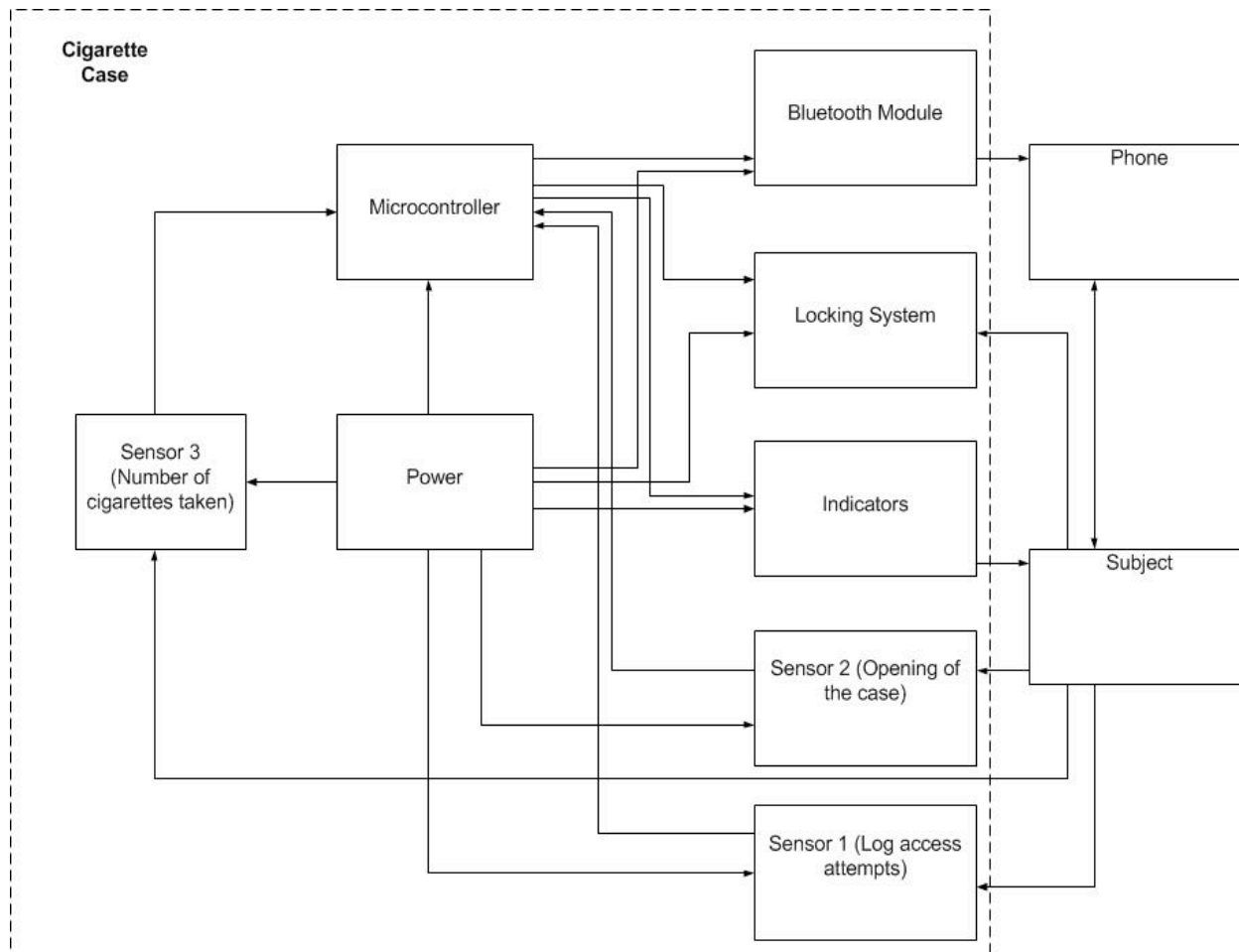
# Final Design

- ❑ Integrate circuit into case
- ❑ Log access data and send to phone
- ❑ System interacts with user to obtain data about smoking habits
- ❑ Data presented user and health professionals to aid user in quitting



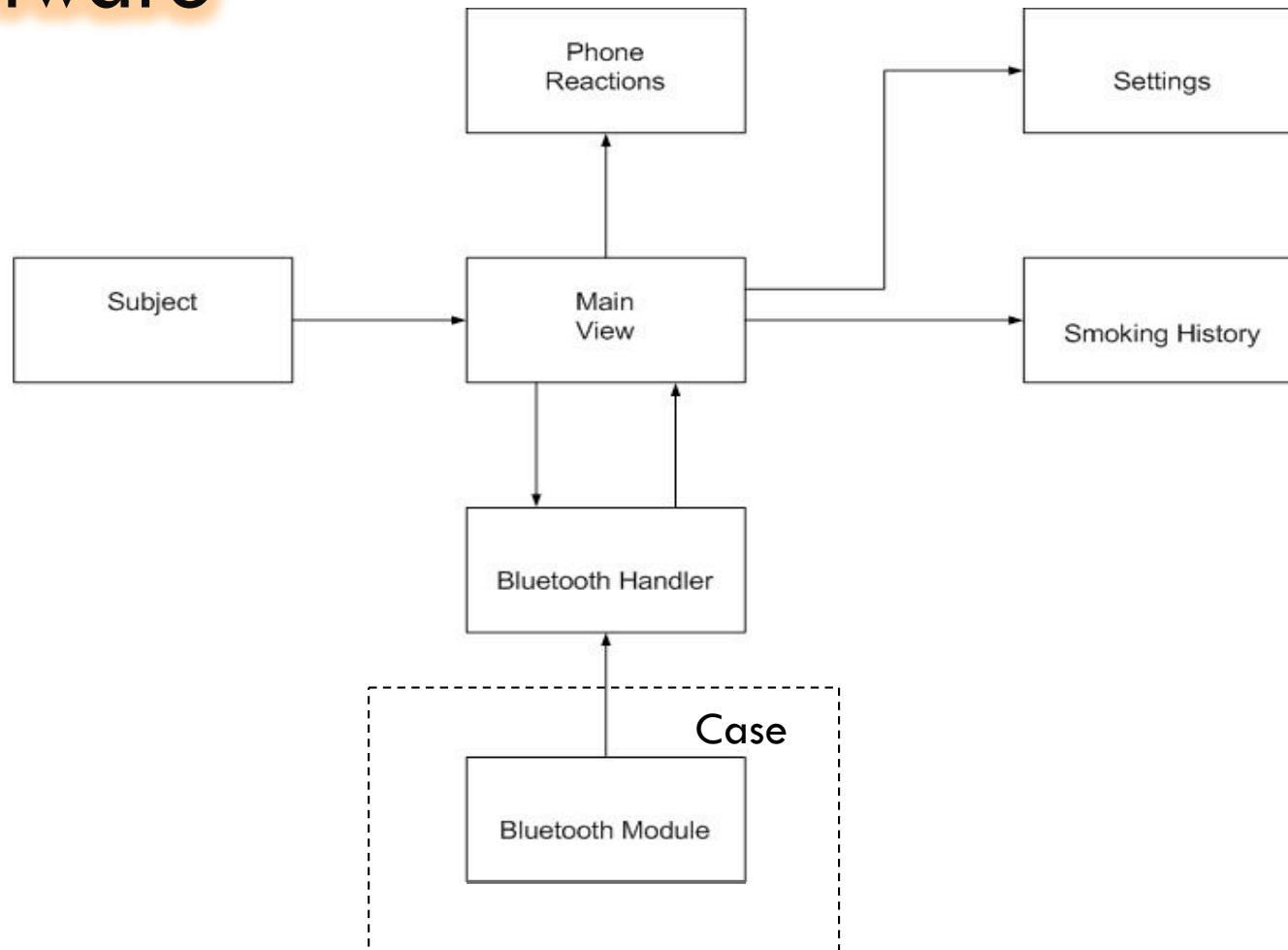
# Block Diagrams

## Hardware

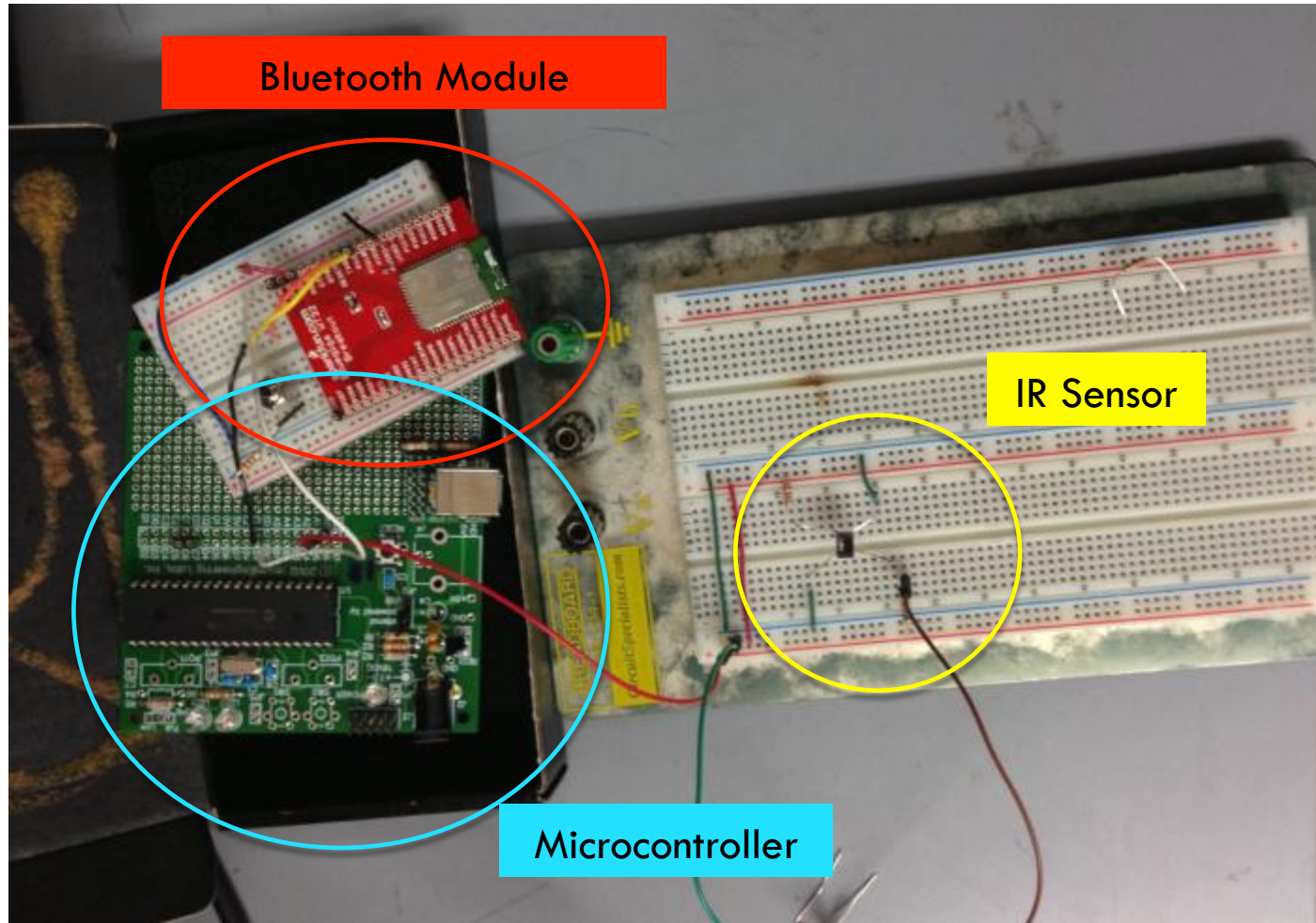


# Block Diagrams

## Software



# Future Work and Implementation



# Future Work and Implementation

## □ Future Work

- Case Design
- Application
- Electronics

## □ Implementation

- Participant Testing
- Clinical Trial

# Acknowledgments

- ▣ **Prof. David Gustafson (Client)**

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- ▣ **Prof. Mary Brunette (Client)**

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- ▣ **Prof. Joelle Ferron (Client)**

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- ▣ **Dr. Amit Nimunkar (Advisor)**

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# References

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Any Questions?

