18 days

to

PDR

Senior Design Project - SDP18

Schedule

This schedule shows the main events for SDP18. Please note that the schedule is subject to change.

September 2017

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5 First day of classes	6	7 Lecture 1: Introduction	8	9
10	11	12	13	14 Lecture 2 : Problem Specification and Team Management	15	16
17	18	19 Advisors due	20	21 Lecture 3: PDR	22	23
24	25	26 Benchside meetings	27	28 Benchside meetings	29	30

October 2017

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9 Holiday	10 PDR	11 PDR	12 PDR	13 PDR	14
15	16 PDR	17 PDR	18 PDR	19 PDR	20 PDR	21
22	23	24	25	26	27	28
29	30	31 Benchside Meetings	1	2 Benchside Meetings	3	4

SDP18

PDR Prep

Department of Electrical and Computer Engineering
Lecture 3

?

Design Process

“Place and Paste”
SDP12

Design Process: Set Intermediate Goals

assess needs

analyze requirements

design system

? **Problem Statement**

? **Systems Specifications**

? **Block Diagram**

detailed block level design and test

Functioning subsystems

system integration and test

Covering the Fundamentals of PDR

- We will examine a previous PDR presentation
  - Covers all major points
  - Well executed presentation for a useful project
  - Place N Paste – Senior Design Project 2012 - Salvatore Cacciatore, Kenny Neyhart, Benjamin Oven, Tony Saloio
- You need to describe what you have done so far and what you will do in the future
  - Ask *yourself* the tough questions first before evaluators do
- Stress teamwork and moving forward together

PDR Preparations

- Your presentation must address
  - Assess needs (Problem Statement)
  - Analyze requirements (System Specification)
  - Design System (Design Alternatives & Solution: Block Diagram)
  - Team roles (technical and administrative)
- MDR Deliverables
  - Very *specific*
  - What will your prototype be able to do?
    - *Focus on most essential, technically challenging portion of project*
  - Note: it's better to under-promise and over-deliver
- Handouts (1 per reviewer)
  - Problem statement
  - System Specification
  - Block diagram

PDR Rules

- 20 Minutes of Presentation
- Evaluators May Not Interrupt Presentation
- Evenly Divided Among Team Members
- Advisor Present but Silent

- 20 Minutes of Questions
- Invited guests may also be present

- Evaluators will meet immediately after presentation

PDR Questions

Is your project impressive?

Do your reviewers have advice?

What will you deliver for MDR?

Practice, Practice, Practice

Four speakers is 20 minutes is a lot of handoffs. Practice at least 2 times in front of advisor.

Assess Needs (Problem Statement)– Place n Paste

- Assess Needs
  1. Students cannot properly squeeze toothpaste
  2. Unable to apply appropriate amount of toothpaste
  3. Teachers must assist students every time they need to brush
  4. Students must be independent in maintaining *their* daily hygiene

- Problem Statement
  1. Difficult for disabled people to brush their teeth without assistance
  2. Automated system that doesn't make a mess. Easy to use
  3. Functioning system that can easily be used by a disabled person without external assistance

Analyze Requirements (System Specifications)

1. Dispense pea-sized toothpaste onto brush
2. Will hold toothbrush such that the machine and toothbrush will stay sanitary
3. Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush
4. Product will take no longer than 20 seconds from when toothbrush is correctly inserted to return loaded toothbrush
5. Product size will not obstruct normal use of school's single occupancy bathroom
6. Product will be designed such that it will guide toothbrush motion once it is placed into holder

Design Alternatives (Existing Products)

This product will not meet:

Specification 3: Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush

Specification 6: Product will be designed such that it will guide toothbrush motion once it is placed into holder

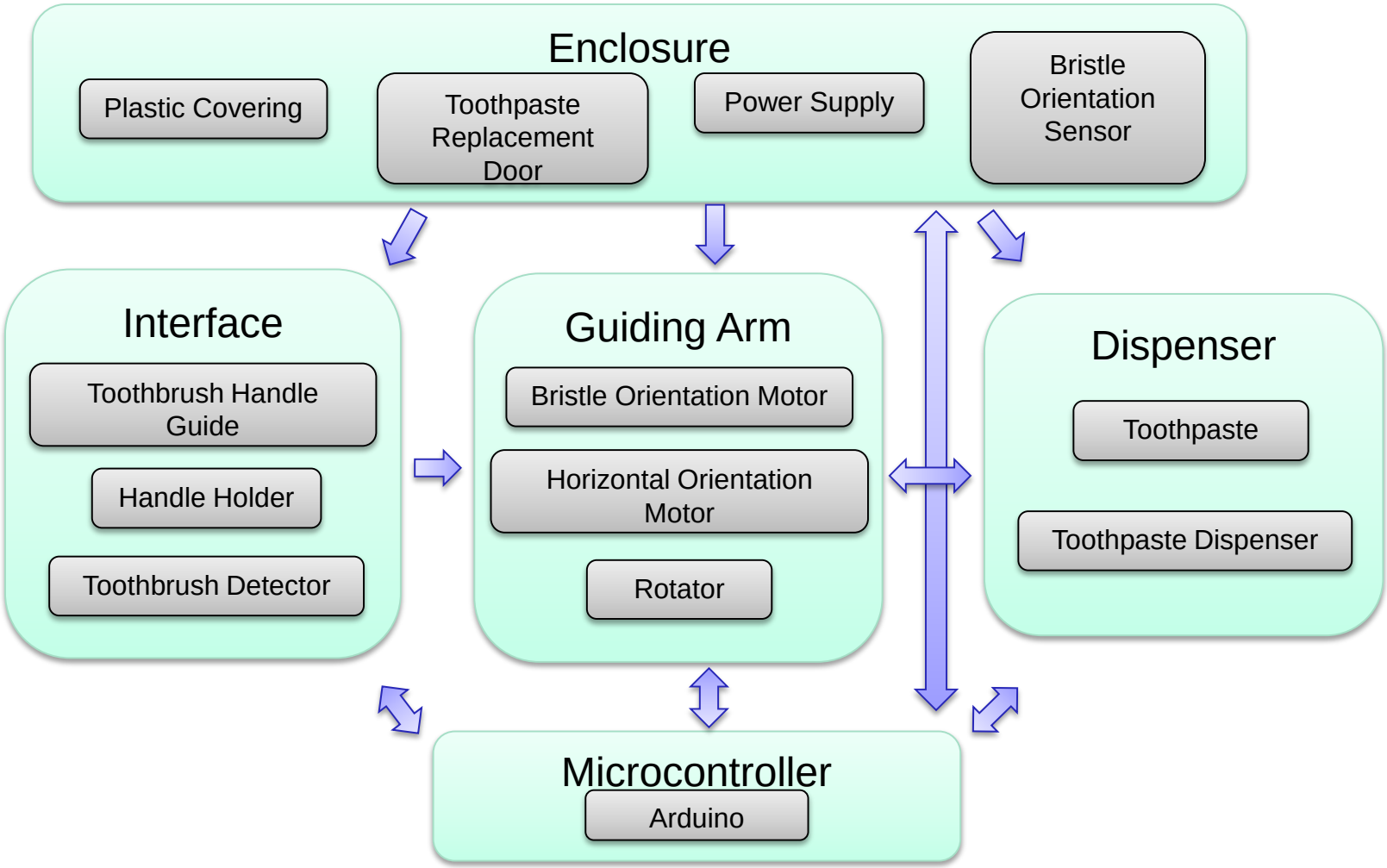
Design Alternatives (Existing Products)

This product will not meet:

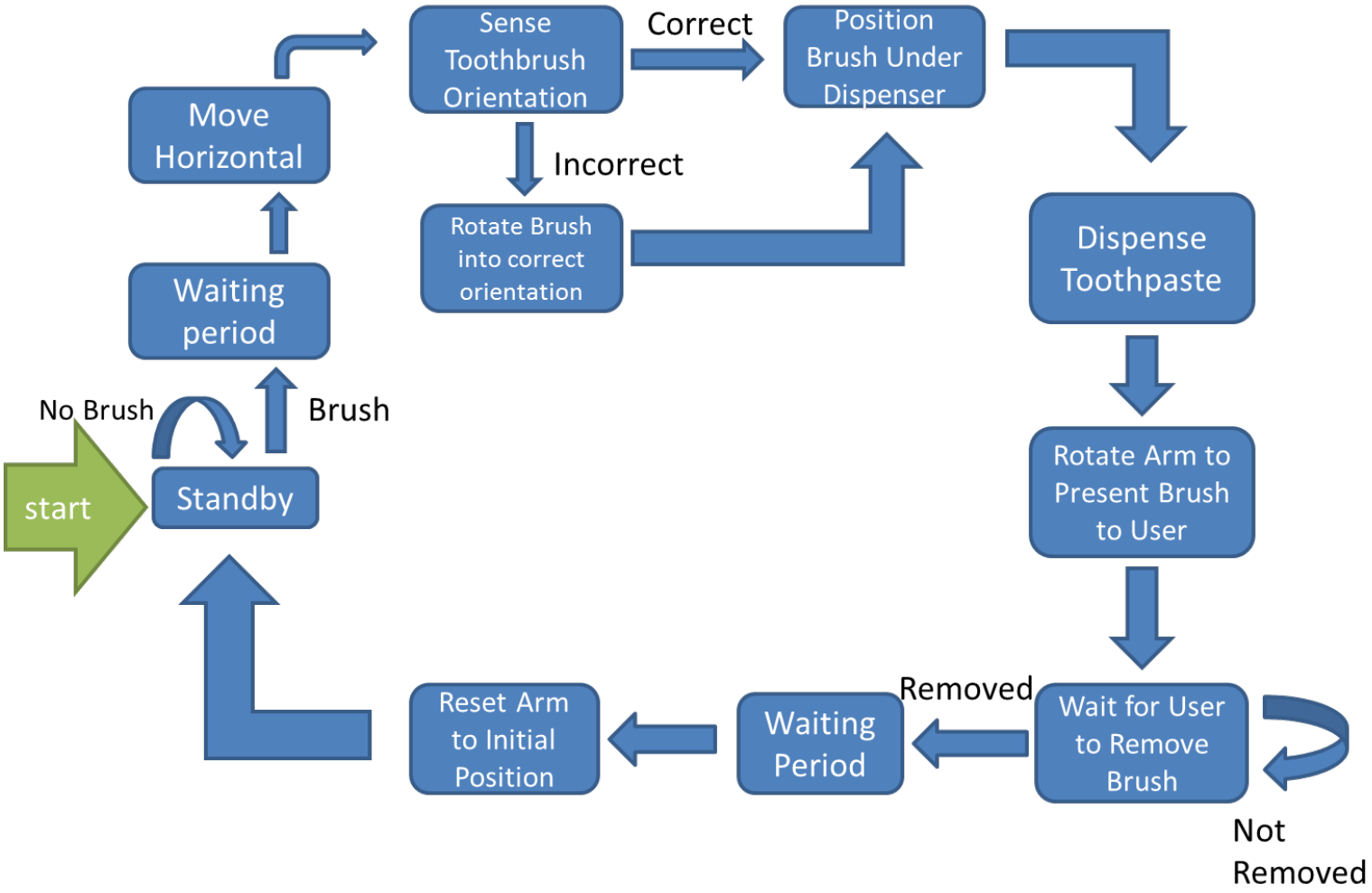
Specification 2: Will hold toothbrush such that the machine and toothbrush will stay sanitary

Specification 3: Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush

Solution: Block Diagram

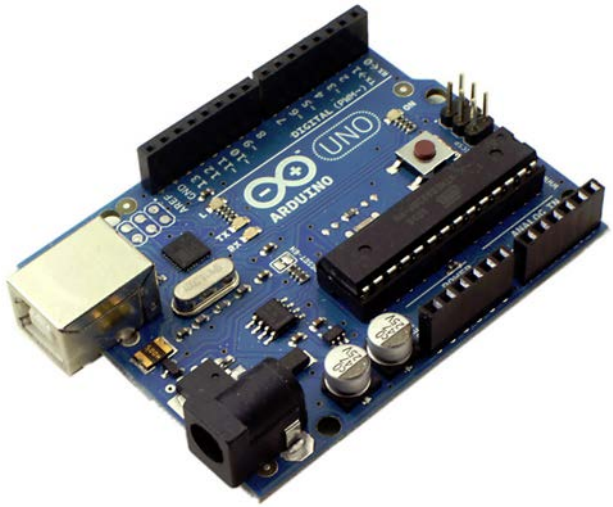


Solution: State Machine



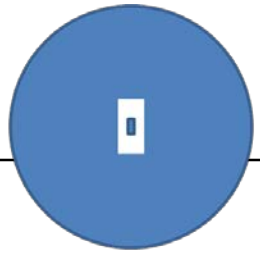
Subsystem: Microcontroller

- Satisfies requirement 4
- Arduino Uno
- Controls all motors and sensors
- Controls timing of operations
- Easily programmable
- Digital and analog inputs and outputs
- Contains onboard clock

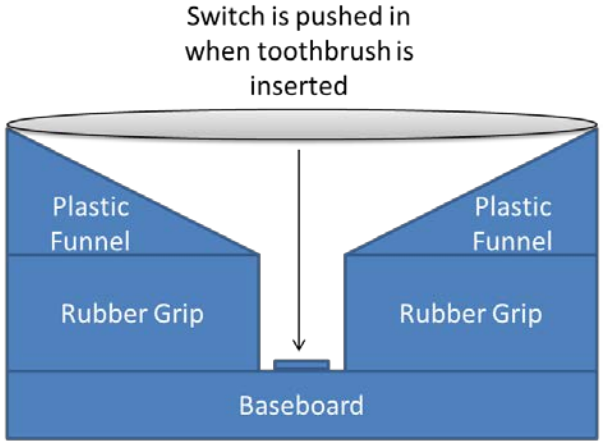


Subsystem: Interface

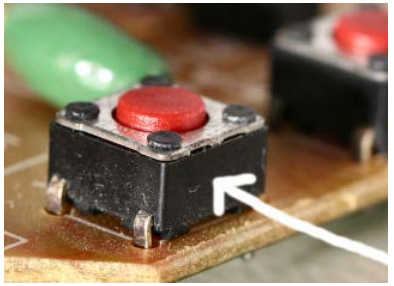
- Satisfies requirement 3
  - Plastic funnel allows for guided entry into grip
- Helps satisfy requirement 2
  - Direct contact only with handle of brush
- Rubber grip holds toothbrush in place while allowing easy entry and exit
- Micro switch indicates toothbrush detection



Top View

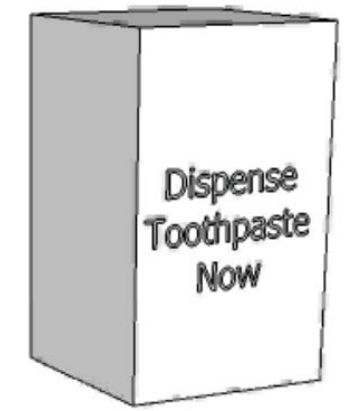


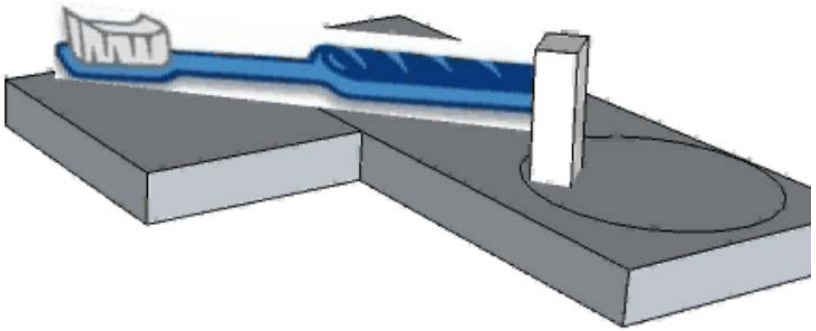
Side View



Subsystem: Guiding Arm

- Satisfies requirement 6
  - Once activated toothbrush is fully guided through motion
  - Limits user involvement to initial insertion and final removal
- Uses Servo motors to control motion
  - Compact
  - Easy to Use
- Helps satisfy requirement 2
  - Controls motion for minimum surface contact





Subsystem: Dispensing

- Satisfies requirement 1
  - COTS dispensing product designed to dispense proper amount of toothpaste
- Helps satisfy requirement 2
  - Toothbrush does not come into contact with dispenser
- Uses Servo Motor to control Dispensing
- Will dispense toothpaste only when toothbrush is in correct position

Subsystem: Enclosure

- Need enclosure to house all products
- Plugged into wall for power
- Helps with requirement 2
  - Limits access to dispensing mechanism
- Allows for easy replacement of empty toothpaste tube
- Keeps electronics, motors, and other components out of direct contact
- Helps satisfy requirement 3
  - Allows for easy toothbrush insertion and removal
- Satisfies requirement 5
  - Compact enough to fit into confined space in bathroom

Subsystem: Additional Features

- Time Permitting:
  - Sound indicators for proper toothbrush insertion and removal
  - LED indicator to show low toothpaste supply
  - Programmable timer to help encourage proper brushing for students
    - Light and Music integration
  - Network interface to notify teacher of low toothpaste
  - Work for a wider range of toothbrush sizes

Products: Budget

- COTS Toothpaste Dispenser: $25.00
- Toothpaste: $5.00
- Arduino Microcontroller $35.00
- Interface Product: $50.00
  - Funnel
  - Rubber Holder
  - Microswitch
- Motor/Servo
  - 4x $40.00 = $160.00
- Proximity Sensor: $70.00
- Enclosure: $150.00

TOTAL: $495.00

Subsystems: Risks

- Hardware
  - Custom Designed Enclosure
  - Third Party COTS Dispenser
  - Many moving parts
- Software
  - Arduino working with chosen sensors
  - Proper timing of motors crucial to success

MDR Deliverables

- Prototype of basic movement
  - Starts in horizontal Position
  - Moves guiding arm to specific location
  - Dispenses toothpaste

- **This slide is not sufficient.**
  - **It should include a figure**
  - **More details of what specifically will be shown**

Other Slides You Need

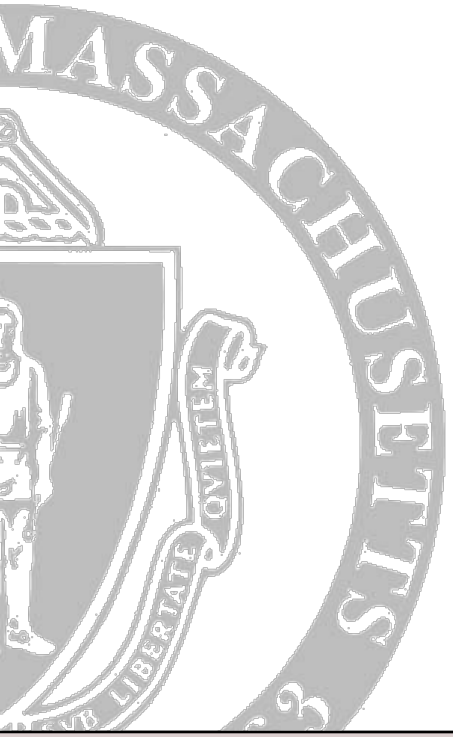
- Breakdown of activities for each student
  - Each student should discuss their responsibilities
  - Each student should be able to answer questions regarding their approach

- What will you present at FPR and at Demo Day
  - Be prepared to answer questions about this.
  - A drawing would be helpful
  - Be realistic

Other Suggestions

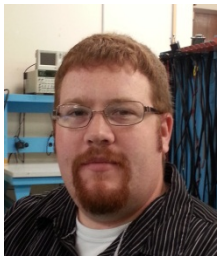
1. Have a friend or family member review your slides.
2. Practice by asking each other questions
3. Wear nice clothes. Easier to be taken seriously
4. Have fun! Think of it as a performance rather than a presentation

Preliminary Design Review



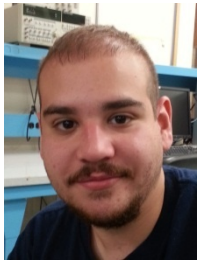
Team RCA
October 15, 2012

RCA (Real-Time Concussion Analyzer)

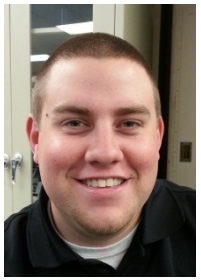


Timothy Coyle
EE

Kenneth Van Tassell
EE



Scott Rosa
CSE



Justin Kober
EE

Concussion Detection in High School Football

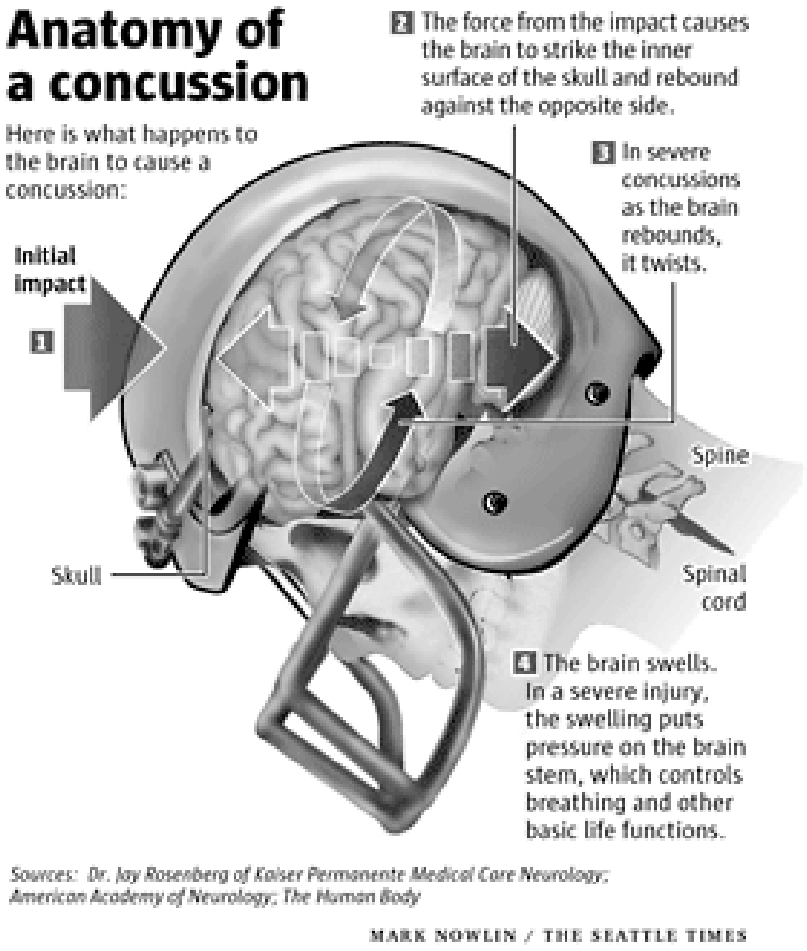
- Current concussion detection
  - Train coaches to recognize symptoms
- Players may hide or not experience symptoms right away

How significant is the problem?

- 1.6 – 3.8 million sports-related concussions in the United states every year
  - Have reached “epidemic level”

- Not only professionals
  - Young people ages 15 – 24 years
    - Second leading cause of TBI (Traumatic Brain Injury)

Context: Effect on Individuals



- Post Concussion Syndrome
  - Problems concentrating, irritability, sensitivity to light…
- If gone undiagnosed
  - One hit away from traumatic brain injury
  - Multiple impacts add up

Context: Effect on Groups

- Affects team sports and the way they're played
- "Tough guy attitude"
  - Creates a culture
- Subjective decision making

Requirements Analysis: Specifications

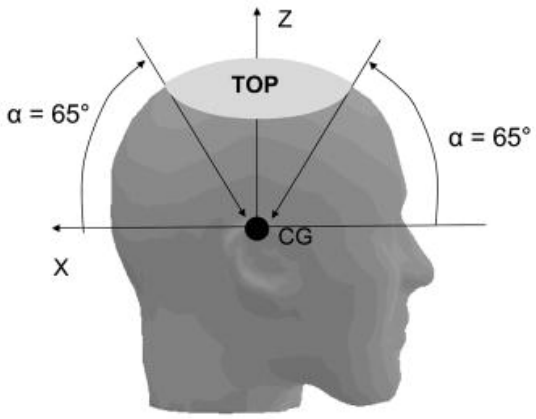
- Real-Time continuous impact measurements
- Player specific adaptability
- Equipment weight increase less than 5%
- Effective range 150 m
- Responds in under two seconds
- Robust
  - Interference
  - Durable

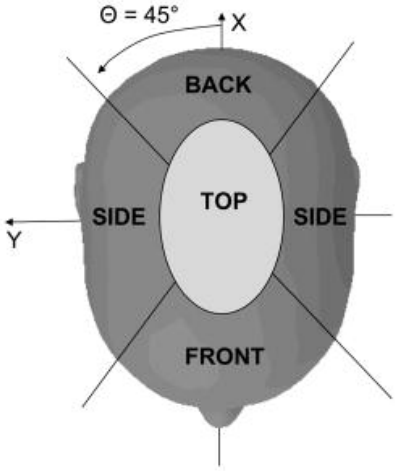
Requirements Analysis: Inputs and Outputs

- Input
  - Impact data
- Output
  - Likelihood of concussion
  - Access to archived impact data

Design Alternatives

- HITS – Head Impact Telemetry System †
  - Six accelerometers
  - Frequency, location, and magnitude
  - Sideline response system
  - Linear acceleration

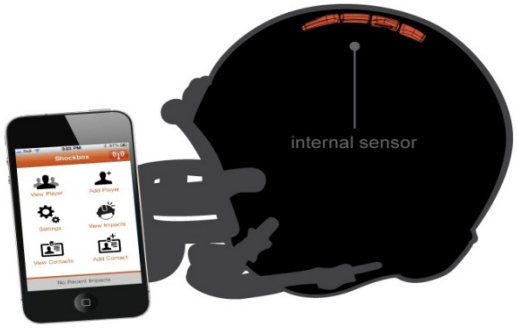




†Measuring Head Kinematics in Football: Correlation Between the Head Impact Telemetry System and Hybrid III Headform. Beckwith, Jonathan, Jeffrey Chu, and Richard Greenwald. October 13th 2011

Design Alternatives

- ShockBox
  - *Impakt Protective*
  - Commercial use for football/hockey
  - Secured with high adhesive bonding tape
  - Wireless transmission
  - Threshold of 50 g set by app



- HEADS
  - *BAE Systems*
  - Military use
  - Suspended beneath the crown of the helmet
  - Wireless/USB transmission
  - Processing done by computer at base

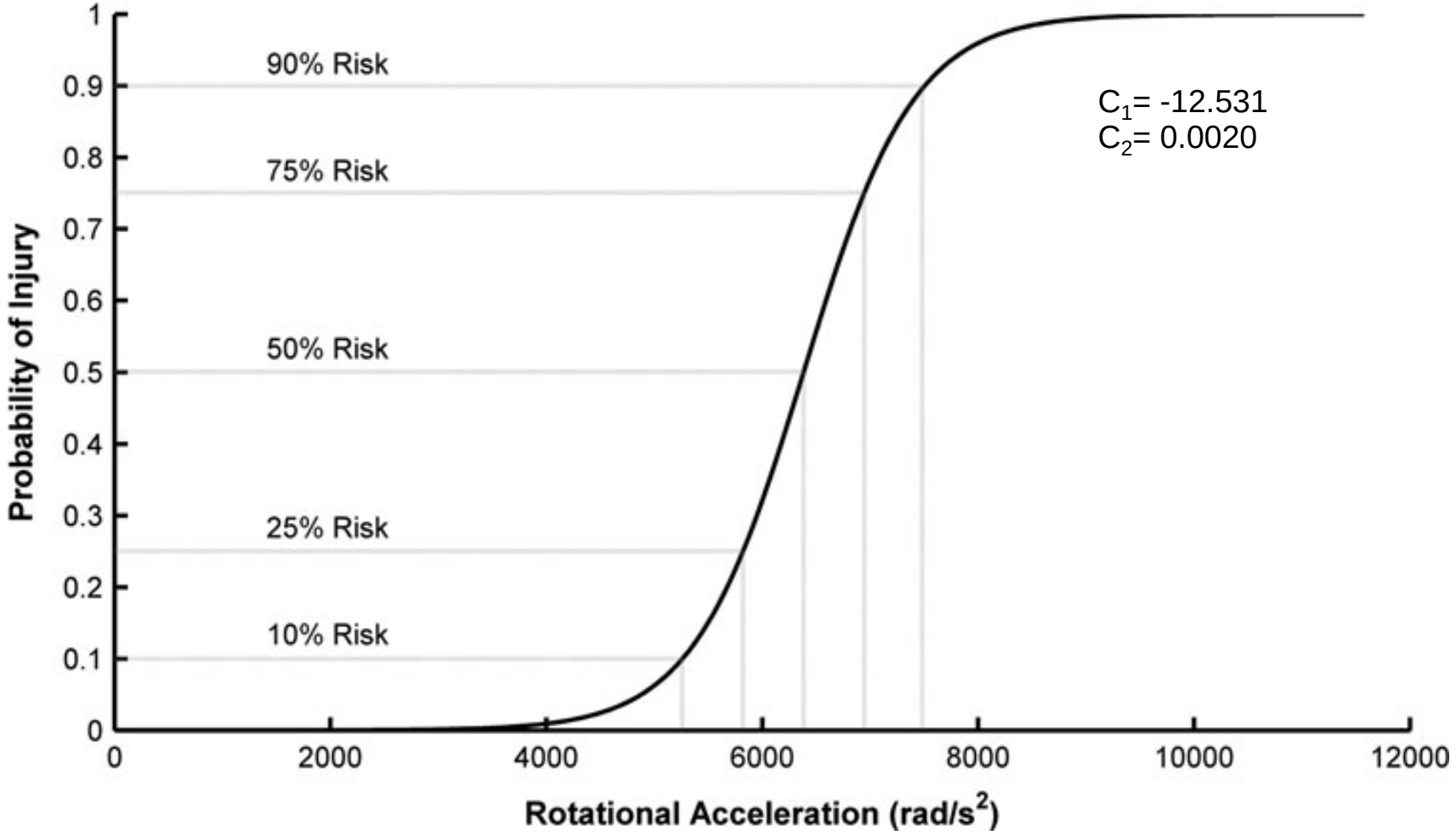
From Impact to Probability

- "Rotational Head Kinematics in Football Impacts: An Injury Risk Function for Concussion"
  - S. Rowson *et al. Annals of Biomedical Engineering, Vol. 40, No. 1, January 2012*

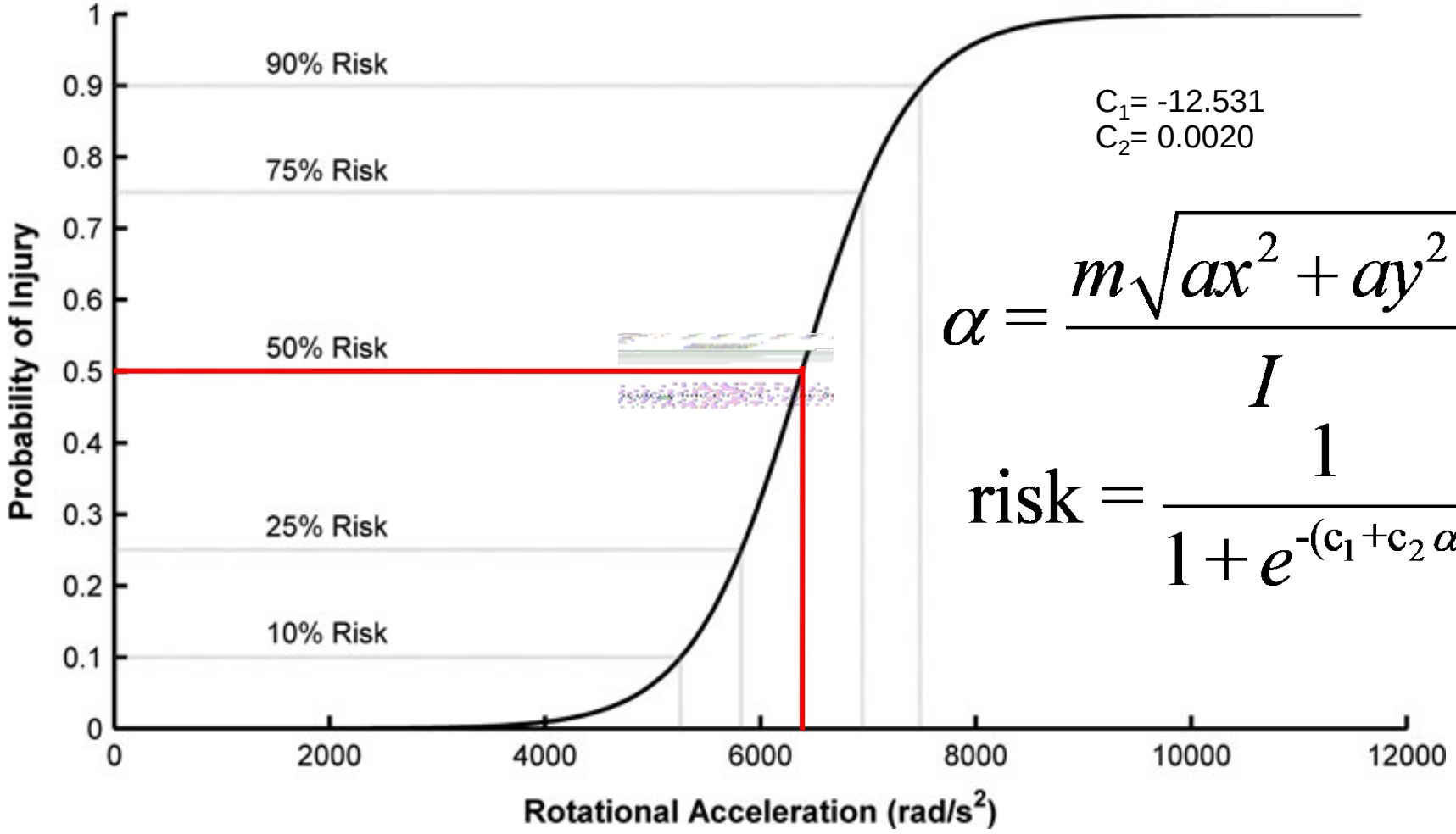
- Rotational acceleration is important

$$\text{risk} = \frac{1}{1 + e^{-(c_1 + c_2 \alpha)}}$$

Risk Function



Risk Function



C_1= -12.531
C_2= 0.0020

$$\alpha = \frac{m\sqrt{ax^2 + ay^2}}{I} d$$

$$risk = \frac{1}{1 + e^{-(c_1 + c_2 \alpha)}}$$

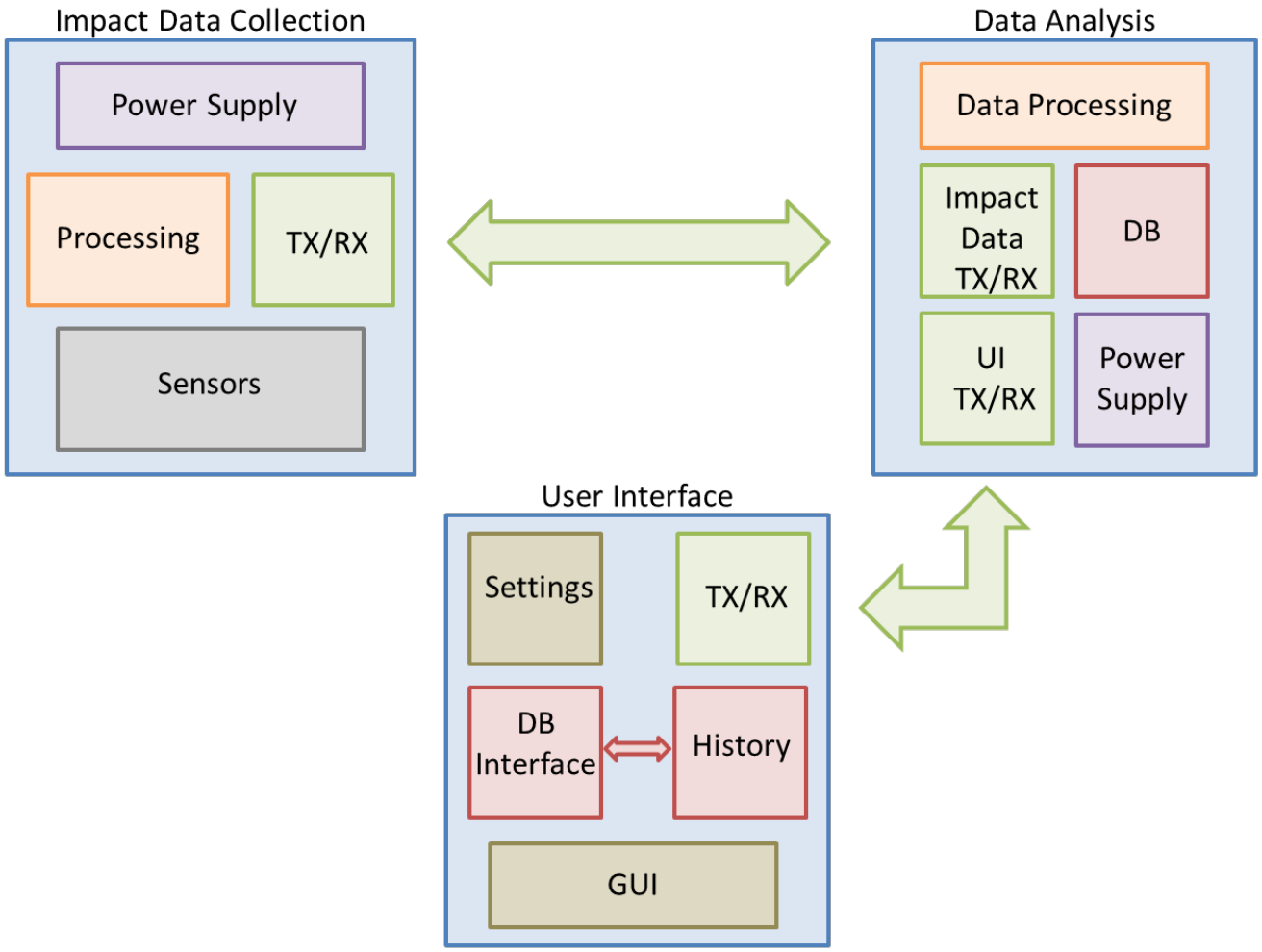
Our Solution: RCA

- Array of sensors in helmet padding
  - Continuous measurements
  - Variable impact thresholds
  - Wireless transmit on threshold trigger
- Base station
  - Database: Impact data & medical history
  - Concussion algorithm
  - Wireless transmit to UI & triggered helmet
- UI
  - Android device
  - Easy to interpret results within two seconds of impact

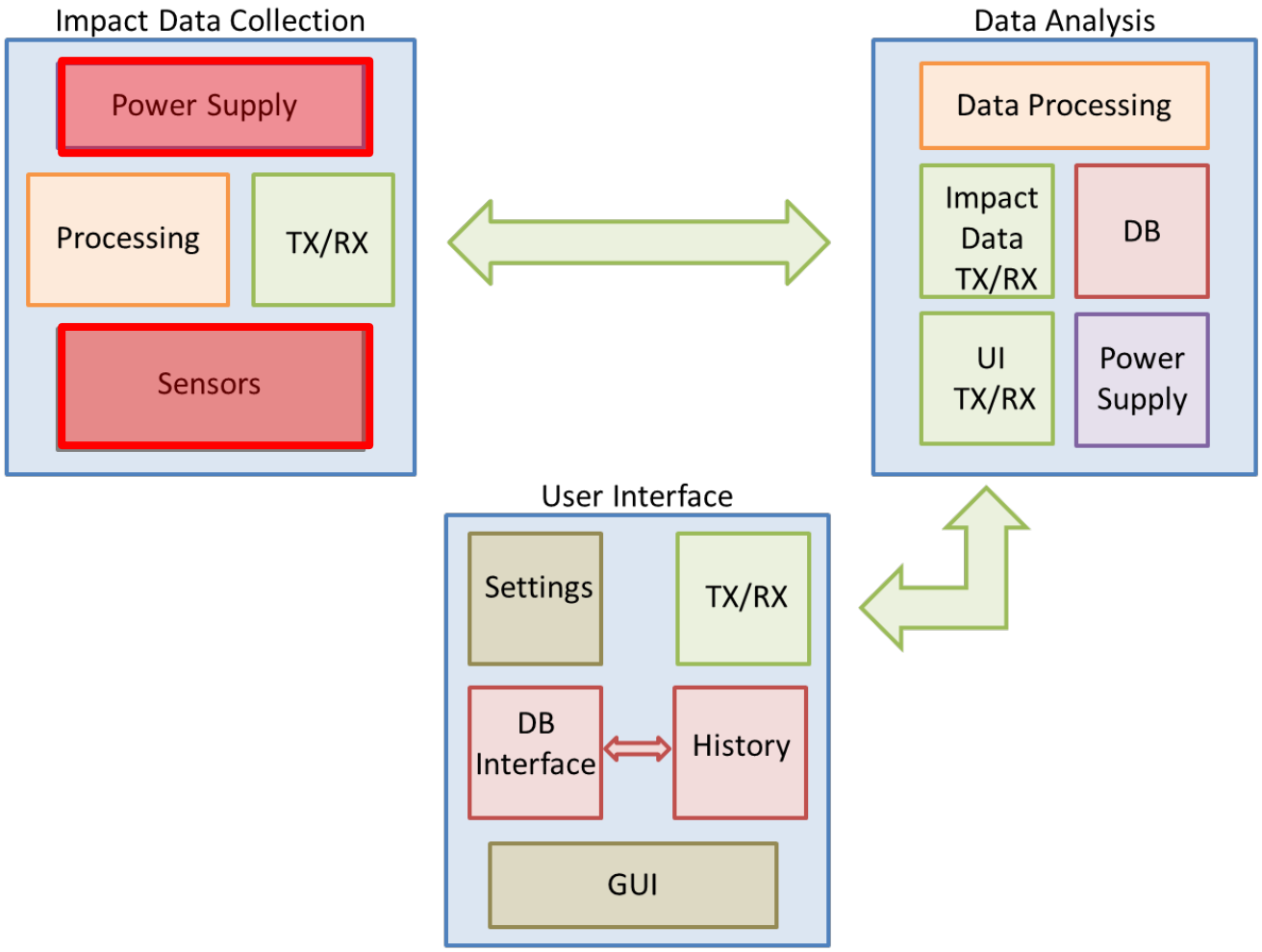
Our Solution: RCA

- Array of **sensors** in helmet padding
  - Continuous measurements
  - **Variable impact thresholds**
  - Wireless transmit on threshold trigger
- Base station
  - **Database: Impact data & medical history**
  - Concussion algorithm
  - Wireless transmit to UI & triggered helmet
- UI
  - Android device
  - Easy to interpret results within two seconds of impact

Our Solution: Block Diagram

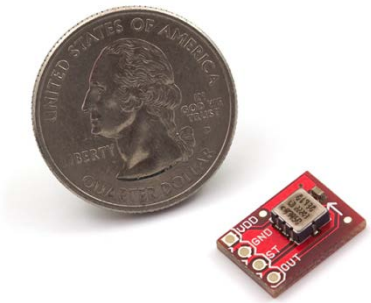


Sensor Network



Sensors

- Requirements
  - Accurate
  - Response time under 100 ms
  - Low power
  - Lightweight and secured safely
    - Players should not notice sensors



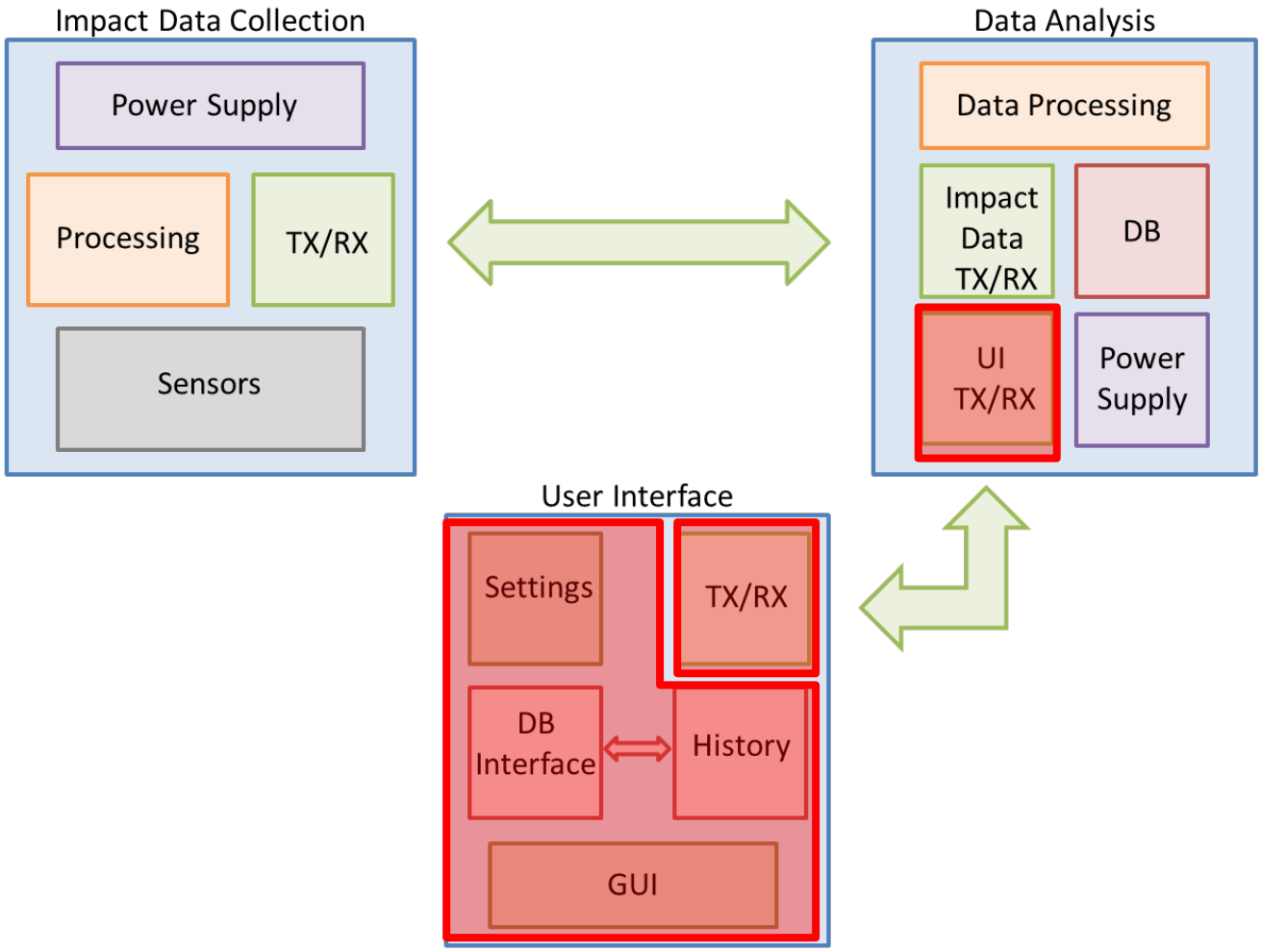
- Implementation
  - Accelerometers, Gyroscope
  - Successful Senior Design Projects
    - Motion Analyzer for Physical Therapy (2010) for Accelerometers
    - Personal Head-Up Display (2009) for Gyroscope

Power

- Requirements
  - 3.5 – 6 V in helmet
  - Safe, reliable and lightweight
  - Up to five hour run time

- Experience
  - Power supplies
    - Design experience in previous coursework
    - Theater design project

User Interface and Communication



UI

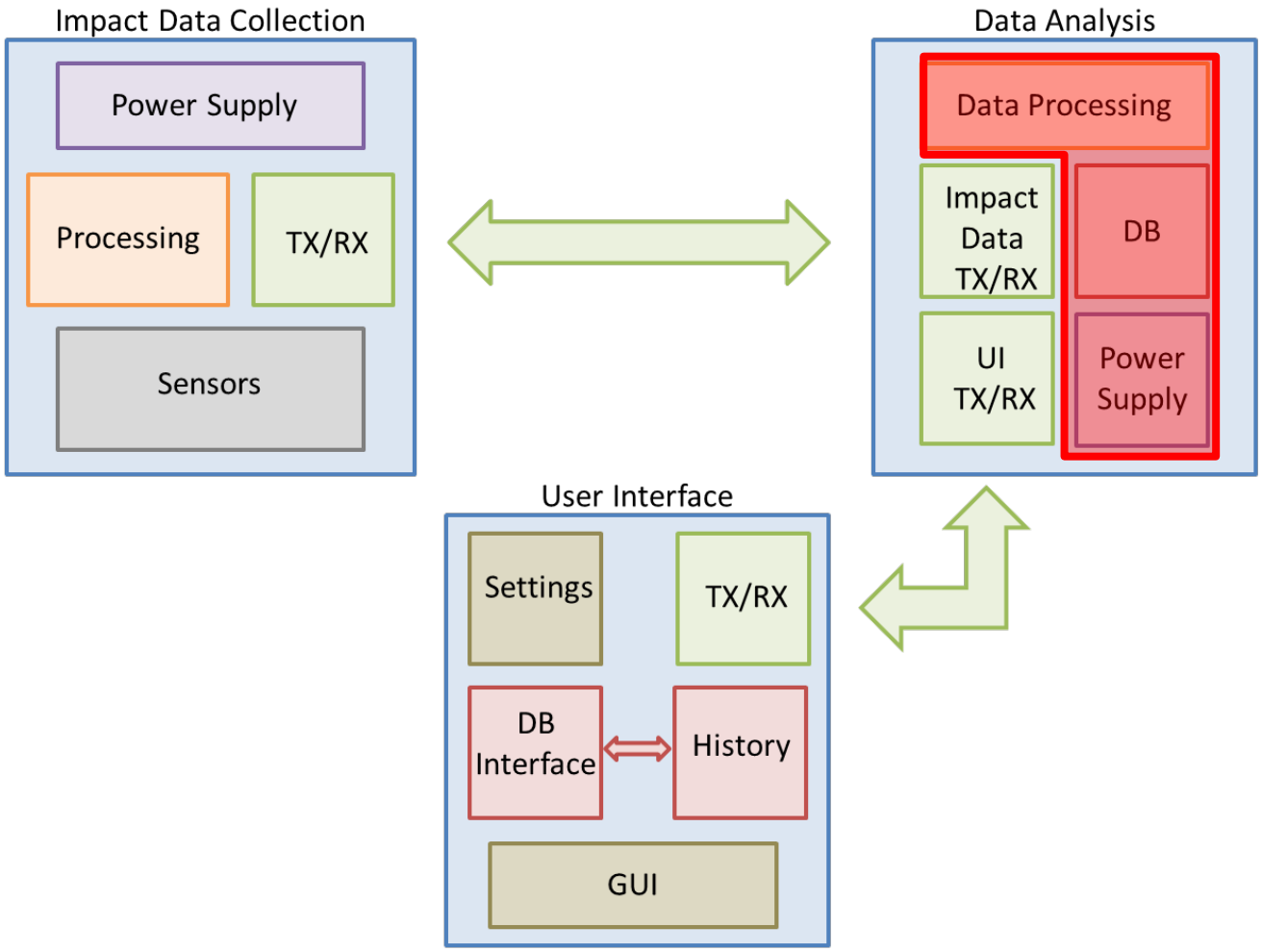
- Requirements
  - Easy to use
  - Deliver meaningful results
    - Medical staff
    - Coaching staff
- Implementation
  - Android Development

Tx/Rx for UI

- Requirements
  - Reliable
  - Response time under 500 ms
  - Easy to implement

- Implementation
  - Android WiFi/ Bluetooth Integration
  - Successful Senior Design Projects
    - BlueTag (2010) for Bluetooth
    - UMass Campus View (2010) for WiFi

Data Processing and Storage

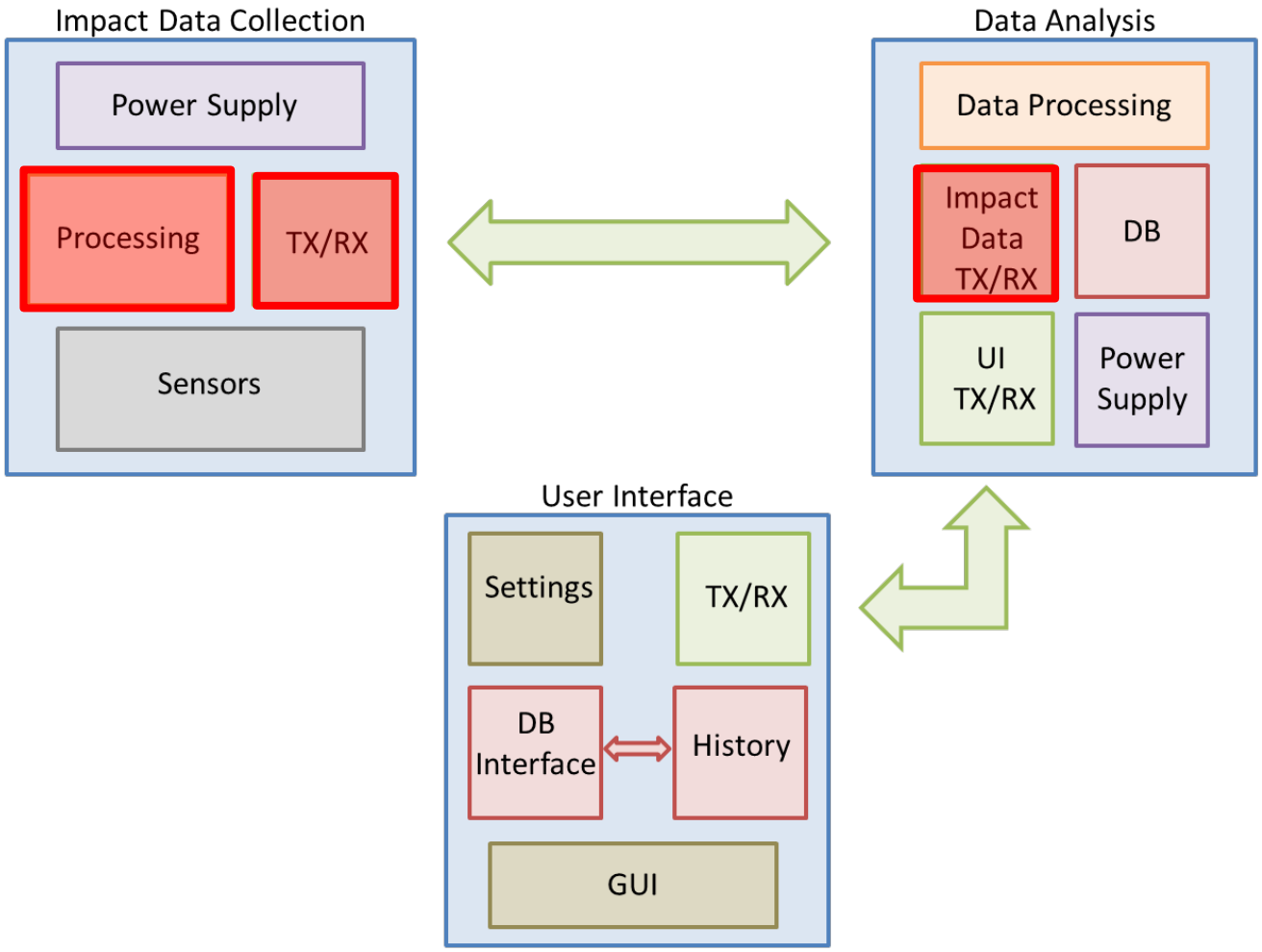


Data Processing and Storage

- Requirements
  - Calculates rotational acceleration
  - Determines probability of concussion
  - Output within 500 ms
  - Store all impact data efficiently

- Experience
  - Software development for Bose
  - Data organization and analysis algorithm development for ECM

Impact Processing and Communication



Impact Processing

- Requirements
  - Low power and lightweight
  - Inputs for at least 7 sensors
  - Tx/Rx Capable
  - Flash memory
- Experience
  - ATMega Microcontroller
    - Used in ECE 353
    - LED Cube

Impact Data Tx/Rx

- Requirements
  - Low power and lightweight
  - Effective range up to 150 m
  - Efficient data transfer rates
  - Secure

- Implementation
  - XBee
  - Successful Senior Design Projects
    - SAFE-T (2012) for XBee

Proposed MDR Deliverables

- Demonstration of Impact Data Collection
  - Accelerometer interfaced with processor
  - Helmet processor transmission
- Demonstration of Base Station/UI Interaction
  - Using test data
    - Receive from helmet
    - Run algorithm
  - UI able to receive and display test results