

# Heart Exercise Accelerometer Rehabilitation Tool

ODU CS410

Orange Team

Feasibility Presentation

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## Introduction

### Abstract

Over five million people are living with heart failure, and there are over 550 thousand new cases a year. Of these five million post cardiac-rehabilitation patients, 80% of them never complete their cardiac rehabilitation program. This can cause muscle atrophy, lower the quality of life and other complications due to lack of self care after the cardiac crisis. A recent study showed that nearly 79% of patients who did not complete their rehab program will die prematurely.

So, our solution to this massive problem is to design a system that will be utilized during long-term rehabilitation patient follow-ups and allows the rehabilitation specialist to reinforce positive progress. It will do this through mechanics that monitor and record the patient's exercise while being non-intrusive to the established rehabilitation process.

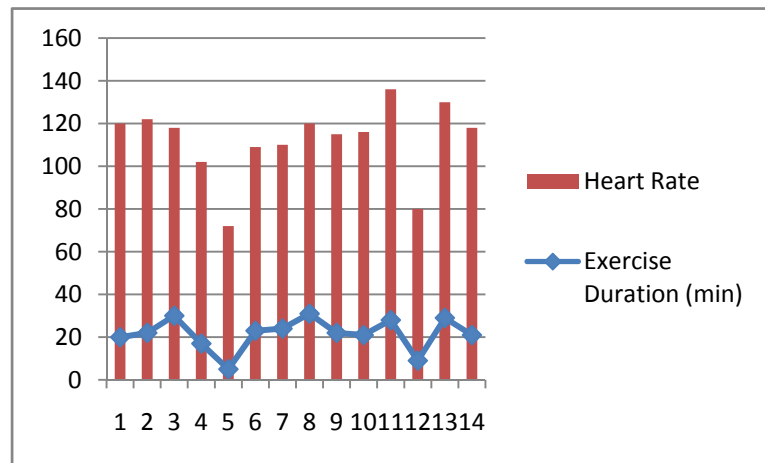





Figure 1 – Chart displaying sample heart rate data next to exercise duration.

A study was conducted that proved that if patients are involved in their rehabilitation program and believe that the program will enhance their recovery, then they are more likely to stay in rehab programs and less likely to experience heart complications. This will lower the risk of a heart attack, lessen hospitalization, and increase rehabilitation retention rate.

So how does our solution involve the patient? By integrating the patient into their rehabilitation process, we are offering the patient education and information, and offering the rehab specialist patient accountability. When the data is downloaded to the provided software, it will produce a chart similar to figure 1. This will inform the specialist of the progress of the patient. So if the produced chart shows that patient is not performing at the expected rate, then the rehab specialist can reinforce the severity of the patient's exercise. If the chart shows that the patient is performing at an expected rate, then the specialist can reinforce positive progress. Therefore, the data produced by the device and outputted by the software will increase patient accountability, and will allow the rehab specialist to inform the patient of their progress. By doing these things, we can increase patient involvement.

## Our Team

### Photos and Biographies

Photo	Name	Bio
	<b>Andrew Cartwright</b>	I am from Newport News, VA. I graduated with honors from Denbigh High School. I am currently a senior at ODU and should graduate in May with a BS in Computer Science with a minor in Electrical Computer Engineering. I have worked as a web administrator/developer since 2006 and my portfolio includes websites such as The Virginia Living Museum, ODU Alumni and Virginia Ship Repair Association. In my spare time I enjoy riding ATVs and dirt bikes, and spending time with my family and friends. I am a founding father of a local fraternity to ODU, Gamma Tau Chapter of Phi Kappa Tau.
	<b>Spencer Garland</b>	I am a senior attending Old Dominion University for a bachelor in Computer Science and minor in Computer Engineering. I have experience from the basics of computer hardware to high end programming. I also have knowledge in the SQL and database fields (Oracle certified). During my spare time I enjoy making useful GUIs and constructing basic circuits. Some of my current interests are web design, graphic design, and computer networking. I plan to graduate in spring 2009 and pursue a job in the Computer Science field.
	<b>Nicole Jackson</b>	I am from Woodbridge, Virginia located in northern Virginia. I graduated from C.D. Hylton High School in 2004 and I am a senior at Old Dominion University majoring in Computer Science. I recently interned for FINRA as a SharePoint administrator. I enjoy spending time with family and friends, and listening to music.



**Dave  
Norris**

I graduated from Bayside High School in 1993. I obtained an A.A.S. in programming from Tidewater Community College in 2003. I am currently majoring in Computer Science at Old Dominion University and plan to graduate in Spring 2009.

I worked in the technology industry for telecommunications and financial security monitoring firms from 1993 to 2000. Since 2000, I have worked as an independent consultant.

I am a native of Virginia Beach, Va. My interests include foreign languages, chess, and racquetball.



**Ryan Null**

I am very self driven individual. I graduated from Princess Anne High School in Virginia Beach and I am currently a senior at ODU majoring in Computer Science with a minor in Geology. I currently own my own software engineering business, and spend my spare time developing software and hanging out with friends.



**Generoso  
Nunez-  
Arias**

I hold an associates degree in Computer Science and graduated with honors from La Guardia Community College of the City University of New York. I am now a senior at Old Dominion University majoring in Computer Science with a double minor in Electrical and Computer Engineering and Modeling and Simulation. I am currently, doing an internship as a Software Developer focusing on Java enterprise systems (J2EE) and Test Driven Development. On my spare time I study the Linux kernel internals and Microsoft Windows internals, and when I can I love to travel to interesting places.

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## Referenced Experts

Dr. Garland M.D. – Specialty, Information Given, Where he works, etc.

Janet L. Jackson B.S.N. R.N. – HCMSDM Regulatory Compliance Manager, Amerigroup Corporation.

## Overview

- Problem
- Solution
- Customer and Market Analysis
- Risk and Benefit Comparison
- System Overview
- Conclusion

## Problem

**Post cardiac-rehab patients do not commit to necessary long-term recuperation requirements.**

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### Problem Characteristics

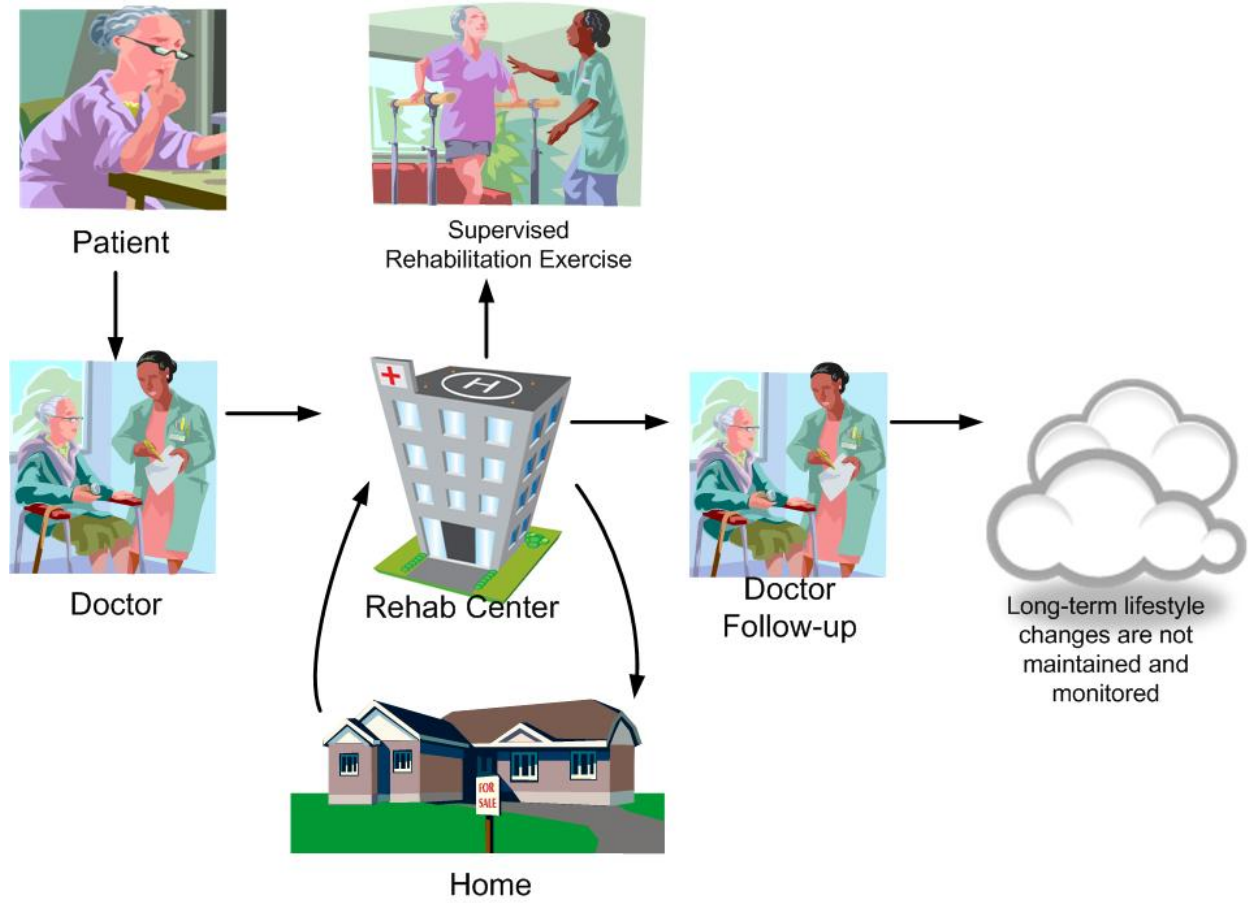
The patient lacks involvement in the rehabilitation maintenance phase.

- 5 million people are living with a heart condition. <sup>1</sup>
- 550,000+ develop a heart condition every year. <sup>1</sup>
- 80% of patients never complete cardiac rehabilitation. <sup>2</sup>

This has many impacts on the patients.

- Up to 79% of patients who don't complete cardiac-rehab will die prematurely. <sup>3</sup>
- Those who don't complete rehab will have deleterious side effects. <sup>1</sup>
- Quality of life is diminished for patients. <sup>1</sup>

### Current Rehabilitation System



# H.E.A.R.T.

## Definition

H.E.A.R.T. will be a multi-sensor system with one primary band and multiple optional secondary wristbands connected to the primary via a wireless technology.

## Capabilities and In-capabilities

Capable	Incapable
<ul style="list-style-type: none"> <li>Involve the patient</li> <li>Record exercise data</li> <li>Record heart rate</li> </ul>	<ul style="list-style-type: none"> <li>Offer immediate alerts</li> <li>Display immediate information</li> <li>Force attendance</li> <li>Provide transportation</li> </ul>

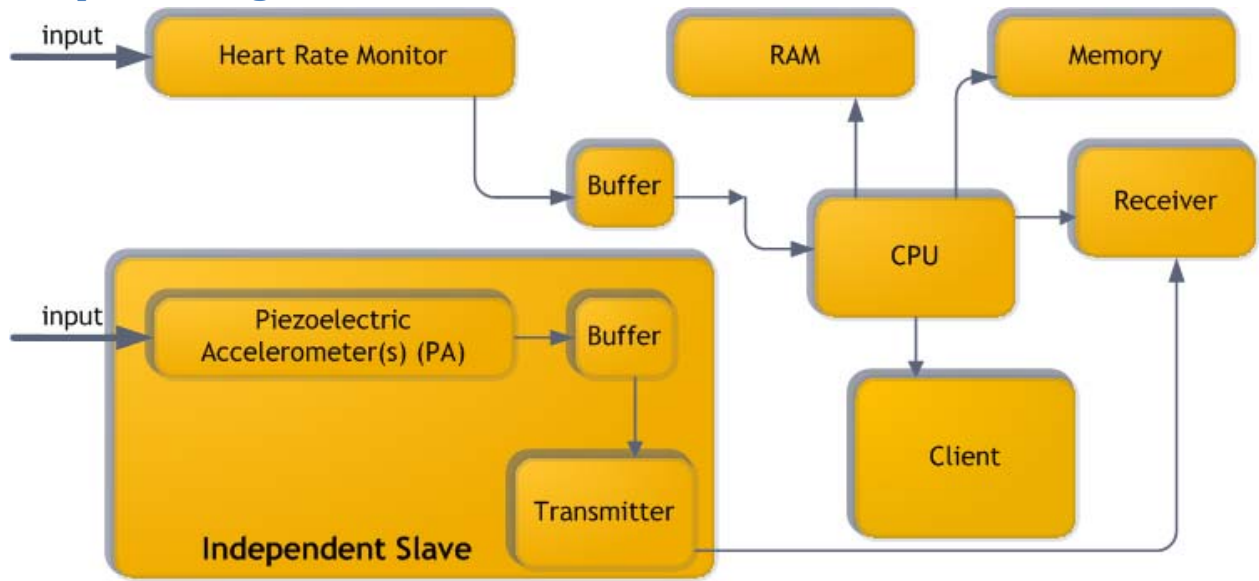
## Technology Utilized

Technology	Min	Mean	Max
Heart Sensor	\$5	\$20	\$50
Accelerometer	\$20	\$25	\$55
Battery	\$10	\$10	\$20
CPU	\$10	\$14	\$19
RAM	\$1.63	\$3.27	\$5.12
USB	\$0.19	\$0.19	\$0.19

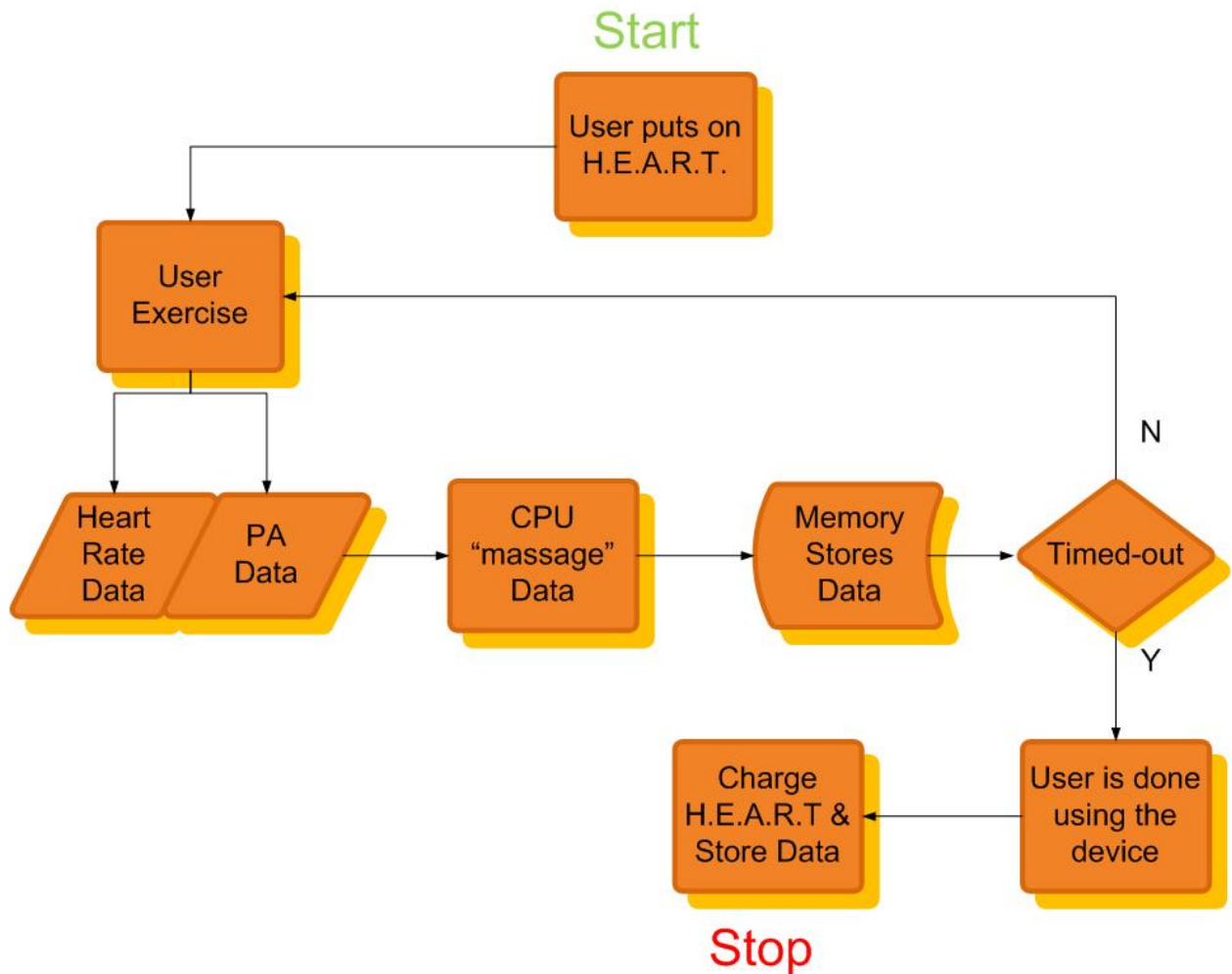
## New Technology Requirements

- The client software for the cardiac rehabilitation specialists will need to be developed.
- The circuitry and firmware/micro operating system has to be created.

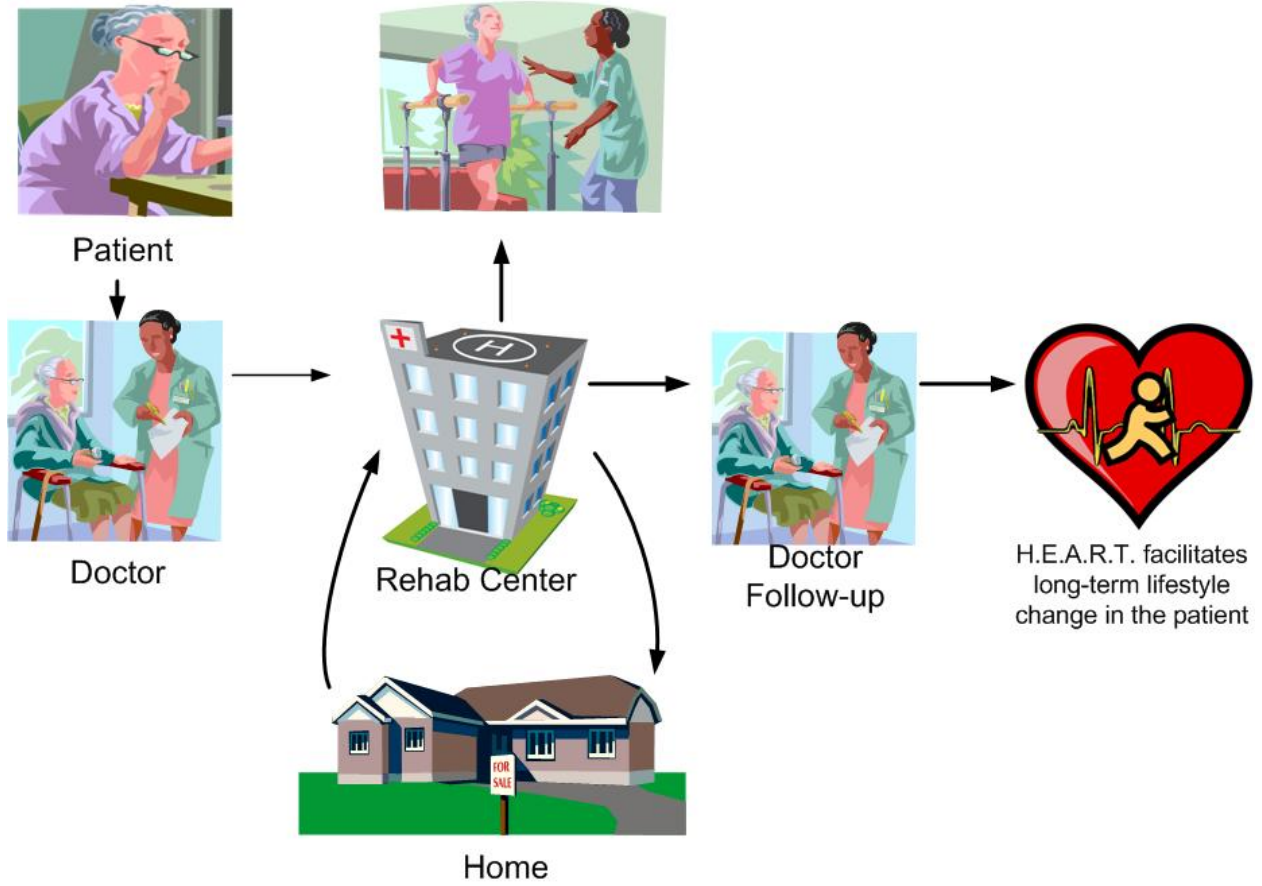
Component Diagram



Device Process Flow

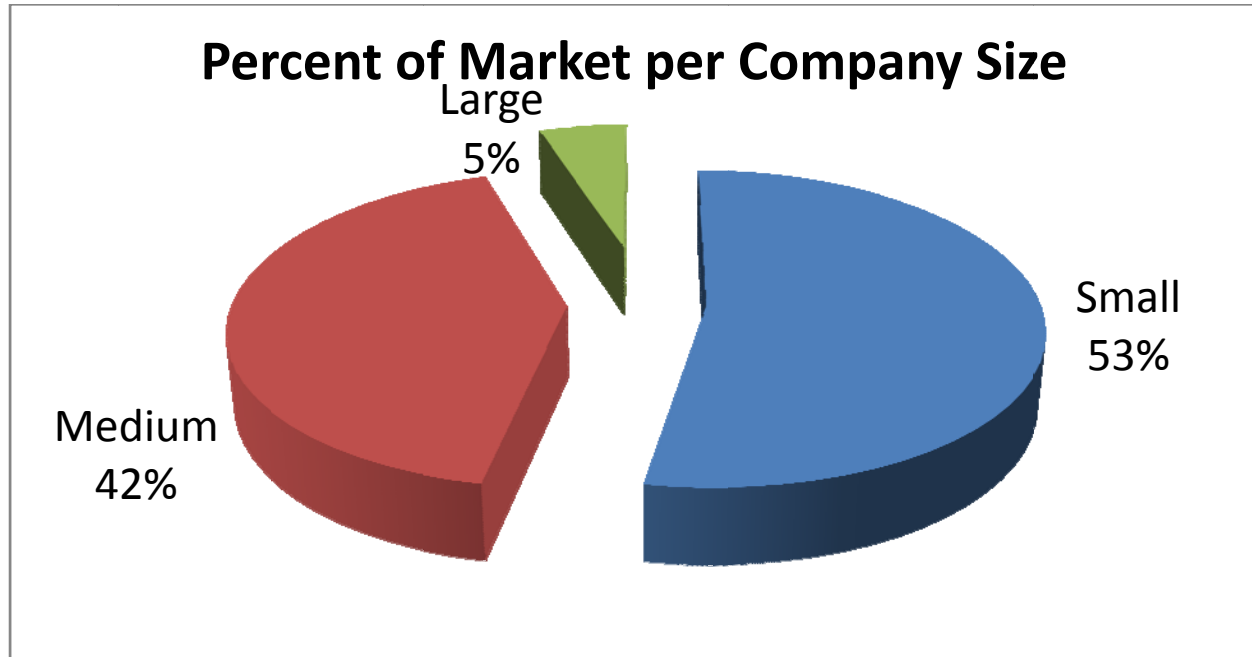


### Modified System Process Flow



## Market Analysis

### Rehabilitation Industry Analysis



- Small: <\$5 million
- Med: \$5-\$10 million
- Large: >\$10 million

### Demographics of the Industry

- Most rehabilitation companies are either small or medium in size. <sup>4</sup>
- Large
  - 100% of large companies made a profit. <sup>4</sup>
  - Average profit was \$977,421 in 2007. <sup>4</sup>
- Medium
  - 67% of medium companies made a profit. <sup>4</sup>
  - Average profit was \$434,898 in 2007. <sup>4</sup>
- Small
  - 78% of small companies made a profit. <sup>4</sup>
  - Average profit was \$67,930 in 2007. <sup>4</sup>

## Financial Analysis

### Marketing Budget Plan

Category	Estimated Quantity	Estimated Cost per Unit	Estimated Subtotal
<b>Research</b>			
Research firm fees		\$17,000.00	\$17,000.00
Web research		\$3,250.00	\$3,250.00
Independent research		\$15,000.00	\$15,000.00
Other research (Testing)		\$15,000.00	\$15,000.00
Legal Expenses		\$\$\$\$\$	
<b>Research Costs Total</b>			<b>\$50,250.00</b>
<b>Long Term Effects</b>			
Promotional Marketing		\$50,000.00	\$50,000.00
Support (Device Repair, Sales, etc)		\$320,000.00	\$320,000.00
Device Refinement		\$10,000.00	\$10,000.00
Legal Issues		\$\$\$\$\$	
<b>Long Term Costs Total</b>			<b>\$380,000.00</b>
<b>Device Design</b>			
Circuit Design		\$25,000.00	\$25,000.00
Physical Design		\$25,000.00	\$25,000.00
<b>Design Costs Total</b>			<b>\$50,000.00</b>
<b>In Production Costs</b>			
<b>Hardware/Production Services</b>			
Heart Rate Monitor	1	\$100.00	\$100.00
Piezoelectric Accelerometer	1	\$50.00	\$50.00
Software (QA)	1	\$10.00	\$10.00
Production	1	\$10.00	\$10.00
Material (Box, Paper, assoc, etc)	1	\$10.00	\$10.00
Assembly and Manufacturing	1	\$30.00	\$30.00
Memory, Battery, cables	1	\$60.00	\$60.00
Distribution	1	\$10.00	\$10.00
Labor and AV technicians	1	\$300.00	\$300.00
Tax (8.8%)		\$51.04	\$51.04
<b>Production Subtotal</b>			<b>\$631.04</b>
<b>Advertising</b>			
Brochures (development and production)	5,000	\$0.15	\$750.00
Mailings	15,000	\$0.04	\$600.00
Postcards	15,000	\$0.03	\$450.00

Television	1	\$600.00	\$600.00
Radio	1	\$300.00	\$300.00
Newspapers	1	\$220.00	\$220.00
Billboards	2	\$556.00	\$1,112.00
Bus sides	3	\$125.00	\$375.00

**Advertising Costs Total \$4,407.00**

**PRE-PRODUCTION COST \$100,250.00**

**IN PRODUCTION COST \$631.04**

**POST PRODUCTION COST \$384,407.00**

**GRAND TOTAL COST \$485,288.04**

## Competition

	H.E.A.R.T.	Inquiry	In Home	Rehab Only
Involvement	X	X	X	X
Long-Term	X		X	
Cost Effective	X	X		
Mobile	X			

## Risks

		Probability				
		Not Likely	Low	Moderate	High	Expected
Impact	Extreme	P1	F1			
	High	T2	T1, S1			
	Moderate	T3, F2				
	Low	T4				
	Negligible					

Item	Technical Risks	Probability	Impact
T1	Insurance Rejection	2	4
T2	Integration Failure	1	4
T3	Malfunction (Device and Software)	1	3
T4	Software/Hardware Complexity	1	2
Item	Financial Risks	Probability	Impact
F1	Market Refusal/Overpriced	2	5
F2	Not First to Market	1	3
Item	Patient and Schedule Risks	Probability	Impact
P1	Not Utilizing device (Post-purchase)	1	5
S1	Development Delay (Time Management/Cost Management)	2	4

## Benefits

- Higher patient involvement in rehabilitation.
- The patient will have made positive long-term lifestyle changes.
- The patient will live a longer and healthier life.
- The rehabilitation centers will experience a larger retention rate.
- Rehabilitation specialist will be provided with data to assist in the rehabilitation maintenance phase.
- The H.E.A.R.T. system is extensible.
- The system is portable to allow freedom to exercise anywhere.
- Historical long term data is stored on patient.
- A low impact is made on how rehabilitation is currently conducted.

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### Additional Health Benefits

- 25% reduction of risk of heart attack <sup>6</sup>
- Reduced need for hospitalization <sup>6</sup>
- Decreased blood pressure <sup>6</sup>
- Ability to exercise longer <sup>6</sup>
- Lower cholesterol <sup>6</sup>
- Decreased emotional stress, depression, and anxiety <sup>6</sup>
- Significant weight loss in certain scenarios <sup>6</sup>

## References

All references were accessed and stored during October 2008.

<sup>1</sup> [http://www.cdc.gov/dhdsp/library/fs\\_heart\\_failure.htm](http://www.cdc.gov/dhdsp/library/fs_heart_failure.htm) -Center for Disease Control – August 30, 2006

<sup>2</sup> <http://esciencenews.com/articles/2008/07/17/mini.ecg.gets.heart.attack.rehab.patients.mobile> - eScienceNews.com – eScienceNews.com – July 17, 2008

<sup>3</sup> <http://www.carondelethealth.org/chi/cardiarehab.aspx> - Carondelet Heart Institute

<sup>4</sup> <http://www.ncartcoalition.org/media/whatshot/Simon%20Study%20on%20Rehab%20Industry.pdf> – Simon Business School at University of Rochester - 2007

<sup>5</sup> <http://www.abc.net.au/rn/healthreport/stories/2007/2023663.htm> - ABC National Radio *The Health Report* – September 3, 2007

<sup>6</sup> <http://www.revolutionhealth.com/conditions/heart/coronary-artery-disease/cardiarehabilitation/overview/proven-health> - RevolutionHealth.com – October 16, 2006