SET FACTORS

The first step in the development process was to identify a number of social and economic factors that need to be addressed as well as new technology that could led the way.

Social

- **Urbanization**: Increasing population growth has led to the growth and overcrowding of urban areas around the world.
- **Sustainability**: There is a need to conserve natural resources in order to curb climate change and preserve our planet.
- **Spread of Infectious Disease**: There have been a number of large outbreaks of infectious diseases around the worlds in the last year. The number of outbreaks will only increase as population increases and people travel more.
- **Landmines in Conflict Zones**: Thousands of innocent people are killed or injured by landmines left behind in conflict zones.
- **Flooding**: Climate change has led to rising sea levels and flooding in low lying areas.
- **Bicycle Safety**: The number of bicyclist in urban areas has increased dramatically in recent years due to rising gas prices and congestion in city centers.
- **Athlete Rehabilitation**: As high school and college sports become more competitive there are more and more young athletes with a wide range of rehabilitation needs.
- **Athlete Training**: As sports get more competitive team need to find more creative ways of training player in order to gain the upper hand.
- **Disaster Relief:** There has been an increase in the number and severity of natural disasters around the world.

Economic

- **Low Income**: There is a growing wealth gap around the world and low income people are being disenfranchised
- **Industrial Development**: Growth of the world economy has led to the development and growth of urban areas
- **Commuting in Developing Countries**: People in developing countries often live far away from markets, doctors, potable water sources, etc. and need an inexpensive way to travel and transport good long distances.
- **Distribution of Medication in Developing Countries**: Distribution of medication for diseases including malaria and diarrhea is often more expensive than the medication itself.
- **HIV Medication Dispensing in Developing Countries**: Even though some people infected by HIV have access to HIV medication they often do not have clocks and cannot take the drugs at the proper times for them to be effective.
- **Waste Treatment in Developing Countries**: Many people in developing countries do not have access to proper sanitation which leads to the spread of disease and contamination of groundwater.

Technology

- **Additive Manufacturing**: The development of additive manufacturing has revolutionized the design and development process and could soon be implemented to produce customized products at a large scale
- **Smartphone Apps/Bluetooth**: Smart phones are increasingly popular and can be used to control and receive data from any device.
- **Microcontrollers**: Microcontrollers including the Arduino are highly versatile and easy to program and can be used to control actuators and collect data from sensors
- **GPS**: GPS allows people or robots to locate themselves accurately and reliably making navigation much faster
- **Lithium Ion Batteries**: Lithium Ion batteries are more energy dense than lead acid batteries and make it possible to create more versatile robots and other devices
- **Inexpensive/Accurate sensors**: Sensor technology is improving allowing for more accurate sensors at lower prices
- **Composites**: New advances in composites can allow for light and stiffer structures
- **Microcontrollers**: Microcontrollers have become very easy to use and prototype with allowing for more creativity and versatile mechatronic designs

PRODUCT OPPORTUNITY GAPS

The second step in the development process was to generate a list of product opportunity gaps that we thought would address the SET factors that we found.

Social - Disaster Relief/Emergency Response

POG: Land Mine Detection in Conflict Zones
S: Large Numbers of Unexploded Land Mines in Conflict Zones
E: Low Cost Mine Detection/Removal
T: Sensors, Microcontrollers

POG: Portable Solar Battery Charger for Aid Workers
S: Large Number of Natural disasters
E: Low Income
T: Solar Cells, Microcontrollers

POG: Locating Victims in Disaster Areas
S: Natural Disasters
E: Limited Rescue Works/Resources
T: Quadrotors, Sensors, GPS, Smart Phone Apps

POG: Firefighter Assistance
S: Overcrowding, Growing Urban Population
E: Underfunded First Responder Network
T: Microcontrollers, Smartphone Apps, Quadrotors, Sensors

POG: Bridge Repair/Replacement
S: Overcrowding, Growing Urban Population
E: Underfunded Bridge Maintenance Programs
T: Microcontrollers, Smartphone Apps, Quadrotors, Sensors

POG: Portable Mechanical Cell Phone Charger
S: Natural Disasters shutting down city power grids
E: Expediates vital communication between populus, Limited resources.
T: Small electrical generators, cell phone adaptors

POG: Emergency Rain Water Collecting Lightpost
S: Offers clean drink water during emergency situations
E: Utilizes natural rain water as resource
T: Compact filtration systems, Light posts

Social - Disabled/Injured/Elderly

POG: Elderly Health Alert Sytem
S: Elderly, Disabled
E: Accident prone elderly or disabled caretakers
T: GPS, Cell Phones, Sensors

POG: Vacuum compression brace
S: Injured, athletes, bed ridden
E: More effective system of compressing muscles
T: Vacuum, Overmolded Injection Plastic

POG: Braille E-Book
S: Visually Impaired
E: Reduce Price for Printed Braille Books
T: Use of Nano Mechanism, Smartphone, Ferrofluids

POG: Suction Cup with Over-center Latch
S: Omni-purpose hooking feature for consumer convenience
E: Replaces alternate that require more expensive/destructive infrastructure
T: Mechanism have been proven for this technology

POG: Integrated City Automated Sidewalks
S: Injured, Crippled or Disabled citizen who are hard of walking.
E: Ease of transportation and reduction of elderly transportation assistance
T: High powered conveyer belt system

POG: Automated Walkway Snow System
S: Ease of shoveling snow for elderly or disabled
E: Ease of labor
T: Solar Panels, Under Heating

POG: Shoe to Aid Walking/Running
S: Disabled People
E:Reduce Price of Mobility Aids
T:Overmolded Injection Plastic

POG: Rehabilitation Sensor
S: Athlete Rehabilitation
E: Reduce Habilitation/Treatment Time
T: Sensors, Microcontrollers

POG: Smart/Dynamic Brace
S: Athlete Rehabilitation
E: Reduce Habilitation/Treatment Time
T: Sensors, Microcontrollers

POG: Stair Climbing Wheelchair
S: Disabled people
E: More accessibility
T: Motors, Drive train, Microcontrollers

POG: Haptic Locating Device for Rehabilitation
S: Handicapped or disabled needing to navigate during rehabilitation training
E: Less manual labor for caretakers
T: Wireless xbee distance rangers, Wearable interface

POG: GPS Clothing for Blind
S: Blind people
E: Better navigation cues
T: Vibrators, GPS

POG: Augmented Blind Sensory Stick
S: More independence for the blind
E: Current blind caretakers and seeing-dog require lots of resources
T: Sonar, IR range, vibrators, LIDAR lasers, camera scanners, GPS

POG: Attachable Door Opening Mechanisms
S: Elderly and handicapped trouble opening doors
E: Currently installation takes time and resource
T: Motors,wireless sensors bluetooth

Economic - Low Income/Developing Countries

POG: More Efficient/Sustainable Farming
S: Malnourishment, Organic Crops
E: Reduce Cost of Organic Foods
T: Sensors, GPS, Microcontrollers

POG: Latrine/Rural Waste Management
S: Inadequate Sewage System
E: Reduced Cost of Waste Management
T: Low Cost Plastics

POG: HIV Medication Dispenser
S: Large number of people with HIV without proper medical help
E: Low income
T: Microcontrollers, Additive Manufacturing

POG: Medication Preservation System
S: Disease Outbreak Prevention
E: Preserve Medicine, Longer Life span, Less Money Spent
T: Coolant, 3D printer, vinyl vacuum chambers
POG: Dispensing Medication in Third World Countries
S: Large HIV Epidemic
E: No Access to Adequate Health Care/Health Education
T: Injection Molded Plastic, Sensors, Microcontrollers

POG: Water Transport Device
S: Large number of people in developing countries travel far for water
E: Low income
T: Additive Manufacturing, Injection molded plastic

POG: Human Waste Electricity Generator
S: Large Number of People in Developing Countries Without Electricity
E: Low Income People
T: Chemically Based Electricity Generator

POG: Affordable Bicycle For Low Income People
S: Travel Long Distances To Work, No Public Transport
E: Cars Not Affordable, No Public Transport
T: Cheaper Manufacturing

POG: Efficient Stove in Developing Countries
S: Large number of people in developing countries cook over fires leading to health problems
E: Low income
T: Additive Manufacturing

POG: Water Transport Device
S: Large number of people in developing countries travel far for water
E: Low income
T: Additive Manufacturing, Injection molded plastic

POG: Portable Utility Unit (Solar Panel, Internet Connection)
S: Large number of people in developing countries live in remote areas without infrastructure to get them connected to utilities
E: Low income
T: Solar panels, satellite

POG: Inexpensive Rain Collection Tank
S: Large number of people in developing countries have inadequate access to water
E: Low income
T: Additive Manufacturing

POG: Water Filtration System
S: Large number of people in developing countries have inadequate access to water
E: Low income
T: Additive Manufacturing, Injection molded plastic

POG: Predator Alert System
S: Farmers living close to wild animals
E: Low income
T: Speakers, Motion sensors

POG: Quadrotor Health Delivery
S: Large number of people who live in remote areas
E: Low income
T:Quadrotor, GPS

POG: Inexpensive Water Bicycle Attachment
S: For developing countries with flooding issues
E: Low income, Flooded areas
T: Additive Manufacturing, Injection molded plastic

POG: Soil Rehabilitation System
S: for developing countries with demanding agricultural needs
E: Increase food production
T: Water Irrigation Systems, Crop Cycling Methods

Social - Conservation

POG: Climate Reactive Housing
S: Natural Disasters,Global Climate Change,Rising Sea Level, Over Crowding
E: Low Income, Disaster zones
T: Sensors, GPS

POG: Algae Biofuel Generator
S: Global Climate Change, Need for Renewable Energy Sources
E: High Cost of Oil
T: Centrifuge for Oil Separation

POG: Miniature Deployable Wind Generators
S: Need for electrical energy in remote locations with little sunlight
E: Generates electrical energy for electronics complete off a renewable source
T: Reverse motors to generators, rapid prototyping and form factor design

POG: Adaptive Furniture
S: Overcrowding, Growing Urban Population
E: Low Income
T: Actuators, Recycled Materials, Microcontrollers, Smart Phone Apps

POG: Doorknob Generators
S: Reusable energy from everyday common action
E: Energy gained from human motion instead of paid electrical energy
T: Motors, simple electrical circuit, simple manufacturable housing

Technology- Microcontrollers

POG: Cattle Herding/Tracking system
S: Food generation
E: Increase a cattle ranch efficiency
T: GPS, Drones, Microcontroller, Microchips

POG: Automated Farming system
S: Food generation
E: Increased farming efficiency
T: Solar panels, Drones, Rovers, GPS

POG: Face Tracking Camera
S: Action Cameras, DIY Videos
E: Reduce Cost of High Quality Video
T: Xbox Kinect, Face Tracking

POG: Central House Control Unit
S: Growing Suburban Population
E: Large Number of Single Family Homes
T: Sensors, Smart Phone Apps

POG: Cyclist Safety/Automated Crash Alert
S: Growing Number of Urban Cyclists
E: Large Number of Urban Cyclists
T: Smartphone Apps, Sensors, Microcontrollers

POG: Retrofit Appliances/Smart Appliances
S: Old Appliances Being Replaced By Smart Appliances
E: Retrofit Appliances to Create Smart Appliances
T: SmartPhone apps, Sensors, Microcontrollers

POG: Smart Coffee Maker/Alarm Clock
S: More Time Effective
E: Retrofit Appliances to Create Smart Appliances
T: SmartPhone apps, Sensors, Microcontrollers

POG: Automated Soccer Training
S: Help Kids Train
E: Growing number of young athletes
T: Sensors, Microcontroller, Apps

POG: Mining Safety
S: Large Increase in Natural Resource Mining
E: More Affordable Safety Equipment
T: Sensors, LED, GPS

POG:Cheaper/More Reliable Printer
S: More Students/Professionals Working From Home
E: Low Cost Printing
T: Injection Molded Plastic, Low Cost Actuators

POG: Personalized/Ergonomic Tools/Helmets
S: Aging Workforce
E: More Productivity
T: Additive Manufacturing, Scanning

POG: Vibration Shovel
S: Ease digging irrigation in third world countries
E: Ease of labor
T: Vibrators

NARROWING DOWN SELECTED PRODUCT OPPORTUNITY GAPS

To help select the most viable product opportunity gaps for further development we created a weighted matrix. The product opportunity gaps were judged on seven selection criteria usability, excitement, feasibility, technological availability, safety, need, and cost. Each of these criteria was given a weight in order to bias the criteria that are more important. Each of the POGs was then given a ranking 1-not ideal, 3-acceptable, and 9-ideal for each of the criteria.

Product Opportunity Gap	Usability (weight -3)	Excitement (weight-4)	Feasibility (weight -5)	Technology (weight-3)	Safety (weight-1)	Need (weight -4)	Cost (weight -2)	Points
Firefighter Drone	3	9	1	3	3	1	1	68
Bridge Repair/ Replacement	3	3	3	3	1	9	3	88
Low Cost Bicycle	3	3	9	9	9	1	3	112
Adaptive Furniture	9	9	3	9	9	3	1	128
Braille E-Book	9	3	3	3	9	3	1	86
Face Tracking Camera	9	9	1	3	9	3	1	100
Smart/Dynamic Brace	3	1	3	9	9	3	9	94
Cyclist Safety/ Automated Crash Alert	9	1	3	9	9	1	3	92
Automated Soccer Training	3	3	3	9	9	1	3	82
Landmine Detection	1	1	3	9	9	1	9	80
Climate Reactive Housing	3	1	1	3	9	1	1	42
Cheaper/More Reliable Printer	9	1	1	3	9	3	3	72
Victim Location	3	3	3	3	9	9	3	96
Blind Navigation	9	9	3	3	9	3	9	126

Based on the results of the weighted matrix we decided to take a deeper look at four of the product opportunity gaps adaptive furniture, low cost bicycle, face tracking camera, blind navigation.

INITIAL RESEARCH | ASSESSMENT OF IDENTIFIED OPPORTUNITIES

I. Adaptive Furniture

Overpopulation is a growing problem in urban areas around the world. As a result living spaces are getting smaller and it is necessary to utilize space efficiently. We envision a furniture system that would allow the user to easily adapt their living space.
Advantages: Large potential market, Many potential mechanical and mechatronic solutions
Disadvantages: High cost of prototyping, mechanical aspect complex

II. Low Cost Bicycle

People in developing nations do not have access to cars or public transport and are often forced to travel long distances on foot. We envision a rugged low cost easy to maintain Bicycle that would allow people to travel faster and be more productive.
Advantages: Large potential market, Large Social Impact
Disadvantages: High cost of prototyping, Not much room for improvment

III. Face Tracking Camera

Many people use go pros and other action cameras to capture themselves or other people skiing, snowboarding, etc. however it is often hard to keep the subject in the frame while trying to keep up. We envision a camera that would be able to recognize a target and keep it in the center of the frame in order to create a more stable video.
Advantages: Large potential market, Exciting, Many potential mechatronic solutions
Disadvantages: High cost of prototyping, Time consuming, Program and mechatronics are complex

IV. Augmented Sensory Stick for the Blind

We envision an augmented sensory stick for the blind in order to help them navigate. We would install accelerometers in the stick linked to vibrators attached to the handle or wrist. The device would allow blind people to navigate independently.
Advantages: Large need, Large room for improvement
Disadvantages: Lacking potential for mechanical solutions

VOA CHARTS | ASSESSMENT OF IDENTIFIED OPPORTUNITIES

I. Adaptive Furniture (EXAMPLE: Murphy Bed)

EMOTION	Note	low	medium	high
Adventure	Cool to convert	■		
Independence	Easy to convert	■	■	
Security		■		
Sensuality	Enjoyable	■	■	■
Confidence		■		
Power	Multifunctional	■	■	
ERGONOMICS				
Comfort		■	■	■
Safety	Dangerous mechanism	■		
Ease of use		■	■	
AESTHETICS				
Visual		■	■	
Auditory	Quiet	■	■	
Tactile		■	■	■
Olfactory		■		
Taste		■		
IDENTITY				
Point in time		■	■	
Sense of place		■	■	
Personality		■	■	
IMPACT				
Social		■		
Environmental		■	■	
CORE TECH				
Reliable		■		
Enabling		■	■	
QUALITY				

Craftsmanship				
Durability				
PROFIT IMPACT				
BRAND IMPACT				
EXTENDABLE				

II. Low Cost Bicycle (EXAMPLE: Cheap Bicycle)

EMOTION	Note	low	medium	high
Adventure				
Independence				
Security				
Sensuality				
Confidence				
Power				
ERGONOMICS				
Comfort				
Safety				
Ease of use				
AESTHETICS				
Visual				
Auditory				
Tactile				
Olfactory				
Taste				
IDENTITY				
Point in time				
Sense of place				
Personality				
IMPACT				

Social				
Environmental				
CORE TECH				
Reliable				
Enabling				
QUALITY				
Craftsmanship				
Durability				
PROFIT IMPACT				
BRAND IMPACT				
EXTENDABLE				

III. Face Tracking Camera (EXAMPLE: Gopro)

EMOTION	Note	low	mediu m	high
Adventure				
Independence				
Security				
Sensuality				
Confidence				
Power				
ERGONOMICS				
Comfort				
Safety				
Ease of use				
AESTHETICS				
Visual				
Auditory				
Tactile				
Olfactory				

Taste				
IDENTITY				
Point in time				
Sense of place				
Personality				
IMPACT				
Social				
Environmental				
CORE TECH				
Reliable				
Enabling				
QUALITY				
Craftsmanship				
Durability				
PROFIT IMPACT				
BRAND IMPACT				
EXTENDABLE				

IV. Augmented Sensory Stick for the Blind (EXAMPLE: sensing stick)

EMOTION	Note	low	medium	high
Adventure				
Independence				
Security				
Sensuality				
Confidence				
Power				
ERGONOMICS				
Comfort				
Safety				

Ease of use				
AESTHETICS				
Visual				
Auditory				
Tactile				
Olfactory				
Taste				
IDENTITY				
Point in time				
Sense of place				
Personality				
IMPACT				
Social				
Environmental				
CORE TECH				
Reliable				
Enabling				
QUALITY				
Craftsmanship				
Durability				
PROFIT IMPACT				
BRAND IMPACT				
EXTENDABLE				

FINAL OPPORTUNITY SELECT

In order to choose the final opportunity we discussed the advantages and disadvantages of each of the final four POGs.

We decided to eliminate the idea of a low cost bicycle because there are already a lot of existing bicycle designs and as a team we felt that there was little room for improvement. We also felt that people in different countries had vastly different needs from a bicycle and that designing a bicycle to fit all these needs would be too difficult.

We were very excited about the idea of a face tracking camera, however, the prototype would require a xbox kinect face tracking technology which would be too difficult to implement in the time frame of this class. The face tracking camera also did not have a large potential for social impact.

As a team we also decided to eliminate the idea of an augmented sensory stick because we felt that there was not a lot of room for mechanical design which is critical for this class.

After eliminating the face tracking camera, low cost bicycle, and the sensory stick we were left with adaptive furniture as our last POG. Based on our initial research into existing designs and the VOAs of these designs we decided that adaptive furniture offered a lot of areas for improvement and the potential for a creative mechanical solution.