Engineering Problems

Identifying problems appropriate for engineering solutions

Some Examples of Engineering Problems and Projects that follow the Design Process

Identify Problem ->
Define Requirements ->
Design a Solution

(PSU Engineering Capstones, 2017-2018)

Rhamey Mobility Device: Accessibility

Problem Statement: (Requirements provided by ‘client’)

“Our clients want a device that is capable of safely transporting a person across various terrains. The device must be lightweight, collapsible, and it should allow its user the option to sit or stand. No single component of the device should exceed 30lbs. The scooter should be battery powered and the battery itself should provide its user with a minimum of one hour of continuous use. The cost must not exceed $1,000 and the scooter must have variable speed with a maximum top speed of 4mph.”

Content Excerpts from:
http://web.cecs.pdx.edu/~gerry/class/ME493/projects/2017/Rhamey_mobility.html

Rhamey Mobility Device

Solution Design: (Invention designed to address the *client-specific* problem)

“Our team is focused on building a lightweight scooter that allows the user to detach components and to allow the user either to sit or stand. Main concern with the structural design of scooter was safety. With this, we wanted to create a design that would assure the client safety and stability..”

Rhamey Mobility Device

Solution Outcome:

“The team has developed a conceptual design that meets the sponsor requirement. The scooter will be lightweight, not exceeding $1,000, and capable of transporting the user safely. There scooter will also have an adjustable and detachable tripod seat to allow client to sit or stand. Also a hub motor with a twist throttle to allow user to adjust speed.”

Ventacity Sensor Platform: Environmental

Problem Statement: (Requirements provided by ‘client’)

Venacity Requires

“A robust sensor platform to provide accurate ambient and above ambient indoor air quality data to an HVAC controls unit no later than June 9, 2017 with a unit cost less than $2000 and with an engineering budget of $2500 provided by Ventacity Systems”

Content Excerpts from:
http://web.cecs.pdx.edugerry/class/ME493/projects/2017/Ventacity_IAQ_platform.html

Ventacity Sensor Platform

Solution Design: (Invention designed to address the *client-specific* problem)

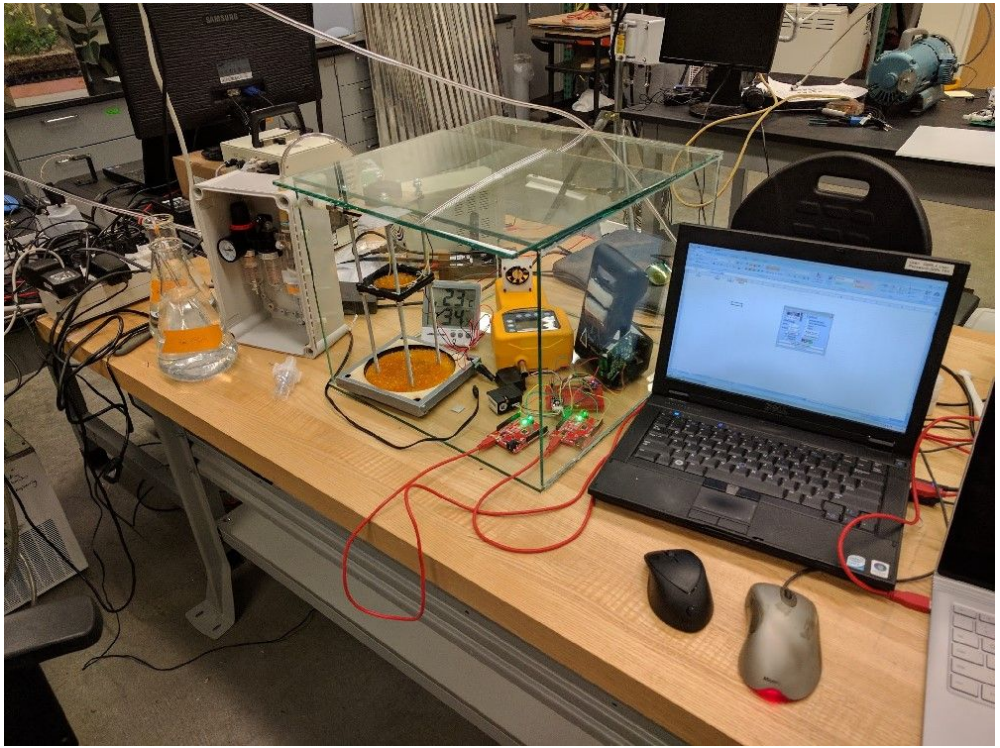
“A device that:

- measures dry bulb temperature and relative humidity, and at least four pollutants out of CO, CO2, O3, PM2.5, VOCs and NOx
- contains sensors that can be calibrated in a timely manner by Ventacity or the team, or are pre-calibrated
- has an aesthetically neutral and weatherproof housing that does not hinder the operation of the sensors or wireless communication”

Ventacity Sensor Platform

Solution Outcome:

Complete system with aerosolyzer, test environment, sensors, baseline detection instruments and laptop



DRC Adjustable Desk

Problem Statement: (Requirements provided by 'client')

"Design and fabricate a lightweight, reliable, and adjustable desk with enough under clearance to accommodate any type of wheelchair."

Content Excerpts from:
http://web.cecs.pdx.edu/~gerry/class/ME493/projects/2018/DRC_Adjustable_Desk.html

DRC Adjustable Desk

Solution Design: (Invention designed to address the *client-specific* problem)

“The project sponsor requires a device that is easily adjustable, durable, and contains only mechanical components.

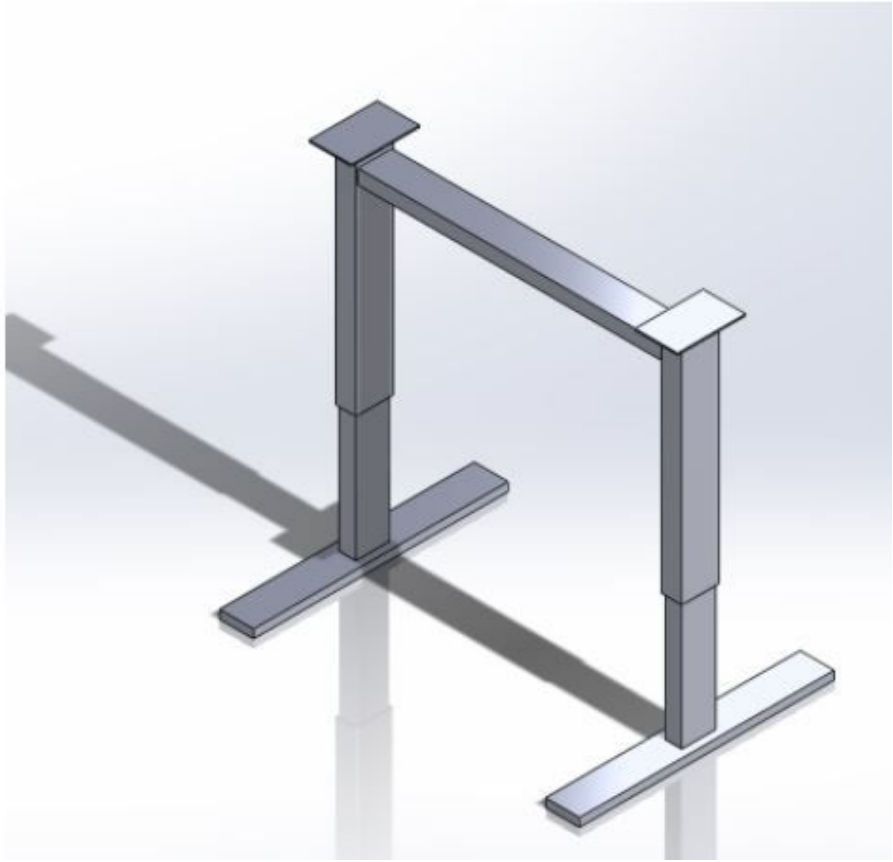
The design team is focused on building a lightweight structure that allows the desk to be adjusted while carrying 200 lbs.”

DRC Adjustable Desk

Solution Outcome:

The team has developed a conceptual design that will fulfill the clients requirements. To fulfill these requirements the team will use two remote release gas springs that will easily adjust the desk with infinite number of increments.

The following image show a CAD of a design of halfway through development:



Identifying Problems Suited to *Engineering* Solutions

- Value: What do you care about?
- Problem: What is a specific problem (or opportunity) related to that value?
- User: Who does it affect? Who causes the problem?
- Scope: Can this user be provided with a single tool to *help* address this problem?
- No?
- Then Narrow the Scope

Questions to Ask:

Can I reach my hypothetical user? *Identify a human user, not just institutions or 'society'.*

What are the specific components involved in my problem that could be addressed by a technology? *Look for tangible problems, look for intervention points.*

Is there a physical setting for my potential solution?

Example Problem Identification Process

- Value: Environmentalism
- Problem: Waste and pollution damaging planet.
- User/Affected: Corporations, Governments, Individuals, Animals
- Scope: No tool that could be utilized on all user levels
- Narrow the Scope*:*
  - Problem: Unnecessary Food Waste
  - User: Grocery Stores, Shipping Companies, Farmers, Government, Individuals
  - Scope: No clear tool that could be utilized by all users.
  - Narrow the Scope: ….

Narrowing the Scope Further:

Problem 1: Individuals are bad at estimating how much food they will eat when preparing a meal, leading to wasted food.

Problem 2: Individuals forget about leftovers, end up throwing food away.

Problem 3: Individuals buy more than they can eat in a week, causing food to go bad before it is eaten.

User: Individual Food Consumer (reachable)

Intervention Points/Setting:

1. During Meal Preparation, at Dinner Table, Plating, before Food Disposal, Garbage.
2. Fridge, Food Packaging, Garbage.
3. Grocery Store, Shopping Cart, Fridge, Packaging, Shopping List, Garbage.

Major Problem Topics: (See Bottom of Day 2 Page for Complete List)

Environmental:

- Climate Change / Lack of renewable energy options.
- People wasting Food / Lack of Composting Options.
- Lack of incentive to Recycle Properly.
- Excessive water usage (shower, sink, etc)
- Factory Farm meat production.

Major Problem Topics: (See Bottom of Day 2 Page for Complete List)

Accessibility:

- Mobility limited when in a cast
- Complex food preparation difficult for visually impaired
- Food Insecurity (ties in with homeless issues)
- People not respecting Service Dogs
- People unaware/not respecting another person's disabilities or need for alternative accommodations.

(Potential for many more Accessibility Issues - *think about everyday tasks that are made more difficult by physical/ developmental disabilities*)

Major Problem Topics: (See Bottom of Day 2 Page for Complete List)

Health:

- Back and heel pains from extended time on feet
- Limited Access to Clean Drinking water

(Potential for many more Health issues - *think about common health issues - the need for systems and tools that support/ mitigate these issues*)

Major Problem Topics: (See Bottom of Day 2 Page for Complete List)

Convenience & Comfort:

- Left-handed writers+drawers smudge marks as they write.
- Headphones overheat in your ears.
- Pillows never the right height.

(Potential for many more convenience issues)

Major Problem Topics: (See Bottom of Day 2 Page for Complete List)

Socio-Political:

- People not voting / Not following Campaigns *(Registration?)*
- Childcare costs too high *(making childcare easier)*
- Not enough music education in schools *(altern. education)*
- Inequality *(big issue, many sub-issues to address)*

(A lot of these issues are too big to address directly with a physical tool, but could raise visibility, increase engagement)

When Selecting a Problem Scope, Consider your Resources:

- Research Tools: The internet, your mentors and instructor, friends and family.
- Fabrication Tools: Hand Saw, Drill, Laser Cutter, 3D Printer, Soldering Iron, Glue Gun (others upon request).
- Materials: Wood, Plastic, Tubing, Tape, Glue, String, Wire, specific supplies upon request (metal materials, wheels, containers, hinges, springs, etc.).
- Electronics and Control: Computer, Arduino Microcontroller (Brain), Motors, Speakers, Lights, display screens, battery and power supplies, sensors *(soooo many sensors: light, sound, distance, vibration, orientation, temperature, etc. Think of a thing, there's probably a sensor for it).*
- Programs: Arduino, 3D modeling, others upon request (need to log data? Display information on a screen? We can help).

You have all the resources you need for:

- Movement:
  - You can build levers and pulley mechanisms
  - Drive motors
  - Open and close compartments
  - Lift objects
  - Spin objects
  - Open and Close Valves (Solenoids)

You have all the resources you need for:

- Sensing:
  - You can listen or watch for movement
  - You can sense light
  - You can measure distance/proximity
  - You can measure orientation (Gyroscope, tilt)
  - You can measure environmental conditions: temp, humidity, pollutants
  - You can store data and keep the time (SD and RTC)

You have all the resources you need for:

- Communicating:
  - You can make sounds and tunes
  - You can turn on lights, change colors, emit a laser
  - You can print to an LCD Screen
  - You can send messages back to the computer (serial)
  - You can receive user input via knobs, buttons, remotes, number pads, and joysticks

Your Invention:

When Identifying an engineering problem, focus on:

Desirability: Would a technical solution to this problem be desired/used by my target user?

Feasibility: Can I address this problem using the resources I have? Can I build a solution?

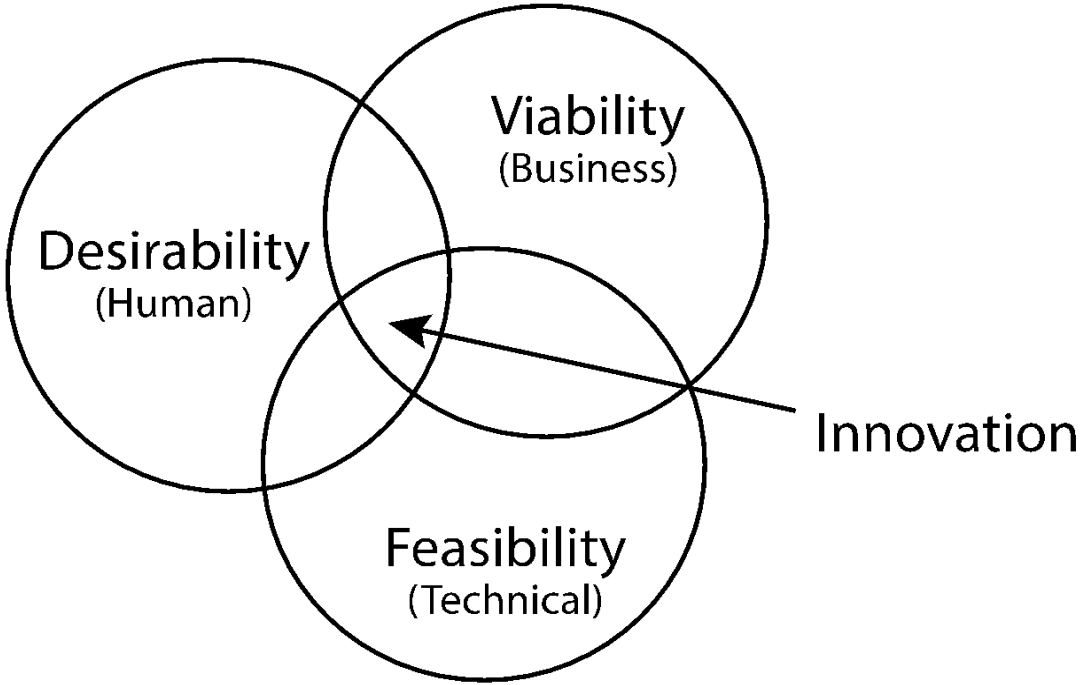


Image from https://designthinking.ideo.com/?page_id=1542