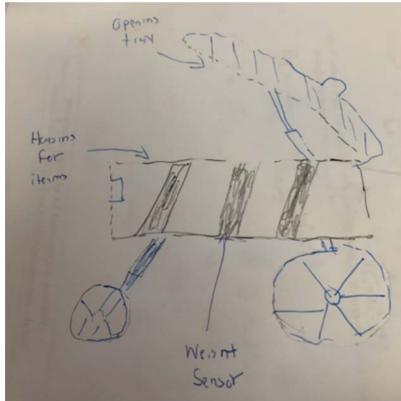# Deliveroid
Solution Design Report

For our project, we wanted to create a robot that could autonomously deliver documents and materials between offices on the third floor of the engineering building. Before we begin building this robot, the team needed to come up with some design solutions that could achieve this task. Below contains designs each group member came up with in this design process. Later on, we explain how we went from three different solutions to choosing one based on our needs and how we want our final product to act.

Design #1 - Forzando - Small Truck

This first design of the Deliveroid is for a more compact and maneuverable robot. This design is to suit those who are not going to be transporting a lot of things and also want their things to be transported faster. We want the design to be built like on top of a small rectangular shelf. The robot will be guided by a light sensor and will follow a white tape strip as a means of navigation. Four smaller wheels will be how the robot moves and they will be controlled by a microcontroller in forward-wheel drive. We want the user to load in any documents they want transported into this shelf and the robot will carry these documents to the room it is set to. With this design, our robot will be lighter weight

and the components will not have more of a strain on them. The design will also be able to move at a faster speed and be more nimble when moving through the halls.
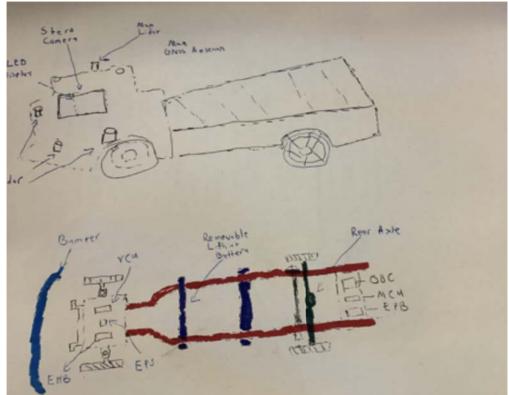
Methodology

Through Internet of Things (IoT) we will be able to send instructions to the device through an internet connection. The internet connection will act as a port, where the user can connect and send instructions to the device. We want the user to be able to set a pick-up and drop-off location and the device will be able to plot its route to deliver the documents by utilizing an algorithm that will find the shortest route to the destination.

Drawbacks

With this design we have run into a few drawbacks. For example, we run into the problem of what happens when the device is to deliver a document that meets weight requirements, but is too big. This is where we run into the problem of size. A lot of the time, our professors need to transport documents that are large in size. This design will have a hard time trying to complete this, at least, not in a safe way. We do not want any piece of the document to be hanging outside of the shelf, then it will run into the risk of becoming damaged or falling out of the shelf entirely. Also, with this device being smaller in size we run the risk of it being easily stepped on or damaged. We want this device to be durable and sturdy and this can be an issue when trying to transport documents in a congested environment. Not only do we want our device to make quick deliveries, but we also want it to get there safely.
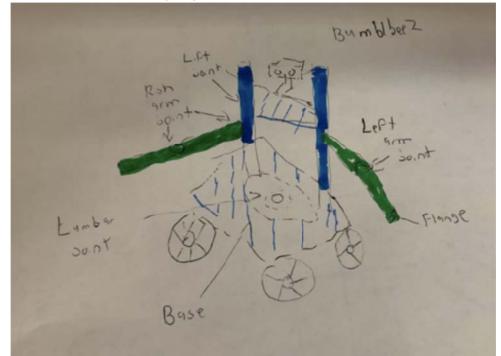
Design #2 - Michael - Big Truck

This design will follow a design layout similar to a pickup truck. The idea is to have a truck bed that will hold the documents that we want the device to transport. The size of this device will be much larger than that of the Small Truck design, and this will allow for users to load larger and heavier documents to the device that the Small Truck would not have been able to.

Methodology

Like the Small Truck design, this design will be connected through the internet to receive instructions. It will also utilize a light sensor that will follow a strip of tape which will be its path that it will follow from one place to another. We will also utilize arduino to be the main circuit board for this design where we will program the logic. One of the key differences between the Big Truck and the Small Truck is that the size of the design will be a lot bigger, in turn we will use larger tires to support the load and this will mean we need stronger motors to turn the wheels when it is in motion.

Drawbacks

There are some drawbacks with this design as well. Since the design is larger than the Small Truck, this will mean we need to use larger components. Using larger components will cause this device to be slightly more expensive as they will need to be of better quality as well. The device may also be slower since the larger wheels may take more to move. This will result in slower deliveries but they will arrive more safely due to the Big Truck's more durable frame.

Design #3 - Williams - Multipurpose Truck

       This design follows a different method as opposed to the first two. In this multipurpose design, the truck will do two different functions. The first function being able to pick up documents that have been laid in a designated location. The second function is that the truck will be able to transport those documents a short distance (maybe a room or two over) to the recipient. So not only will the device be able to transport documents, but it will also be able to pick up any documents it needs to transport on its own. This design will be about midsize in between the Small Truck and the Big Truck. This is to allow the device to be big enough to handle picking up documents without tipping over and also small enough to be able to maneuver through the tight spaces of an office.

Methodology

       This design will have two modes of operation, first it will be autonomous following the same path as the first two designs by connecting it over an internet connection to receive instructions, but there will also be an alternative operation where the user will be able to control the device through an interface when they want the robot to pick up documents if they are in a location not specified by the robot. This will allow for greater flexibility when the user wants the robot to pick up documents in hard to reach areas. This mode will be entirely optional, if the user wants the device to be completely autonomous, it will have to specify a pick up location for the device to go and retrieve documents. In order to pick up documents, this device will also come equipped with a mechanical arm that will be capable of both extending and retracting. This will be the only additional feature to this design all other components like wheels and motors will be similar to designs 1 and 2.

Drawbacks

      One apparent drawback that can already be seen with this design is this will be a very expensive design to implement. This could also be a very time consuming solution to implement since we have to not only program the device but also the arm that is supposed to be autonomously picking up documents. Not only will this design be time consuming and expensive, but it is also straying away from the original problem. We are trying to come up with a device that can transport documents from one office to another. Adding additional functionality to this device like the autonomous arm could complicate the device in ways that could be avoided.

Section 1: Individual Designs

Forzando - SMALL TRUCK
We can use a microcontroller that can receive a signal so that it can go to the correct destationatin.

Michael Vaughan - BIG TRUCK
We create a bigger design that can carry more or larger things from place to place

We can also include a weight sensor to keep track of the weight we have.

Williams - Multipurpose Truck
We will expand the deleroid's capabilities by making it multifunctional

We can add a mechanical arm that will be able to pick up documents that need to be transported

Section 2: Top 2 Solutions Pros and Cons
Small Truck

Pros	Cons
The size is very small.	Only can transport small amount items
Maneuverable	Design is less stable
Cheaper Design	Less durable
Papers are transported in protective capsules	Frame does not accommodate paper shape
Deliverables are clearly labeled	Capsules cannot transport non-foldable items, Like envelops
Currently in possession of frame so we know how it looks	Extra work for user to gently roll documents and insert in capsules

BIg Truck

Pros	Cons
Design is very durable	Costs more to manufacture as it requires more parts/components
Will be able to fit more stuff	Additional microcontroller connections and power consumption
Can carry large items such as desktops.	Items must be flat in shape in order to fit onto truck bed
Has a weight sensor to keep track of load limit.	Additional programming of microcontroller needed for more components
Better design to fit documents more securely	Device moves slow

Section 3: Decision of the top design using decision matrix

Small Truck(Design 1) vs. Big Truck(Design 2)

	COST	Aesthetics	SIZE	Efficiency	Practicality	Total Score
Weight	3	4	1	5	2	
Design 1	3	2	4	3	3	
Aggr. Score	9	8	4	15	6	42
Design 2	3	3	4	5	4	
Aggr. Score	9	9	4	25	8	55

Category Breakdown:

❖ **Efficiency(5):** Measure of how well the selected design would be at performing its sole function. We base this on speed and how much the device can carry on each trip. Our ultimate goal of this project is to create a device that will make it easier for professors to move documents from place to place without the need to leave their desk. In order to do this we need to make sure that the Deliveroid is able to complete its work in a timely manner similar to what it would take someone to do themselves.

❖ **Cost(4):** Measure of how expensive the design will be to implement. In order to create a device that will compete in the market we need to take careful notice of its cost. This will be extremely important should our device ever reach mass production.

❖ **Aesthetics(3):** Measure of how pretty to the eye our device is. We want to make a device that will look sophisticated and sleek while being relatively easy to use. This will capture the potential customer's eye, thus increasing our demand

❖ **Practicality(2):** Measure of how easy our device it to use. We want to make sure our device is easy to use even for young ages. We are planning on creating a device that will replace a human function of getting up and walking from one place to another. We want to make this process even easier for the user and to do this we need to make the device very simple to use so that the user chooses to use it instead of doing something themselves

❖ **Size(1):** Something that we don't have to consider as much is the size of the device. Since where it will be operating will be a place with a lot of space space is a small concern of the Deliveroid. However, we still want to keep this design relatively sleek, while being a bigger size may not impact it, if the device is bulky then we run the risk of it hitting too many objects while it travels.

Section 4: Description of Top Design

Our Goal was to create a robot that will autonomously deliver items to multiple floors and buildings and we wanted to create a truck that can store alot of documents. We wanted to create a truck that could move everything in a fast and effective way. Some of the software we wanted to use were 2D mapping which can help map the area , Arduino code we can use for embedded development and also meshing map with motor code. Some of the constraints are that our budget is under 200 and we have to use recycled materials to create the material. We also have to follow the IEC regulations.

Software Operation Algorithm:
1. Deliveroid is given instructions over internet connection through https port
2. Arduino board reads instructions from port connection through its wireless receiver
3. Arduino uses memory map that was hardcoded into the system to plot shortest route to its destination
4. Motors are powered on once route has been mapped
5. Light sensor is activated used to guide Deliveroid along a safe path laid out by white tape
6. If an object falls onto the Deliveroid's path it will stop using infrared sensors, and while beep for notification for obstacle to be removed or for someone to remove the obstacle
7. Deliveroid arrives at destination
8. Once weight sensor has reached 0, it is indicated that there are no more documents it is holding
9. Once the Deliveroid realizes that all documents have been removed from the loading bed it will begin the process of returning back to its original location
10. Once Deliveroid has returned to its original location it will power off and await further instruction.

Hardware Operations:
- ❖ Computer: To give the Deliveroid instructions over https
- ❖ Arduino Uno: Provides instruction set for Deliveroid to operate on.
  - ➢ Operates:
    - ■ Motors
    - ■ Sensors
    - ■ Wifi Access
- ❖ WiFi Connection(Router): So Deliveroid has mode of communication between Computer and Arduino device
- ❖ Microcontrollers: To operate Deliveroid lower level operations:

- ➢ Wheel control
- ➢ Axle alignment