

# Project Schedule and Cost

Team Members: Pthahnil Guo, Zijie Chen, Paulo Meneses, Cisco Musetti, Ben Paul

## INTRODUCTION:

In this deliverable, we will outline our prototyping test plan, with stopping criteria included, and document our first prototype, which is a simple model by limited material to physically illustrate basic ideas of our conceptual design, with demonstrations and explanations. In addition, a simple analysis for the critical components and system will also provide. Furthermore, we will extract useful information from the client meeting and add these as improvements into our design. Due to the reason that we still did not get the sensors which we order online, we will just use several small cartons as the sensors.

## PROTOTYPING TEST PLAN:

### 1) Why are we doing this test:

In order to improve the effectiveness of Bowie about its performance to help environmental restoration, our team come up a conceptual design that uses several different functional sensors to improve its braking system, objective detection, environmental measurement, and wildlife monitoring. This plan is used to test our prototype one which is a physical approximation to basically demonstrate our conceptual design, especially to verify the position of sensors on Bowie. Furthermore, we do want to use it to explore different ideas and improvements, as well as the communicate intermediate for our next client meeting.

### 2) Test Objectives Description:

#### A. Specific test objectives:

- 1) Verifying the position of multiple sensor, demonstrate whether these sensors are placed in reasonable and suitable positions on Bowie.
- 2) Determine to what extent will the detective sensor under end effector get damage.
- 3) As a tool for communication in our next client meeting, to better illustrate our conceptual design, seek for feedbacks and improvements from our client.
- 4) Explore for different new ideas about the solution and improvement, especially for the solution to minimize the damage to sensors during the operation process of Bowie.

#### B. What being communicated with the prototype:

The positions of each individual type of sensors, our team is certainly agreed on the positions of both temperature and infrared ray sensors, while detective sensor is the one needs further discussion for a proper positioning plan.

#### C. Possible types of result:

There are mainly two kind of possible results. First is we satisfy with our current conceptual design which will be proved by this prototype, and base on this to do further development. Second is the design will not be properly executed in reality via prototyping, we may need to come up several alternative designs to test and verify.

#### D. How will results be used to make decisions:

In first situation, we will present our prototype and communicate the ideas to our client in next meeting to seek for improvements and feedbacks about next prototype.

In second situation, we will perform the analysis and evaluation within our group firstly, and then discuss the results during next client meeting to select most suitable one.

E. Criteria for test success or failure:

The success or failure of the prototype depend on our team's consensus, and will the detective sensor work properly without affection to end effector.

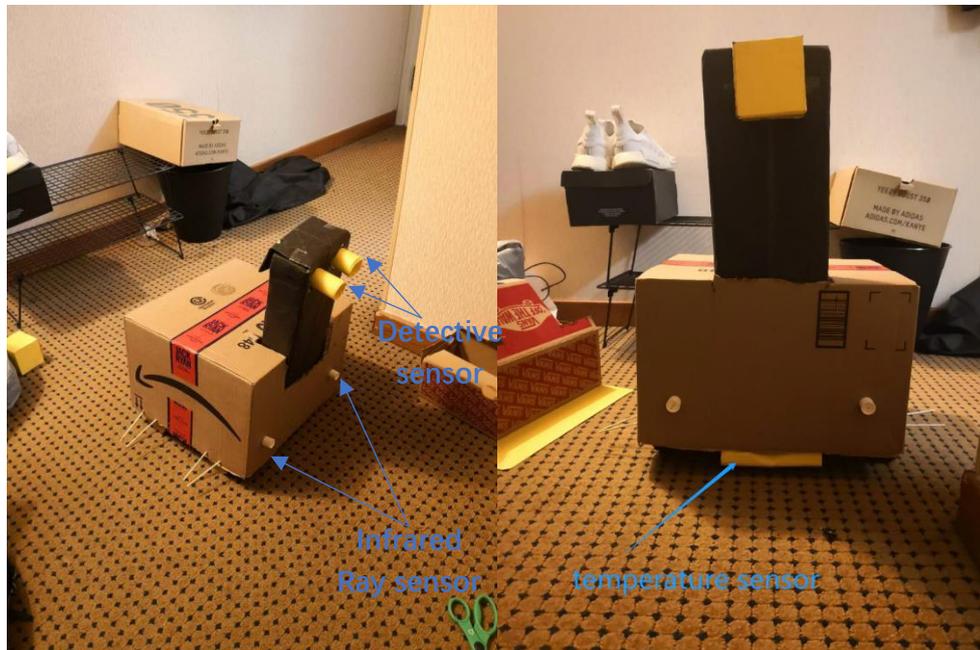
3) What is going on and how is it being done:

A. The reason for selection of this type of prototype:

We choose this type of prototype because our conceptual design is about using integrated sensor system to improve performance of Bowie, which our main focus is programing and integrating. However, we do need to solve the position problems of each sensors, especially the detective sensor, so we decide to use a comprehensive physical prototype to test all sensors' positions with limited materials.

B. Testing process:

We build the model of bowie with our sensor on its robot arm:



By using this model, we physical approximate the positions of sensors on Bowie. There is not any problem for infrared ray and temperature sensors, since they are not position depended. Furthermore, temperature sensor is used to measure the ground temperature and system will compare it with the information from infrared sensors to determine wildlife.

Then we put the arm down to see the distance between detective sensors and ground. However, there is an angle between arm and ground when Bowie picking up garbage in reality, and we will fix the exact position of it in next prototype. Because it requires the actual detective sensor and Bowie robot which we did not get it yet for this prototype.

- C. What information is being measured:  
We measured the shape of the sensor, the position of the robot arm and the position of the sensors.
- D. What is being observed and how is it being recorded:  
First, we found that the most suitable position for this sensor is the top of robot arm, in this case we can maximize its detecting range. Second, we got the conclusion that if we put the sensor on the front plane of robot arm, it won't touch the ground when robot lowers its arm. Third, we found that if we only put one sensor on the robot arm, it will be hard for robot to detect the object because of the limited effective detecting range. We recorded these in our meeting notebook.
- E. Required materials and costs:

Material	Cost (CAD)
Hardboard	\$5
Glue	\$3
Total	\$8

- F. What work needs to be done:  
Build a simply module of Bowie with sensors (small cartons) in it as shown in conceptual design.

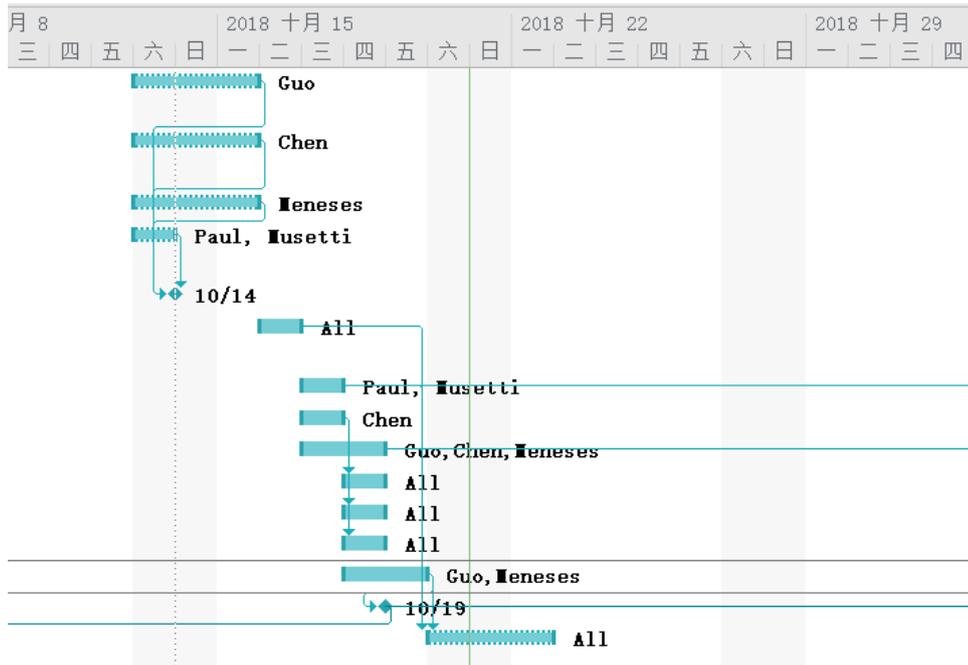
4) When is it happening:

- A. How long will the test take and what are the dependencies (i.e. what needs to happen before the testing can occur)?

This period will take 5 days

- B. A separate test planning Gantt chart:

任务模式	任务名称	工期	开始时间	完成时间	前置任务	资源名称
1	Project schedule	2 个工作日	2018年10月13日	2018年10月15日		Guo
2	Gantt chart for schedule	2 个工作日	2018年10月13日	2018年10月15日		Chen
3	Cost estimate	2 个工作日	2018年10月13日	2018年10月15日		Meneses
4	Significant risks and contingency plans	1 个工作日	2018年10月13日	2018年10月13日		Paul, Musetti
5	Project Schedule and Cost completed	0 个工作日	2018年10月14日	2018年10月14日	1,2,3,4	All
6	Getting Customer feedback for conceptual design	1 个工作日	2018年10月16日	2018年10月16日		All
7	Analysis of customer feedback	1 个工作日	2018年10月17日	2018年10月17日		Paul, Musetti
8	Buy the material and tools we need	1 个工作日	2018年10月17日	2018年10月17日		Chen
9	Device testing plan	2 个工作日	2018年10月17日	2018年10月18日		Guo,Chen,Meneses
10	Test for touching sensor	1 个工作日	2018年10月18日	2018年10月18日	8	All
11	Test for infrared sensor	1 个工作日	2018年10月18日	2018年10月18日	8	All
12	Test for temperature sensor	1 个工作日	2018年10月18日	2018年10月18日	8	All
13	Analysis of critical components or systems	2 个工作日	2018年10月18日	2018年10月19日		Guo,Meneses
14	Prototype I Completed	0 个工作日	2018年10月19日	2018年10月19日	13	All
15	Deliverable - Prototype I and Customer Feedback	2 个工作日	2018年10月20日	2018年10月22日	6,7,9,13	All



C. When are the results required:

The results are required on October 19, since this deliverable is depending on the testing process and results, as well as we need to ensure we reach the milestone of prototype I completed to start working on our prototype two.

**ANALYSIS OF CRITICAL COMPONENTS OR SYSTEMS:**

Material being used: Hardboard

1. Why use hardboard?

- It's available in a wide variety of different designs and sizes.
- It's cheap and affordable. It's cheaper than wood or metal.
- It's environmentally friendly. It is made up of leftover wood material and fibres.
- It's sturdy and durable.

2. Properties of hardboard:

Properties	Values
Density (kg/m3)	800 - 1025
Modules of elasticity (N/mm2)	3000
Modules of rupture (N/mm2)	30
Tensile strength perpendicular to the plane of the board (N/mm2, Min)	1
Coefficient of friction	0.25

3. Detection sensor position risk

The detective sensor which is used to detect objects for possible collisions and stop before or while the accident happens is positioned under the end effector of the robot which has a possible risk of damage happening to it. If the sensor were to be damaged or made ineffective then the robot would essentially be blind there because it would get no feedback. A potential risk for the detective sensor is that objects such as rocks behind what the robot is attempting to pick up with the end effector could potentially scrape or hit against the detective sensor underneath. Another possible risk of damage for the detective sensor

under the end effector is that it is at risk for damage from the environment if it is too close to the end of the end effector. If the robot were to go to pick something up in a muddy area or somewhere where water is pooled up the detective sensor could come into contact with it damaging it.

#### **CUSTOMER FEEDBACKS:**

As a team, all our prototype ideas revolved around some sort of sensor, that will detect something and automatically function. Erin was very impressed with our ideas and loved that we included sensors in our prototypes since sensors are a very important aspect of robotics. Erin noted that the robot can perform manual, and autonomous navigation, therefore the implementation of sensors onto Bowie will further develop the robot's autonomous aspects. We plan on using a temperature sensor, and we were told by Erin that the camera on the robot cannot detect temperature, so our prototype will create a new function on the robot. Erin gave an example on how to allow Bowie to work with a manual brake and sensors. The idea was to add two LED's on each side of the robot, one green and one red, the red light will light up on one side depending on if there is an obstacle is sensed, indicating to brake. Erin was curious to know where we plan on putting the sensors, in which we plan on putting at the form of the robot just above/beside the wheels, where any obstacle will be closest to.

#### **LIFE-LONG LEARNING: TRANSFER OF KNOWLEDGE:**

In this deliverable, we firstly discuss the types of prototype and decide comprehensive physical prototype will be most suitable type for our prototype one, because there is not any technical problem involved and we only want to approximate a model and verify the portions of all sensors. Then, we apply the knowledge of how to test a prototype that includes: prototype fidelity, executing test, benefits from test, and form a testing plan. Furthermore, we also use the knowledge of receiving and how to form productive feedback in order to extract useful information from our first discussion with client to improve our solution for next prototype.

#### **CONCLUSION:**

We develop comprehensive physical prototype to verify the positions of the sensors in our conceptual design. After the testing, we conclude that the positions of both temperature and infrared ray sensors are suitable to stay the same as original conceptual design, while the position of detective sensor still under the end effector expect it will move down a little bit to minimize damage to it. In addition, the exact position, such as the how far down from end effector or its angle, will be verify in next prototype. According to our customer feedback, we also need to come up a plan about how to work with a manual brake and sensors since Bowie can be manually and automatically controlled. We will imply these suggestions from feedback into our prototype two to make a better approximation for the final solution. Furthermore, our next prototype will be a focused analytical prototype to determine the exactly position of detective sensor under the end effector as previous mentioned.