The 3P Bee

Section 1: Abstract

Our world depends on bees. Around 90% of wild plants and 30% of crops are pollinated by these striped insects. Since the nineteen hundreds, the bee population has been drastically decreasing. More than 40% of the bee population in the USA has disappeared since 2006 due to unknown causes. Our vision is to design a robotic bee. The robot's main purpose would be to function as a temporary, but necessary replacement for bees. Some other capabilities of our robotic bee are clearing polluted air and locating harmful pesticides. To complete these tasks, we would use technology such as AI, nanosensors, solar power, mesh and swarm technology, and a futuristic air converter. This robotic bee could save our planet from inevitable destruction. "The 3P Bee", stands for the three key capabilities: pollination, pesticide detection, pollution converter.

Section 2: Description

1. Present Technology

Bees pollinate food that we eat daily. They pollinate 30 percent of our crops and 90 percent of wild plants. Foods like apples, bananas, mangos, coffee beans, and many more. We would die without them. Cross pollination happens when a bee lands on a flower. Pollen sticks to the bee and it flies to another flower, and the pollen is transferred to the other flower. Cross-pollination makes flowers and crops grow without human interference. The sudden unexpected decrease in the bee population is the reason we have decided to do this project, to learn more about the bees and how we can help them regain the natural population.

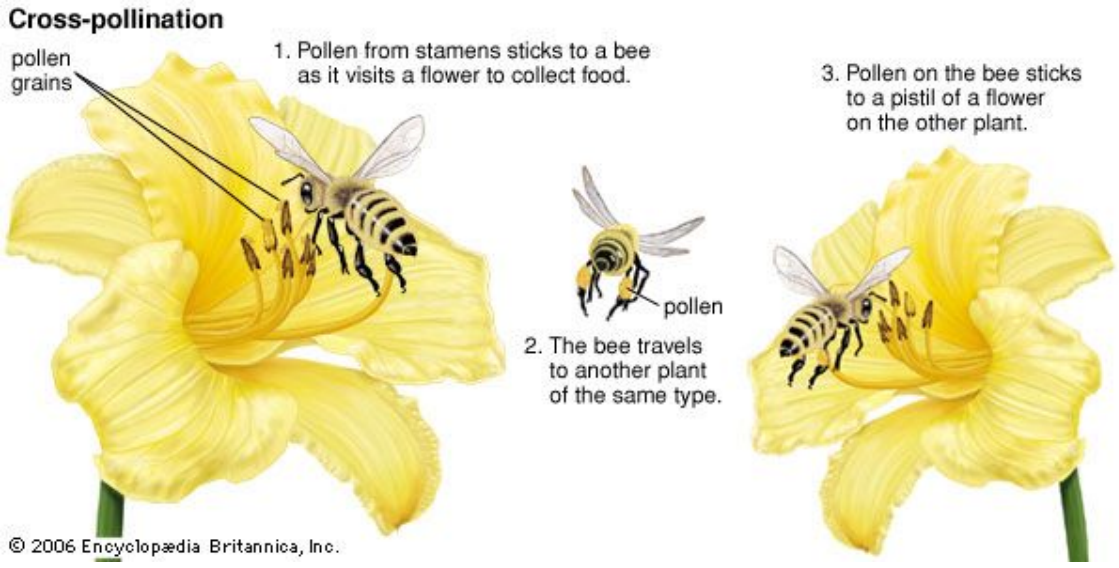

Figure 1: Cross pollination

Robotics

Robotics is the science of making robots. A robot has a brain that stores information and tells the muscle system what to do. The muscle system moves the body structure, which is the robot's body. The robot runs on a power source. There is a sensory system that sends information to the brain about the surroundings and what the body is doing. There are many different types of robots. Some examples are articulated, cartesian, cylindrical, polar, SCARA, and delta. Robots have different types of joint configurations which are referred to as axes. Joint configuration allows robots to be more flexible and able to perform various types of tasks.

Artificial Intelligence

Artificial Intelligence is also called "AI." AI can perform recognition by various measurements of the object and comparing then to stored data. A robot gathers information through sensors and it will decide what to do from stored data. The computer program goes through a list of solutions it could use, and chooses the most successful solution. Artificial intelligence program allows the ability to learn and display intelligent solutions.

Solar Power

Solar Power is started by sunlight hitting a solar panel. Solar energy allows us to turn the sun's energy into electrical energy. Photons from the sun excite the

electrons in the semiconductor and use conductors with positive and negative sides to allow the electrical current to flow to the device that requires power.

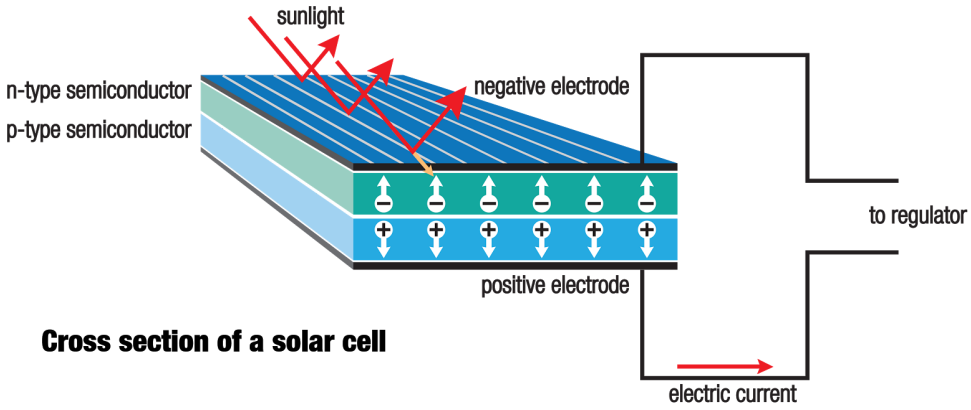

Figure 2: Cross section of a solar cell

Mesh Technology

Mesh technology is used to send messages from point A to point B, utilizing a minimal amount of power. Mesh nodes are small radio transmitters that act as wireless routers. Nodes use wifi to communicate with users. Power is saved by the message hopping from node to node to get from point A to B. Each node uses a low power radio which saves power compared to using a high frequency radio to get from point A directly to point B.

Swarm Robotics/Intelligence

This swarm intelligence is used by birds, fish, insects, and now robots. It allows for a group to work together without needing a leader.The robots are doing it

without even having a leader. It has three rules. They are: 1. Avoid bumping into other objects. 2. Move in the average direction that those closest to you are heading. 3. Move toward the average position of those closest to you.

2. History

Bee:

- Honey Bees date back to 35 million years ago in Europe, and 40 million years ago in Africa.
- There are nearly 20,000 species of bees in the world.
- Bees live approximately 150 days.

Robotics:

- 5th century BC: Greek mathematician Archytas of Tarentum made a steam pigeon.
- 1136- 1206: Al-Jazari designed a lot of automatic machines, including kitchen appliances and music powered by water.
- 1452-1519: One of the first recorded designs of a humanoid robot made by Leonardo da Vinci.
- 1898: Nikola Tesla demonstrates first radio-controlled vessel.
- 1961: First installed industrial robot.

AI:

- 1232-1315: Majorcan Philosopher Ramon Llull developed several logical machines devoted to the the production of knowledge.
- 1940: A programmable digital computer with mathematical reasoning was invented, and it inspired many scientists.
- 1950: Alan Turing created a machine that had intelligent behavior
- 1956: Research was discovered at a workshop in Dartmouth, and the people that were there became leaders of AI.
- 1993: Ian Horswill created the Polly robot at MIT was one of the first robots to demonstrate behavior for computer vision navigation.
- 2010 to present: We continue to see AI advancements used for gaming, phones, devices, computers, AI programs, and now self driving cars.

Solar Power:

- 1839: Solar power was invented by Alexandre Edmond Becquerel.
- 1956: Solar cells are sold commercially.
- 1960: USA and Soviet programs used solar cells to power satellites.
- 1970's to the present it is much more common to see in present day life such as on house, cars and factories.

3. Future Technology

Bees are significantly declining in population. Our vision is to ensure that in 20 years we will have a robotic bee with multiple capabilities. Our robot bee called, “The 3P bee”, stands for the three key capabilities: pollination, pesticide detection, pollution converter.

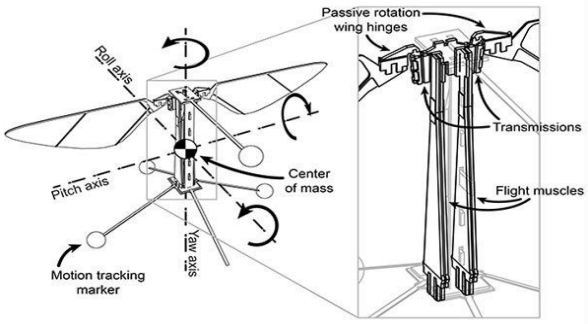

Figure 3: Robotic bee made by Harvard

Figure 4: The 3P Bee Aesthetics

Our robot has to be able to fly and be lightweight. Flying objects like planes manage longitudinal, vertical, and lateral axes. They are commonly called roll, yaw, and pitch. In Figure 3, the robotic bee design by Kevin Ma and Pakpong Chiarattanon at Harvard will be leveraged for the body structure. We will use sensors for each axis and algorithms to stabilize and navigate in 3D space. The muscle system design will allow the body structure to move and the sensory system will send information to the brain about the surroundings and what the body is doing.

The the brain of the robot will include artificial intelligence. This will allow us to be able to mimic the ways that a bee cross pollinates. As mentioned, a bee pollinates on complete accident. However, this robot would be pollinating on purpose, so we couldn't simply replicate the way a bees mind works. One way we could give the robots the intelligence to pollinate is to let the robots watch real bees pollinate, then follow their lead. Robots with AI generally learn from experience.

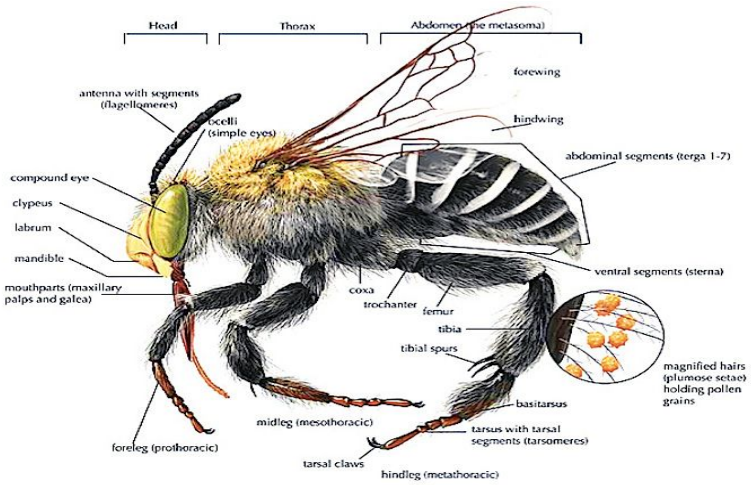

Figure 5: Pollinating Legs

This image shows how bees pollinate, but for our robotic bee we will use suction to suck up the pollen then release it at the next flower or the designated one. The suction will be on the bees legs holding the pollen that still needs to be released.

Besides motion sensors, we will include sensors to detect harmful pesticides and pollen on flowers. We would need a special sensors system that could differentiate the chemicals in harmful pesticides from the rest of the environment.

The data collected from these sensors would be sent to the hive then transferred to a lab for analysis. For the flowers, a simple face recognition technology would fit well.

As our bees travel, they will spread out over a large distance of many miles. Our messages would need to travel this distance. One way to achieve this would be mesh technology. Messages would travel from bee to bee until it reaches the hive. In addition, Swarm Intelligence will allow the bees to work together when they are getting pollen. Our goal is that our robotic bee will behave similar to how actual bees behave and work together.

We will be able to power our bee using electrical energy produced from carbon dioxide. Taeyoung Kim and Bruce E. Logan from Pennsylvania State University researched how you can dissolve CO_2 gas into water and by using electrical chemical reactions, convert into electrical energy. The first takes CO_2 and converts it to electrical energy for the bee to operate. As shown in figure 5, they created a pH-gradient flow cell allowing ions to flow generating electricity.

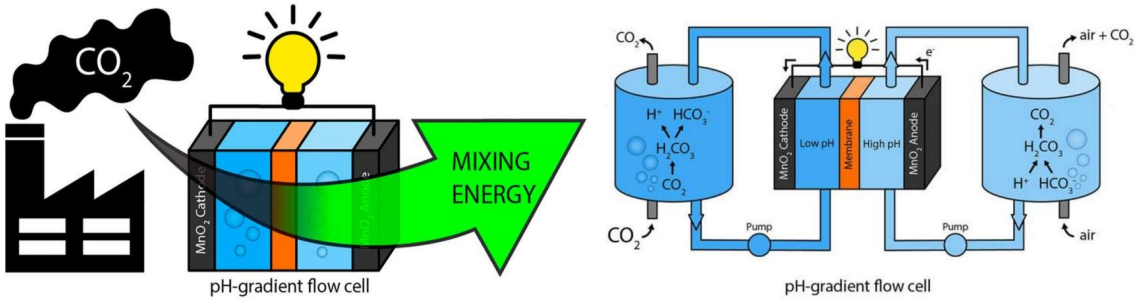

Figure 6: Pollution Converter

We have a vision for a solar power hive to act as a charging station for the bees and provide power required for the micro computer, AI programs and communication. The solar power hive will allow us to recharge the batteries.

4. Breakthroughs

AI is a fairly new technology, and for it to properly apply to the 3P Bees, new improvements would have to be made. AI would need to continue advancements in object recognition and in our case, learning from other bees on what to pollinate.

Detecting for harmful pesticides is one of the bee's more important jobs. Harmful pesticides are one of the main theories on the decline of bee populations. Nanosensors would need to be further advanced to detect harmful pesticides. So far, there is no simple way to detect the chemicals frequently found in the pesticides, such as ammonia, arsenic, benzene, and many others.

Studies that would need to be conducted would include: what areas the bees are declining fastest in, how many plants bees in the area pollinate per day, and others as well. First and foremost, we would need to research which areas are in the greatest need of bees and which areas people have to pollinate by hand, as well as which areas the bee population decline was prominent. These areas would be where we focus our hives and robotic bees. Secondly, we would need to study how many plants bees pollinate a day. This would be to set the rate of work for the 3P Bee. The

study would mainly be to decide how fast the robot bee should pollinate, so that it ends with the same, if not better, results to the bee pollination at its height.

5. Design Process

Originally, we decided to make a bee that could be a doctor and a bee. We rejected this idea because it didn't make sense. Having a drone that delivered medicine, yet at the same time pollinated flowers was unreasonable and unrelated. We had many ideas as a team and decided to focus on the main purpose of a robotic bee and how to better understand why they are declining. In the end, we decided to have the robotic bee do three things that could all be done at the same time: Cleaning the air, pollinating the flowers, and detecting harmful pesticides.

Our team discussed using batteries and charging to power the bees. Once we learned about the artificial leaf technology and other ways to produce electricity, we thought we could have our bee provide another purpose. We learned we could reduce harmful CO2 found in the air while converting to electricity. We could clean the air and generate electricity at the same time.

Our initial design included a queen bee to do some of the duties of the hive. The queen bee would collect data from the roaming bees. We kept this idea for quite awhile, and even began writing about how the Queen Bee works, before realizing that everything the Queen Bee was doing could be done by the hive. We found the Queen bee to be redundant and deleted it from our design.

6. Consequences:

For every new technology, there are many positive impacts along with potential negative consequences. Our team carefully discussed the consequences and wrote them below.

Pros:

- Reduce the chance of starvation due to loss of crops.
- The robot will take the polluted air (carbon dioxide) and turn it into electric energy.
- We gain intelligence on bees and potential reason for the decline.
- It will detect harmful pesticides.

Cons:

- If we had robotic bees, our population might not care about finding causes for why bees are declining.
- Robotic bees could malfunction and fail.
- Robotic bees might be a problem for people who think AI flying bees will invade their privacy.
- Robotic bees might have difficulty performing in a swarm approach like actual bees.

Section 3: Bibliography

Figure 1: Cross Pollination

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Figure 2: Cross section of a solar cell

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Figure 3: Robotic bee made by Harvard

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Figure 4: Created by team

Figure 5: Pollinating Legs "Bee Anatomy Diagram." *Types Of Bees*, 17 Mar. 2017, http://typesofbees.info/bee-anatomy/.

Figure 6: Pollution Converter

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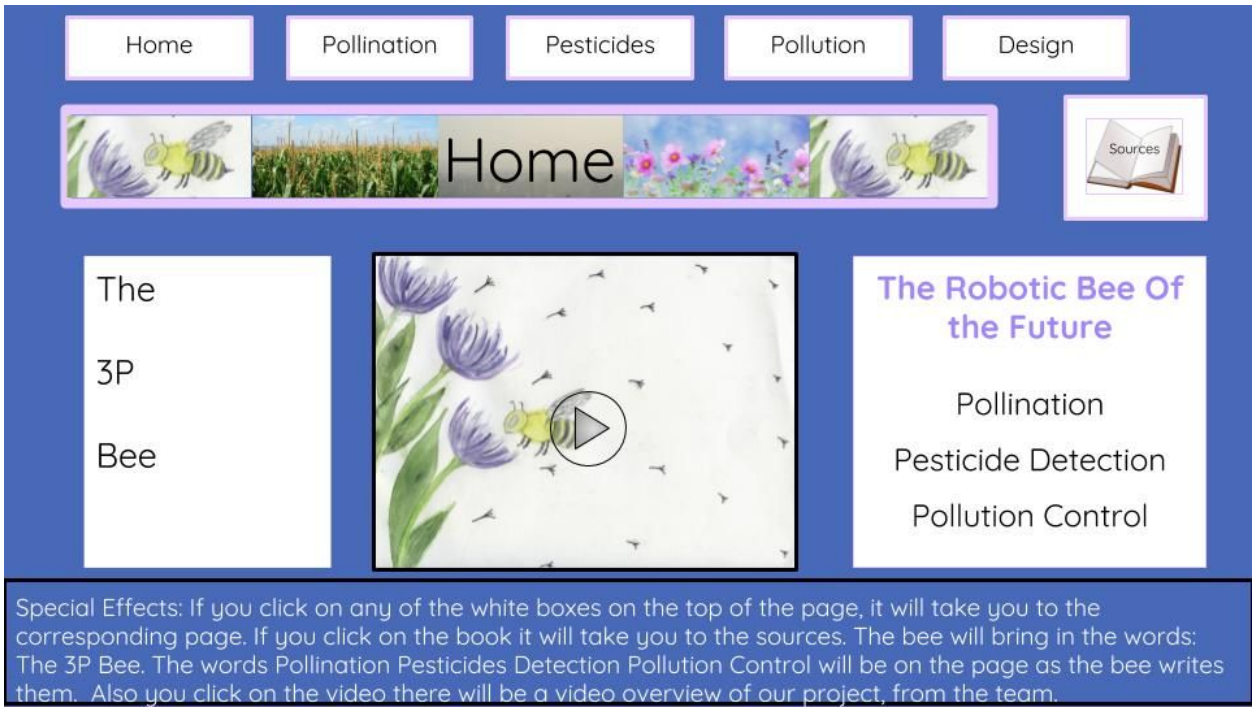
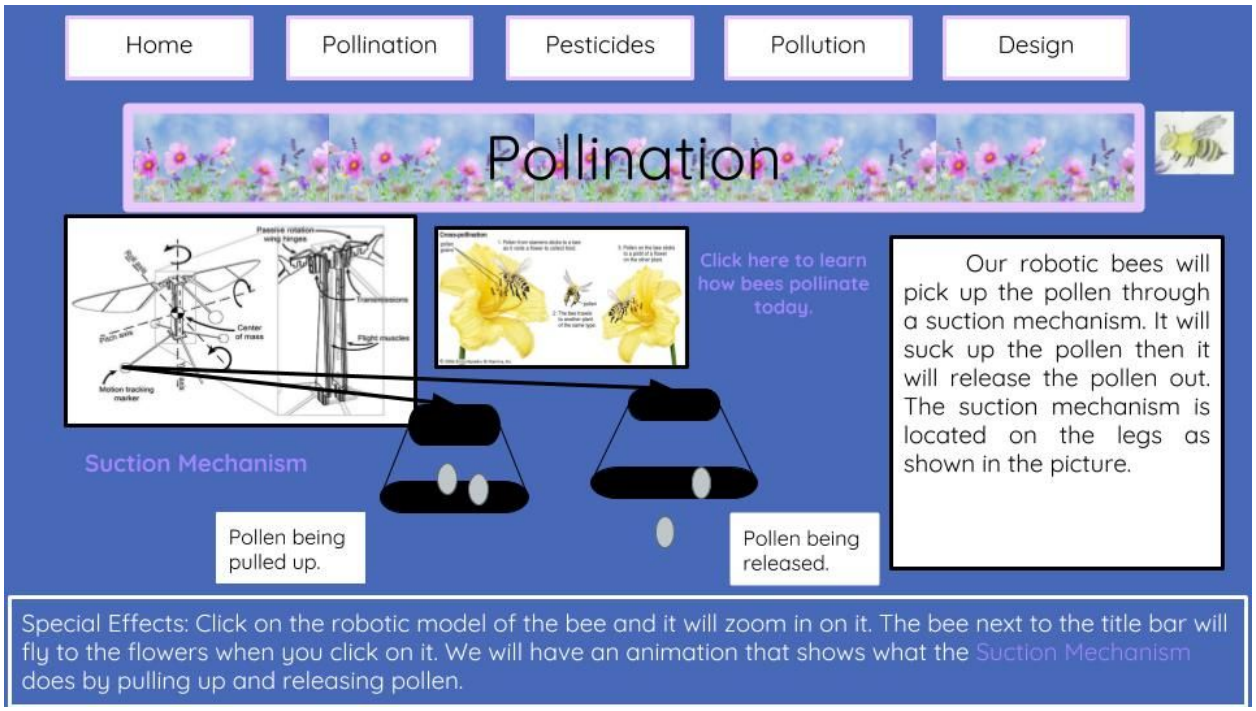
Section 4: Web Pages

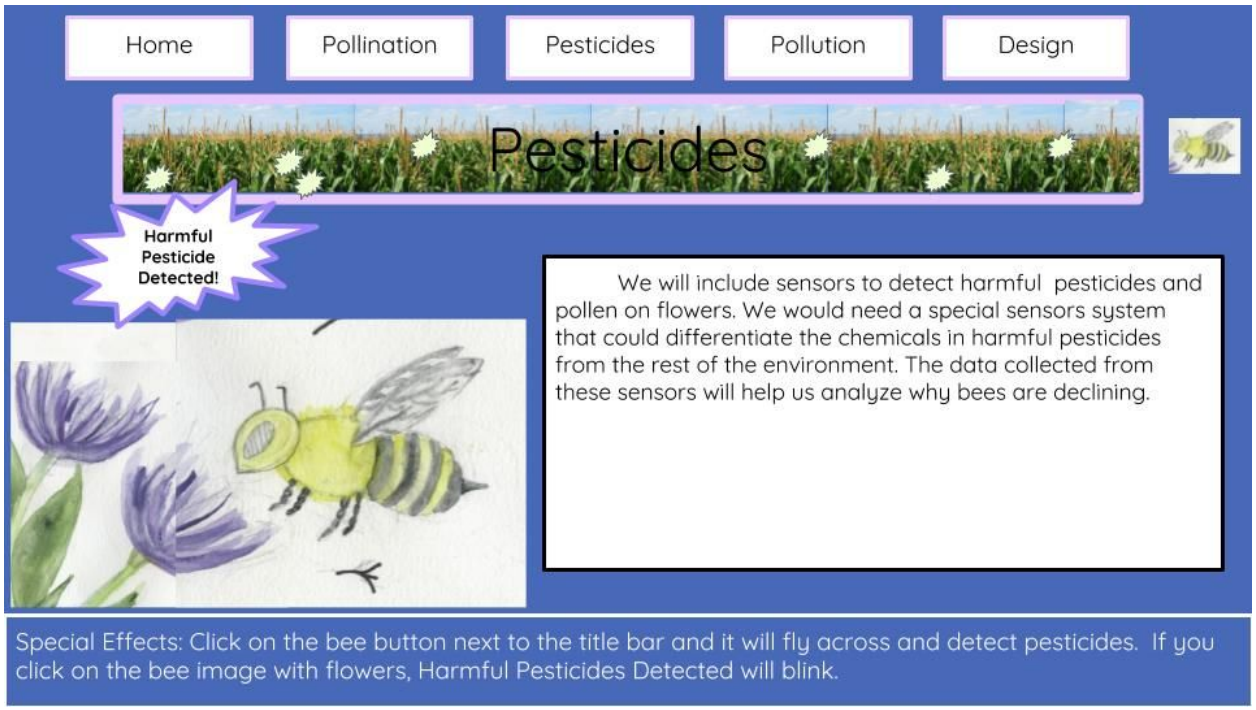
Page 1



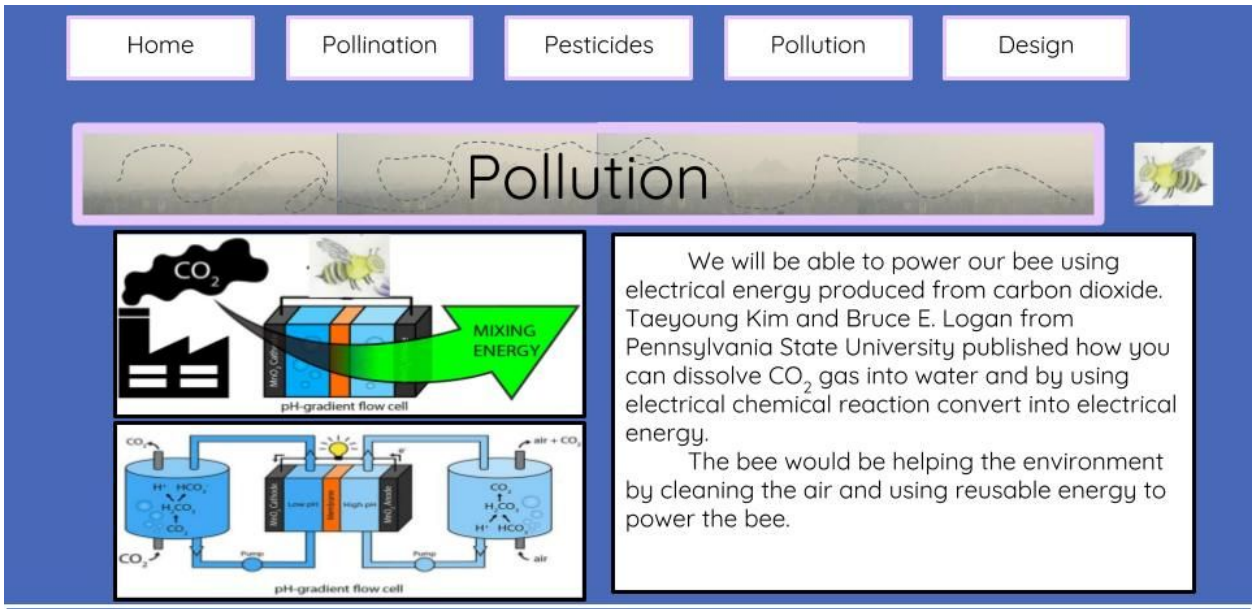
Page 2


Home
Pollination
Pesticides
Pollution
Design
Pollination
Click here to learn how bees pollinate today.
Our robotic bees will pick up the pollen through a suction mechanism. It will suck up the pollen then it will release the pollen out. The suction mechanism is located on the legs as shown in the picture.
Suction Mechanism
Pollen being pulled up.
Pollen being released.
Special Effects: Click on the robotic model of the bee and it will zoom in on it. The bee next to the title bar will fly to the flowers when you click on it. We will have an animation that shows what the Suction Mechanism does by pulling up and releasing pollen.

Page 3

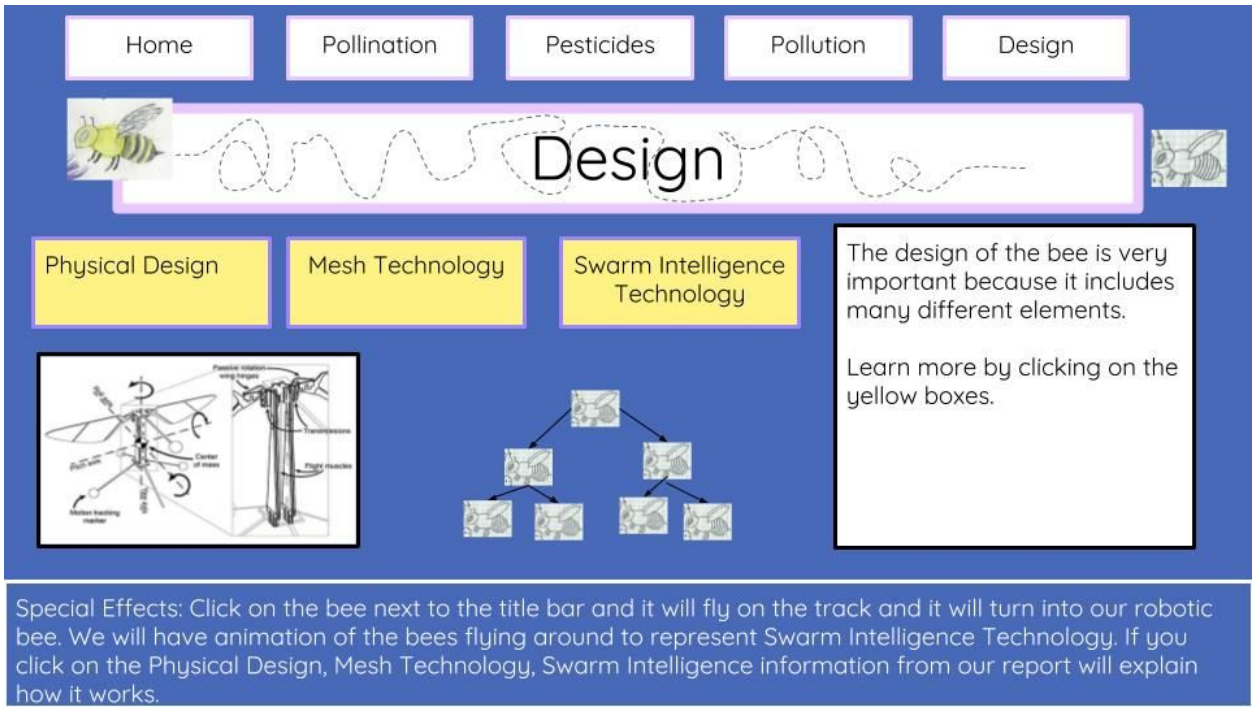

Home
Pollination
Pesticides
Pollution
Design
Pesticides
Harmful Pesticide Detected!
We will include sensors to detect harmful pesticides and pollen on flowers. We would need a special sensors system that could differentiate the chemicals in harmful pesticides from the rest of the environment. The data collected from these sensors will help us analyze why bees are declining.
Special Effects: Click on the bee button next to the title bar and it will fly across and detect pesticides. If you click on the bee image with flowers, Harmful Pesticides Detected will blink.

Page 4



Special Effects: The bee next to the title bar will fly and clean the polluted air. If you click on the gradient flow cell it will zoom in on it and explain how it works. When you click on the Mixing Energy Gradient Flow Cell the bee will fly away.

Page 5



Special Effects: Click on the bee next to the title bar and it will fly on the track and it will turn into our robotic bee. We will have animation of the bees flying around to represent Swarm Intelligence Technology. If you click on the Physical Design, Mesh Technology, Swarm Intelligence information from our report will explain how it works.