Title: The BioBot

Abstract

Marine plastic pollution seems like a never-ending problem. The top 10% of the world’s polluting rivers contribute to 90% of the world's oceanic pollution. Plastic pollution suffocates and damages coral reefs and affects every creature from zooplankton to humans. We know that with our technology, we can reverse this tragedy we have put upon ourselves.

We have designed a super-enzyme that will tackle our plastic pollution problem by confronting the source while being mindful of the environment. Our Super Enzyme is designed to consume plastic at a far more rapid pace than any enzyme in existence at a rapid volume to match the pace of creation of more pollution. The byproduct of this enzyme would be organic matter or micronutrients that can feed oceanic life.

We have created the perfect partnership between two technologies that will eliminate plastic pollution and provide micronutrients to oceanic wildlife.

Title: The BioBot

Description

Present Technology

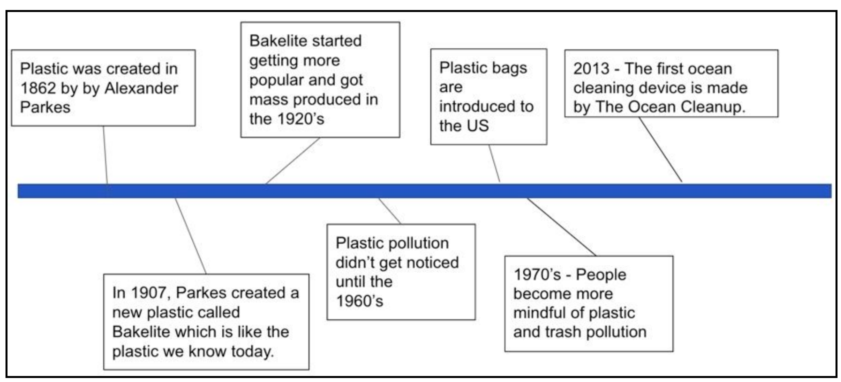
The problem we have is there is too much plastic being produced, consumed as single-use plastic, and then disposed of incorrectly. Plastic pollution affects us and our health. Fish eat the plastic and then we eat the fish so then we get plastic in our bodies which is bad for us. Our pollution is harming the entire oceanic ecosystem, heating the oceans, and acidification of the oceans is damaging the coral reefs. Nearly 70% of Planet Earth is covered in ocean. At this rate, our oceans will soon be covered in plastic, which means we are headed for a disaster.

Many companies have attempted to collect trash from the oceans. One company called Ocean Cleanup created a barge that removes trash from the rivers called "The Interceptor." The Interceptor operates on rivers and uses its long "U" shaped "arms" to guide the trash to a conveyor belt that then gets sorted. When the bins become full, a boat operator comes to pick up the barge of recycling and trash, then replaces it when emptied. People in the shoring process recycle or dispose of the trash. This is one of the most effective river plastic pollution solutions that exist. Collecting the trash out of the rivers is a good solution, but then our landfills will just keep growing.

Plastic eating enzymes were recently discovered. Scientists use supercomputers to create new enzymes. This new category of enzymes has given people a lot of hope that we might find a solution to our plastic problem. The problem with current plastic-eating enzymes is that they are not able to consume enough plastic fast enough to make it a good solution for the size of our problem.

History

Plastic pollution was noticed first in the oceans by scientists studying plankton in the late 1960s and early 1970s. Many people and organizations have tried to find good ways to clean up the ocean plastic, but no solution is perfect. In 2013, The Ocean Cleanup organization started making solutions that are large scale enough to collect large amounts of plastic and trash successfully, but this is still a band-aid, trying to clean up the oceans while the world is polluting them faster and faster.



Scientists first discovered enzymes in 1833. The first enzyme that was discovered was discovered by Anselme Payen and was called Diastase. However, scientists know that enzymes have been around a lot longer than that. They think that enzymes have been around since the dawn of time. Enzymes are proteins that help speed up chemical reactions. In December 2014, it was announced that an articulation eye was created from molecules - combining two things intelligently - using Rosetta, a supercomputer.

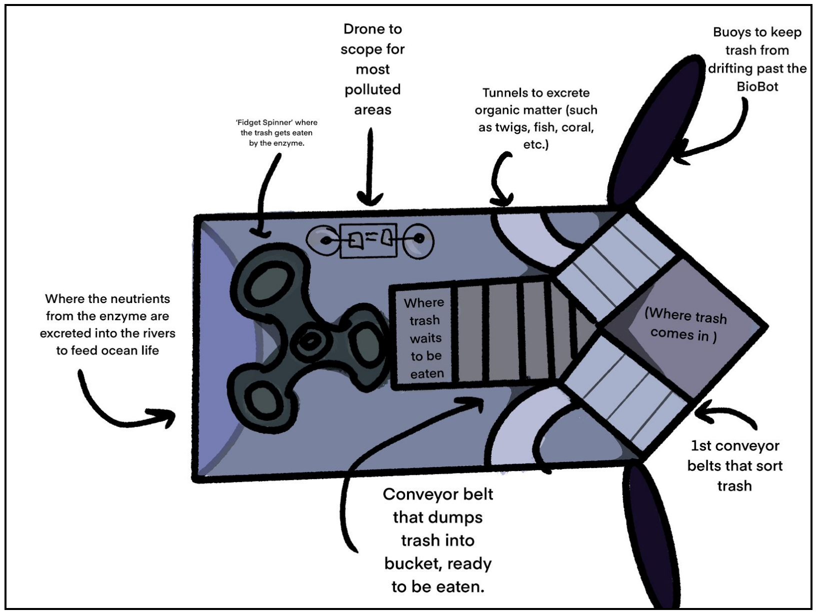
Kenji Miyamoto discovered a bacteria called Ideonella Sakaiensis in 2016 which produces both PETase and MHETase, enzymes that can break down plastics. These enzymes were combined to create a super-enzyme that is bigger, stronger, and faster at eating plastic. This was an important discovery and huge advancement.

Ideonella sakaiensis, a plastic-eating bacteria, was first identified in 2016 by a team of researchers which were led by Kohei Oda from Kyoto Institute of Technology and Kenji Miyamoto from Keio University. Scientists are still studying enzymes and are combining the best features of some enzymes to create new ones. Many enzymes are still a work in progress and are unnamed but they are created to address many different issues. Teams of scientists are hopeful that enzymes can solve many of the world's problems, but they haven’t found a sustainable solution using them for plastic.

Future Technology

We are becoming more aware of how single-use plastics are impacting our rivers, oceans, and water supply. Single-use plastics are cheaper and more convenient to use, this makes them harder to stop using them. Globally, we can be re-trained and introduce a policy to change our plastic consumption habits. While this worldwide shift happens, we must still clean up the mess we have made.

We envision a world where hundreds of our BioBots are scouring the rivers and eventually oceans of the world, cleaning up what we have done, but also converting it into micronutrients for the ocean ecosystems that we harmed in the first place. What if we could not just clean it up but also rebuild and help the oceans thrive? We could then reduce global warming and supply more food for the animals and people that rely on it.



Our new BioBot Super Enzyme splices it with several other enzymes, to make it faster, cheaper, and more dependable. In the future, once the rivers and oceans are cleaned up, we want our enzymes to clean chemical wastewater, battery acid, and mercury from solar panels. We want the byproduct of this enzyme to be able to feed organisms below in the rivers and eventually the oceans.

We created a super-enzyme that has such a rapid plastic-eating ability that it can take the top 10 most polluted rivers in the world and prevent that plastic from being dumped into the oceans. Because the enzyme is so fast it would also need to be able to stop when we need it to. The super enzyme in its safe chamber has many applications, from rivers to oceans, to landfills. It could completely reverse the plastic pollution problem, eventually matching the pace of pollution creation. The Machine that holds the enzyme can be improved a lot too. We think as technology advances, so will its ability to sort trash and pick up more trash at a time. After reviewing the technologies available, the Interceptor by the Ocean Cleanup organization is the best for our project, but it needs modifications, and many new technologies added to it. We want to add AI technology, drone technology, solar panels, and supercomputers to manage the enzymes and their containment.

To develop this technology we will need to first develop our super enzyme to be powerful and effective. This will require advanced technologies to be used on it such as selective breeding of bacteria, directed evolution, supercomputer modeling, AI technology, and genetic modification. We want this enzyme to make a byproduct that will help the oceanic ecosystems that have been damaged by humans.

Breakthroughs

Multiple breakthroughs helped to bring this SuperEnzyme to creation today. One big breakthrough was the discovery of Aspergillus tubingensis which is a fungus that can consume plastic by breaking down the chemical bonds in the material. In lab experiments that were published in *Environmental Pollution* (via *ScienceDirect*), the fungus was isolated, identified, and found to be able to break down polyurethane (PU). This showed the world what was possible. Then a bacteria was discovered that could also do this, and scientists were off and running to improve this.

A team of scientists at the University of Portsmouth and the National Renewable Energy Laboratory focused on a combination of two enzymes made from a bacterium that was discovered in Japan in 2016. The scientists found that this bacterium could break down PET. In 2018, the team had success breaking down plastic using one of the two enzymes. But when the second enzyme is added, students found, the process works six times as fast.

We will use technology and artificial intelligence to create our BioBot SuperEnzyme that is powerful enough and fast enough to eat millions of pounds of plastic per month. This is needed to consume all the legacy plastic and all the new plastic that's being produced daily. The new Interceptor can find the most polluted areas, process, sort, and convert millions of pounds of plastic, and share this information with scientists. The BioBot Tracker App will allow scientists to see what's happening in real-time in the Interceptor and with the SuperEnzymes.

This technology does not exist yet because we are still learning how to combine these enzymes and have not come near increasing the speed we need to make this possible.

If the enzymes for BioBot were created we could test them by putting them into an empty cement truck to spin in a certain amount of plastic to test the speed at which the plastic is consumed and turned into carbohydrates. We could measure speed, volume, byproduct, and confirm it can consume all types of plastic. We could also test it in various temperatures to see if that changes the speed which would help us understand what areas in the world would do better with it. We can also understand how to keep the enzymes working around the clock by testing the right speed to spin them in our device. Next, we would test the byproduct to see if it's fish-safe carbohydrates.

The enzymes will be designed to create a byproduct that can support the same ocean wildlife that was harmed by plastics. The byproduct of the carbon plastic will be carbohydrates - CHO2 - fish food to help the oceanic systems from the bottom of the food chain up.

Gene splicing and Genetic modification already exist. The modification of enzymes only exists to a certain degree. As of now, no super enzyme has been created to eat plastic that can create a byproduct that will help provide nutrients for sea life.

The BioBot will not only allow the Interceptor to find the most polluted places, to sort it's plastic and trash better, and to increase the use of the BioBot Super Enzyme, but the data gathered will help our group calculate the total millions of pounds of plastic collected. This will help us raise more awareness and funding to expand our project. The Interceptor will need new technologies including solar panels, self-recharging batteries to keep it running, drone technology to predict weather issues or roadblocks.

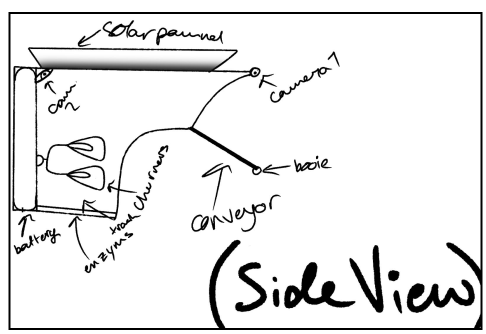
The enzyme needs to have a suitable chamber that the enzyme cannot break out of. It also needs to have a system that makes sure that the trash can get into the chamber safely without the enzyme escaping. Our BioBot will have the capability to eat or consume trash at a faster rate than it is produced! Our chamber will work like a fidget spinner, it will move and spin so fast that it will allow our BioBot SuperEnzyme to use constant agitating motion to consume the trash 100 times faster and once the process is done, the byproduct will be pushed into the river to feed the ecosystems.

The world needs smarter enzyme technology so the enzyme can break down the plastic at a very rapid pace and a much higher volume, or it isn't useful for this endeavor. It would be too expensive and too slow to use worldwide. Another important feature of enzymes is that after they complete their action, they are done, they aren't like a virus that will keep changing, and spreading. Safety is important.

Recent breakthroughs like the one by The Ocean Cleanup Project for the Great Pacific Garbage Patch have shown that through collaboration, big ocean cleanup projects are possible and can make a big difference.

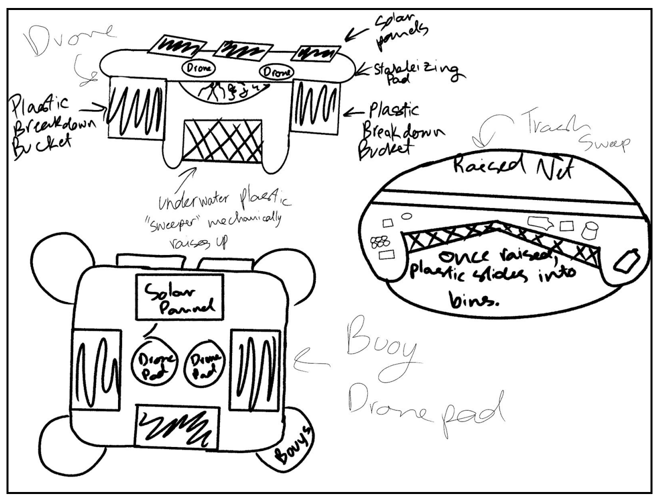
Design Process

All people want to see beauty on Earth. Unfortunately, we humans have disrupted nature's beauty with our pollution. Ocean pollution winds up on beautiful inhabited and uninhabited islands and coastlines and kills sea life so we wanted to end manmade trash pollution in the ocean. We thought a lot about the perfect machine but we went through many changes to get to something that we think will truly work.



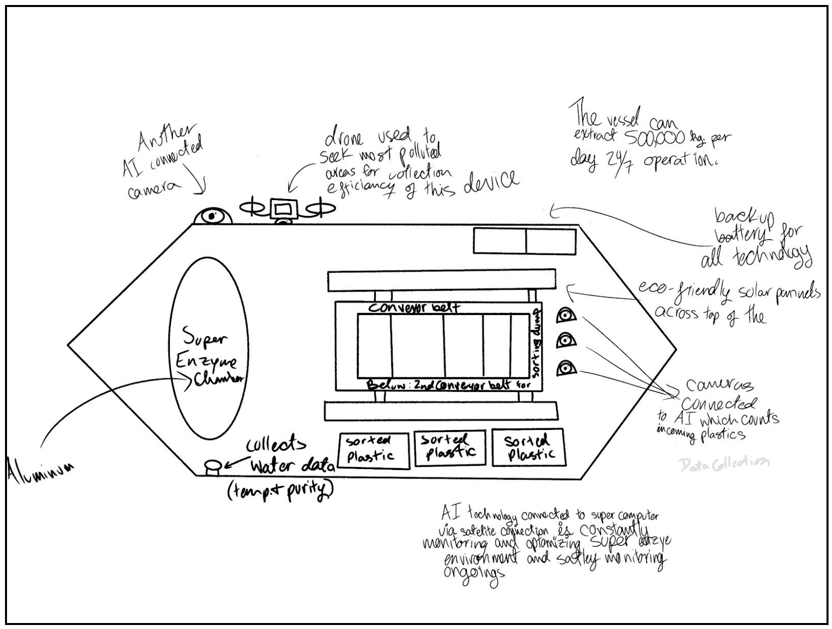
Our first design was modeled after the WasteShark. At first, we wanted our robot to go out to sea to collect trash and bring it back to shore. We decided after more research to create something that cleans the rivers instead. We found out that 10 of the most polluted rivers in the world contribute to 90% of the trash in the ocean. We realized there would not be an easy way to consume a large volume of plastic and trash pollution from the oceans, so this idea just did not work. We decided to improve the WasteShark device by adding a solution to consume the plastic while it was being collected.

Our second design involved nets to catch smaller plastics and breakdown buckets where the enzymes would be, but the drawback is it would result in capturing fish and debris as well. Also, there was no space on this device to sort and move the amount of plastic we want to collect. We decided we would need some sort of conveyor belt at this point.



We thought about the least polluting way plastic can be broken down. We were excited to learn there were two different solutions; PETase, MHETase, and fungi found in the Amazon. We decided to choose the enzymes because we could not find much information about the fungi or how to make them work faster. We thought creating enzymes using advanced technology would be a new cutting edge way to solve this plastic problem. The more we learned about enzymes, the more we discovered how they can be intelligently mutated to perform in various ways. We decided to splice our enzyme with the fastest performing enzyme using supercomputer technologies of the future to make it faster at digesting plastic. Keeping enzymes in a moving chamber would agitate them and the constant friction would create more heat, which would improve their efficacy. This is how we came up with the fidget-spinner design for the enzyme chamber for our concluded BioBot - we needed a solution that kept consuming the plastic as it was collected and kept the enzymes doing what we needed from them.

Finally, we took the Interceptor design and combined it with our SuperEnzyme, trying to sketch different variations that would allow us to efficiently collect the trash and allow the enzyme to do its job. This is when we studied many devices and finally picked the Interceptor for how efficiently it collected and sorted trash. This is also how we designed our new enzyme chamber to house the BioBot. We knew we still needed an agitation chamber idea. We realized we had to figure out what the by-product would be because Plaxx is also a byproduct of plastic breakdown and could be dangerous for the environment should it be let into the ocean. We struggled with this because it didn't make sense to us to break down plastic into building blocks of plastic, transfer it to shore using fuel, transport it to a factory using more fuel and resources, only to make more plastic. We needed a better way.



We came up with a brilliant idea! We learned all organic matter can be broken down into carbon and that by changing the arrangement of the atoms, we can make the by-product a carbohydrate. By creating a carbohydrate from the plastic waste, we could restore the ocean to a thriving ecosystem by feeding all the lower levels of the ecosystem, and that in turn would help all the higher levels. So this was our solution to the biggest problem of all: what can a SuperEnzyme break plastic into that benefit the ocean's ecosystem or ours?

Consequences

The consequences of this project include:

- The Interceptor machine will be large, expensive, and probably loud. It will be a little bit disruptive in the areas that it'll be used in, but it will be effective.
- Most of the waste will be collected but non-plastic items will have to be picked up from the device on a daily or weekly basis for recycling or disposal
- We do not know if the new SuperEnzyme stops feeding on plastic if it will die out
- If the new SuperEnzyme gets out, it may consume our project itself!

Some positive consequences are:

Once existing plastic is cleaned up and our system matches the pace of the world's plastic production, the same technology can be installed into landfills and other locations that need plastic to be transformed. The nutrients we put in the water could revive so many ocean wildlife populations that are going extinct.

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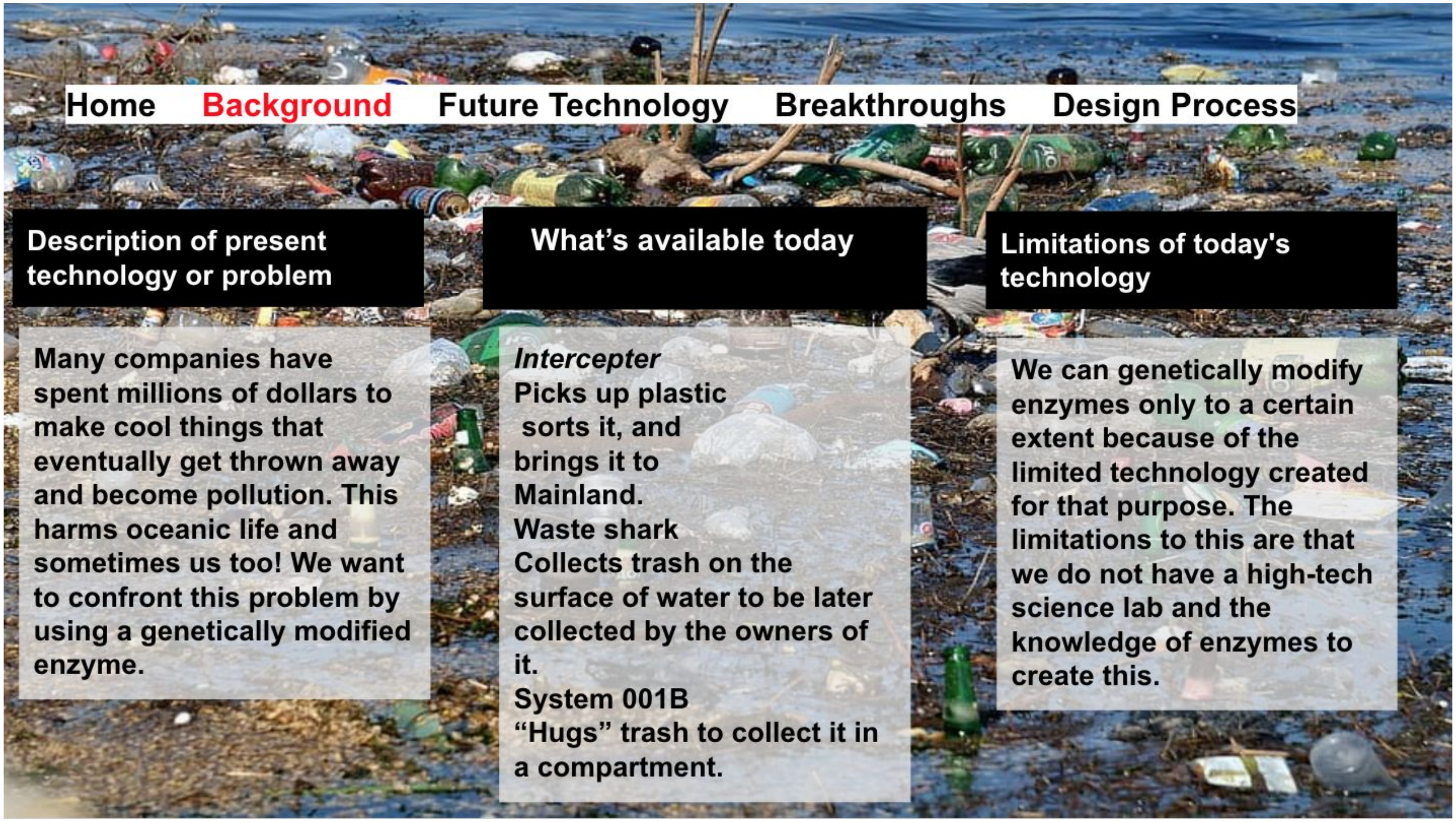

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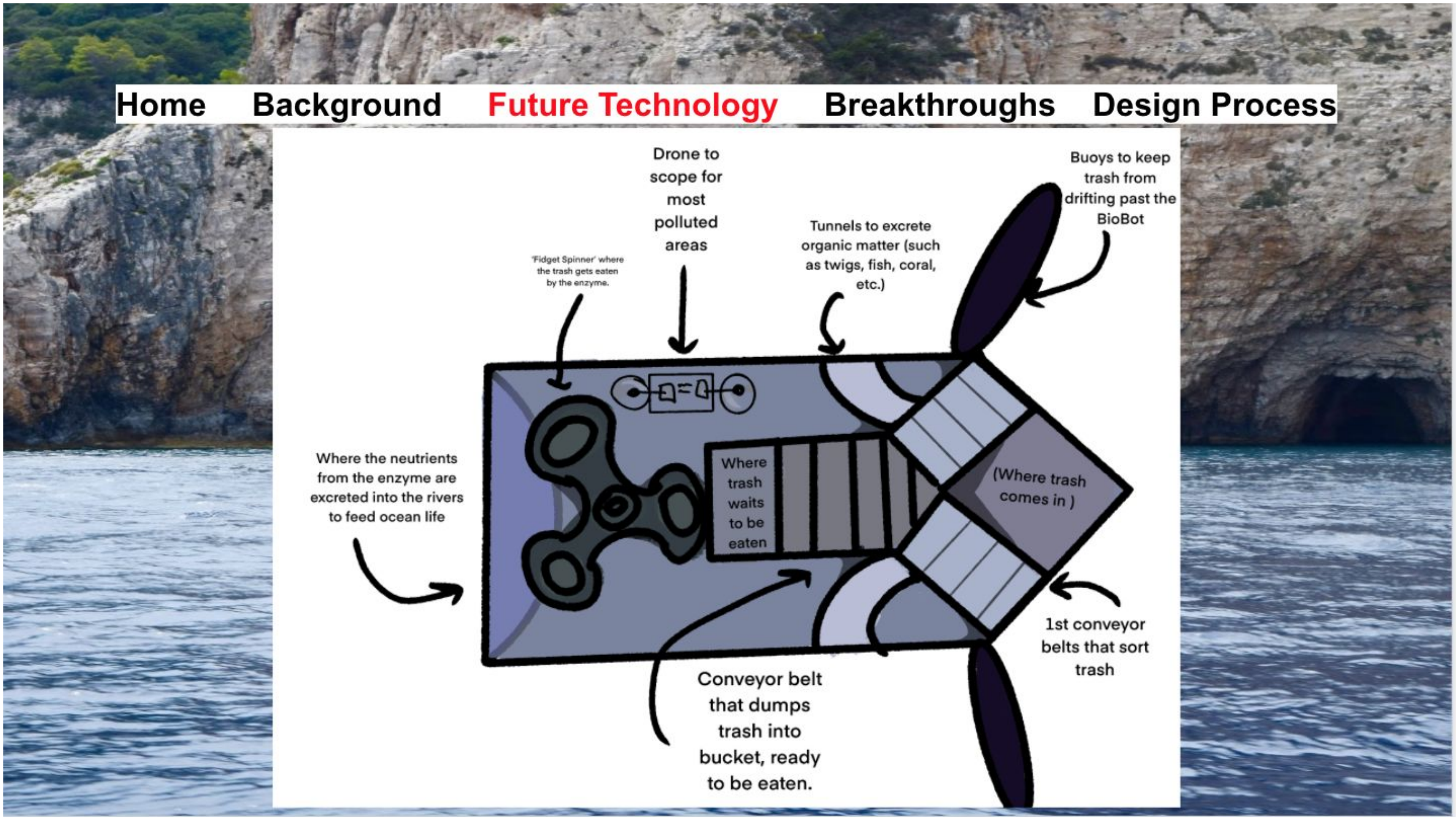

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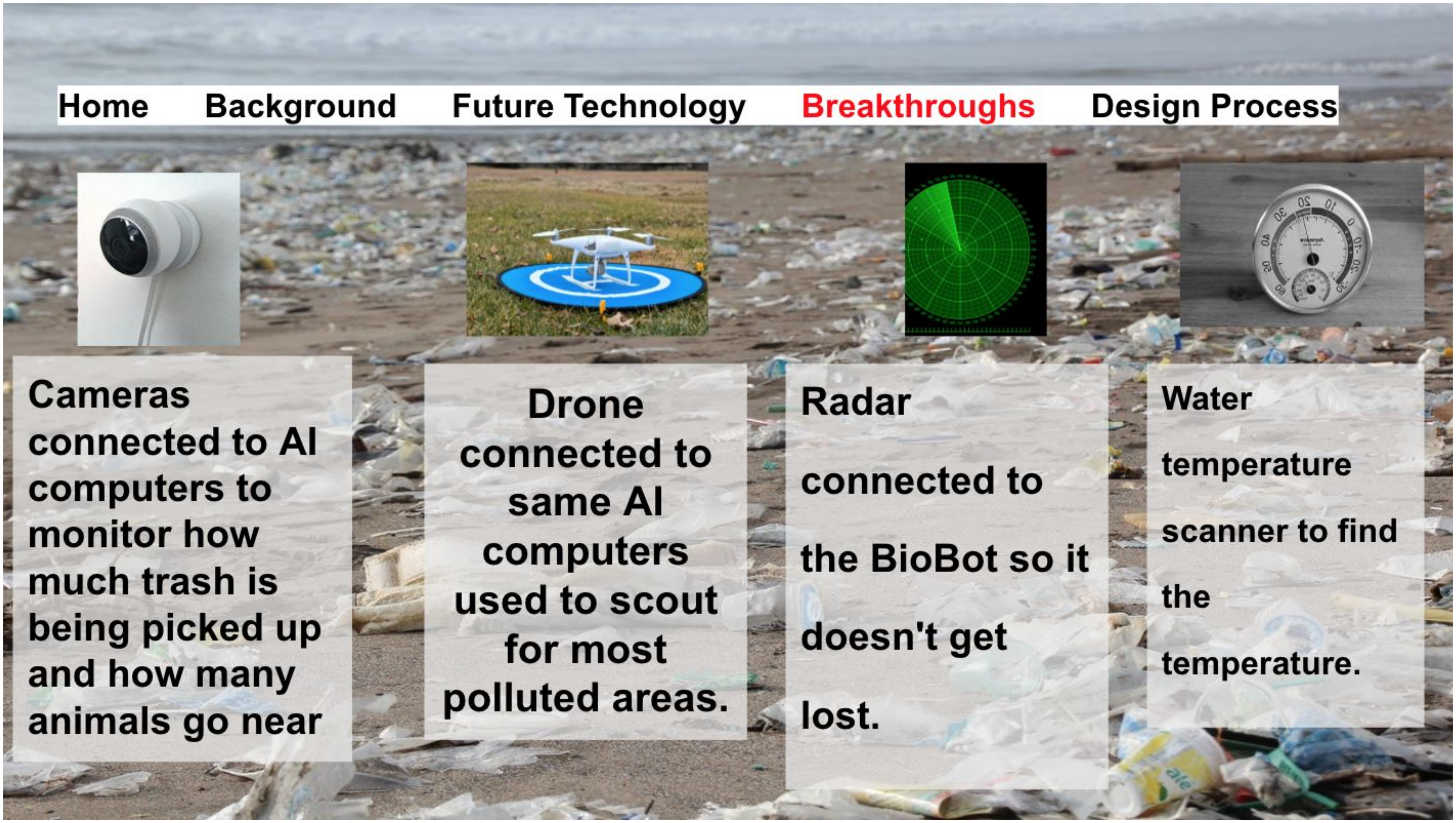

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