

PROJECT TERRAPIN

OUR JOURNEY



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HOW WE STARTED



THE STORY

TERRAPIN was born out of a question - *“Why isn’t there a bottle that is capable of cooling its contents?”*

The idea for TERRAPIN began with a conversation – “Why isn’t there a bottle that is capable of cooling its contents?” We did a Google search and found that such a product has not been commercialized. Bottles that were capable of heating were aplenty, but none that can cool. We sat and pondered, thinking of why such a product had not existed till the point. We thought to ourselves, how such a product could be made.

We had many ideas, from Phase Change Materials (PCM), liquid coolant jackets, and finally, a thermoelectric cooler. However, getting the contents of a bottle cool and keeping it cold were two separate ideals. The ideas we listed could essentially cool our contents, but to keep it cold, we need vacuum insulation.

This is where the dilemma began. How do we incorporate a system that can expel heat while being thermally insulated? With a thermal flask in our hands, we realized something. The only component that is not thermally insulated is the cap of a thermal flask. We thought that we could modify the cap to include a system that can cool its contents. A thermoelectric cooler seemed like the ideal solution for this. Its cold surface is capable of reaching sub-zero temperatures, it was compact, and it was relatively inexpensive. However, to efficiently cool the contents of a bottle, we need thermal contact between the thermal electric cooler surface and the beverage. We could not place the thermoelectric cooler at the base of the flask as it is vacuum insulated. Placing the cooler on the cap had its issues too. This was a problem as we had a barrier of air between the surface of the cooler and the beverage. This issue would only get worse as the beverage gets depleted. That was when we had this eureka moment. Why not flip the flask during operation? This would solve the issue of thermal contact while not sacrificing the vacuum insulation.

On 15 October 2020, TERRAPIN was born.

IAN FERGUSON INNOVATION CHALLENGE



THE COMPETITION

Our next step was to apply to the Ian Ferguson Innovation Challenge. Over the two months from the inception of the idea to the submission deadline in December, we refined our design idea.

We started creating the product on the 3D modelling software – SolidWorks. We thought of the dimensions we wanted for the flask and the features list. The TEC has an advantage over the PCMs and cooling jackets. While it is capable of cooling, it also can heat on the same surface. This can be added by modifying the circuitry. Changing the polarity of the current allowed us to control both heating and cooling of our beverages. Thus, this became the main feature of TERRAPIN – a flask that allows you to enjoy your beverage, anytime, anywhere, any weather, and any temperature.

We knew that the competition was fierce from a prior experience, so we knew we had to impress. It was one thing to convince the judges that our idea had merit, but it was another to show them what our idea could do.

Between the submission and the presentation day, we built our concept out of commercially available parts. It was not the most beautiful thing ever, but it showed that the concept works.

We won first place for the competition.

“I was excited and nervous at the same time.” - Danielle

“We were confident in our product.” - Nazir

PRESENTATION DAY

10 MARCH 2021

It was the day that we had to prove to the judges that our idea had merit. We developed a Proof-of-Concept (POC) showcasing the potential of our TERRAPIN idea to both heat and cool its contents.

From prior experience we knew that the judges were difficult to please. So we sat and analysed weak points in our product and potential questions from the judges. We could not afford any mistakes.

When we heard our names being called from outside of the meeting room, we said good luck to each other, and gave it our all.

As expected, we had volleys of questions from the judges.

The presentation ended in the most memorable way possible, with the judges providing us feedback on how we can improve our product. Our biggest gratitude goes to them as we took on their suggestions to improve TERRAPIN.



THE CHAMPION

KHRONAUTS



THE FORMATION

May 2021

We were offered the opportunity to turn our concept into a functioning prototype as part of the prize for winning the Ian Ferguson Innovation Challenge.

However, we were both limited in knowledge when it comes to electronics and design. We knew we needed a team. The first new member of the team was Nizam, an Aerospace Engineering student from NTU. He has a strong foundation in electronics and programming and became the Technical Lead of our team. Ideas that concerned the electronic components of TERRAPIN were evaluated by him.

These include our circuitry, Arduino programming and prototype testing. We had the function, now we needed the form.

Thus, came Faris, our Design Lead. He was tasked with designing the thermal flask on SolidWorks, incorporating all the technical elements that were chosen by the team. We tried various shapes, color, and textures for the TERRAPIN thermal flask to maximize the user experience. We travelled across Singapore to various departmental stores, armed with a ruler and drawing inspiration from other products in the market.

Data is noise if not understood well. We needed a member who is apt in statistics and data processing. That was when the last member of the team joined us, our Analytics Lead, Amirul. His knowledge in data and engineering granted him the ability to work with Nizam in his experiments and process its data for the team. He created deductions and analyzed the data to provided direction for the project.

KHRONAUTS. The name is an amalgamation of the words Chronos and Nautical. The name was inspired by the ideals for the team. Chronos, meaning “time” in Greek and Nautical as our desire to explore. Putting them together, we get KHRONAUTS, a desire to explore innovation beyond time.

THE TEAM

THE DREAM TEAM

Equipped with knowledge from different backgrounds, we assembled our dream team for the TERRAPIN project.



Danielle

Entrepreneurial Lead
NTU Alumni



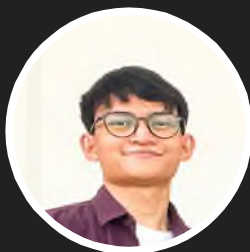
Nazir

Team Leader
NTU Postgraduate



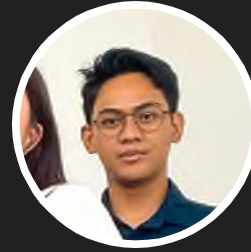
Nizam

Technical Lead
NTU Undergraduate



Faris

Design Lead
NTU Staff



Amirul

Analytics Lead
NUS Undergraduate

LEAN LAUNCHPAD



BEFORE

Before we joined the Lean LaunchPad Run 8 in September 2021, we had created TERRAPIN based on features that the team would want as consumers. This felt inadequate as we were not accounting for the needs of our consumers. While looking onto NTUitive's website, we stumbled upon their Lean LaunchPad programme and registered our interest. To our surprise, we were shortlisted and thus, began our journey on market evaluation.

To visualise our product at this point, it was a large cylindrical bottle, with a capacity of 350 ml and in a grey stone finish. We also opted for a stylized, art deco inspired design for the vent holes on the cap. The design choices were all based on what we felt would look good for TERRAPIN. We called this design, TERRAPIN Version 2.0.

AFTER

Through the Lean Launchpad, we had a better grasp of market evaluation and on launching our own startup. We had a great instructor and mentor, who guided us on how we can conduct our interviews, improve our products, and how to approach our beachhead market.

Through the programme, we interviewed 90 people from different backgrounds - office workers, lecturers, researchers, among many. From their feedback, the TERRAPIN thermal flask evolved, adopting an octagonal grip and a smaller footprint, more colour options, and accessories that targeted our initial markets: parents with young children and outdoor adventurers.

We evaluated the potential markets and came up with a business plan for our product. In all, it was a very rewarding experience.

“The LLP provided us with a journey of self-discovery, where we had to work to understand our business better and customers' needs. Every week, we received feedback from our instructor and mentors, who molded our ideas and guided us to fulfill our ambitions for the business. The boot camp lessons instilled practical knowledge, and the deep dive sessions with the instructor and our assigned mentor were useful. Also, our mentor supported and encouraged us when we hit various walls to validate our market. At the end of the LLP, we felt more confident with our product, and we're well-equipped to tackle more daunting challenges as we take our business to the next level.”



At the end of the LLP programme, we were awarded with certificates for its completion.



PROTOTYPE

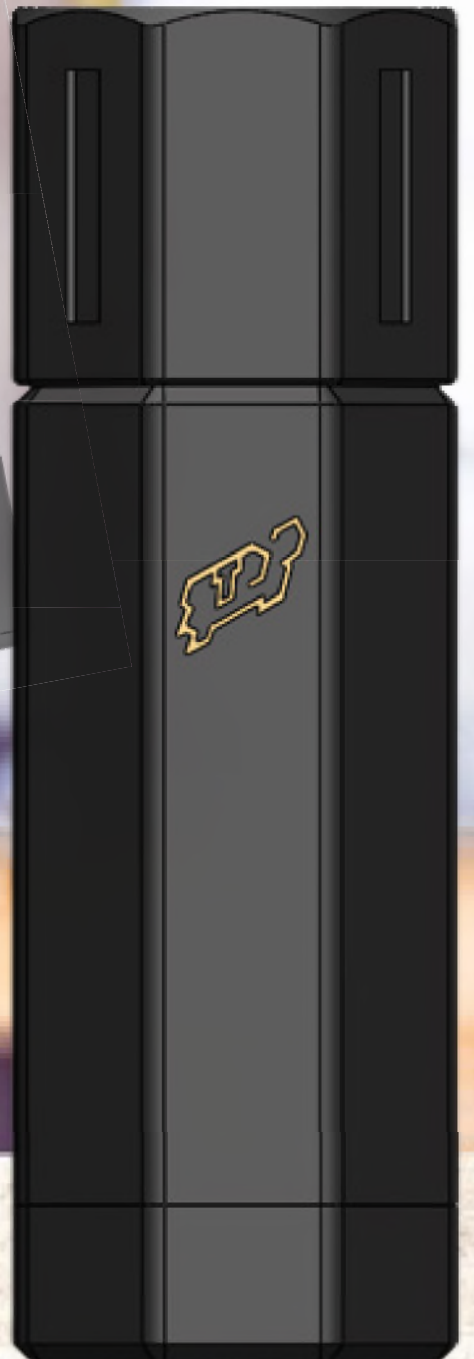


THE DEVELOPMENT

The TERRAPIN thermal flask aims to revolutionize the reusable water bottle industry by incorporating a unique temperature control that allows for heating and cooling of the liquid inside. Situated in the cap of the flask is a thermoelectric cooler (TEC), which utilizes the Peltier Effect and can heat up to 100 °C or cool down to - 40 °C. This allows the flask to heat or cool its contents rapidly within minutes. This temperature can then be held for extended periods through vacuum insulated walls. TERRAPIN is also simple to operate with a temperature controls built onto its exterior and can be activated with a flip. Safety features were also designed to prevent accidental activation and leaking of liquids onto the electronic components.

Through the project, TERRAPIN had underwent three major versions. We started with the first version that was submitted to the IFIC competition. Following that, we had our TERRAPIN Version 2.0 with its taller design. Finally, through the LLP, we developed TERRAPIN Version 3.0 with its octagonal design decked in black with gold accents. In this iteration, we had forgo the large internal battery in favour of a smaller, more portable design. Additional heating and cooling cycles can be powered by a potable power bank.







TERRAPIN
TERRAPIN

POC #01

ON
OFF



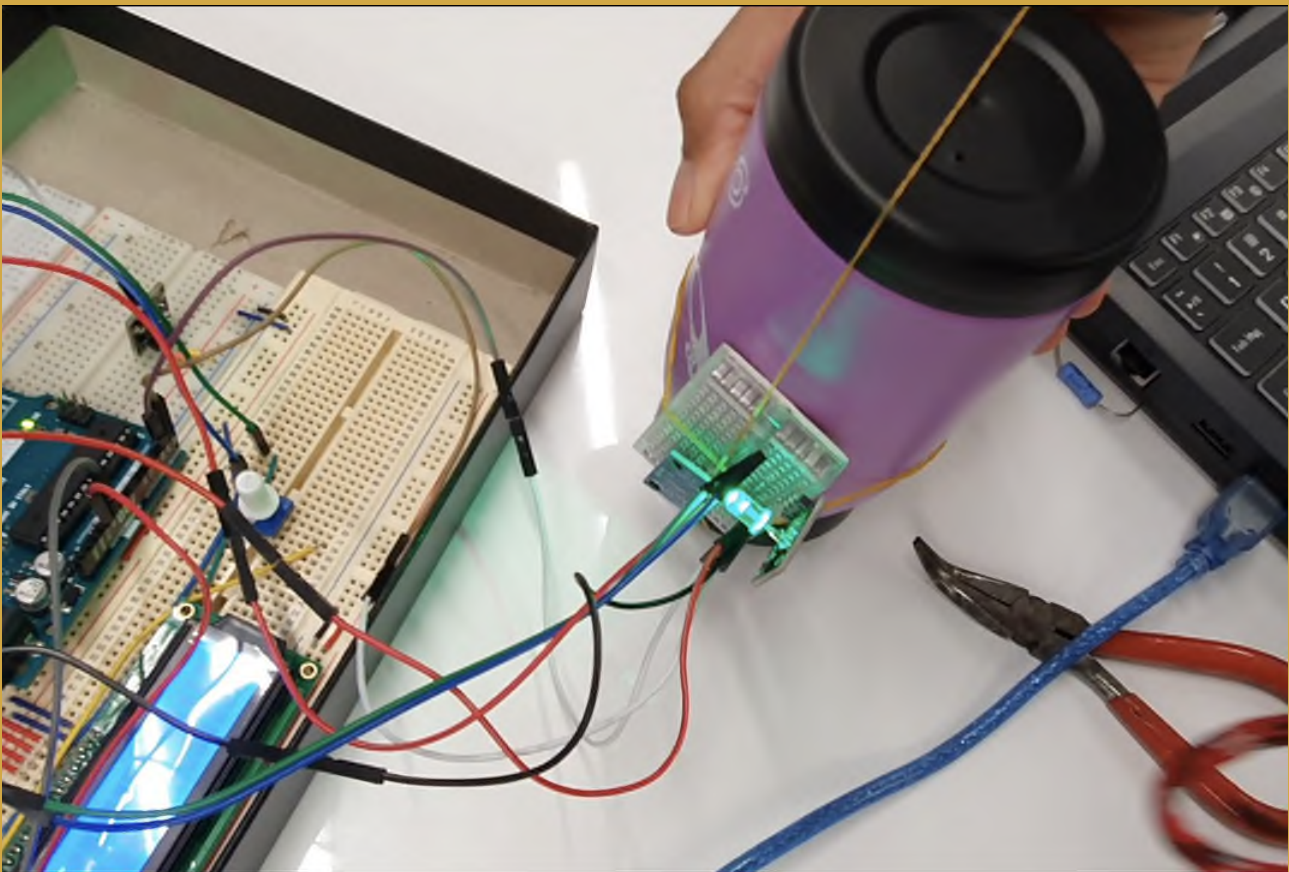
STEVE & LEVY
ON OFF 29.8 HOLD
50-300°C

直式
ウーロン
採歐洲天然花茶和烏龍茶-嚴格製成-不含人工
Made with European natural
oolong tea by special fermentation
baking process. No artificial
沖泡方法
1. 放入茶包於杯中
2. 待3-5分鐘輕輕攪拌，即可飲用
1. Put tea bag in 8 oz. cup and fill with water
2. Remove tea Bag after 3-5 minutes



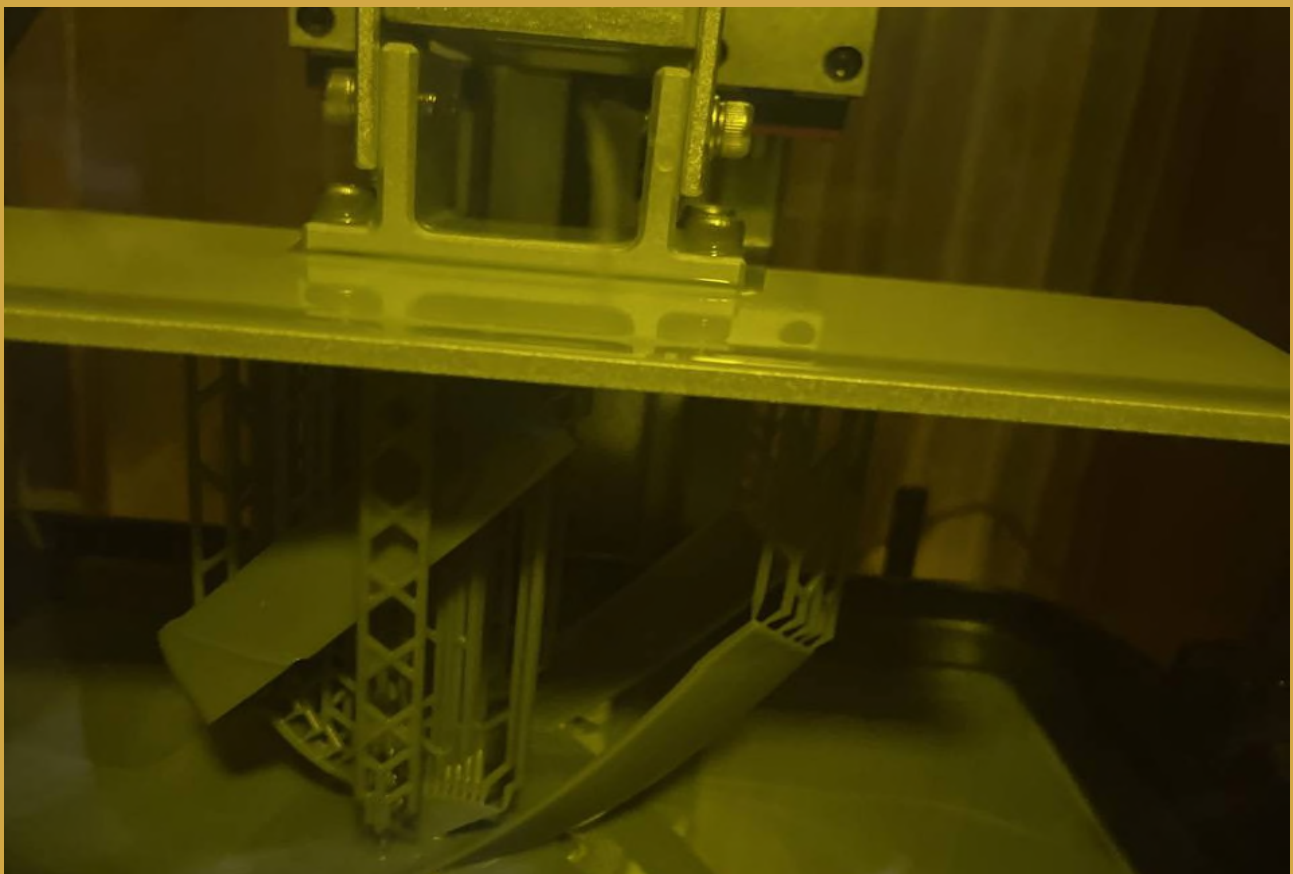


Our testing of the thermoelectric cooler - fan cooling system , capable of reaching -10°C .





Testing the stone finish on the TERRAPIN bottle for enhanced grip even when wet.





3D print of the TERRAPIN Version 3.0 mock up for the MSE video.





Pouring of hot water into a baby bottle from our TERRAPIN introduction video .



PROJECT PROGRESS

0%

05/21

We finalized our concept design for the TERRAPIN bottle. At this stage, we were concerned about the appearance of the bottle and the feature list we would like to include in the project. This was also when we had started designing the cap and sleeve components of the thermal flask on SolidWorks.

50%

09/21

This was the start of our LLP Programme. At this stage, we had 3D printed two design concepts of TERRAPIN. We used the mockup for the MSE video and finalized this design as the one we would continue our work on. We designed the internals of TERRAPIN to situate all the components.

70%

11/21

This marked the end of our LLP journey. Armed with knowledge on what a consumer wants for TERRAPIN, we modified the thermal flask. We reduced the temperature range of TERRAPIN and removed the large battery in favour of a smaller one. We also dropped the idea of wireless charging in favour of the faster USB-C.

100%

02/22

We did multiple 3D prints of TERRAPIN as we had issues with fit and water leakage. This was then we chose to incorporate o-rings into the design to seal the chamber of the cap. We also experimented with various colors and textures for the exterior. We ended with the stone texture in black for an enhanced grip and exquisite color combination with the gold accents. We continued to do stress testing of the product and evaluated its features.

FUTURE

We intend to improve the cooling capabilities for the TERRAPIN thermal flask. Our current tests have shown there it is not reaching its maximum efficiency possible. Thus, we hope to continue with more experiments and improvements to make TERRAPIN the best thermal flask it can be.

OUR FINAL THOUGHTS



WHAT WE GAINED FROM THIS EXPERIENCE

"Through this project, I've improved on my SolidWorks skills and had picked up numerous others. I learnt how to use Adobe Photoshop, InDesign, and Illustrator. I also gained experience in working with a 3D printer and how to create models more effectively. We also had a lot of fun shooting the TERRAPIN video for LLP." - Nazir

"The 10 weeks brought me experience that could not be gain within my field. I was pushed out of my comfort zone to constantly improve my interviewing and presentation skills. The feedbacks from the mentors greatly elevates and improve our product which then help us streamline our product development. I enjoyed myself during the entire journey." - Danielle

"This project has greatly challenged my abilities and knowledge in terms of electronics and programming. It was a valuable experience where I was able implement my skills and knowledge. It reinforces my understanding and problem-solving skills. It made me realize the importance of team work, and that we are only as strong as the weakest link." - Nizam

"It was a pleasure to work with the group for the past 7-9 months period. This project pushes my creative boundary as the designer and also as a team member. The most memorable part of the project is definitely the video shoot for the LLP program and I hope to work with the team again may it be on TERRAPIN or other projects." - Faris

"It was interesting to work with people from different backgrounds and learning from them. This project allowed me to connect the theoretical concepts of Systems Engineering in a real-world context. I gained invaluable experience that I cannot attain from the regular school curriculum ." - Amirul

PARTING WORDS



THANK YOU FOR BELIEVING IN US

"A journey of a thousand steps begins with a single step." - Chinese Proverb

We had overwhelming support from friends and families for our TERRAPIN project. Without them, we would not have been successful in this endeavour.

Thank you Joy and Christina, for your overwhelming support for the project. You had given us an invaluable experience with this opportunity. It was an honour to be able to showcase our project as part of the MSE video. It brings a smile to our faces whenever we enter the MSE building and see our video playing on the screen. We hope that we had shown that MSE students are capable of applying interdisciplinary engineering concepts and that our project would inspire future students to join the Ian Ferguson Innovation Challenge. Also, thank you for facilitating our purchases to ensure that we had no disruptions to our project. Our project ran smoothly because of your support.

Finally, I would like to thank my valuable members of KHRONAUTS, who without them, I would have never been able to see this idea come to fruition. We had worked hard, returning to school almost every Saturday to develop the project. We had our laughs, our worries, the pain of seeing our ideas fail. But, I could not have asked for a better team. Thank you Nizam and Faris, the duo that turned a concept into a prototype. We could not have produced the prototype without the knowledge of electronics and programming from Nizam and the design instincts of Faris. Thank you Danielle and Amirul, for your work on the Lean Launchpad. Because of you two, we identified our potential target markets for TERRAPIN and were always on track for the LLP presentations every week. Your processing of the interviews and data gathered helped Nizam and Faris refine their work. That being said, we took it upon ourselves to learn each other's work, too. At the end of the project, it seems that we are able to work together like clockwork. Together, we had created something we can be proud of. Together, we created TERRAPIN.

TERRAPIN is just the first step in our journey as KHRONAUTS. We will continue to develop this project, and hopefully many more in the future.



KHRONAUTS

INNOVATION BEYOND TIME.

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