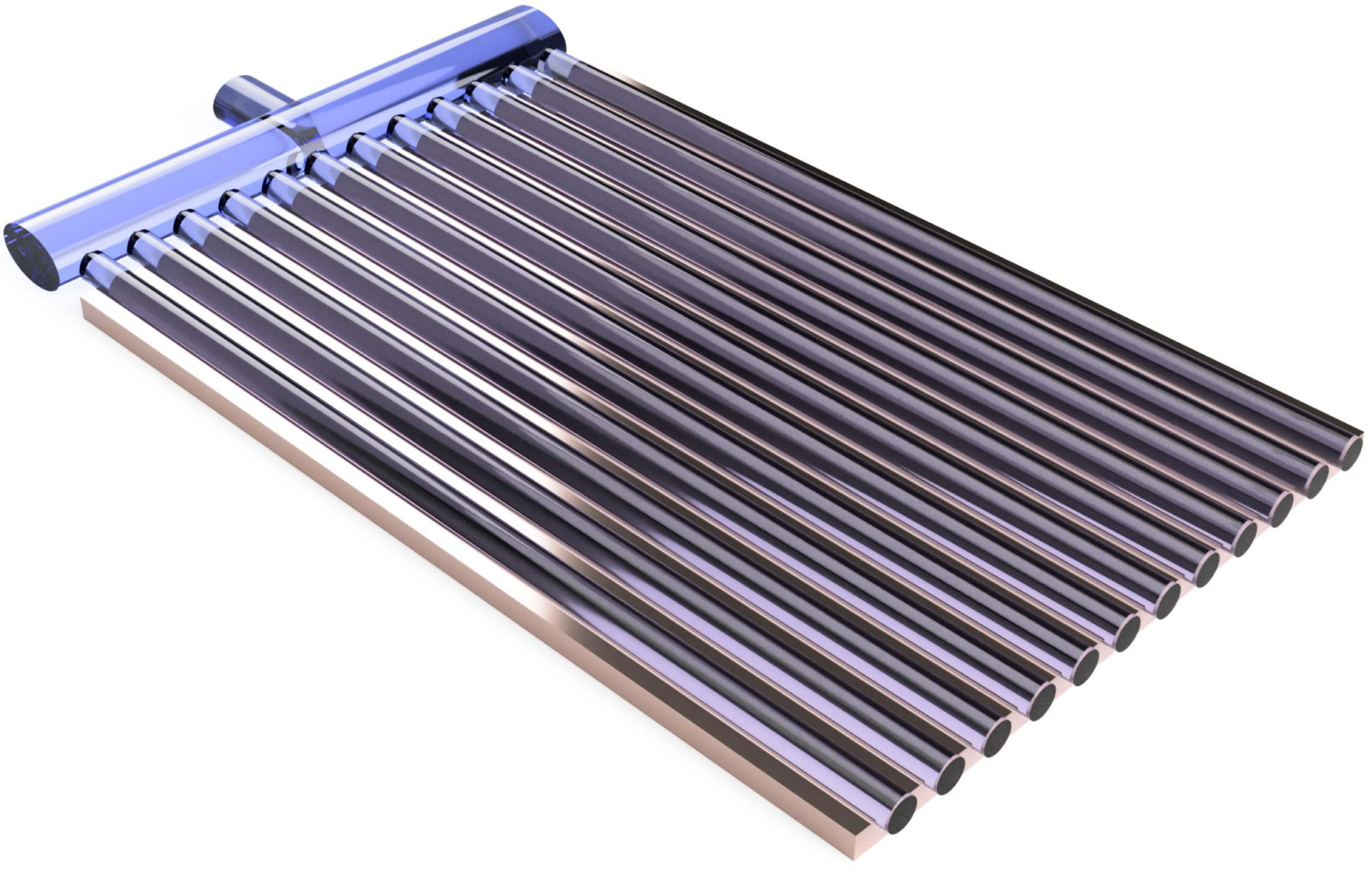
GRP 01

Glassify



Alonso Ocaña, Cinthia Cruz, Kavya Mittal, Kareem Al Hajj Fakieh, Sebastian Romero

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ATTRACT

Design is an iterative process. Over the course of three weeks, we as a group have learned and used human-centered design to explore possible applications for a novel glass manufacturing technology developed by Glassomer.

We began the course with exploring how design and design thinking are not just limited to the "arts" but rather have unlimited applications. It is more about the thinking process and how one approaches the problem. For instance, we used design to solve a problem of being late to work. This example helped us understand constraints and how they impact the solution. It helped us define design as a process of solving problems while being mindful of all the constraints that are present alongside. Now, we approach design as the art of managing constraints while finding a solution in the most effective and efficient way possible.

We then delved further into design thinking, and learned how to use extensive brainstorming to design optimal solutions to problems. Brainstorming allows us to look at problems from different angles and understand what we are dealing with better. And it is important to not set limits to our brainstorming, as the more ideas we come up with, the more likely we are to find a good one that could work. We also learned about user-centered design, where the process of designing a solution becomes oriented towards addressing the real necessity of the user. We started looking at design from a business perspective where users became potential customers and the solution became the product or service.

This meant that in the world of business, design thinking is about responding to a potential customer's needs by creating a solution to those needs - which in most cases is actually a solution to a problem the customer did not even know existed. We also learned that an efficient way to design a successful solution would be to start from a niche or a specific target of customers, and to then expand from there into a larger "market". For instance, initially Tesla targeted and catered to a very specific customer segment and then later expanded their audience to include general car users.

During the course, we also got a chance to explore innovation, as we came up with ideas and had to work to turn them into something real, concrete, and viable. We explored abstraction, i.e., how to create solutions for problems that the user is not even aware of, how to create something that

has not yet been created. During a guest lecture, examples of Sid Carnot and the conservation of energy, or Schrodinger and his famous equation came up, and helped us understand the nuances of innovation. Prior to these discoveries, physicists still carried out research in physics and saw no issues with their work, but once these discoveries were made, the physics world was disrupted. Another example could be an anecdote of Henry Ford saying that if he asked the people what they wanted, they would have said faster horses, not cars, simply because they could not fathom a car in their imagination.

Throughout the course, we explored how design and innovation are iterative processes. And an important step of this journey is prototyping. Over the course of three days, we got to play around with several prototyping processes. We started with electronics where we did basic programming to use the Micro Bit. This was a great introduction to understand the scope of algorithmic thinking and paved the way to think of potential applications for our ideas. We then moved on to 3D printing and used Tinkercad to understand additive manufacturing. And lastly, we explored laser cutting and subtractive manufacturing, and this was a great contrast as now we could understand the nuances that differentiate additive and subtractive manufacturing.

At the same time, we also learned about Glassomer, which has developed and operates a cutting-edge technology in glass production and glass modeling. They use the Polymer technique to create structures in the glass at a microscopic level, where the final product is silica glass. Some of its benefits include energy-efficiency, cost-efficiency and the strength and rigidity of the resulting glass in comparison to other solutions such as standard glass, gorilla glass or enhanced plastic. It is thus a sustainable solution for businesses who have direct applications for this material as it can cut costs (and thus increase profits), all while being environmentally and socially conscious.

Nevertheless, it is also not easy to find businesses with beneficial applications of this material for various reasons. Firstly, the material itself has downfalls just like it has benefits. Some of these include the fact that glass is a dangerous material which can shatter and cause injury to those who are handling it. Secondly, it is not always an easily moldable material which presents a limitation to businesses that require flexibility and moldability.

However, after brainstorming, we were able to come up with several possible applications due to its rigidity, social impact, cost effectiveness, and the ability to create micro structures. Some of the potential applications we came up are:

1. Glassomer straws since plastic straws are banned in many countries and paper straws stain the taste of the drinks in which they are submerged
2. Access control securities as microscopic etchings can be created in the glass that are highly difficult to match
3. Souvenirs with microscopic designs as the high level of precision and detail can be attractive to customers, especially if personalized
4. Improving cooling systems of data centers using Glassomer as precise micro-channels can be created inside the glass to run coolant through

Even though we came up with more ideas, these were our top ones as we thought them to be the most practical and viable. And so we started our research to understand more about these industries and how our product could play into them. One of the ways we did this was by reaching out to relevant people who are already working in these industries - we used the strategy of beginning small and then expanding to guide our research.

We reached out to these contacts via email and LinkedIn to ask them for interviews and get their opinions about the applications of Glassomer in their respective fields. However, we quickly realized that none of the contact requests we had sent out were fruitful as no one got back to us. This was an important milestone for our team as now we had to figure out other ways to move forward with our research.

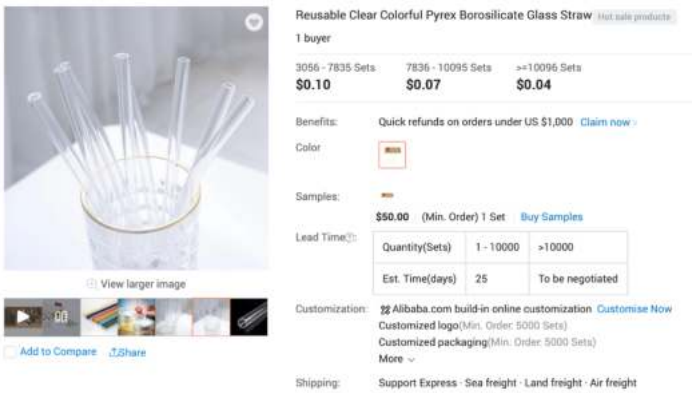
One of the first things we did was drop our idea to enter the security market. The idea was to add an extra level of security for access badges used by high level institutions like Governments, Banks, etc. We would add a thin layer of glass on top of the security badges, where the glass would have micro-inscriptions of a personalized pattern chosen by the clients that can be scanned

by the scanner when the user swipes or inserts the badge. Since the pattern on the glass will be made with microscopic precision, it would be hard to replicate, thus adding an extra layer of security.

This idea targets places that require a high level of security due to the sensitive information they handle at national and international levels. We reached out to access control officers in different organizations and security companies to understand their current security processes. Unfortunately we were unable to connect with any of them, and we hypothesize that due to the confidentiality of the matter - the idea behind access control security providers is security - it makes sense for them to not share information.

We also had to drop another one of our initial ideas to explore making glass straws, as plastic straws are either banned in a lot of countries or they're not being used by properitiers due to environmental reasons, see Paris Agreement 2016. Given the social shift away from plastic straws, one of the most popular replacements has been paper straws. However, paper straws are not an effective substitute as they stain the taste of the drink and also lose their structure after being submerged in drinks. These shortcomings led us to think that glass straws can easily fill this gap in the market - because even though users love straws, they do not love paper straws.

Once we had the idea, we started initial research to understand the viability of making glass straws in terms of manufacturing, supply chain, and usability. We knew that in order for glass straws to replace paper and plastic straws, they would have to be manufactured at an extremely cheap rate that could compete with the existing products. This is where we were hopeful for Glassomer as it can be injection-molded and thus mass produced at a cheap rate. However, once we looked at glass straw manufacturers on websites like Alibaba, we realized that borosilicate glass straws are already being manufactured at incredibly cheap rates.



Source:
https://www.alibaba.com/product-detail/Glass-Straw-Glass-Reusable-Clear-Colorful_62331105697.html?spm=a2700.7724857.normal_offer.d_title.2c8b5c73NYYRCN&s=p

After doing some initial research on Google, we assumed the weight of one glass straw to be around 20 grams. Glassomer can be injection molded for

20€/1 kilogram, so manufacturing a single straw would cost around 0.4€. While incredibly cheap, this price cannot compete with the existing price of ~0.038€ per straw. Since existing prices are cheap enough, Glassomer straws lose their competitive pricing edge. This combined with another shortcoming that glass straws can easily be broken, like for instance if bitten by the user, led us to drop the idea of making glass straws using Glassomer.

While at CERN, we also came across another potential application for Glassomer when we visited the CERN glass section where glass components are designed, manufactured, cleaned, and stored. We spoke to Mr. Thomas, who walked us through their process of creating glass coatings to be used in the particle accelerator research and technologies. He told us that the glass they use needs to fulfill certain standards and requirements and that this makes the glass they use very expensive. Since Glassomer could potentially meet these requirements, we were excited to explore this partnership. But we also realize that this is just a one-off personalized solution, and not broad enough to be scalable, and so we dropped this idea as well. However, we do recommend that Glassomer pursue this opportunity independently as we found great synergies between what CERN needs and what Glassomer can provide.

We were now down to two ideas. However, we decided to drop our idea to create glass souvenirs for the tourism industry as well. This idea was inspired from our personal experiences with cheap quality plastic and ceramic souvenirs that flood the tourism market right now. These low quality souvenirs often break very easily but they're attractive to tourists because of their affordability. We also found an article from 2019 explaining a plan for the Spanish tourism industry called the "Sustainable Tourism Strategy of Spain 2030". This plan hopes to push socio-economic, environmental and territorial sustainability. This report was encouraging, and we decided to reach out to people working for the Catalan Tourism Board to understand how this plan is being implemented on the ground.

However, we could not successfully get in touch with anyone from the Tourism Board, and this combined with the fact that Glassomer cannot compete price wise with plastic and even borosilicate glass when mass-manufactured, we decided to drop this idea. Further, this idea also failed to meet the social and environmental impact we hope to achieve with our product. So,

even though this idea has potential, our team decided to pursue our last remaining idea to solve the current issues of cooling down servers.

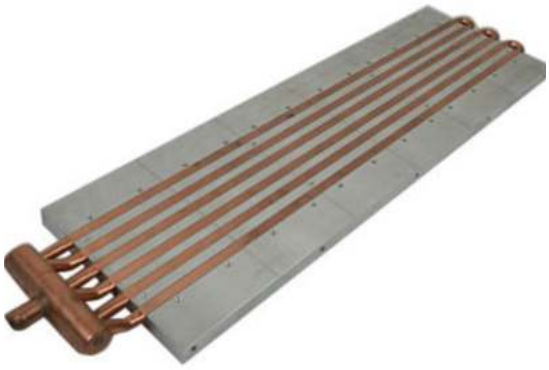
The idea to use glass to cool down servers was originally limited to data centers, the need for which is only going to grow exponentially as they're essential to the day-to-day functioning of almost all companies. Their great importance causes, for different users, a considerable capital investment to keep them working all the time to ensure that there is no delay in daily operations. And to maintain an optimal data center, a good cooling system is necessary.

The problem with modern server components is that they generate extreme amounts of heat, and we're reaching the limit of being able to cool them with just air as a coolant. There is no way to push enough air through the systems to cool them sufficiently. Further, existing cooling systems require high amounts of energy, which implies a high electrical expense for businesses and is also not beneficial for the environment. We came up with two applications within the sphere of server cooling to see if we can solve for some of these problems - the already existing cooling mechanisms of immersion cooling and direct contact liquid cooling.

First, we will look at immersion cooling, which involves placing electronic components directly into a non-conductive fluid, allowing heat to be transferred directly from the components to the fluid. Many companies and data server centers are aiming for this solution because they are scalable, faster, energy efficient and cost-efficient for businesses. During our initial research, we discovered that almost everyone using immersion cooling faces one issue: how, when removing the servers from the liquids, they must wait for the oil/liquid to stop dripping to do maintenance.

Since Glassomer is highly customizable and extremely precise, we thought to create a thin, airtight, customisable case that would surround the server before it got immersed in the liquid. This would allow the server to still be immersed but since the server would not be in direct contact with the liquid, it would not get wet. Thus, the need to wait for the server to dry for maintenance would be eliminated and repairs could be done immediately. However, this idea depends on the assumption that we will be able to achieve an airtight seal for the glass case. Without an airtight seal, liquid will enter the glass case and that defeats the entire point of the product. We brainstormed as a team to come up with ideas to create airtight seals, but we could not come up with any viable and feasible ideas, and so we decided to drop this idea.

Our next idea was to work with direct contact liquid cooling. We were not aiming to redesign the entire process but rather see if we can improve any current shortcomings. Direct contact liquid cooling works by transferring heat away from processors and other heat-generating system components via contact with a liquid-cooled heat sink, rather than using just air in the heat-exchange process.



Source: https://www.globalsources.com/Liquid-cold/copper-tube-heating-plate-1185012832p.htm

The existing product, as seen in the picture, has copper tubes running through a plaque to try and reach as much of the server's surface as possible to provide maximum cooling, where liquid runs through these copper tubes to cool down the server. Our idea is to replace the copper tubes with glass tubes made of Glassomer. Before moving ahead, we looked into why copper is currently being used and how replacing it with glass will affect it, since glass is an insulator of heat, whereas copper is a great conductor of heat and not easily prone to corrosion. But we realized that if we replace copper with glass, we will be able to create microchannels that are extremely thin and precise within the glass and this will maximize the surface area in contact between the liquid and the server. We hypothesize that by increasing the contact surface area, we should be able to compensate for change of material, i.e., from a heat conductor to an insulator.

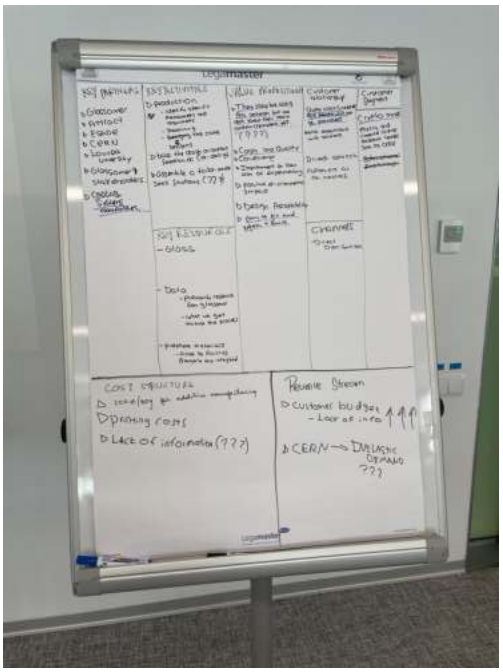
We also discovered another advantage of replacing copper with glass when we spoke to physicist, Mr. Juan Ramos Castro about our idea. He explained that all direct contact liquid cooling solutions have two components (amongst others) - the copper plate and a specially designed paste that is used underneath it to compensate for the lack of copper's smoothness. The smoother the plate is, the better the energy transfer is. Since Glassomer is highly customisable, we can create the glass plates to be smoother than copper, and this will improve the energy transfer between the heated server and liquid coolant.

Now that we zeroed in on our final idea, we started work to understand its potential market. Even though our search for connections had not been fruitful, we had managed to interview two data

center professionals, who helped us understand how data centers of different levels work and also the scope of our product. Our first interview was with Mr. Olof Barring, the manager of the CERN data center. He helped us understand how data centers function at a huge scale. He spoke to us about how high energy consumption is a constant but necessary concern, and how currently, the organization is working and investing in a new cooling system with economic and environmental benefits.

We also spoke to Mr. Maurici Añaños, the manager of the data center at ESADE Business and Law School. Since the data center at Esade is relatively smaller and stores considerably less data than that at CERN, this conversation helped differentiate between the needs of different data centers, because before this, we were looking at their needs as a collective entity. Mr. Añaños told us that the Esade data center has been slowly migrating to the cloud and decreasing their usage of physical servers, as the cloud offers them unparalleled convenience. He told us that even though cloud storage is more expensive, the convenience makes it worth it. This conversation helped us eliminate small data centers from our target customer base.

Taking all the information from these interviews, our team also used the Business Model Canvas to flesh out our idea. This activity helped us define our vision and find more potential customers.



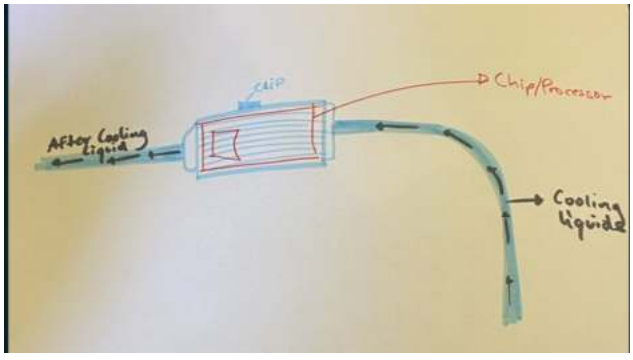
Firstly, we hypothesize that big data centers will benefit from our product due to the efficiency and cheaper prices. The cheaper prices will decrease their cost of operations, and they can either use this to decrease their selling price to gain a competitive advantage in the market or keep the same selling price to increase profit margins that can then be invested in other projects.

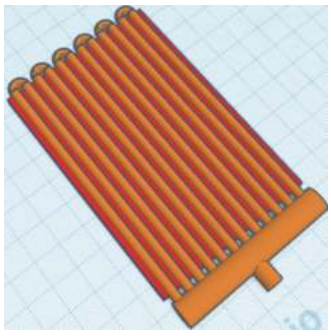
We were also able to identify another niche target audience: bitcoin miners. Since this was a relatively late discovery, we were unable to speak to any bitcoin miners and used Google for our research. We discovered that the machines used to

mine bitcoin use extremely high power capacities and that in order to competitively mine bitcoin, miners need to invest in powerful computing equipment like graphics processing units (GPU) or application-specific integrated circuits (ASIC). These are expensive equipment and their cost can go upto tens of thousands of dollars. Bitcoin mining is a lucrative field but the benefits are directly dependent on the quality of the equipment. However, more important than even the quality of the equipment is the necessity that the equipment keeps working in an optimal working condition. And a good cooling system is essential for this. Thus most, if not all, miners invest large amounts of money in cooling systems.

Since both, large data centers and bitcoin miners, invest a lot of money in technologies that ensure that the servers keep working in optimal conditions, we feel confident in our target customer audience, because both these groups will need efficient cooling systems so that their servers do not overheat. The marketing strategy to be implemented to make way for bitcoin miners in the market is to create partnerships with bitcoin academies and sell the product, at first in 2-for-1 promotions or discounts to make way for them to try the product. The idea is that the professors and directors of the academies add direct contact liquid cooling as part of the package for new students who buy their first mining hardware.

Now that we had fleshed out our idea, we started prototyping. We started with a physical drawing to visualize our idea. This was incredibly helpful as it allowed all of us to see what our product could look like for the first time. After we had this visual drawing, we started playing around in Tinkercad to see if we can 3D print some models. We ended up printing two versions, because after we held the first one in our hands, we realized that there was scope for improvement.





This iterative process led us to create our final prototype, as seen below -

This model has 12 tubes running across the plate and a single flow of water gets divided into them to control the flow and speed.

After going through this process of iterative design, we feel confident in our idea, but at the same, we realize that this is an unvalidated idea solving an invalidated problem due to the lack of sufficient research, interviews, and validation on our end.