Degree Project for Bachelor in Fine Arts in Design

Main Field of Study: Industrial Design
Lund University, School of Industrial Design

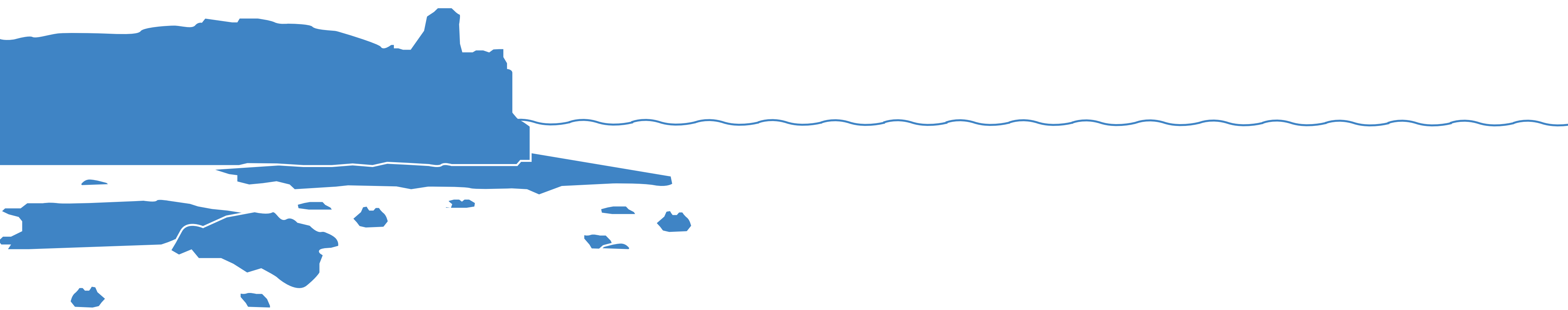
CHANGING TIDES

Erin Karlsson

EXAMINER:
Prof. Claus-Christian Eckhardt

SUPERVISORS:

Professor Claus-Christian Eckhardt, Lecturer Charlotte Sjödell
Professor Jasjit Singh, Lecturer Anna Persson

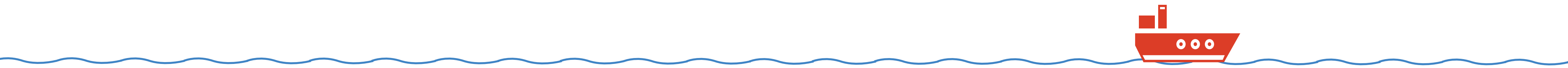


The project began with the thought of how humans will be able to adapt to impending climate change. I sought to create a tool that encourages self-reliance, because this will be extremely beneficial in times of crisis.

Sea level rise is particularly disastrous result of global warming, and has the potential to displace millions of people from their homes. How will we be able to cover our most basic needs when we suddenly find ourselves cut off from the land's resources? I decided to approach this issue by addressing the most fundamental human need: pure drinking water. When surrounded by rising seawater, it seems only logical to convert this source into something useful, which is why I began to focus on various desalination techniques. The resulting brief became to "create a desalination tool for those living at sea."

I opted for more simple, low-tech methods and tested the functionality in different forms. My goal was to incorporate the final design for use on sailboats, and formed the design within this context. After creating several mock-ups, the result became a functioning model, which was able to aptly demonstrate the original brief and concept. The materials used for the prototype, however, were not optimal; the final product would require food-safe and more durable materials.

Nevertheless, the brief was accomplished, and the research and creative process led to a quality result. The concept is solid but if it's to become a real product, it will require further testing and use of more appropriate materials. However, in the end, I'm quite satisfied with the process that led me here.



PART ONE

CHANGING TIDES

AN INTRO

Despite the many predictions of the future, one thing is absolutely for certain: **we will all be affected by climate change**. Many will be forced to adapt to a new environment because it is shifting dramatically. The effects of climate change are already felt today with, for example, the evidence of rising sea levels.

What is causing the sea levels to rise, what are the consequences of it, and how will humans react to these changes? This project seeks to be a response to this change and to act as preparation for survival in the impending floods and damage that will follow.

SEA LEVEL RISE

WHY AND HOW?

Conclusive scientific data shows that the ocean is steadily rising.This is because the earth's oceans absorb more than 90% of the heat trapped by human-produced green-house gases.

As a result, the over-heated oceans rise because water molecules move about when heated and take up more space. Not to mention, the extra heat creates a disastrous melting effect on the polar ice caps, thus causing the ocean to rise even more.

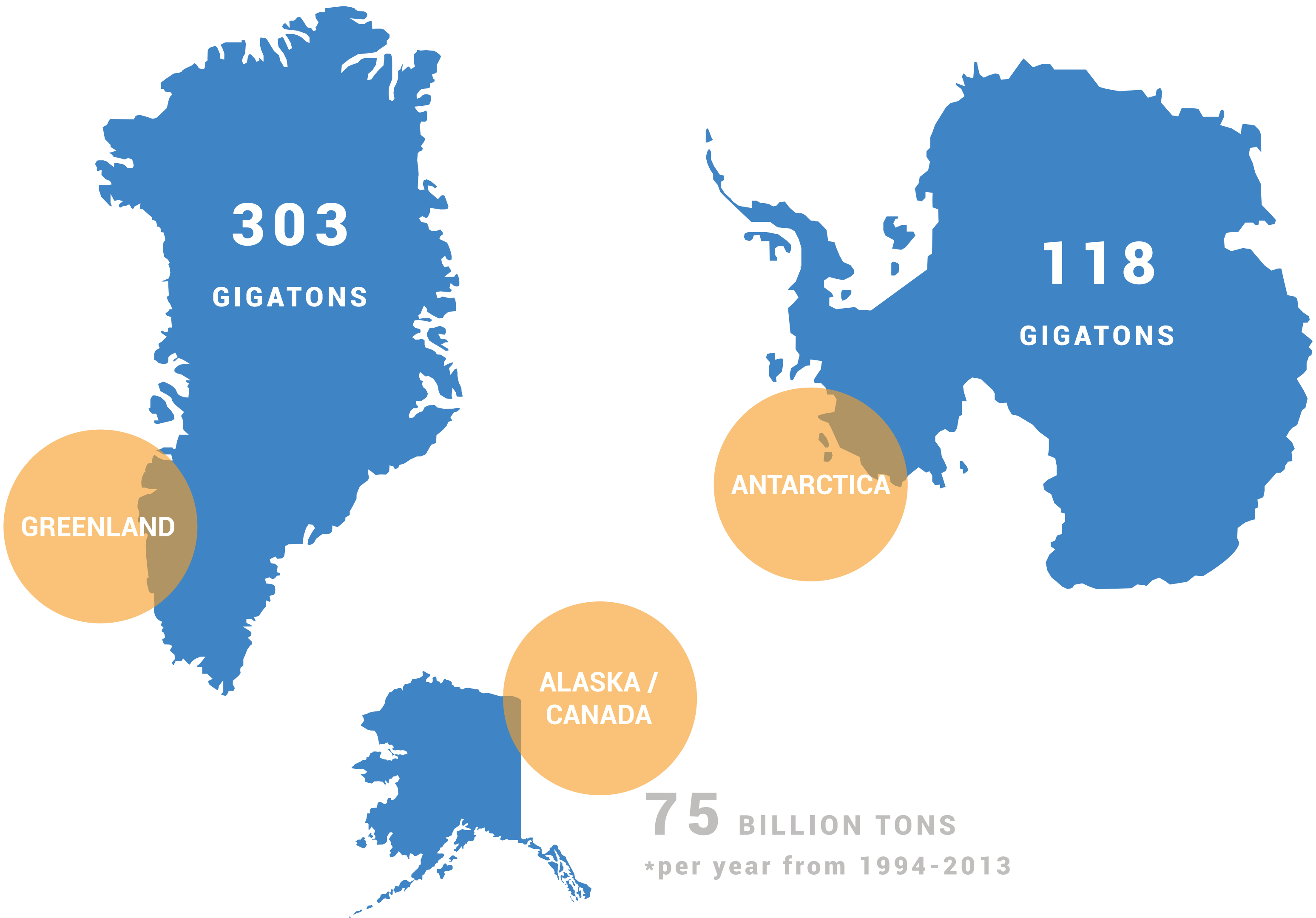
COOLED WATER MOLECULES

HEATED WATER MOLECULES

Source: Nasa Climate Resources

HOW MUCH ICE ARE WE LOSING?

*DATA FROM THE YEAR 2014

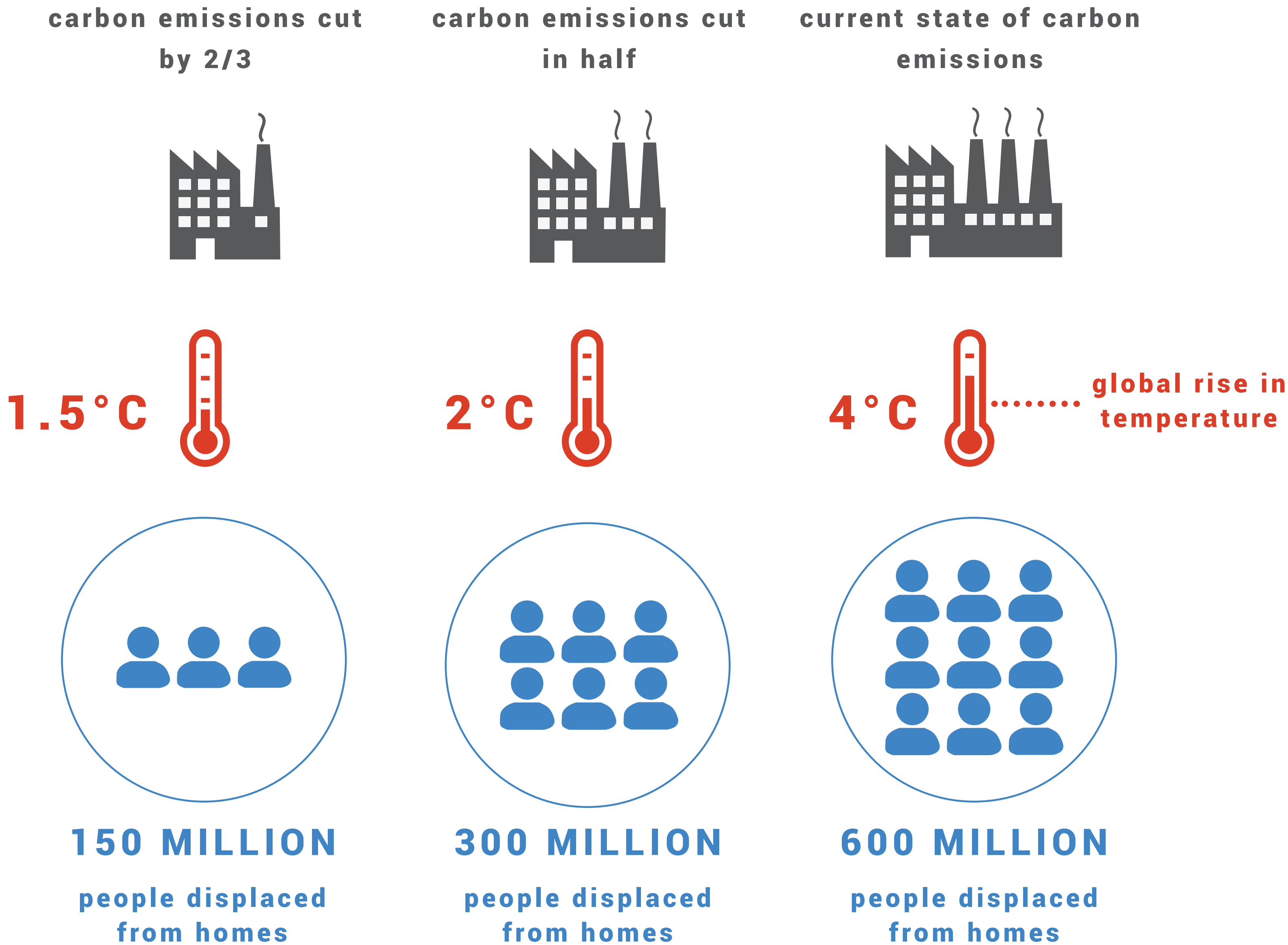


Source: Nasa Climate Resources

THE CONSEQUENCES

11 of the world's 15 largest cities lie along shores. Due to sea level rise, the ocean will gradually inundate low-lying areas and storms such as hurricanes and typhoons will extend their reach inland when bolstered by higher seas. The damage floods cause in large coastal cities today costs $6 billion per year and is expected to rise to $1 trillion per year by 2050.

Source: Nasa Climate Resources


carbon emissions cut by 2/3
carbon emissions cut in half
current state of carbon emissions
1.5°C
2°C
4°C
global rise in temperature
150 MILLION
people displaced from homes
300 MILLION
people displaced from homes
600 MILLION
people displaced from homes

THE SCALE

Though it is immensely expensive to repair large cities after floods, it is perhaps less difficult than relocating entire urban populations. If the global temperature heats by **4°C** (roughly matching our current path) more than **600 million people** could be displaced from inundated land. If we are optimistic, and able to limit the amount of warming to 2°C, the number of displaced people would be cut in half. And if we can manage to cut carbon emission by two thirds, then about 150 million people would eventually be displaced.However, even this would cause a large-scale migration crisis unlike we've ever seen before
.

Benjamin Strauss, VP for Sea Level and Climate Impacts, Climate Central

THE FUTURE

What will the future look like when the sea has inundated our major cities? Architects, city planners, and engineers are already anticipating this change. Instead of allowing the water to displace millions of inhabitants, perhaps adapting to rising sea levels is our best option for a better quality of life.

Floating micro-homes, using water-ways for transportation, and desalination plants for agriculture and drinking water are all fairly recent developments made in the wake of climate change.

SHIFTING TRENDS

// more living in cities

// more mobililty

// less possesions

// smaller households

Perhaps as a result of over-consumption and the environmental damage it has caused, many people are resolving to live more minimal lives. They are owning less material objects than generations before and are generally choosing to have smaller homes and families. People are also much more mobile than ever before, often moving between different places several times during their lives. Not only are people moving more, but they are moving to urban areas in large droves because the most economic opportunities are found in cities.

Though many are choosing to live minimally, rising sea levels will force many into this lifestyle. "Wants" will no longer be so important, but rather, basic needs and survival. How will we adapt to life in a large city suddenly affected by ocean floods?

A good example is to observe those who currently live on the water. Meet Quincey, a 28 year old who doesn't just consider sailing a hobby; the sea is her home. She lives on the coast around San Francisco and has an otherwise, normal urban life. To some, it may seem uncomfortably small to live on a boat, but she proves that this life can suit all her needs and more. There are still challenges to living at sea, but there could be solutions to help make her more self-reliant.

EXAMPLE

NAME: QUINCEY

AGE: 28

LOCATION: SAN FRANCISCO

HOME: 10 M SAILBOAT (WIND ROSE) WITH PARTNER

Chooses boat life for the mobility, lower costs, and minimal lifestyle.

BRIEF

// Design an essential tool that assists humans affected by rising sea levels or living at sea. //

PART TWO

ESSENTIALS AT SEA

TOOLS FOR SURVIVAL

A DAY ON THE WINDROSE

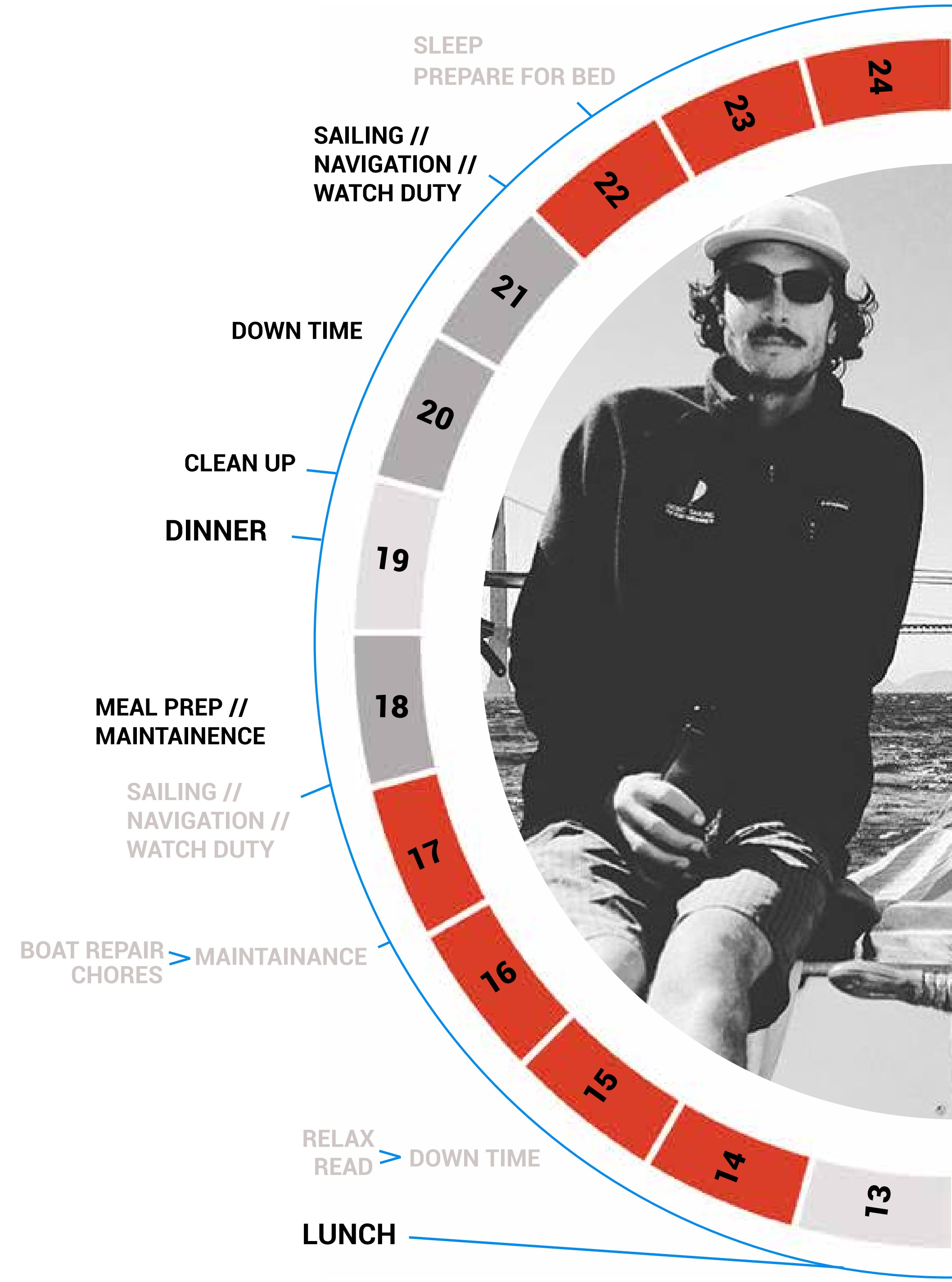
* The average schedule for a crew of **2 persons** spending many days at open sea. The days are divided into **4 hour shifts** between sailing duty and other, miscellaneous duties/resting hours.

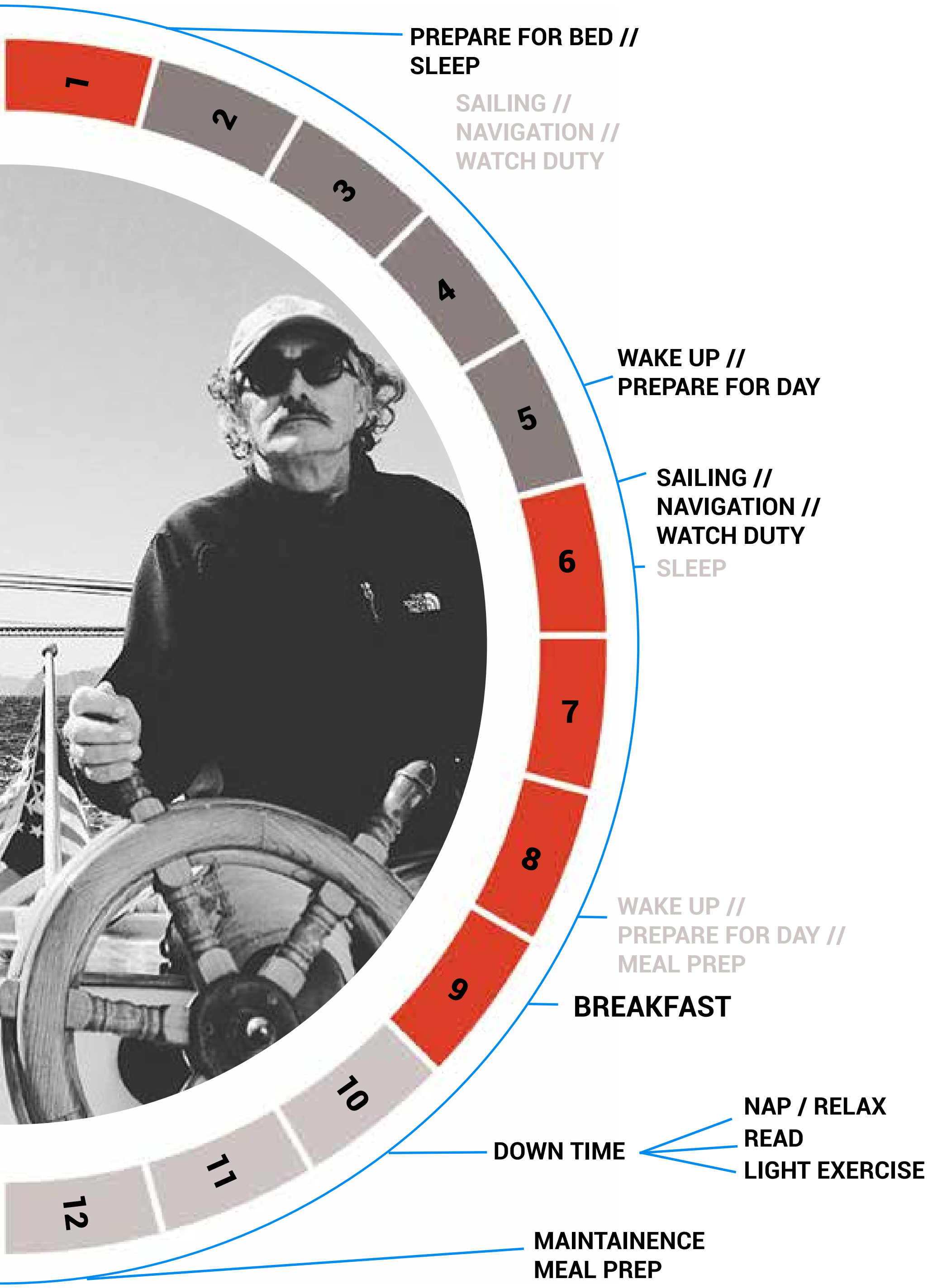
SAILOR 1

SAILOR 2

SAILING / NAVIGATION DUTY (SAILOR 1)

DOWN TIME / OTHER DUTIES (SAILOR 2)





* Since sailing for long periods with a small crew of 1-3 persons is quite demanding on time, sailors don't have room to waste this resource by thinking about how to cover basic needs.

Energy is scarce as well, and man-power must be saved as much as possible while operating a ship at sea. This is why this tool must effectively cover a basic need without standing in the way of managing the ship or wasting large amounts of energy during use.

This tool should fulfill a necessity with minimal maintenance, allowing the sailors more free time to focus on controlling their vessel.


WATER

MAPPING THE ESSENTIALS

What are the most basic human needs that are hard to come by while living at sea?

>>FOOD

preservation techniques:
-fermentation
-dehydration
-pressure canning

food collection
-fishing tools
-seaweed/kelp gathering

>>OTHER

safety tools
-first aid
-rafts, lifevests
-SOS signifiers

clothing
-loose, light weight
-water resistant
-UV resistant

>>WATER

desalination techniques:
-reverse osmosis (machine or physically operated)
-solar stills

purification techniques
-sediment filtration
-UV exposure

I chose to focus on water desalination because water is our most basic need yet it is so difficult to come by, despite being surrounded massive amounts of water in the ocean.

FUNCTIONAL ANALYSIS

A new type of saltwater desalinator would require the following functions:

// provide fresh water from seawater

// produce enough drinking water for 1-2 persons a day (1-1.5 liters)

// low-tech and low-maintenance, runs on nature not man-power

// ease of use and assembly

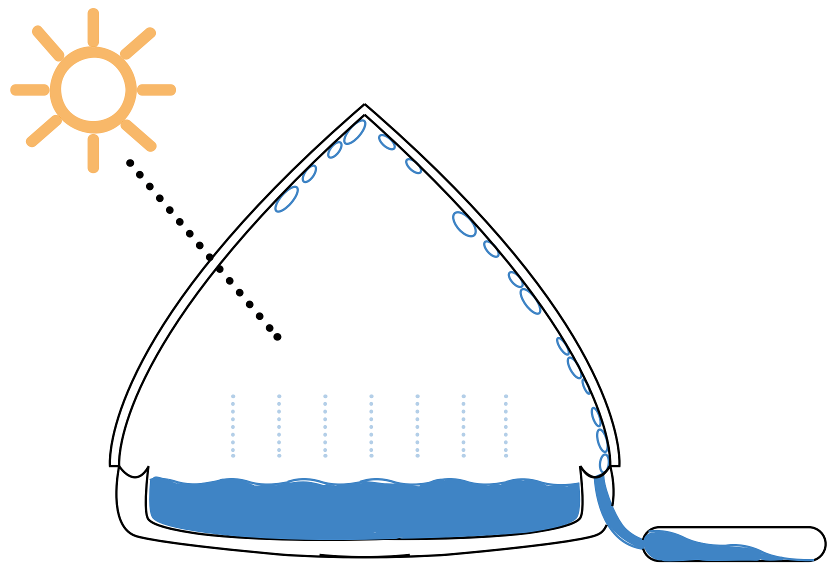
// compact, allows for minimal lifestyle

// adapted for use on sailboats

APPLYING SOLAR ENERGY

Most methods of purifying saltwater require either physical energy or relaince on an electrical source. Since long-distance sailors need to preserve their energy and cannot risk depending on certain power sources during an emergency, their most reliant source of energy would be the sun.

By using the sun as a water purifier, sailors do not need to exert energy or rely on a system that could potentially fail. Certain tools have been developed for solar powered water-purification, one of the simplest being **solar stills**, often found on naval lifeboats.

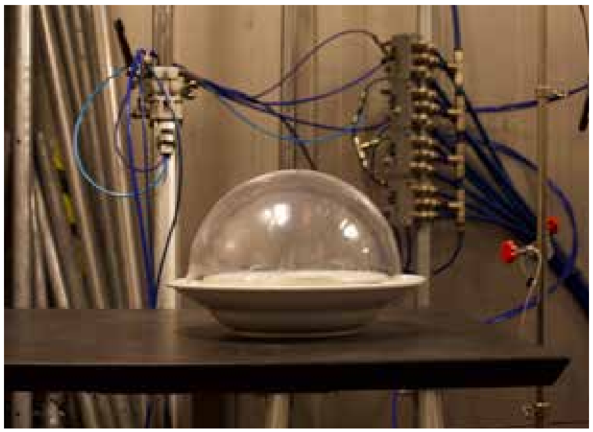


HOW A SOLAR STILL WORKS

A solar still is a transparent dome that holds saltwater (or any impure water). When placed in the sun, the saltwater evaporates and condensates to the edge of the dome. The condensation becomes purified, drinkable water which is collected after it trickles down the sides of the dome and into an attached vessel.

PART THREE

PROCESS




Programregulator
IMAGO 500
Prog.Kanal 1
20.8 °C
42.0 °C
LeifsCold

ALPHA TESTING

A rough mock-up made of two bowls and a transparent dome was constructed in order to test the principle of purification by evaporation. I filled a bowl with water and salt and secured the dome over in order for it to catch the condensed saltwater after it has evaporated. I placed the contraption in the climate lab for 24 hours to observe how quickly the water would evaporate. The lab was set to 40°C at 40% humidity. Surprisingly, the water would not condense to the outer dome so well because the plastic was too warm.

I then placed the object in the window to be exposed to some natural sunlight at room temperature. The water condensed much easier in this setting, but I've concluded that the container holding the saltwater needs to be warmer than the rest of the object in order for the evaporation to be quicker and so that condensation will occur on the cooler surface.

ALPHA TESTING

Because the saltwater condensed so well while sitting at the windowsill, I wondered if it had actually been purified. I asked a classmate to test the water for salinity. It was lukewarm, tasted a bit plasticky from the dome, but the good news- not salty at all!

This method of desalinating water almost seemed to simple to work, and I was actually rather surprised that it did. For this project, it is extremely beneficial to be able to prove the functionality of this technique in order to make a convincing product. It is so simple, yet has so many possibilities.

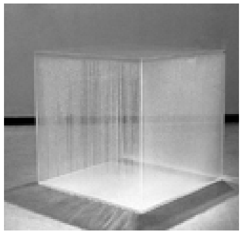








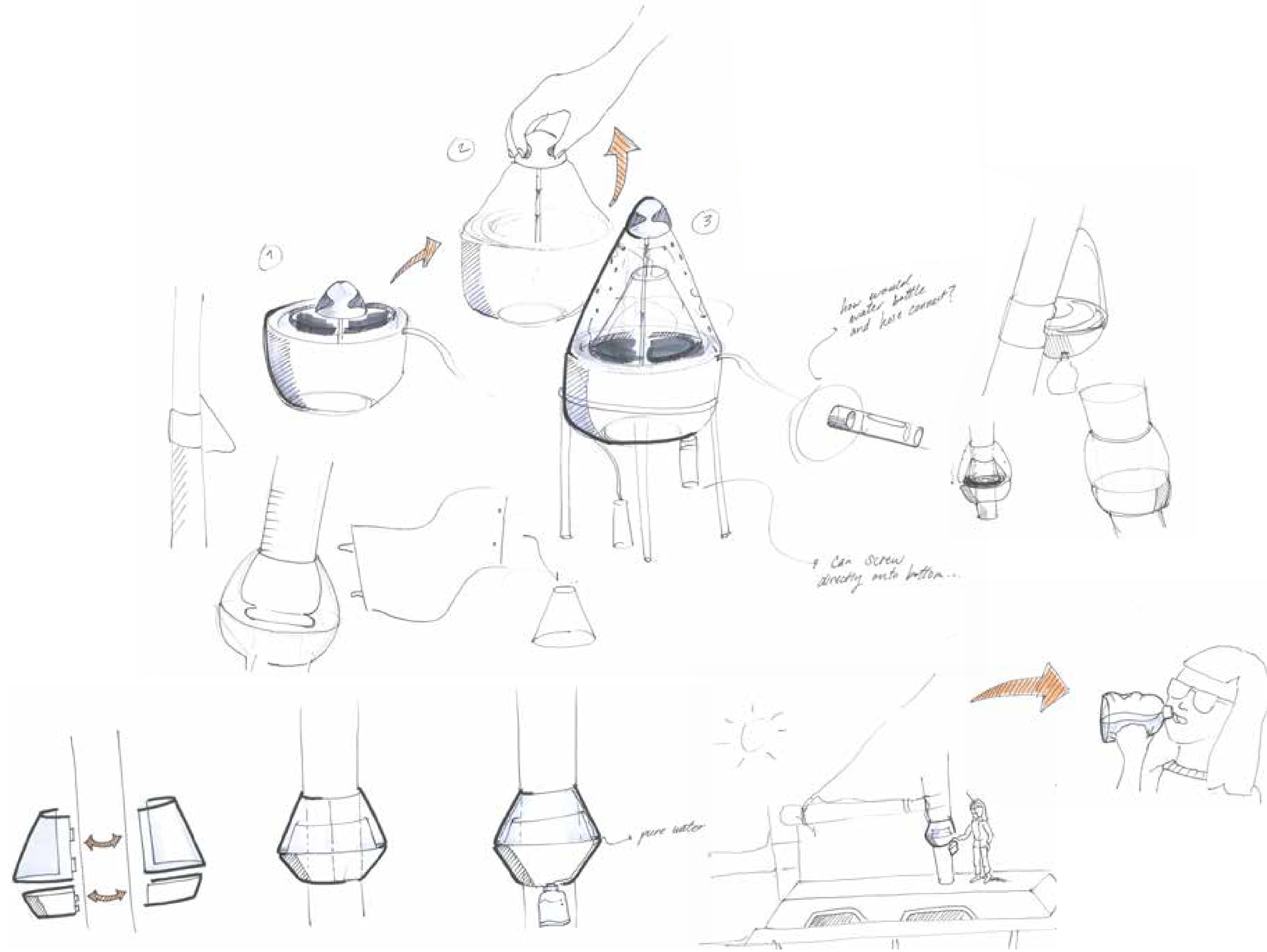




INSPIRATION

//LIGHT //AIRY //SOFT //ROUND

An object with soft edges, communicates buoyancy, but sturdiness at the same time, much like a water buoy. I was also inspired by flowing forms, such as the way jellyfish float in water to objects that are light, transparent such as the thin, silicone vases made by Nendo.

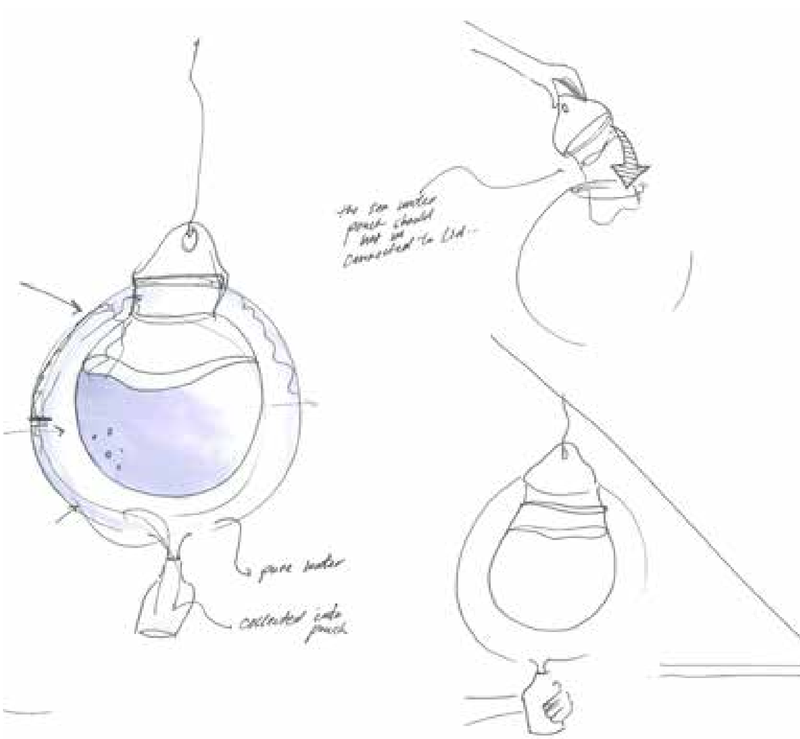


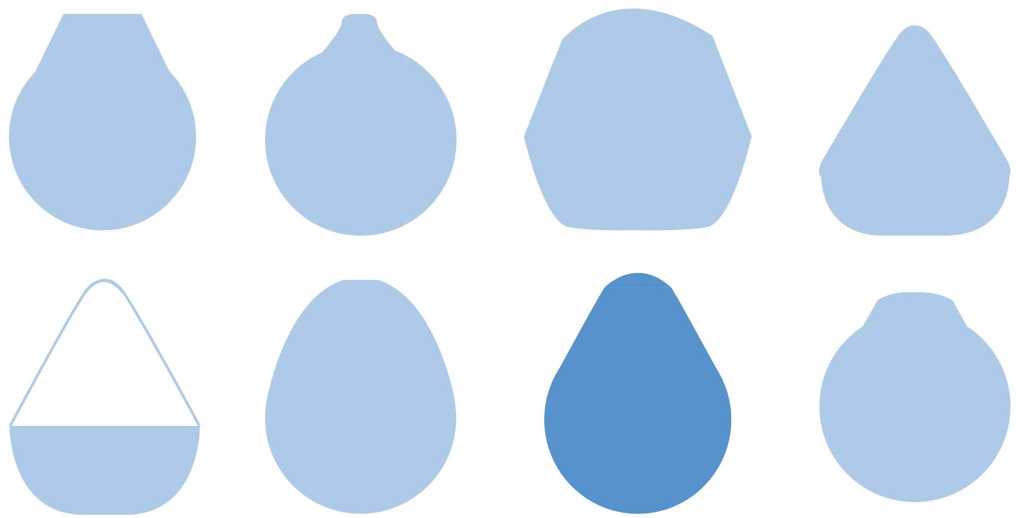
1
2
3
how would water bottle and hose connect?
+ Can screw directly onto bottom...
pure water

IDEATION

There are many different forms a solar still can take. However, the positioning of this object on a sailboat will determine exactly how it should function. Since it will be filled with water, it is more optimal that it hangs from the railings or the mast, instead of being fastened on the ground or to the rails. This will allow it to rock along with the waves.

I also needed to determine which materials will be soft and which will be hard. For this, I decided that a harder, yet flexible, transparent plastic should be the outer shell and the inner container would be a soft pouch, one that is easily removed and can be filled with saltwater.

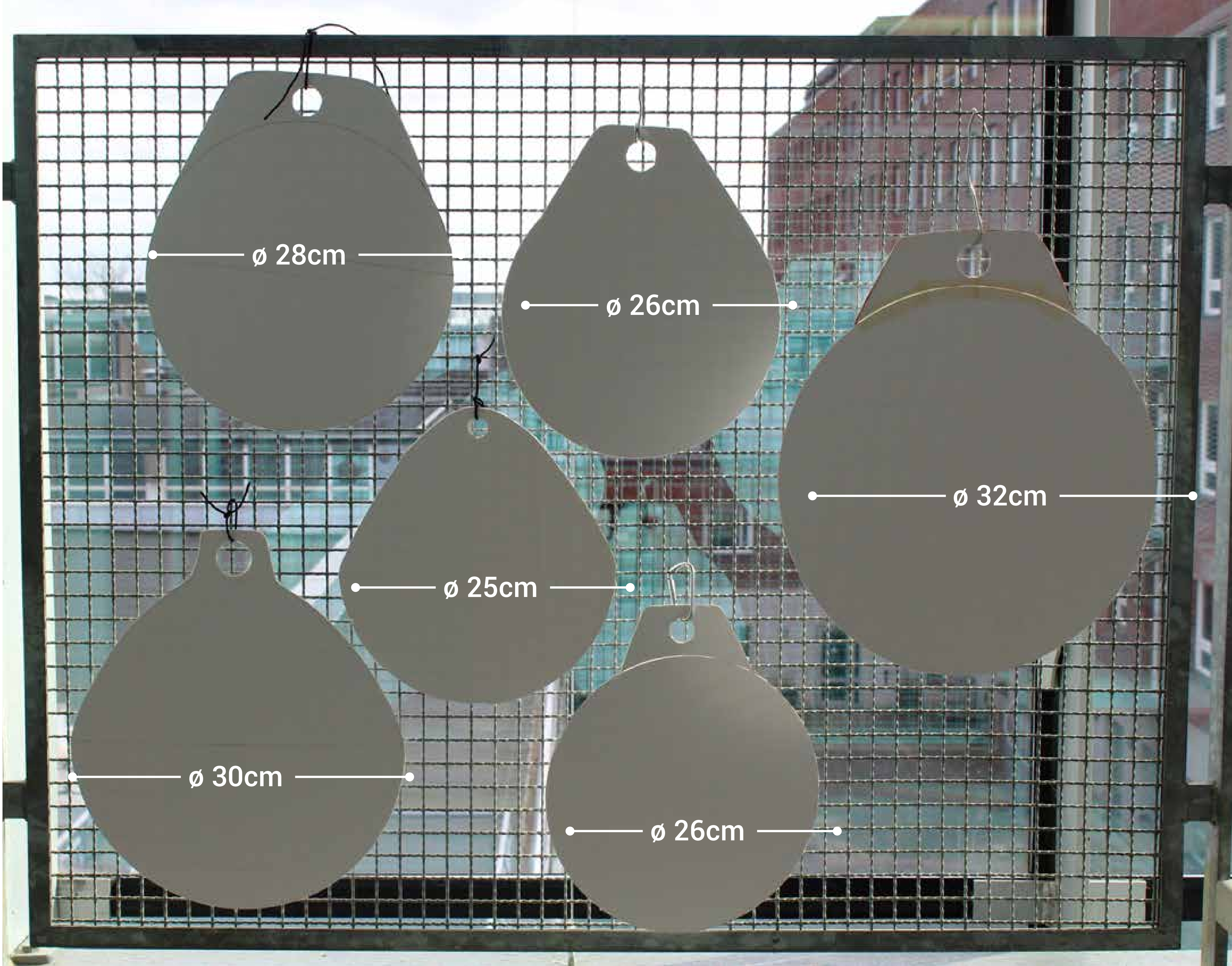


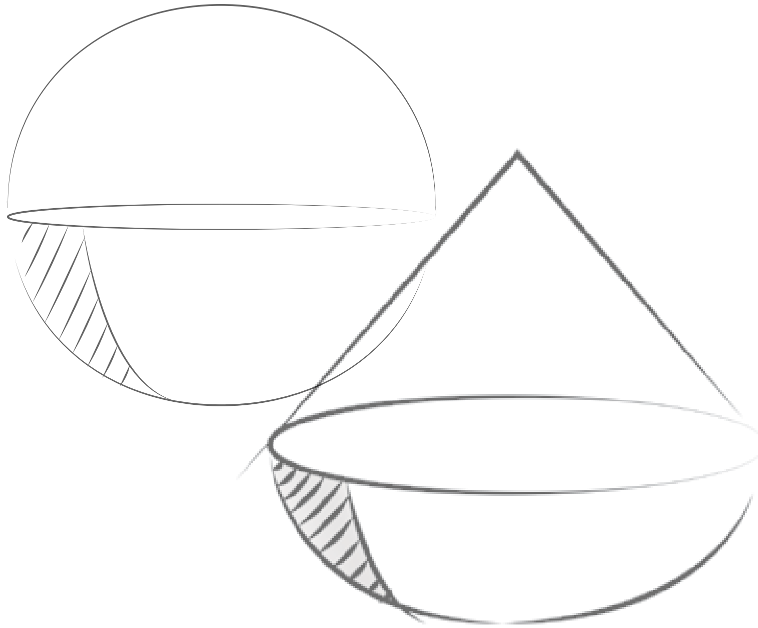


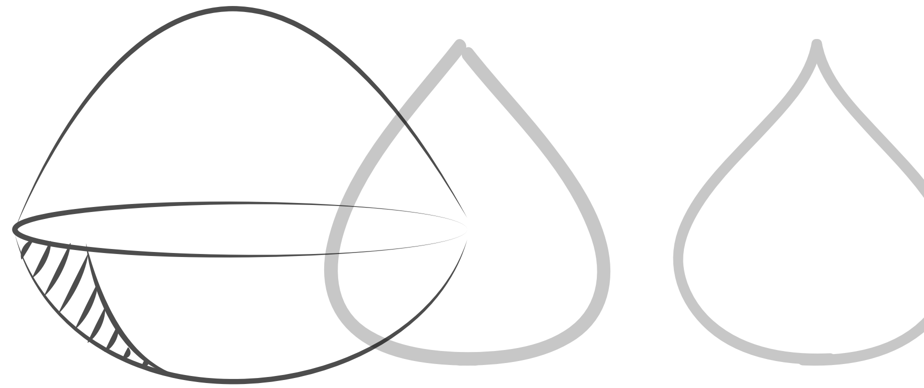
FORM & DIMENSIONS

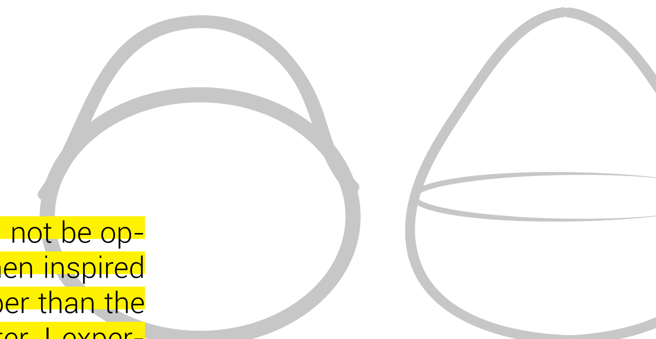
I shaped the device with smooth, round lines for a softer appearance. However, I needed to determine just how round the shape should be. I liked the look of the spherical form but it would not be optimal for directing water flow to the bottom half. I was then inspired by a teardrop, buoy-like shape, and since the sides of the upper half would be steeper than the rounded bottom, it would be allow the condensation to trickle down quicker, and then gather in a pool at the bottom.

Size was an additional factor to consider. The device needed to be large enough to ideally produce a bit more than a liter of pure water per day, all without being too large or bulky. After considering how much water each design would realistically be able to contain, I chose the form with a 26cm diameter as the best option.


ø 28cm
ø 26cm
ø 32cm
ø 25cm
ø 30cm
ø 26cm



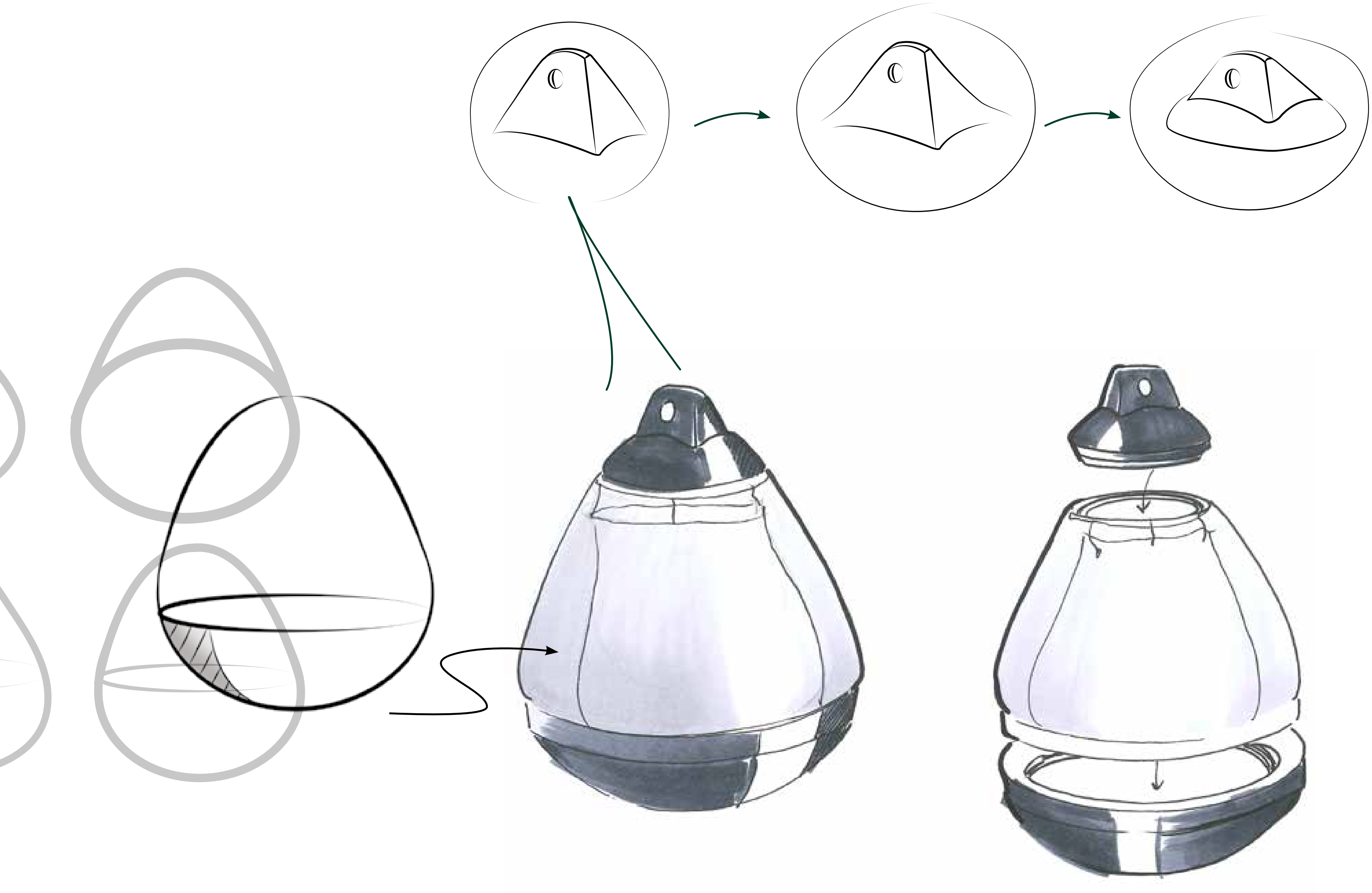




IDEATION

First, I was drawn to softer, rounded, spherical forms but realised it would not be optimal for directing the water flow downwards to the bottom part. I was then inspired by a teardrop shape, and since the sides of the upper half would be steeper than the rounded bottom, it would be allow the condensation to trickle down better. I experimented with different forms for the tear-drop shape, ultimately deciding to make it more rounded and buoy-like, fitting for a sailing environment.

For the form of the cap on top, I tested different forms, and chose a shape that would be better for griping when removing it or placing it on.





ALPHA TESTING 2.0

I constructed another rough model to test the method again, this time in the hanging form to see if it would work just as well. I made a pouch out of water-resistant cordura material, filled it with saltwater and hung it from the top of the plastic form. I then took this contraption to the Botanical Garden greenhouse in Lund because there I could find both heat and plenty of sunlight.

The plastic fogged up almost immediately in the tropical room (about 30° C) and I left the object there for an additional 24 hours. When I returned, I could see that much of the saltwater had condensed to the sides of the plastic container and had trickled down to the bottom. I was very excited to believe that this experiment had worked and asked a brave classmate to test the water for salinity.

It tasted salty. The cordura textile was, in fact, not the most optimal material to use for the water pouch, as some of it managed to leak through. I would need to try again but with a more reliable, water-proof material.

MATERIAL TEST

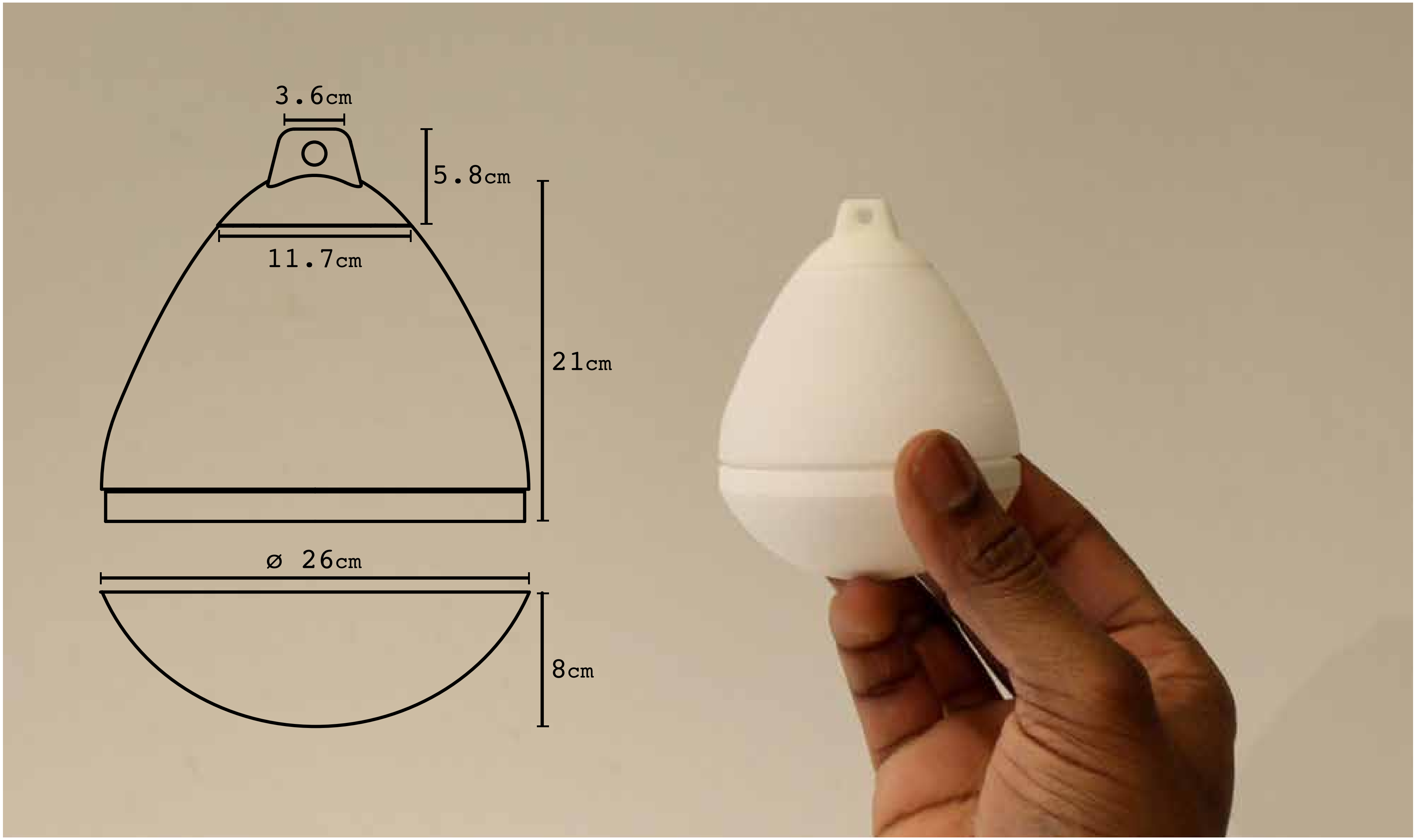
The functionality test was conducted again in the exact same way but with one minor difference. Rayon was used to hold the saltwater instead of cordura, being the more optimal material since it is 100% waterproof. After a period of 24 hours, the saltwater evaporated and condensed as it should. It was therafter offered to another classmate to drink and test the salinity. This change of material proved to be solution because the water tasted pure and not salty.



PROPORTIONS

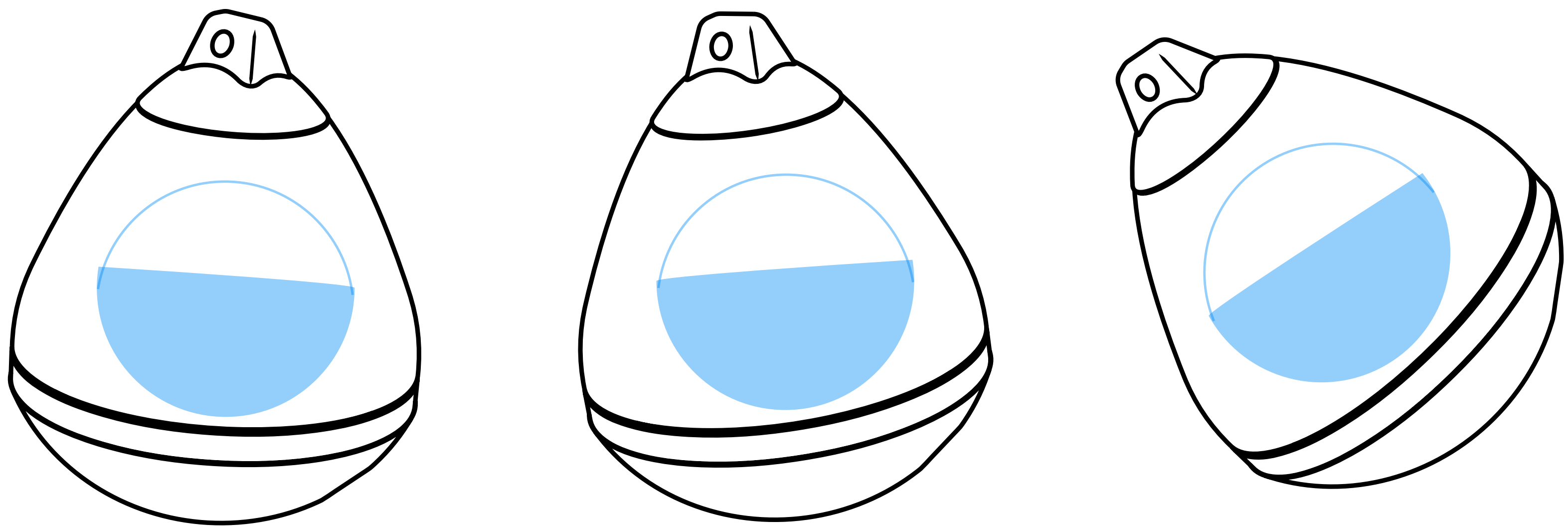
The device will be made into two parts: the container, which will collect all of the purified water, hold the saltwater pouch, and allow evaporated water to condense on its outer walls, and the second part being the cap, which seals the device and allows it to be hanged from the rails or mast.

I determined the proper size for each component and 3D printed a scaled-down version to observe how well each piece fit together.


3.6cm
5.8cm
11.7cm
21cm
ø 26cm
8cm

“TILT TEST”

The “tilt test” was preformed on the mock-up to determine how far a sailboat can tilt to the side without risking saltwater spilling out of the inner pouch and mixing with the pure water. There must be a limit to how much saltwater can be added to the pouch, and this test determines exactly where that line should be drawn. This line should clearly indicate the maximum amount of saltwater that should be added to this device. It was observed that the pouch could hold about 1.2 liters of water without spilling over easily when tilted.



PART FOUR

FINAL SOLUTION

SUNDROP DESALINATOR

This desalinator is called SunDrop because it creates a mass of pure water in the form of droplets with help from the sun. The transparent part of the shell is completely seethrough because it needs to let in a large amount of sunlight in order to heat the saltwater in the black pouch, which is a colour that will retain the most heat. The other parts are coloured blue because it is a cooler colour, in order not to reheat the purified water once more. The blue colour is also not so bright and noticeable because it should not be mistaken for a safety device or become a distraction while sailing.

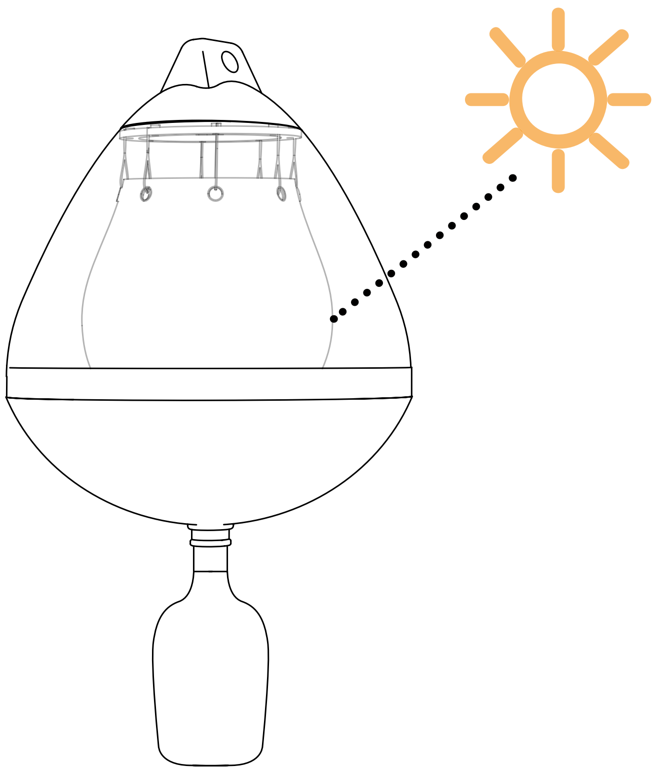
It must be a sturdy device that can withstand weather-wear and be extremely airtight for hygiene. Bacteria, bugs, and other impurities should not be able to make its way into the device while it is purifying seawater.

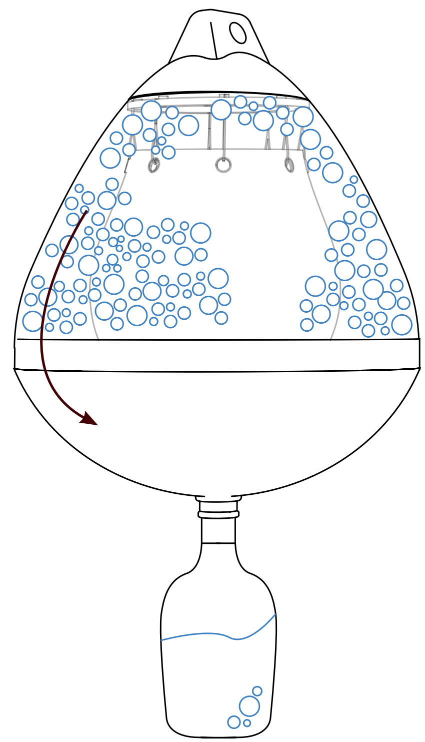
The plastic material used for the outer shell must not only be durable, but food-safe as well because the water created inside will eventually be consumed, which is why I chose to use polypropylene. The inner water sack should be made from pvc-coated cordura because it needs to be completely waterproof in order to hold seawater for a long period of time. And lastly, the rubber stop detail, at the bottom, much like what is used in scuba gear, ensures that no air or other unwanted impurities can enter the object.


ABS plastic
polypropylene
pvc-coated cordura
rubber stop

1 The first step to setting up the SunDrop desalinator is by pouring 1,2 liters of saltwater, or impure water, into the inner water sack.

2 The cap is then screwed on top and a rope can be fed through the hole on the cap. The device is ready to be hung and can begin evaporating and condensing the saltwater immediately.





3 A water bottle is attached to the bottom part of the object and the sun can begin to heat the impure water in the inner water sack. Optimal temperature is 25°C or higher.

4 The water will begin to evaporate and condensate outside of the water sack, naturally purifying the saltwater. The pure water will eventually trickle down into the attachable water bottle at the bottom.

REFLECTIONS

This project was based on extensive research and consideration regarding the future, how human behaviour and lifestyles will shift, as well as various scientific methods of water purification. It required one academic term to realise the final concept after many hours of ideation, prototyping, and finally, model building. The final prototype is functional but not ideal in material, since it proved to be rather unstable for its end purpose. In order to fully develop this product, more testing with different kinds of materials will need to be conducted.

However, the process that led me to the decision to create this product was extremely valuable and helped me to identify its overarching purpose: to empower individuals. It is meant to promote self-reliance; if society cannot provide clean drinking water, users of this product can produce their own and share it with those around them. In the near future, when natural disasters displace millions of people and create a massive scale climate migration crisis, we will, at least, be able to fulfill this need. I believe that giving individuals this opportunity of producing pure drinking water for themselves can allow them to have a sense of security and empowerment in the face of upcoming natural disasters.

Throughout the process, I often found myself looking for solutions to existing problems and wondering "how does this create real value?" It has helped me to bring my project from simply being a helpful tool, to an object that can communicate, one that asks questions, and provokes a little more thought about the nature of our current situation

REFERENCES

Global Climate Change: Vital Signs of the Planet, NASA 2017
www.climate.nasa.gov

Global change and relative sea level rise at Venice: what impact in term of flooding,
Carbognin, L., P. Teatini, A. Tomasin, and L. Tosi, 2009

Rapid sea-level movements and noneruptive crustal deformations in the Phlegrean Fields caldera, Italy, Morhange, C., N. Marriner, J. Laborel, M. Todesco, and C. Oberlin, 2006

Sea Level Change, Observations from Space, NASA 2017
www.sealevel.nasa.gov

Unabated global mean sea-level rise over the satellite altimeter era, Nature Climate Change 5, 565–568 (2015)
http://www.nature.com/nclimate/journal/v5/n6/full/nclimate2635.html

Before the Flood, Documentary 2016

Surging Seas, Benjamin Strauss, Vice President for Sea Level and Climate Impacts Climate Central 2017
www.beforetheflood.com/explore/the-crisis/sea-level-rise/

Clean Dirty Water with the Sun, Scientific American, 2015
www.scientificamerican.com/article/clean-dirty-water-with-the-sun-bring-science-home/

Experimental Study on Various Solar Still Designs, ISRN Renewable Energy
Volume 2012 (2012), Article ID 569381
www.hindawi.com/journals/isrn/2012/569381/

Interview with Quincey Cummings, 2017

Interview with Mitchell Andrus, 2017

Science and technology for water purification in the coming decades, Nature 452, 301-310 (2008) www.nature.com/nature/journal/v452/n7185/abs/nature06599.html

6 Water-purifying Devices for Clean Drinking Water in the Developing World, Inhabitant, 2013 www.inhabitat.com

Inexpensive New Solar Still Ups Water Purification Efficiency, New Atlas 2017 http://newatlas.com/inexpensive-efficient-solar-still/47652/

Solar Still Basics, SolAqua 2017 http://www.solaqua.com/solstilbas.html

5 Infographics that Capture the Changing Millennial Lifestyle, Vision Critical 2015 www.visioncritical.com/millennial-infographics/