[Innovative design]

SUBAQUATIC 3D PRINTER FOR BUILDING A TUNNEL

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INDEX

SUBAQUATIC 3D PRINTER FOR BUILDING A TUNNEL

INTRODUCTION

Once upon a time, in the bustling city of Gothenburg, Sweden, there lived a young man named Högafflel. One day, while he was walking along the beach, he noticed a beautiful Danish girl named Fysse who was visiting Gothenburg on holiday.

As fate would have it, Högafflel and Fysse crossed paths and struck up a conversation, they felt an immediate connection and talked for days about their hopes and dreams about the world, the similarities between their languages, cultures and traditions.

After many encounters they fell in **love** and quickly realised that they shared a common goal - to bring their two cities closer together. They started dreaming of building an **underwater tunnel** that would connect **Gothenburg** to the Danish city of **Frederikshavn**, so they could visit each other's city.

Fysse was a civil engineer and Högafflel was a teacher of international relations so they both understood how important it is building bridges (or tunnels) between cultures so that both countries can benefit from the exchanges made.

The world is becoming increasingly connected, with people from different cultures and nations interacting more than ever before. However, despite this progress, there are still many challenges, one of them being, the lack of **physical infrastructure** connecting different regions of the world.

Högafflel and Fysse saw the solution to this problem in the development of an infrastructure project that would connect the regions and create new opportunities for people to interact and collaborate.

However, infrastructure projects can also have negative impacts, particularly on the environment, so they made sure they had careful planning and execution so that the project would be **sustainable** and would not cause harm to the natural world.

KEYWORDS & DEFINITIONS

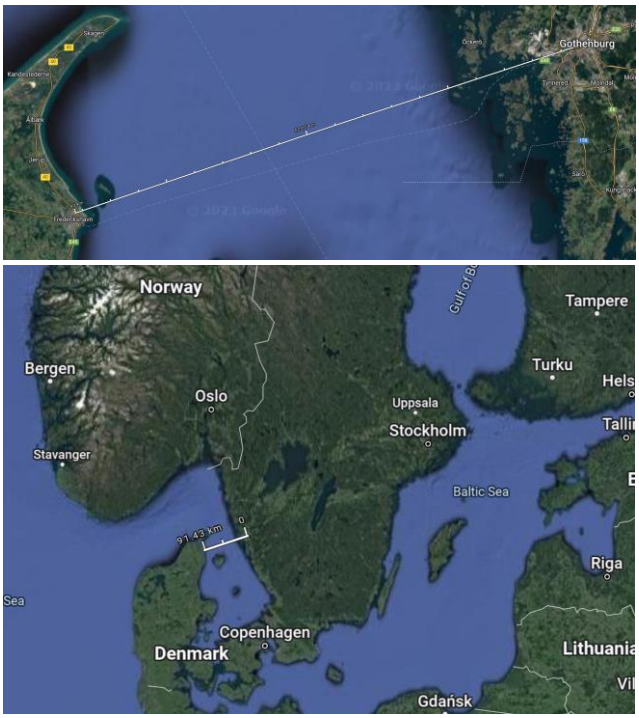
- **Gothenburg:** a major city in Sweden, is situated off the Göta älv river on the country's west coast. An important seaport, it's known for its Dutch-style canals and leafy boulevards like the Avenyn, the city's main thoroughfare, lined with many cafes and shops.
- **Frederikshavn:** Frederikshavn is a Danish town in Frederikshavn municipality, Region Nordjylland, on the northeast coast of the Jutland peninsula in northern Denmark. Its name translates to "Frederik's harbor".

- **Sustainable:** capable of being maintained at a certain level or rate without depleting natural resources or causing environmental damage. It refers to a system or practice that meets the needs of the present without compromising the ability of future generations to meet their own needs. Examples of sustainable practices include using renewable energy sources, reducing waste and pollution, and conserving biodiversity.
- **3D printer:** a device that creates three-dimensional objects from digital designs by layering materials, such as plastic, concrete or metal, on top of one another.
- **Concrete:** a building material made from a mixture of cement, sand, gravel, and water. When the mixture dries and hardens, it forms a strong and durable substance that is commonly used in construction.
- **Recycling:** the process of converting waste materials into new products or materials, in order to reduce waste and conserve resources. Recycling can involve the collection, sorting, processing, and remanufacturing of materials like paper, plastic, glass, and metal.

TASK

You are a team of civil engineers. Fysse and Högafflel asked you to make a system to build a tunnel between both countries under the sea above the seafloor to connect them through a road so they can visit each other easily.

Make a subaquatic tunnel and connect Fysse and Högafflel!



OBJECTIVES

Create a 3D printer that can build an underwater tunnel that connects Denmark and Sweden, the tunnel must be able to host a road. The width of the road must be 8 metres and must be able to pass vehicles of 5 metres height.

Furthermore, it is necessary to establish a preventive maintenance plan for the 3D printer that can tell if the machine needs any type of repair, you should focus on which data is useful and how you would gather it to develop this plan.

SUB-OBJECTIVES

- At the end, the tunnel must not have water inside.
- Define the materials that are going to be used for the construction of the printer.
- Describe the way the printer will reload the constructing material, remembering this should be easy and practical.
- Describe the mechanism that enables the printer's mobility, it can be external or internal.
- Estimate how much weight the tunnel created can support, knowing the dimensions and the materials used, in this case the specific concrete that can be used underwater.
- Define how the maintenance and the repair (in case this is needed, especially considering the water) of the machine will be performed.

WORKING CONDITIONS

- The system should be designed to be as cost-effective as possible.
- The system should also be designed to reduce costs in the long run by minimising maintenance, repair, and operating costs.
- The system should use sustainable and recyclable materials and minimise the environmental impact of the processing method.
- The system must be scalable, meaning it can be adapted for the different conditions of the work to perform.
- The system should be designed to be non-invasive for the underwater environment.
- The system should ensure structural stability and meet the necessary strength and durability requirements for its intended use under the environment's conditions.
- The system should require minimal human interaction.
- The system must be capable of working at least at a depth of 150 metres.
- Transportability is also important, which means that the system should be easy to move from one location to another.

- The final solution must be realistic towards implementation methods and actual technologies.

USEFUL LINKS

- https://www.sciencedirect.com/topics/engineering/underwater-concrete
- https://homeguides.sfgate.com/concrete-cure-standing-water-81786.html
- https://www.structuralguide.com/underwater-concrete/
- https://en.wikipedia.org/wiki/Channel_Tunnel#:~:text=The%20tunnel%20consists%20of%20three,diameter%20service%20tunnel%20in%20between.
- https://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/mindmap_es.html

REQUIREMENTS AND DELIVERABLES

All the background information and research for your solution has to be delivered in a presentation in **.ppt format** through a google form **(open from 21:00 to 21:30h)**.

The layout, technologies and materials of your solution must also be referred to and justified. Any special needs that the solution requires to function must be specified too.

Also, a prototype of the solution is needed for the final evaluation. No need to make it completely functional but make sure it reflects the technologies used in your solution.

The prototype must be brought to the presentation. You can support your presentation on the prototype.

RESOURCES AND MATERIALS

You can make use of your personal laptop, to write the report and make the presentation. You have access to the internet and can consult all available sources.

Moreover, if you need to, you can ask for paper, pens, pencils, erasers, etc. to the Topic Team or an organiser.

The use of any type of specialised software must be firstly asked to the Topic Team.

Also, you are given the lists of materials you can use for your prototype.

GENERAL RULES

- Help from outside the team and the competition is strictly forbidden.
- Copying or taking ideas from another team's solution is strictly forbidden.
- Please respect the schedule. You are able to work on your task during the given time. The task was made to be solved during Working Hours written on the schedule.
- Clean your working space after the competition. Failure to do so will lead to a penalty.
- Any question regarding the task has to be asked to Topic Team members.
- Respect everyone around you: your team, other teams, organisers, the jury, faculty staff, etc.

PRESENTATION RULES

You will have **15 minutes to present** your solution so be sure to use your persuasiveness to make sure that the jury gets your solution and finds it viable to be

applied. You will only have access to the submitted presentation so be sure to rehearse your presentation beforehand so that everything goes smoothly. Not everyone has to speak during the presentation but make sure that the jury sees your team spirit as well!

You have a **5 second tolerance** window after the 8 minutes are finished and for **every extra second beyond the predetermined time of the presentation the penalty will be 0.1 points.**

The presentation will be completely cut after 1:15 extra minutes

After the presentation the jury will have **8 minutes to comment and question** your team, so make sure you answer concisely to clear any doubts the jury might have.

Note: **the presentation time given is the total time you will have to present both your tasks, use that time wisely.**

PENALTIES AND DISQUALIFICATION

- Any rule, requirement or deliverable deadline violation will lead to penalization.
- The extent of the penalization is up to the Topic Team/Jury.
- The penalty points will be subtracted from the team's final score.
- In some cases, if the violation is severe, the team may be disqualified.
- For every extra second beyond the predetermined time of the presentation the penalty will be 0.1 points.
- The use of any kind of AI tool (such as ChatGPT) is forbidden and can lead to disqualification.

EVALUATION CRITERIA

Presentation		10%	Quality of the presentation checks the guidelines, visual aids, adequate for an academic context, quality of the explanation...
Economic and energetic efficiency	Economic efficiency	5%	Minimising the costs and having a realistic budget
	Energetic efficiency	5%	The solution minimises the energy costs
Prototype		15%	Representative prototype: it is representative of the real product (scaled, realistic, adapted to chosen scenario...)
Innovation		20%	Find a new way, or reinvent old ones by making improvements, to solve a problem that fits the context of this problem. Innovation is not restricted to just one aspect, an ideal solution should innovate across the whole process and every aspect of the development of this project.
Check objectives	System to empty the tunnel	5%	At the end, the tunnel must not have water inside
	Environmentally friendly	5%	The system is friendly with the environment and the sea life
	Define the materials the system will need to be functional	5%	State the materials needed to build the system you are proposing
	Reloading mechanism	5%	Describe the way the printer will reload the constructing material, remembering this should be easy and practical
	Mobility system	5%	Describe the mechanism that enables the printer's mobility, it can be external or internal
	List the properties of this new tunnel	5%	Estimate how much weight can the tunnel created support, knowing the dimensions and the materials used, in this case the specific concrete that can be used underwater
	Maintenance functioning	5%	Define how the maintenance and the repair (in case this is needed, especially considering the water) of the machine will be perform
Systems distribution		10%	Shows the systems and methods used in your solution had been thoughtfully planned and used in an efficient way