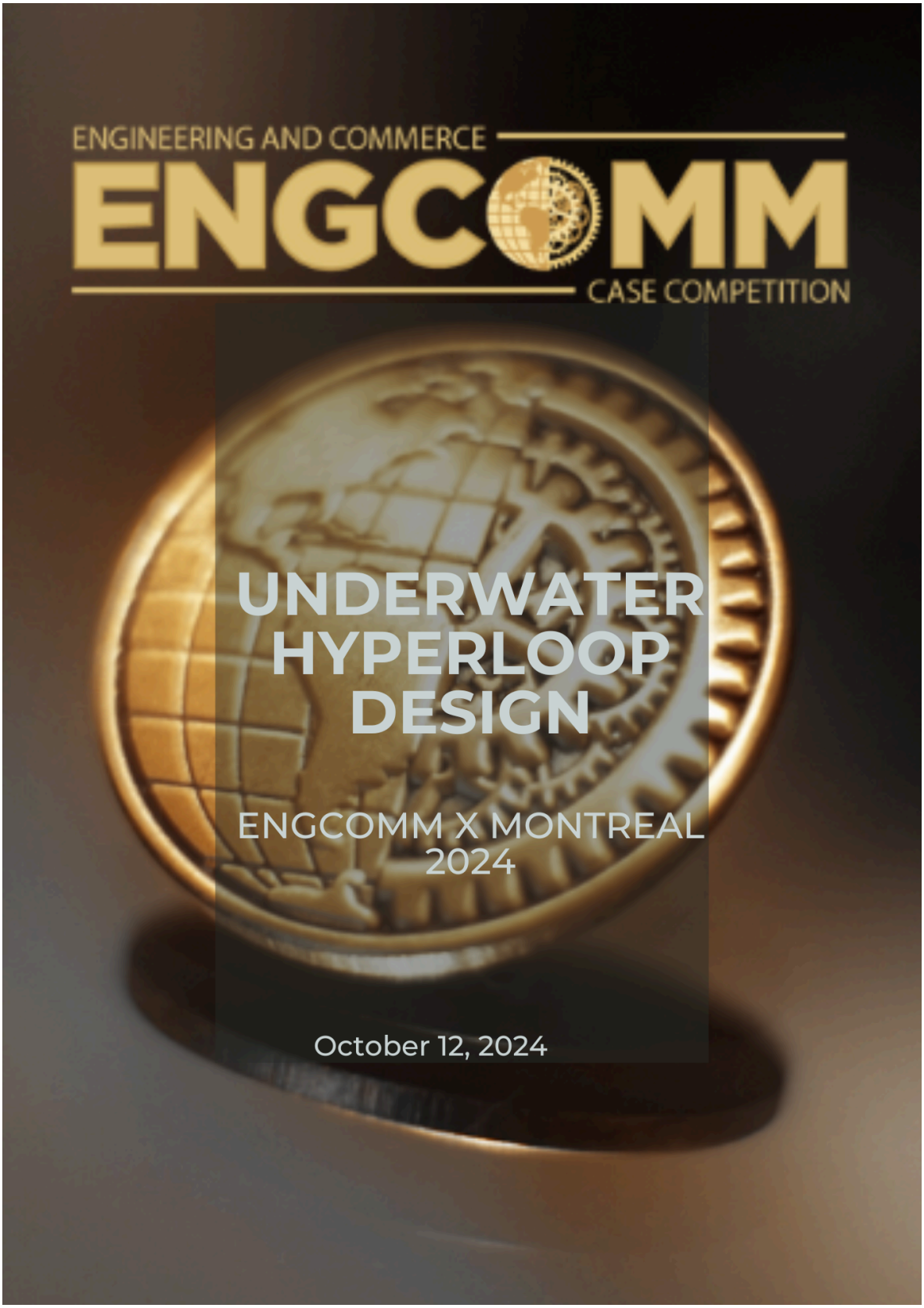

UNDERWATER HYPERLOOP DESIGN

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Underwater Hyperloop Design

Introduction

China, South Korea and Japan are leaders in bleeding edge technologies. In a historic shift in policy, the three countries are coming together to build a metaphorical and literal bridge to foster economic and trade growth between them.

In September 2011, the three countries initiated the "Trilateral Cooperation Secretariat" in Seoul. Trade chiefs from Japan, China and South Korea have agreed to promote negotiations on free trade and cooperation in the energy sector as well.

So far, negotiations amongst the three have eliminated tariffs on 90 percent of the goods traded between China and South Korea.

Seoul's trade ministry estimated this would boost China-South Korea trade to over $300 billion a year. Negotiations are also projected to lift South Korea's GDP by roughly 1 percent within the next ten years. China, meanwhile, is expected to see its GDP rise by 0.3 percent during the same time frame thanks to the FTA.

In 2023 only, Japan and South Korea contributed to 19.7% of total imports to China. In return, 16% of exported goods from China were imported to South Korea and Japan (see Appendix 1 for more info). The three countries have built a solid trade relationship such that in the past 4 years, they constantly showed up in each other's top 5 import/export annual reports.

To that end, a construction project to link the three countries together is being thoroughly planned. To initiate the project, the three countries have founded a new Asian Development Bank (ADB) with substantial capital, bonds and loan guarantees.

The trio recognizes that building such a bridge will be costly, but they believe that starting a new

chapter in their collective history will significantly improve trade and that the increase in trade will substantially grow their economies. They would support a project that would pay for itself in 50 years.

Interestingly, in the USA it has now been a few years since some companies unveiled their plans to revolutionize transportation mechanisms. One of such emerging ideas titled “Hyperloop” - introduced by Musk in 2013- envisions a radical and ambitious high-speed transit line that promises a travel time of 35 minutes from Los Angeles to San Francisco.

Hyperloop transport system, as described by Musk, houses people in a pressurized capsule riding on a cushion of air, and may use a number of propulsion systems such as magnetic levitation, or air pressure like that in an air hockey table.

This has attracted lots of attention in many parts of the world. *Hyperloop Technologies* and *Rival Hyperloop Transportation Technologies* were both vying to build the world’s first Hyperloops by 2020 with one building a test track in Las Vegas and one hoping to have a mini five-mile Hyperloop up and running in California by 2020.

In addition, Hyperloop One, a Los Angeles-based startup started developing the technology for a Hyperloop that can travel underwater.

In Europe, the Norwegian government is investigating a project that could see a number of floating underwater tunnels built across the country and running through the nation's various fjords.

Now is the time for Japan, China and South Korea to cultivate the idea and see if an underwater Hyperloop can be a viable solution for their economic and trade needs.

Objective

The goal is to transform current shipping practices in the East China Sea between Shanghai (China), Busan (South Korea), and **a port of your interest in Japan.** You are hired as a consultant by the three governments, funding and loan guarantees will be provided by the ADB. You must design a Hyperloop that will connect and permit shipping amongst these three ports. To cross the sea, this loop may take advantage of the buoyancy force to be positioned at a certain depth below the surface of the water.

Comparing to current transportation alternatives, **your design must deliver at least 5 out of these 7 qualities:**

1. Safer
2. Faster
3. Lower cost
4. Energy efficiency
5. Environmental impact
6. Resistant to Natural forces (weather, earthquakes)
7. Impact on the economy and trade

A plausible design must identify and account for numerous challenges that occur during construction of an underwater structure, a Hyperloop in this case.

Another concern is the straightness of the Hyperloop path. At high speeds, even a gentle curve jerks cargo to the side. In physics, it's known as lateral G-force. Your design must consider a balance between the curviness of Hyperloop and traveling speed and an acceptable level of G force for the cargo.

Current Hyperloop designs include a magnetic linear accelerator based on a Rand Corporation patent from 1978. For the purpose of this case, it is favorable to use more recent technologies.

Engineering Criteria:

- Extensive design specifications
    - Dimensions - shape - material choice - structure strength - resistance to pressure - Degree of flexibility of the loop
    - Loop depth
    - Strength: How your design responds to current forces.
    - Buoyancy of the loop.
    - Medium inside the loop and how it is maintained.
    - Overcoming the Kantrowitz Limit.
    - Reliability of the system and related FMEA analysis
    - Shipping/transportation system used inside the loop.

Business Criteria:

- Provide a cost benefit analysis considering real-world scenario shipping practices and ensure your model is profitable within 50 years (positive ROI, tax revenue).
- Provide a 50-year budget estimate (total cost).
- Describe the impact on GDP.
- Provide a high-level maintenance strategy based on reliability of the system and estimate the costs.
- What industries/potential markets can benefit from your design and what is your estimate of the potential additional revenue?

APPENDIX 1- Import/Export Stats*

Year: 2023	Import From**		
	China	Japan	South Korea
China	-	$ 160.48	$ 161.74
Japan	$ 168.06	-	$ 30.24
South Korea	$ 90.2	$ 54.71	-

Year: 2023	Export To**		
	China	Japan	South Korea
China	-	$ 157	$ 149
Japan	$ 126.44	-	$ 46.8
South Korea	$ 155.79	$ 30.61	-

*Source: http://www.trademap.org/ & https://tradingeconomics.com
** Unit : USD Billion

While using tables above, please note that it is sometimes assumed that corresponding export and import data between partner countries should be consistent. Meaning, the exports from Country A to B should be equal to the imports of Country B from A, after taking into account the insurance and freight costs under the generally observed case that Country B imports are valued on a cost, insurance, freight (c.i.f.) basis. The DOTS estimation system uses this assumption in cases where one partner has not reported data.

However, notwithstanding the inclusion of insurance and freight in imports c.i.f., it should be noted that there are several complications that can cause inconsistency between exports to a partner and the partner's recorded imports f.o.b., or between imports free on board (f.o.b.) from a partner and the partner's recorded exports.

The principal reasons for inconsistent statistics on destination and origin for a given shipment are differences in:

1) Classification concepts and detail
2) Time of recording
3) Valuation
4) Coverage
5) Processing errors

DOTS Link: http://data.imf.org/?sk=9D6028D4-F14A-464C-A2F2-59B2CD424B85