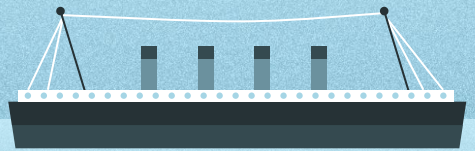
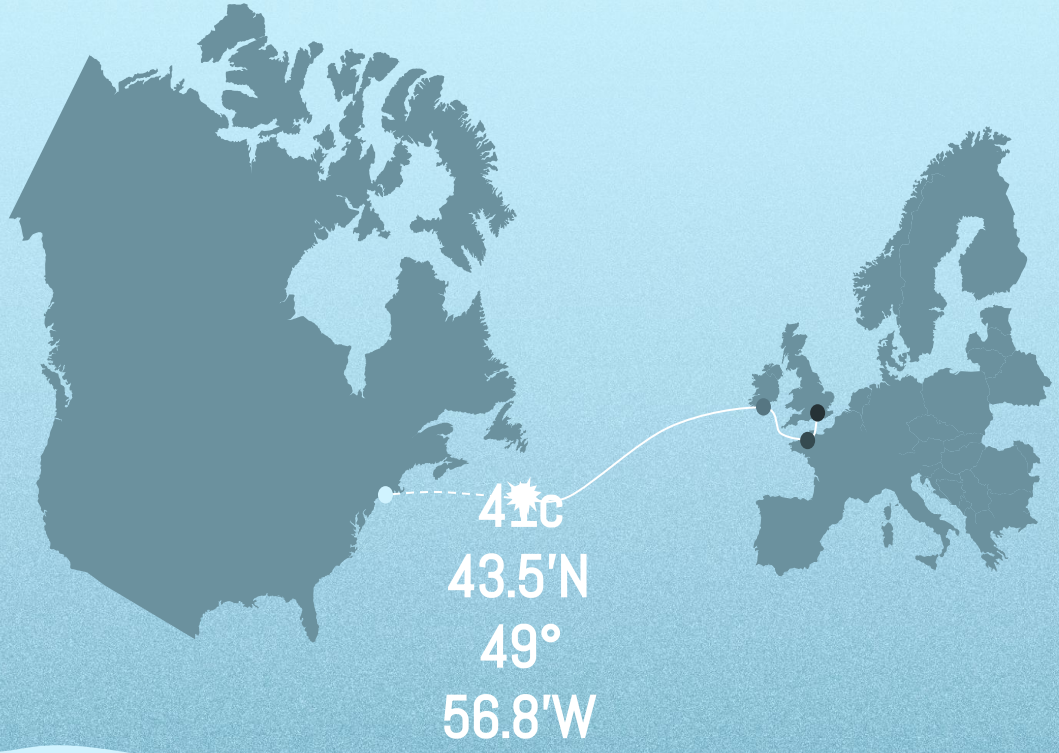
TITANIC

Thema Green
Selin Alptekin,
Marly Saravia
Sarah Soliman



— Titanic maiden voyage —



Titanic, also known as Royal Mail Ship (RMS), was a British luxury passenger ship that sank on April 14–15, 1912, while on its maiden voyage from Southampton, England, to New York City, USA. Of the 2,200 persons on board, more than 1,500 were taken to the bottom. Titanic was the largest cruise ship in operation in the day.

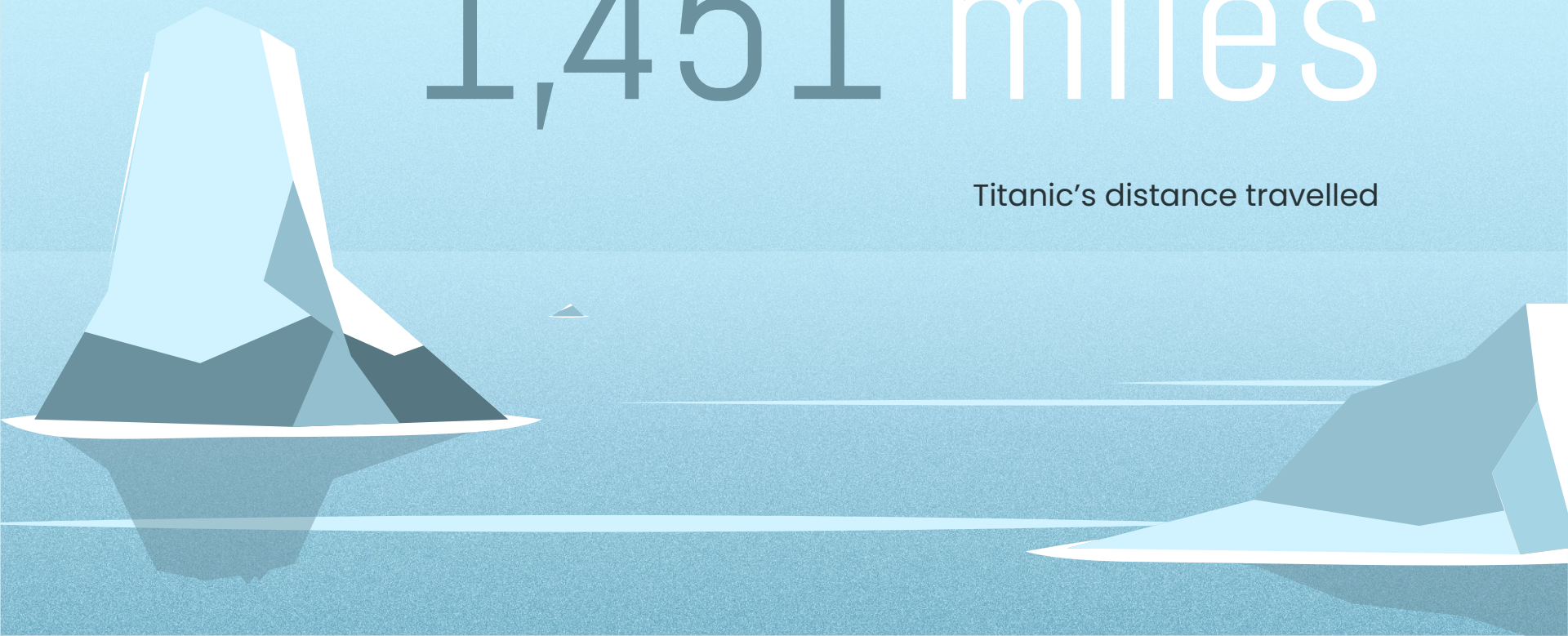
Description of the accident

Although it was an iceberg that sunk the "unsinkable" Titanic, there were other factors involved in the tragedy that happened 100 years ago.

The only means of seeing icebergs at the time was through lookouts, and in the dark the ship was not quick enough to avoid the collision. The ship's steel plates were pierced by the ice as it crashed down its starboard side, flooding six compartments.

1,451 miles

Titanic’s distance travelled

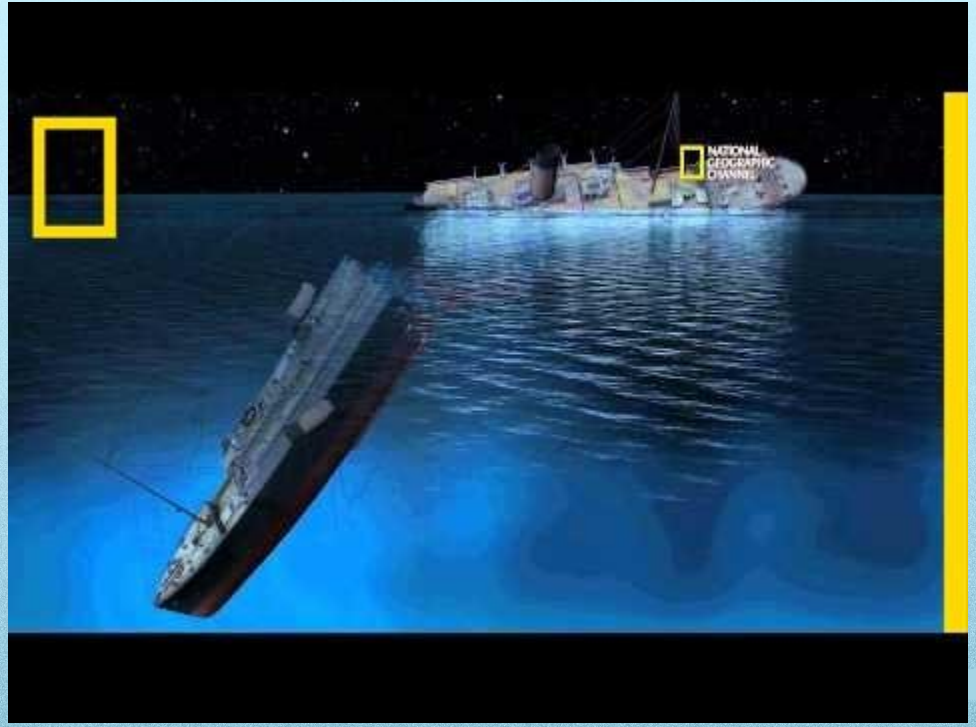



882 ft
Titanic’s length
1,517
Lives were lost
28°F
The ocean’s temperature

Wreck of the accident

After looking for it for years, when oceanographer Robert Ballard finally found the ship's wreckage 2.5 miles below on the ocean floor in 1985, he revealed that it had split in two before sinking.

Description of the accident



Why did the accident happen?

- Climate caused more icebergs
- Tides sent icebergs southward
- The ship was going too fast
- Iceberg warnings went unheeded
- The binoculars were locked up
- The steersman took a wrong turn
- Reverse thrust reduced the ship's maneuverability
- The iron rivets were too weak
- There were too few lifeboats

— Contributing Factors —

Equipment Design

Physical Environment

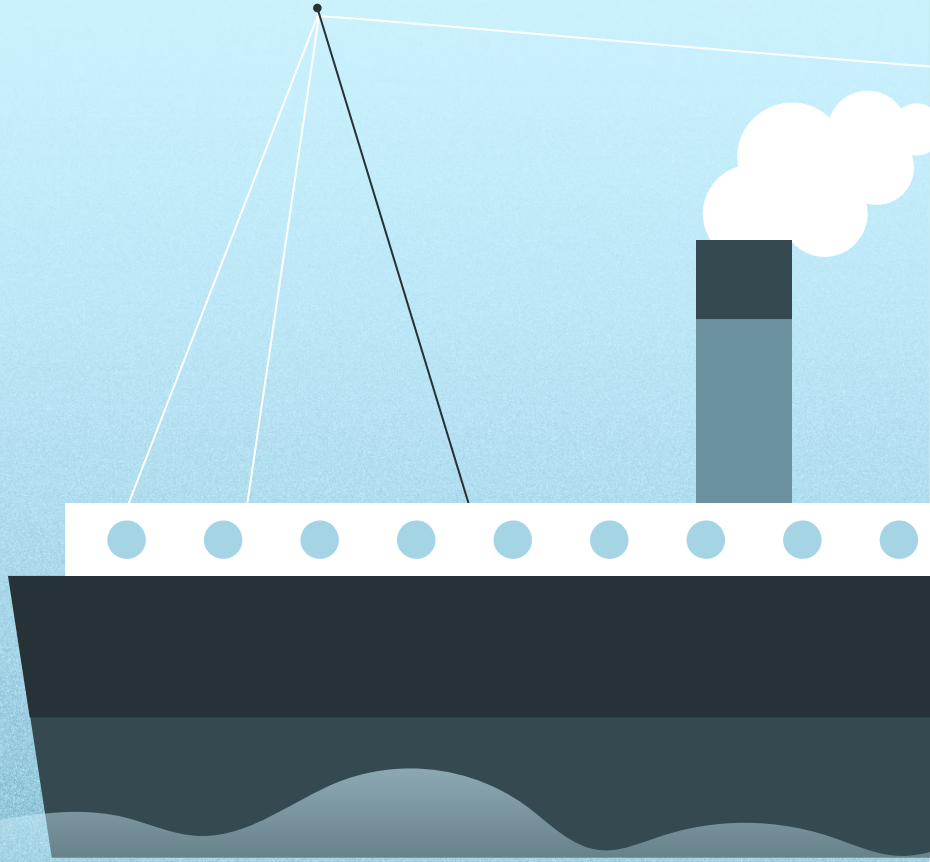
Workers

Management

— Equipment Design —

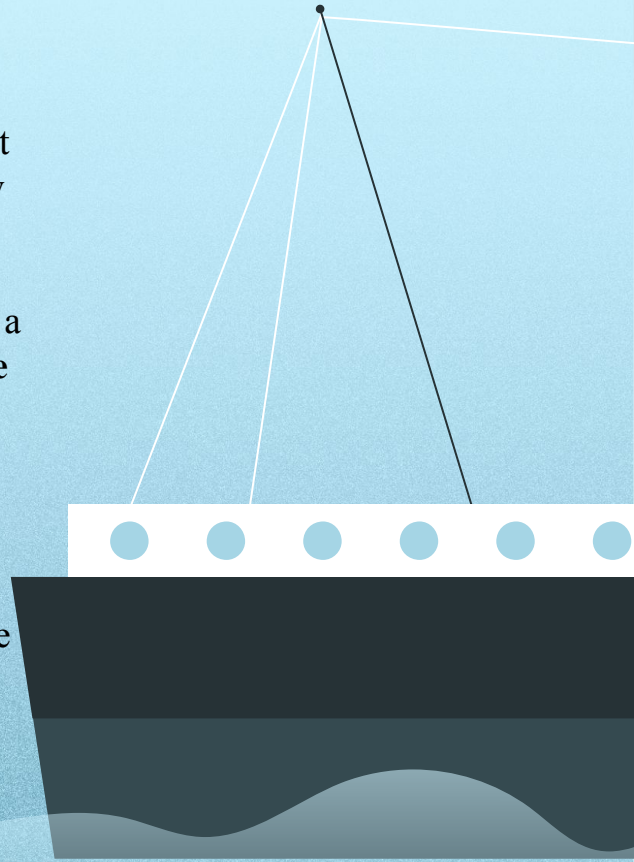
- **Portholes were left open.**

Passengers of the titanic became aware of the impending collision with the iceberg and had the **natural reaction** of wanting to get a closer look. They **opened their portholes** (cabin windows) located in their rooms and upon fleeing from the incident, they **left these windows open**. This minor mistake was made by a large number of passengers and as a result, **the cost came out the have a doubling effect on the sinking rate of the ship.**



— Equipment Design (Cont.) —

1. High Sulphur Levels:
   - When the Titanic collided with the iceberg, the hull steel and the wrought iron rivets **failed because of brittle fracture**, which occurs at **extremely high speeds** and is caused by low temperature, high impact loading, and **high sulphur content.**
   - "Although **most** of the steel used for shipbuilding in the early 1900s had a relatively high sulphur content, the **Titanic's steel was high even for the times** [Hill, 1996]."
1. High Oxygen Content:
   - **Most modern steels** would need to be **chilled below -60°C** before they exhibited similar behavior to the Titanic. As for this ship, **Titanic's steel reached 25 to 35°C** High oxygen content **lead to an increased ductile-to-brittle transition temperature.** This made it more susceptible to the aforementioned brittle fracture.



— Physical Environment —

1. **Large icebergs**

The **large icebergs** were related to **inclement weather** and a **surplus of iceberg numbers in 1912** caused by **freezing gusts of wind** migrating from the northeast of Canada to the western Atlantic ocean, which was unusual at the time.

According to survivors from the accident, the iceberg that the Titanic collided with was roughly **122 meters long (400.3 feet long)** and between **15 to 31 meters high (49 to 102 feet high)** (Bigg & Wilton, 2014).

Bigg, G. R., & Wilton, D. J. (2014). Iceberg risk in the Titanic year of 1912: Was it exceptional? *Weather*, *69*(4), 100–104. https://doi.org/10.1002/wea.2238

— Physical Environment —

2. Mirages and Hazy Horizons

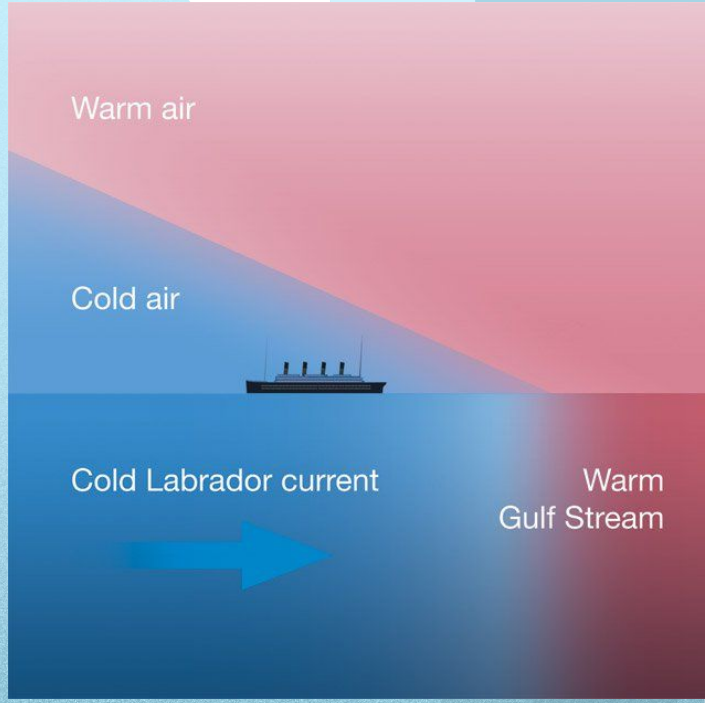
It is theorized that a phenomenon known as super refraction, which is, in short, an optical illusion or mirage caused by the bending of light, caused just the very top of the iceberg to be visible and appear further away.

The Titanic crew's vision was also compromised by the haze, which may have caused the super refraction to appear worse and amplified the false horizon.

— Physical Environment —

https://www.smithsonianmag.com/science-nature/did-the-titanic-s
ause-of-an-optical-illusion-102040309/

Mirages and Hazy Horizons



— Physical Environment —

— Management —

When the captain was informed of an ice field ahead, he **did not reduce the speed** of Titanic.

The owner was subtly **pressuring the captain to break the previous speed record.**

A scheduled **lifeboat drill was postponed** by the captain.

The iceberg was initially noticed by a skilled seaman at 500 yards. The seaman never found the binoculars, even though visibility should have allowed him to see the iceberg at a distance of at least 1000 yards. (80 years later) There had been no shakedown cruise, so **no one directed the seaman to where the binoculars were**.

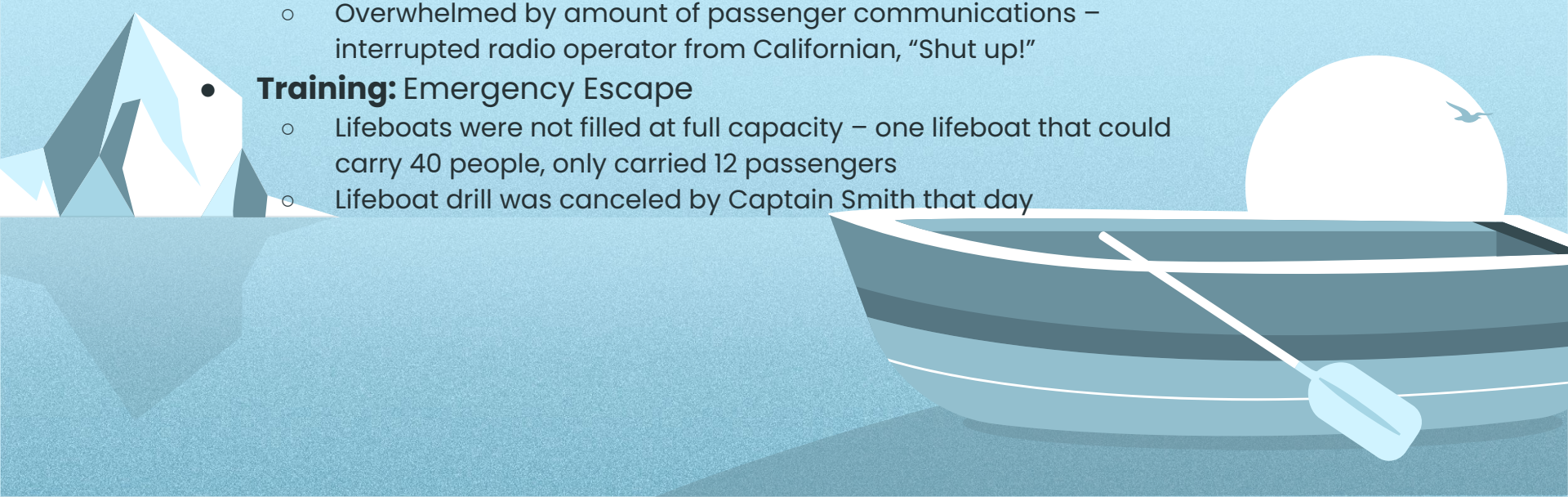
— Management —

Another sailor immediately put the **engines in reverse after hearing the iceberg warning**. He followed his training. We now understand that it would have been preferable for him to accelerate the engines and circumnavigate the iceberg. As he retreated, he exposed the starboard side of the Titanic to the iceberg for a longer period of time.

Knowing that the regulations might pass before the ship would sail, the Titanic's designers planned double davits to accommodate the extra lifeboats. Sketches for these double davits were found after the ship sank. However, **owner decided not to add the extra lifeboats** since they would have cut down on the space on the promenade deck.

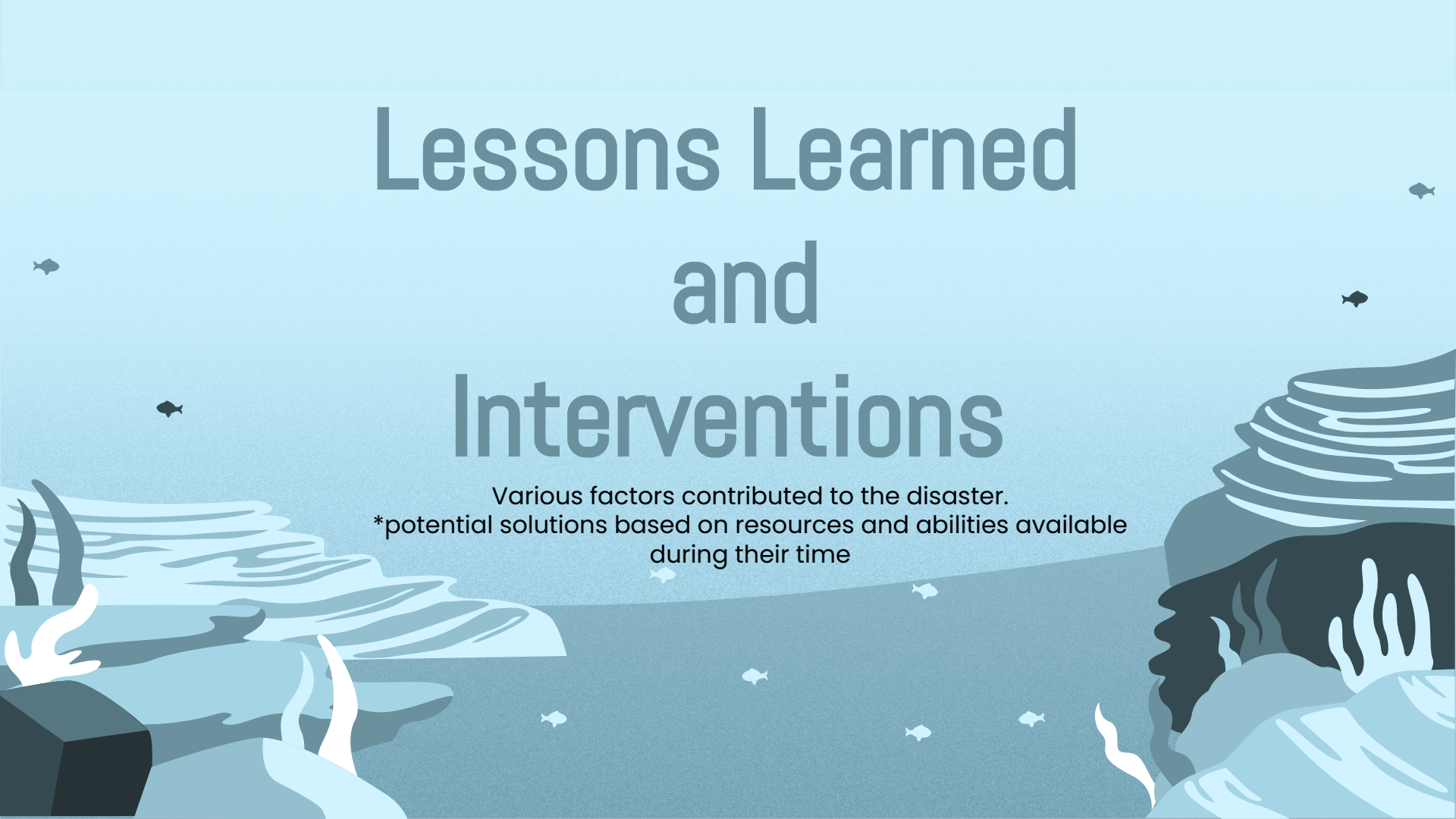
—Workers —

- **Experience**: Captain Smith
  - Did not reduce speed and assumed there was good visibility (overconfidence)
- **Personality:** Wireless Officer Phillips
  - Placed priority on personal messages for Lady Astor
  - Overwhelmed by amount of passenger communications – interrupted radio operator from Californian, “Shut up!”
- **Training:** Emergency Escape
  - Lifeboats were not filled at full capacity – one lifeboat that could carry 40 people, only carried 12 passengers
  - Lifeboat drill was canceled by Captain Smith that day

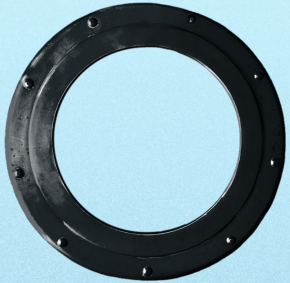


Lessons Learned and Interventions

Various factors contributed to the disaster.
*potential solutions based on resources and abilities available during their time



— Equipment Design —

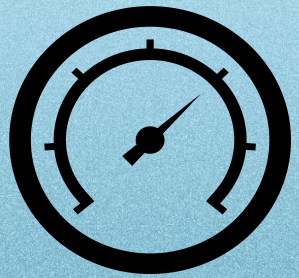


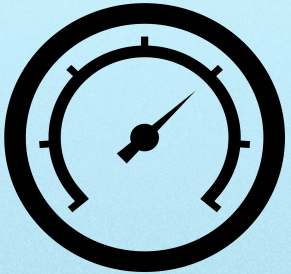
Portholes Left Open

The passengers, upon seeing the collision, fled; leaving their portholes open. The result was a sinking rate increase by two times. Solution? **Emergency protocol.**

Extreme Sulphur Levels

The ship suffered from brittle fracture, which was brought on by higher than normal sulphur levels and worsened by high speeds. Solution? **Better material** (i.e. steel with lower sulphur content.)





High Oxygen Levels

The temperatures of the ship's steel were below the standard temperature of other ships. This was due to the type of steel used and resulted in the steel being more susceptible to becoming brittle. Solution? **Better material** (i.e. lower reactive metal)

— Management —

- Risk management was not adequate
  - Titanic could have been constructed with a double hull.

- The boat was **not ready** for the maiden voyage.
  - The required drill was postponed therefore the crew was not ready for a crisis moment. The ship could have waited for the voyage until all inspections were complete. If every crew member had understood what to do, an estimated 500 lives could have been saved.

- The iceberg was not noticed until 500 yards.
  - The seaman never found the binoculars, even though visibility should have allowed him to see the iceberg at a distance of at least 1000 yards. (80 years later) There had been **no shakedown cruise, so no one directed the seaman to where the binoculars were.**

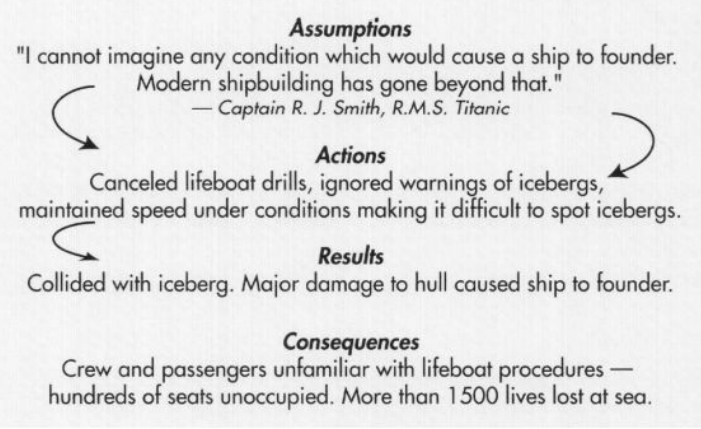
- Main focus should have been the safety of the passengers.
  - The subtle **pressure** from the owner directly or indirectly might have affected the decision of the captain before or after detecting the iceberg.

— Management (Cont.) —

- Captain was **not paying attention** to communications and warnings.
    - The captain had the option of slowing down or coming to a complete stop and waiting for daylight in response to the multiple ice warnings the ship received. Management could have implemented a comprehensive guide for such weather conditions.
- The officer on duty had a choice in how to respond after spotting the iceberg in an effort to prevent a collision.
    - Maintaining full speed was another option for avoiding the ice cube. Officer tried to fully swing the ship to the left after ordering the engines to go into reverse and turning the bow toward the iceberg. He seriously reduced the rudder's capacity to turn. The margin manoeuvre failed to prevent a collision with submerged iceberg pieces that lasted seven seconds and scraped portions of the Titanic's frontal starboard hull.
- The budget cuts **did not prioritize safety.**
    - Priority was improperly allocated. The budget cuts could have been applied to non-safety aspects, such as the size of the ship.

— Workers —

Systems Approach



- System: interdependent components that work together and accomplish the aim of itself
- Upon collision, focused system on improvement
  - Prior to sailing, system was centered on assumptions + generalizations
  - All protocols developed under false assumption
- Should have utilized a systems perspective based on passenger safety

— Workers —

High Detection Sensitivity Level (DSL)

- Most employees followed protocol and procedure from higher-ups, who are more likely to participate in latent error
  - Captain Smith and Bruce Ismay
- An organizational culture where any inconsistency or error is reported may have addressed this dynamic
- Could have also held employees accountable over one another
- Higher reporting rates lead to a higher DSL to aid in error prevention
  - Amount of information goes up, risk goes down

Conclusion

Using the sliced cheese framework, each step from start (ship preparation/building, travel planning, policy placement, worker training) to finish (Emergency operations, lifeboat access,, worker communications,, environmental obstacles). Just like a building, if it is built upon a weak foundation, it is bound to topple eventually. The calamity that occurred on and to the titanic was a multi-step process in which a mistake was made each step of the way leading to a mass casualty incident that could have been avoided with things as simple as better planning, cost delegation towards safety measures, extreme weather protocol, etc. This speaks to the significance of human factors specialists throughout each step of the design and product creation process.

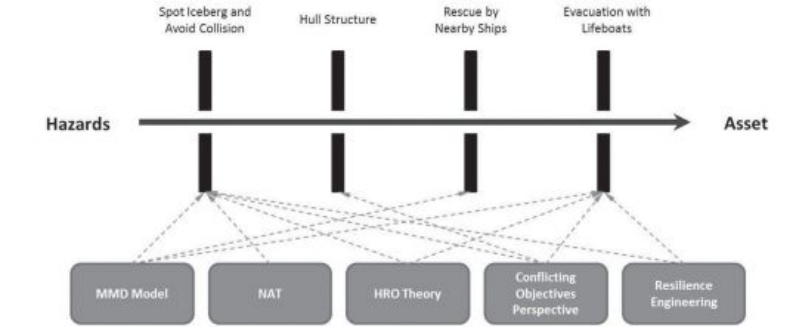


Figure 3. Integrated accident model and Titanic accident.

Resources

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Thanks!

Questions? Comments?
Concerns?