



Opyrchal Leszek,  0000-0001-7585-843X
Military University of Technology, Warsaw, Poland, leszek.opyrchal@wat.edu.pl
Bak Aleksandra,  0000-0002-5340-7790
Military University of Technology, Warsaw, Poland, aleksandra.bak@wat.edu.pl

Sequence of events and probability of sinking of German battleship *Bismarck* (short communication)

Keywords

battleship *Bismarck*, event tree, second world war

Abstract

'Rheinübung' was one of the most important war operations of the Second World War. It was carried out in May 1941. The German battleships *Bismarck* and *Prinz Eugen* were to sail to the Atlantic Ocean and attack convoys with supplies from the United States to Great Britain in May 1941. The breaking of supplies would force Britain to surrender. The mission was unsuccessful. The largest battleship of the world, *Bismarck*, was sunk. This short communication discusses the sequence of events that led to the sinking of the ship. The calculations show that the probability of sinking is 0.00137. This is one hundred times less than the probability of a fatal accident in deep-sea fishing, which is 0.104.

1. Introduction

Success and failure – these are two concepts depending on who and when is evaluating. The same event can be rated the same time as a success and another time as a failure. This principle is well reflected by the song of the Polish band Skaldowie: “You told me you didn't love me, when I offered you marriage. I thought then, failure, and today I think what a success” (Zieliński & Młynarski, 1970).

Likewise, the success of one side may be the failure of the other, and vice versa. Such a situation takes place especially during hostilities. The victory of one of the warring sides is the failure of the other. This case is discussed in this article. The destruction and sinking of the German battleship *Bismarck* was a success for the British Royal Navy and a failure for Germany.

This article presents the event tree for the destruction of the German battleship *Bismarck* during the World War II. The assessment will be carried out from the German point of view, i.e. the sinking of the battleship *Bismarck* was a failure.

The first subsection discusses the tasks of the *Bismarck* military mission, followed by a brief description of the ship. The next subsection concerns the course of the voyage, taking into account the events that have a significant impact on the sinking of the ship. Finally, is presented the event tree with an assessment of the probability.

The course of events was taken from the book by (Skiwot & Prusinowska, 1999).

2. *Bismarck*'s mission

2.1. Military goals

During World War II, the defence of Great Britain against fascist Germany was possible only due to supply from the United States delivered by sea. To defeat Great Britain, these supply had to be interrupted. For this, British ships were first attacked with submarines. This made it necessary to combine transport ships into large convoys. In order to liquidate the convoys, it was decided to send large, fast battleships to the Atlantic, whose task was to surround and liquidate convoys. For this purpose ‘Operation Berlin’ was conducted from

January 22 to March 22, 1941 by the battleships *Scharnhorst* and *Gneisenau*, in which 22 British ships were sunk.

The German intended to repeat this operation with increased forces. It was given the code name 'Rheinübung'. The following ships were to take part in it: battleships *Bismarck*, *Tirpitz*, *Scharnhorst*, *Gneisenau*, *Admiral Hipper*, *Admiral Scheer* and heavy cruiser *Prinz Eugen*. Unfortunately, battleships *Gneisenau* and *Scharnhorst* were damaged and needed heavy repairs and the battleship *Tirpitz* was not finished yet. It is not known why the battleships *Admiral Hipper* and *Admiral Scheer* did not take part in the operation. Therefore only two ships were dispatched to carry out Operation 'Rheinübung': Battleship *Bismarck* and heavy cruiser *Prinz Eugen*.

2.2. Battleship *Bismarck*

The *Bismarck* (Figure 1) was the largest battleships ever built. Its standard displacement was: 45451 tons, full displacement: 49406 t, length 250.50 m, width 36 m and draft 9.33 m (max. 10.55 m). Its weapons included: 4 twin guns 380 mm, 6 twin guns 150 mm, 8 twin guns anti-aircraft 105 mm, 8 twin anti-aircraft guns 37 mm and 12 anti-aircraft 20 mm. The battleship *Bismarck* was able to reach a speed of 30 knots, that is approximately 55.5 km/h.



Figure 1. The battleship *Bismarck*.

Source: https://upload.wikimedia.org/wikipedia/commons/d/d1/Early_Bismarck.jpg (accessed 13.04.2022).

2.3. First and last cruise of battleship *Bismarck*

The plan of Rheinübung's operation was as follows. Because Gdynia (Gotenhafen) was the port of *Bismarck*, the battleship was to sail at night and

cross the Danish Straits to the North Sea. In the Norwegian fjord, refuel and then, together with the heavy cruiser *Prinz Eugen*, they was to circle Great Britain from the north and through the located between Iceland and Greenland Denmark Strait get to the Atlantic Ocean, where battleship and heavy cruiser was to destroy the convoys sailing with supplies to England. After completing the mission, ships was to return to France.

Bismarck left Gdynia on May 19, 1941, accompanied by escort ships, the group of ships was spotted in Kattegat on the afternoon of May 20. British intelligence was notified of this fact and began an aerial search for *Bismarck*. On May 21 in the morning, German ships anchored in the fjord near Bergen to refuel, where they were spotted by a Royal Forces reconnaissance plane. Since the commander of *Bismarck* was afraid of the bombing, they would decide to leave immediately, despite the fact that only heavy cruiser *Prinz Eugen* had refuelled. Due to bad weather only on May 22, the British discovered that *Bismarck* is no longer in the fjords near Bergen. It was supposed that German ships would be sailing through the Denmark Strait, so British ships were sent there. The flagship cruiser *Hood*, the battleship *Prince of Wales*, the heavy cruisers *Suffolk* and *Norfolk* set out to meet the German ships. On May 25, at dawn, there was a fight between British and German ships (Figure 2).



Figure 2. The battleship *Bismarck*. Naval battle.

Source: Bundesarchiv Bild_146-1984-055-13.

Cruiser Hood was hit by a *Bismarck* salvo and sank within two minutes. The battleship *Prince of Wales* was seriously damaged and withdrew from the fight. But also *Bismarck* was hit in the bow and the fuel tank was damaged. Fuel was partially

contaminated with seawater and leaked, leaving a trail behind the battleship. The ship needed to be repaired.

There were two options: go back to Norway or sail to a port in France. It was 600 miles closer to Norway. Since the *Bismarck* was not fully refuelled, it had to sail slower, so as not to run out of fuel. Both German ships split up. *Prinz Eugen* was to continue his mission on the Atlantic Ocean and *Bismarck* would go to French port Saint Nazaire. The captain of the *Bismarck* ship notified the Berlin command via radio about the fact that the mission 'Rheinübung' was interrupted. The radio signal received by British intelligence revealed the location of the ship. *Bismarck* was located on May 26. The manhunt has begun. The torpedo attack was carried out on the *Swordfish* aircraft at 20:47. They were slow-flying, outdated, two-winged planes (Figure 3).



Figure 3. Allan Wilson, Aircraft Swordfish
Source: [https://commons.wikimedia.org/wiki/File:Fairey_Swordfish_II_LS326_L2_\(G-AJVH\)_\(7297367482\).jpg](https://commons.wikimedia.org/wiki/File:Fairey_Swordfish_II_LS326_L2_(G-AJVH)_(7297367482).jpg) (accessed 13.04.2022).

They flew slower than modern airplanes, and therefore the missiles of the German anti-aircraft artillery exploded too early. Not a single plane was knocked down. One of the torpedoes hit *Bismarck's* rudder and prevented him from going in the desired direction.

The battleship *Bismarck* was sunk in the morning of May 20.

The route of the first and last voyage of the battleship is shown in Figure 4.

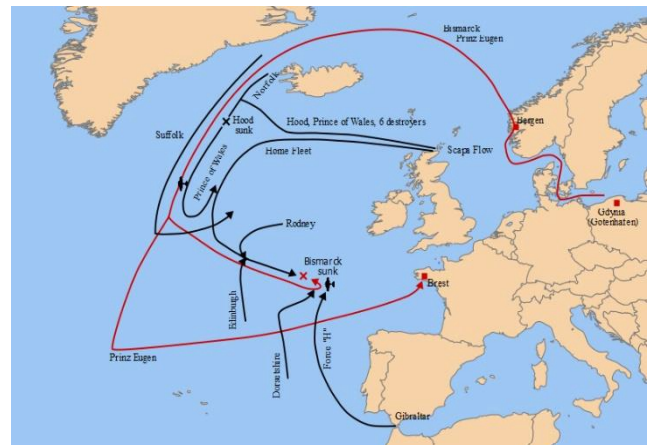


Figure 4. The cruise route of the battleship *Bismarck* and the cruiser *Prinz Eugen*. The cross marks the site of the sinking of *Bismarck* on May 27, 1941. Source: https://commons.wikimedia.org/wiki/File:Map_Rheinuebung (accessed 13.04.2022).

3. Probability assessment of *Bismarck* sinking

3.1. Word estimative probability

Words estimative probability was assumed in Table 1 by Kent (1966).

Table 1. Words estimative probability by Kent (1966)

Word	Probability
Certain	1
Almost certain	0.93 ± 0.06
Probable	0.75 ± 0.12
Chances about even	0.50 ± 0.10
Probably not	0.30 ± 0.10
Almost certainly not	0.07 ± 0.05
Impossible	0

3.2. Events that influenced sinking of *Bismarck*

The sequence of events that led to the sinking of the battleship *Bismarck* with the words estimative probability is presented below.

1. *Bismarck* and *Prinz Eugen* leave the port of Gotenhafen (Gdynia) without the other four ships – *chances about even*.
2. Unmasking the operation by British intelligence – *chances about even*.
3. Departure to sea from Grimstadfjord without refueling *Bismarck* tanks after the localization of the ship by the British – *almost certain*.

4. *Bismarck* is damaged during a battle with *Hood Cruiser* – chances about even.
5. *Bismarck*'s commander decides to sail to France instead of returning to Norway – *probable*.
6. Revealing your position by establishing radio communication with Berlin – *probable*.
7. Attack on *Bismarck* with obsolete planes *Swordfish* – *probably not*.
8. Rudder lock due to being hit by a torpedo – *almost certainly not*.
9. Sinking of *Bismarck* – *certain*.

3.3. Calculation of probability with uncertainty

We calculate the probability after assigning the numerical values p_i to the verbal probability. The total probability P is the product of the probabilities p_i of the component events.

$$P = 0.07 \cdot 0.3 \cdot 0.5^3 \cdot 0.75^2 \cdot 0.93 \cdot 1 = 0.00137. \quad (1)$$

Uncertainty ΔP of the probability P can be calculated by the well known logarithmic derivative (e.g. Piotrowski, 1976) method and is:

$$\Delta P = 1,37 \cdot 10^{-3} \left[\frac{0.05}{0.07} + \frac{0.1}{0.3} + 3 \left(\frac{0.1}{0.5} \right) + 2 \left(\frac{0.12}{0.75} \right) + \frac{0.06}{0.93} \right] = 0.003. \quad (2)$$

The obtained result can be written as:

$$P = 0.00137 \pm 0.003. \quad (3)$$

This means that the calculated probability P is in the range [0, 0.0044] with the confidence level 68%.

4. Conclusion

It would seem that the Rheinübung mission was doomed to failure. However, the probability of the ship sinking is low, and is $1.37 \cdot 10^{-3}$. For example, the probability of losing a life for the following occupations are presented in Table 2 (Safety and Health, 1977).

Table 2. Occupations with largest probability of loss of life by Safety and Health (1966)

Occupation	Probability
Fishers	$104 \cdot 10^{-3}$
Timber cutters	$101 \cdot 10^{-3}$
Airplane pilots	$97 \cdot 10^{-3}$
Structural metal workers	$64 \cdot 10^{-3}$
Taxi cab drivers	$46 \cdot 10^{-3}$
Construction labourers	$39 \cdot 10^{-3}$
Roofers	$29 \cdot 10^{-3}$

Thus, the probability of the battleship *Bismarck* sinking was not so great. It is a hundred times less likely than a fatal accident in deep-sea fishing.

It is somewhat surprising that the error in the estimation of the probability of *Bismarck* sinking is three times smaller than the probability itself. This is due to the large error range of 71% in the word estimative probability assessment.

Comparing the result obtained with the probabilities of other defeats due to warfare is very difficult, as similar calculations are not published. It is possible that the results of the calculations are classified, just as Kent's (1964) work on word estimative probability assessment was classified until recently.

References

- Kent, S. 1964. Words of estimative probability, *Central Intelligence Agency*, 3-9-27, 49-65. <https://dp.la/item/083a07cc8f855b93fd883db708290a09> accessed 15.04.2022.
- Piotrowski, J. 1976. *Podstawy metrologii*. PWN, Warszawa.
- Safety and Health. 1977. Dangerous jobs, <https://www.bls.gov/iif/oshwc/cfar0020.pdf> accessed 15.04.2022.
- Skiwot, M. & Prusinowska, E.T. 1999. *Operacja Rheinübung. Polowanie na Bismarcka (Operation 'Rheinübung'. The Hunt for Bismarck)*. AJ-Press, Gdańsk.
- Zieliński, A. (music) & Młynarski, W. (lyrics). 1970 on the long play: *Od wschodu do zachodu słońca (From sunrise to sunset)*.