An Analytical Approach to the Question of a Clock Change

by Samuel Halpern

One of the ongoing arguments that continues to be brought up is the question of whether or not clocks on *Titanic* were put back some time before the accident took place Sunday night, April 14, 1912. Some of the deck crew, awakened by the accident at 11:40 p.m. ship's time, thought that it was close to the time that they were due to take their watch on deck, which would be at 12 o'clock. Despite Boatswain's Mate Albert Haines, who was awake and on duty at the time, testifying that "The right time, without putting the clock back, was 20 minutes to 12," there are some that try to argue that a 24 minute clock adjustment had already taken place, and the time of the accident on an unadjusted clock still keeping April 14th time would have been 4 minutes past 12.

The underlying question that would resolve this issue is the run time from noon Sunday to the time of the accident. If the run time from noon to the time of the accident was 11 hours 40 minutes, then no clock change had yet taken place, and the time of collision was 11:40 p.m. in *unadjusted hours*. If the run time was more than 12 hours, then there was a clock change of some 23 or 24 minutes, and the time of collision was 11:40 p.m. in *adjusted hours*. It really is that simple.

So how do we determine the actual run time from the available evidence that does not have to rely on subjective estimates such as time intervals or other measures that people may have perceived? The answer is to take an analytical approach to the problem using the taffrail log mileage data offered by quartermasters George Rowe and Robert Hichens at the inquiries.

The taffrail log measures distance traveled through the water, not distance-made-good. More importantly, the ship's speed through the water over a given period of time is independent of the speed of the body of water that the ship is moving upon. I know that some people have argued that taffrail log mileage data should not be relied upon because the log itself may not provide a true measure of the actual distance traveled. But there are ways to remove this accuracy factor from the overall equation, as we shall soon see. However, it should be noted that the measured 260 log miles taken by QM Rowe at the time of the accident is only 2 miles greater than the 258 mile distance-made-good that is measured from *Titanic*'s noontime position to her final stopping point just north of the wreck site.[1] If there were inaccuracies in the log mileage, it obviously wasn't very much.

To begin with, everyone knows that speed is nothing more than a measure of the distance traveled divided by the time traveled. The speed of a steam vessel through the water is a function of the revolutions carried on her engines. We were told that *Titanic* was carrying an average of about 75 revolutions per minute on her reciprocating engines since noon Saturday, and from Sunday afternoon up until the time of the accident late Sunday night, we have strong evidence that she was carrying 75 to 76 revolutions per minute.[2] That being the case, her speed through the water, thus her distance traveled through the water over a specified period of time, would have remained more or less about the same all day Sunday, with variations of about 1% at most.[3] As *Titanic*'s Fifth Officer Lowe explained to Senator Perkins on day 5 of the American inquiry when asked if the vessel's speed by revolutions was compared to the speed ascertained by log:

> "We ring him [the engineer] up, and we see how she is doing with the revolutions, whether she is going faster or going slower; and you will find a corresponding difference in the log."

Thus, if revolutions were increased or decreased by some percentage over a given interval of time, then one would expect to see a corresponding increase or decrease in log mileage by the same percentage over the same interval of time.[4]

With the speed through the water essentially the same all day Sunday, the distance traveled through the water, **d,** divided by one period of time, **t,** must approximately equal the distance traveled through the water, **D,** divided by another period of time, **T,** on that day. Mathematically, it becomes:

$$\mathbf{V = d/t = D/T}$$

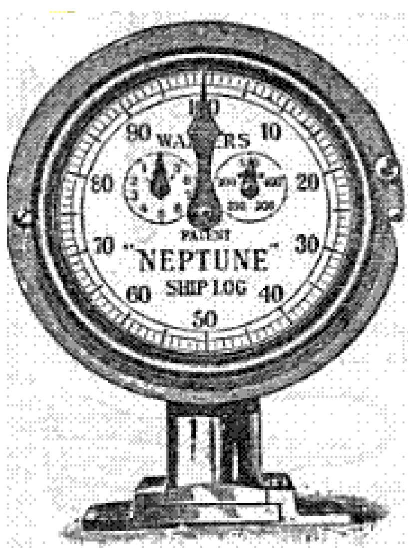
If we are given **d** and **t**, and also given **D**, then it is easy to find the time **T** because:

$$\mathbf{T = t\ D/d}$$

The beauty of this method is that any calibration error in the measured mileages taken off the log cancels out. It would not matter if the taffrail log had zero error, or 10% error. Any calibration error cancels out when taking the ratio of two readings off the same instrument.

So what do we know about the distances measured by log? QM Hichens said the ship was advancing about 45 miles every two hours that Sunday, and the QMs were even talking about it in the their quarters. "It is taken every two hours by the quartermaster when he got on the poop at the time…The reading for the last day had been 45 miles." Hichens last recorded the log at 10 p.m. that Sunday night just before relieving QM Olliver at the wheel. "I took the log which was part of my duty at half a minute to ten, as near as I could tell, and the vessel was going 45 knots by the Cherub log every two hours."[5]

QM Rowe testified that the ship traveled 260 nautical miles from noon to the time of the accident when he took in the log line right after the collision. "As soon as the berg was gone I looked at the log and it read 260 miles. The log was reset at noon. I had charge of the taffrail log, which was a Neptune log."



What the taffrail log actually measures is the number of revolutions of its finned rotor at the end of a log line as it is pulled through the water. Its accuracy in recording nautical miles depends on how well it was calibrated at different speeds, when it was calibrated last, and its overall condition, including the log line and all internal parts. So let us simply refer to the log readings that were given as "log-miles."

Using what we were given, we have **d** = 45 log-miles, **t** = 2 hours, and **D** = 260 log-miles. Solving for **T**, the run time in hours from noon to the time of the accident, we get: **T** = 11.56 hours, which is a run time of 11 hours 33 minutes based solely on the numbers we were given.

How accurate is this? That depends on how accurate the information is that we were given. It is almost certain that both, the advance of 45 log-miles every two hours given by Hichens and the 260 log-mile run given by Rowe were rounded numbers. Also called into question is how close in time to every 2 hours were the log readings actually taken?

To answer the first part, we can assume that the stated log mileages could have been off by up to half a log-mile either way. This is insignificant for Rowe's number because it would produce at most a 0.2% error in the overall result. However, for Hichens' number, a half mile error would produce at most a 1.1% error in the overall result.

As for the 2 hour time intervals, we have from Hichens that the log readings were called up usually within less than a minute before the hour when they were due. However, even if there was as much as a one minute error in a two-hour reporting interval, it would contribute at most a 0.8% error in the overall derived run time.

Finally, allowing for variations of 1 revolution per minute (e.g., from 75 to 76 rpm) in the *average* number of engine revolutions between reporting periods, a 1.3% error can be considered.

Combining all these error factors together (by the accepted method of taking the square-root of the sum of the squares in combining variances), an overall uncertainty of plus or minus 1.9% in the derived run time, or 13.1 minutes, can be expected. In terms of our result for the run time from noon to the time of the accident, this overall error gives us an expected run time interval from 11 hours 20 minutes to 11 hours 46 minutes.

A run time of 11 hours and 40 minutes easily falls within these confidence limits, and is what we would expect to see if no clock adjustment had taken place between noon and the time of the accident that Sunday night. With a run time of 11 hours 40 minutes, the speed of the ship by log would average 260/11.67 = 22.29 knots, and the expected distance measured over a two hour period would result in 44.6 log-miles; a value when rounded to the nearest mile gives 45 miles, the number given to us by QM Robert Hichens.[6]

However, if clocks were put back a total of 24 minutes prior to the accident, as some people theorize, then the run time from noon to the time of the accident would be 12 hours and 4 minutes, a result well outside our derived limits. The speed of the ship through the water would then average 260/12.07 = 21.55 knots, and the distance traveled over a two hour period would be 43.1 log-miles; a value when rounded to the nearest mile gives 43 miles, well under what was reported by Hichens. Furthermore, an average speed through the water of 21.55 knots would result only if the ship was carrying an average of 72 to 73 revolutions per minute, a result that is not supported by the available evidence.

From the results that we see here, a 24 minute clock adjustment taking place prior to the accident simply does not hold up to detailed applied analysis.

As previously noted, the actual distance-made-good by *Titanic* from her noontime position Sunday to the time of the accident late Sunday night was about 258 nautical miles. If that distance is divided by a run time of 11 hours 40 minutes we get a speed-made-good of 258/11.67 = 22.11 knots. It is interesting to note that the ship posted 546 nautical miles between local apparent noon Saturday to local apparent noon Sunday. The run time between those noontime positions was 24 hours 45 minutes, giving an average speed-made-good against the North Atlantic Drift of 546/24.75 = 22.06 knots. Essentially, we see that the ship performed about the same that Sunday afternoon and evening as she did over the previous day's run. Given that she was carrying about the same number of revolutions on her engines since noon Saturday, this result should come as no real surprise.

[1] *Titanic*'s position at local apparent noon Sunday was approximately 43° 02' N, 44° 31' W at 2:58 p.m. GMT, or about 126 nautical miles before the corner point at 42°N, 47°W. The distance from the corner to her final stopping point was about 132 nautical miles.

[2] Direct evidence concerning revolutions comes from Leading Fireman Frederick Barrett (75 rpm ordered on Saturday), Leading Fireman Charles Hendrickson (76 rpm carried between 4 and 8 p.m. Sunday), and Greaser Frederick Scott (75 rpm carried at 11 p.m. Sunday). Second Officer Charles Lightoller, who went off duty at 10 p.m. Sunday night, mentioned that "On one occasion I have a recollection of one side turning 76, not necessarily both sides though." Although three additional double-ended boilers were connected up at 7 p.m. Sunday evening according to Fireman Alfred Shiers, the firemen were told to "ease down firing" in what seems to be an obvious attempt to keep the revolutions from increasing much above the 75 rpm that were called for at that time. We know from Ismay that a full speed trial was planned for Monday afternoon if conditions permitted, and adding the 3 remaining double-ended boilers to the 21 already on line were needed to raise the average number of revolutions carried from 75 to a little over 78 for the trial run if they were to keep up the same firing rate that they carried on Saturday and most of Sunday.

[3] It is well documented that a number of passengers observed an increase in the vibrations from the ship's engines late Sunday night. However, it should be noted that observations of increased vibrations do not prove that the engines were running at a faster rate. This could easily have been a case of the two reciprocating engines achieving a point of resonance in their rotations while the ship was traveling through very calm waters. However, there is little doubt that *Titanic* was running at a relatively high speed late Sunday night, between about 22.15 to 22.40 knots through the water.

[4] On White Star Line vessels it was the practice that the oncoming most junior officer at the beginning of each watch would call down to the engine room to get the average number of revolutions per minute. The information would specify the average rpm made on each reciprocating engine, port and starboard, during the previous watch. This was then entered, along with other navigational related data, into the ship's log book. The distance run by taffrail log was reported by the quartermasters every two hours and entered in the quartermasters' note book.

[5] Although Hichens referred to the patent log as a "Cherub log," it really was a patent Neptune log designed for relatively fast steamers. He also referred to the two-hour advance of the ship as 45 "knots." But he was actually speaking about the distance traveled in nautical miles, not speed. This was a common misuse of the term "knots" by many sailors back then, just like when they would refer to a vessel's speed in terms of "knots per hour." A "knot" is really the term used for speed, and 1 knot is equal to 1 nautical mile per hour.

[6] Based on a study of speed versus revolutions, *Titanic* theoretically would make about 22.15 knots through the water at 75 revolutions per minute, and 22.40 knots through the water at 76 revolutions per minute. The average of these two numbers is 22.3 knots. With the average number of revolutions running between 75 and 76 revolutions per minute all day Sunday, measuring an average advance of 44.6 nautical miles every two hours on the taffrail log should come as no surprise. It is also conceivable that if the revolutions were allowed to reach as high as 77 per minute at some point that evening, the ship could have reached as high as 22.65 knots through the water for that brief period of time. (See my article, "Speed and Revolutions," at: http://www.titanicology.com/Titanica/SpeedandRevolutions.htm.)