MANUAL TARGETING TUTORIAL FOR S-BOATS (NO TDC)

Warning! This tutorial has been written for those users who are already familiar with the manual targeting procedures and want to have an additional challenge. It is not recommended or written for absolute beginners who don't know what the Gyro Angle, Angle on the Bow, Bearing to target and similar concepts are, and who do not yet know how to calculate/measure range and speed of enemy vessels.

I.- Introduction:

As many of you already know, the old US S class submarines had no Torpedo Data Computer unlike the bigger, modern Fleet Boats, and therefore the captain and weapons officer had to calculate all by themselves the firing solution. While there was a tool called Torpedo Angle Solver (A.k.a BANJO, see here: http://www.hnsa.org/doc/banjo/index.htm), which allowed calculating any Gyro Angle, the easiest procedure for the use while playing Silent Hunter 4 is to use a zero Gyro Angle, i.e. a shot straight from your bow, the torpedo going in the same direction as your submarine is heading to. This tutorial will try to describe in an easy way what you must do to calculate the firing solution and pull the trigger in the proper moment. For that purpose we will use the Submarine Attack Course Finder MK3 (Though any Slide ruler with a Sine scale will do) which was also used in real S-class Submarines for calculating intercept solutions and enemy speed.

If you have not yet built one, you can find the templates here:

http://www.subsim.com/radioroom/showthread.php?t=106923 (Front Side)

and here:

http://files.filefront.com/Printable+IS+WASrar/;7476918;;/fileinfo.html (Reverse Side)

In any case, for this tutorial you will only need the reverse side, where the Sine Scale ruler is. You are however encouraged to build the full tool and use it to gather all necessary target data: Speed, Course, etc.

II.- The Firing Triangle:

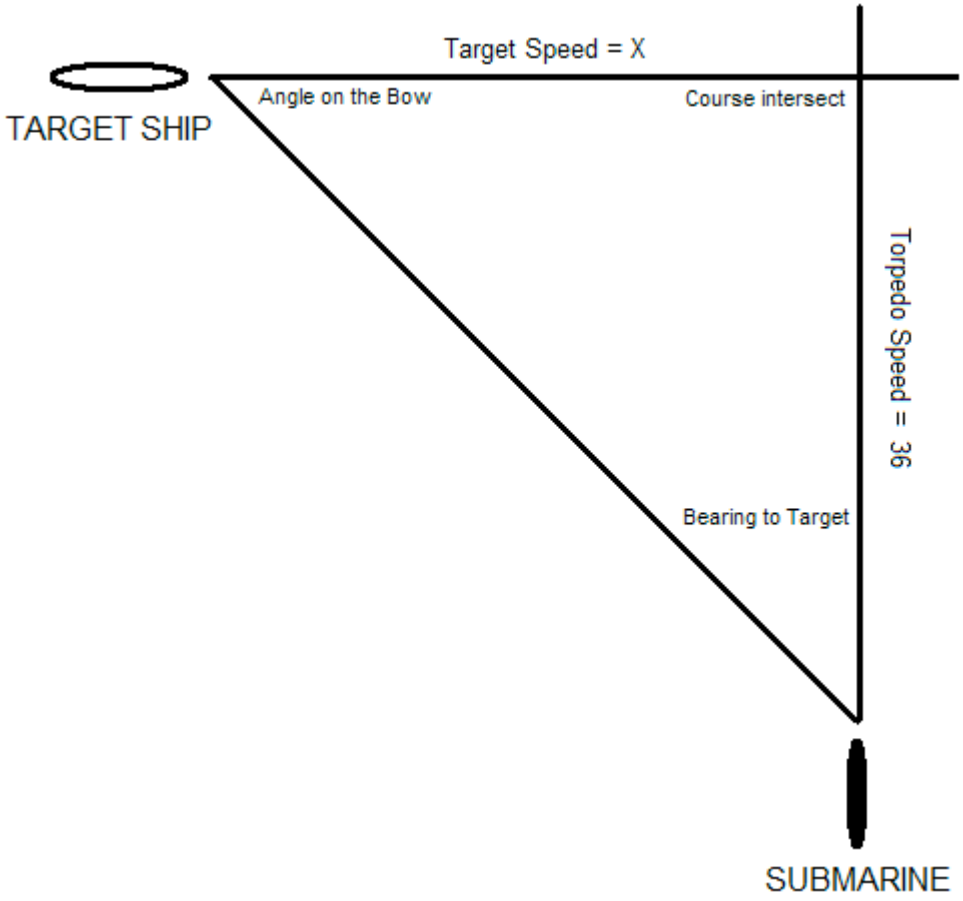
For the calculation of our firing solution we are going to set up a triangle, whose three corners are respectively:

A) Our Submarine,
B) The Target,
C) The point where our course intersects with the target's course.

The angles on the corners will be respectively:

A) Bearing to target,
B) Angle on the Bow, and
C) Course Intersect.

This all is represented in the next figure:



Now, torpedo firing is all about a very simple task: *Making torpedo and target be at the same place and at the same time, so a collision between both moving objects occurs.*

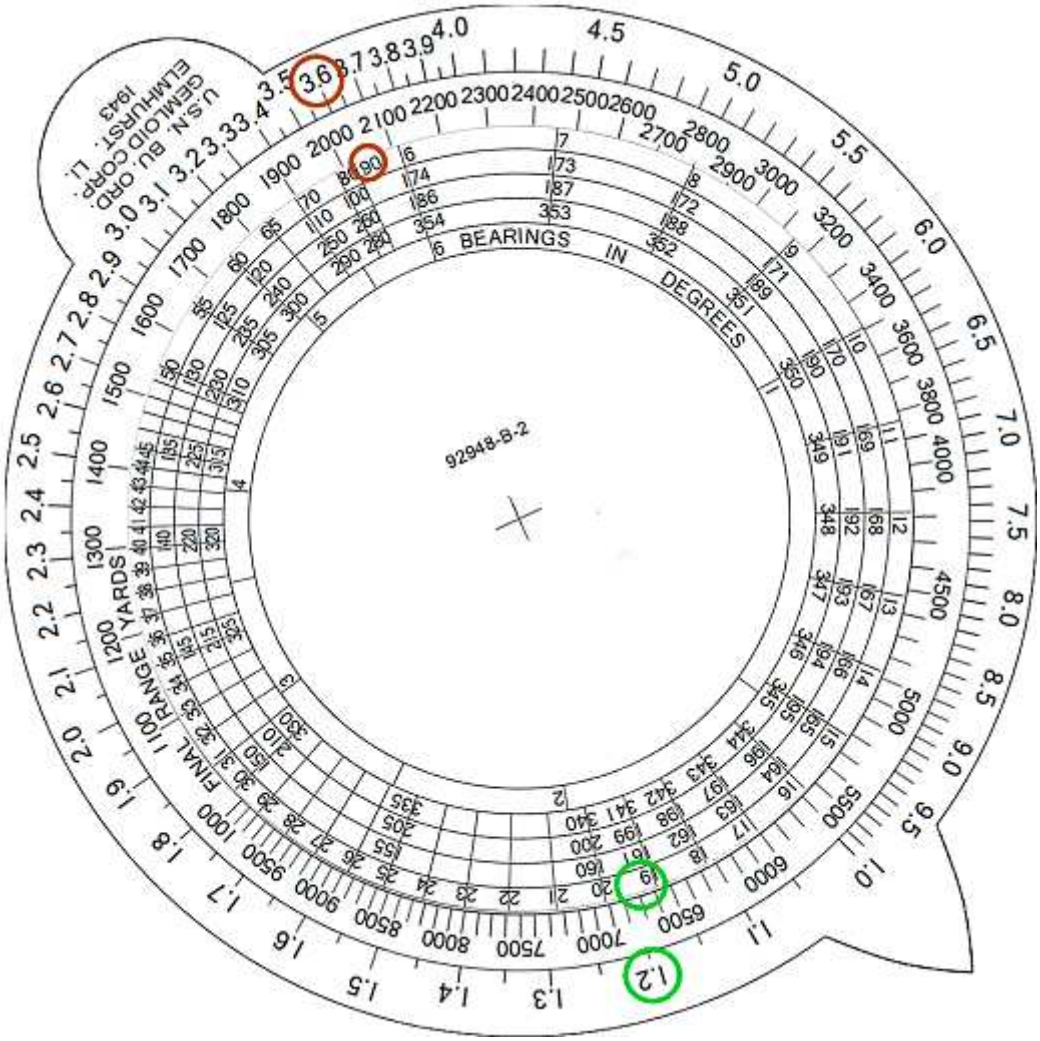
In order to know how to achieve that collision, we must set up an equation based on their respective speeds and courses, which is graphically represented by the triangle above. As you can easily observe, all we need to do is ensure that at the moment of shooting the target is times as distant to the collision point (Course intersect) as its speed is different to our torpedo speed. For example: Our torpedo speed is 36 Knots (Fixed speed for the Mark X torpedoes of the S class submarines), and the target speed is 12 knots. In that case, 36 is 3 times 12, so the target must be *3 times closer to the impact point than the torpedo* in the moment of shooting *because in the same time the latter will cover three times more distance.*

Thus, the key to knowing WHEN has the triangle the correct proportions is simply the bearing to target angle. As you can also see in the example above, the wider the bearing to target angle is, the more distant the target is from the impact point, and inversely, the narrower the angle, the closer to that point. Fortunately, if we know the speed of the target, calculating the bearing to target angle for the moment of shooting is a child's game with the Submarine Attack Course Finder MK3, as it takes full advantage of the Law of Sines. All we need to do is get that bearing, point our scope/TBT there, and shoot as the target goes through the crosshair! (More on this in Section VI: Final Notes)

However, we will differentiate three situations, as the way to get the solution is slightly different on them, and we will always use the target speed of 12 of the example above, so the differences can be understood better.

III.- First Case: Course Intersect Angle of exactly 90º

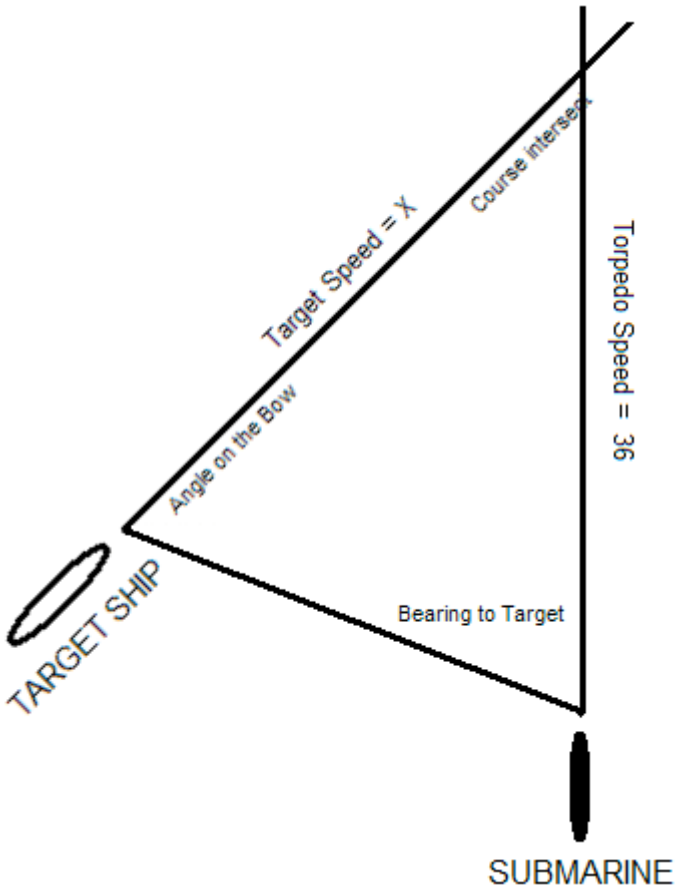
This is a very easy to solve problem, and the situation you should always seek. Target and submarine have exactly perpendicular courses, like in the previous figure. To get the Bearing to target for the moment of firing, you must align the "90º" mark of the middle wheel opposite the 36 knots mark of the outer wheel, like this (Both highlighted in red):



By aligning the wheels like that, we can directly read the solution opposite the target speed mark (12 knots), highlighted in green in this example: When the target is at a bearing of 19.5 degrees, we must shoot our torpedo.

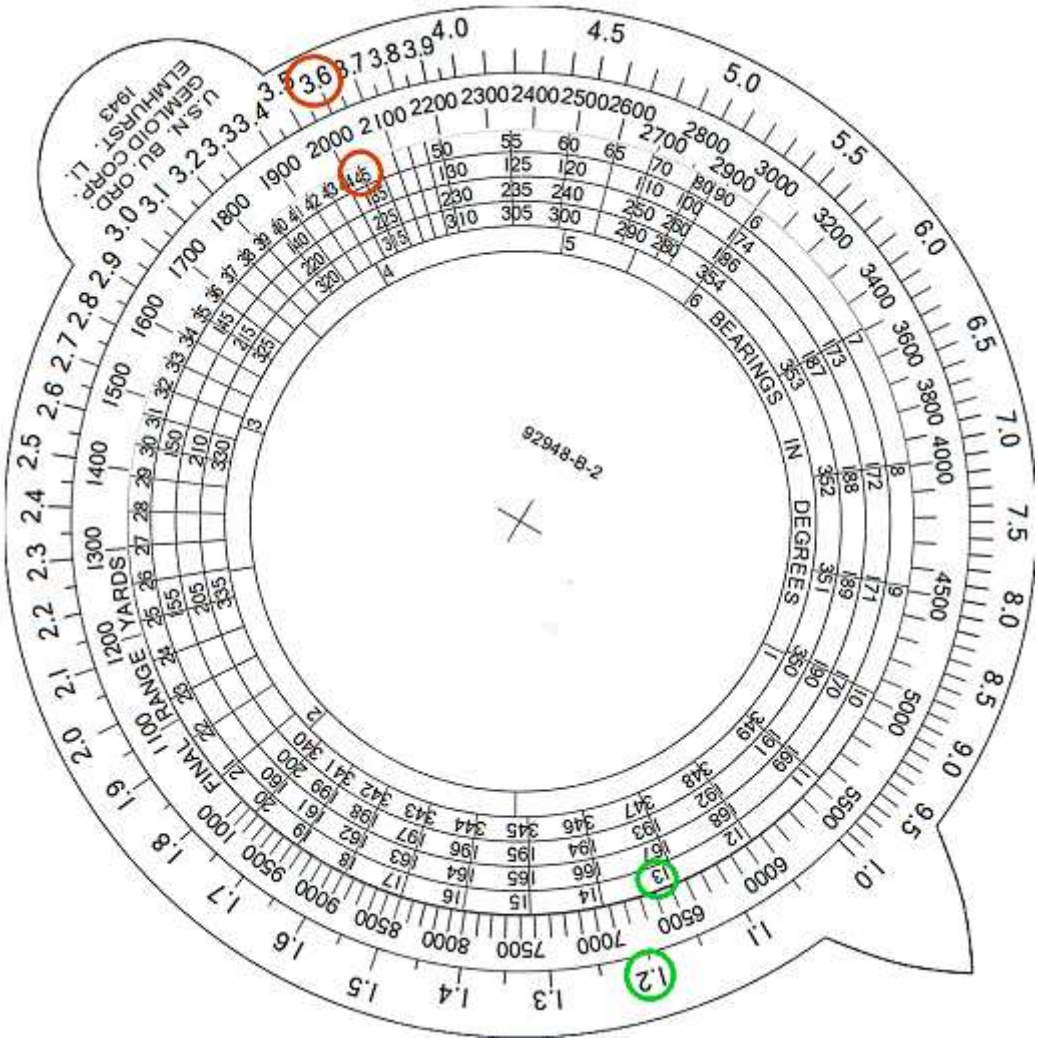
IV.- Second Case: Acute Course Intersect Angle (Less than 90º)

This happens when your course and the target's course are not fully perpendicular, but instead make an acute angle (Less than 90º, in this example it is 45º) between them. This case is still pretty simple, as you will do exactly the same as in the case above, only you will this time align the new course intersect angle with the torpedo speed.



In the figure that follows you can see the 45º degree mark in the middle wheel aligned opposite the 36 Knots mark of the outer wheel (Red) which gives a result of 13.5 degrees bearing to target in the moment of firing opposite the 12 knots mark (Green).

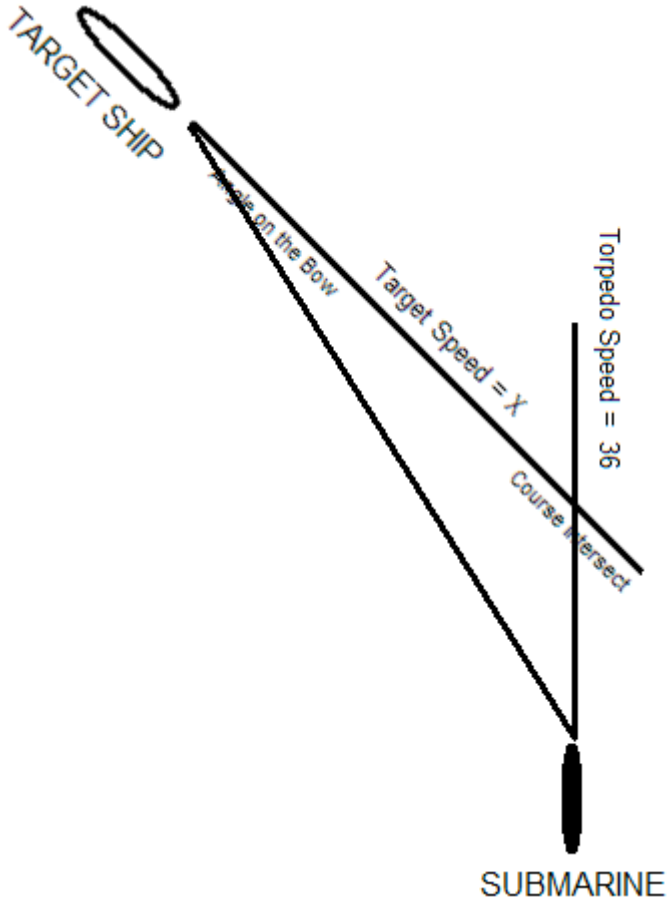
Important note: The torpedo impact angle with the target will always be the same as the Course Intersect Angle! Keep that in mind as very acute torpedo impact angles cause theoretically many more duds than the perfect 90º impact angle.



V.- Third Case: Obtuse Course Intersect Angle (More than 90º)

Now this is the most complicated case of all, yet it still can be solved with the MK3 Attack Course Finder. Only you will need a bit more of patience and practice.

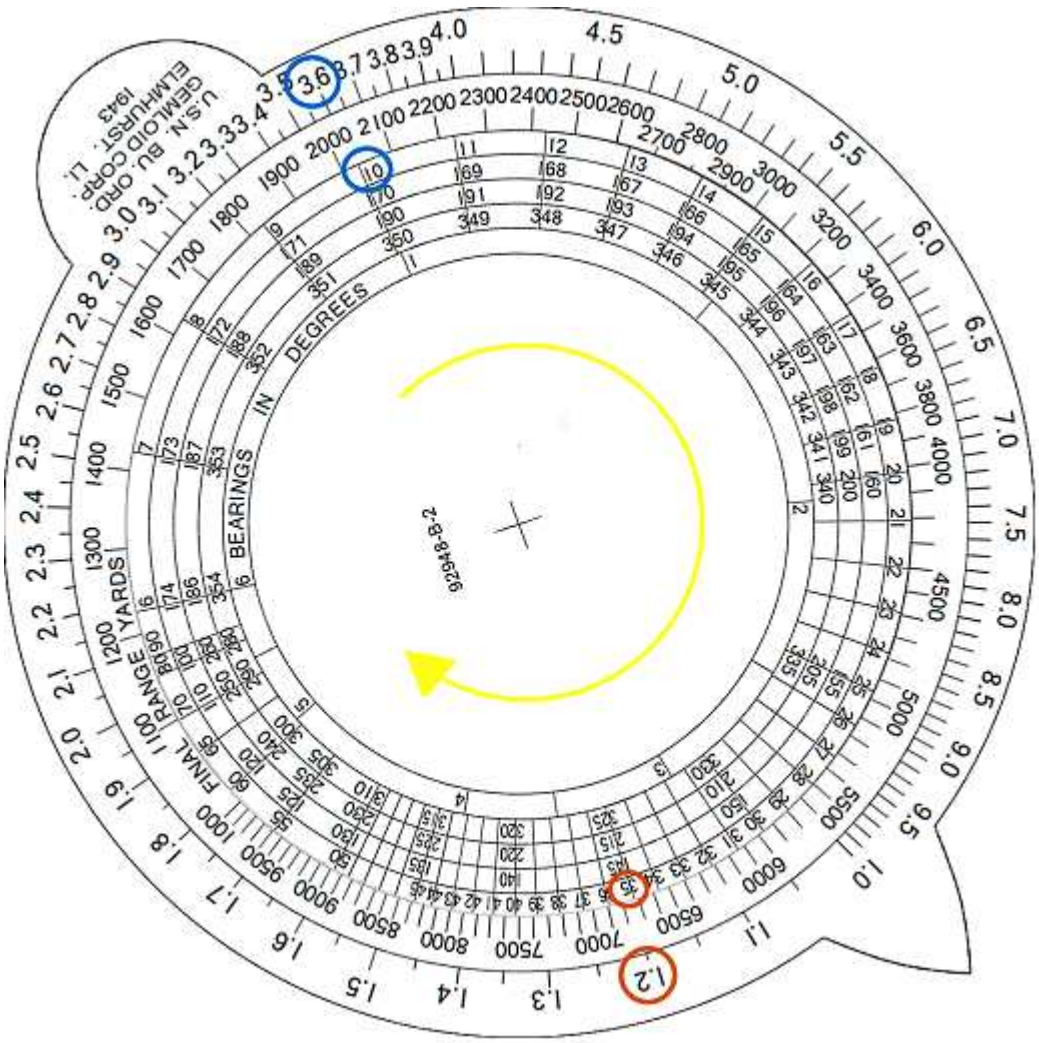
First of all, note that any triangle's angles will always add together 180 degrees. In the previous cases our task was easy because we were limited to calculating no more than 90º, but with obtuse angles we must use a different approach. First of all, take a look at the example in the next figure, which displays a Course Intersect Angle of 135 degrees:



Now, once we know that the Course Intercept Angle is 135, first thing we must do is substract 135 to 180, so we can know how much is the sum of the two other angles: 180-135=45, therefore we know that the bearing to target angle and the angle on the bow at the moment of shooting sum 45º, but which exact size must be each?

We go back to the Submarine Attack Course Finder and start by aligning the 45 degree mark of the middle wheel with the 12 knots mark of the outer wheel. This gives us a read of 12 degrees opposite the 36 knots mark, right? OK, what we must do is turn progressively the wheel until the sum of the degrees opposite the 12 and 36 knots marks sum exactly 45º. For example, we start turning the middle wheel clockwise and read 44-12, then 43-11.5, then 42-11, and so on...until we finally see a combination that fits well: 35-10. There we have it: A total of 45 degrees! Now, 35 is the target AOB at the moment of shooting, and 10 the bearing to target by which we must fire our torpedo.

See this next figure to have an idea of how the SACF looks like once correctly set up (Angle on the Bow and Target Speed in Red, Bearing to Target and Torpedo Speed in Blue, Rotation direction to find the solution represented by the yellow arrow):



Important reminder again: The torpedo impact angle with the target will always be the same as the Course Intercept Angle! Keep that in mind as very acute torpedo impact angles cause theoretically many more duds than the perfect 90º impact angle.

VI.- Final notes:

A) Target Data:

You can use the obverse (main) side of the SACF to determine the target's course and its relation to your own course, thus calculating easily the "Course Intercept" Angle that is so essential for setting up your firing solution. You might have already noted that there is no mention to range anywhere. That's correct. Since we are setting up proportional triangles for our firing solution, it will work equally well no matter the target range, though of course you should take range measurings for other purposes, like speed calculations and ensuring you shoot at the ideal distance (1000 yards or less).

B) How to set up your point of aim:

All the results you have achieved in the form of bearing to target in the moment of firing must be used by turning your scope/TBT from the zero degree position (Pointing at your bow) that many degrees left or right in the direction of your target (i.e. left if your target is at that side of your bow, right if at the opposite). You can use for that the bearing marker on the top of the screen, but note that while turning right is easy (Degrees start at zero and go up), turning left means substracting that number to 360, i.e. 20 degrees left is 340 in the bearing marker. Now, all you have to do is shoot when the target crosses your vertical crosshair,.

C) Spreads/Salvos:

You can even choose (If your estimations of speed and course are very exact) the impact point of your torpedoes: If you shoot when the bow crosses the vertical line, the torpedo will impact on the bow, if you shoot when the funnel crosses the line, the torpedo will hit below it, in the engines, and so on. It even serves for adding a spread to your torpedo salvo (Without messing around with the spread angle wheel) if you shoot and leave a little time before the next shot....each torpedo will impact a different place along the target.

Enjoy!

Hitman, August 2007