

TORPEDO MASTER

General Instructions

Purpose: To improve virtual pilot's skill in torpedo bombing.

The Torpedo Bombing problem: The proper deflection angle pilot has to set when aiming at a ship when he is on the point of dropping his torpedo, is a function of aircraft speed, altitude, angle of Attack, Torpedo specs and, of course, Target speed and route with respect to the aircraft. Once he has dropped the torpedo, the weapon describes a trajectory that can be divided into three main phases: the air phase, a transient underwater phase and, finally, a cruise phase at constant depth and speed. In the meanwhile, the target ship may continue its straight course or, more likely, it may react by changing its route according to two basic choices: close its distance from the incoming torpedo or move away from it. The decisions about attack route, aiming point and shooting distance depend on many tactical considerations but, once these are defined, it is of paramount importance to master all the ballistic laws determining the success of a torpedo attack. In order to achieve such a capability, both theoretical and practical skills are to be developed. Therefore, together with a tactical board approach, a Pilot's view scenario is to be considered.

Tool general description: Torpedo Master (TM) is made of two main sheets (Tactical Board and Pilot's View) and of a data base (DB_Pers) for user customizations.

The purpose of the **Tactical Board** is to study the ballistic problems underlying an aircraft to ship torpedo attack. It allows the user to understand the relationships between aircraft, ship and torpedoes characteristics and the amount of deflection he has to consider for a successful attack, in "ideal" conditions. That is, the ship is a line and its route is straight. At the same time the Tactical Board allows to see what happens in more realistic conditions such as the actual ship shape and, even more important, ship countermeasures. This allows the user to understand and quantify the consequences of his decisions about aircraft speed, altitude, attack route, aiming point and torpedo specs, related to target specs and manoeuvring capability. All this stuff within an environment where it is easy to change parameters and look at graphs showing a "bird view" and a "torpedo path" scenario, where it is possible to look at what happens from the time the torpedo is dropped to the moment it hits or misses its target.

The purpose of the **Pilot's View** is to put the user into the torpedo bomber cockpit at the very instant he has to deliver the weapon. Once again, it is possible to change parameters and see how these changes affect deflection angle. But, differently from Tactical Board approach, all this stuff is translated into the way pilot perceives it "in action". Therefore, Pilot's View has the purpose to train the pilot's eye whereas Tactical Board is aimed to train the pilot's brain.

Both in Tactical Board and Pilot's View, user can choose between two usage modes: "Calculate" and "Guess". In "Calculate" mode, once the boundary conditions are defined (input parameters), Torpedo Master calculates the amount of deflection (output parameter) for a "perfect" shoot. In "Guess Mode", the user has to define the deflection angle and Torpedo Master allows to see how different the guess is from the calculated deflection and, more importantly, it allows to see what the consequences of pilot's guess on the final result are.

The **DB_Pers** allows Torpedo and Target data base customization. It is possible to add torpedoes and targets to those already coded into Torpedo Master. It is possible to define custom torpedoes by entering some basic parameters and it is possible to add, for each ship type, a custom target by entering, again, few basic ship parameters. Please note that for targets it is not possible to customize their names.

Parameters Setting: User can set each parameter by entering it into the related yellow cell. For most of them, it is possible to adjust the value by means of a sliding bar with a cursor. It is possible to click on the arrows at the edges of the bar or to directly move the cursor by a select&drag mouse action.

Operating Notes: a close look to the sheet layout reveals some red tips near some items. By placing the cursor on them, user can access to notes about the item. These notes should hopefully help the user to gain a better understanding of Torpedo Master usage. Finally, a note about Torpedo Master window size. Depending on screen resolution and worksheet size, it could be possible that a) all the stuff is too small for a clear vision or b) a part of the interesting stuff is out of the window. In order to adapt all the stuff to user needs, please consider that it is always possible to tell the worksheet which amount of zoom the user need. Usually the popup menu is on top of the tool bar. Moreover, by selecting the area of interest, it is possible with the same zoom function, to adapt the window to the area of interest.

Tactical Board Description

On the left side of the worksheet user can input data about aircraft, target and torpedo. The parameters are:

VA: Aircraft speed at torpedo delivery time.

H: Aircraft altitude at torpedo delivery time.

AA: Aircraft Angle of attack at torpedo delivery time.

A pop up menu allows the user to select the target.

Then user has to input:

D: Distance of the ship (at aiming point) from the torpedo bomber at torpedo delivery time. The aiming point is supposed to lay along the ship longitudinal symmetry line.

VN: Target speed at torpedo delivery time.

AN: Ship route angle with respect to aircraft route. Clockwise sense is assumed to be positive. A ship coming from left with a route orthogonal to the aircraft course will have a ship angle of 90°. A “face to face” approach will have a ship angle equal to 180° etc.

Then the user can find a popup menu for torpedo type selection and can input the

PS: depth set point for torpedo underwater cruise phase.

User can select aiming point by a dedicated popup menu. The aiming point is supposed to lay along the ship longitudinal symmetry line.

The user can complete the boundary conditions by selecting via a pop up menu the kind of ship reaction, starting from the torpedo delivery time.

By choosing “none”, the ship will continue to move along its straight course.

By choosing “close in “ the ship will move along a circular path attempting to reduce its distance from the incoming torpedo.

By choosing “move away” the ship will move along a circular path attempting to move away, increasing its distance from the torpedo.

Depending on target manoeuvring capability it can happen that the target modified path will never cross the torpedo route. This is the case for a sure success of the avoiding reaction.

Two radio buttons, allow the user to select the usage modes he likes for Torpedo Master.

By selecting “Calculate” mode TM calculates the proper AD for a perfect shot. When TM is in this mode, the shooting triangle is showed in the bird view graph. Such a triangle is made of a side associated with the ship route, a side associated with the torpedo route and, finally, the side associated with the line connecting the ship and the aircraft positions at torpedo delivery time. Such a line will form an angle with the torpedo course side that is the so called deflection angle. Both the ship and the aircraft sides are divided into three parts with three different colours. The green one is associated with the torpedo air phase, the blue one with the torpedo underwater transient and the orange one with the torpedo underwater cruise phase.

By choosing the “Guess” mode, the user can directly input (but only in the Pilot’s View Sheet) the Angle of Deflection. This allows the user to see if, accordingly to boundary conditions he has defined, the deflection estimate is successful or not for each reaction the ship is able to perform.

In the “Guess” mode, the shooting triangle is not shown. Moreover result of TM perfect shot calculations are hidden.

Finally, the right side of Tactical Board shows the Nominal Results of TM calculations for the perfect shot (the one allowed in “Calculate” mode). These results are summarized into the following

Summary table for the perfect shot. These results correspond to an ideal ship size (a straight line). The torpedo will actually hit the target in a point of its contour. This will imply some differences between the nominal results and the actual ones. All this stuff will be shown by looking at the launch story.

When in “Guess Mode”, the only Minimum delivery range will be shown. Such parameter depends on VA, H, AA and the selected torpedo only. This parameter indicates the minimum target distance allowed for hitting the ship in the way a torpedo is supposed to be used. Such a distance steams from the sum of the horizontal distances covered by the torpedo during the air and the transient underwater phases.

This parameter is represented by an half circle with 10° dots on it.

Torpedo trajectory is summarized by:

The horizontal distance covered by the torpedo during its air phase.

The horizontal distance covered by the torpedo during its transient underwater phase.

The horizontal distance covered by the torpedo during its cruise underwater phase.

This figure is not shown in “Guess” mode.

The central part of the Tactical Board shows two graphs:

Bird view of shooting triangle. Distances are in meters.

Vertical plane containing the torpedo trajectory. Distances are in meters. Height to Length ratio is not proportional due to visibility needs.

On the right a sliding bar is placed. The bar and its cursor allow the user to move the torpedo and ship along their paths. At each click on the upper arrow the torpedo and the ship move a step forward. At each click on the lower arrow the scenario goes back by one step

As far as the torpedo approaches the ship, it is better to move cursor by clicking the arrows. This is the right way for picking up the impact time. When the impact point has been reached, a “boom” red star appears on both graphs.

At each time point of the scenario, on the right of Tactical Board the following parameters are given:

Time elapsed from torpedo dropping time.

Horizontal distance from torpedo dropping point.

Torpedo altitude with respect to the sea level.

As soon as the target shape intercepts the torpedo path axis, the ship to torpedo distance is shown. As the torpedo approaches the ship such distance reduces to a minimum value. As such distance drop below 1 meter, an hit is assumed to occur. The background of the ship to torpedo distance goes red and the distance shown is equal to zero. In such conditions the boom symbol appears on both graphs.

Pilot's View Description

In this worksheet user can recognize almost the same parameter input system adopted in the Tactical Board. VA, H, AA, D, VN, AN, aiming point popup and Calculate/Guess usage modes are still present.

Beside these parameter setting system, user can input the amount of deflection used in “Guess” mode, via the dedicated sliding bar and the related cursor. Such a capability is not active in Tactical Board. Nevertheless, it is always possible to switch between usage modes even in the Tactical Board Environment.

As to deflection angle, clockwise sense is assumed to be positive. Accordingly, a ship coming from the left must be aimed to with a negative deflection whereas a target coming from the right will be aimed to with a positive deflection.

The angle of deflection guess is shown in “Guess” mode only.

The graph represents the scenario at the torpedo dropping time, as it is perceived by the pilot placed into the aircraft cockpit. Such a scenario is made of the horizon line, the target, a cross sight representing the direction of aircraft motion and a series of little crosses at 10° distance from each others for an easy deflection estimate. Finally a vertical dotted line connects target aiming point to the crosses line. This dotted line is intended to represent the calculated/guessed deflection angle.

Below such a graph, a little frame shows the Ship to aircraft route angle (the green arrow is associated to the ship whereas the yellow one represent the direction of the aircraft motion).

Finally, on the right, a zoom bar is placed. It is possible to reduce/enlarge the field of view by means of a dedicated sliding bar.

DB_Pers description

DB_Pers allows the user to add torpedoes (up to 10) and ships (up to 7) to the data base already coded into TM.

As to torpedoes, user can specify the name and must enter: mass, max diameter, length and cruise speed.

As to ships, user cannot change the name and has to enter: Length, Height, Width (maximum) and draught. The height is the one without ship aerals and tripods (periscope for submarines).

At the bottom of this worksheet, the main characteristics of the selected torpedo an ship are shown in green background cells. These characteristics may refer to even coded or custom torpedoes/ships databases.

Finally, on the right, some hyperlinks are shown. These links allow the user to switch to the other TM sheets in an alternative way with respect to the standard mode of clicking on sheet labels at the bottom of the worksheet.