AA in Naval Games: We've had it all Wrong!
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We've had it all wrong! Well, maybe not completely wrong, but in need of correction. The standard was set for representing fleet air defense in Avalon Hill's *Midway*. Games have been doing it much the same way ever since, though with some improvement. However, there's now plenty of evidence that we're still off target. Norman Friedman's new book *Naval Anti-Aircraft Guns and Gunnery*, a definitive study of the subject, not only provides the data but also describes the system reasons for revising our models of naval AA.

In *Midway*, each ship has an AA value that is used to oppose some group of aircraft within two squares, the distance to an adjacent ship. So, the player defending against air attack attempts to optimally allocate these AA factors to give the minimum overall odds of taking hits from the several attacks made on targeted ships. Figure 1 shows an example of such a situation, *Hiryu's* attacks on *Yorktown* at Midway. The only two cruisers in *Yorktown's* screen were *Portland* and *Astoria*. Destroyers are not represented. The second number on the ship counter is AA value, 3 in each case. The U.S. player would allocate one ship to each attacking air unit, producing two attacks at 1-2 odds and one at 1-3. (At most he would take three hits, not enough to sink or disable *Yorktown*. The actual attacks by dive bombers and torpedo planes were separate, and more ships were present for the latter, but that's beyond the resolution of the game.)

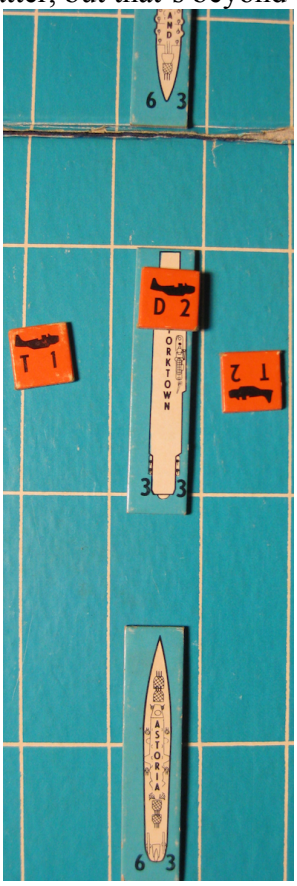

Figure 1 Avalon Hill's *Midway*

ATO's own *Imperial Sunset* does much the same thing. Figure 2 shows the first attack on Ozawa's decoy force off Cape Engano. The top left value for each ship is its AA value. Note the large value for Destroyer Division 61, the *Akitsuki* class destroyers designed for area AA. A special display is used, but as in the Avalon Hill game, ships fire their AA defense value once at an aircraft unit attacking an adjacent ship, but with AA values halved. Unlike in AH *Midway*, the attacked ship can fire at every attacker. These are both improvements. After AA, each surviving aircraft unit rolls its attack. Here, we'll say *Zuiho* gets hit first with *Lexington* torpedo bombers (5). *Ise* (2) and *Zuiho* (2) defend. With 4 AA, a d10 roll of 4 gives a -1 die roll modifier to the attacking aircraft. 5 points attacking with a die roll of 4 (minus 1) just misses. In like manner *Zuiho* and Desdiv 61 put 5 AA against the *Essex* torpedo bombers, which also miss due to bad luck. *Intrepid* dive bombers, defended by *Zuiho* and *Isuzu* (3 total points of AA), score one hit on a die roll of 5, which was not crippling. *Zuiho* was lucky. *Chitose* was sunk and *Zuikaku* took a torpedo in this attack.

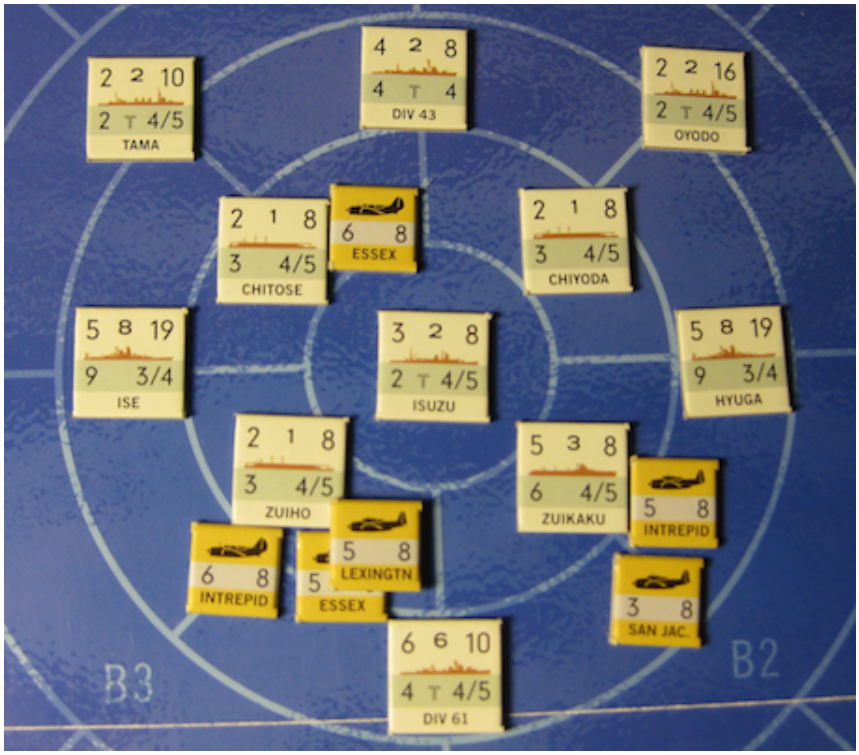

Figure 2 ATO's *Imperial Sunset*

A final example offered is Avalanche's "Second World War at Sea" series. The *Hiryu's* attack on *Yorktown* situation from the *Midway* game of that series shown in Figure 3. Note the presence of destroyers (AA value 1 each). That's an important improvement, because 4 of 5 of these destroyers had the excellent Mk 37 fire control system. Ships firing to defend another ship (area fire) have their AA value halved as in *Imperial Sunset*. For every attacker destroyed, another is ineffective, representing the suppression effect of AA fire. Both of these are significant improvements over the AH *Midway* model. Here the AA total is 8AA halved to 4 plus Yorktown's 5 to give 9 rolls of the dice. One "6" would eliminate one of the already depleted attacking units and

suppresses the other, so we suppose AA misses. Five attack rolls for the aircraft produce a couple of bomb hits and two torpedo hits that reduce the ship to an immobile, almost sinking, condition.

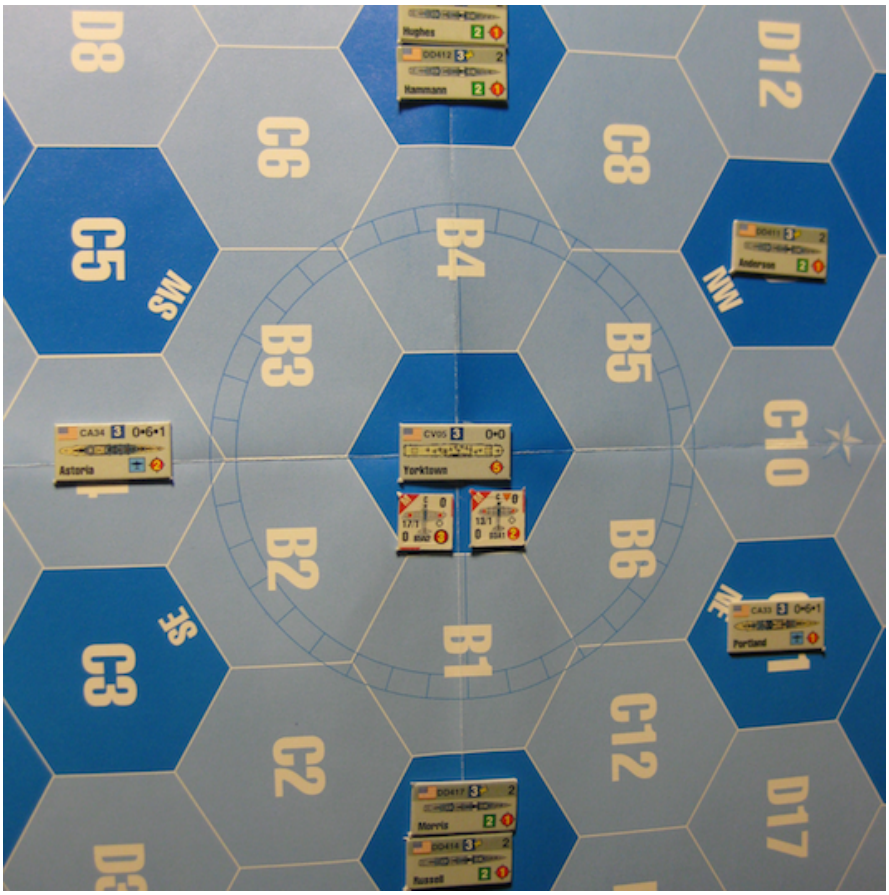

Figure 3 Avalanche *Midway*

Some important points that are usually not represented are:

1. U.S. AA was much better than any of the others. This is due to superior fire control for area air defense, but also a massive increase in effective light AA. The latter was made more effective by good fire control as well. A proliferation of heavy 40 mm. automatic weapons, also with effective directors, added to the advantage. The introduction of VT (proximity) fuses later in the war added yet more effectiveness. The Japanese could only match the proliferation of light AA, but theirs was less effective. The British were able to use many of the same advances as the U.S. late in the war, but didn't have an effective heavy AA control system. The Japanese systems were not nearly as effective as those the U.S. fielded. This is seen in results. The Japanese only shot down 3% of the attacking aircraft in the Battle of the Philippine Sea, while the U.S. AA shot down 32% of Japanese attackers which got through CAP to attack ships. Even in 1942 there was a marked difference in AA effectiveness.

2. Light AA was dominant against dive bombers and torpedo bombers in the Pacific. (Later, kamikazes made longer ranges more important.) For the U.S., 5 inch guns are credited with 30% of confirmed kills, and that includes VT fire late in the war which accounted for half of the total. So, light and heavy automatic weapons make up most of the rest. Table 1 shows some data on U.S. AA gun effectiveness.

Table 1 U.S. AA Effectiveness

				For Year, in "Rounds per bird"			
Gun size	rate of fire	round weight	eff. range	1942	1943	1944	1945
5 inch*	15 rpm	50 lb.	10,000 yd.	252	508	1157	627
40mm	160 rpm	2 lb.	3000 yd	2788	1320	2364	1508
1.1 inch	150 rpm	.9 lb.	2000 yd.(?)	1503			
20mm	480 rpm	.3 lb.	2000 yd.**	1809	6017	9348	4398

*: Data for AA common shells only, not VT. ** effective range with director control. Closer to 1000 yards without.

3. Tactics were not symmetrical. The U.S. relied on aimed area AA more than anyone else, and unlike other countries equipped destroyers with effective dual purpose systems. For the U.S., 40% of kills came from own ship fire versus 60% by an average of four supporters. That means the defending ship is about 3 times more effective. (For other navies, own ship's fire would be even more relatively effective.) The U.S. tactically believed in aimed heavy AA fire, but especially against dive bombers early in the war, often used barrage fire. The Japanese simply did not have effective area AA. Typically Japanese carriers under attack maneuvered independently, rather than with a screen keeping formation as in U.S. practice. A screen has a difficult time staying in formation when you're doing circles. The Japanese did build a class of AA (area defense) destroyers, and did use some heavy AA barrage (even up to 18 inch guns), but the overall effect was that each Japanese ship defended itself. The British lacked good medium caliber aimed AA, but used timed barrages effectively to try to keep attackers at a distance, or over the attacked ship against dive bombers. In the Mediterranean, German and Italian torpedo planes generally released weapons from outside the screen, typically at about 6000 yards. Small ships were to get out of the way of the big ships' AA barrage. This may account for why Prince of Wales was critically hit in the first attack on December 8, 1941. The Japanese torpedo planes pressed much closer before releasing weapons. The ship maximized defensive fire on the broadside but was then too late in turning.

Often in wargames, AA values seem to be calculated mostly based on the number of 5 inch AA guns. That is the data most readily available and seldom changes over a ship's life. For example, in AH *Midway*, U.S cruisers and carriers (8 x 5 in.) are "3", the AA cruiser *Atlanta* (16 x 5 in.) is "6". Avalance *Midway* gives AA values of only 1 to 2 for comparable U.S. cruisers, 6 for *Atlanta*, 5 for the carriers of both sides, and "2" for Japanese heavy cruisers and battleships respectively. *Atlanta* can deliver a broadside fire of 14 guns. Most destroyers each get a "1". These numbers seem to reflect roughly broadside rather than 5 in. count (except for the carriers) and perhaps larger numbers of smaller guns on the larger ships. In *Imperial Sunset*, destroyers are also rated "1", cruisers 3 to 4, and large ships a bit more. *Clevelands* (12 x 5 in) rate "4" compared to most U.S. cruisers at "3". However, it is noteworthy that CVL's with no 5 inch at all still

get ratings of 3, comparable to a cruiser! While some consideration may have been included for smaller guns in these more recent games, all focus on area fire, and the AA ratings seem to reflect that.

Table 2 AA values in representative games

Ship	AH *Midway*	Avalanche	*Midway*	*Imperia*	*Sunset*
CV *Yorktown* (8 x 5" Mk 33, 16 x 1.1")	3		5		
CV *Enterprise* (8 x 5" Mk 33, 40x40mm, 40 x 20mm)(sister to *Yorktown*)					5
CA *New Orleans* (8 x 5" Mk 28, 16 x 1.1")*	3		2		3
DD *Simms* class (4 x 5" Mk37, 4 x 1.1")*	-		1		1
CV *Hiryu* (12 x 5", 37 25mm)	3		5		
CV *Unryu* (12 x 5in, 51 x 25mm) (late war sister to *Hiryu*)					4
CA *Chikuma* (8 x 5", 6 x 25mm)*	3		2		3
DD *Akitsuki* class (8 x 3.9", 4 x 25mm)*		-	2		1.5

* By late in the war ships carried a lot more light AA, as can be seen by comparing Enterprise (1944) and Yorktown.

The U.S. had an advantage in aimed heavy AA from the very beginning with the Mk19 director system. The system's mechanical analog computers modeled the target aircraft course, speed, and altitude. This required a good gyro stabilized vertical reference. An aircraft flying a straight course could be accurately modeled, even on a crossing trajectory. Later systems improved rangefinding (Mk 28), added power drive (Mk 33) and added radar (Mk 37), among other changes to improve speed, tracking, and accuracy. In contrast, the Royal Navy High Angle Control System modeled the aircraft in angular terms referenced to the ship. Also, their horizontal coincidence rangefinders performed poorly. This system was considered a failure, and the British typically resorted to barrage fire, which put up a good deterrent show but did not often achieve hits. The Japanese system was somewhat intermediate in concept between the U.S. and British systems, oriented along the target – ship axis. But the Japanese destroyer guns were not suitable for AA, and the Japanese usually resorted to barrage fire.

The U.S. advantage in light AA stems in large part from the development of an effective predictive gunsight for 20mm guns by Dr. Charles Stark Draper of M.I.T. This gunsight was first fielded in late 1942. It became a director Mk 51 used for both 20mm and 40mm guns and eventually for local control of 5 inch guns at short ranges where the Mk 37 system was less effective. This system dramatically improved short range AA. No other power developed a comparable capability in significant numbers.

So, what needs to be done? Let's assume the same basic mechanism for portraying AA is retained. Triple self-defense AA relative to area AA for the U.S. Eliminate area AA for the Japan except optionally a minimal amount for barrage, including the Akitsukis. Give a probability of hit bonus for radical maneuvering at a cost of AA effectiveness. For the Japanese, this can be built into the ship AA and U.S. probability of hit tables. For the British, give some AA benefit for barrage, but mainly self-defense. Tables applicable to AA in general may need to be tuned. Or use different tables for different countries (IS). Maybe even rate each ship separately for area, self defense.

Perhaps it would make even more sense to represent the explicit representation of AA allocation entirely. Simply let each ship be attacked individually, defending itself, with smaller (Japanese, British) or larger (U.S.) additions for assumed area fire. That's probably at least as accurate as the current allocation models, which don't really represent a process that happened in reality.

[Specific recommendations if you decide to use them]

Based on these observations, the following adjustments could be tried in the three games mentioned. (These suggestions have not been playtested.) Count the AA of the attacked ship +3 (US) or +1 (Japanese) for escorts. Otherwise disregard area AA. Late in the war count the Japanese ship as +2, U.S. ship as +6, for more light weapons and better U.S. heavy fire control and VT fuses. In AH *Midway* and ATO *Imperial Sunset*, subtract 1 on the attack die roll against Japanese ships for radical maneuvers; "1" misses. For AH Midway, resolve all attacks at less than 1-2 as 1-3. (Perhaps also, for a carrier with readied planes hit by bombs, add a d6 roll (Japanese) or d3 roll (U.S.) for further damage instead of just +1. After all, just one bomb destroyed Akagi.) In the Avalanche *Midway* game, add four to the damage table, but count 13+ as a miss against Japanese ships. Or roll three dice rather than two. This models poorer damage control as well as radical maneuvering.

Bibliography

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A. J. Watts, *Japanese Warships*, Doubleday, New York, 1966. Used for basic data on Japanese ship AA weapon numbers, supplemented by various more recent sources.