DESIGN ERRORS IN THE HUNT CLASS (1938)

BY

DAVID. K. BROWN MENG CENG FRINA RCNC
(Consultant Naval Architect and Historian)

The design of the HUNT class destroyers has been covered in detail by John ENGLISH[1] and will only be outlined here. Two very quick studies were produced in September 1938, one for a ship with a nominal speed of 25 knots and the other for 30 knots. There was a three knot difference between the speed deep and light and the nominal speeds were about midway between. The armament was to be 2 twin 4 inch and 2 quad 0.5 inch machine guns but the faster ship was also to have a quad torpedo tube mounting.

The faster ship was selected but with a third twin 4 inch and no tubes. This was a very heavy armament for a small ship—twice that of the World War I S class of much the same size—and this should have sounded a note of caution to the design team. The sketch design was put in the hands of a very experienced assistant constructor (BESSANT) who realised that the novel fin stabilisers fitted to improve anti-aircraft fire would work best if the stability (metacentric height—GM) was not too great. He selected a GM of 2 feet in the standard condition, which he expected would lead to a roll period of about 7–8 seconds. This choice was quite sound but care was needed to ensure that stability was not reduced below this figure.

BESSANT used a very complicated formula of his own to estimate hull weight:.

$$\text{Hull weight} = \{(\text{Dispt})^{0.5} \times L \times B^{0.35} \times (\text{Depth})^{0.35}\}/\{82.5 \times (\text{Draught})^{0.175} \times (\text{Stress})^{0.175}\}$$

Before computers (BC), it was customary to use complicated formulae which minimized the amount of repetitive arithmetic. Today, we would use a simpler formula and use the machine to iterate several times. It is also interesting that though the maximum design stress enters the equation, its exponent is only 0.175, showing that it had little importance. Later in the design it was found that the use of high strength steel showed a saving of only 13 tons. Having used the weights of the TRIBALs to scale the weight for the HUNTs, BESSANT then checked the estimate by scaling up the estimated HUNT weights to the JAVELINs. (Unfortunately, he did not make a similar check on the centre of gravity). The hull form was developed and model tests carried out on seven forms to improve on the original which was itself a good one. Further estimates were made of roll period which gave a period of 8 seconds with an improved GM of 2.65 ft.

By mid October, the revised calculations were ready for inspection by the Director of Naval Construction, Sir Stanley GOODALL. He approved the alterations suggested by the designers, mainly an increase in length of 7 ft. He also asked a number of questions concerning the cost of speed, armament and endurance. The latter was interesting:

> To increase endurance from 3000 to 4000 miles would put up the standard displacement by 125 tons (mainly more powerful engines) and the cost by £50,000 (in about £400,000).

A later set of trade off studies came up with:

> One twin 4 inch = ⅔ knot = 340 miles endurance at 20 kts.

The detailed weight calculations were then put in hand. The departmental rule was that such calculations should be carried out by two men, working independently, comparing answers only at the end. The work was carried out by two experienced senior draughtsmen whose calculations agreed precisely. This in itself is almost certain evidence of collusion but, worse, their estimate of the height of the centre of gravity was 0.8 feet lower than BESSANT's quick estimate. There seems to have been no enquiry into the discrepancy and the new figure was accepted. The BLACK SWANs were being designed in the same room, under the same head of section, and carried the same armament but had 10ft more beam!

The final design review was carried out by GOODALL on 9 February 1939. Clearly, from his diary entries, he was unhappy even with the figures presented to him and increased the beam first by 6 inches and, having slept on it, by 9 inches. He did not realise that there was an error in the quoted figures. But, having done something to improve stability, he did not dig deeper. This is a common failing, not to consider the possibility of two errors but stop when the obvious problem is remedied.

The first 20 ships were ordered and building was rapid. A check on the stability was planned for *Atherstone* in February 1940, by which time it is clear that the error in the original design had been spotted and new calculations carried out. (These have not been found). The inclining experiment showed that the true state was even worse with a GM of 1.22 ft in the deep and 0.95 in the light condition. BESSANT, who had moved to a different section, was called back to sort out the problem. He showed that two thirds of the discrepancy was due to the original error and one third to uncontrolled weight growth during building. He suggested various alternative actions. For the first 20 ships (later 23) the only solution was:

- To reduce the armament to 2 twin 4 inch.
- Cut down the after superstructure.
- Lower the funnel and mast.
- Add 50 tons of ballast.

Later ships would have increased beam. *Goathland* and *Haydon* were 'kippered' on the slip and widened. (It is possible that one or two others were treated the same way).

There are many stories concerning this sad affair; true, false and unproven. One unconfirmed story, which does fit the facts very well, is that the two 'independent' calculators had made the identical error of taking the height of the upper deck above the keel as 7 feet instead of 17ft. There is a story that GOODALL offered his resignation but from his diary entries, this seems unlikely. It is also said the BESSANT was blamed for the trouble, which may be true but, if so, was most unfair since his sketch design was far closer to reality than the detail figures. GOODALL clearly sympathized with BESSANT and promoted him soon after. The main source for this note is BESSANT's work book[2]. The custom of the Service, then and now, is that once the head of section has approved a calculation, he personally is responsible if errors are found later.

The main cause of this design error was the over work throughout the design department due to the re-armament programme. Senior officers must remember that errors in calculations are inevitable—and computers have done little to reduce the frequency of errors—yet. (If the story that the upper deck height was wrong is true; it is equivalent to punching the wrong data into a computer, not unknown today). After all, one only needs about 60% to be awarded an Honours degree and the pressure of a busy design section is very similar to that of an examination. When errors do occur, it is important to hold a formal and independent enquiry to see why things went wrong and make recommendations to reduce the chance of future errors. If all concerned are to tell the whole truth, such an enquiry must not be a witch hunt[3] and individuals should not be blamed for failings of the system.

I was much impressed by Boeing's attitude to errors when in Seattle. Their engineers move every three years or so and, if an error is found later, the original team is brought back to sit alongside the new team and find a solution. The proposed remedy is then put before a panel of the company's best men in the subject to make sure it is right and economic. I was assured by both senior and junior members of staff that no one was penalized for an error. The company thought that any such penalty would discourage originality and also lead to the whole truth being concealed. Now that most calculations are carried out in industry, it is important to ensure that their design 'quality assurance' is sufficient and, even so, to cast a critical eye over the solution. Experience is the best corrective for error and experience is necessarily lacking today.

Design errors do happen and only careful inspection by experienced men can reduce the chance of them being undetected.

References:
1. John ENGLISH. 'The HUNTS' *World Ship Society*. Kendal, 1987.
2. J. L. BESSANT Work Book 308/6, held in the National Maritime Museum, Greenwich. GOODALL's diaries are in the British Library.
3. J. COWLEY. 'Presidential Address'. *Institute of Marine Engineers*. 1986.