**Fastenings on the Sutton Hoo ship**

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**Abstract:** The Sutton Hoo ship used many rivets, and a few similar fastenings. What the rivets were made of (probably wrought iron) and the material that they were used with (probably oak) would be important in any attempt at reconstruction. The positive evidence for trenails is scanty. This paper examines the very limited evidence about the nature of those materials in the original ship.

**Keywords:** Sutton Hoo ship, iron, oak, rivet, nail, rove, wrought.

# Introduction

Very limited evidence remains regarding the fastenings which were used for the Sutton Hoo ship. This paper focuses first on what the evidence actually is. In particular, what kind of iron was used, and what kind of wood was being held together? The 1938 story

When Basil Brown excavated Mound 2 at Sutton Hoo in 1938, he had some idea of what to expect. A newspaper report (The Ipswich Journal, 1860) had mentioned some activity there. ‘One of these mounds was opened recently when a considerable number (nearly 2 bushels) of iron screw bolts were found, all of which were sent to the local blacksmith to be converted into horseshoes!...These barrows were laid down in the Admiralty surveys by Captain Stanley during the stay of the Bluzer when taking the soundings of the [Deben] some few years since.’

Brown had already checked the ‘iron’ rivets at Aldeburgh Museum taken from the ship burial at Snape Common in 1862, and found similar in Mound 2. There can be little doubt they were originally iron, but all the existing rivets from Snape Common and Mound 2 are heavily oxidised. How much success the blacksmith had in 1860 is unrecorded.

# The 1939 story

Phillips (1940c, p. 24) says, ‘All the nails were in an extreme state of rust and it is doubtful whether any metallic iron remained, though the form was readily recognizable and all the nails were exactly in their places except in the burial-chamber area, …’ Phillips (1940b, p. 354) says of the clench nails, ‘Very little or no iron remained in them, but the forms were well preserved.’

However, Crosley (1943) was more forthcoming – ‘Some of the nails were so rusted that they could be broken across by hand, and were found to be hollow….Many of the nails were still solid, however, and one of them had to be sawn through with a hacksaw and appeared to be wrought iron of good quality.’ Crosley, a member of the team who surveyed the ship in 1939, worked at the Science Museum, and was later vice-president of the Newcomen Society. He would have been familiar with artefacts from the Industrial Revolution and was probably a good judge of iron.

Phillips only mentions trenails in connection with speculation about a composite gunwale (Startin, 2019a).

Crosley (1942, p. 113) mentions a particular iron spike which was sectioned longitudinally and showed a ‘wooden dowel or trenail some 5/16 inch in diameter … fitting alongside the top portion of the spike’. There is an illustration in his fig. 20 on p. 115, but ’This dowel and its exact location was not defined at that stage of the survey.’

On the 1939 provisional drawing (Science Museum, 1939), there are many drawings of the fastenings found. These are generally keyed to the position they were found in on the ship. . In all cases, the shanks are shown as round and not square.

There is also a prominent note:

“As iron nails bolts etc. were mostly encrusted with sand, gravel, etc., & were also corroded, outline shapes were difficult to determine with accuracy.

All roves or washers were diamond shaped & placed inside boat, with major axis always parallel to line of keel.”

## Riveted through oak?

Fastenings are only as good as the material the fastening passes through. Phillips is generally careful to mention ‘wood’ rather than ‘oak’, but in Phillips (1940a, p. 160) he says, ‘At a later stage a piece of much decayed oak was found among the objects placed just inside the west end [of the burial chamber] which proved to have been of not less than seventy-five years growth (see Appendix III).’ Appendix III on p. 200 is a ‘Report on the timber from the Sutton Hoo Ship-burial’, by Dr H. Godwin of the Botany School, Cambridge. This is a tree-ring analysis, and the sample is stated to be ‘… a moderately-sized piece of oak, *Quercus Robur* (sensu lato [in a broad sense])…’ This is variously called common oak, pedunculate oak, European oak or English oak. The tree-ring analysis actually showed it was at least 150 years old when cut, from a tree at least 14 in. in diameter. The report is reproduced in Bruce-Mitford (1975, p. 680), who also says (p. 507) it may have been from a roof support, at least 8 inches square. At any rate, it was not from the hull.

Crosley (1943, p. 109) says, ‘The wooden strakes of the ship, probably oak, had disappeared almost completely…’

The direct evidence for an oak hull is scant. The general of assumption of oak is probably based on the lack of plausible alternatives, and the clear evidence for the use of oak planks in the Nydam ship (ca. AD 325) and many Viking ships.

# The 1966-7 investigation

## The wood

Evans (1975, p. 354) says ‘Although it has proved impossible to make any formal identification of the wood used, the wood grain, preserved in the iron oxide from the rivets, has a denseness similar to that of oak, and it is probable that oak planking was used.’ Otherwise, in relation to the hull, she talks simply of ‘wood’.

## The fastenings

Bruce-Mitford (1975, p. 451), for the British Museum inventory item Q 202, relating to the ship, says, ‘*Rivets*, numerous, with scarf and rib bolts, gunwale spikes, and one nail from the hull of the ship, numbering in all some 1560 items, all of iron heavily oxidised. Bolt, rivets etc. removed in 1939 by the Science Museum are included, also one plank-joint lifted intact in plaster in 1967.’ There is no mention of any metallic iron having been found from the ship itself, so the opportunity to take samples and subject them to chemical and metallographical analysis never arose.

Bruce-Mitford, 1975, mentions lots of other ironwork from the burial artefacts and the construction of the burial chamber. The coat of mail, and the hanging chain, are obviously quite elaborate. The way iron objects in the burial chamber interacted with the textiles close to them yielded invaluable information. Even so there is no mention of sampling and analysis of the iron.

Regarding trenails, there is very little to go on. Evans (1975, p. 371) says, ‘Despite intensive searching through contemporary photographs, only in three instances could faint traces in the sand of the ribs be convincingly interpreted as evidence for the former existence of the use of trenails.’

## Radiographs of rivets etc., and derived drawings

Bruce-Mitford (1975) has radiographs (X-ray photographs) of a range of the surviving rivets, spikes and bolts. They are shown in figs 277-8 on pp 362-3.

Fig 279, p 364 illustrates, at half-size, the British Museum’s best guess at the shape and size of certain fastenings, based on an evaluation of the radiographs. In all cases the shanks are shown as round, and not square.

These evaluations can be compared with the 1939 drawings, and In nearly all cases they are a bit smaller.

## Size comparison of 1939 drawing rivets with 1975 evaluation.

For specific comparisons:

1939: ‘A’ is said to be a strake rivet, although it is rather short from the inside of the head to the inside of the rove – just 1 and 3/8 inches (34.9 mm). The diameter of the shank is said to be 5/8 inch (15.9 mm).

‘B’ is said to be a rivet which connected strake 4 to the stern. It is 2 inches exactly (50.8 mm) from the inside of the head to the inside of the rove. The diameter of the shank is said to be ½ inch (12 .7 mm).

1975: Fig 279D is said to be a strake rivet. It is 1 and 11/16 inches (42.9 mm) from the inside of the head to the inside of the rove. By measurement from the figure, the diameter of the shank is 5/16 inches (7.9 mm). A plank rivet, fig 279C, and a rivet from the stem-post, fig 279E, are both shown to have shanks 3/8 inches (9.5 mm) diameter. The cores of the comparable radiographs range from ¼ inch to 3/8 inch across.

The difference in estimated shank diameters, 1975 relative to 1939, implies a significant reduction in the estimated weight of iron in the whole ship. For a conservative example, stepping down the shank diameter from ½ inch to 3/8 inch is a ratio of 0.75. This must be squared to give the ratio of cross-sectional areas – 0.56. This will relate quite closely to the total volume of iron, and so its weight.

# Some interpretation

Something of the nature of the iron can be inferred from the treatment that it must have been given. The roves had been hammered out. The nails had been clenched over the roves by hammering to form a burr over them. This does suggest wrought iron.

Descriptions copied from Wikipedia, and validated from other sources:

* Wrought iron is an iron alloy with a very low carbon (less than 0.08%) content in contrast to cast iron (2.1% to 4%). It is a semi-fused mass of iron with fibrous slag inclusions (up to 2% by weight), which gives it a "grain" resembling wood that is visible when it is etched or bent to the point of failure. Wrought iron is tough, malleable, ductile, corrosion-resistant and easily welded. Before the development of effective methods of steelmaking and the availability of large quantities of steel, wrought iron was the most common form of malleable iron. It was given the name *wrought* because it was hammered, rolled or otherwise worked while hot enough to expel molten slag. The modern functional equivalent of wrought iron is mild or low-carbon steel. Neither wrought iron nor mild steel contains enough carbon to be hardenable by heating and quenching.
* Mild steel contains approximately 0.05–0.25% carbon making it malleable and ductile.

General reading suggests that the Anglo-Saxons at that time would have smelted the iron. This is heating up the ore with a chemical reducing agent to a temperature which is high enough to work, but not so high it produces molten metal. The result is that very little carbon then reacts with the iron. When the source of the ore is bog iron (limonite), then ‘bog’ iron is produced, important across Scandinavia in medieval times. In any case, much working of the smelted material would be required to produce wrought iron.

# Conclusions

Very limited evidence remains regarding the fastenings used to hold the Sutton Hoo ship together. The rivets were definitely iron, probably wrought iron; and the wood they were used through was probably oak . The positive evidence for trenails is scanty.

# History

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| **Status** | **Date** | **Author** | **Details of change** |
| Published for Symposium. | 6/10/18 | Paul Constantine Joe Startin | Published after two drafts |
| Draft 0.1 | 15/1/19 | Joe Startin | Inserted Evans’ view concerning oak into section 4.1. Expanded section 5.1, comparing the use of iron, copper and aluminium. Added History section. |
| Issue 1.0 | 7/4/19 | Joe Startin | Absorbed Section 2 into Section 1. Clarified limited information from 1939 on trenails. Clarified how samples of metallic iron would be needed for chemical and metallographical analysis. Removed words concerning possible use of copper or aluminium for the rivets, as not relevant to a document concerned with the archaeology. |
| Draft 1.1 | 16/4/20 | Joe Startin | Added copyright notice at beginning. |
| Draft 1.2 | 2/8/21 | Joe Startin | Information about drawings of fastenings on Science Museum (1939) added to section 2. Added section 3.3 about radiographs and drawings in Bruce-Mitford (1975). Added section 3.4 comparing 1939 and 1975 interpretations. Changed header, removed footer. |

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