



Digital computer model of the completed replica ship

# BUILDING A REPLICA OF THE SUTTON HOO 'GHOST SHIP'

Currently being undertaken by a team of maritime experts and volunteers, **John Greeves** talks to Master Shipwright **Tim Kirk** about building a full-size replica of the Sutton Hoo burial ship

When Basil Brown began digging in 1939 on Mount 1 in Sutton Hoo, Suffolk, he had no idea that the excavations would turn into one of the greatest discoveries in British archaeology. Brown was soon joined by a team of eminent academics and professionals. Not only was the team dazzled by the gold and silver treasure and artefacts uncovered, they were also intrigued by the imprint of a great ship, now believed to be the final resting place of King Raedwald, the 7th century ruler of the Anglo-Saxon kingdom of East Anglia.

The wood from the approximately 27m ship hadn't survived; all that was left to excavate at the time was an extremely fragile impression, which was formed from a thin crust of sand that had hardened with the decomposition of decaying wood. The 3,598 rivets remained in very much their original position, in the sand, with stake runs of planks, which were instantly recognised. The 'ghost ship' as it's has often been called, also showed the regular spacing and location of 14 pairs of tholes – primitive rowlocks. The ship had been subject to enormous pressures of twist and tilt in the ground, and its distorted shape was certainly 'broken backed' or 'hogged'.



Sutton Hoo Ship burial excavation, 1939 – photographic archive Mercie Lack – courtesy of the British Museum



The Royal Burial Mounds at Sutton Hoo



Life-size metal sculpture of the Sutton Hoo ship

After being buried for 1,400 years, the ship's planking at either end of the vessel was missing with 2.2m lost from the bow and 1.76m from the stern. Fortunately, with records available from the original and later re-excavation in 1967, it's been possible to deduce the most likely lines of the vessel when fed into a digital CAD programme.

In 2016, Paul Handley, an independent naval architect, began the design phase for the replica ship, starting with a calculation of its lines. Much of the computer modelling was undertaken by Dr Julian Whitewright and Pat Tanner from Southampton University, who used 3D scanning to create the computer model that'd be used to build the ship.

The rebuilding of the Sutton Hoo Ship is being undertaken by the Sutton Hoo Ship's Company – a team of around 80 specialists and volunteers – in the town of Woodbridge, in the Longshed, which is located on the opposite side of the River Deben from Sutton Hoo. Project Manager Jacq Barnard described what they hope to achieve: "Our aim is to understand what the ship was capable of, which will in turn help us to establish how the original was used and

why it was important enough to warrant a burial chamber. From the grave goods, we know that the Anglo Saxons were highly skilled when it came to craftsmanship, but we're learning that their shipbuilding capabilities are awe-inspiring. While it may look simple in profile, when it came to construction, the ship was incredibly advanced."

## Overview of the ship

The clinker-built Sutton Hoo ship is 26.1m long with a 4.4m wide beam and built mainly of green oak. The original craft was built with thousands of iron rivets – 650kg in total – and treenails, which are the wooden pegs used to secure things together. Although the lines of the hull's exterior measurements can be accurately predicted, little is known of the internal structure. The original ship was stripped of all internal features, including oars, thwarts – seats – spars and likely the rudder, too. This conundrum needed to be addressed. Master Shipwright Tim Kirk and his team are tasked with calculating measurements such as the height of the sole – deck – nature of seating arrangements, foot bracing and how the ship was steered.

Tim calls this "reverse engineering." He uses the tholes – oar pivots – among his approaches to deduce some placement of the ship's missing features. A half physical section of the midships and a one-fifth scale model of the ship were also built to aid understanding of the construction. The ship will also comprise 26 unique frames – ribs – from multiple pieces of curved timber, some of which are three, two and one parts – cruck frame. The framing will contain the following:

- **Floors** – cross the centreline and provide much traverse strength;
- **Futtocks** – attach to the ship's floors and frame sides;
- **Rongs** – combining a floor and futtock.

## Anglo-Saxon tools

As far as possible, traditional methods of Anglo-Saxon ship building, using tools from that period, are being used. Little evidence exists on the Anglo-Saxon use of saws; instead, they appear to have relied on a variety of axes to cut and shape their wood. Some of the notable tools being used for the build include felling axes, forest axes and the tee-axis or shipwright's axe.



Partway through lifting the stern-post into place





The tree follows the stem underloute's pattern incredibly well

The tee-axes are bespoke and made by Alex Pole Ironworks. A range of mallets and wedges are also used to cleave timber including large 14lb oak-headed mallets. Spoon augers have also been made, which drill the wood – one for the treenails and the smaller one for rivets, and for more delicate work, chisels are used. Tim is astounded at how proficient his team has become with their axe working in just a relatively short period of time.



Alec Newland completing the final profile of the inner face of the stern

#### Keeping the build authentic

Tim explains how Julian Whitewright and Pat Tanner produced the computer model and the fair lines for his team. Tim's team then lofted – drew – these to full size. "We started with the ship's cross-section followed by the ends and made full size patterns, so we could then go into the forest and find the right trees. The build uses large green oak and finding the appropriate timber up



Joint between stern underloute and stern-post treenails and caulking

until now has proved challenging," he said. For example, the keel log took 18 months to find. The oak is largely donated, with much coming from major estates in East Anglia. Tim estimates that it'll take between 12 and 20 oaks to complete the ship, but a lot will depend on finding the right curved timber. The project makes use of modern technology and machinery, but Tim is determined to keep this influence to a minimum in a bid to ensure the building process is as authentic as possible.

The 'molds' – temporary softwood frames – were installed to maintain the ship's shape during the build. Saxons wouldn't have used them, but as Tim explains, they ensure the integrity of the Anglo-Saxon hull without deviating from the ship's line. The station molds are painted black so they can be digitally removed while a photographic and video record is made of the ship in-build, without the need to remove temporary parts for filming.

The ship's backbone took over 2,000 hours to complete, and much of the work has involved using axes to work the timber. The ship's keel was first laid down. The overall backbone consisted, essentially, of five components: stem, stem underloute, keel, stern underloute and stern-post. A piece of green oak measuring around 13m x 40cm x 15cm was cut as a blank. "We sawed a blank out of the top-half of that great long log. It was such a valuable piece of timber; I couldn't risk us getting it wrong during cleaving, so we used a chainsaw mill. The keel still wasn't long enough, so extensions called the stem and stern underloutes with natural curves



A shipwright's tee-axe

were added using stepped scarf joints attached with willow treenails, in order to meet the overall dimensions. The stern underloute was worked completely with axes. The large curved log had V-shaped notches cut out and these were removed using a variety of axes, including the tee-axe, to produce a flat surface. The keel blank was also worked by hand and when completed, placed horizontally on a strongback – a sturdy frame that's very solid and very level. The bow underloute, along with the lower stem, was sawn out of a curved log and finished with a combination of axes and chisels. The underloutes and keel were then bevelled out using chisels for the garboards – the first strake of planks or plates laid on a ship's bottom next to the keel. Next, the stern-post was hollowed out for the planking, then the molds went on attached with ribbands and stringers to set out the planks' widths. The timber components were then hoisted and jointed into place. The lower stem section was turned through 180° to form the stem's upward thrust and similarly, the aft underloute and stern-post. The stepped scarfs that secure the ship's backbone aren't only attached with treenails but also have joint caulking based on the *Nydam Oak Boat* – a Saxon-era ship

discovered in a bog in Denmark, which is 300 years older than the Sutton Hoo ship.

Tim and his team are already cleaving logs for the planks. "The wedge-shaped sections that come out of the cleaved log will be converted into 25mm planking," he explains. To make these, the log is halved, quartered, then cleaved into eighths and even sixteenths if it's really big. All this planking is needed for the nine strakes – a strake is a complete run of planking – on each side of the hull.

When the build reaches this point of construction, the frames will go in along with the strakes. "All the planking is unique; there's no uniformity of width or curve. They're all different and they all change, particularly in the ends of the lower streaks. On these there's probably 50 or 60° of twist as well as curvature," Tim comments. The five lower strakes will go on first along with the lower permanent framing. Next, the upper planking and framing will be added before the molds are removed. The ship will then be fitted out with sole – deck – sole bearers, thwarts to sit on and a side rudder, all of which are reverse-engineered from the tholes' positions. Besides construction of internal features, a number of experimental oars will be made of various lengths and shapes, in order to determine the best design.



Initial lifting of the stern-post

#### The anomaly

The ship is believed to have 20 benches suitable for 40 oarsman, but during the 1939 excavation, archaeologists couldn't find the tholes in the middle of the ship. Were they removed to build the burial chamber or could there be another explanation? Tim explains: "It could've been where the King and his retinue sat; it might've been for cargo or it was possibly also a sailed ship, and that's where the rigging went." We'll never truly know. From a rowing



Splitting the log for planking



Stern-post once erected



Knotting out a piece of planking



A treenail is hammered in to join the first two parts of the keel on the replica ship





Molds going on the main build – at the side is the fifth sized model

perspective, the best position for this is in the middle but future trials may help to establish the way the boat was manoeuvred. In 1993, Edwin Gifford built *Sae Wylfing*, a half-length model of the Sutton Hoo ship in softwood, which proved to sail very well with the wind abaft the beam with a single square sail, but she wasn't so impressive going to windward.

### Looking to the future

Tim is amazed at what the build has revealed so far in terms of Anglo-Saxon craftsmanship: "What we're discovering in terms of the ship's technology and design, particularly techniques and craft skills, is that they were fantastic craftsmen." If all goes to plan, the Sutton Hoo Ship's Company is hoping to launch in 2024. Extensive sea trials will take place, which will allow them to see what the ship and crew can do in terms of performance on river and sea, as well as its handling of wind and tide.

Hopefully, this will resolve the long debate as to how the ship was propelled, be it by oars, sail or using a combination of both. Answers will also be forthcoming in terms of the ship's use and what she might have carried. Trials will also determine safe sailing conditions, and therefore, where the original vessel might have travelled. ✂

### FURTHER INFORMATION

The Sutton Hoo Ship's Company – [www.saxonship.org](http://www.saxonship.org)

Tours are available and it's possible to sponsor a rivet for someone's birthday or Christmas present, or even an important anniversary

Anglo-Saxon artefacts can be seen at the Sutton Hoo Ship burial, in room 41 of the British Museum



It's hoped the replica will be completed by 2024



Now it's complete, you can start to appreciate the real shape of the ship's backbone