Reinventing the Wheel

(The Design, Construction and Installation of the Brake Wheel)

Why a Brake Wheel is needed

As the sails rotate they turn the wind shaft which runs through the centre of the (green) brake wheel. The brake wheel meshes with the wallower, a horizontal wheel on the drive shaft.

Because the brake wheel meshes with and turns the wallower, the drive shaft also turns and powers the milling machinery.

Research and planning

Trust volunteers have built up their knowledge of mills and milling from books, films and visits. Planning for the brake wheel utilised this knowledge and included a visit to Heage Windmill in Derbyshire to examine their brake wheel. Advice was also obtained from a mill consultant to confirm that the Trust's plans were appropriate.

Clasp arms

Cross halving dovetail joints were used on the clasp arms. This requires one side of the joint to be cut at an angle which increases the rigidity of the joint when the two halves are out together.

Rim

The timber had been purchased roughly cut in circle segment shapes as the Trust did not have the tools for such a heavy cutting task.

It then took several sessions to plane the surfaces to a consistent level, as well as tone the ends so that they were a perfect fit in the circle.

Although the wheel was made from four year old seasoned oak, there was

significant movement in the timber as it dried out from week to week.

Weights were used to prevent the wood from warping as this required the surface to be planed level again.

Joints were cut out of the rim ends so that quadrants could be held together with carefully crafted wedges.

Because of the movement in the wood, each wedge was tailor made for a specific joint.

The rim segments were held in place by a band which was tightened by a ratchet. This prevented the timber from expanding outwards between work sessions.

The rim of the brake wheel comprised three sections:

- A centre section comprising four quadrants, the clasp arms were attached to this section.
- An outer section on each side of the centre section. Each comprised six segments which were carefully positioned to avoid points of weakness by overlapping the quadrant joins.

The brake wheel is held together by approximately 100 bolts. The ¾ inch holes had to be drilled through 10 inches of three section rim or 12 inches of two section clasp arms.

This was a considerable task which took a number of sessions (and drill bits) to complete. The force needed to drill the holes required standing on the wheel to apply sufficient power.

The wheel was so large that it only just fitted in the width of the workshop / education centre.

Cast iron teeth

A professional pattern maker was used to make the pattern for the cast iron teeth. Great care was required to ensure that the teeth were at the correct angle. This was a difficult calculation as the brake wheel is 90 degrees to the wind shaft which (for optimal efficiency of the sails) is 10 degrees off horizontal.

The more pieces the lighter their weight, but each join is a risk and a challenge. It

was decided to have a hollow area at the base of each set of teeth which would reduce their weight. This also saved money as the cost was proportional to the weight.

The teeth were placed on the brake wheel to confirm that they made a rough fit. This was the first time that the end product could be viewed. Many visitors were really excited by the project.

The brake wheel needed to be evenly balanced, placing 1¾ tons of cast iron off centre had to be avoided. A bespoke measuring device was made to mark the rim with the position of the edge of the cast iron teeth.

That was the easy part. Placing 198.4 pounds (90kg) of cast iron on to the rim was hard enough. Placing it in the precise position was challenging.

Each segment of cast iron teeth required a lot of fettling to remove the rough edges and ensure that the edges abutted to each other as closely as possible. This took several sessions and wore out lots of grinding discs.

Even with the attention focussed on the castings, the wood could not be neglected. The wood needed constant attention to keep it level.

Pre installation preparations

The restoration of the mill had included the provision of trap doors between most of the floors. However, millers did not need to take materials into the cap, so there was not a trap door in place.

A new trap door had to be made and the risk assessed to ensure that nobody would fall down the hole when working in such a confined space.

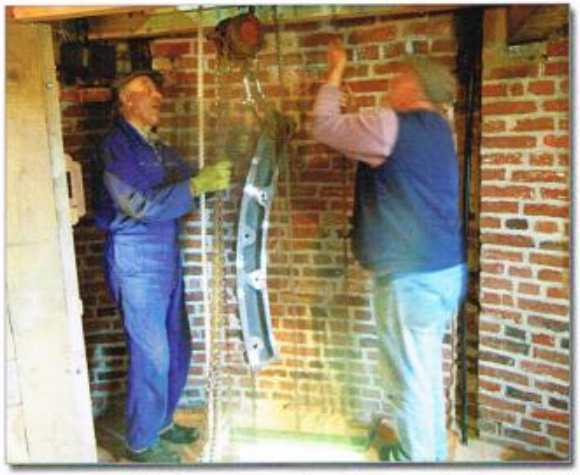
A pulley system was set up and the rope tested for weight.

The chain hoists were also checked as they were used for the heavier cast iron teeth. The wind shaft needed to be manually turned to the fitting position. There were regular discussions to resolve all the issues and to agree the plan of action to install the brake wheel. It was essential that at the beginning of October everyone followed the same plan.

Dismantling and moving

To dismantle the brake wheel all of the metal nuts had to be unscrewed. These were placed in separate bags for each size.

There was so much friction as the wood gripped the metal studs that they had to be physically knocked out with some careful persuassion. The bolts were stored in



different sized boxes.

Heavy timbers such as the quadrants which made the central section of the rim were very heavy. It was not just the weight, the quadrants did not have handles to catch hold of which made it particularly difficult when going through doorways.

The outer layers of the rims came off before the quadrants but needed to go back on after the quadrants had been fitted.

They therefore needed to be stored. This was not an easy process when the mill and workshop were both fully used. At the bottom of the mill, each piece of timber was securely attached to the rope before it was hauled to the cap.

Installation

Assembly of the brake wheel began by putting the clasp arms together around the square part of the wind shaft. The clasp arms were then wedged into their permanent position.

The first of the quadrants could then be fitted at the bottom of the wheel. The bespoke measurer ensued that the height was correct. The wheel was then turned so that the next piece could be added.

Already the brake wheeL was starting to look quite magnificent in the cap. The wheel dominated the whole of the cap and working area was at a premium. Once the quadrants had all been added it was time to move on to the outer rims which had been brought up to the cap during the quadrant fitting. There were careful checks at each stage.

With the wooden part of the brake wheel completed, it was time to ensure that the parts stayed in place by fitting the studs and nuts. Stud by stud the wheel was securred.

The whole process of dismantling, moving and installing the wooden brake wheel had only taken a day and a half.

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