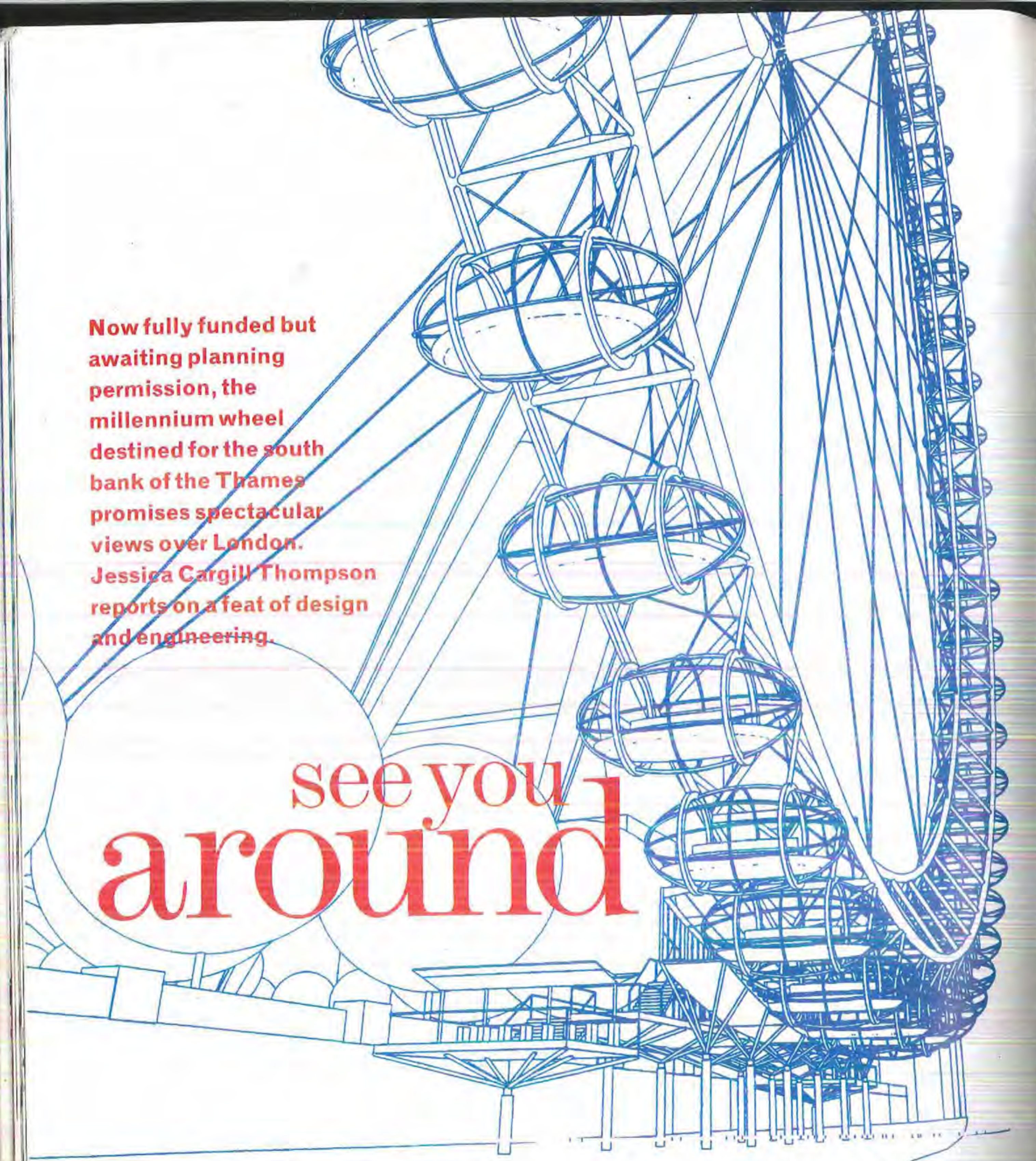


# see you around

**Now fully funded but awaiting planning permission, the millennium wheel destined for the south bank of the Thames promises spectacular views over London. Jessica Cargill Thompson reports on a feat of design and engineering.**

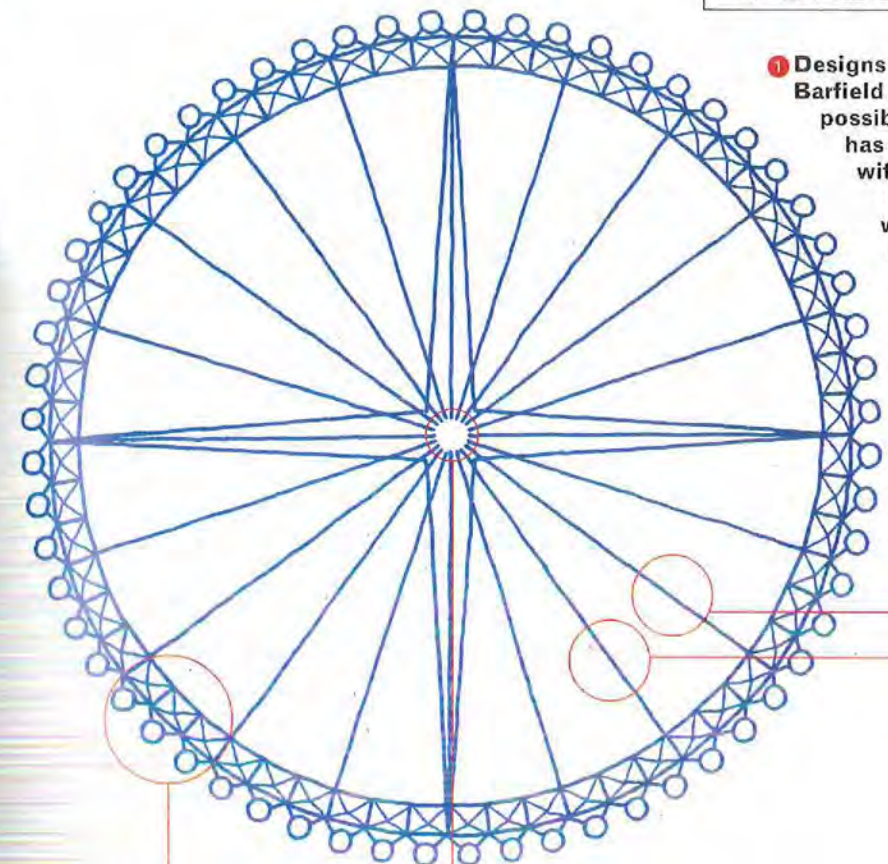
At 150 m, the millennium wheel will be the world's highest Ferris wheel, beating the current record holder in Tokyo by 50 m. It will also be the fourth-tallest structure in London, and its elegant design and similarly elegant engineering solution will make it an exciting, if temporary, addition to the capital's skyline.

The £9m project, which has received the full financial backing of British Airways, is earmarked for a site on London's South Bank, opposite the Houses of Parliament. An application for planning permission, first sought two years ago, is about to be resubmitted with detailed design. If the application is successful, the wheel will open in summer 1998 and remain operational for five years. After this it may be dismantled and moved elsewhere.

Everyone involved in the millennium wheel idea is keen to make it as energy-efficient as possible, which means using renewable energy sources as the means of power. Engineer Ove Arup & Partners aims to meet 50% of the power needed to turn the wheel from renewable sources – half from solar cells on the wheel's capsules and half from a grid arrangement of current turbines in the Thames. Any extra energy gained from the solar cells will be fed back into the grid. This method is also designed to provide enough energy to get the capsules back to base in an emergency.

The wheel will rotate at 0.4 m/s, one-quarter of walking speed, and take 20 minutes for one full rotation. The mechanism has yet to be fully developed but may involve hydraulics or electrics.





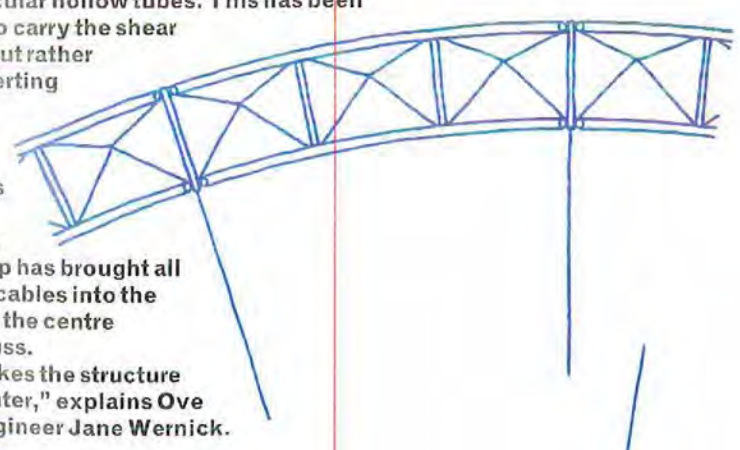
❶ Designs by architects David Marks and Julia Barfield aspire to making the wheel as light as possible – both physically and visually. This has meant aiming for maximum transparency within the rim.

One of the earliest designs featured a ring with just one stiff arm across its diameter. However, to support its own weight over a whole semicircle, the ring would have had to be extremely strong and therefore thick and heavy.

Funding from British Airways allowed Ove Arup to investigate several different options. Its chosen solution is similar to a bicycle wheel, essentially consisting of a thin rim attached to the central hub by thin cables. This gives the wheel stability and means the rim is required to span short distances between spokes.

❷ The rim itself has been reduced from a width of 12 m for the single-brace option to a slender 6 m. It is formed from an equilateral triangle-shaped prestressed steel truss made from circular hollow tubes. This has been braced to carry the shear forces, but rather than inserting the bracing across the faces of the triangle, Ove Arup has brought all bracing cables into the nodes at the centre of the truss.

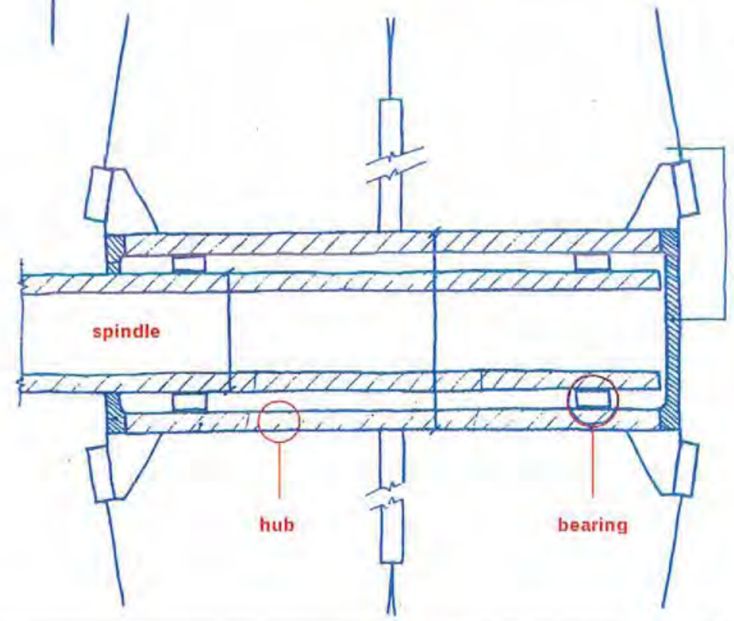
"It makes the structure look lighter," explains Ove Arup engineer Jane Wernick.

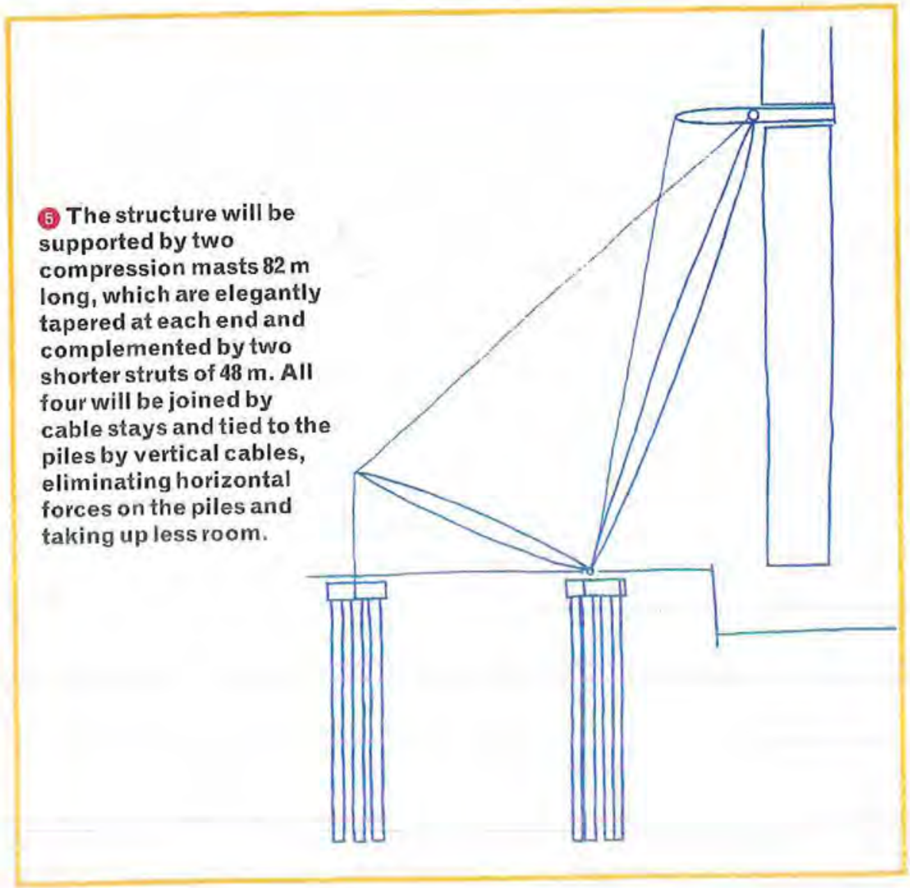


❸ Most of the spokes only go to the bottom of the triangle on the rim, but some additional restraining cables have been inserted that go to the outside edge of the rim. These will stop the wheel twisting and the rim moving relative to the hub. All cables will be prestressed so they are always in tension.

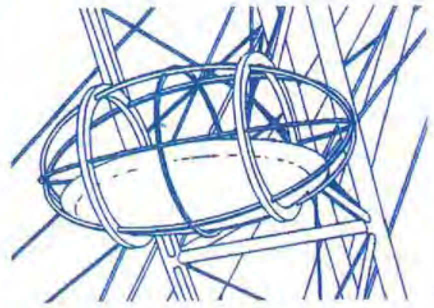
"These are second-order effects, but we have to consider those things as well," says Ove Arup's Wernick.

❹ An 8 m long sleeve at the centre of the wheel fits over a spindle. Both are made of forged steel cylinders with 300 mm thick walls. These are separated by an assembly of spherical roller bearings of 1.8 m inner diameter to allow the wheel to spin.





⑤ The structure will be supported by two compression masts 82 m long, which are elegantly tapered at each end and complemented by two shorter struts of 48 m. All four will be joined by cable stays and tied to the piles by vertical cables, eliminating horizontal forces on the piles and taking up less room.



⑥ The 60 capsules will be transparent ovoids, attached to the rim by rigid ring beams rather than the traditional hanging basket arrangement. Each 2 m high capsule will seat 16 people – roomier than a Tube train. The centre section will be glass, but the curved ends' complex geometry makes polycarbonate a far cheaper option.

To keep the floor of the capsules horizontal throughout the 20-minute ride, an inner ring inside the ring beam rotates the capsule at the same speed as the Ferris wheel.

Fan-assisted ventilation and vents in the roof will stop capsules getting too hot in summer. Air-conditioning is ruled out, as one important aspect of the brief is to keep the project as green as possible.

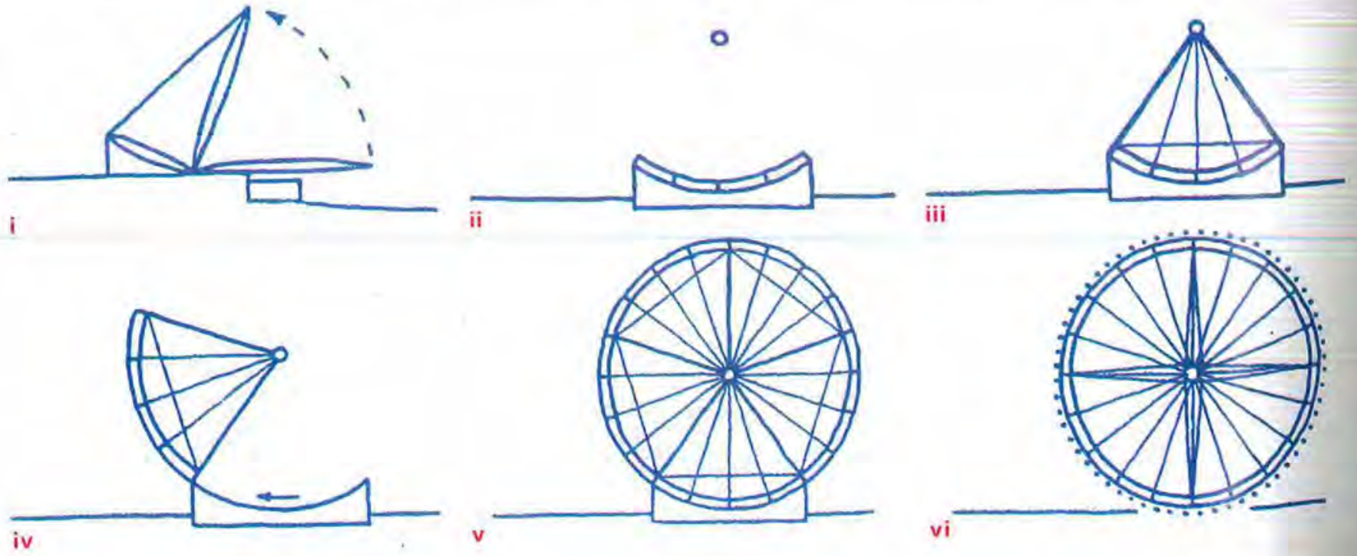
## THE CONSTRUCTION PROCESS

Although it was easy to see that this would be the lightest solution, the problem was how to build it. Laying the wheel on the ground and hoisting it into position was out of the question – not only would the structure weigh 1800 tonnes, but it would require a crane with a 75 m reach. The solution found was to insert temporary stiff arms that will be removed after construction.

The wheel will be built from the river using a platform on top of a caisson (i). Prefabricated sections of the rim, each 1/20 of the circumference, will be brought to the site by river and attached to the radial cables at ground level (ii). After each group of four pieces is constructed, a stiff arm will be inserted and the whole segment prestressed to keep the wheel rigid (iii and iv) as it is built up. Only when all five segments have been completed (v) will the five radial arms be removed. Extra cables will then be added to resist torsion of the rim, and the capsules will be attached, again from ground level (vi).

"The good thing is that all the construction work is done at low level which is much safer," says Wernick.

The entire construction programme will take 18 months from awarding the tender to the wheel being operational. This includes five months for steelwork erection and three months for the capsules to be attached. Other associated structures such as ticket booths will be built at the same time as the wheel is being constructed.




client British Airways architect David Marks Julia Barfield engineer Ove Arup & Partners quantity surveyor Gardiner & Theobald