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Building a white water canoe course

The white water site in May 2008, before the start of building work

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Building things is really complicated. Not only do you have to be out in the cold and wet and have a huge range of practical skills, but you need great science skills too. ***Nick Treby*** *explains.*

If the chemical composition of the mortar isn't right, the bricks won't stick together. If you haven't calculated the forces acting on the steel support structure, the roof could fall off. If the steel is too thin it will bend and the building will fall down.

And there's lots of science that few people ever think about. What materials should I use so that a fire won't spread? How do I get fresh air in and out of the building without it getting cold or feeling draughty? How much lighting do we provide so it's not too bright (and costs lots of money to operate) and not too dark?

There are scientists and engineers whose lives are devoted to these issues, the things you never notice unless they get them wrong. I am an expert in something like that – acoustics.

When you go the cinema you'd know if you could hear the action film next door whilst you were watching the silent film *The Artist*. Or if the auditorium was so reverberant that you couldn't understand a single word of the dialogue. Or if you were sitting below a noisy air-conditioning grille.

But what about a white water canoe course, being built in a country park for the Olympic Games?

The white water site in May 2008, before the building work

Get digging

This project was a huge landscaping job. Diggers, excavators, dozers, you name it, it was needed to dig out a 10 000 m^2 lake, a 300 m long canoe slalom course and a 160 m long training course.

That is potentially a very noisy activity. And it can't be done over a few weeks. It's made trickier because people live right around the edge of the site, and you can't disturb them in the day, or at night.

So the scientist has to calculate how much noise all this work will generate at these people's homes. We then calculate how the noise will travel to the homes.

It's quite easy to find out how noisy these machines are. We can measure it, and there are standards that tell you.

Sound measuring equipment

But we need to know what happens to the sound waves once they leave the machines. It's physics on a grand scale, in 4 dimensions (3 dimensions of direction, and time as well).

Noise annoys

Noise is measured in decibels (dB). Every time you double the distance away from the machine making the noise, the noise goes down by 6 dB. So if the machine is 100 dB at 10 m, it's 94 dB at 20 m, 88 at 40 m, 82 at 80 m and so on. Every time the noise level goes down 10 dB, it is half as loud. If it just changed 3 dB, you probably wouldn't even notice. After working out your distances you take a bit more off depending on the ground. If the ground is soft it will soak up more noise than if it is hard. (That's why everything outdoors sounds different on a snowy day.)

It is affected by the wind and the temperature. It's affected by anything in the way that might screen it, or might reflect the sound towards it. And it's affected by the distance. So we know how noisy it is at the homes.

But how do we know if the people next to the canoe course will be affected by this? If it's already noisy, because of cars and lorries, then they might not notice the construction work. But if it's quiet they will. This one was in between.

Researchers have spent many years doing experiments to find out how much noise disturbs people who are trying to sleep, or to work, or watch TV. And they've found out whether people will just be a bit disturbed by it (so would put up with it for a while) or whether it will affect them physiologically – causing stress, anxiety and even heart disease.

Lorry noise

Now when you dig out all that earth, you have to take it away. By lorry. And so we had to calculate how much extra noise all those lorries would make on the road between the Canoe Course and the main Olympic Park.

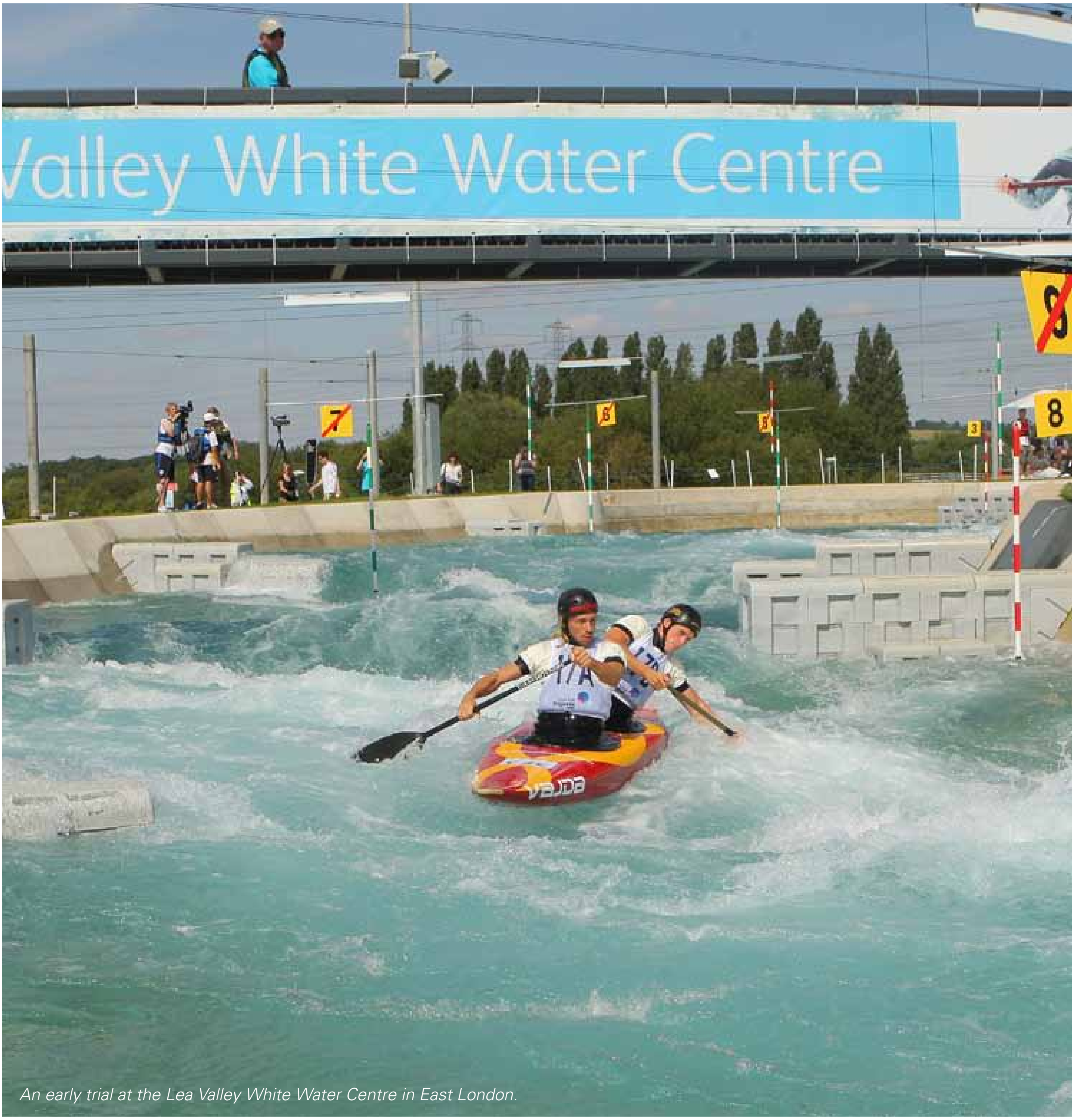
Noise from lorries is generated by their wheels interacting with the road. As the wheels go round they squash air out, which makes a noise. This is the main noise source at high speeds. At low speeds you will hear their diesel engines rumbling away. So we can calculate how much noise they make, and the effect on people. We need to know the distance from the road to the houses, the speed of the lorries, the number of lorries, the type of road surface, the gradient and lots of other things. We can do all this using the physics that explains how a sound wave travels.

Pumping water

Once the digging has been done, there are lots more acoustic things to consider. The pumps need to move 15 m^3 every second. That's a lot of water, and needs big pumps. It wouldn't be a good day out if whilst watching the Olympics you were deafened by the pumps, and felt the ground shake when they were running. So we set noise limits for the pumps, and a pump engineer helps to design and build them so they are quiet and vibration isolated.

15 m^3 of water weighs 15 tonnes

A pump being lowered into position



An early trial at the Lea Valley White Water Centre in East London.

The competitors need somewhere quiet to prepare and get changed. So there's a building where we help design the walls and windows so they have a nice calm place to get ready. Because we know what happens when a sound wave hits a window, we can calculate how much is bounced back and how much passes through. So we know how noisy it will be inside, and can make the windows thicker if we need to, or save money by making them thinner.

An audio engineer will work out where to put the loudspeakers for the tannoy, so the supporters can hear what is going on during the event.

So even for a canoe course, there are plenty of noise issues that have to be considered. And understanding wave motion – which you can see when you shake a slinky spring – means that we can make sure that when it comes to the Olympic Games nobody notices the acoustics!

About the author

Nick Treby read Engineering Acoustics and Vibration at Southampton University, and has subsequently gone on to an 18 year career in Acoustic Consultancy. He mainly works on buildings, but has visited petrochemical plants, golf courses, oil rigs, sports stadia and anywhere else that has a need for acoustic advice. He is a Senior Consultant at Spectrum Acoustic Consultants Ltd, who work all over the world from their offices in Bedfordshire, Lancashire and Switzerland.