

## 'Bubbles in Beijing: The story behind the Watercube Aquatics Centre'

**An LKL Maths-Art seminar by  
Patricia Wackrill  
Tuesday 8 December 2009,  
6.00–7.30pm  
London Knowledge Lab,  
WC1N 3QS**

The Watercube made a spectacular impression at the Beijing Olympics, resembling at night a glowing cube made of blue bubbles. The story of the Watercube's design can be told as the mathematical history of efficient packing in 2 and 3 dimensions. Lord Kelvin studied soap bubbles and defined the 'Kelvin problem' in 1887: how can space be partitioned into cells of equal volume with the least area of surface between them, i.e., what is the most efficient soap bubble foam? Kelvin's solution consisted of polyhedra with 8 hexagonal and 6 square faces; a model makes it easier for one to be convinced that such shapes do fit together to fill space. For more than 100 years, Kelvin's solution was believed to be the most efficient foam structure. Then, in 1993, two physicists in Dublin, Denis Weaire and Robert Phelan, used computer-based search to, surprisingly, identify a more efficient structure. This uses two kinds of irregular polyhedral cells, and models are even more necessary to enable one to see how they squeeze up to one another to fill space.

Ten years later, a team of architects and structural engineers were looking for a design idea for the Olympic Aquatics Centre which would portray the theme of water and also symbolise some Chinese ideal in cultural terms. They already knew about using bubbles to form a structural cage for a building; they discovered that the Weaire–Phelan structure could be used as a basis for a structural frame for a cuboidal building, and present an exterior surface which appears organic and 'random' whilst actually being a repeating pattern. The story is not over yet: Anthony Gormley may well realise his idea for a sculpture of a man, based on the same structure, for the Dublin Docklands.



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*PATRICIA WACKRILL developed a love for geometry and pattern during her childhood in Ireland, surrounded by souvenirs her parents had brought back from the Sudan with Islamic interlacing, and by Christmas cards with Celtic knotwork. This led her to a mathematics degree at Oxford, and a passion for geometry that has continued to this day alongside a professional career as a university teacher and mathematical researcher. A current enthusiasm for constructing 3-dimensional models threatens to overwhelm the Wackrill household!*

**All welcome. No registration or ticket required, but an email to [lk1.maths.art@gmail.com](mailto:lk1.maths.art@gmail.com) is appreciated to assist with planning.**

## ***LKL Maths-Art seminar series***

Website and archive: [www.lkl.ac.uk/events/maths-art](http://www.lkl.ac.uk/events/maths-art)

This seminar is part of a regular series of maths-art seminars held at the London Knowledge Lab, usually on the second Tuesday of each month during term times. To receive email announcements about events, subscribe to the mailing list at: [www.dcs.bbk.ac.uk/mailman/listinfo/lkl-maths-art](http://www.dcs.bbk.ac.uk/mailman/listinfo/lkl-maths-art).

We propose these seminars as explorations of the connections between "mathematics" and "art", where both terms are understood broadly: art implies visual art (painting, drawing, sculpture, computer graphics, video), architecture, music, textile art, literature/poetry (and others), and mathematics implies both mathematics as a discipline and the related disciplines in science and engineering for which mathematics is an essential means of expression and communication.

Next seminars: January 12, Gregory Epps on curved folding; February 9, Alan Sutcliffe and John Sharp on circles.

The seminar organisers are John Sharp and Phillip Kent. We welcome your suggestions about speakers or topics for future seminars; email us at [lkl.maths.art@gmail.com](mailto:lkl.maths.art@gmail.com).

## ***Getting to the London Knowledge Lab***

Nearest tube stations are: Holborn (Central, Piccadilly lines), Russell Square (Piccadilly line). Approximately 10-15 minutes walk from either station.

