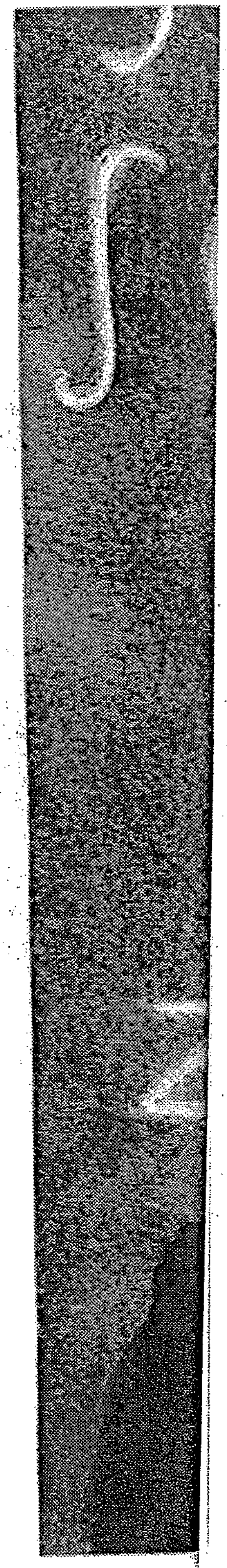
Formula gets its big finish



Tedium can lead to revelation, writes **Lewis Smith**

BOREDOM during a lecture proved to be the key to finishing a formula that has baffled the best mathematical brains since the 19th century. Darren Crowdy's mind was wandering as he tried to listen to a talk on vortex dynamics when he hit on the solution to the incomplete equation.

"I was in Paris listening to a talk when it suddenly came to me," he says. "It just clicked. I stood up and left the room. I was so excited that I had to get up to work on it there and then."

The Schwarz-Christoffel formula was created in the 1860s as a tool to help designers work out if the structures they wanted to create would stand up to stress or fall apart. It proved invaluable in the design of countless buildings, bridges and aircraft but was limited because it would not work for irregular shapes or those with holes.

Crowdy, a specialist in applied mathematics at Imperial College, London, has succeeded in completing the formula that has eluded scientists for 140 years. He realised that by applying a different mathematical technique — the theory of Schottky groups, developed 20 years after the original equation — the formula could be improved to cope with any shape.

The mathematician was first put on to the idea of using Schottky groups in Sydney at the 2003 International Congress of Industrial and Applied Mathematics. He had been working on Schottky groups and realised as he listened to Alan Elcrat, from Wichita State University in Kansas, the US, describing the problems of the Schwarz-Christoffel formula, that it could provide the solution.

The Schwarz-Christoffel formula was developed independently by German mathematicians Elwin Christoffel in 1867 and Hermann Schwarz in 1869. Its uses in predicting the success or failure of designs before a single rivet, nail or screw is bought derive from the formula's ability to test the stresses that will be brought to bear.

Now that it has been adapted to cope with other shapes it is likely to be used more frequently by designers. Its main uses so far have been in modelling airflow over wings of aircraft while they are still on the drawing board and in explaining the shapes that are created in nature, such as patterns of expansion by bacteria.

"This formula is an essential piece of mathematical kit which is used the world over," says Crowdy, whose findings are published in the journal *Mathematical Proceedings of the Cambridge Philosophical Society*.

"Now, with my additions to it, it can be used in far more complex scenarios. In industry, for example, this mapping tool was previously inadequate if a piece of metal or other material was not uniform: for instance, if it contained parts of a different material or had holes. With my extensions to this formula, you can take account of these differences and map them on to a simple disk shape for analysis in the same way as you can with less complex shapes without any of the holes."

John Elgin, head of mathematics at Imperial College, says: "Darren is perhaps the world's leading expert in solving challenging problems involving multiply-connected geometries. This longstanding classical problem was a natural one for him to tackle. It is an important result: his new formula will appear in the next generation of textbooks."

The Times