Peter Giblin, Holgate Session Leader

Research Interests

My research area is singularity theory and its applications to differential geometry and computer vision. I have worked on many geometrical problems such as the study of light caustics by reflexion in mirrors, symmetry of various kinds, recovery of three-dimensional shape from two-dimensional images (that is the objective of 'computer vision') and geometrical properties of surfaces in 3- and in 4-dimensional space. In all these cases particular interest attaches to the question of what happens when *something changes or moves*—this might be a curve, surface, mirror, scene in the world or camera position or orientation. Naturally such questions involve a significant use of calculus, and in fact singularity theory can be seen as one of the significant directions in which differential calculus has moved in the last 50 years or so.

There is a Rough Guide to my research on my webpage, http://www.liv.ac.uk/~pjgiblin/newsletter.pdf

Most of the dozen students I have supervised for PhD worked in the area of singularity theory, and several of their theses, as well as other works by my students, are on my webpage http://www.liv.ac.uk/~pjgiblin This includes a number of essays written by high-school students under my supervision during work experience or Nuffield Bursary summer projects. A full list of my publications is also available via a link from the same webpage.

Outreach Work

At the University of Liverpool we had a succession of EPSRC grants under the 'Partnerships for Public Engagement' heading (or similar ones) which allowed us to employ outreach officers to develop the *Funmaths Roadshow* http://www.maths.liv.ac.uk/lms/funmaths/ and take it into schools nationwide (and sometimes internationally). I was the Principal Investigator on a number of these grants, before I retired. The grants also helped us to run a *Maths Club* http://www.maths.liv.ac.uk/~mathsclub/ which has flourished for many years now. (The University now employs outreach officers as permanent members of staff, taking over from the EPSRC grants.) My personal outreach work has revolved around going into schools to give mathematics talks, the Maths Club, and the two organizations *Mathematical Education on Merseyside* (MEM) http://www.maths.liv.ac.uk/~mem/ and the *Liverpool Mathematical Society* (LivMS) http://www.livmathssoc.org.uk I have given many masterclasses and other presentations in the University and in schools under the auspices of these organizations. I have also run interactive 'problem-solving' workshops where the problems/puzzles are more formal.

Some suggested presentations/workshops

As a rule I make my presentations *interactive*, that is involving the 'audience' in actually doing some mathematics. Thus a more descriptive name is often a 'workshop'. Only rarely have I given 'talks' or 'lectures'. My presentations are generally aimed at Year 11/VI form but can be for Years 8-9 which is the age of MEM Masterclass pupils. Many sample presentations (roughly Year 11/VI form) are on the Maths Club archive http://www.maths.liv.ac.uk/~mathsclub/talks.php though I rarely repeat an old talk without redesigning it to some extent. Here are a few ideas I have used in the past. I hope also to develop a presentation or two on mechanics.

1. *Card tricks that are 'doomed to succeed'* There are many mathematically based card tricks which, though puzzling, can be explained with some elementary mathematics. This presentation can involve a smallish 'audience' trying the tricks for themselves or, for a larger one, volunteers can try them out. The presentation can be combined with ideas about shuffling cards and with other things that 'must work' such as number puzzles.

2. *Counting* This can involve various aspects of combinatorics: counting things in different ways to obtain striking results. Fibonacci numbers figure in this quite often, as do magic squares, partitions and probability.

3. *From maxima and minima to surface shape* This is a somewhat more formal 'talk' which starts with problems of maxima and minima solved without calculus and moves through properties of curves to fairly modern ideas of using mathematics to measure the symmetry of shapes and to compare one shape with another.

4. *Universal cycles* This also has connexions with card tricks, though it is mainly a mathematical topic, involving use of graphs (networks) in the plane to find sequences of 0s and 1s with special properties (de Bruijn sequences). This enables a set of five cards chosen from a pack to be identified knowing only which are the black cards. There are many ways in which this topic has been developed over the last decade, and I talk about some of them. There is opportunity for audience participation.

5. *Graphs, trees and Brussels sprouts* Graphs (networks) in the plane are studied, Euler's theorem (vertices minus edges plus finite regions = 1 for a connected graph) is introduced and the theorem used to de-bunk a pencil and paper game, showing that the winner can be predicted from the start.