SIAM UK and Republic of Ireland section annual meeting 2009

The UK and Republic of Ireland section of SIAM held its 13th annual meeting on January 9th 2009 at the University of Limerick, Ireland. Approximately thirty mathematicians from across the UK and Republic of Ireland attended. Membership of the section continues to grow, currently standing at over 400 members (252 nonstudent, 153 student)370 (compared to 187 members when founded in 1996 and 370 last year): approximately one-third of the membership are students.

Andrew Fowler (University of Limerick) opened the meeting with an illuminating talk on the formation of drumlins. Drumlins are elongated hills, almost whale-like in shape, that are thought to have resulted from glacial flow and are an extremely common phenomenon in many parts of the world. For example, there are thousands in Ireland and Scotland. The study of drumlins (a word which has Irish origins) and how they were formed goes back to the early 1800s when Sir James Hall investigated them. It has been proposed that the formation of drumlins occurs through and instability associated with the flow of ice over a wet deformable till. Andrew proposed a mathematical model which describes this instability and showed how a simplified version of the model may be solved numerically to produce two-dimensional wave forms with the properties that are associated with drumlins.

Andy Wathen (University of Oxford) was the next speaker, with a talk on preconditioners for PDE-constrained optimisation. Optimisation problems with constraints which require the solution of a partial differential equation (PDE) arise in many areas of the sciences and engineering, in particular in problems of design. Andy mainly discussed the class of problems known as distributed control where you have a PDE of the form $\mathcal{L}(u) = f$ and you wish to minimise the function $f(u, f) = \frac{1}{2}||u-\hat{u}||_2^2 + \beta||f||_2^2$ subject to $\mathcal{L}(u) = f$ being satisfied, where β is a positive real value, typically $\beta \approx 10^{-2}--10^{-4}$, and $\hat{u}$ is a known desired state. After discretisation, a large linear system must be solved which is symmetric but has both positive and negative eigenvalues: the system is sometimes called a saddle-point system. Additionally, the coefficient matrix associated with this linear system contains the discretized PDE (and its adjoint) as some of its sub-matrices. Andy showed how efficient preconditioners can be devised by combining known preconditioners for generic saddle-point systems with effective methods from computational fluid dynamics for (approximately) solving the sub-matrices within the pre-

conditioner. He showed that his overall method would converge in a mesh-independent number of iterations and that the time to solve the problems increased linearly with the problem size.

The business meeting followed. After a brief report on the finances and activities funded in the last year, the members were reminded that the posts of section president and vice-president become vacant at the end of March 2009, and nominations were solicited. At the time of writing this process had been completed: David Silvester (Manchester) and Alan Hegarty (Limerick) will be taking up the positions of president and vice-president, respectively, on 1 April. A short discussion on SIAM Student Chapter took place. It was agreed that the Section should support the Chapters within the UK and Republic of Ireland and, as part of this, a page would be added to the website which would contain a list of suggested speakers that Chapters could call on to give suitable talks at their meetings. The membership has since been asked for suggestions and such a webpage is being compiled.

After lunch, Robin Knowles (TotalSim) described how TotalSim uses mesh-deformation based optimisation within computational fluid dynamics (CFD). TotalSim are fluid dynamics consultants who specialise in the application of CFD to engineering design. In particular, they do a lot of work for the motorsports industry and cycling teams, for example, they have been used by the very successful British cycling team. Robin presented the components of the design process that they use to design components for various motor vehicles. In particular, a dart throwing methodology is used to pick different design parameters, they then model the designs and compare them. Rather than forming a new mesh for each design, a mesh-deformation procedure is used to move between designs. Since the meshing procedure is very costly in terms of time, this mesh-deformation approach allows the company to consider many more designs in the time available to them. The use of wind tunnels in the design of vehicles for use in motorsport is extremely expensive (sometimes prohibitive for teams) and, hence, this sort of computer-aided design is extremely valuable to teams in order for them to optimise their performances.

The theme of optimisation was continued by our international speaker Annick Sartenaer (University of Namur, Belgium) who spoke on multilevel optimisation. Recently, multilevel methods have grown to be very popular within, for example, computational fluid dynamics. Annick discussed how multilevel approaches can also be used within optimisation. One straightforward idea is to use multilevel approaches to solve the large linear system that

must be solved during each iteration of an optimisation method. However, there are many other possibilities and Annick showed how multilevel approaches can be successfully applied within the overall optimisation method and not just the linear algebraic parts of the method.

After a short break, Dave Hewett, the president of the University of Oxford SIAM Student Chapter, spoke are the experiences he had had in forming a SIAM student chapter. He also described the events that they have had since the Chapter was set-up: Pizza & PDEs, two student conferences, and drinks receptions to date. The Chapter has a large membership (100+) which comprises of both undergraduate and postgraduate students. He encouraged everyone to consider setting up a student chapter.

James Gleeson (University of Limerick) concluded the meeting with a talk on cascade dynamics on complex networks. He discussed models of epidemics: for example, the transmission of infectious diseases through communities and computer viruses over email networks; the adoption of innovations and the spread of fads over social networks. In certain circumstances, interactions between the nodes of the network may cause initially localised effects to propagate throughout the whole network. James discussed how such cascades are strongly dependent upon the structure of the underlying network and on how they spread, and showed how they can be modelled using undirected networks where the state of a node is updated according to the state of the node's immediate neighbours.

An enjoyable meeting was rounded off with an excellent dinner.

Information about the UKIE section can be accessed from links at `http://www.siam.org/sectchapts/sections.htm`*. The next annual meeting will take place in Edinburgh on January 8th 2010.*