Meeting 4 Report – National Structural Integrity Research Centre, Granta Centre, Cambridge

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The fourth UK Fluids Network Smoothed Particle Hydrodynamics (SPH) Special Interest Group (SIG) was hosted by Brunel University London's National Structural Integrity Research Centre at the Granta Centre in Cambridge on the 10th of July 2019.

This meeting had the express purpose of bringing industry and those working on SPH as a research topic together to find common ground and goals. Attendees from the SIG were present as well as a number from industrial research backgrounds interested in the method. To this end there were also a number of representatives of the various SPH software packages available to give overviews of current capabilities and future directions.

SPH SIG at the Granta Centre, Cambridge

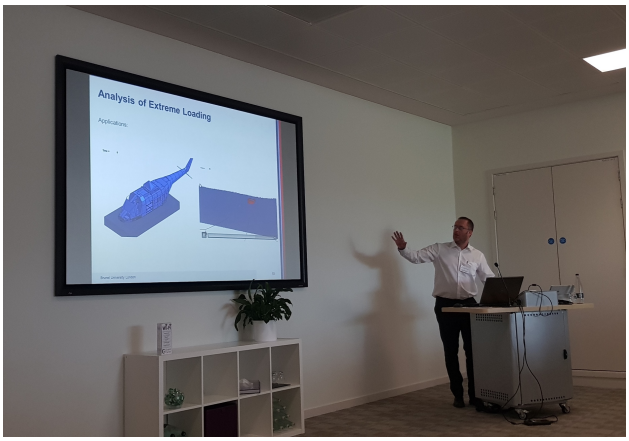
The following organisations were represented by SIG members and those from industrial backgrounds: Brunel University London; UKRI Science and Technology Facilities Council (STFC); Centre for Modelling and Simulation (CFMS); The University of Bristol; The University of Cambridge; Altair; National Institute of Geophysics and Volcanology (INGV, Italy); Heriot-Watt University; Arup Group; Nextflow Software; The University of Sheffield; The University of Manchester; Simpact Engineering Ltd; TWI Ltd; ESI Group

1.0 Presentations

1. **Stephen Longshaw (UKRI STFC):** SPH: The UK SIG, the method and the software

2. **Benedict Rogers (The University of Manchester):** Multi-physics SPH for complex problems – From fundamental physics to the development and application of new paradigms
3. **Karl Travis (The University of Sheffield):** From atoms to the continuum: Use of Molecular Dynamics and SPH for engineering applications
4. **Yeaw Chu Lee (Heriot-Watt University):** Modelling multiphase and surface tension dominated flows
5. **Aidan Chalk (UKRI STFC):** SWiFT: More than just a universe in a box
6. **Tom De Vuyst (Brunel University London):** Application of SPH to solid mechanics problems
7. **Gareth Lee (Altair):** Numerical simulation as a tool for EV powertrain development
8. **Tomas Rendall (The University of Bristol):** SPH applications in aerospace and composites manufacturing
9. **Benedict Rogers (The University of Manchester):** DualSPHysics: The open-source unified simulation tool for applications of violent hydrodynamics
10. **Paul Groenenboom (ESI Group):** Industrial simulation of fluid flow and fluid-structure interaction with SPH from the VPS software
11. **Amaury Bannier (Nextflow Software):** Practical uses of SPH in automotive, aerospace and marine industrial applications
12. **Laura Rovira Crespo (Arup Group):** SPH capabilities in LS-DYNA
13. **Giuseppe Bilotta (INGV):** The GPUSPH particle engine: a high-performance parallel implementation of SPH for industrial applications and scientific research

Laura Rovira Crespo from Arup presenting the SPH capabilities of the LS-DYNA software suite



Tom De Vuyst from Brunel University London talking about the application of SPH to solid mechanics problems

2.0 Meeting Overview

This meeting differed from past SPH SIG events in that it aimed to provide a contextual overview of SPH technical developments by SIG members with a view to defining new and interesting industrially-driven problems. With this in mind, presentations were also given by those involved in the development of SPH software, these were both from those involved in open-source projects and also from commercial software vendors. Talks came from both those within the SIG and from external invited speakers.

Technical content was therefore fairly high-level, however some interesting details of the physics of problems were discussed. Presentations around available SPH software and its capabilities were well received and to see all of the major SPH software solutions showcased in a single event was an interesting and useful exercise. Available software to deliver the promise of SPH is a typical question that comes from potential industrial users (this method looks very interesting but how do I embed it into my company) and therefore having both the method and the software discussed together was a successful format.

3.0 Meeting Outcomes

The event was well attended and provided an in-depth overview of the state of SPH as both a practical method and research topic. The inclusion of current software implementations of the method ensured that its potential use was more than just theoretical, with direct pathways to adoption shown.

The meeting made it clear that SPH has a place in both industrial and academic work-flows, with examples showing applications to fluid sloshing, high-velocity impacts, oiling, entrained media transport and many others. It was also clear that the state of SPH software is now relatively mature, with a good mix of open-source and commercial packages available, all providing strong pre- and post-processing capabilities and most utilising high-performance computing, including advanced GPU implementations.

The day saw a number of guided question and answer group discussions which uncovered a number of potentially interesting use cases and ultimately concluded that the SPH community, through organisations like the SPH SIG and SPHERIC, should aim to drive a set of industrially relevant benchmarks to allow the different solvers to prove their capabilities to those new to the method in terms of ability to capture physics and also in terms of computational performance.

4.0 SPH SIG Future

The future direction of the SPH SIG was discussed. In the short-term the next meeting will be hosted by the Durham University on the 28th and 29th of November and will be called *SPH: Greatest Hits (so far)*, where some of the most impressive and note-worthy achievements of the SPH method to date will be shown, alongside a training event designed to bring the method to those outside of the SIG. As of July 2019, the SIG's membership stands at around 80.

More generally, as the UK Fluids Network funding model ends in January 2020, a number of questions were asked about how best to keep the SPH SIG going beyond this date. The conclusion was that as the per-person cost of organising a SIG event is low (around £50 in 2017-2019), asking those wishing to attend to pay shouldn't have a negative impact on attendance and member interaction. In order to facilitate this, the organisers of each of the 5 UK Fluids Network funded events will form a committee (with the scope for this to grow and change over time) who will look to organise a SIG meeting once or twice a year (or whenever a significant event in the SPH community calls for it), with the goal of continuing to keep the UK Fluids Network web resources up to date for as long as they are supported. Formal announcements around this new structure will be made at the November SIG meeting and the SIG mailing list will continue until further notice.