The day started with a presentation by Andy Acred (University of Cambridge) on the topic of water bath modelling. Andy first explained how the differences between different types of buoyancy sources can be used to interrogate ventilation flow patterns associated with different types of heat source in buildings. The topic of dynamic similarity was then introduced, with various dimensionless parameters being reviewed and discussed in terms of helping the audience understand the relevance of the water bath experiment findings and the interpretation of these with respect to potential air flows in a building. Examples of the technique being extended to explore the interaction of wind and buoyancy forces were then shown, before a discussion on discharge coefficients, exchange flows and unstable flows.

The next presentation was delivered by Malcolm Cook (Loughborough University). Malcolm discussed computational fluid dynamics (CFD) modelling of buoyancy-driven natural ventilation. The talk discussed the RANS, URANS and LES approaches to modelling fluid flow, using case studies of plume interactions and situations in which multiple steady state solutions can arise. The talk highlighted the high degree of computational resource which is required in order to generate results which are reasonably accurate and also the care and attention to mesh size and time stepping which is needed.

This was followed by a further presentation on water bath modelling by Shaun Fitzgerald (Breathing Buildings). The talk discussed how the technique can be used to guide engineers in the development of appropriate analytical models using theory from CIBSE AM10. The presentation explained how the determination of different solutions is aided by the technique, and used the Contact theatre in Manchester as a case study to show that multiple steady states are readily observed. Finally, Shaun showed an example of unsteady flows in an environment with steady forcing (constant heat flux), to explain how challenging it can be to identify all potential flow patterns.

The first presentation of the afternoon was given by Stephane Sanquer (Meteodyn) on the topic of natural ventilation of buildings in an urban area with the CFD tool UrbaWind. The presentation described how wind driven ventilation in a building can be modelled using a network technique which captures flow path resistances in a building, but that a good description of the appropriate wind pressures around the building are needed. UrbaWind is one of the tools available which can provide wind roses, distribution and time series of the air change rate through a building. From this, the thermal comfort conditions can be estimated. Stephane shared several case studies to illustrate the application of this design tool.

Wayne Pearce (RWDI) and David Hamlyn (RWDI) then gave a presentation entitled “Wind – analogue or digital?” This talk discussed the different strengths of wind tunnel experiments and CFD for assessing the potential flows and pressures around buildings. The talk highlighted that there are features which are simply too difficult to accurately capture using CFD, and that both techniques are used by RWDI in their design work. There was a good discussion on the characterisation of gusts, which is important in terms of assessing ventilation flow through apertures and indeed the associated impact on thermal comfort for occupants. David concluded the presentation with a number of case studies, highlighting the value in combining the CFD and wind tunnel approaches in a given design exercise.

The penultimate presentation of the day was given by Janet Barlow (University of Reading) on the DAPPLE Dispersion Project: Comparison of Full Scale and Wind Tunnel Experiments with CFD.

Research work on gas dispersion in an urban setting was described, with inner city London being used as an example. The challenges of adequately capturing vortex shedding and consequent dispersion lateral to a mean flow were reviewed. Finally, Janet shared findings from data collected at the BT tower in London, which highlighted the potential differences in air quality and temperature in the vertical direction and which are of course important when designing natural ventilation in tall structures.

The final presentation of the day was given by Jannick Roth (Windowmaster) on the topic of Building Openings – Smoke Testing vs CFD Modelling. Several examples of CFD were shown, with heat sources in a room at discrete points to represent sensible gains from occupants. Smoke testing experiments from Aalborg University were presented, and modifications to CFD were discussed to improve the agreement between the techniques. One of the intriguing CFD results shown indicated that the coldest spot at occupied level in a 7m deep room ventilated by opening windows was the point furthest from the window. Jannick commented that in reality a cold plume would likely develop near the window and hence real flows may differ in reality from CFD output.

The afternoon concluded with a discussion on the different modelling techniques available to engineers. It was agreed that the different approaches of modelling available (dynamic thermal, CFD, water bath, analytical, wind tunnel, smoke test, zonal) all help build knowledge of the ventilation flows and importantly can be used to aid the communication within design teams and client meetings. The discussions highlighted the importance of applying engineering knowledge in the use of modelling tools – in the wrong hands all of the tools can generate results which are wrong or misleading. The real power of the modelling tools lies in their appropriate use, and combination in design projects, so that the right tools are used to address the questions being asked at a certain stage in the design process. This may suggest the use of wind tunnel, analytical, zonal and perhaps laboratory modelling in the early stages in a design programme, with more detailed CFD analysis and dynamic thermal modelling being used later on.