OMEGA Aviation Sustainability Short Course

From the 17th –19th June, AEF staff attended the OMEGA Aviation Sustainability Short Course at Cranfield University, alongside delegates from airlines, airports, environmental NGOs, aircraft manufactures, academics, and civil servants. This document provides a summary of the presentations given over the three-day event, and thus a glimpse of the latest research evidence across the range of topic areas that the Omega partnership is addressing.

More on the course, and on OMEGA's other activities, can be found at www.omegapartnership.org/

The science of aviation and climate change:

- *Non-CO2 effects*
  Professor David Lee discussed the concept of Radiative Forcing (an index of the importance of a potential climate change mechanism expressed in watts per square metre). This included the effects of nitrogen oxides, contrails and aviation-induced water vapour, sulphates and soot. Whilst Professor Lee did not support the use of a radiative forcing index multiplier in calculating the overall impact of aviation emissions, he emphasised that alongside CO2 there were other significant factors (or 'species') that increased the warming impact of aviation. One key finding was that aircraft are currently designed to cruise at *precisely* the most damaging level for the production of contrails, and cruise heights may need to be altered to mitigate these effects.

- *Future scenarios*
  Dr Sarah Raper gave a broad overview of future projected anthropogenic emissions and their potential impacts on climate change projections. She described the projected upward curve of aviation emissions based on her own study and assessment of other scientific literature and hypothesised an increasing share of anthropogenic emissions coming from aviation.

- *Metrics and science trade-offs*
  Professor Keith Shine described the metrics used by the IPPC to describe global temperature changes, the use of aviation multipliers and trade-offs. He explained the disparities between some internationally recognised metrics and considered the volatility of some measurements, arguing for greater clarity and transparency over how values were arrived at.

Air traffic management:

- *Fundamentals of Air Traffic Management, and ATM's role in improving environmental performance*
  Dr Tom Reynolds discussed the role of ATM in environmental impact mitigation, and the importance of reducing traffic congestion. The emergence of environmental impacts as an ATM concern has only been very recent with safety, system performance, technological capability and cost versus benefit still primary considerations. Managing growth in the future and projected increases in airport capacity will undoubtedly require substantial revisions to ATM procedures. These could include CDA (continuous descent approach), derated thrust, and steeper approaches, and should be implemented as soon as technologically appropriate, for maximum gains on emissions, preferably on a regional or even global basis.

- *Current issues and challenges for air traffic management in India*
  Dr Rajkumar Pant presented a picture of a rapidly growing industry facing infrastructure limits, where route congestion leads to delays of 30 minutes or more in the air as a matter of course.

Growing levels of disposable income have seen the industry grow from 13 million passengers in 2001-02 to 117 million in 2007-08. Growth rates are currently at 8.5%, estimated to continue at 5-6% for the next 20 years. Demand has outstripped capacity and certain routes are suffering as a result. The Mumbai-Delhi route, for example, is the sixth busiest in the world, handling over 50% of the country's air traffic. The implementation of more advanced ATM technology has helped, but poor radar coverage and the rapid growth in demand means extensive modernisation is necessary.

Local air quality:

- *Airport emissions*
  Professor David Raper described the work carried out by Project Sustainable Development Heathrow (of which he was a Chair) as "the gold standard" in emissions quality monitoring, referring all delegates to the project report. He reviewed air quality standards and objectives with regard to pollutants (including nitrogen oxides, carbon monoxide, particulate matter, hydrocarbons, sulphur dioxide and carbon dioxide) associated with aircraft, ground support equipment, airside and landside vehicles, electricity generation, fuel sources and fire training. He described at which point in the landing/take off (LTO) cycle emissions are concentrated, and how these might be reduced. Of particular interest was the section on the increasing road transport emissions landside at Heathrow, with reference to their Nox components.

- *Dispersion modelling*
  Professor Rex Britter's presentation covered his findings around Heathrow activities, emissions, dispersions, concentrations, exposures and health effects. He outlined the modelling techniques used to study exposures, and discussed how robust or otherwise the results were. Overall, Professor Britter suggested that EU and UK local air quality regulations were targeting the wrong pollutants in their stringent measures against Nox and CO. Work in the USA has largely focused on particulate research, as the evidence suggests this has a greater effect on mortality in a local context.

- *Emissions measurements*
  Dr Mike Bennet looked at the chemistry and effects of the species produced from aviation. He described the different kinds of apparatus used to collect and measure the plumes from aviation and how to ensure accuracy in their collection.

Technologies:

- *Developments in engine and airframe design: fuel efficiency prospects*
  Professor Ian Poll outlined the benefits that a blended wing aircraft could bring in terms of efficiency, reduced fuel burn and improved laminar flow. Other tactics for reducing overall fuel burn included operating with a full payload, increasing engine efficiency, reducing the structural mass by using lighter materials (such as carbon-fibre composites), increasing the lift-to-drag ratio and, finally, finding a better source of fuel.

- *Advanced open rotor powered aircraft*
  Dr Rod Self described the development of advanced open rotor aircraft engines. He described the evolution of aircraft engines and what characteristics were desirable in such hardware, key amongst these being reduced fuel burn and reduced noise. Achieving the ACARE targets of 50% reductions in fuel burn and CO2 emissions, an 80% reduction in NOX emissions and a halving of community noise levels by 2020 will be impossible without substantial innovations in engine technology, he said. Open rotor aircraft may present the best means of achieving this, as they are more efficient in terms of fuel consumption and Nox emissions. However, they have a severe noise penalty, due not to the decibel quality of their noise, but to its tonal quality, which is more annoying to communities.

The aircraft are also slower, meaning they are unsuitable for long haul flights. Work continues to try and decrease the noise problem and harness the benefits of this technology, although manufacturers will find it extremely difficult to meet all the ACARE targets given the trade-offs between noise, Nox and fuel burn.

- *Alternative fuels*
  Professor Chris Wilson outlined some of the issues surrounding the development of alternative fuels for aviation. As an engineer, he defined the 'best type of fuels' as those requiring least engine modification to operate safely. Other criteria for a sustainable fuel included engine performance, emissions, noise, safety implications and blend limits. Using alternative fuels could have implications for aircraft design, engine design, the environment and socio-economic factors. Those alternative fuels that could, with further development, be used in conventional aircraft included synthetic kerosene derived from the Fisher-Tropsch synthesis process, bio-diesel, liquefied gases and bio-ethanol. He described the tests required to establish whether fuels were fit for purpose, the known engine issues that would affect the use of alternatives, and some unresolved problems including how the lifecycle of engine components could be affected, the handling and storage of some more sensitive fuels, and of course, the complex economic and environmental factors surrounding their production.

Demand, Economics and Market Issues:

- *Community responses to aircraft noise*
  Dr Ian Flindell described the impacts of aircraft noise on communities. He outlined the differences between the 2007 ANASE and 1983 ANIS studies into disturbance caused by aircraft noise, and noted the significant rise in levels of community annoyance, hypothesising that a considerable portion of this could be due to increased numbers of noise events. He discussed the difficulty of explaining noise impacts to lay people, and described the work currently being undertaken to find better communicative metrics. He said that the stated preference work used in ANASE but criticised by some reviewers was nevertheless 'state of the art' and repeated the conclusions given by this and other similar studies, pointing out their consistency, but also the difficulties innate in this type of measurement. He concluded that the situation today is very different from that in the 1980s in terms of community reactions to noise, types of aircraft in operation and measurement techniques, implying that newer research was more accurate.

- *Costing Noise Impacts*
  Zia Wadud of MIT/Cambridge delineated some of the different methods for calculating noise costs, one route involving property prices (hedonic), and the other, health effects and concurrent costs. Wide disparities exist between different techniques. For example, whilst a study by Pearce and Pearce (2000) estimated the cost of aircraft noise to the UK economy from Heathrow alone as between £37 and £67 million, the Department for Transport has assessed the costs to the whole of the UK as only £25 million (although Dr Wadud believes this to be a severe underestimation). Ways of assessing noise costs include stated preference and revealed preference techniques. Dr Wadud has conducted a meta-analysis of several noise studies to link the variables for calculating noise costs. Modelling the effects of background and aviation generated noise separately is very important to obtain clarity of results. Some research indicates that aircraft noise impacts house prices only when information about noise levels is easily available to people considering a house purchase.

- *Business travel – the Icarus toolkit and best practice business models*
  Project Icarus, an OMEGA-funded project with which AEF has been involved, has been successful in persuading a number of blue-chip companies to commit to working to reduce their transport-related carbon footprint. 40% of air travel is business-related (and the number of business trips is growing at a rate of 5% a year), but 20% of this is 'escapable' or avoidable. Icarus assists

companies in identifying which of their travel is non-essential and how much time and money could be saved by holding remote meetings that new communications technologies can provide. It awards service suppliers with badges to demonstrate environmental commitments and strategies. This is delivered at point of sale to encourage the 'greening' of supply chains.

Dr Mason went on to describe the relative impacts of different aviation business models, and how these can affect the environmental impacts of carriers. Load factors, types of aircraft used, distances flown, frequencies of flights and services provided (such as real crockery and on-board duty-free sales) are all relevant. A workshop will be held in the autumn for interested parties.

- *Marginal costs of environmental abatement*
  Joe Morris of Cranfield University talked of the need for policy instruments and interventions to regulate the marginal costs of environmental abatement. These could be statutory, voluntary, or economic, each having a different impact on environmental purposes, and each with a varying degree of appropriateness. Engineered airframes, ATM enhancement, and fleet management are examples of possible measures. At an economic level, the cost of achieving abatement should be measured over the short, mid and long term. Easy wins include better operating practices and improved ATM, while harder, yet potentially more environmentally valuable schemes include early replacement of older aircraft. Combining design improvements with regulatory frameworks is the best way of achieving significant long-term gains.

- *Emissions trading schemes*
  Angela Anger from Cambridge University gave a brief presentation on emissions trading schemes, focussing on the projected impacts of the introduction of aviation to the European ETS. She identified some flaws with the system (such as impacts on newer market entrants) but said that the scheme is currently the most important European climate change policy in place. She disputed the need for APD to run concurrently, arguing that it should be regarded as an environmental tax.

- *Carbon offsetting to mitigate climate change*
  Holly Preston of Manchester Metropolitan University described the potential role of offsetting and the intricacies of the industry, including the core components of offset schemes, the costs of voluntary offsets, and standards of quality assurance with purchasers. Such schemes are only short-term solutions to the problem, she argued and the variety of procedures and outcomes available raises questions about the effectiveness and credibility of schemes. Carbon calculators vary, for example in their use of RFIs, which means the cost of offsetting the same journey can vary by hundreds of pounds. A more expensive offset is not necessarily a better one. How 'carbon credits' are generated is another bone of contention: some solutions like forestry projects have been shown to be ineffective in immediate footprint reduction. The whole industry would benefit from independent external regulation and standardisation, accurate calculators and transparent reporting. Take-up would need to be drastically increased for offsetting to become effective.

- *Carbon neutral airports*
  Holly Preston described the need for carbon accounting and management, and the implications of implementing neutrality schemes at airports. Strategies could include technology changes, operational enhancements, and energy conservation, with a systematic approach to environmental management including the use of performance indicators and corporate reporting (which should be regulated).

  Airports should define the scope for their accounting, which may include direct greenhouse gas emissions from all sources owned by the company (statutory and mobile combustion), indirect GHG emissions from energy purchases, and indirect emissions from upstream and downstream activities. Though flights provide 91.4% of most airports' carbon footprints, Ms Preston argued that controlling these emissions was the responsibility of carriers. This contentious point was debated by some organisations, who suggested that the claimed 'carbon neutrality' of some airports ignored the

fact that their very existence would increase CO2 levels, and argued that should they take responsibility for their area of business.

The total carbon footprint of an airport, excluding flights, is largely taken up by transportation, responsible, on average, for 68.8% of the total, of which 91.1% derives from passenger journeys. Airports can have a strong influence over this figure through better investment in public transport access schemes (such as rail terminals), discouraging ‘kiss and fly’ journeys (by friends and family coming to the airport simply to wave goodbye to an air passenger), and, as a last resort, offsetting transport emissions, perhaps using a portion of parking fees. Tackling these ‘easy wins’ can add momentum to solving harder problems. Transparent accounting of any actions should be communicated to all stakeholders, accompanied by robust evidence of effectiveness.