BRITISH SOCIETY FOR THE HISTORY OF MATHEMATICS

History of Mathematics and Flight
Concorde Centre, Manchester Airport
2 July 2022

A day of talks about the history of mathematics and flight. Flight will be broadly conceived to cover the flight of man-made objects and animals, flight formation, navigation and control.

The day will include a free tour of the Concorde flight deck, and tea/coffee at break times, but not lunch, as we wanted to keep the registration fee to a minimum. The conference centre is situated within the Runway Visitor Park, where there is both a café and an outdoor picnic area.

Travel directions

(https://www.manchesterairport.co.uk/at-the-airport/concorde-conference-centre/):

The Concorde Conference Centre is located within The Runway Visitor Park:
The Runway Visitor Park, Sunbank Lane, Altrincham, **WA15 8XQ**

By Car
From the M56, leave at Junction 6 and follow the A538 to Wilmslow. After approximately 500 metres take a left turn down Sunbank Lane. At the T-junction go right onto Wilmslow Old Road and follow the road to the Runway Visitor Park gates.

By Train
Manchester Airport train station is less than 3 miles from the Runway Visitor Park. You can catch the 200 bus from the station out to the Park.

Google maps link https://goo.gl/maps/AxTCBLZCCTUJPeS9A

Programme

09.50 Registration

10.10 Welcome

10.15 Kate Hindle (St Andrews): *D'Arcy Thompson and flight*

10.35 Concorde tour + Coffee

11.30 Jane Wess (Independent): *Benjamin Robins: Elegant Mathematics Versus Experimental Inconvenience?*

12.10 Deborah Kent (St Andrews): *A champion's counterexample? PG Tait and the flight of a golf ball*

12.50 Lunch break (lunch not provided, but there is a café and a picnic area in the Runway Visitor Park)

14.00 Isobel Falconer (St Andrews): *James Bell Pettigrew: reasoning by precise drawing?*

14.20 Jim Boyd (Essex), Gareth Roberts (Bangor), and Alwyn Owens (Bangor): *Stability in Theory, in the Laboratory and in the Air: William Ellis Williams' Campaign for Proof Positive (1904-1914)*

15.00 Tea

15.30 Tony Royle (Open): *When the Numbers Don't Add Up!*

16.30 Finish

Abstracts

Kate Hindle (St Andrews): *D'Arcy Thompson and flight*

D'Arcy Thompson (1860 - 1948) is most remembered for his influential book *On Growth and Form* (1917), which looked to maths to explain why biological creatures take the shapes that they take. In January 1917, a few months before this book was released, Thompson had a letter to the editor published in *Nature* titled "Stability in Flight". A month later Herbert Maxwell (1845 - 1937) - a baronet, politician, and fellow of several learned societies - published a letter in *Nature* as a criticism of Thompson's work. Thompson reacted to this criticism with a defensive response letter, showing that he was affected by it. This exchange also highlights how Thompson conceptualised advancements in maths as a guiding light for biology, showing how his views on flight coincide with his other biomathematical work.

Jane Wess (Independent): *Benjamin Robins: Elegant Mathematics Versus Experimental Inconvenience?*

While academically a constituent of fluid mechanics, practically ballistics was an important area of knowledge for nation states in the eighteenth century. William Mountaine, a mathematics teacher, wrote in 1781 wrote; 'it is not possible in the nature of things for any one kingdom to continue long in a state of peace, the art of gunnery has from time to time engaged the attention of the most eminent mathematicians.' However, the essential nature of the knowledge of the flight of cannon balls did not result in an efficacious mathematical description for a remarkable length of time. Whereas both Huygens and Newton had acknowledged the role of air resistance, textbooks continued to discuss parabolas following Galileo, Torricelli, Halley, and Cotes until the end of the 18th century. The obvious question is 'why?'

There may be several factors at play, including the status of Robins, who challenged the status quo, but it will be argued that beautiful and simple mathematics can be beguiling. As for the case of epicycloidal teeth in gearing, it seems many of those who advocated a mathematical approach were not completely au fait with the most advanced thinking on the topic, in this case by Huygens, Newton, and of course later and most effectively, by Euler.

Deborah Kent (St Andrews): *A champion's counterexample? PG Tait and the flight of a golf ball*

Nineteenth-century mathematician and physicist Peter Guthrie Tait (1831-1901) is well known for the *Treatise on Natural* Philosophy, which he co-wrote with William Thomson (later Lord Kelvin), and collaborations with James Clerk Maxwell. Less familiar are his aerodynamical studies from the 1890s, which resulted in over a dozen papers on the path of a rotating spherical projectile. Tait's culminating work on the trajectory of golf balls was experimentally tested in St Andrews with the help of his son, celebrated amateur golfer Freddie Tait.

Isobel Falconer (St Andrews): *James Bell Pettigrew: reasoning by precise drawing?*

James Bell Pettigrew (1832-1908) was a comparative anatomist, physiologist and pioneering aerobiologist. He occupied positions at the Hunterian Museum, London, the Royal College of Surgeons of Edinburgh, and the Edinburgh Royal Infirmary before becoming Chandos Professor of Medicine and Anatomy at the University of St Andrews in 1875. His interest in the flight of birds and insects had begun in the mid 1860s, and by the end of the decade he was experimenting also with artificial flight.

He made his name in 1873 with his outstandingly illustrated *Animal Locomotion*, more than half of which was devoted to flight. In 1879 he wrote the article on flight for the 9th edition of the *Encyclopaedia Britannica*, the "scholars edition". He is alleged to have made and tested small model aircraft and to have corresponded with the Wright brothers, before their successful 1903 flights.

Pettigrew's ideas on flight originated in close observations which he claimed were conducted "according to strict mathematical principles". This talk will investigate what he meant by this, and how these principles related to the precise drawings that he used to demonstrate his arguments.

Jim Boyd (Essex), Gareth Roberts (Bangor) and Alwyn Owens (Bangor): *Stability in Theory, in the Laboratory and in the Air: William Ellis Williams' Campaign for Proof Positive (1904-1914)*
The equations that determine the stability of aircraft were formulated at Bangor (Caernarfonshire) over the first two decades of the twentieth century, a formulation that was to prove remarkably durable, as fit for purpose in characterising the stability of *Concorde* or even the jumbo jet, as for the aeroplane-allsorts that took to the skies in the wake of the Wright brothers' *'Flyer'*.

While the stability equations have come, rightly, to be identified with George Hartley Bryan, Professor of Mathematics at the University College of North Wales from 1896 to 1926, others, both at Bangor and at the newly-founded National Physical Laboratory and the Royal Aircraft Factory, Farnborough, contributed in material and distinctive ways to their success. Not the least of these was William Ellis Williams, Bryan's first research student, who collaborated in the original mathematical analysis of glider flight in the first stability campaign that ended with its publication in 1904.

In this paper, attention centres on the contributions made by Williams to the second campaign that got under way in 1908, notably his success in attracting funding that enabled him to build the *Bamboo Bird* in the basement of the physics department at Bangor, one of the earliest aeroplanes of its day in a university setting, and on the measurements recorded in flights over Traeth Coch (Red Wharf Bay), Anglesey, in the summers of 1911 and 1912.

Tony Royle (Open): *When the Numbers Don't Add Up!*
The safe operation of aircraft is predicated on certain numbers adding up and falling within specified limits. When mistakes are made and these limits are exceeded, the consequences can be catastrophic and often fatal. I will draw upon several personal anecdotes and a selection of aircraft accidents and incidents to highlight the importance of getting the numbers right in aviation.