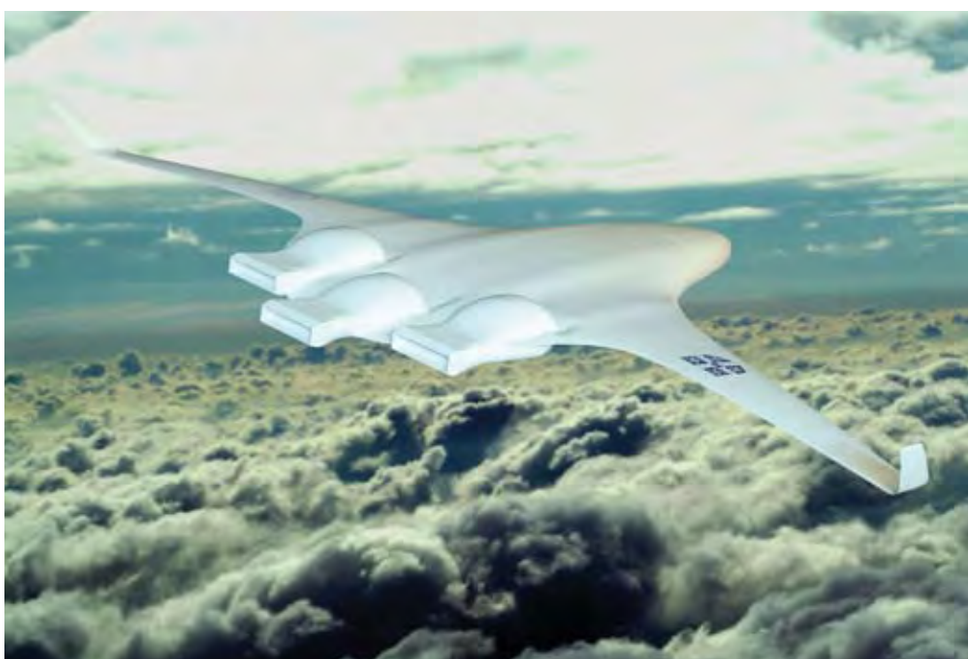
CREATING SILENT SKIES

PROFESSOR DAME ANN DOWLING CBE FREng

Working on Concorde – in a belated attempt by the makers to do something about noise – got Ann Dowling's career off to a flying start. Since then, noise, and not just from aircraft, has permeated her research. But what started off as a small but important piece of the picture grew to take in the whole aircraft. Her next move will take her on to even bigger systems – cities and how to make them more sustainable. Michael Kenward OBE talked to Dame Ann Dowling at Cambridge University.



A silent aircraft would look very different from today's tube-and-wing designs. The concept aircraft SAX-40 (Silent Aircraft eXperimental) © Cambridge-MIT Institute

Unlike for many of today's eminent practitioners of the subject, engineering wasn't unknown territory for Ann Dowling before university. Professor Dowling was already more than familiar with the profession; her father was an engineer with the Army. Even so, when it came to choosing a university subject, she opted for maths, albeit applied maths, "I was never quite sure whether to do maths or engineering. But I was always interested in applied things", she says.

A holiday job at RAE Farnborough brought engineering to the forefront of Professor Dowling's thinking. She first thought of working on fluid mechanics but couldn't muster much enthusiasm. "As I got further into learning about fluids, I discovered a lot of it was pretty well known. You can spend a long time just working for the next decimal point." So when it came to choosing a PhD subject, her Farnborough experience kicked in and she opted to work on aircraft noise.

Professor Dame Ann Dowling FREng (2000) © James F. Hunkin / National Portrait Gallery, London

The opportunity to spend time at MIT [Massachusetts Institute of Technology] came not long after Professor Dowling returned to research on aircraft noise. She puts this revival of interest down to advances in the numerical methods available to researchers. This change of direction was also her first opportunity, after 25 years of married life, to work with her husband, Tom Hynes, another Cambridge engineer who specialises in turbomachinery aerodynamics.

RESEARCH TAKES OFF

Then came Concorde. Conceived before anyone dreamed of picketing airports to protest about aircraft noise, the supersonic airliner promised to be the noisiest as well as the fastest way to travel. However, late in the aircraft's gestation, the designers came under pressure to quieten the airliner, which is how a relatively young engineer came up with some important findings even before she had completed her PhD.

Her work on Concorde gave Professor Dowling the makings of a PhD on the theory of jet noise and a career that has covered not just aircraft (and a pilot's licence) but also noise from tyres and underwater sonar systems. This progress has also taken her from working on components of a system – fuel combustion in gas turbines and its relationship with noise, for example – to thinking about entire systems, including whole aircraft.

NOISE REDUCTION

One recent highlight in Professor Dowling's career was as one of the people in charge of the Silent Aircraft Initiative (SAI) which started in 2003. This major research programme – part of the Cambridge MIT Institute (CMI), a joint venture between Cambridge University and Massachusetts Institute of Technology (MIT) – took Professor Dowling's interest in aircraft noise on to another plane, so to speak. No longer was the aim to reduce engine noise, but to start from scratch and design a new aircraft around an ambitious target for noise reduction.

The then Chancellor of the Exchequer, Gordon Brown, dreamed up the idea of bringing MIT to the UK as a way of injecting a more entrepreneurial mindset into the UK's universities. By coincidence, Professor Dowling learned about the idea of CMI while on sabbatical leave at MIT. By then she was running Cambridge's Division of Energy, Fluid Mechanics and Turbomachinery.

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SILENT PARTNERS

Their first joint research project was on helicopter noise. "Tom worked on what was happening close to helicopter blades. Once he had determined that, my bit was to look at the far-field sound that it would produce." Their work together with a small team enabled them to develop a new approach to helicopter noise.

While at MIT, Professor Dowling, her husband, and MIT colleagues asked themselves what was holding back the expansion of the aerospace business, and noise was a good place to start. In these days of climate awareness, shouldn't they have concentrated on designing something more fuel efficient? "I don't think the project would have had quite the novelty," she says. Plenty of people were already thinking about environmentally friendly, green aircraft. "We wanted to break out of the mould."

QUIETLY AMBITIOUS

Back at Cambridge, Professor Dowling helped to run a team of 35 researchers working on the SAI. The engineers, backed up by a considerable array of industry participants, set themselves an ambitious goal: to design an airliner so quiet you wouldn't hear it if you were outside the perimeter of an airport. In numerical terms, they wanted to devise an aircraft 25dB quieter than today's airliners, which are already pretty quiet compared to earlier generations. Around this time, Professor Dowling and Dr Hynes delivered the 2004 Wilbur and Orville Wright Lecture to the Royal Aeronautical Society.

As the SAI matured, the engineers did eventually turn their attentions to fuel efficiency. "At the beginning we were saying that it shouldn't have any worse energy consumption than current aircraft. By the end we had investigated the trade-offs and we had multiple designs. We could say 'So many decibels of noise reduction equals so many passenger miles a gallon'." Indeed, the project now continues with this 'green aircraft' focus, although no longer under the auspices of CMI, which has effectively come to the end of its planned life.

BLUE-SKY DESIGN

The SAI looks like no other aircraft; it is not just a long tube with wings stuck on the sides. "Setting a very ambitious target for noise levels made us look at the design of an aircraft – the integration of an aircraft, engines and the airframe – in different ways," says Professor Dowling. That led to some new ideas for aerodynamics and engines. "The important thing was to break away from incremental change, from current thinking."

The SAI certainly did that. "With the silent aircraft, the step change was going to a blended wing body," she explains. The large, delta-shaped aircraft is effectively a single structure. Unlike conventional aircraft, the SAI has an 'all-lifting' design, with the centre-body producing lift as well as the wings.

The novelty of the SAI's airframe and its engines explains why it could be quite some time before something like it ever gets off the ground. Boeing is planning wind-tunnel tests, but we aren't likely to see a new generation of airliners in the near future. Professor Dowling reckons it could take 30 years or so to build such an aircraft. This makes her much less optimistic than one person from Boeing, who has said publicly that they could do it in seven years. It is a matter of the resources needed, which would be considerable.

"The cost of developing a new airframe is just astronomically high," says Professor Dowling. Then there is the revolution that the SAI brings in terms of materials. "The blended wing body also has to be an all-composite aircraft," she adds. This is relatively new materials technology that is slowly finding its way into aircraft.

MIXING INDUSTRY WITH ACADEME

Professor Dowling is also involved in engineering issues of more immediate commercial interest. She is director of the University Gas Turbine Partnership (UGTP), one of a series of one-to-one University Technology Centres that Rolls-Royce has set up with universities around the world. The UGTP brings together around 20 'principal investigators' from across the university to work on the fluid mechanics and thermodynamics of gas turbines. Professor Dowling likes working with industry in this way because, "It gives us access to really important problems where finding answers can make a difference. If you are in engineering, actually addressing the things that matter to industry is what makes research exciting."

It helps here, she explains, to be working in aerospace. Unlike many engineering sectors, with their short time horizons, aerospace companies work on a time frame that is not too much out of line with academic timetables and the four years that it takes to complete a PhD project. "Such projects attract excellent students," says Professor Dowling. "It is thrilling for students to see their research results influencing the next generation of aircraft engines."

HANDING IN HER WINGS

Aircraft engines were, until recently, not just one of Professor Dowling's professional interests. She actually held a pilot's licence and flew herself around until bifocal lenses crept up on her, making map reading something of a chore. In any case, she adds, "I had done all of the things I really wanted to do. More recently, lack of time meant that I was just doing local flights rather than long-distance ones." She found this "less challenging," which is clearly something that does not appeal to Professor Dowling. These days her leisure pursuits are more likely to include snorkelling and the opera.

Even snorkelling has a roundabout connection with Professor Dowling's research. She has worked on underwater acoustics and how to reduce noise as water flows over a sonar dome, stopping it from getting in the way when you are trying to listen to very weak noises from afar. "I worked on ways of having multilayer coatings to reduce the noise."

That work also fed into her aerospace engineering. Another project concerned the noise created as air flows over the surface of a flying aircraft. "If you're sitting inside the aircraft, you have got turbulent flow going past. It excites the walls of the aircraft and they vibrate." This is yet another of the many individual bits of engineering research that came together in the SAI.

TREAD QUIETLY

As if water and flight weren't enough, Professor Dowling also found time to apply this research to tyre noise. Like the sonar dome, tyres have many layers of complex materials. Tyres have structures, 'tread blocks', that are amenable to similar analysis used to fathom vibrations rattling around in an airframe.

This variety of applications confirms Professor Dowling's interest in academic research rather than working in industry. "You wouldn't find an industry that went across that space. I have always worked very closely with industry. But I felt that I could contribute more by being in the university. I guess I like the freedom about what I can work on."

Industry also might not offer the opportunity to span dimensions from something as big as an airliner down to nanometres. But Professor Dowling managed to fit in the very small while running her division, the University Gas Turbine Partnership, and the SAI project. She chaired an important committee on nanotechnology set up by the Royal Society and The Royal Academy of Engineering and commissioned by David Sainsbury, the science minister. (Professor Dowling was appointed a DBE for her services to Science in 2007, and is one of a handful of people with fellowships in both august bodies.) "It was an eye opener to me to learn just how broad the whole area was."

BUILDING SHAKE-UP

Professor Dowling's next moves will be back at the macro, if not mega, scale. Next year she takes over as head of Cambridge's Department of Engineering, the biggest in the country, with over 130 academics. One priority that this aerospace engineer has set herself will be to do something about the department's civil engineering: the very building that houses it. It isn't just that the 60-year-old buildings are in desperate need of attention – "They are not very energy efficient."

Naturally enough, for someone interested in engineering and systems, Professor Dowling sees this as more than just an attempt to save energy. The engineers have all sorts of ideas to use natural ventilation and sensors to create an 'intelligent' building. "We want to make it an exemplar of what you might do in refurbishing a building." After all, as Professor Dowling points out, the UK has a lot of old buildings that are far from energy efficient and you can't tear them all down and start from scratch.

"What I'm working on at the moment is pulling a whole group of people together around energy efficient cities. This sounds completely different from the SAI, but again the challenge is how to bring together all the knowledge that we have got, to assess the trade-offs." With a new project on 'energy efficient cities', and £2.9 million of funding from the Engineering and Physical Sciences Research Council (EPSRC) for the first five years, Professor Dowling plans to draw in architects, materials scientists and experts in sensors and systems. And we shouldn't forget, she adds, that people are an important factor.

The EPSRC grant may not stretch so far as helping to rebuild bits of Cambridge's engineering department, but the research programme could well have its own local test bed. Indeed, Professor Dowling may not be able to pilot herself over the region these days, but the whole Cambridge area could come under her microscope. The region desperately needs new homes, commercial premises and the infrastructure to make it work. Some of the proposed developments, says Professor Dowling, "Are ideal test vehicles for the energy efficient cities work".

The Silent Aircraft Initiative team in 2006 with Professor Ann Dowling in the front row

Further reference

http://silentaircraft.org

BIOGRAPHY – Michael Kenward OBE

Michael Kenward has been a freelance writer since 1990 and is a member of the *Ingenia* Editorial board. He is Editor-at-Large of *Science|Business*.

PROFESSOR ANN DOWLING – PRIZES AND DISTINCTIONS

Elected Foreign Associate US National Academy of Engineering, **2008**. Appointed DBE for services to Science, **2007**. Confederation of European Aerospace Societies (CEAS) Aeroacoustics Award **2006** for outstanding contributions in the field of aeroacoustics. ScD University of Cambridge, **2006**. Elected Fellow of the Royal Society, **2003**. Appointed CBE for services to mechanical engineering, Queen's Birthday Honours List, **2002**. Elected Foreign Associate of the French Academy of Sciences, **2002**. Best Acoustics Paper, American Helicopter Society **2003**. Best Technical Paper Award from ASME, IGTI Combustion and Fuels Committee **2001**. The Ackroyd Stuart Prize awarded by the Royal Aeronautical Society, **2001**. Gordon Moore Distinguished Scholar, California Institute of Technology, **2001-2002**. Jerome C Hunsaker Visiting Professorship, Massachusetts Institute of Technology, **1999-2000**. Elected Fellow of the Royal Academy of Engineering, 1997 (Council member **1998-2002**, Vice-President **1999-2002**). AB Wood Medal and Prize awarded by the Institute of Acoustics for underwater acoustics, **1990**. Robert Angus Research Fellowship awarded by Sidney Sussex College, Cambridge in **1978**.