The Imperial College
Department of Aeronautics

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The success and growth of the UK Motorsport Industry is well documented and has even been sanctified by being studied by academic institutions and business study groups. It is often portrayed as an example of how new high-tech industries can and should be encouraged to evolve in this country. Like most of these industries, their assets are as much the quality of their staff as their plant and machinery. As the companies grow and multiply, the flow of new, well-qualified staff into the industry is essential to their continued success. It is to the universities that they turn for engineers, and the resulting competition for the best graduates is intense.

For some reason the government of the UK decided to blur the distinction between the traditional universities, and the technical colleges and polytechnics, labelling the lot as universities. However, whatever the label, the distinction remains. While the technical colleges and polytechnics take people at the end of their school education, following A-level, and train them in the knowledge and skills necessary to carry out their chosen career, the traditional universities continue with education, endowing graduates with knowledge and understanding in their chosen subject. Both are necessary in motor sport. Technicians and engineers working on sophisticated racing cars from Formula1 downwards, need the ability to understand the technologies involved - electronics, computer sciences, materials, control systems, aerodynamics etc. Designers must be computer literate and able to use the latest CAD, CAM and CAE software. The new universities have become aware that there is a need for engineers versed in the motorsport technologies and are designing courses specifically for the motorsport industry, based on existing automotive engineering courses.

However, the fierce competitive nature of motor sport means that the key technologies -aerodynamics, composite structures, engine combustion and tribology, measurement and control, and electronics and computer sciences - are being pushed ever harder. The minimum qualification for an R&D job at the forefront of one of these technologies is a PhD. With many of these technologies coming out of the aerospace industry, it is not surprising that the physics and engineering departments of the traditional universities, many of which were set up to provide graduates for the British Aerospace Industry, have become the prime source of the top quality engineers that motorsport needs. Of these, the Department of Aeronautics at the Imperial College of Science, Technology and Medicine

has been the most successful in providing the type and quality of research engineers required by motorsport, and Formula1 in particular.

Two of the Imperial College's earliest and best-known graduates in motorsport, Keith Duckworth and Frank Dernie, completed their degrees in the Mechanical Engineering Department. However, it is the Department of Aeronautics that has supplied many of the aerodynamicists since then:
PhD's

Dr John Davis 1982 ex Lotus, Ligier, Pi Research and Jordan; now Technical Director, Arrows
Dr Mark Handford 1987 ex Swift Tech Director; now at Lola International

Dr Robert Dominy 1987 Reader Durham University; active in vehicle

Aerodynamics, including racecars

Dr Eghbal Hamidy 1988 ex Williams and Stewart; now Chief Engineer, Arrows
Dr Seamus Mullarkey 1990 Sauber Petronas; Aerodynamicist

Dr Nicholas Tombazis 1993 ex Benetton; now Chief Aerodynamicist, Ferrari

Dr Jo Amodeo 1998 Jaguar Cars, Aerodynamicist

Dr Garry Elfstrom Manager of wind tunnel design and build, Aiolis Eng. Corp.

Dr Rhodri Moseley 1999 McLaren, Aerodynamicist;

Russell Thompson 1997 Williams, Composites;

MSc's

Peter Prodromou 1991 McLaren, Aerodynamicist

Graduates

Ian Cowley 1988 ex Ferrari GTO
Darren Davies 1988 ex-Reynard; now Jaguar F1.

Simon Jennings 1990 Arrows, aerodynamics test engineer
Jarrod Murphy 1996 Benetton, Composites

Alex Cinelli 1997 ex Tyrrell; now Williams, Aerodynamicist
Lawrence Price 1997 ex Tyrrell; now BAR, Aerodynamicist
Dominic Smith 1998 G-Force, Aerodynamicist

Ben Hindley 1998 Peugeot Test Centre, Aerodynamicist

Among the undergraduates, and postgraduates doing PhD's currently within the Department, there are a number who have definite intentions of pursuing a career in motor sport, preferably Formula1, so the pipeline is well primed.

The involvement of the Departments of Aeronautics in automobiles, goes back to the early 1960's, when John Stollery carried out consultancy for Donald Campbell's Land and Water World Speed Records attempts. Stollery carried out wind tunnel tests on both Bluebirds, in the fixed ground plane, 5ftx4ft wind tunnel. The tests predicted the aerodynamic pitch instability that both vehicles suffered from, though the warnings were not adequately taken into account. Stollery went on to develop a moving ground plane for seaplane research in the tunnel, which was later re-named the Donald Campbell wind tunnel. In 1969 he co-authored a paper on "Forces on bodies in the presence of the ground", which perfectly described ground effect.

In 1966, John Harvey, a lecturer and hypersonic researcher in the department, met Sir Alfred Owen, the owner of BRM, and was asked to assist with solving some cooling problems on the BRM. He performed pressure measurements on the car, storing them on tape (one of the first applications of modern data acquisition techniques in motorsport), and became BRM's aerodynamic consultant. I met him at BRM in 1967, and we started a programme of wind tunnel testing the Formula1 cars.
John Harvey teamed up with another lecturer and low-speed aerodynamic researcher in the department, Peter Bearman, to provide consultancy within motor racing. They worked with Tony Southgate at BRM, Shadow and Arrows and then with Williams. In the early 70's, one of Harvey's PhD students, John Fackrell, carried out basic research into the flow around a rotating wheel in contact with the ground as his thesis. The research was funded by Dunlop and has remained the definitive work on the subject, published by Fackrell and Harvey in 1973. Fackrell subsequently pursued a career outside the automobile industry.
Team Lotus used the moving ground, Donald Campbell tunnel to develop the pioneering ground effect T78 and T79 cars in the mid-late 70's. Frank Irving, the gliding technical guru, provided consultancy as Harvey and Bearman were committed elsewhere. In 1985, Harvey and Bearman secured a contract to design and build a new wind tunnel in the department, suitable for testing 40% models of cars. The tunnel was funded by Honda, and was fitted with a moving ground plane, and the facility to yaw the model. Lotus used the tunnel extensively during the period they used Honda engines.
By the mid-80's, most of the fundamentals of single-seater racecar aerodynamics had emerged from the Imperial College's Department of Aeronautics: moving ground plane, ground effect, rotating wheel flow,

and suitable wind tunnel design appropriate to racecar model testing. In working with Formula1 teams, key personnel in the department met organisations that wanted accurate answers to aerodynamic questions, and who wanted them fast. Because they were equipped and able to provide the answers, the relationships thrived and the reputation of the department spread.

John Harvey is now Professor of Gas Dynamics - he is a world expert on the design of hypersonic "shock-tunnels", used for research at Mach15 and above - and Peter Bearman is Professor of Experimental Aerodynamics and a Pro-Rector of the College. They consult on wind tunnel design, often being called in to sort out flow problems on other people's designs. They have been involved in the Swift, Ferrari, McLaren(British Maritime Technology), Sauber, Lola, Arrows (DERA, Bedford), and Jordan (ex March) tunnels, and had just completed the design for Honda's new tunnel, when Honda pulled back from creating their own team.
Such an environment has inevitably attracted both students interested in motor racing, and inspired others who were initially only interested in aerodynamics, to take up a career in motor racing. It also attracts racing teams to come in search of the answers they need and to seek out the best students to join them in finding their own solutions.

Nikolas Tombazis, Chief Aerodyamicist, Ferrari: "I had always been interested in Formula1 from my childhood years in Greece, and the idea of aerodynamics fascinated me. It was back in the 1978-1979 years, and the importance of aerodynamics was becoming more and more obvious, which is probably what attracted me to that field. After my undergraduate studies in Cambridge (Engineering), I decided to go to the Aeronautics Department of the Imperial College for my PhD. Apart from its general scientific reputation, its links to Formula1 played an important role in this decision. I confess that I thought that I would be able to pop in the wind tunnel and have a look and a chat when the various racing teams came to test! This did not happen, but working with my supervisor, Prof. Bearman and the rest of the staff, I had the opportunity to study a very interesting unsteady aerodynamics problem, and accumulate a lot of practical knowledge and experience, which has later proven invaluable to me. I am sure that the reputation of the Imperial College helped me a lot in getting my first job of Aerodynamicist at Benetton and after four years I moved to Ferrari, which is a great place to be. Even though seven years have passed since I left the Imperial College, I still remember the years in its Aeronautics Department very fondly, because of its high scientific level and its very friendly environment. From my current perspective, I believe that there are various reasons why the Imperial College achieves such a good success rate in Formula1:
"The combined strength in both experimental work and CFD is important for Formula1

"The presence of different wind tunnels (including a couple with a rolling road) exposes the students to the problems of the racing industry

"The active links (in the form of consultancy or various student projects) between the Imperial College and F1

"The general high level in engineering and science"

Another Imperial College PhD, Mark Handford, has made his name with the design of the Swift Champcar, and the Handford wings used by CART to limit speeds on the ovals. He is now at Lola International, but had no particular interest in motor racing while at university. "I did my first degree at Southampton University. I was fascinated by airplanes and wanted to be an airline pilot. However, I was too big for either the airlines or the RAF, and my professor kept on about going to do a PhD at the Imperial College. At the time I did not realise the potential leads into motor sport. The teams who used the tunnels were very secretive and I only stumbled on them by chance. I met Ross Brawn, who was with Force at the time, and that meeting set me thinking.
"I wish I had done my degree at the Imperial College; the resources and academics were excellent and there were good workshops and backup. What one gains there is a proper understanding of the building blocks of aerodynamics. The flow around an open-wheel racing car is very complex: the front wheels generate rotating turbo-machinery type flows and right near them is the vortex inducing tip of a wing. An understanding of embedded vortices is essential to analyse the flow in an objective manner. I have learned that for this type of work it is necessary to recruit people with the right kind of background, people who are academically solid, good at experimental aerodynamics and who are prepared to get their hands dirty. The Imperial College attracts and hones engineers and researchers with the right characteristics."

John Harvey and Peter Bearman are heading towards official retirement, though they are unlikely to halt their involvement with motorsport. The British Motorsport Industry needs institutions, such as the Imperial College, to round off the education of engineers who will go on to work in the organisations where original research is carried out. The Department of Aeronautics at the Imperial College has played a major role for over 30 years, imbuing students with a background in aerodynamic fundamentals, good experimental techniques and a strong understanding of CFD, and will probably do so in the future. Maybe one or two of those who passed through the department will hanker after the relative calm of an academic institution after years of relentless Formula1 pressure, and return to carry forward that reputation.

As the late Dr Harvey Postelthwaite told a hopeful young engineer who was seeking a career in Formula1: "Don't bother with anywhere else, just go to the Imperial College."