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Elected FRS 1976

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John Harold Horlock was one of the outstanding engineers of his generation. His expertise was in the thermodynamics and fluid mechanics of turbines and compressors, as used for jet engines and for power generation. He made major contributions to this field over 60 years. After graduating from Cambridge he worked for Rolls-Royce for two years before returning to Cambridge to study for his PhD, and was subsequently appointed a lecturer in engineering and a Fellow of St John’s College. At the age of 30 he was elected to the Harrison Chair of Mechanical Engineering at Liverpool, where he remained for nine years, producing an impressive amount of individual research as well as transforming the department into one of the best in the country. Returning to a chair at Cambridge he reorganized the Mechanical Sciences Tripos and founded the Whittle Laboratory, which became one of the world’s leading centres for turbomachinery research. He then became Vice-Chancellor of Salford University, remaining there for seven years before moving on to become Vice-Chancellor of the Open University. After retirement at the age of 62 he continued to be very active: as a consultant, as Treasurer and Vice President of the Royal Society, as a frequent visitor to the Whittle Laboratory and as the author of many papers and several books. Knighted in 1996, Sir John Horlock will be remembered not only for his intellectual abilities but also for his personal skills, which enabled him to interact freely with all levels of society, from cabinet ministers to graduate students.

FAMILY BACKGROUND AND SCHOOLING, 1928–46

John Harold Horlock was born in April 1928 in Edmonton, north London, the son of Harold and Olive, who already had a daughter, Beryl, seven years older than John. Harold and his...
brother Horace ran a family undertaking business in Edmonton and Enfield, the business having been in the Horlock family for several generations. His grandfather on his mother’s side was a master baker who had moved to England from Germany in the 1880s and married Catherine, who was English but of German extraction. There was no family history of scientific or engineering interests.

John was beset by early medical problems, having a major operation for osteomyelitis before the age of two. This left him with a slightly shortened right leg, which caused some problems in later life. He also had an operation for appendicitis a year later. When John was born the family lived above the shop on Edmonton Green, but in the 1930s they moved to the more salubrious suburb of Winchmore Hill and in 1933 John entered Highfield Road Primary School. After a few years he moved on to another Edmonton primary school, Raglan. Here John first developed a love of football and cricket that was to remain with him throughout his life. He played for the school against other local schools and had a trial for Edmonton junior boys, but unfortunately did not make the team.

In 1938 John took the 11-plus examination, a year early at the age of 10, on the basis of which he was accepted for the Latymer School in Edmonton but had to stay on at Raglan for another year until he was 11 years old. He thus started secondary schooling just before the start of World War II and was initially evacuated to Diss in Norfolk, but he did not settle well there and because there had not yet been any air raids he returned to Edmonton after a few weeks. He subsequently spent many nights with his family in an air raid shelter in their garden.

John had fond memories of Latymer School. Although many of the pupils had been evacuated and there were frequent air raid warnings he was taught a full curriculum, including the sciences. Although the air raids eased in 1942–43, the V1 flying bombs and later the V2 rockets continued to cause disturbances at the time when he was taking the School Certificate examinations in 1944. He took part in a great variety of school sports, representing the school at football, cricket, athletics and swimming. Outside school he played cricket for Edmonton cricket club and Middlesex schoolboys, and football for a local youth club, even playing one game for Tottenham Hotspur Juniors. One suspects that it is fortunate for his future career that he was not selected for a more formal trial. He also took part in a remarkable variety of other school activities being a member of the literary and debating, science and music societies and he also acted in school plays. In the vacations John took part in school forestry and farming camps and went on long cycling tours, staying at Youth Hostel Association hostels.

After obtaining eight distinctions in the School Certificate at age 16, John went in to the sixth form to study pure mathematics, applied mathematics, physics and geography for the Higher School Certificate. He always regretted not studying chemistry at that stage. After just one year in the sixth form he took the Cambridge Scholarship examination for St Catherine’s College. Because he was in competition with pupils from public schools who were in their third year of sixth-form studies it is unsurprising that he was not successful. However, at the same time he took the qualifying examination for the Cambridge Mechanical Sciences Tripos and passed it comfortably, although at that stage he showed no great interest in engineering topics. After two years in the sixth form he obtained three distinctions in his Higher School Certificate examinations, only missing out on a distinction in geography. On the strength of these results he was awarded a state scholarship and a Middlesex county scholarship. However, his father was concerned about whether he should go to university or take an apprenticeship and at one stage it was planned that he should start an apprenticeship with the aircraft firm Short Bros in Rochester. Perhaps fortunately this idea was dropped and he was
entered for St John’s College, Cambridge, where he was accepted as a commoner. John left Latymer School in 1946, having been Captain of School in his final year. He was full of praise for the broad education he received at the school and it is clear that he was an outstanding pupil. One important legacy of his schooldays is that he met his future wife, Sheila Stutely, at the school and they became close friends, sharing an interest in music. Although they went separate ways on leaving school they were to get together again five years later.

**CAMBRIDGE, 1946–49**

After John left school it was expected that he would have to do National Service before going up to Cambridge. However, despite all his sporting achievements, he was declared medically unfit because of his damaged leg, and was able to gain late entry to St John’s, starting in the second week of the Michaelmas term. He started to study mathematics but soon changed to mechanical sciences under the guidance of Harry Rhoden, the Director of Studies for Engineering. This choice was surprising because John had shown no previous interest in, or aptitude for, engineering. Harry Rhoden was a specialist in the relatively new field of turbine and compressor aerodynamics and it is likely that it is from him that John got his interest in this field, which has come to be called ‘turbomachinery’. At that time it was possible to take Part I of the Mechanical Sciences Tripos in two years instead of the usual three and John was enrolled on this ‘fast course’. At first he found it very hard going, having missed the first few weeks of term and with many of his contemporaries having returned from the services with some engineering experience. The workload left little time for relaxation and the only other activities he took part in were football and cricket, both of which he played intermittently for the college first team. In one football match he twisted his knee badly and the injury remained with him for the rest of his life.

At the end of the first year John obtained a First in the ‘preliminary examination’, which covered all branches of engineering. In the long vacation it was necessary to gain workshop experience and he did this in the departmental workshops and at the de Havilland aircraft factory in Hatfield. De Havilland were one of the pioneers of jet propulsion and this experience must have contributed to his future interest in aerodynamics and jet engines. In his second year John worked hard, and in the Mechanical Sciences Tripos Part I examinations at the end of the year he won the Rex Moir prize for obtaining the top marks among the 300 or so undergraduates. In his third year he studied for Part II of the Tripos. In this it was possible to specialize in one of the main engineering disciplines and John chose the ‘mechanical engineering’ option, although at this stage he did not have any strong leaning to this as opposed to one of the other branches. The course covered all aspects of mechanics and thermodynamics, and John was partnered with Neville Kirby, who had worked on gas turbines with the Newcastle-based company C. A. Parsons during the war; as a result John became interested in these then-new power plants. At the end of his third year John obtained another First, but this time not the top First, which clearly disappointed him.

On the basis of his second-year performance John had received a scholarship to visit Massachusetts Institute of Technology (MIT) and he did this in the summer of 1949 after graduating from Cambridge. He travelled around the east coast of America by hitch-hiking and recounts how he was given a lift by a Princeton professor who took him into the university common room where Albert Einstein was present. John was clearly impressed by the teaching
and research at MIT, where he met some distinguished engineers, and he was tempted to stay there for further study. However, he had already accepted a graduate apprenticeship with Rolls-Royce and in the late summer of 1949 returned to the UK to start on this.

**ROLLS-ROYCE, CAMBRIDGE AND MIT, 1949–57**

The graduate apprenticeship involved a year’s practical work in several different departments of the company and ended with a spell working at the drawing board in the compressor design office. John enjoyed this experience of compressor design and at the end of his apprenticeship was allowed to stay on in the compressor office, working under Geoffrey Wilde, who subsequently was largely responsible for Rolls-Royce’s development of the very successful RB211 family of three-shaft high-bypass engines. He was initially given the task of redesigning the compressor of the Avon engine, which had been in trouble because of surge. Surge is a violent instability that can occur when the compressor is being started or otherwise operated off-design and it can rapidly destroy the engine. It seems remarkable that such an important task was entrusted to a new graduate but John found that his education at Cambridge soon enabled him to pick up the methods involved. In fact the compressor was redesigned, built and tested in six weeks, a staggeringly short time. It is estimated that a similar task nowadays would require a team of engineers who would take at least a year to complete it. So much for the influence of computers! The new compressor worked first time and cured the surge problem, thus gaining John quite a reputation within the company.

After that success John worked on a variety of projects within the company, including the experimental testing of a low-speed research compressor. Outside work he played cricket for a local village team and enjoyed walks in the Derbyshire countryside. He met and worked with several experienced turbomachinery specialists and realized that there was still much that was not understood about the flow in compressors and turbines. Because of this he enquired of his old Director of Studies, Harry Rhoden, about the possibility of returning to Cambridge to study for a PhD, and in 1952 he obtained a DSIR studentship to work with Professor William (later Sir William) Hawthorne (FRS 1955), whom he had previously met at MIT.

Hawthorne was a brilliant theoretician who had worked with Frank (later Sir Frank) Whittle (FRS 1947) on combustion problems during the war but had subsequently become more interested in the aerodynamics of internal flows, including turbomachinery. He had developed a method of modelling the complex three-dimensional flow through blade rows of turbines and compressors, using a technique called ‘actuator disc theory’. This replaced the blade row by a discontinuity, the actuator disc, across which the axial and radial velocities were conserved but the circumferential velocity and pressure underwent step changes. This enabled the effects of the blade row to be felt far upstream and downstream, in contrast to the radial equilibrium theory, developed in the USA and independently by Whittle, in which all changes in flow were confined to the blade rows. However, the theory was complex and was restricted to a single blade row and so was of limited use to designers. John’s PhD task was to simplify the theory, apply it to multiple blade rows and try to validate it by experimental testing. The latter task was facilitated by Rolls-Royce’s donating to the Engineering Department a copy of the two-stage compressor that John had tested in Derby (figure 1). His PhD thus involved a great deal of both theoretical and experimental work. Hawthorne’s supervision was very ‘light touch’ and John was left very much to plan his own research. In fact he must have completed his
original tasks early, because his PhD thesis includes the investigation of an almost unrelated problem of the secondary flow in a sinusoidal pipe, which is relevant to the meandering of rivers. Again this involved both experimental and theoretical work; in particular the theory led to a differential equation, which he solved numerically on the EDSAC computer. Hence John must have been one of the first engineers to make use of a digital computer. It is therefore surprising that his future work remained largely analytical while the field of turbomachinery aerodynamics soon became dominated by computerized numerical methods. This work was published in *Proceedings of the Royal Society* (4)* with John as the sole author, quite an achievement for a research student.

In 1953, while still working for his PhD, John was offered and accepted the position of demonstrator in the Engineering Department. Despite the title this involved him giving lectures to the undergraduates, including the large first-year class. At first he was not happy with his lecturing performance; however, he learned rapidly and after a few years, when he was giving thermodynamics lectures to the first-year students in parallel with two famous professors, Hawthorne and A. H. Shapiro (who was on leave from MIT), he attracted the larger audience.

John and Sheila had got together again after five years, and the security of John’s university salary enabled them to get married in 1953. They lived in a university flat close to the department until the birth of their first daughter, Alison, in 1955, when they moved to a new house in Girton.

* Numbers in this form refer to the bibliography at the end of the text.
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While still a research student John published several papers based on his PhD research and his work at Rolls-Royce (1–3) and in 1954 he was elected to a Research Fellowship at St John’s. He continued to play cricket, captaining the departmental team, which at one time included three future vice-chancellors and which won the University Laboratories cup. In 1956, at the age of 28, he was appointed to a full lectureship in the Engineering Department. In the same year he accepted a year’s exchange with a lecturer from MIT and the family enjoyed living in Boston for that period. At MIT John gave some lecture courses but also spent time writing his first book, Axial flow compressors (5), which was finished soon after his return from MIT in 1957. The book covered the whole field of compressor aerodynamics from the basics up to the latest research developments: it has had a major impact on turbomachinery designers and researchers and continues to be in widespread use.

Liverpool University, 1958–67

Soon after his return from MIT John was approached by Liverpool University and encouraged to apply for the Harrison Chair of Mechanical Engineering, recently vacated by Professor W. J. Kearton. He was surprised to be offered the post at the young age of 30 but accepted it without hesitation. Soon after moving to Liverpool he returned to a feast at St John’s College. One of the senior fellows was heard to remark to another, ‘There’s that young fellow Horlock—been appointed to a chair at Liverpool.’ The other replied, ‘That’s not a chair; it’s only a stool.’ Such an attitude did not go down well at Liverpool.

On arriving at Liverpool John found that the department he inherited was strong on teaching but less so on research and he set about remedying this. A principal constraint was the existence of separate and competing Civil and Electrical Engineering Departments, with engineering mathematics being taught by the Mathematics Department. Within the Mechanical Engineering Department Professor Harry Preston had built up a strong fluid mechanics group, which overlapped with John’s interests. These conflicting interests naturally resulted in some in-fighting but overall the spirit of the department was friendly. The department was initially understaffed but, taking advantage of the stimulus of the 1960s energy and technology boom, and the consequent university expansion, John was able to recruit several new lecturers and quickly built up a strong turbomachinery group. This attracted outside funding that was used to set up good experimental facilities and to recruit some excellent research students, many from overseas. The Liverpool Mechanical Engineering Department was built up to become one of the strongest in the country.

This was a time before the development of computational fluid dynamics (CFD) as the dominant research and design tool that we now know. However, John supported the acquisition of the university’s DEUCE computer. The computer worked well but getting a sensible run involved the student in an all-night session. Around 5 a.m. the disc would clog up with dust and the unfortunate student had to wipe it clean with a handkerchief before continuing. Woe betide any unfortunate student who became so frustrated that he ‘pulled the plug’. Warm-up time was three days, and for the student the penalty was a lifetime ban. John saw the computer as an important element of the work and encouraged his colleagues and students to use it. They produced accurate potential flow solutions for two-dimensional cascades and initiated some viscous and three-dimensional approaches. However, John himself was more interested in an approach based on a balance between experimental, analytical and computational
work. This approach characterized his work throughout his lifetime and is still important for turbomachinery research and design today.

The family was very happy at Liverpool, living on the Wirral peninsula, by the sea. Their son, Tim, was born soon after their return from MIT in 1958, and their second daughter, Jane, was born in 1961. The 1960s were a lively time in Liverpool. An unknown group called The Beatles played for dances in the student’s union for £20 per night and the new Catholic Cathedral, fronting on to Hope Street with its legendary Philharmonic Pub, was built within sight of the engineering department offices. For the engineering students it seemed that there was never a dull moment.

John’s personal research output during his time at Liverpool was prolific; he published more than 50 papers in the nine years he was there. His paper on actuator disc theory, written jointly with Hawthorne (6), was awarded the James Clayton Prize of the Institution of Mechanical Engineers in 1962. He continued his interests in turbomachinery with work on cascade aerodynamics, secondary flows, annulus boundary layers, tip leakage effects, compressor stall and unsteady flow. He also tried to diversify his interests outside turbomachinery with work on cycle analysis, magnetohydrodynamics, steam properties, marine propulsion and noise generation. His interest in cricket led to wind-tunnel experiments and a paper attempting to explain the swing of a cricket ball (9); however, he was unable to explain (nor can anyone else yet) why this is affected by the atmospheric humidity. His work on turbocharging led to good collaboration with researchers on internal combustion engines, with similar groups at the University of Manchester Institute of Science and Technology and Queen Mary College and, in industry, with Napier’s and Hawker Siddeley Brush Turbines. On top of this he found time to write another book. *Axial flow turbines* (7), published in 1966, was a companion to his first book, *Axial flow compressors*, and was equally successful.

In his nine years at Liverpool University John turned around and built up the Mechanical Engineering Department into one of the foremost in the country. In this he was helped by the fact that this was the time of the ‘white heat’ of Harold Wilson’s technological revolution. Mechanical Engineering at Liverpool was bursting at the seams and research grants and students flowed in. The department needed a new building but the main line into Lime Street station carved right through the university; the only space available was over the railway cutting. Such considerations never daunted John Horlock and he built a tower over that cutting (figure 2). This is an aspect of John’s character that should be emphasized: he was a dreamer of big, but achievable, dreams.

Inevitably the job also involved a good deal of administrative work. In addition to running the Engineering Department John chaired the Departmental Grants Committee. Outside the university he was a member of the Aeronautical Research Council and the chairman of its Propulsion Committee; he was also the editor of a series of books for Pergamon Press. In the latter context he came to know the late Robert Maxwell. In 1966 he spent some time at Pennsylvania State University, where he collaborated with George Wislicenus, a pioneer of turbomachinery aerodynamics.

**CAMBRIDGE AGAIN, 1967–74, AND THE WHITTLE LABORATORY**

In 1967 John was offered and accepted one of three newly created chairs in engineering at Cambridge. The family moved back to Cambridge and built a house in Newnham, quite close to the Engineering Department.
At first John found it difficult to be only one of several professors and no longer the head of the whole department. In particular his old supervisor, Will Hawthorne, who had recently been elected to the Royal Society, worked in the same field of research and John worked closely with Will on the fundamental flow physics of turbomachinery. He was elected into a Professorial Fellowship at St John’s, where he renewed his friendship with his former Director of Studies, Harry Rhoden. In his new job John had responsibility for the allocation of teaching duties to the approximately 100 teaching staff of the department. Sir John (later Lord) Baker FRS remained as Head of the Department and he gave John the daunting task of revising the Mechanical Sciences Tripos, which was renamed the Engineering Tripos. With the help of Sir David Harrison, John steered the changes through the university’s formidable bureaucracy; in the process he inevitably upset some individuals. The new course was more modern and broader than the old one and better addressed industrial requirements. Within the department professorial relations were very good, the administrative set-up was sound and the department ran well.

On the research side John was disappointed to find that the facilities at Cambridge were not as good as those he had built up at Liverpool. There was no space in the overcrowded Engineering Laboratory for major new turbomachinery facilities, which might anyhow have been too noisy. On the basis of John’s experience as a member of the Mechanical Engineering Committee of the Science Research Council (SRC), John and Hawthorne applied to the SRC for funding to construct a new dedicated turbomachinery laboratory in west Cambridge. Although this was a joint application there is no doubt that the initiative came from John. The application was successful and an unprecedented grant of £272,000 was awarded. In 2015 money this is equivalent to about £10 million. This was the first time that the SRC had funded a building outside the special-purpose facilities of nuclear physics. The plan was to
build the new laboratory on the west Cambridge site, near to the proposed new Cavendish Physics Laboratory. There was some opposition to the plans from the occupants of the nearby astronomy buildings because of possible noise and light interference. Because of this the plans were revised to place the potentially noisy compressors in an underground basement, to have no windows in the high-speed laboratory and to surround it with an earth embankment. Despite these measures the proposal attracted a ‘non placet’ in the Senate. John argued vigorously for the proposal and when it came to the vote it was only passed by nine votes.

Construction started in December 1969 and the laboratory was completed in May 1971. In retrospect it is surprising that such a complex laboratory could have been constructed so quickly and at such a modest cost. The building (figure 3) contained two large laboratories, a workshop, ten staff offices, a student office and a common room. The ‘high-speed’ laboratory included an underground basement containing two large compressors, with a combined power of almost 1 MW, driving two transonic wind tunnels at ground level; it also contained a new large (5 ft diameter) low-speed turbine. The facilities in the ‘low-speed’ laboratory had mainly been moved from the main department and included a large (5 ft diameter) low-speed
compressor, two large cascade wind tunnels and the two-stage compressor first used in John’s thesis. The laboratory was officially opened by Sir Frank Whittle in May 1973 (figures 4 and 5) and was then called the SRC Turbomachinery Laboratory. It was renamed the Whittle Laboratory in November 1975. A new wing, named the Horlock Wing, was opened in 1997 and further extensions were added in 2013.

John became the first director of the laboratory and recruited several of his past PhD students from Liverpool to help staff it. In addition several existing teaching staff from the Engineering Department based their research in the new laboratory. The group worked closely with Rolls-Royce to improve the understanding of flows through turbines and compressors, for which small improvements in efficiency have a major impact on a jet engine’s fuel consumption. After Baker’s retirement in 1968 Hawthorne had become Head of the Engineering Department. He was very much a ‘hands off’ leader, frequently away travelling on government or university business, and one suspects that John had to do much of the running of the department, which at that time was probably the largest university department in the country. In 1973 Hawthorne’s five-year spell as head came to an end and he was free to concentrate on his duties as Master of Churchill College (1968–83). John naturally hoped to be considered for the headship of the department but he was only one of several eligible professors and the headship went to Austyn Mair, the Professor of Aeronautics. John had already been approached about the Vice-Chancellorship of Salford and he decided to accept it. However, he asked for the Salford appointment to be deferred until 1974 to allow him to help get the new turbomachinery laboratory established.

Because of his increasing administrative responsibilities John was able to do less individual research. However, he continued to publish profusely during this time at Cambridge with more than 30 papers, some of which were based on his previous work at Liverpool or were...
written with co-authors. His work continued to concentrate on the physics of turbomachinery flows rather than on the development of numerical methods, which were now coming into widespread use. However, he encouraged his students and colleagues to make use of the best available numerical methods, including some unusual approaches, such as obtaining solutions in the hodograph plane.

**Salford, 1974–80**

John moved to Salford in April 1974 and initially stayed in a flat on campus while the rest of the family remained in Cambridge to enable the children to finish their school year. The family then moved into the Vice-Chancellor’s house in Hale, where they settled in quickly and where Sheila became involved in a good deal of entertaining of university officials. Later Sheila became a JP on the Manchester bench.

The job of Vice-Chancellor at Salford was very different from that of an Oxbridge professor. Salford was a recently established university, having previously been a college of advanced technology. It had a large engineering department that was well staffed; but the quality of the student intake, many of whom were overseas students, was lower than average, and there was little research funding. John worked hard to try to remedy these issues. Many of the problems he encountered revolved around staffing issues, one particularly difficult problem involving a dispute between groups of students. John also spent a good deal of time outside the university trying to put it on the map nationally and he took on several tasks of national importance. He was a member of the Aeronautical Research Council, becoming its chairman in 1979,
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and also a member of the Finniston committee of inquiry into the engineering profession, of the Science Research Council and of the Marshall committee looking into combined heat and power. As Vice-Chancellor he became a member of the Committee of Vice-Chancellors and Principals (CVCP) and later of the Universities Committee for Non-Academic Staff. The university Chancellor was the Duke of Edinburgh. John got on well with him and found him genuinely interested in Salford and its students. The relationship led to John and Sheila's being invited to a dinner in Windsor Castle in the presence of The Queen and the then Prime Minister, Harold Wilson.

Despite these heavy duties John attempted to continue some academic research. He wrote another book, *Actuator disk theory* (10), published in 1978, which applied the ideas generated in his thesis to many related problems of internal flow. This book represented a major intellectual exercise as it contained a great deal of complex analytical theory. However, by then the topics it covered had been largely taken over by numerical methods and so the book was of limited use to designers. During his time at Salford he also published several papers and gave many invited lectures. He was elected a Fellow of the Royal Society in 1976, and a Fellow of the Royal Academy of Engineering in 1977.

Towards the end of his time at Salford John was approached about several senior positions at other universities and Oxbridge colleges, but was not tempted until he was approached by the Open University (OU). As a result of his work on the Finniston committee John was very much in favour of continuing postgraduate education for engineers. He saw the OU as an ideal vehicle for furthering this objective and so decided to accept the position of Vice-Chancellor. John and Sheila had enjoyed their time at Salford and were sad to leave; in recognition of his contribution the university awarded John an honorary degree and named a residential building after him.

THE OPEN UNIVERSITY, 1981–90

The Open University represented a major change from the traditional university that John was used to. It was based at Milton Keynes, but the large number of teaching staff were spread around the country, as were its more than 100,000 students. The move was more difficult because the registrar had retired at the same time as the previous Vice-Chancellor and John took some time to settle in. In this he was ably assisted by the new registrar, Joe Clinch, and his secretariat. The family moved into the Vice-Chancellor’s house in Aspley Guise, which, by coincidence, was only a mile or so from where Sheila’s grandmother had lived. Sheila was able to continue as a JP on the Bedfordshire bench and she also accompanied John to the many OU degree ceremonies around the UK.

A major difference between the OU and the more traditional universities was that the funding came directly from the government via the Department of Education and Science rather than through the University Grants Committee. This meant that John had to deal directly with government ministers and senior civil servants and it is clear that he resented this intrusion into academic freedom. A major confrontation occurred when a staff member complained directly to the Secretary of State for Education and Science, Sir Keith Joseph, alleging political bias in the material taught in a social sciences course. John’s political views were not aligned with the then conservative government and one gets the impression that he and Sir Keith did not ‘hit it off’. The course in question had already been comprehensively
reviewed by external assessors but the government appointed three more to review it further. They expressed some reservations but John refused to withdraw the course and managed to continue it with minor modifications.

The OU was also hit by funding cuts, as the conventional universities had been rather earlier. These threatened the very existence of the OU. John led a major ‘Save the OU’ campaign involving the press and politicians, which involved his appearing on the radio and television. The support of the large number of students was an important part of this campaign, which probably prevented any further cuts.

The OU was very strong on teaching but most departments were not strong on research. John tried to encourage more staff research, but with limited success. He was also active in trying to encourage more women to take up engineering: this was an interest that continued throughout his whole career. His ambition to initiate postgraduate courses was handicapped when the government made it clear that any such courses would have to be self-financing. However, over time he initiated postgraduate courses in management studies, computer science and manufacturing. These increased the size of the OU student body by some 50%. John did little teaching himself but did become proficient at television presentations and interviews. The job brought him into contact with a very large number of senior politicians and other well-known personalities. The skills he required were very different from those of his early career and it is a tribute to his abilities and personality that he was able to carry such a heavy load so successfully.

Although able to do little personal research during this period he did publish 10 papers, several of them related to his work on the Marshall committee on combined heat and power plants. He also edited two books, jointly with D. E. Winterbone, *The thermodynamics and gas dynamics of internal combustion engines*, volumes 1 and 2 (11), and wrote another himself entitled *Cogeneration: combined heat and power* (12). The latter again related to his work on the Marshall committee. He was also involved in many outside activities, most notably as a member of the Engineering Council, as a director of the National Grid Company and as chairman of the Advisory Committee on Safety of Nuclear Installations. Towards the end of his 10-year term the enormous workload started to take its toll, leading to the need to take a few months’ leave, and to his decision to retire from the position a few months before the end of the 10-year appointment. As at Salford, he was awarded an honorary degree by the OU, and a new building for management studies was named after him.

**Retirement, 1990–2015**

After John’s retirement from the OU, John and Sheila moved the short distance from Milton Keynes to Ampthill, near Bedford, so that Sheila could continue as a JP on the Bedfordshire bench, of which she later became chairman. She also became chair of the Bedfordshire Probation Committee. Given his vast range of outside activities and interests it was clear that John was not going to retire in the usual sense. In addition to his existing commitments he returned to his turbomachinery interests by becoming chairman of a high-level advisory committee for Rolls-Royce. This consisted of senior academics and staff from the National Gas Turbine Establishment at Farnborough and from Rolls-Royce (figure 6), who met regularly to advise the company on major technical issues. John was an ideal chairman for this group: he caught on to new developments remarkably quickly and was always eager to
contribute ideas of his own. As chairman John had to pass the committee’s recommendations on to the Rolls-Royce Engineering Director, and once every year to the main board. Hopefully, these recommendations contributed somewhat to the success of the company over the 15 years during which he was chairman.

John also renewed his turbomachinery interests by becoming a regular visitor at the Whittle Laboratory, which he had founded 20 years earlier. The laboratory had expanded greatly over that period and had earned a worldwide reputation for its research. It is appropriate that when a new wing of the laboratory was opened in 1997 it was named the Horlock Wing. John used to visit the laboratory every week, sharing an office with one of his past students, Ivor Day, now a leading expert on experimental methods and compressor stall. He interacted extremely well with the staff and research students in the laboratory, encouraging them in their research and publishing several papers jointly with students. He even learned to use numerical methods, which now dominate the subject, at both a research and a design level, to study some interesting features of flow in compressors. However, his main interests were now on the thermodynamics of gas and steam turbine cycles for power generation, especially on the effects of cooling flows on gas turbine efficiency. He published several papers on this topic in collaboration with Professor J. B. Young from Cambridge (15, 18, 19) and with L. Torbidoni from Genoa University (17, 21).

Another of John’s activities after retirement was to chair the Board of Trustees of the EMF Biological Research Trust. This was an offshoot from his directorship of the National Grid Company and looked into a possible relationship between strong electromagnetic fields and cancer. It also looked at the design of electricity pylons with a view to improving their visual impact.

In the 15 years after retirement John wrote some 30 papers. He was a regular attendee and contributor at the annual American Society of Mechanical Engineers gas turbine conferences.
and received two of their major awards: the Calvin Rice lectureship in 1994 and the R. Tom Sawyer Award in 1997. In 1998 a 70th birthday party for John was held at the Whittle Laboratory and at St John’s College. This included a series of seminars and was attended by many prominent colleagues from the UK and overseas (figure 7). After retirement he wrote four books related to the thermodynamics of power generation. These were *Combined power plants* in 1992 (13), *Energy for the future* (jointly with Sir Denis Rooke FRS and I. Fells) in 1995 (14), *Advanced gas turbine cycles* in 2003 (16) and *Energy: resources, utilisation, and policies* in 2009 (21). He also published an autobiography, *An open book*, in 2006 (20), which greatly helped in the preparation of this memoir.

In 1992 John became Treasurer and Vice President of the Royal Society, the first engineer to hold that office since 1843 (figure 8). This involved him in spending two or three days per week in London. In this capacity he saw the need for further independent funding of the Royal Society and initiated a fund-raising scheme named Project Science, chaired by Prince Philip, which eventually raised about £20 million for the Society. He was also responsible for the Society’s policy on education, in which capacity he interacted with Lord Dearing’s Committee on Higher Education and was instrumental in formulating a new career structure for school technicians. His five-year term as Treasurer and Vice President ended in 1997 and at the age of 69 John felt that he had done enough and was glad that the tenure of the position had recently been reduced from ten years to five.

For the last few years of his life John was physically handicapped but he continued to be technically active almost up to the time of his death, co-authoring his last paper in December 2014 (23). This came 46 years after an earlier paper in the same antipodean series (8) and demonstrates how consistently John retained his interest in solving the remaining physical
problems of flows through turbomachinery blading and how there remain many interesting issues for succeeding generations to resolve.

In 1996 John was knighted for services to science, engineering and education. The three topics correctly reflect the areas on which he has had influence but do not do justice to the magnitude of his contribution. His contribution to science was partly through his work for the Royal Society but much of his research, for example actuator disc theory and secondary flow theory, falls midway between science and engineering and he made major contributions to these fields. His contribution to education comes largely through his Vice-Chancellorship of two universities. His time at the OU was especially important and it is quite possible that the OU might have been closed down had it not been for his determined resistance. He also contributed to education through his reorganization of the Engineering Tripos at Cambridge and through his teaching and supervision of many research students. His contribution to engineering is enormous. His many research papers have aided researchers and designers over many decades, but probably the major influence has been through his books. These have been the main source of information for thousands of engineers in the field of turbomachinery aerodynamics and the thermodynamics of power generation; they are certain to continue in widespread use for decades to come. A major achievement, which alone would earn him international recognition, was his founding of the Whittle Laboratory. Judged on the number of best-paper and other awards this has grown to be the world’s most successful turbomachinery research centre. John would be proud of its continued success.

However, a list of his achievements does not do justice to John as a person. In fact his achievements would not have been possible without his personality. He had a rare combination
of outstanding technical and administrative abilities, coupled with the facility to communicate effectively and to relate to colleagues at all levels of society. These talents are illustrated by the fact that he rose to become chairman of almost every committee that he was invited onto. He was equally comfortable arguing over government policies with cabinet ministers or discussing detailed technical issues with research students. He had a long and happy family life and is fondly remembered by his wife Sheila, daughters Alison and Jane, son Tim and eight grandchildren and by very many past and present colleagues.

ACKNOWLEDGEMENT

The frontispiece photograph was taken by Godfrey Argent and is reproduced with permission.

HONOURS

1976 Fellow of the Royal Society (Vice-President and Treasurer, 1992–97)
1977 Fellow of the Royal Academy of Engineering
1980 Hon. DSc, Heriot-Watt University
1981 Hon. DSc, University of Salford
1987 Hon. DSc, University of East Asia
   Hon. DSc, University of Liverpool
1991 Hon. Fellow, St John’s College, Cambridge
   Hon. DUniv, Open University
   Hon. DSc, Council for National Academic Awards
   Hon. Fellow, University of Manchester Institute of Science and Technology
1995 Hon. DSc, De Montfort University
1996 Knighted for services to science, engineering and education
1997 Hon. DSc, Cranfield University

Fellow of the Institution of Mechanical Engineers
Fellow of the American Society of Mechanical Engineers
Foreign Associate of the National Academy of Engineering, USA
Honorary Fellow of the Royal Aeronautical Society

AWARDS

1962 James Clayton Prize, Institution of Mechanical Engineers
1969 Thomas Hawksley Gold Medal, Institution of Mechanical Engineers
1994 Calvin Rice lecturer, American Society of Mechanical Engineers
1997 R. Tom Sawyer Award, American Society of Mechanical Engineers
   Arthur Charles Main Prize, Institution of Mechanical Engineers
2001 Sir James Ewing Medal, Institution of Civil Engineers
2003 ISOABE Achievement Award, International Society of Air Breathing Engines
Biographical Memoirs

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