HOW “THEO” WILLIAMSON FRS CHANGED THE SOUND OF MUSIC

Institution of MECHANICAL ENGINEERS

Professor
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CEng FIMechE

Presidential Address
2019

BIOGRAPHY

Professor Joe McGeough has been a Member of the Institution since 1979 and is currently an Honorary Professorial Fellow in the School of Engineering at the University of Edinburgh.

Joe has been a long-time volunteer in the Institution having previously served on both Trustee Board and Council. He has held a number of positions at the Institution, including chair of the Publishing Board, the International Strategy Board, the Scottish Region and the Edinburgh & SE Scotland panel. He was also a member of the Qualifications & Membership Board for 10 years.

Joe is a graduate of Glasgow University and also holds a DSc from Aberdeen. During his undergraduate years he worked as a vacation apprentice at ICI Nobel Division, and also with Cossor Radar and Electronics and at the Royal Greenwich Observatory. Following graduation he worked for International Research and Development Ltd in Newcastle as a Research Metallurgist. He also held research appointments as a Demonstrator and Senior Research Fellow at respectively Leicester, and Queensland and Strathclyde universities.

Joe was then successively a Lecturer, Senior Lecturer, and Reader in Engineering at Aberdeen University before transferring to Edinburgh as Regius Chair of Engineering and serving for eight years as the Head of Department of Mechanical Engineering.

His main field of research is manufacturing and especially unconventional (electrochemical) machining. He has been awarded prizes for his research by both us and the Society for Underwater Technology, as well being a recipient of a Royal Society industrial Fellowship.

He has worked to extend electrochemical machining (ECM) methods to surgery, helping establish an orthopaedic engineering centre in the Royal Infirmary of Edinburgh. His collaboration with surgeons has looked at the engineering analysis of back pain and the effects of age on the mechanical properties of bone.

Joe is a Fellow of the Royal Society of Edinburgh, the Royal Academy of Engineering, and the International Society for Nanomanufacturing as well as being Emeritus Fellow of the International Academy for Production Engineering.

He has held visiting University appointments at Naples, Glasgow Caledonian, Monash, Tokyo University of Agriculture and Technology, and Dublin City. Currently he is an Honorary Professor at Nanjing Aeronautical and Astronautical University, and is Visiting Professor in the Department of Mechanical, Aerospace and Civil Engineering at the University of Manchester.

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INTRODUCTION

The Institution of Mechanical Engineers has been at the heart of the world's most important industries since its formation in 1847, industries which have underpinned the economic and cultural transformation of our world.

This fact gives enormous weight to the Institution's vision "to improve the world through engineering" and places a significance that I believe sometimes gets lost on the Institution's objectives to develop professional engineers, to promote the role of engineering within our society and to encourage future innovation.

In this address and during my year in office, I want to concentrate on developing professional engineers and ensuring that the broadest possible range of people have a chance to experience all the fantastic opportunities that my career in engineering has been able to offer me.

I have been extremely fortunate to have been able to enjoy a long career in engineering from my first steps as an undergraduate vacation apprentice through teaching positions at a number of universities where my main field of research has been manufacturing, before moving to the University of Edinburgh in 1983 and latterly serving as Honorary Professorial Fellow in the School of Engineering.

That career has also given me huge opportunities through becoming a Fellow of the IMechE, the Royal Society of Edinburgh, the Royal Academy of Engineering, the International Society for Nanomanufacturing and Emeritus Fellow of the International Academy for Production Engineering.

I have been a Member of this Institution since 1979 and have previously served as vice-president of the IMechE and part of the Trustee Board, as well as being chair of its Professional Publishing Board and of its International Strategy Board.

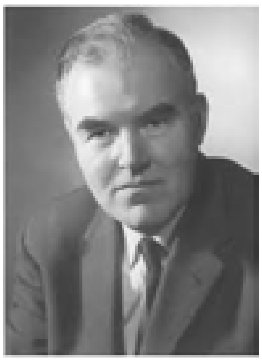
The experience I have gained through these positions has given me a unique perspective on the sector and I want to use my year as President to share what I have learned and hopefully inspire more people to become involved in engineering; a profession that has given me and many of the people in this room so much.

And the theme of inspiration brings me to the topic of my lecture this evening – Theo Williamson who I believe is a shining example to all engineers, but especially young engineers, of those qualities which best capture the essence of what it is to be an engineer: creativity, problem solving and the need for perseverance.

1. EARLY DAYS

David Theodore ('Theo') Nelson Williamson was born on 15 February 1923 in Edinburgh. His family lived at 65 Gilmore Place, not far from a well-known landmark, The King's Theatre. His initials are still to be seen in a stone in the back garden of their home, which is now a guesthouse, called 'The Town House'. His parents had come from Northern Ireland. His mother was one of the old school; British through and through, and a woman of very strong character. His father ran a car-hire business, with a collection of fine cars, on which he did much of the maintenance, stripping and rebuilding of engines, or repainting the car body painstakingly by brush. Each room in their house was heated with much effort by anthracite stoves, in the days before central heating. His father's health broke down in middle age, and he retired making life, and generally running the family home, much more difficult for Mrs Williamson. At this time the young Theo Williamson was an enthusiastic reader of scientific magazines: 'Popular Wireless', 'Wireless World' and 'Popular Science' were three of his favourites. Much of Theo's scientific reading was done during a time when he was suffering from tuberculosis. He would read in bed, listening to the tramcars running down the street along the King's Theatre. It is to all of good fortunes however that he survived the life-threatening illness and was able to embark on his engineering career.

In 1932 when he was 9, his father decided to build a valve radio. It spurred Theo also to construct radio receivers and transmitters, and how to get these complex devices to work properly. This began Theo Williamson's life-long interest in sound transmission and reproduction, and in science in general. He regularly visited The Royal Scottish Museum in Chambers Street in Edinburgh, admiring its scientific and engineering exhibits. Nearby, the Museum of Communications at Burntisland in Fife is the proud home of one of Williamson's early famous inventions, his 'amplifier' (of which more later).



Theo Williamson

Sanderson Building, University of Edinburgh

2. EDUCATION

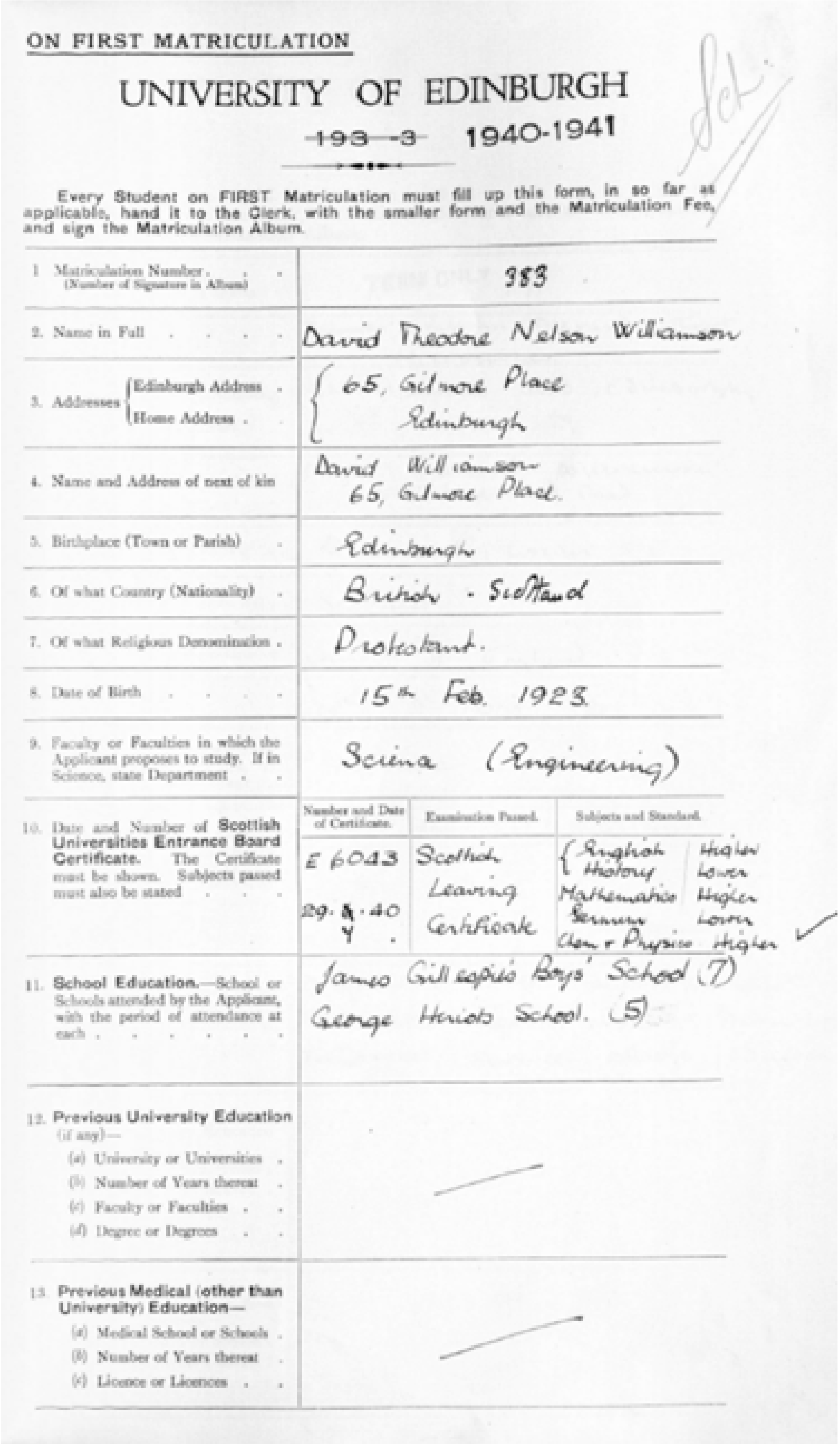
From Gilmore Place, Theo was able to walk to his primary school, James Gillespies; then at the age of 12, to begin his secondary school education, at George Heriot's School (GHS). George Heriot had been the goldsmith to King James the Sixth (of Scotland) and First (of England). Theo's scholastic performance was unremarkable, his examination grades, especially in the science subjects showed little evidence of the heights to which he would climb. Nonetheless, his practical skills were confirmed by gaining the first prize for Handicrafts, in his fifth year, and twice the Miller Prize in Applied Science. The first concerned radio transmissions, the second, a forerunner of things to come, the construction of a lathe to cut gramophone record discs.

When he finished school, he began an undergraduate general engineering degree at the University of Edinburgh in 1940. By then Edinburgh already had a proud history of engineering teaching. He was joining a University where George Stephenson; our first President, had sent his son, Robert, our second President, to study the basic sciences of Physics, Chemistry and Mathematics, that they felt were necessary for the development of their burgeoning steam locomotive industry. It was probably Stephenson's studies at Edinburgh, that prompted its three professors in the above subjects to persuade the University to introduce Engineering as a recognised discipline. Its Regius Chair of Engineering (or "Technology", as it was first entitled) was established in 1868.

The teaching in the mechanical engineering subjects stood Williamson in good stead for his entire professional life. Those in Electrical Engineering were delivered mainly by Professor M.G. Say at Heriot-Watt College, (now University), and gave Williamson a solid grasp of its principles. Coupled with courses in Civil Engineering, they equipped him with a deep appreciation of the breadth of Engineering that prepared him for dealing with engineers from different, more specialised backgrounds. His examination marks in the Engineering topics were high, and indicated that he would be likely to gain an Honours BSc degree. In his first year, he however twice failed a compulsory Mathematics examination. He was permitted to carry on his studies into his second year, but twice again failed the same examination. Under University regulations at the time, Williamson was disqualified from continuing the course. He therefore left the University without a degree.

Williamson's failure to graduate BSc rankled throughout his life and he did not talk about it. He was however not alone in that lack of achievement at Edinburgh. He was probably unaware that Robert Louis Stevenson had also studied Engineering at the University of Edinburgh, and had also left without gaining a degree. It didn't mean that Stevenson left without a mark as this memorial gate in Colinton shows. Later in life Theo too was to get his own memorial with an honorary degree from his alma mater. As an aside, Charles Darwin also found Edinburgh too challenging and did not complete his medical degree there either.

When Williamson left Edinburgh, it was still wartime and he had to report for military service. The compulsory medical examination however revealed that the TB from which he had suffered as a boy had left him with only marginal use of his lungs, owing to extensive scars. Williamson was declared physically unfit for active duties. He therefore applied to join the government Telecommunications Research Laboratory. CP Snow, later known for his books such as "Corridors of Power", interviewed him. Williamson's application was rejected.



ON FIRST MATRICULATION

UNIVERSITY OF EDINBURGH

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Every Student on FIRST Matriculation must fill up this form, in so far as applicable, hand it to the Clerk, with the smaller form and the Matriculation Fee, and sign the Matriculation Album.

1. Matriculation Number. (Number of Signature in Album)	383
2. Name in Full	David Theodore Nelson Williamson
3. Addresses {Edinburgh Address / Home Address	65, Gilmore Place Edinburgh
4. Name and Address of next of kin	David Williamson 65, Gilmore Place.
5. Birthplace (Town or Parish)	Edinburgh
6. Of what Country (Nationality)	British - Scotland
7. Of what Religious Denomination	Protestant.
8. Date of Birth	15th Feb. 1923.
9. Faculty or Faculties in which the Applicant proposes to study. If in Science, state Department	Science (Engineering)

10. Date and Number of **Scottish Universities Entrance Board Certificate.** The Certificate must be shown. Subjects passed must also be stated	Number and Date of Certificate.	Examination Passed.	Subjects and Standard.	
	E 6043 29. 8. 40 Y	Scottish Leaving Certificate	English History Mathematics German Chem & Physics	Higher Lower Higher Lower Higher

11. **School Education.**—School or Schools attended by the Applicant, with the period of attendance at each	James Gillespie's Boys' School (7) George Heriots School. (5)
12. **Previous University Education** (if any)— (a) University or Universities (b) Number of Years thereat (c) Faculty or Faculties (d) Degree or Degrees	—
13. **Previous Medical (other than University) Education**— (a) Medical School or Schools (b) Number of Years thereat (c) Licence or Licences	—

School report

3. THE MO VALVE COMPANY

Instead, he was drafted to the Marconi-Osram (M.O.) Valve Company in London. His first job there was to help in the testing of valves, then later in the Applications Laboratory, he helped with the testing of circuits for new valves, writing the reports and manuals needed for their proper use. His boss was Graham Woodville, who let the young Williamson pursue his interest in sound amplification, when his duties for the day had been completed. The outcome was an amplifier producing 20 W with less than 0.1 per cent harmonic distortion, compared to the 5% or more normal at that time. The amplifier, matched with a very lightweight gramophone pickup and a good loudspeaker yielded a quality of sound hitherto unheard of.

The design of the amplifier was published in 'Wireless World' in 1946. Enthusiasts worldwide built many thousand copies of the Williamson Amplifier. The instrument thereby established his name, but provided him with no income.

4. FERRANTI LTD, EDINBURGH

Ferranti Poster

Williamson returned to his home city in 1946, joining Ferranti as a development engineer. John Toothill was then its General Manager. John had started life as an engineering apprentice, but soon decided that he was not cut out for that kind of job, and trained as an accountant. About 1950, Toothill put Williamson to work on improving Ferranti's manufacturing. There was congestion in the workshop, especially in milling. There was a pressing need to make an increasingly wide variety of parts. The machine tools operators were being expected to produce components such as waveguide assemblies for radar out of aluminium alloy to a consistently high accuracy. The workshops, especially the milling sections were finding it difficult to cope with the demand. Williamson put together a small group of about six colleagues. They investigated how to guide precisely the slide ways of a machine tool using computer-controlled servo-mechanisms, to an accuracy of 0.5µm. This would remove the dependence on the manual skills of the operator. Instead of following the established practice of using lead screws for measurement, Williamson's team devised a system based on the Moiré fringe effects produced when two photographic plates are superimposed. They were assisted in this development by the National Physical Laboratory. The system was patented. The revolutionary Ferranti grating measurement machine was born. The team next adopted recently produced recirculating ball screws to overcome other mechanical difficulties in the way of their drive towards high precision machine tools. They decided that computers available at the time were too slow to feed the machine tool. Instead, Williamson's colleague produced a 'Digital Differential Analyser'. This procedure could enable them to manufacture circles, ellipses and parabolae in three dimensions. It let them develop the computer system needed for their purpose. Data could now be generated at ten times the speed needed to move the machine tool slideways, and magnetic tape (replacing the conventional paper) facilitated the transfer of data.

The Fairey-Ferranti milling machine epitomised the efforts of Williamson and his team. In it, they had strived for mechanical perfection. In 1957, the first application was manufacturing the tail engine cowling for the Trident aircraft and later machining sections of the ramps used to launch the Sea Harrier from aircraft carriers.

It was not all work for Theo Williamson as Ferranti. He met Alexa Neilson there. After school and Edinburgh University, where unlike her husband to be she did graduate, she took a job as a secretary with Ferranti in November 1949, initially working in the same laboratory as Theo. They married on 8 June 1951, in Edinburgh. The first three of their children, Ann, Carol and Peter, were born there, and their fourth, Alasdair arrived after the family moved south to Kent to join Molins.

5. MOLINS LTD, LONDON

Molins was started by two brothers, Walter and Harold; in 1912 it began making the paper packets in which the first ‘Woodbine’ cigarettes were sold, and later cigarette making machines. By 1960, it was exporting 78% of its tobacco machinery. They had heard of Ferranti’s achievements through the Digital Differential Analyser in making three dimensional shapes. A collaboration was established between the two firms to make three-dimensional cams and associated machine tools, to increase the speed and life of the Molins packaging machinery particularly the ‘flip-top’ packs which they had just patented. The Ferranti-inspired machine tool provided the answers for Molins. Williamson was invited to become Molins Director of Research and Development. He was to be paid four times the salary that Ferranti gave; it was more than that of the prime minister of the day. Ferranti certainly did not want Williamson to leave: but as Sir John Toothill pointed out, Ferranti had a salary scale that could not be broken, so they could not even approach anything near to that of Molins.

At Molins, amongst his early tasks, Williamson had to recruit the right kind of mechanical materials and electronic engineers that he needed. Where possible plastic parts now replaced metal ones. Plastic injection moulding machines were procured. All tooling was now made at Molins. Electronic inspection and control of the cigarette machines became a mainstay. Continuous flow systems were developed, and other novel ways for packing the cigarettes devised. Cigarette production rose from 1800 to 4000 per minute over the next few years, on this new generation of the Molins (Mark 9) machine. Next they turned to computer numerical control, based on Williamson’s experience with the Fairey-Ferranti cooperative exercise. Realising that most of the metal parts needed for the Molins’ machines could be manufactured from light alloy, and were relatively small, about 300 x 300 x 150mm in size, they built a two-spindle milling machine, with hydrostatic slide ways. A Pelton wheel spindle was designed, that was driven by a high pressure oil jet; which operated at constant temperature. Two numerically controlled milling machines were built. The machines demonstrated the capability of Williamson’s concepts for a new generation of machine tools. Molins were about to enter a new field of manufacturing, which was not related to cigarette machinery. An integrated flexible manufacturing system (FMS) became the aim. FMS would give continuous operation, 24 hours a day. The system would incorporate machine tools that could provide any machining operation. Components would be delivered from storage racks by automatic conveyors (‘Molacs’) to and from machines, and then returned to the racks, their final position being recorded on the computers. A buffer store containing cutter magazines and work pieces was to be installed between the main store and the machines. This procedure provided a means of efficient materials transfer prompt rescheduling, if required, without queuing.

A detailed model of the Molins ‘system 24’ was constructed to demonstrate to potential customers. The latter included IBM, who wanted the system, installed with their computer technology for their own manufacturing plant in the USA. (Williamson was to observe many years later that if you want your own engineering work to succeed you need the backing of the big industry players). The Molins “System 24” was described by Williamson in this very lecture theatre in the James Clayton lecture of 1967.


KUKA

6. SYSTEM 24 AND THE SOUND OF MUSIC

Many years later Williamson was invited to review the history of System 24 at the machine tool MATADOR conference in Manchester in 1992. In his briefing notes for the conference, he describes himself as the conductor of the Molins System 24 orchestra. Its instrument players were his team (that numbered about 100) who created the music. There were no principal soloists as all gave of their best. Yet again Williamson had changed the sound of music, this time for the manufacturing industry.

7. ROYAL SOCIETY

The President of the Royal Society of London heard about Williamson's work at Molins. His colleague Dr Feilden paid a visit, and reported back that the activities there were truly outstanding. Theo Williamson was elected Fellow of the Royal Society (FRS) in 1969 at the young age of 46.

The Royal Society, London

8. RANK XEROX

Around this time however Williamson fell ill, and was off work for some months. During this period some of the main board and family members at Molins decided to retire. There were consequent management changes and in 1974, Williamson too decided to move on and he took up an invitation to become the European Director of Research for Rank Xerox. There he oversaw the development of the fax machine and the colour copier.

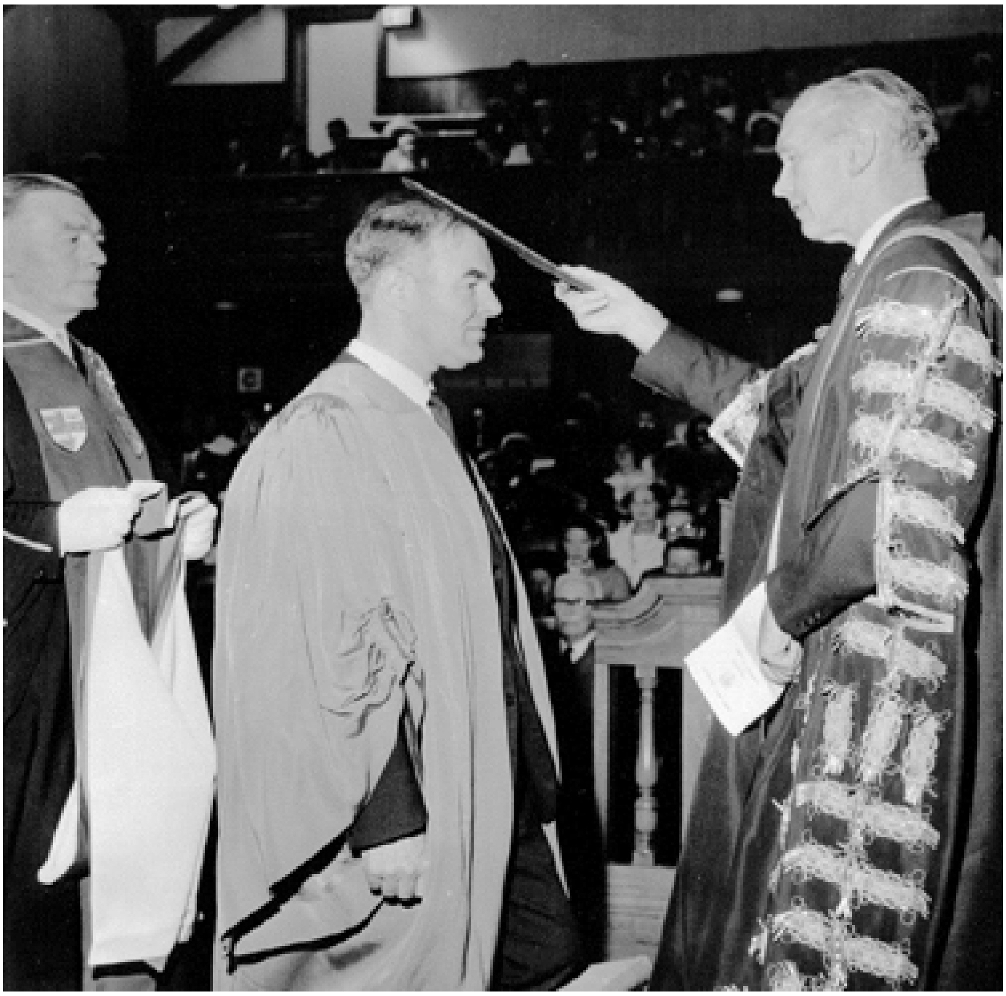
Rank Xerox Photocopier

9. SCIENCE RESEARCH COUNCIL (SRC) ENGINEERING BOARD

He was still at Molins however when he was appointed to the Engineering board of the Science Research Council (SRC) now Engineering and Physical Science Research Council (EPSRC) in 1972, chairing its manufacturing panel. He had already been attending meetings of the National Economic Development Organisation (NEDO) sitting with senior industrialists and trade unionists. At NEDO, a paper showing the fall in the balance in payments between exports and imports notably in mechanical engineering industry had already caught his attention and gave him great concern. At the SRC he advocated that this imbalance could be in part addressed by a 'Teaching Company Scheme'. The expertise of our academics in UK Universities and Colleges were to be brought to bear for the benefit of the manufacturing industry. This scheme has endured for over 40 years and is now termed the Knowledge Transfer Partnership (KTP). It remains the most successful example of industry university cooperation. Williamson was also made aware of a national shortage in the manual skills needed for finishing the surfaces of dies and moulds. He promoted a coordinated programme of research in advanced new methods of surface finishing by electro-discharge (EDM) and electrochemical (ECM) machining, drawing in the key researchers In UK universities. Similarly, he introduced a programme of grinding research for manufacturing industry. Much of this effort saw the start of new University-inspired spin-off companies.

10. HONORARY DOCTORATES OF SCIENCE

As a footnote to those of us who have known setbacks, it is important to realise that his hometown of Edinburgh now felt it was right to recognise his achievements. Despite suffering the ignominy of failing his BSc in Engineering in 1940, both Heriot-Watt and Edinburgh University decided it was right to award him honorary Doctorate of Science degrees (DSc) respectively in 1971 and in 1985.



Theo Williamson receives his honorary degree from Heriot-Watt University

11. LEGACY

Theo Williamson retired in 1976 and moved his home to Italy overlooking Lake Trasimeno. He died in May 1992 at the age of 79. During these Italian years, he maintained his interest in developments in the UK and continued to contribute important papers to the National Economic Development Office and Science Research Council committees as well as the professional engineering institutions.

In preparing this lecture I was able to draw on papers about Theo Williamson given to me by his family members over many years. The biographical memoir of The Royal Society for David Theodore Nelson Williamson by G.B.R Feilden CBE, FEng, FRS provided much useful information, as did the notes that Dr Williamson had prepared for the 1992 MATADOR conference at which his engineering achievements were commemorated. I chose it for my Presidential address as I feel it epitomises the need for perseverance as well as creativity and problem solving in carving out an engineering career.

12. ACKNOWLEDGEMENTS

As you would expect, I am very proud of my children, their spouses and their children and their achievements. They make me happy everyday: Andrew, Karen and Ella McGeough, Elizabeth, Barry, Patrick, Thomas and Sophie Keane, Simon, Louise, William, Amelia, and Isabella McGeough; also my brother Edward, President of the Scottish Bridge Union. Not all engineers, but still true to the engineering ideal of doing what they can to 'improve the world'.

My greatest thanks of course go to my wife Brenda who remains a steadfast source of support and encouragement and could equally have given such a lecture herself to describe her own significant achievements.

In closing however I would like to speak directly to the 120,000 members of our great Institution all over the world. First to say that I am honoured to have been appointed to become the Institution's 134th President. I am acutely aware of the responsibilities that come with this roIe and the 133 pairs of shoes that I need to fill. I intend to ensure that during my year we energetically pursue the Institution's object and purpose under its Royal Charter: to 'promote the development of Mechanical Engineering and to facilitate the exchange of information and ideas thereon'.

I would especially like to thank Tony Roche, the Trustees, Council and all the Members who have been involved in refocusing the Institution over the last year and to pledge that I will ensure this progress continues under my Presidency. The important work being undertaken by the review teams now needs to be translated into action and I will continue to work across our membership and with the Head Office team to make sure that the Institution works hard to support its Members' interests and activities whilst continuing to deliver on its charitable aims.

As I said at the beginning of this address, IMechE has been at the heart of the world's most important industries since its formation in 1847. We need to ensure that we stay there and continue to support the next generation of Theo Williamsons through our events, our professional registration and our mentoring capabilities. There has never been a better time to be an engineer and I would like to do my part to help as many as possible from the widest range of backgrounds to get the chance to realise their full potential. I look forward to working with all of you to ensure that our Institution continues to deliver on our vision of 'improving the world through engineering'.

Thank you.

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