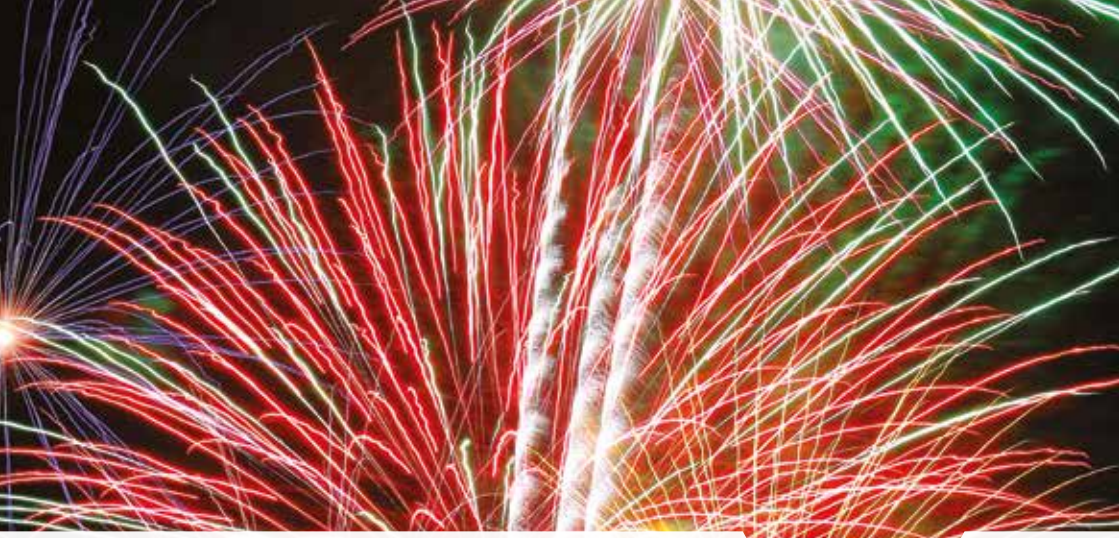

WARWICK
THE UNIVERSITY OF WARWICK

Dr Don Eigler Hon DSc

Oration by Professor Chris McConville
Department of Physics

Dr Don Eigler Hon DSc

I am personally delighted that today's honorary graduate is being given this award. Dr Don Eigler is quite literally a giant in the "Small World" of Nanoscience and Nanotechnology, and he is universally acknowledged as the first person ever to move and control a single atom.

Nanotechnology impacts on all our lives, from the ever-present smartphone to medical and environmental applications, but its origins can be said to have begun in December 1959 with a lecture by the visionary – and often controversial – physicist, Richard Feynman, entitled *There's Plenty of Room at the Bottom*. In it Feynman speculated that, "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom, arranging them the way we want them – but in practice it has not been done because we are too big." Of course, that was back in 1959, but our honorary graduate today was to make that visionary statement a reality.

Don Eigler received both his bachelors' and doctorate degrees from the University of California at San Diego. After a postdoctoral position at AT&T Bell Labs he joined the IBM Almaden Research Centre in San Jose, California in 1986 – the same year that two of his colleagues shared the Nobel Prize for Physics for the development of the scanning tunneling microscope (or STM) – a microscope capable of imaging individual atomic positions.

The STM, in principle at least, is quite a simple device. You bring a small metal wire – approx. 2mm in length, and sharpened to only 1 or 2 atoms wide at the very tip – close enough to a surface so that when a small voltage is applied, electrons can jump or tunnel across the gap from states in the tip to states in the surface – or vice versa.

However, the engineering practicalities to actually achieve this – in terms of stability and vibration isolation – are technologically very significant.

Don took this idea one step further, and built an STM that not only operated in ultra-high vacuum, but at liquid helium temperatures (just four degrees above absolute zero, or -269°C). With this reduced temperature, the thermal motion that all atoms experience is significantly reduced and he was able to study non-interacting inert gas atoms such as xenon on a metal surface. However, he observed that even at these low temperatures the Xe atoms would still change positions on the surface due to the forces exerted on them by the tip of the microscope. He concluded that if these forces could be controlled, he should be able to move the atoms deliberately.

On 10th November 1989 he arranged 35 xenon atoms on a nickel surface to spell out 'I.B.M.' As he said in his log book this was "the first ever construction of a patterned array of atoms". That now famous image not only appeared on the front cover of *Nature*, but when the news broke in an IBM press release, on the front page of most broadsheet newspapers in the western world. The original experiment to arrange those 35 atoms took almost 22 hours, but this can now be achieved in about 15 minutes.

I first met Don in 1991, at a meeting at the University of Liverpool, where 10 young (in those days at least!) surface scientists from the USA and 10 from the UK met to discuss the future directions of the field. Don gave the last talk on atomic manipulation and all were left spellbound. At the end of the lecture someone asked him "Why did you spell out IBM?" He answered, "I'm not sure really, but I think it was a good idea. What do you think?".

Having conclusively demonstrated the ability to position individual atoms, Don went on to construct numerous atomic structures to demonstrate some of the most fundamental principles of quantum mechanics, from the quantum corral – a ring of 48 iron atoms that beautifully demonstrated how electrons behave as waves, and by changing the shape of the corral from a circle to an ellipse, he also produced the first demonstration of a quantum mirage formed by the coherent projection of atomic states. The Physics students graduating today who took my Quantum Phenomena course back in their First Year should certainly recognize those STM images from the IBM gallery!

Not content with moving atoms, Don turned his attention to moving molecules, in particular the carbon monoxide or CO molecule. He discovered that by positioning literally hundreds of CO molecules in atomically precise positions on a copper surface he could construct and control a 'molecular cascade' – each molecule triggering the movement of

the next. In reality he constructed the world's smallest electronic device – a logic circuit made up of several AND and OR gates – occupying an area of approximately 1 trillionth of a square inch – and over 10,000 times smaller than the best silicon CMOS- based devices of the time.

An indication of the respect and esteem in which Don and his work are held can be judged by the fact that while most scientists labour to publish one or two papers in *Science* and *Nature* during a career, Don's work is almost exclusively published in these journals. He has also received many honours and prizes, too many to list here, but the prestigious Kavli Prize for Nanoscience in 2010 does merit a mention.

In his spare time Don is an accomplished speaker and yachtsman – sailing his yacht 'Wetnose' – and he is a dedicated trainer of service dogs with the specific aim of helping people with impaired mobility. Indeed, his dogs Neon and Argon were both familiar features around the IBM Research Centre where they received special permission to be on-site and at least one of them was almost always his companion.

Finally, for those rare individuals who achieve a major breakthrough in any field of endeavor tend to have their name associated with a related phrase or saying. For example, if I were to say: "the first man on the moon" or "the first men to achieve powered flight" – you would immediately think of Neil Armstrong and the Wright brothers. In science, Ernest Rutherford, the man whose work in nuclear physics ushered in the nuclear age, is often referred to as "the man who split the atom". Don Eigler's achievements in demonstrating the ability to move matter at the atomic scale and make the age of nanotechnology a reality are no less monumental and will have impact on the lives of generations to come.

He is quite simply, "The man who moved the atom".

Chancellor, in the name of the Senate, I present for admission to the degree of Doctor of Science, *honoris causa*, Dr Don Eigler.