Induction WA Science Hall of Fame, Scitech, March 9, 2016

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The **Honorable Donna Faragher**, Parliamentary Secretary to the Premier and the Minister for State Development and Science, **Professor Peter Klinken**, Chief Scientist of Western Australia, distinguished guests, ladies and gentlemen.

I too wish to acknowledge respectfully the traditional owners of this land, the Noongar-Whadjuk people, and to pay my respects to elders past and present. It is a privilege live in this wonderful country.

I was surprised, and delighted when I first heard about this induction into the WA Science Hall of Fame. I wish to thank the WA Science Awards Committee for this honour. Indeed I feel very humble to be joining such an amazing group of people: especially Robin Warren, Lyn Beazley, Alan Robson, Bernie Bowen, who are here this evening.

In accepting this induction I am conscious that it is not only for me, but also for Mathematics. The discipline of Mathematics is central to Science, to Technology, and it is also important to the Social Sciences and Humanities. For example, studying the philosophical assumptions, foundations and implications of mathematics is a branch of Philosophy, while mathematical methods have transformed Economics. Indeed the American mathematician John Nash was awarded the Nobel Prize in Economic Sciences in 1994 for his mathematical work on non-cooperative games, and in particular the Nash equilibrium.

But it is in **Science** that we see the most powerful impact of Mathematics. Physicist and Nobel Laureate Eugene Wigner spoke of the "unreasonable effectiveness of Mathematics in the natural sciences". That was in 1960, and we have seen evidence of this over the centuries. In 1687, Isaac Newton's mathematics unified the theories of gravitation proposed by Galileo and Kepler.

More recently my own discipline of **Group Theory** has proved remarkably good at predicting structure in the quantum world – such as the existence of subatomic particles. At a larger scale Group Theory underpins descriptions of crystalline structure in chemistry and the structure of nucleocapsids in the classification of viruses.

Understanding planet earth and its climate requires sophisticated mathematics to analyse complex data sets, and solve massive systems of equations. And in recent decades our understanding of the genome has depended on mathematical and statistical methods for assembling the data from gene sequencing.

These scientific breakthroughs have a huge impact on our lives, and **maths plays a central role.** I am thinking, for example, of the statistical agricultural and clinical trials which transformed agricultural production and clinical practice in WA. I'm also thinking of medical procedures such as CAT scans and MRIs which rely on mathematics to produce an image. I note that Australia's own Fields Medalist Terry Tao – a pure mathematician – has made major contributions to this area: his mathematical work on compressed sensing – which he describes as "both simple and unintuitive" - is expected to improve both the speed and resolution of MRI scans.

I guess it's very easy for enthusiasts, like me - **Mathematicians and Scientists passionate about their work** – to give glowing reports, quoting examples of the high impact their discipline has had on the economy, and on our quality of life.. But how

should this be taken by those outside this "club" who have to weigh up competing claims and priorities? I was immensely grateful that the former Australian Chief Scientist Ian Chubb, together with the Australian Academy of Science took up the challenge of quantifying these contributions. Their recent report finds that the *"total direct and flow-on impact of advances in the physical, mathematical and biological sciences*" is worth $330B each year – that's 26% of Australian economic activity. It translates to more than 1.17M jobs – around 10% of total Australian employment – and 25% of total Australian exports of goods and services.

I have been very pleased to see **a renewed focus on science and innovation** by both the Western Australian and federal governments, and by parliamentarians from all sides of the political spectrum. I recently had the opportunity and privilege, with two colleagues, to represent the Australian Academy of Science in discussions about science priorities with six federal parliamentarians representing five Australian states, and four political parties. Australia's future economic and social prosperity depends above all else on science, technology, engineering and mathematics (STEM). Whether it is solving the great challenges facing us for food security, the environment and health, or whether it is pursuing basic research that will deliver unexpected but transformative breakthroughs – the STEM disciplines provide the power behind innovation.

In our meetings with the parliamentarians we spoke about many things **surrounding the importance for Australia of a world class science and mathematics education and research capability**.

Let me say a bit about **Mathematics education**. Australia produces outstanding young mathematicians. In 2015, the Australian team at the International

Mathematical Olympiad had their best result in 35 years of competition – leaping into the top 10 of the more than 100 countries competing, and with all team members winning medals: 2 gold and 4 silver medals for Australia. At the same time as this success, all Australian States are starting to adopt the Australian Mathematics Curriculum, and a new federal government-funded school Mathematics Project, called **re-Solve**, is just underway. It will provide resources to support teachers as they introduce the new curriculum. I chair the Management Committee for this new project, which is hosted jointly by the Australian Academy of Science and the Australian Association of Mathematics Teachers. We are keenly aware of a complex of issues that would affect a successful delivery of a high quality mathematics education program. There are certain areas where Australian kids have fared less well in recent international tests-such as PISA – compared with kids in other countries, such as Singapore. Also we are conscious of the need to support the many teachers in mathematics class-rooms who are teaching out of field, without the appropriate training to give them confidence in teaching new mathematical material.

The need for more well-trained mathematics teachers is competing with the need for mathematically and scientifically trained graduates for many, many different careers related to STEM – and it comes at a time when not enough school students are studying maths at an appropriate level to let them progress to such careers easily. Although 80% of year 12 students are studying some mathematics, only around 30% of year 12 students do intermediate or advanced mathematics – which is needed for STEM study at university - and the proportion appears to be trending downwards.

As WA's Chief Scientist Peter Klinken mentioned recently, a rather laissez faire attitude, to the choice of subjects students take at school, has led to insufficient kids being prepared for tertiary studies in STEM areas.

It's hard to imagine that a **single** initiative will change this overnight, but I note that the University of Sydney has just announced the introduction of **maths prerequisites** for beginning students into a range of courses – including Economics and Commerce, Science, Vet Science, Pharmacy, Engineering and IT[1]. Perhaps a re-introduction of maths prerequisites for WA universities is a strategy to be considered seriously.

Speaking of the University of Sydney, I also note that **that** university has just celebrated an Australian first: it now has **four women full professors** in its School of Mathematics and Statistics[2]. In WA there is only one woman professor of Mathematics apart from me (namely, Jo Ward at Curtin); and across the whole of my Faculty – of Engineering, Computing and Mathematics – at the University of Western Australia, we have only four woman professors.

I realise both the importance and the difficulty of attracting sufficient women into careers in STEM. So I would like to dwell briefly on my own history.

It is now forty years, and a few weeks, since John and I drove across the Nullabor to take up short term academic positions at UWA. For me it was a two year contract lectureship, and from that post essentially my whole career has developed.

[1] http://sydney.edu.au/news-opinion/news/2016/02/01/mathematics-to-become-a-prerequisite-for-university-of-sydney-ad.html

[2] with the promotion of two of my colleagues Mary Myerscough and Jean Yang

I surprised myself, and possibly others when, in late 1983, I was appointed Professor of Mathematics at UWA, filling the Chair made vacant on the retirement of Professor Larry Blakers. I was **a woman, a mathematician, a Western Australian** – three rather different measures of "diversity" – and this resulted in invitations to serve on innumerable committees over many years. These ranged from the **Prime Minister's Science Council** – where wide-ranging STEM issues were discussed – to the **Curriculum Development Council** – which oversaw educational projects from Kindergarten to Year 12 in all areas of the curriculum and all state systems – to the **Australian Academy of Science** – where I am now the Foreign Secretary and on the Council and its Executive.

Over my career there were **choices** to make – whether I should stay working in Science – in my case, Mathematics – or whether I should move to an executive leadership position. It may have been my personality; or it may have been my unquenchable passion for Mathematics. Whatever it was, I chose to stay in Mathematics, to be a champion for Mathematics. And I have been extremely fortunate – with wonderful students and colleagues in the Centre for the Mathematics of Symmetry and Computation, and the School of Mathematics and Statistics at UWA, and indeed across the whole University. UWA has been very encouraging, especially in supporting my Australian Research Council Federation Fellowship which allowed me to strengthen my research group.

Looking back on what seems to me like an unusual career, and wondering how I came to where I am now, it is hard to disentangle those "diversity" aspects: **gender, living in a relatively isolated state, working in a somewhat mysterious discipline**.

Let me comment on that last one: Mathematics services so many of the sciences, as well as technology and engineering, that it often has an amorphous identity. It bears so

many demands: “to be relevant to industry”; “to solve real world problems”. The uniqueness and value of Mathematics is not always recognized. Mathematical methods are almost always relevant to diverse fields, and are rarely only appropriate to just one problem or area. The Mathematical Sciences simply do not fit into a narrow industry focus. It is important that the identity of Mathematics is not lost, or become invisible behind other labels –such as Quantitative Methods in Economics or Engineering. **Mathematics cannot be squeezed into a narrow area without losing its power**.

Thank you for indulging me in allowing me to speak like this. Western Australia is a wonderful State in which to live and work, and I am personally grateful for so many valued colleagues, and friends, made across the State during my career at the University of Western Australia.

Very special thanks to my husband John Henstridge, of 40 years, and to our two wonderful sons, James and Tim, for giving me the freedom to pursue my mathematical dreams over all these years.

Once again, my thanks for the honour of being inducted into the WA Science Hall of Fame.