Timoshenko Lecture – Ray Ogden – 15 November 2016

Thank you Arun for the very kind introduction. However, I think the citation is rather too generous and more than a little exaggerated!

It is indeed a great Honour to be awarded the Timoshenko Medal, and I would like to give a sincere vote of thanks to those good friends and colleagues who thought it might be worthwhile to take the chance to nominate me and write supporting letters. And to the awards committee for believing their fabrications.

It is quite humbling to look down the illustrious list of mechanicians who have been previous recipients of the Timoshenko medal, and to realize that my name has been added in 2016. It is still difficult to believe.

Actually, I didn’t hear the great news until late in May because I was away from Glasgow visiting my good friend Gerhard Holzapfel in Graz, Austria, and the letter from ASME was sitting in my Department unopened. It wasn’t until I received an email from Peter Wriggers while I was in Graz that I received the news, so I immediately went out and bought an expensive bottle of red wine to celebrate!

I wasn’t quite sure what should be involved in the Timoshenko Lecture, so, as most recipients do, I did my homework by studying the texts of a few previous Timoshenko lectures, which, fortunately, are conveniently collected together in iMechanica. There I discovered that the typical length of a lecture is about 2500 words, so that’s what I aimed for, more or less.

As a mathematician I was not, unfortunately, exposed to Timoshenko’s books while a graduate student, but I do have them on my shelves now and benefit from dipping into them occasionally. I was actually raised on Truesdell and Noll ...

I mentioned Glasgow a moment ago. I’ve been there, at Glasgow University, for more than 30 years. However, I’m not Scottish (you can tell that from my accent or lack of accent) so I’m certainly not following Bob McMeeking’s example and wearing a kilt.

As many people know, Bob, himself the 2014 Timoshenko medallist, did his undergraduate studies in Glasgow in Civil Engineering and received some of his mathematics training from the late Professor Ian Sneddon and was to some extent influenced by him, in particular by his recommendation to go to Brown for his PhD with Jim Rice (Timoshenko medallist in 1994).

Ian was instrumental in my appointment at Glasgow, although I wasn’t his direct successor because we overlapped for a year before he retired, and my Chair, the George Sinclair Chair, was different from his. George Sinclair, incidentally, held the first Chair in Mathematics at Glasgow, to which he was appointed in 1691. So, you realize that Glasgow is an ancient university, established in 1451 and the fourth oldest university in the UK.

Let me take a step back – to High School (actually, it was called a Grammar School). There I had an excellent mathematics teacher, called Mr. Barker-Jones (I never knew his first name). He somehow recognized that I had some ability in mathematics and persuaded me to focus
on the subject, along with physics. In those days, there was quite a lot of mechanics in the mathematics curriculum and I really enjoyed working out problems of projectiles, pulleys, moments of inertia and rolling rigid bodies, for example.

This set me off on the path that I haven’t strayed from throughout my career. Under his guidance I sat the entrance exam for Cambridge University and was fortunate enough to be offered a place to study Mathematics. I was based at Gonville and Caius College, which is the college where Stephen Hawking is based – in those days he was mobile, and occasionally I saw him walking around, albeit with difficulty, in the Cambridge streets.

Incidentally, many of the sorts of theories and problems I worked on in Grammar School are not normally covered in today’s curriculum, and, because of this lack of background, it is distressing that I am not able to teach this sort of material until the third year of our undergraduate course, and even at that level the students struggle with it. This is all part of the dumbing down of school education in the UK, and I’m sure it is true elsewhere – many students are not well prepared for university work.

I had the good fortune to be able to study a wide range of mathematics topics at Cambridge for four years, the first three as an undergraduate and the fourth year in the one-year graduate course known as “Part III of the Mathematical Tripos”. In the latter two years I focused very much on the applied side and this included a lot of fluid mechanics (George Batchelor, Timoshenko medallist in 1988, was one of the lecturers and at that time he was completing his now very famous text on fluid dynamics).

There was some linear elasticity and elastic waves in the course, although there was not a lot of solid mechanics available at that time, but rather more exotic things like general relativity, cosmology and quantum theory, inter alia. It was certainly a very inspiring course.

After Part III, I had to decide what to do for my PhD – my inclination was towards Solid Mechanics, although I could equally have gone for Fluid Mechanics. It seemed natural to stay in Cambridge and no one suggested anything else. The obvious choice for an advisor (supervisor in the UK) at that time was Rodney Hill, and I embarked on my PhD with him.

At the very start, in his characteristic handwriting, he wrote out a list of problems for me to work on and let me get on with it. Unfortunately, I couldn’t find that list to refer to this evening (I’m not sure if I kept it), but I do know that none of those problems have been solved to this day. Basically, it was sink or swim, so I learnt to swim and developed my own research problems and studied the nonlinear theory of elasticity intensively (largely following the likes of Truesdell and Noll and Rivlin). This led to my first publications, which dealt with constitutive inequalities, wave propagation and special material models (such as harmonic and Hadamard materials).

As most people of my generation know, Hill was quite an unusual man, and there are many stories about him. He was actually very reticent and this is reflected in the little anecdote I will now relate. The usual mid-morning ritual in DAMTP (Department of Applied Mathematics and Theoretical Physics) was for supervisors and students to gather for tea/coffee, and on one occasion Hill and his students were joined by a visitor from the
Technion in Israel (not a visitor of Hill). It came to light that he was a colleague of Sol Bodner and Hill indicated that he knew him. The visitor (whose name I don’t remember) said he would mention to Bodner that he had met Hill, and asked Hill what his first name was. Hill seemed embarrassed at this and thought for a little while, and then said ‘the initial is R.’ The graduate students never dared to address him as Rodney!

During the final few months of my PhD I applied for some academic positions. I was offered a lectureship at the University of Liverpool, where the well-known rheologist Jim Oldroyd was Head of Department (of Mathematics). At about the same time I was offered an SERC (Science and Engineering Research Council) Research Fellowship at the University of East Anglia (UEA), in Norwich, and I decided to accept that so I could focus on research for two years before committing to a teaching career. SERC was the previous incarnation of what is now the EPSRC (Engineering and Physical Sciences Research Council), the UK’s counterpart of NSF.

My mentor at East Anglia was Peter Chadwick, who also happened to be my thesis examiner – he clearly had something to do with my Fellowship appointment since he was a member of the SERC Committee at the time – and I am very grateful for that – I had a wonderful time at UEA. I immersed myself in rubber elasticity and it was during my two years there that I devised what have become known as the ‘Ogden materials’. This modelling work was very much driven by the need to understand and capture data, a theme that has permeated much of my subsequent work.

At UEA I didn’t only do research – I also had my first experience of lecturing – I lectured on the mathematical theory of cracks at MSc level for two years, helped by reading some of Jim Rice’s papers and some lecture notes that John Willis (Timoshenko medallist in 1997) generously provided.

In my second year at UEA John Willis, who was in Cambridge at the time, accepted the chair of mathematics at the University of Bath, and invited me to join him as a lecturer, which I duly did – my first proper academic job. John was always very supportive and I was very grateful for his encouragement.

I stayed in Bath for 8 years, and then moved to Brunel University, which turned out to be a brief encounter but a period during which I wrote my first book “Nonlinear Elastic Deformations”. In 1984 I moved to Glasgow, where I have been until now, except for a two-year sojourn at the University of Aberdeen from 2010-2012, but a change in the administration there turned out to be a disaster and I was happy when Glasgow persuaded me to return.

In my time at Glasgow I have been able to travel a great deal and I am fortunate to have developed, and benefited enormously from, collaborations with a number of talented colleagues in other universities worldwide, in a variety of different research areas, which has enabled me to expand my range of interests and perspectives.

Long term and ongoing collaborators include my good friends David Steigmann (Berkeley), Gerhard Holzapfel (Graz), Luis Dorfmann (Tufts), José Merodio (Madrid), Giuseppe
Saccomandi (Perugia) and Michel Destrade (Galway), more or less in chronological order of our initial collaboration. This sort of collaboration, with like-minded colleagues, is both stimulating and one of the pleasures and rewards of being an academic.

It was Gerhard Holzapfel in 1996 who introduced me to the subject of biomechanics, which offered, and still does, a wealth of interesting problems in mechanics (increasingly so at a range of different scales, from subcellular through to organ level). We have continued our collaboration quite intensively since then, and developed successful models of soft tissue mechanics, increasing in complexity as more detailed data on soft tissue structure and behaviour became available as a result of advances in imaging and experimental techniques.

Data are absolutely vital for the modelling – in order to capture the material structure and mechanical behaviour that current experimental techniques are able to bring forth, to build descriptive mathematical models and to use them both for understanding the mechanical interactions and for prediction for parts that experiments can’t reach (this sounds a bit like the advert “Heineken refreshes the parts that other beers cannot reach”).

Education in the discipline is also a very important part of our activities, which have included organization of a series of week-long intensive Summer Schools in Graz aimed mainly at PhD students on the model that has been running at CISM (the International Centre for Mechanical Sciences) in Udine, Italy, for many years. This last July, for example, around 120 students attended our course from over 25 different countries (and the next course is scheduled for September 2018).

I now want to make particular mention of Luis Dorfmann. We have worked on several topics, but it was he who introduced me to magneto-mechanical interactions way back in about 2002. This led to our development of forms of the equations and constitutive laws governing magnetoelastic and electroelastic deformations of magnetosensitive and electrosensitive elastomeric materials that have been used by quite a number of researchers, which is very gratifying.

This is an area that has much potential for applications as ‘smart materials’ in transducer devices, for example. Unfortunately, at present, there is a shortage of appropriate data for informing the development of truly reliable material models, so we fall back on simple prototype constitutive laws, for now. More good data are needed, and this is why it is important for theoreticians and experimenters to collaborate.

My contributions would not have been possible without a strong grounding in nonlinear continuum mechanics. I am sure that many people here will agree that it is important not to lose sight of the fundamentals, which all too often are being dropped from curricula. This is reflected in my reviewing of papers – I often come across errors which are basically down to an inadequate grasp of the fundamentals. Unfortunately, such errors also appear in the literature, sometimes in quite respectable journals, in which case the reviewers are also at fault!

Also, unfortunately, it is very difficult to secure funding for fundamental work, and in the drive for funding the fundamentals are very often forgotten. That reminds me of a little
anecdote about Sir Harold Jeffreys, a famous geophysicist/applied mathematician in Cambridge who died in 1989 (some of you may know his book entitled “The Earth”). On one occasion, he was visited by some scientists from an oil company who wanted to know if he could help them with a technical problem. After they explained the problem he is reported as saying “I’m glad it’s your problem and not mine” – in those days it was possible to turn down the opportunity for funding.

Nowadays, mechanics is very much a multidisciplinary endeavour and benefits enormously from interaction with many other areas, which bring forward new, challenging problems for mechanics and different perspectives. Thus, I believe that mechanics is in a very healthy state, underpinning, as it does, so many different areas of application, and it has much potential for new entrants to the subject. I must say, however, that young faculty have a much tougher time now than was the case when I was a young faculty member, particularly with the pressure to bring in funding, so they need as much support and encouragement as possible from established faculty.

To finish, I have to say that it has been very rewarding to be an academic in a university and to have had the privilege to do more or less what research I liked and to have interacted with so many excellent colleagues, many of whom I consider to be close friends. I count myself as being very lucky.

2016 has been an especially good year for me since not only have I been awarded the Timoshenko Medal, but also, in August, I received the Rodney Hill Prize in Solid Mechanics at ICTAM in Montréal. That is an incredibly prestigious combination for which I am extremely grateful and humbled!

Well, I think that those of you who are still awake will have heard enough from me by now. That brings me to the end of my Timoshenko Lecture (or acceptance speech as it is otherwise known), and I am delighted and honoured to be able to accept the Timoshenko Medal, and I sincerely thank again all those who made it possible. Thank you so much!