Professor Chris Calladine, Department of Engineering, University of Cambridge

See:
http://www-civ.eng.cam.ac.uk/crc/crc_web.htm
http://www-civ.eng.cam.ac.uk/struct/crc/index.html
http://www.eng.cam.ac.uk/news/stories/calladine.shtml
http://www-structures.eng.cam.ac.uk/directory/crc@cam.ac.uk
http://en.wikipedia.org/wiki/Christopher_Calladine
http://www.amazon.co.uk/Understanding-DNA-The-Molecule-Works/dp/0121550893

Chris Calladine is Emeritus Professor of Structural Mechanics. He was on the teaching staff of the Department from 1960 until 2002. Before then he was a Development Engineer with English Electric Company, working on the design of fuel elements for gas-cooled nuclear power reactors.

His interests are now mainly in research. He sees Structural Mechanics as a wide and inter-disciplinary field that provides many challenging, interesting and unexpected problems. For example, progress made in grappling with new structural phenomena in civil, mechanical and offshore engineering leads to more rational design methods in these fields; while at the other end of the spectrum, and on a much smaller scale, there is much scope for the elucidation of subtle phenomena in microscopic and sub-microscopic biological structures. And there are regions in-between - such as deployable structures - where cross-fertilisation of ideas can lead to new structural concepts that are of great interest to the aerospace industry.

Professor Calladine has been a member of the U.K. panel of the International Union of Theoretical and Applied Mechanics. He is a Fellow of the Royal Society, the Institution of Civil Engineers, and the Royal Academy of Engineering.

He is an Emeritus Fellow of Peterhouse, University of Cambridge

Research Interests:
Thin-shell structures in general; and their buckling and vibrational behaviour in particular.
Irreversible thermal and other buckling phenomena in submarine pipelines.
Biological micro-scale mechanics : liposomes, bacterial flagella, and sequence-specific interaction between DNA and protein, and the detailed behaviour of interfaces between alpha-helices.

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Publications
See publication list (160 publications)

A Tribute on the occasion of the retirement of Professor Calladine:

Professor Chris Calladine,FRS, a retirement celebration, 19 August 2002

A Conference on the theme "New Approaches to Structural Mechanics, Shells and Biological Structures" was held in the Department of Engineering, University of Cambridge, on 9-11 September 2002. The conference marked the retirement of Professor C.R. Calladine, FRS after 42 years on the teaching staff of the Department of Engineering, University of Cambridge, UK. Former research students, collaborators, and colleagues from around the world gathered to discuss the unique contributions made by Professor Calladine and the new avenues that have been opened as a result. Around 40 lecture presentations were given and a published volume, edited by Horace Drew and Sergio Pellegrino, was available at the meeting. The list of contents is downloadable.

Professor Calladine, well known for his contribution to the field of structural mechanics, is considered to have made a scientific contribution outside engineering, in molecular structures, at least as significant. A scan through his publications reveals his range of expertise from 'the yielding of clay', through 'buckle propagation in submarine pipelines' to 'design requirements for the construction of bacterial flagella'.

"What would an engineer know about DNA?" once remarked an eminent biologist at Cambridge about Professor Chris Calladine. He soon proved what he did know; culminating in a book on the subject (Calladine and Drew 'Understanding DNA: the molecule and how it works.' Academic Press: second edition 1997).

Nobel Laureate Sir Aaron Klug tells of scientific conversations with Calladine over dinner at Peterhouse about the structure of spherical viruses and the relation of their protein shells to geodesic domes. It was these conversations -- a classic example of the value of College life -- that led Calladine into a field far from the normal stamping grounds of engineers (certainly in the 70s). The interesting geometric features of protein assemblies were to occupy a significant part of his working life. Klug had realised the importance of Gauss' work on the curvature of surfaces for the construction of spherical virus coats; and Calladine applied these same ideas to the deformation of thin-shell structures. This led to the production of Calladine's major book 'Theory of Shell Structures' (Cambridge University Press, 1983).

Klug also introduced him to the biological problem of the construction of bacterial flagellar filaments, which self-assemble from a single type of protein subunit in a helical array. Calladine took a structural engineer's approach to the problem of how the various different observed helical forms of the flagella could be derived from a single type of subunit; and he proposed that there were two slightly different versions of the connections between the building-blocks, so that the assembly is constructed of bi-stable subunits. His simple mechanical model reproduced all of the main aspects of the observed family of helical forms of bacterial flagellar filaments.

In each of the systems he studied, Calladine constructed physical models to illustrate the mechanical and geometric principles involved -- leading to an interesting summation in a paper by Dr Ben Luisi of the Cambridge Department of Biochemistry entitled: 'Understanding biological machines using household items' -- a description of the many models that Calladine has come up with over the course of the years. Luisi summarises: "Somewhat like the best childhood toys, these models and others from Chris have inspired a lot of insight, fun and imagination that have somehow transcended far beyond their deceptively simple construction."

Professor Calladine has applied the same line of investigation to many engineering structures whose behaviour did not follow conventional wisdom. A notable example is his work on 'Tensegrity structures' (Buckminster Fuller was responsible for coining the term "tensegrity", which he used to describe a structure which maintains its integrity through tension.) These structures were at first thought to be "highly non-linear" by structural engineers, but Calladine showed that when the analysis had been properly formulated, they were almost as linear in their response as conventional structures.

Another example of Calladine's work was his solution to a problem regarding the geometric instability of an early helium balloon. Large unmanned helium balloons provide NASA with an inexpensive means to place payloads into a space environment, and Calladine's work recently provided the basis for the design of the Long-Duration Flight Balloons, which -- after several failures -- were recently successfully tested by NASA.

Klug sums it up "He has the knack of picking out problems which are tractable, or which he makes tractable, by using physical insight to simplify them to their essentials and produce imaginative solutions. Coupling these with simple but powerful mathematics, he explains the phenomena quantitatively, but at the same time provides clear pictures which all can understand. We are in his debt."

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