Professor Paul M. Weaver

See:
http://www.bris.ac.uk/engineering/people/paul-m-weaver/index.html
http://www.bris.ac.uk/engineering/events/2011/107.html
http://www.bristol.ac.uk/composites/dtc/
http://journalogy.net/Author/12720435/paul-m-weaver

Professor in light-weight structures, Department of Aerospace Engineering, University of Bristol, UK

Professor Weaver's research interests lie in elastic tailoring for lightweight structures, particularly using anisotropy in structures subject to buckling. Most structures for which buckling is an issue are designed to resist buckling - under such circumstances anisotropy may be used to induce secondary loading that delays the onset of buckling. On the other hand, elastic buckling phenomena may be used to encourage large scale geometry changes. Then, the multistability aspects may be used in shape changing or morphing applications. He has worked with design aspects of composite materials for 20 years having started his career with Courtaulds Aerospace as a sponsored PhD student. He currently works closely with NASA Langley, Airbus UK, GE Aviation and leads the university partnership with Vestas Wind Systems. Since 2009 he is Director of the ACCIS Doctoral Training Centre (ACCIS DTC).

He was awarded the Federation of European Materials Societies Lecturer award in 2004 for his contribution to structural design of materials and was an EPSRC Advanced Research Fellow (2002-2007).
Research:

Professor Weaver is a member of the ACCIS research centre in composite materials and structures. In general terms his interests lie in material/structural interaction on performance - where performance is judged primarily on weight and cost. One specific area of interest concerns the scope for trade-offs between the lay-up and structural shape on structural performance of composites. He believes that theoretical analysis should be used to provide the necessary physical insight that can be implemented in simple guidelines/software tools.

Suppression/mitigation of buckling phenomena. A series of closed form expressions has been developed which accurately reflect the effects of various types of anisotropy on buckling loads of flat plates, curved panels and cylindrical shells. In conjunction with NASA Langley, the existence of definite bounds to buckling performance of flat plates subject to various loads has been shown. By normalising performance of an elastically tailored laminate with respect to a quasi-isotropic plate it was shown that an upper bound for performance enhancement was approximately 33%. Such knowledge should prove useful for initial sizing purposes in conceptual design.

Exploitation of buckling phenomena-morphing applictions. It is well known that, in general, non-symmetric laminates warp with temperature changes-analogous to the bimetallic strip effect. Indeed, it is possible to make curved panels from flat plate just by inducing residual stresses, due to thermal strains (differences in thermal expansivity). These curved panels are bistable in the sense that they may snap from one cylindrical configuration to another, as shown in Figure 1. Such large changes in geometry may be exploited in morphing structures or actuators. These structures do not need external energy to exist in one of their configurations as energy is only need to snap from one configuration to another. As such, potential actuators only undertake work during the snapping process. Work has concentrated on integrating these nonsymmetric structures into the wider structure to induce camber changes in efficient aerofoils and for making lightweight mechanism-free trailing edges in aerofoils.

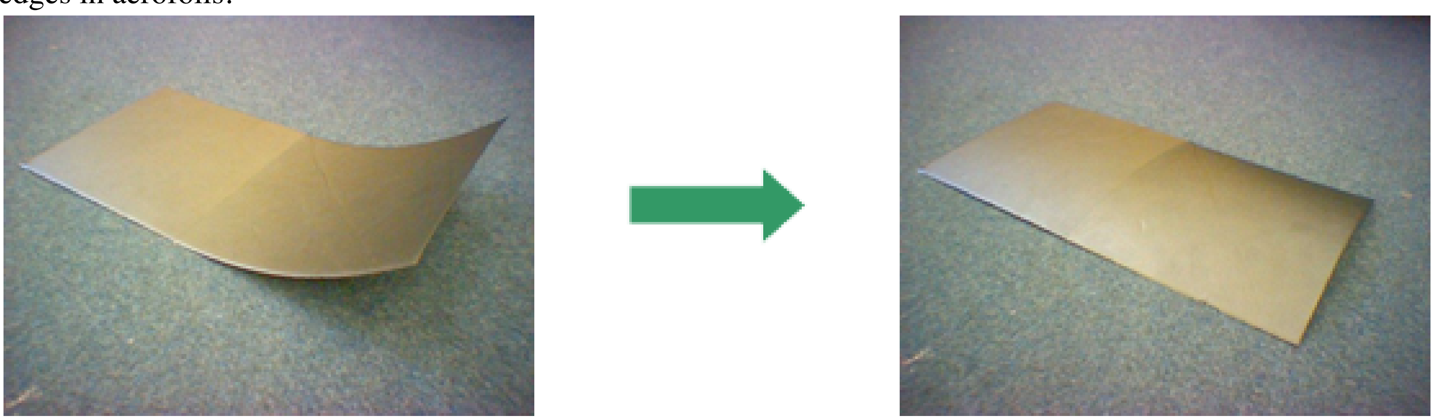

Fig. 1 Bistable composite structure

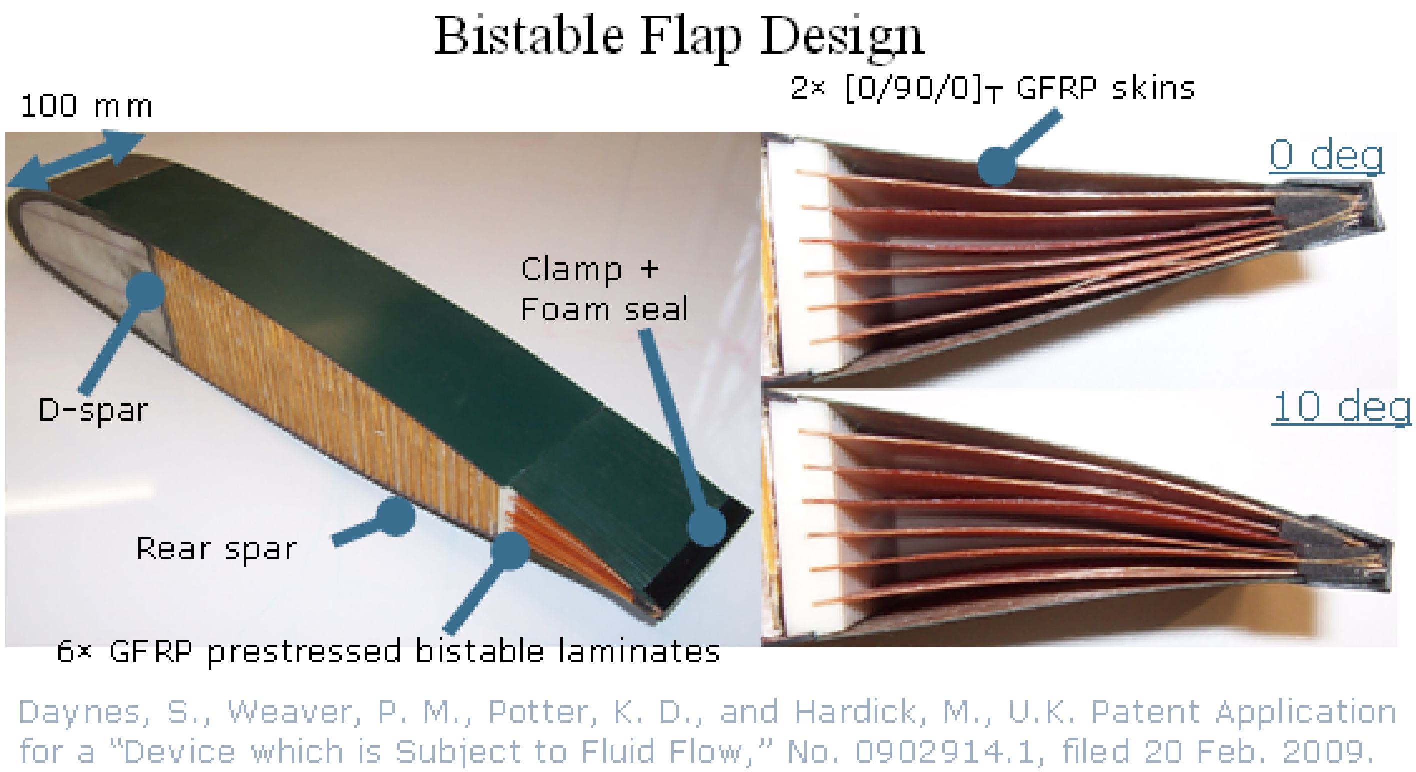

Fig. 2 Another bistable composite structure

Design and optimisation of anisotropic composite structures. Optimisation techniques have been developed for multi-part anisotropic structures that significantly increase computational efficiency. Intuitive optimisation is a technique based on design guidelines for lay-up optimisation that provide initial sizing details for more detailed two-level numerical optimisation strategies that make use of lamination parameters to represent laminate properties at the first level whilst using genetic algorithms, particle swarm optimisation or ant colony techniques to determine actual lay-ups. The advantage of the two-level approach is that gradient-based search algorithms may be used as an optimiser, as the response surface is convex in nature, when laminates are represented in terms of lamination parameters. The second level subsequently matches real discretised stacking sequences to the optimal lamination parameters (obtained in level one) using a heuristic discrete-based optimiser, i.e. genetic algorithm or particle swarm optimisation). Collaborating partners include AgustaWestland, Airbus and Vestas. Projects include optimisation of multi-part wing structures, morphing flaps, aeroelastic tailoring and novel structural concepts for least weight design.

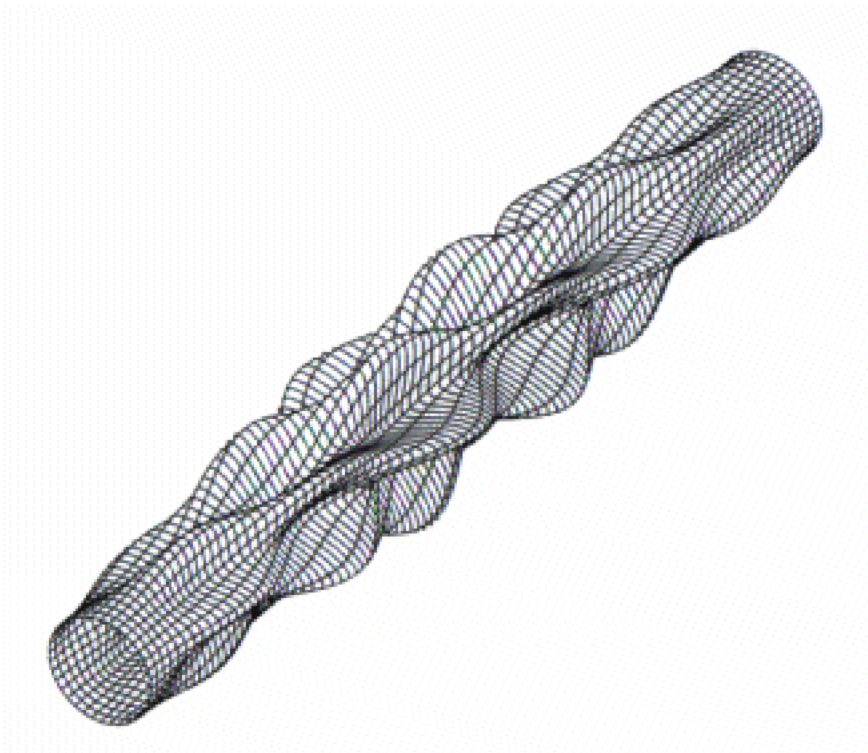

Fig. 3 Buckling of anisotropic axially compressed cylindrical shell

Microstructurally tailored composites. Work has centred on improvement of effective material properties by altering the material microstructure. For example, laminated composites have poor through-thickness properties partly due to the lack of fibre reinforcement in this direction. It was shown that lobed fibres (anisotropic polyhedrally-shaped fibre composites) could provide a degree of intralaminar locking or overlap to provide a degree of fibre reinforcement that could improve through-thickness strength and enhance fracture toughness properties due to the tortuous crack paths that must be encountered. See Figure below. An alternative mechanism to improving through-thickness properties is by accepting a certain level of poor performance and mitigate its effect by using self-healing networks. Please see Multifuntional Composites webpages.

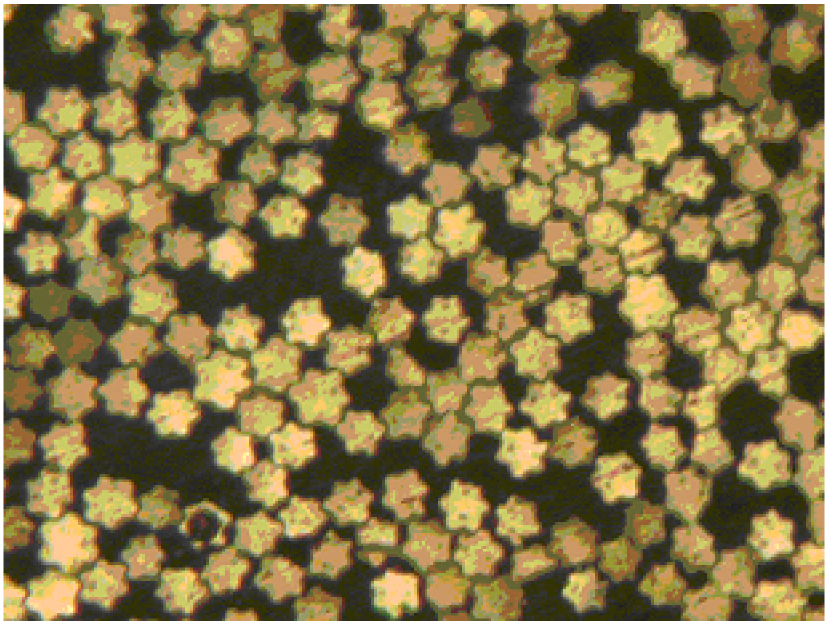

Fig. 4 Transverse Section of a Composite Plate of 50 Micron Diameter Lobed Fibres in a 913 Epoxy Matrix.
Materials/Shape Selection

Work here has centred on the extension of materials selection techniques, developed at Cambridge University (EDC), to structural sections. This has been a collaborative effort resulting in the Structural Sections database in the suite of Cambridge Engineering Selector software CES.

Publications:
There are 176 publications by Paul Weaver. (Google "Paul Weaver Bristol" for a complete list).