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**Advanced application-motivated design techniques for high
performance piezocomposite underwater sonar transducers and
arrays**

Sandy Cochran^a, Christine Demore^a, Pablo Marin^b, Richard Marsh^c, Keith Mayne^b, Graeme McRobbie^d,
Michelle Wallace^e, Mark Walsh^b and Richard Wright^c

^aInstitute for Medical Science and Technology, University of Dundee, Wilson House, 1 Wurzburg Loan, DD2
1FD Dundee, UK

^bPiezo Composite Transducers Ltd, Aberdeen Science Park, Balgownie Drive, Bridge of Don, AB22 8GU
Aberdeen, UK

^cTritech International Ltd, Peregrine Road, Westhill Business Park, Westhill, AB32 6LJ Aberdeen, UK

^dUniversity of the West of Scotland, High Street, PA1 2BE Paisley, UK

^eDoosan Babcock Energy, Porterfield Road, PA4 8DJ Renfrew, UK

Developments in areas as diverse as advanced piezoelectric materials and low cost digital electronics continue to offer new possibilities to the designer of high performance underwater sonar transducers and arrays. Many of these are likely to be realised with complex composite materials comprising a polymer matrix with rods of piezoelectric ceramic such as PZT 5H or crystal such as PMN-PT which require advanced design techniques. This paper first briefly reviews relevant capabilities of conventional equivalent circuit and wave equation transducer models, and the composite homogenisation technique of Smith and Auld. The increasing possibilities offered by finite element analysis (FEA) running on relatively low-cost computing hardware are also considered. Whichever design technique is adopted, accurate material properties are crucial and this is reported through reference to a range of piezoelectric and passive materials. The potential variation of such properties across the operating temperature range of underwater transducers is also considered, illustrated with experimental measurements. As understanding of high performance transducer structures grows, future possibilities also become evident, such as the 3-1 connectivity multilayer composite. The paper is therefore completed with an outline of these complex structures and a stochastic mathematical technique that can be used to optimise their designs automatically.