EDITORIAL

1000 gems: celebration of *STWJ*

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It was during a pleasant evening stroll through the estates of Schloss Segau in Graz, Austria, that we decided to create a journal with the intention of providing a rigorous and efficient mechanism for the dissemination of knowledge on all aspects of joining. The occasion was the 1995 meeting on the mathematical modelling of weld phenomena. It did not take us long to act on this following our journeys home. The birth of the new journal was straightforward. The first issue was published in 1996 under the auspices of the then Institute of Materials in London. There were the usual growing pains which are best forgotten, but persistence, not to mention the unquestioning faith of the Institute, paid off.

The community now has what is certainly the leading journal in the subject, but also one which can hold its own against the long established tomes in the general field of materials science. This recognition is a credit to all the authors who have contributed over the years; to the Institute and to Maney Publishing for maintaining the highest standards of production and language; and to the Editorial Board and referees for their supervision of this venture. We recently reached a tally of one thousand publications and took the opportunity to celebrate – by inviting articles which are less constrained, and which may include informed speculation and some notions of the future directions of the subject. Those who were able to meet the deadlines form this special issue and we express our unreserved gratitude to them. Those who escaped are still in our minds for future projects! We will sing some further praises of the journal later, but first a taste of the contents of this issue.

The monumental success of the friction stir welding process makes it fitting, once again, to refer to the original work[1] which also stimulated academic research with some 3000 papers published on this topic over the last decade. We are pleased to report that according to the databases, *STWJ* is the journal of choice for the publication of these papers. The stirring process involves severe deformation and we know in other fields that such trauma leads to rotations of crystals and the development of texture. Fonda reviews this subject in the context of stir welding, for all of the prominent crystal structures of metals, with the surprising finding that there are common features irrespective of the lattice type.[2] One wonders whether the consequences of the shared features are different for the lower symmetry crystal structures.

It is now becoming increasingly clear that in some cases, friction stir welding is associated with the formation of liquid films. The problem is acute in alloys containing low melting point phases or when readily melting phases form by mixing of the alloys being welded.[3] Gerlich, in his paper[4] studies the relationship between this phenomenon and defect formation, to reach the conclusion that it will be necessary in some cases to limit the welding speed in order to avoid damage.

It is often said that the whole is greater than the sum of its parts. The benefits of combining an arc and a laser process are extolled in the paper from Missouri University,[5] and it is implied that the creation of a united mathematical model may lead to a better optimisation of the process. The problem is in essence similar to that stated by Babu,[6] that existing models are far from 'full solutions'. The general area of hybrid welding is active, including innovative permutations, for example, electrical resistance heating combined with friction stir welding;[7] simultaneous welding and brazing;[8] exotic methods such as HyDRA (involving double arcs) and LUPuS (laser submerged arc welding).[9] The paper by Phanikumar *et al.*[10] focuses on the modelling of dissimilar material joining and describes, for example, the challenges associated with the modelling of a hybrid laser welding–brazing method.

Mathematical models are sometimes incorrectly seen to be the panacea for the future of weld design. They often are not,[11] but nevertheless can dramatically reduce the volume of work, and hence the resources needed for development, and can yield insight into new phenomena.[12,13] Babu emphasises another aspect, that the complexity of the phenomena that welders routinely have to face, means that generic solutions (models) are difficult.[6] Indeed, as he points out, there are domains of solutions rather than unique solutions for particular requirements, making it necessary to choose. A classic multiobjective optimisation problem where any solution along the Pareto front is optimal and one has to use another convenient criterion to pick a particular one.[14] In a fascinating paper, Hattel[15] looks at optimisation from a different point of view. Not only should we seek to use sophisticated models with autonomous optimisation in the context of multiple objectives, but should also seek robust solutions. By this he means solutions which remain feasible in spite of some variations in the design parameter; after all, most manufacturing processes have tolerances specified. Of course, Hattel's paper contains much more than this, a vivid discussion of friction stir weld modelling and future challenges. A critical component of friction stir welding is the tool material[16]

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a subject which is reviewed by Rai *et al.*,[17] with an emphasis on the welding of difficult materials. Although aluminium is not in this context regarded as a 'difficult material', De and Mishra[18] point out that strong aluminium alloys do pose problems because the heat due to friction stir welding can upset the delicate balance between precipitate reversion, reaging and coarsening. Some post-weld plastic deformation is suggested as a method for enhancing the nucleation sites available for precipitation, rather like the method used to mitigate precipitate free zones in similar alloys.

There is increasing pressure to develop simple but insightful quantitative tools for the treatment of weld phenomena. This approach has been enormously beneficial in the case of arc welds where the carbon equivalent, for example, has appeared in academic publications as well as in the welding shop. Just imagine the contributions made by the elegant heat flow solutions that Rosenthal developed so many years ago and which still form the basis of many simplified models. It is in this light that the suggestion by Mendez[19] and others,[20,21] that handbook type analytical methods which capture the essence of the problem, should be developed for processes such as friction stir welding. We would like to encourage more work in this area, because by definition, large, computer intensive methods are not suited to back of the envelope estimates.

With a subject that has so much significant detail, it is necessary to focus both on the development of mathematical and of experimental techniques. Characterisation is of vital importance and still reveals phenomena which have not been dreamt of in models. The first 2011 issue of *STWJ* (Vol. 16, pp. 1–107) contains an extensive series of papers dealing with some of the latest techniques and their application or potential application to welding. In the next issue, there will be a paper by Palmer and co-workers[22] describing the use of synchrotron X-radiation to study austenite formation during continuous heating, and the discovery is made that the last austenite to form grows as nearly pure iron because the higher carbon regions of the original microstructure are consumed first. The paper by Kokawa on the control of crystal orientations to enhance the resistance of austenitic stainless to corrosive attack also relies on detailed characterisation and follows a long history of grain orientation engineering research from Japan[23].

Residual stress makes its appearance in all known joining processes; it is pernicious in that its consequences are often not visible until the manufacture is completed, for example in the form of distortions or worse. Michaleris[24] highlights, among other items, the need for work on very large structures where complexities such as tack welding and the sequence in which deposits are made can make a difference to the ultimate distribution of stresses.

The journal has not published many papers on polymeric materials. This is not for want of trying, but it seems that the community concerned has not noticed *STWJ*. We intend to change this. In the mean time, there is a nice article on carbon fibre and polyetheretherketone composite from Vacogne and Wise[25] where the difficulties associated with the 'high' melting temperature (343°C) of the polymer are said to be limiting.

We hope that these papers give a glimpse into the future in addition to providing technical stories. *STWJ* has come a long way since its adolescence. We do not intend to quote numbers or the factors which are so abused in assessing scientific performance. You can judge these for yourself in the context of your personal criteria, and look them up on standard databases. We think that the statistics are impressive, but reiterate that the real meaning of the journal lies in its contents. We took the risk of changing from hard copy to electronic only publication and this has worked well, as reflected in publication speed, the availability of full colour, production and content quality. All of the papers ever published are accessible online and a number of selected papers have been made freely available. The journal now has an open access facility so that an author can choose to make their own paper freely available. Further information is available at: www.maney.co.uk/journals/stw.

It is odd that the welding community does not engage in discussion. From its very inception, we have emphasised that contributions can be short communications, full papers and review articles. It cannot be the case that everyone agrees with everything that is published in *STWJ*; that would be dull! Active discussion leads to better understanding and we would like to see more of this kind of constructive activity, and an increased level of passion in our subject.

It is our goal in 2012 to expand. Watch this space.

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