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Experimentally Speaking

A Devil's Advocate

Upon accepting the honor of writing this guest editorial, I went back to previous issues of EXPERIMENTAL MECHANICS to see what sort of thing might be appropriate. Not too surprisingly, I found a number of editorials that described a glowing future for experimental mechanics in general and SESA in particular. Yet, in others, one could detect some clouds on the horizon. These had to do with the rapidly escalating uses of finite-element and other numerical-computational techniques and the possibility that such approaches will constrict the role of experimental mechanics. This gave me my subject.

Contemplating a change in one's professional position naturally brings about some degree of introspection. In my own case, upon reexamining my career, one thing that has become clear is this. The more successful of the enterprises that I have been associated with have all effectively integrated experimentation with mathematical analysis. I would like to use this and other types of experience in fracture mechanics to comment on the desirability of close associations between experimentation and mathematical analysis and SESA's role in promoting it. Let me play the devil's advocate in so doing.

Most of the contributions to the discipline of fracture mechanics have either been virtually all experimentation or all mathematics. But, in practically every case, the really useful experimentation was preceded by a mathematical development. As pertinent examples, consider that Griffith's theory was formulated with Ingles' solution for an *elliptical hole in a stretched plate*, Irwin's demonstration of the equivalence between the strain-energy release rate and the stress-intensity factor needed Westergaard's stress functions, Dugdale's crack-tip plasticity model drew upon Muskhelisvili's complex variable formulation of the theory of elasticity, while the key experiments of Begley and Landes that established elastic-plastic fracture mechanics would have been inconceivable without Rice's J integral and the Hutchinson-Rice-Rosengren near-tip, nonlinear crack-tip-deformation characterization.

Applications of the technology have followed a similar pattern. To mention a few, Paris was able to formulate an effective procedure for the prediction of fatigue crack growth because of the existence of the stress-intensity factor. The vehicle for the development of the COD approach for fracture under large-scale yielding was provided by Dugdale's model, while the establishment of J has given rise to the tearing instability theory that is being ever more widely used for nuclear-plant safety assessments.

Assuming that fracture mechanics can be taken as a microcosm for applied mechanics as a whole, and given that the most useful experimental contributions have been those who have adapted work well outside of their own immediate discipline, begs the following questions. Is a technical society constructed along narrow lines (e.g., experimental mechanics) really worthwhile? Worse, by excluding mathematical analysis, is SESA counterproductive? If so, should it be restructured to allow its members time and resources to be invested in more productive ways?

A devil's advocate might indeed argue along these lines. But, inasmuch as a technical society such as SESA is so obviously necessary as a forum for the exchange of ideas, methods, etc., among its members in their common areas of interest, one would find such an argument obviously fallacious. What nevertheless is too important to not recognize is that a narrow-interest society cannot claim the exclusive attention of its members. In one way or another, SESA members must recognize that theirs is only one aspect of a multifaceted approach to the resolution of technical problems. And, to enable their contribution to be fully worthwhile, it must be one that is both cognizant of, and compatible with, the mathematical modeling being addressed in such problems.

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