A Retrospective Account of Seminal Research by H. M. Zbib

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Throughout his career, Zbib was innovative, originating models in seminal papers that anticipated areas of subsequent increased interest. These include strain-gradient plasticity, discrete dislocation dynamics, multiscale modeling, arrays of Somigliana ring dislocations and nanoscale plasticity. We comment here on these aspects of his work. Many of the papers in this volume represent applications of these ideas. [DOI: 10.1115/1.4051807]

Keywords: strain gradient, multiscale modeling, discrete dislocation dynamics, ring dislocations, constitutive relations, mechanical behavior, plastic behavior

In Zbib's thesis research [1,2], he considered large deformation, including plastic spins and hypoelasticity. This included strain gradient terms and anticipated work in that field. This led to work and models by others, e.g., Refs. [3,4] and is now an extensive area of interest. The aspects of his work dealing with rotation [5,6] per force included nonlinearities, including the concept of couple stresses. Our own work was followed using discrete dislocation theory to describe dislocation pile-ups in stress gradients and higher-order stress derivatives [7]. The essence of the gradient effects is that stress concentrations are enhanced and that only second-order and higher gradients couple with rotations. In addition to couple stresses, driving forces for rotations include changes in strain energy associated with the rotation of the elastic constant matrix in an anisotropic elastic description. Later nonlinear deformation work by Zbib included constitutive modeling [8,9] and applications to shear banding [10,11]. Nonlinearity, in one form or another, pervades Zbib's work throughout his life.

A second area where he was a pioneer is that of discrete dislocation dynamics (DDD) modeling [12–17]. Interactions of generally curved dislocation arrays, to date, are too complex to be described explicitly. The Zbib model is tractable in providing simple rules to enable efficient simulations. Hence, complex unit processes such as dislocation intersection, climb, cross-slip, and nucleation can be incorporated into the model. The DDD models are also incorporated in multiscale modeling [18,19]. Today, there are many such models as reviewed in Ref. [20], but the Zbib model remains valid. The DDD model has been used to describe superplasticity [21] as well as nanodeformation and nanoindentation [22]. A method has been developed to extend the model to deformation during shock loading [23,24].

A third area is that of Somigliana ring dislocations and their arrays [25,26]. These dislocations with Somigliana vectors pointed radially, tangentially, or normal to a circle have a number of applications for fiber composites, e.g., Ref. [27]. These include pile-up arrays or torsional cracks [28]. There are a number of applications for ring dislocations as reviewed in Ref. [29]. The latter work also considers uniform arrays of ring dislocations arranged as disclinations. They are found to describe the standard wedge and twist disclinations as well as three new disclination types: spin, coherency, and edge-mixed-screw coherency disclinations.

Contributed by the Materials Division of ASME for publication in the Journal of Engineering Materials and Technology. Manuscript received October 25, 2020; final manuscript received June 9, 2021; published online August 9, 2021. Assoc. Editor: Tariq Khraishi.

Acknowledgment

It is with great pleasure that I help to honor the memory of my friend and colleague, Hussein M. Zbib.

Conflict of Interest

There are no conflicts of interest.

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