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One Hundred Fifty Years of Residual Stress in Engineering**Abstract**

The discovery that solid materials could have non-zero stresses and strains within them, even when no external loads or displacements are applied, probably occurred countless times over many centuries. The concept and understanding of these ‘self-stresses’ or ‘internal stresses’ began to improve considerably during the 19th century as advancements in the fields of physical chemistry and solid mechanics led to (at least qualitative) models for the processes which produce them. These self-stresses or internal stresses eventually came to be called residual stresses. Initially they were of concern to the engineering community only in so far as they impacted their ability to successfully *fabricate* artifacts or components. However, it quickly became clear that these residual stresses could also have a dramatic impact (both detrimental and beneficial) on the *performance*, especially the fatigue performance, of these components. By the beginning of the 20th century, significant advances were being made, not only in the experimental quantification of the effects of residual stress on structural strength and fatigue life, but also on the measurement of the residual stresses (or to be more precise, residual strains) themselves. During the latter half of the 20th century, the technologies surrounding residual stresses matured to the point that the field now represents a major sub-discipline within the solid mechanics / structural mechanics domain. This included the continuing development of existing residual stress measurement techniques, the development of new measurement techniques, the development of industry specifications and standards, the development and validation of models for the formation of residual stress by thermal, chemical and mechanical processes, and the development and validation of models for the effects of residual stress on strength, life and other performance characteristics. Both modeling and measurement capabilities have advanced to the point that today, the engineering community has the means to explicitly address the generation of residual stresses during manufacturing, the evolution of those stresses during service usage, and the impacts of residual stresses on structural performance throughout the entire product life cycle.

This presentation will offer a historical perspective on the advancement of residual stress technologies over the past 150 years, and then will describe the current state of the art, in which residual stresses are quantified and then used explicitly in engineering design, manufacturing and operational usage analyses.

Biography

Dale Ball is a Senior Fellow in the area of aircraft structural integrity and has worked in the military aircraft manufacturing industry throughout his 42-year career. He has directly supported programs ranging from the B-2 stealth bomber to the National Aerospace Plane (NASP), to the F-35 Joint Strike Fighter. Dale holds a BS in Mechanical Engineering (from Louisiana State University), an MS in Engineering Mechanics and a Ph.D. in Materials Science and Engineering (both from the University of Texas at Arlington), and has authored or co-authored numerous papers and presentations in the areas of advanced structures, materials, and analysis methods. He is an ASTM JoDean Morrow lecturer and a recipient of the USAF Aircraft Structural Integrity Program Lincoln Award. Dale is currently a Senior Fellow in the area of fatigue, fracture and sustainment methods development and test at Lockheed Martin Aeronautics Company in Fort Worth Texas, where he has been for the past 37 years.