Applications of Automation Technology in FATIGUE and FRACTURE TESTING and ANALYSIS

4th Volume

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Foreword

This publication, *Applications of Automation Technology in Fatigue and Fracture Testing and Analysis: Fourth Volume,* contains papers presented at the symposium of the same name held in Orlando, FL, on 15 November 2000. The symposium was sponsord by ASTM Committee E8 on Fatigue and Fracture. The symposium co-chairmen were Arthur A. Braun, MTS Systems Corporation, Peter C. McKeighan, Southwest Research Institute, Murray Nicolson, Instron Corporation, and Raymond Lohr, Instron Ltd.

Overview

The greatest technological gain that has occurred in the mechanical testing laboratory in the past twenty years arguably has been the benefits as a result of the persistent and rapid growth of computer technology. Although sensor technology has also evolved considerably over this time, the new features that have resulted with higher performance, low cost hardware, and software systems are providing exciting new capability in the general areas of test control, data acquisition, data analysis and interpretation, modeling, and integration of testing and design.

This symposium is the fourth in a series of symposia concerned with advancing the state of the art in automated fatigue and fracture testing. This series of meetings was initiated in 1975 with STP 613, entitled "Use of Computers in the Fatigue Laboratory" and held in New Orleans, Louisiana in November, 1975. Although it is hard to believe, the personal computer as we know it was still five years away when the first symposia was held in 1975. Over the past two and a half decades, the role of the computer in the test laboratory has dramatically altered the range of test control and analysis capabilities available.

For example, purchasing a servohydraulic test system today typically includes a digital control system to provide an interface between the user and the control of the frame. Although analog controllers can be purchased, the clear trend for the future is digital command and control. Twenty-five years ago, it was the exception rather than the rule to see a computer attached to a servohydraulic test machine. This is contrasted by today's mechanical test laboratory, where it is not uncommon to see *multiple* personal computers connected to the same test frame, where one might be controlling the test and the second involved in highly specialized data acquisition.

The rapid changes in computer technology have created some problems with regard to the stability of tools in the laboratory. As an example of this, consider one of the latest trends of personal computers where the DOS operating system is no longer accessible. The tools developed during the 1980s and early 1990s were written based on this platform. The absence of DOS means that some applications that work perfectly well can no longer be used with modern hardware. This software-retirement-through-hardware-obsolescence is an issue that needs to be further examined and worked on to minimize extra expense. This example is not the only occurrence of this; component level (e.g., cards and chips) hardware nonavailability has also impacted "the big boys," as some of the servohydraulic system manufacturers have had to accelerate software development to accommodate obsolete hardware.

Given this computer development and its growing role in the test laboratory, the question that can be asked is what do we really do differently today, as opposed to the precomputer days. Without question, tests have become more automatic and, by virtue of this, more efficient to run. As an example of this, in the precomputer days fatigue crack growth tests were laborious efforts with a technician spending considerable time staring down a microscope. Today, a test can virtually be started at the end of the day shift and the results be available the next morning. Whilst this has become more efficient, coping with the vast quantities of data that can be generated can be overwhelming. Automated tools for performing analysis are continually evolving to provide the test engineer with the critically required quantity from his transducer data.

The test engineer is faced with a challenge to attempt to keep technical knowledge current with the continual developmental onslaught that occurs with modern silicon devices. This symposium, and the fourteen papers presented, provides some bases to understand the range of applications that computers have in the modern test lab. Classifying the content of the papers included is difficult, since the range is quite broad. Nevertheless, a number of papers examine the challenges faced in full-scale testing, either from a control or end-level editing viewpoint. Several papers also examine how fatigue or fracture data are applied in the design process to yield safer structures with longer service lives. As described, a variety of computer-based lifting tools are now available to users to apply to the design process. Finally, a number of papers examined specific system implementations, especially as related to more challenging applications such as high frequency or thermomechanical fatigue testing. The applications undertaken in the latest reported systems with the newest automated testing software include some of the greatest testing challenges currently faced in the mechanical testing laboratory. This is certainly a new development as the computer and software each have increased capability, speed, and flexibility.

In summary, this symposium and the proceedings herein are intended to provide an update on the applications of automation in the fatigue and fracture testing laboratory. It is the intention of the Automation Task Group in ASTM E08 to revisit this area every three or four years to report and track how testing evolves. This is a developmental area that will continue to flourish as technologists apply the newer, faster, and bigger hardware, and software engineers create the newest generation of data manipulation tools.

Finally, the editors would like to express their sincere appreciation to all the authors and co-authors responsible for the papers included in this STP and the presentations made during the symposium. Furthermore, we would like to recognize the efforts of the reviewers whose high degree of professionalism and timely response ensure the quality of this publication. Finally, the editors would also like to express their sincere gratitude to the ASTM planning and editorial staff for their assistance with the symposium, as well as their critical input to this special technical publication.

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