Overview

The continuing advancement of computer and software technology has allowed for the automation of materials testing systems and processes to become commonplace. Automation, which was at first a very expensive and complicated accessory to a materials testing system, is now a inexpensive and often necessary subsystem. Many test techniques now require the speed, consistency, and computational capability inherent in these systems. Hardware costs have continued to spiral downward in conjunction with incredible increases in computational bandwidth, display technology performance, and mass storage capacity and speed. Software technology, the real key to forward progress, has improved significantly, allowing for shorter application development time with higher application performance. This is especially true in the area of real-time systems software which is critical for testing system control and data acquisition.

This symposium is the third in a series of symposia concerned with the advancement of the state of the art in automated fatigue and fracture testing. The first was the Use of Computers in the Fatigue Laboratory held in New Orleans, Louisiana in November of 1975. The proceedings were published in STP 613. The second symposium on this topic was entitled Automated Test Methods for Fracture and Fatigue Crack Growth held in Pittsburgh, Pennsylvania during the Fall E9/E24 meeting in November of 1983. The proceedings of this symposium were published in STP 877. This current symposium was organized in order to conduct a state of the art review of the technology. The symposium was driven by the work of the task group E9.04.01 on Automated Testing which is a task group of the E9 committee on Fatigue and its' subcommittee on Apparatus and Test Methods. The intent of this task group is to conduct such a technology review on a three to four year time interval thus keeping pace with the rapid advances in computing and software engineering technology as they apply to fatigue and fracture testing.

There are a number of areas where automation technology enhances fatigue and fracture testing. The emphasis of this symposium was placed upon the issues of test system implementation, test techniques, applications of networking and information management within a testing laboratory, control and data acquisition techniques, and applications or implementations where the computer provided enhanced analysis or simulation capability. These areas of interest were selected to focus on tasks in the fatigue and fracture testing process that reside at different levels within this process.

Automated systems implementation and test techniques are closest to the actual tasks of acquiring materials property data. In this arena, concerns are primarily on compute bandwidth and real-time software efficiency. Fatigue and fracture tests, being dynamic tests, require higher data acquisition and compute bandwidth than many common real-time systems possess. The task of determining the crack length in a fatigue-crack growth test via the compliance technique for example requires data acquisition speed, simultaneity, and compute speed for online crack length calculations from resultant compliance data. Often the testing task requires parallelism in the system implementation to allow for control, data acquisition, and online conditional processing to be performed in the course of the test. This requires multitasking executive software or highly efficient single tasking environments that allow for prioritized interrupt driven system services or polling implementations with sufficient speed to handle all of the tasks at hand. A number of systems implementation oriented papers were presented in the first session of the symposium. The range of solutions was broad. It should be noted that the hardware options ranged from simple personal computers to multitasking engineering workstations. The Colvin and Swanson paper on "The Development of a Low Cost PC-Based Data Acquisition System" epitomized the trend toward using cost effective yet high performance personal computers to automate mechanical tests. At the other end of the spectrum; McKeighan and Hillberry's paper on "Fatigue and Fracture Testing Using a Multitasking Minicomputer Workstation" is an example of the use of a high-performance engineering workstation where the benefits of using a multitasking executive greatly enhance the utility of such a system in the laboratory by allowing, for example, analysis and network transactions to be performed concurrently with a executing test.

The next level of application, which is actually a step back from the hardware and software details, revolves around the utilization of the technology to allow a new or unique technique to be developed. Fatigue-crack growth near threshold testing may be performed manually without computer automation but with the aid of automation, the system efficiency, test repeatability, and data quality are enhanced significantly. The determination of J_{Ic} can be a rather arduous chore when using multiple specimens and nonautomated analysis techniques. The computer controlled single specimen adaptation of this test is a much less labor intensive task and is the norm for this fracture toughness test. The paper by Bicego et al. illustrates the state of the art for this test and the computer automation that is becoming is integral to this test. The natural extrapolation of all of this as performance in hardware and software increases is the ability to perform true calculated variable control tests where a calculated parameter either directly or via a cascade control approach is used to maintain some specimen condition.

Taking yet another step back from the testing system and the local testing techniques leaves one in the laboratory environment. A key to competitive success be it in the research laboratory or the industrial design allowables laboratory is in the ability to take the results from automation enhanced testing instruments and rapidly and efficiently analyze the raw data and make these results available to the design function, test requestor, manufacturing organization, materials supplier or materials user. Integration of the testing laboratory with the rest of a given organization is becoming a very important consideration. Organizing test results and materials data into easily accessed formats and making this information accessible are the key issues. The technologies through which this is accomplished are networking, database technology, Laboratory Information Management Systems (LIMS), and common access and analysis applications software. These concepts were addressed in the last session of the symposium. The paper by McGaw and Bonacuse and the paper by Sunder illustrate the trend to tie all of the testing automation subsystems within a test laboratory together via a network to facilitate the rapid movement of test information and results to points accessible by other segments of an organization. This scenario will become more common with time. The paper by Over and Buchmayr is concerned with the difficult task of organizing materials data in a database and then providing the tools to allow for easy access to the information. As database software technology improves and the tools for data extraction improve (via the standardization of query tools such as SQL-structured query language), the sharing of materials data will be enhanced thus reducing replication of test work or allowing for more critical experimental work to be carried out.

To summarize, this symposium and the resultant proceedings are intended to provide an update on the applications of automation across the field of computer assisted fatigue and fracture testing. It is the intention of the Automation task group in E9 to revisit this area every three to four years to keep track of the utilization of advancing hardware and software technology. Further advances in artificial intelligence, advanced software development tools, direct digital control, networking technology, and information management systems will promote new test capability and test techniques and allow for further efficiencies to be obtained in the process of materials characterization. Integration of testing laboratories with manufacturing, materials development, inspection capability, and the design functions via automation technology will enhance structural reliability and shorten time to market for new products.

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