

Preface

While many other technologies have come and gone in the last half century, magnetic storage on flexible magnetic media—tape storage—has not. In fact, today customer use of and requirements for tape storage are more stringent, dynamic, and demanding than ever before. This issue of the *IBM Journal of Research and Development* explores and explains the newest technologies and ongoing innovation to anticipate and meet those requirements.

In this issue dedicated primarily to Tape Storage are papers which discuss the critical technologies that enable tape storage, the complex management issues which surround digital information storage and retrieval, a look at global storage dynamics, the impact of the network and on-demand world, and a clear demonstration of the future of digital information storage on high-capacity, reliable tape formats. Tape has the advantage of a long history with digital information storage and processing. It has become so pervasive and commonplace that its complexity is taken for granted, and more than a few times it has been presumed to be doomed to be not only overshadowed but replaced by newer, more exciting and exotic technologies.

The overall intent of this special issue of the *IBM Journal of Research and Development* is to explore the technologies and innovations that are enabling tape to remain a viable storage component of the information storage hierarchy. The issue begins with a limited review of the past by Bradshaw and Schroeder, which is used to provide an appreciation of the present technology and its demonstrated capabilities for the very near future. Next, the application of rigid disk head construction technology to the current and future generations of magnetic recording read/write heads is described in the paper by Biskeborn and Eaton. The two papers that follow, by Iben et al., report the investigations of some issues unique to the recording heads suitable for high-track-density linear recording tape systems. Driven by the need to precisely position a multitrack read/write head to within fractions of a micron on an ever-decreasing thickness of a flexible ribbon moving in excess of six meters per minute, improved heads, actuators, and servo schemes as well as improved media mechanical and physical properties are required.

To achieve the robustness that is demanded of tape storage, innovations in tape formatting and error correction have been required to keep pace with the higher capacity and performance of current and future products. Significant improvements in the encoding schemes discussed in the paper by Jaquette not only have increased the efficiency and reliability of the storage and retrieval of information, but have also made possible higher data rates and capacity. All of these efficiencies are unique to linear tape systems, which utilize multiple-channel formats to provide redundancy to the extent that

entire tracks may be lost or the tape may suffer physical damage without loss of information. Indeed, it is the proven reliability and robustness of tape formats that has sustained them as the media of choice for archival storage and backup.

Rapid access to repositories of digital information which would have required warehouses of the earlier tape storage devices has driven the sophisticated robotic libraries that increasingly dominate tape storage. A comprehensive look at tape automation is presented in the paper by Hellman et al. Tape automation can be integrated into a number of systems ranging from standalone dedicated libraries to multiple libraries in multiple locations connected to networks with shared and/or discrete logical libraries in each physical library. While this greatly complicates tape storage management, the coexistence of tape storage formats with magnetic and optical disk storage formats, which did not exist when the first tape drives were introduced in the early 1950s, has demanded an ever-increasing sophistication in management of the data storage options so as to optimize data acquisition performance, availability, security, and disaster recovery.

A view of the complexity of tape management in storage networks is given in the contribution from Deicke and Mueller, which discusses requirements of both the software and hardware needed to manage the massive amount of data in a typical network. A more detailed look into specific attributes and methodologies used in tape automation and management of tape storage in the hierarchy of data storage are reviewed in the contribution from Kishi. That paper discusses the innovations which address autonomic and virtualized tape storage as a vital part of integrated information storage solutions.

Although the long legacy of IBM innovation and leadership in the application of tape storage to computation and information storage should be adequate evidence of IBM's commitment to tape technology, it is never enough to rest on the achievements of the past. Hence, it is fitting and appropriate that the final contribution in this group of papers, by Childers et al., should describe a recent demonstration of the ability to write and read a terabyte of information in an existing, viable tape format. Demonstration of the capability of placing such a large amount of information in a physical volume only slightly bigger than a deck of playing cards establishes confidence that tape technology will continue to provide useful solutions for the collection and reliable storage of the world's vital information. It is realistic to expect tape to be around for a very long time—that is, of course, if the management of huge (petabyte) collections of information can be easily, efficiently, and reliably achieved in a cost-effective, competitive environment. The Tape Development team in Tucson, Arizona, now part

of the Systems Group within the IBM Corporation, has inherited a legacy and sustained it for more than 22 years. I believe it has clearly demonstrated that it is up to the task of leading tape technology well into the future.

It is with a great deal of pride in the Tucson Tape Laboratory and its supporting groups in Tape Manufacturing and IBM Research all over the world that I have worked to develop this special issue of the *IBM Journal of Research and Development* to commemorate the 50th anniversary of IBM Tape Storage, which officially occurred in May 2002. I'd like to thank the authors and reviewers, and I hope that those who read and reference this issue will be pleased with its content. I thank you all for allowing us to put our stamp on this part of IBM's technology legacy to the world.

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Guest Editor