Book Review

Digital Memory and Storage, W. E. Proebster (Ed.) (IBM Germany, Boeblingen), Friedr. Vieweg & Sohn Verlagsgesellschaft mbH, Braunschweig, Federal Republic of Germany, 1978.

This book is a collection of 27 papers from a three-day conference on digital memory and storage at Stuttgart, W. Germany, in March, 1977. It spans the wide spectrum from physical principles of various memory and storage technologies, cell design, and operation principles to memory and storage system architecture. The excellent editing is demonstrated by the fact that the various aspects of memory technology and architecture are described and the basic principles and applications are covered in a nonrepetitive and clear fashion. This book is well written by application specialists and professionals who have first hand knowledge of the material, and it would be of interest to a wide circle of readers.

The book is directed to people with some familiarity with memory technology. It helps the system architect to understand key technologies of memory and storage as the basis for trade-off decisions in the design of system components. On the other hand, it is a useful reference for people doing research in this field. This information is difficult to obtain at technical conferences which mostly concentrate on a specific and limited field and are tailored to specialists in a specialized area. The book is easy to read and is an interesting and excellent review of the entire area.

Nine sections comprise the book, with one or more papers in each section.

1. Keynote address: This gives a general history of the development of digital memories, with particular emphasis on drum and core memory.
2. Electromagnetic storage: This contains a collection of four papers. It is very complete and presents the basic elements of magnetic recording theory and their application. The general steps of writing, storing, and reading are presented in a simple analytical form. Three of the most popular electromagnetic storage media, namely, disk files, normal tape storage, and tape libraries with automatic reel transport, are examined. Special emphasis is placed on the techniques of these components and the proper design of the associated read-write circuits. In particular, the IBM 3850 is used as an example of a mass store.
3. Semiconductor memories: This is a collection of seven papers. It starts with an overview of the fabrication technologies and the physical fundamentals of components used for semiconductor memories. The present status and application of monolithic memories and LSI RAMs are reviewed. A high performance, low power, 2048-bit memory chip in MOSFET technology is used to illustrate the trade-off for the cost-performance ratio and the power-delay product. Progress in the area of readout methods and circuits for dynamic charge storage elements are presented. The CCD memory organization and its application are examined in detail. The section concludes with an investigation of BEAMOS and its applications. Comparisons are made among the different memories in order to help the designer to make the correct selection. This section is a very complete overview of the current semiconductor technology. However, there should be a paper on the limitations of the present technology and on what cannot be done now, rather than what can be done. For example, the possibility of distributing the control logic so that multiple users can access a chip simultaneously should be investigated. Other questions should be considered, like: What type of useful logic, such as that for performing AND, OR operations, should be added in addition to the logic for the storage of data? What logical capabilities are necessary to enhance the computation, etc?
4. Read only memories: This contains two papers, and the discussion ranges from magnetic coupling elements, e.g., magnetic cores, line coupling, transformers, etc., and semiconductor ROMs of bipolar or FET technologies to electrically alterable MOSROMs of floating gate type. The design of various memory cells and the mechanisms for programming and erasure are illustrated. We suggest that in the future a discussion on programmable logic arrays be included here.
5. Magnetic bubble memories: This section, with three papers, gives an overview of the principles, the relevant magnetic parameters, and the chemical composition of bubble domain materials and their application to information storage. Magnetic bubble memories, together with CCD and BEAMOS memories, are possible alternatives to fill the access gap. The authors have done a masterful job of discussing and comparing their limitations and applications.
6. Low-temperature memories: With one paper, this section examines a new and awakening area of low-temperature memories. The theory of recording is overviewed here.
7. Optical memories: This section is a collection of two papers. The limitations of material properties on the success of optical memories are derived and inter-

preted. A variety of optical storage systems are reviewed. Associative systems are investigated. The well known principle of a disk store is also considered for optical memories. The optical memories provide excellent possibilities for performing parallel logical operations, e.g., AND, OR, particularly in the area of image processing. An important application of image processing is in air traffic control, and this should be studied in more detail here.

8. Reliability: This section is a collection of three papers on the reliability and yield of LSI memories. The yield is discussed as a function of defect density, time (learning curve), and the minimum price/bit for a given integration scale. Problems which are specific for semiconductor memories, such as pattern sensitivity and gate-oxide breakdown, are discussed. Partially defective semiconductor memory devices to be used in memory systems are investigated.
9. Memory/storage systems: This is a collection of four papers on memory architecture. A new associative memory which uses a special chip organized with a coding mode of match indication is proposed. The design of LSI associative memories with increased chip capacity and extended logic complexity is investigated. The impact of gap-filler technology on the memory hierarchy's performance and characteristics is presented. Lastly, the performance of small cache memories in minicomptuers is simulated. We think that in this section, a discussion should be included on the use of associative memories in other applications, e.g., image processing.

The editor might consider expanding the areas of presentation in future editions to include memory architecture and data base processing as well. This area is important for the application of new memory technologies. In particular, the impact and limitation of these technologies on the design of memory architecture should be considered in more detail. Further, the exploitation of logical capabilities in a storage cell for enhanced parallelism should be studied. In particular, the authors should investigate memory design from both an application and a technology point of view. This book has mainly considered it from a technology point of view. However, it is also important to consider fitting special properties of memory to applications. It is from this point of view that new memories will be developed in the future. Lastly, there are rare cases where there are some grammatical errors in English, and these should be corrected.

In conclusion, this book has covered all the memory technologies from a system architect's point of view. All the topics are logically arranged, and complex physical concepts are explained clearly and elegantly. As far as this reviewer knows, there is no equivalent book available which covers this subject area. The authors of this book happen to be the leading experts in the technology they discuss, and this makes the book highly significant. Finally, we want to congratulate this distinguished editor for an outstanding job in this important area.

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