Microprocessors/ Microcomputers/ System Design

TEXAS INSTRUMENTS ELECTRONIC SERIES

Microprocessors/ Microcomputers/ System Design

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 1

Basic Decisions In System Design

INTRODUCTION

Texas Instruments has developed and is manufacturing a family of microprocessor products and systems based on the architecture of its 990 minicomputer. The purpose of this book is to present enough factual information about the 9900 and the family of devices and systems surrounding it to serve not only as a guide for deciding to use the 9900 in an application, but also as the primary reference for design and programming activities. The book is much more than a data book or a collection of application notes. It contains basic concepts, presents methods and techniques, and most important of all, shows how the architecture of the 9900, substantially superior to other microprocessor architectures, can be translated into cost effective applications.

The time investment you make in learning how to use the 9900 will inevitably produce substantial benefits because your designs will be advanced well beyond other microprocessor systems; they will be expandable, flexible, easily upgraded and will not be obsolescent. The capital investment in programming systems will bring powerful computing equipment and software tools to your design team that will have them out-distancing the competition in a very short time.

In reading this book, you will see the 9900 product as more than a single microprocessor. You will find a family of processors, peripherals, boards, minicomputers and systems all based on a single architectural concept called *memory-to-memory architecture.* It is this basic principle which, when fully understood at the fundamental level, will help you understand why and how the 9900 can be used to implement outstanding products. In addition, you will see why Texas Instruments has made the commitment to the continued support of the 9900 family in both hardware and software. New microprocessors and peripheral devices will retain and complement the basic architectural features—the 16-bit word length, the instruction set, the I/O techniques. etc. Texas Instruments software support goes beyond the standard assembler, editor, linker and PROM programmer software. New design tools such as POWER BASIC and PASCAL are now available. These powerful software products bring structured programming disciplines into focus and help you to attain an advanced programming capability.

All in all, the book is a collection of useful factual material which should be of substantial benefit to anyone considering designing with microprocessors. For those who have very limited exposure to designing with semiconductor products, the next few sections will be helpful because the theme of "more functions at lower cost" is demonstrated. These ideas lead to the basic philosophy that designing with *standard hardware* — semiconductor LSI products which are *programmable* — is the most economical procedure, and should be carefully considered for *every* new electronic product.

THE IMPACT OF SEMICONDUCTORS

In the short thirty years since the invention of the transistor (the first semiconductor device to exhibit amplification), there have been more inventions and more scientific and engineering accomplishments than in all time previous. The field of digital electronics (especially computers) has been the greatest contributor of new products for these accomplishments and, therefore, has become one of the most rapidly growing industries. Manufacturers of semiconductor components (transistors, integrated circuits, microprocessors and memories) have been providing the building blocks, and the equipment manufacturers have been taking advantage of the opportunity by developing the most sophisticated systems that are economically feasible.

In his keynote address to the 1977 National Computer Conference, Mark Shepherd, Chairman of the Board of Texas Instruments, made the following points:

> "Until 1971, the semiconductor industry was in the circuits business. Semiconductor circuits, complex though they were, constituted only a fraction of an entire system. The one-chip calculator developed in 1971 was the first significant complete system. Since then many calculators and watches have been developed where the entire system function is accomplished by one or a few semiconductor chips. These were custom chips because the technology did now allow any reserve computing power for other applications.
>
> "The semiconductor industry has now entered an era where the entire system function of an end product can be accomplished by a few semiconductor chips, or a single chip, with enough versatility to permit adaptation to many different applications through the programming.
>
> "This change carries enormous implications for the system designer. 1) The lead time for system implementation is shortened because no special chip development is required. 2) The development cost will be low because it will be limited to software (which may be executed in hardware). 3) The required degree of electronic sophistication on the part of the user is much less. To achieve these advantages the system designer must be prepared to use standard products produced in large volume rather than custom devices.
>
> "The functional equivalent of a medium-scale computer *(Figure 1-1)* cost $30,000 in the early 1960s. Its cost equivalent has now dropped to $4,000 and is projected to be at less than $100 by 1985, penetrating the personal cost threshold. As this is accomplished, greater challenges will be encountered in the cost of sales, service, and maintenance, requiring that we learn to incorporate self-diagnostic and self-repair functions into our systems."

THE IMPACT OF SEMICONDUCTORS

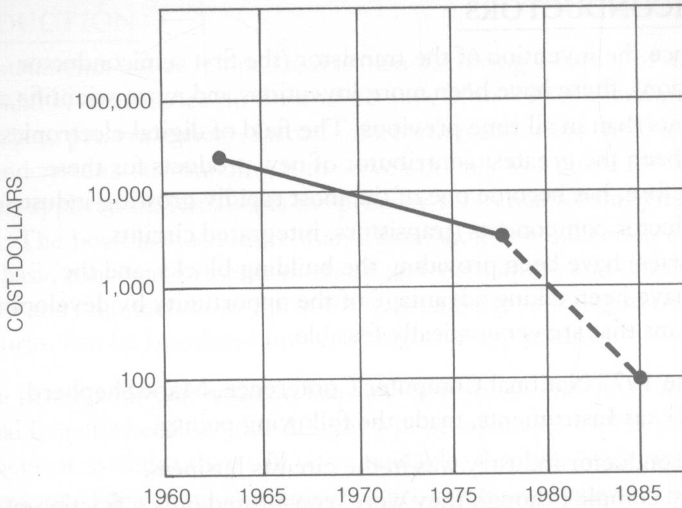

Figure 1-1. Cost of Medium Scale Computer
(M. Shepherd, 1977 NCC)

The cost of the hardware components for a typical digital system has been decreasing with time because new and more powerful semiconductor devices have been developed. Equally important is the fact that the development cost for the typical digital system hardware has also been decreasing. *Figure 1-2* illustrates how impressive this cost reduction has been. Contrast the figures of 7-8 *million* dollars in the early fifties with 8-9 *thousand* dollars in the late seventies; digital system development cost has been reduced by a factor of *one thousand* in a period of 25 years! An extension of this trend indicates that typical system hardware development cost will be approximately $1,000 by 1985.

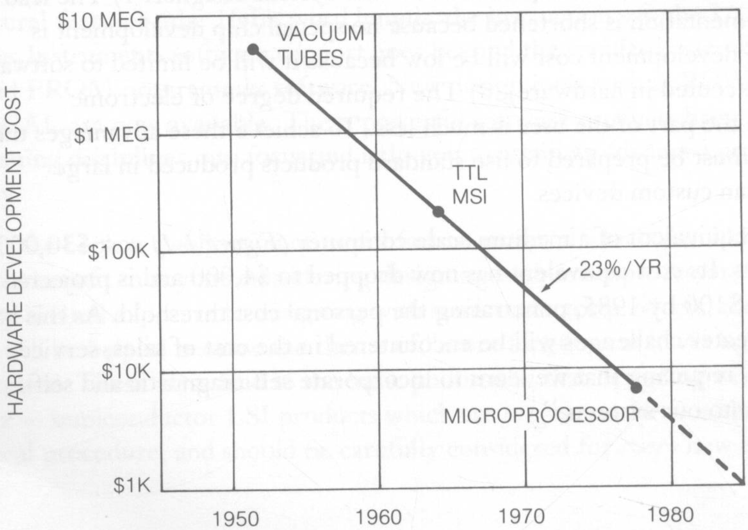

Figure 1-2. Typical Digital System Hardware Development Cost at OEM Manufacturer