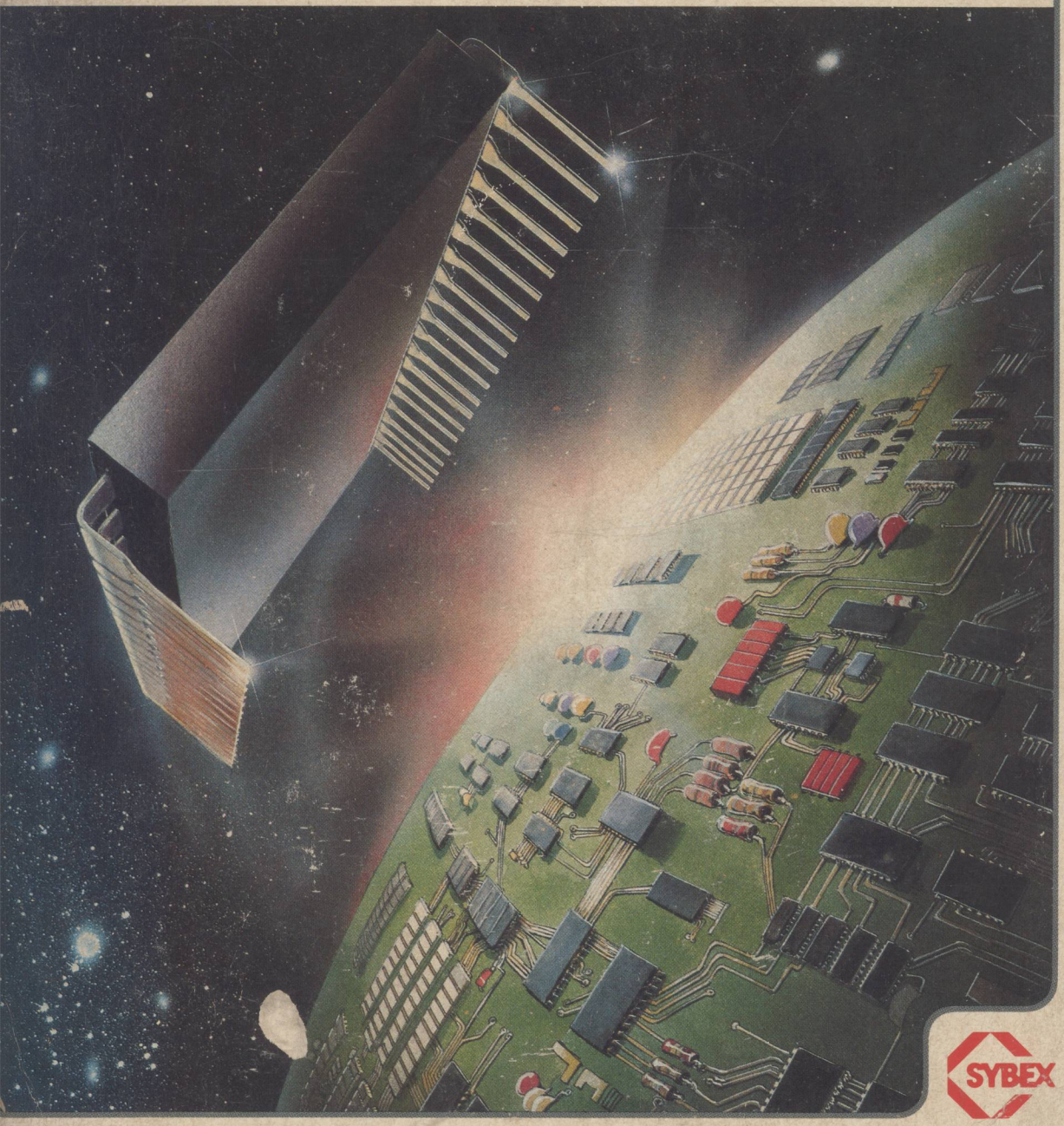
Rodnay Zaks

FROM CHIPS TO SYSTEMS:

An Introduction to Microprocessors



SYBEX

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Here's what they're saying . . . .

". . .The treatment is logical, methodical and yet easy to read.

. . .This is a book that I can recommend without reservation. . .

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PERSONAL COMPUTER WORLD

". . .No knowledge is assumed on the part of the reader—unless such knowledge has been previously put forth. . ."

ELEMENTARY ELECTRONICS

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POWERCONVERSION INTERNATIONAL

". . .For beginners in the field, a cover-to-cover reading would be well worthwhile. . .

". . .The conversational style liberally sprinkled with charts, photographs and diagrams leads to a pleasantly educating experience. . ."

INTERFACE AGE

FROM CHIPS TO SYSTEMS:

An Introduction to Microprocessors

Preface

This book is an updated version of *Microprocessors: From Chips To Systems*, originally published in 1977. It has been completely revised and re-illustrated. It follows the same organization as the original edition and the main changes are in the descriptions of new components. The design techniques and implementation philosophies are unchanged from the earlier editions and will probably remain valid for many years to come because microprocessor design is now standardized.

Comments from the readers of previous editions were an important consideration during the revision process. Any new comments on this updated edition are welcomed by the author.

Introduction

This book is written for everyone who wants to understand how a microprocessor operates and how a complete system is assembled from chips. In particular, it is an important resource for students, scientists, and engineers, as well as the nontechnical reader. Surprisingly, no preliminary knowledge of computer or microprocessor technology is needed to understand this book. The concepts are carefully defined, each in turn, and the text is presented in a simple and progressive way.

The information presented is applicable to *any microprocessor* although many specific examples are given. You are introduced to concepts and design principles common to all microprocessors. You are given the standard rules of design and shown how they apply to various microprocessors. You are shown both the differences between various microprocessors, and the advantages and disadvantages of specific microprocessors.

This book is organized to introduce you quickly and effectively to the inner workings of a microprocessor. It will help you understand how a microprocessor works, even if you have had no prior experience with electronics.

Chapter 1 provides the basic definitions necessary to understand microprocessors and introduces many basic concepts.

Chapter 2 takes you inside a microprocessor. At first glance this chapter may appear very technical, but once you understand all the definitions presented in Chapter 1, you will find this internal journey both easy and enjoyable. By the end of Chapter 2, you will be familiar with the operation of a standard microprocessor. You will know how instructions are executed and how the automatic sequencing of instructions is accomplished.

Chapter 3 then examines the other components that make up a complete system, from the memory chips to the input/output chips.

Once you become familiar with the various types of chips used in a microprocessor system, you will probably want to know about the advantages and disadvantages of the various microprocessors available today. *Chapter 4* provides this information.

Chapter 5 teaches you how to put together a system easily and rapidly.

You are shown how to connect the basic chips including the memory and input/output, wire by wire. Various design strategies are discussed and evaluated according to specific standards of efficiency and economy. By the end of this chapter you will know how to assemble a system.

Chapter 6 then examines the main application areas for microprocessors, ranging from computer systems to consumer applications. It explains that most microprocessors use a common system organization, which greatly simplifies the hardware design.

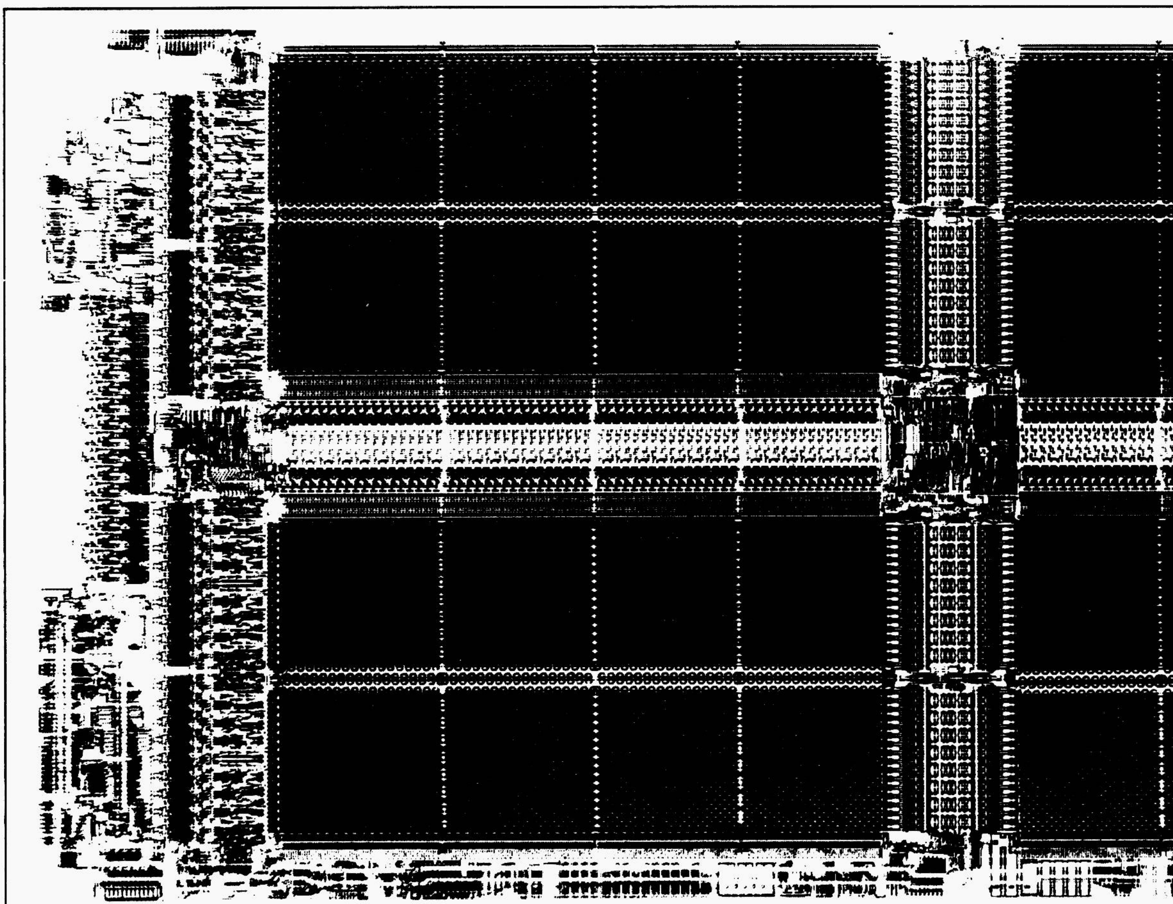
Once you have assembled a system, you still have two tasks to complete: connecting the system to the outside world and programming it. Chapters 7 (Interfacing Techniques), 8 (Microprocessor Programming), and 9 (Assembly and High-Level Programming) address these issues.

Chapter 7 presents the techniques necessary for connecting the main input/output devices and peripherals, from keyboard to floppy disk. *Chapter 8* teaches the basic definitions and techniques for programming microprocessors. *Chapter 9* examines the resources available in assembly language, and surveys high-level languages.

Finally, *Chapter 10* looks at the tools available for efficiently developing a system, from a development system to in-circuit emulation. In conclusion, *Chapter 11* forecasts future developments.

Sequential reading of this book is recommended, but not necessary. We recommend that you read every chapter even though you may be familiar with much of its content.

Microprocessor technology has become an essential component of the industrial world today. It is the author's contention that it is possible to learn about microprocessors in a short time. This book represents a step in that direction.



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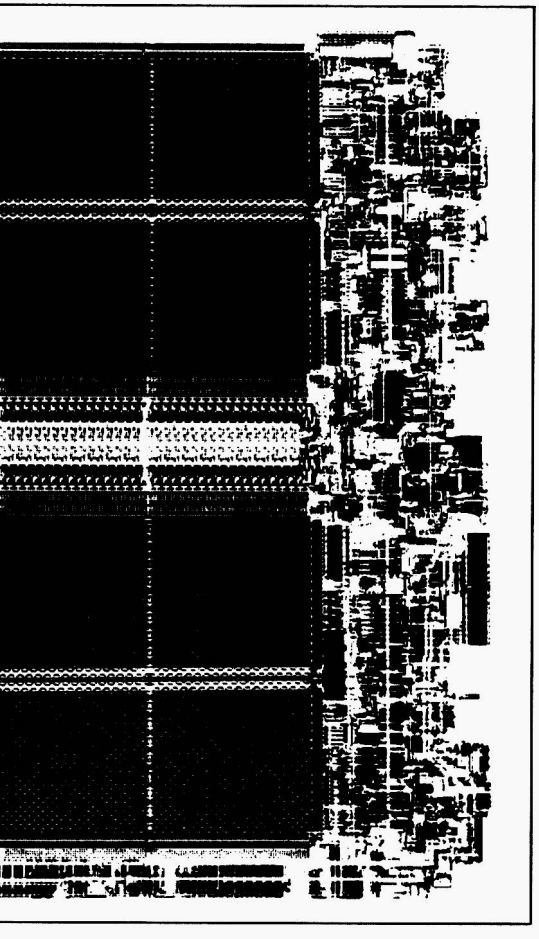
CHAPTER 1
FUNDAMENTAL CONCEPTS



INTRODUCTION

In this chapter we will discuss the principles of operation of a computer system, along with the basic definitions relating to microprocessors and microcomputers. We will also review the history and manufacturing process of microprocessors in order to facilitate the evaluation of existing products and the understanding of future ones.

After reading this chapter, you will be familiar with the terms used in describing microprocessors and microcomputers. We will then proceed to the actual operation of a microprocessor in Chapter 2.

All the concepts and terms introduced in this chapter are fundamental and should be well understood.

BASIC DEFINITIONS

In order to describe precisely the systems and components that will be presented in this book, specific words and abbreviations will be used. Every effort has been made to define these words before they are used. You will learn the language of microprocessors as we proceed.

Here are some initial definitions. Others will be presented throughout the chapter.

An *integrated circuit* (IC) is a device that integrates a circuit of several electronic components in a single package. The number of logical components, typically transistors, may range in number from 2 to more than 100,000.

Large-scale integration (LSI) designates the new technology that integrates thousands of transistors on a single integrated circuit (IC).

A *chip* is the small rectangular piece of silicon on which most integrated circuits are implemented (see Figure 1.1). By extension, "chip" is often used to refer to the package containing the chip (see Figure 1.2).

A *microprocessor* is an LSI component that implements most of the functions of a traditional processor on a single chip.

A *microcomputer* is a computer whose central processing unit (CPU) has been implemented with a microprocessor. Typically, a microcomputer uses one or more boards to implement all the functions of a complete computer. However, simplified computers can be implemented on a single chip and are called *single-chip microcomputers*.

A *microprocessor system* refers to the electronic boards required to implement a functional computer. Generally, this does not include the cabinet, power supply, and peripherals.

A *microcomputer system* refers to the complete set of devices required to use and operate the computer, including the peripherals such as terminal, printer, and disks.

The *binary number system* is used to represent all information in the computer, whether program or data. Each character, number, or entity is encoded internally as a group of 0s and 1s. Each 0 or 1 is called a binary digit or *bit*. A group of eight bits is called a *byte*.

ORGANIZATION OF A COMPUTER

Microprocessors are used, along with other LSI components, to implement computers. The microprocessor implements most of the functions of the *processing unit*, while the other components provide the memory, input/output, and other required functions. The logical

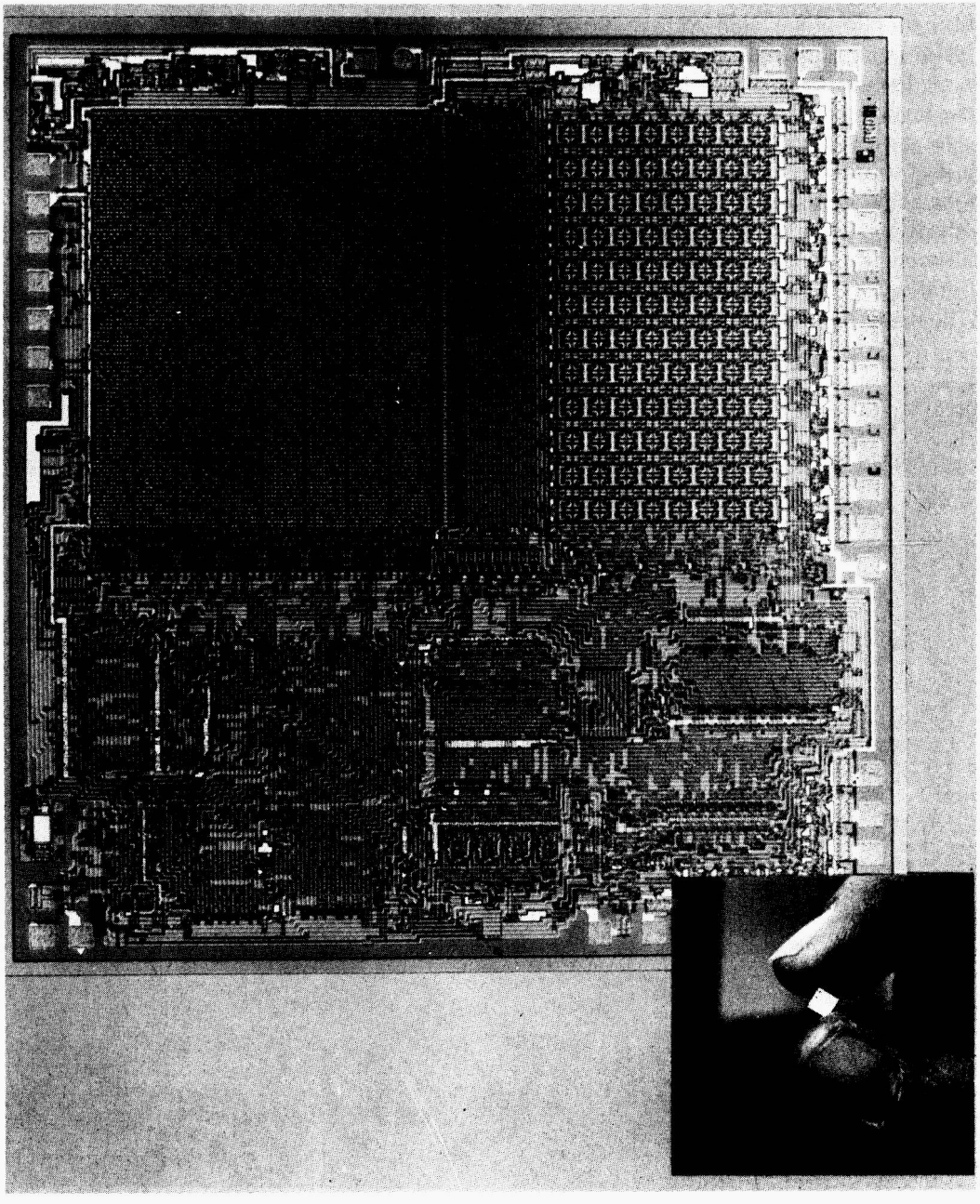


Figure 1.1: A Chip