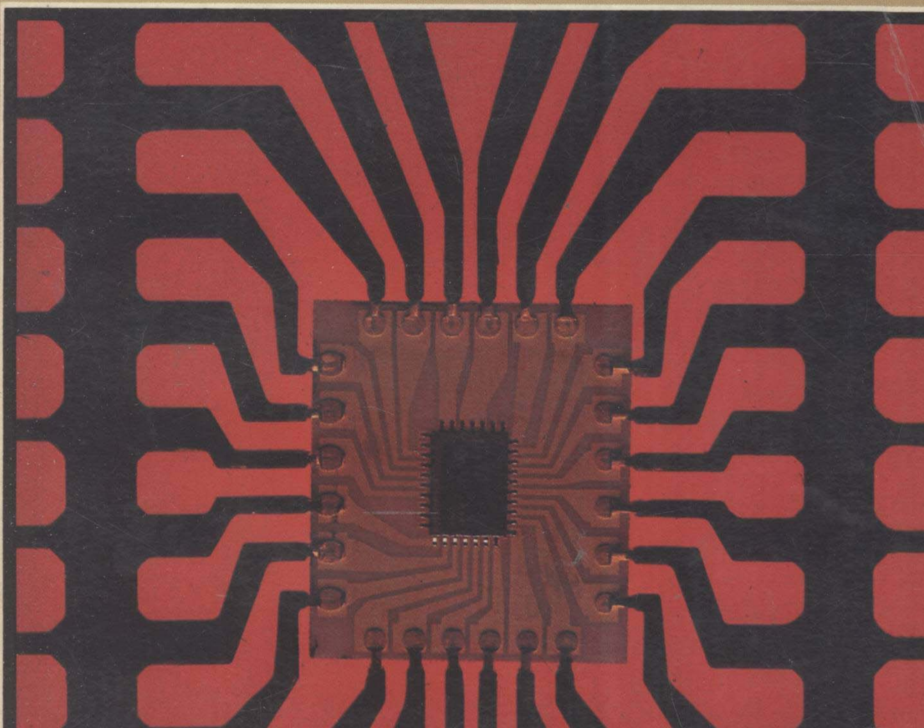
McGraw-Hill Vocational-Technical Series

MICRO-PROCESSORS
An Introduction



UL KIMBERLEY

MICRO-PROCESSORS

An Introduction

PAUL KIMBERLEY

McGraw-Hill Book Company

New York St. Louis San Francisco Bogotá
Guatemala Hamburg Lisbon Madrid Mexico Montreal
Panama Paris San Juan São Paulo Tokyo Toronto

Reprinted by arrangement with Hayes Kennedy Limited, England

First McGraw-Hill Paperback edition, 1982

2 3 4 5 6 7 8 9 0 SMSM 8 7 6 5 4 3 2

ISBN 0-07-034548-1

LIBRARY OF CONGRESS CATALOGING IN PUBLICATION DATA

Kimberley, Paul.
Microprocessors.
(McGraw-Hill vocational technical series)
Bibliography: p.
1. Microprocessors. I. Title.
TK7895.M5K55 1982 001.64 82-28
ISBN 0-07-034548-1 (pbk.) AACR2

Contents

About this book

This book is for those people who need to inform themselves of the principles and jargon involved in modern microelectronics and computer systems, in particular those systems which are beginning to transform business and industry. The book is aimed at professional laymen, that vast body of engineers, managers, executives, lecturers and professionals from every discipline who, although perfectly competent in their own field, may feel insecure and under-prepared, perhaps even intimidated, when confronted with the microelectronic revolution.

Anyone who has had anything to do with the installation of a conventional computer system will ruefully recall the feeling of being left out of conversations because of an inability to share the secret language of the salesman and other specialists. Anyone contemplating the application of microprocessors to any part of his business will have to deal with such specialists, with systems analysts, microprogrammers, electronic engineers and designers, transducer specialists, not to mention salesmen who will attempt to convince that their system is superior to any other. The manager who has responsibility for the installation and supervision of the system needs to acquire at least a superficial knowledge of a number of disciplines; of computer hardware, mainframe, mini and microcomputers; of programming, the different types of language and methods of programming; of electronics, semiconductors, microprocessors and a host of different types of chip; of memory technology, the different types of memory and its applications; of input and output transducers, the devices that enable computers to extend their range of applications into industrial processes and products; of packaging, switchgear and the necessary environmental controls. This book provides a brief guide to the more important aspects likely to be encountered by the professional layman, together with two generalised case studies, one industrial, one administrative, which show how to approach the problems of applying the new technology.

The book is not meant to be a text book, but rather a book for the brief case, to be dipped into during rail or air trips, or kept on the office bookshelf for reference when required. Beginning with an examination of the development of the technology over the last three decades, it goes on to look at the market trends and the rapidly widening range of applications. Chapter 3 analyses and describes the individual microectronic devices which go to make up a modern microcomputer, so that a non-specialist can at least achieve a broad grasp of the technology involved. Chapter 4 discusses the devices and technologies surrounding the microprocessor, without which it would be of no practical use, and chapter 5 puts it all together in two case studies to suggest how to set about applying the technology to real business situations. Finally, there is a Glossary of over 1000 of the most commonly used terms, without which it is almost impossible to communicate on the subject at all.

The book was planned as a businessman's self-defence kit against the secret language of the 1980's technocrats. Executives of the '80's defend yourselves! You will need to, if your business is to prosper.

1. Introduction

Keeping up to date

For the businessman or practising professional in industry or commerce, time is the enemy. Merely to keep abreast of developments in all the subjects relating to a particular job takes a considerable amount of time. To find time to read books aimed at the top-of-the-pyramid specialist, apart from demanding a starting point of knowledge which may be quite rare, inevitably means something else is left undone. Thus anything that is written to advance knowledge or share experience generally finds a fairly narrow, vertically aligned audience. Due to the remorseless, ever increasing volume of work and what appears to be a diminishing number of able and willing executives, there is an increased dependence upon specialist technical advisers, whom everyone trusts to keep up to date in their own fields.

Experience shows that the publications that are of the most use for the professional layman for most of the time are glossaries, introductions to subjects, dictionaries and the like. This sort of book requires no previous knowledge but presents the reader with a pithy, clear, encapsulated definition or explanation, very quickly. Its object is not to entertain or to educate, but to inform or enlighten. Further it does not seek to impose on the reader the burden of retaining that brief illumination since it can always be referred to again if necessary. In the real world this is by far the most practical approach, since one seldom fixes knowledge in the mind on first acquaintance. If often requires several different explanations of the same topic to acquire a genuine understanding. This then is the rationale behind that which follows.

The knowledge gap

The subject matter contained within the remaining pages is based on strictly practical grounds. The hypothesis is that the first step in any new project is always to assess the level of knowledge and experience of the participants and to begin to create the language that ensures mutual understanding.

There is a surprising phenomenon that reoccurs in every separate project. The combination of the industry and its own unique jargon, the level of understanding of the newer technology and the ability and willingness to adopt its unique language always combine to create a language that is absolutely singular for the life of the project. In-jokes, disasters, personalities and local accents all play a part in producing this hybrid vocabulary.

Whatever the reason and however long it takes, a project will never be totally successful until this verbal shorthand begins to be used, often unconsciously. The danger to the non-specialist or professional layman, is that the use of the special language implies an understanding but can in fact cover up a misunderstanding of the real meaning of the terms used.

An unnerving fact is that this is more likely in the 1980's than it was in the 1970's. By 1970 computers had been in use on a fairly general basis for 10 years and on a much more restricted basis for over 20 years. The large computer companies were investing very heavily in training programmes for users, user management and their own salesmen, analysts and programmers.

For a few years in the later 60's and early 70's some computer companies followed the enlightened path of Industry Marketing education, or vertically integrated marketing as it has come to be known. This process involved the wholesale recruitment of qualified professionals from industry and commerce who were then taught all aspects of computers in a methodical and intense fashion. This group of people were, in turn, used to educate customers from their own industrial background and also to educate computer staff in the problems of the industry concerned.

During this period the computer salesman was the educator par-excellence. He was usually a graduate, professionally experienced and qualified and generally very well spoken and groomed. He was trained in the art and tactics of public speaking, in presentation methods and armed with a whole array of expensive visual aids. At the same time the technical press was in an embryonic stage, seeking to capture and inform a wider and wider circle of readers. Introductory books on every conceivable aspect of computing were published and were often given away free by the computer companies. Indeed, many people claimed of IBM that the company was the world's largest publisher during this time. It was a vital and formative period but now unfortunately the rules have changed completely.

The reason, as ever, is economics. When a salesman had a sales quota of $1 million to $2 million and his products sold for upwards of $100,000, an average easily being $500,000, the economics of meeting targets and being able to spend time on education are fairly obvious. This was transparently the case in the golden days of the mainframe monopoly. Any computer company's branch office could envisage running five or six seminars a year for the benefit of their local business community. Outside the universities, virtually the only way of learning about the technology in the 1970's was through a computer company or its employees, and they did a remarkable job.

It will be seen that the US dollar($) is the unit of currency used throughout this book. This is because the US dollar has become the computer industry's standard measure of performance and pricing. The large computer companies set their targets for all territories, domestic and international, in US dollars. The head offices of the majority of these multinationals are situated in the United States.

Naturally enough in the end technology stole a march on the computer giants and the minicomputer made its breakthrough. This revolution, or apparent revolution, (it was in fact caused by an evolutionary change in solid state physics) literally decimated the price of computer hardware. In some cases it was possible to obtain the same computing power for only one tenth of the purchase price. This process of cost/performance reduction is still continuing, although it will probably end by the mid-80's.

In the heyday of the mainframe, computers were sold direct to the customer, the end user. During this period, in the early 1970's, the end user set up his specialist data processing staff; they had their own computer room, environmentally controlled, their own offices and quite often their own hours of working. In many cases they appeared, and still do today, to be marching to a different drummer than the rest of the working population. In this way the supplier had the responsibility for developing and manufacturing hardware, and for developing the software brains for the computer, such as operating systems and programming languages. The end user (customer) took on the responsibility for the application programming. Thus the supplier provided the means for problem solving, the customer used the computer and his own people for the actual solution.

This had a number of consequences. It meant that only larger organisations could afford to install computers. In general the in-depth education was reserved for that type of customer and quite often, because of immediate DP compartmentalisation, their knowledge was not passed on to the average user. In part this explains the source of that plethora of amusing but generally uninformed stories which blamed the computer for everything except the Second World War.

Although the suppliers' education was broad and generous, for clear commercial reasons it was very specifically directed. There was not then, and is not now, any significant altruistic computer education performed by any bodies except colleges and universities. By virtue of their dependence upon the suppliers for information these academic bodies themselves are, inevitably, always behind what is happening in the field.

The minicomputer has an entirely different rationale, in design, in its suppliers' marketing and education support and in the creation of a brand new industrial infra structure.

Firstly, the mini was smaller, and had (originally) much less sophistication and capability than the mainframe. Its software varied between 'very limited' and 'non existent'. However it was a computer; it could perform certain jobs perfectly adequately and was, relatively, extremely cheap. Initially the minicomputer manufacturers' marketing problem was largely influenced by their software limitation. It could not hope to expand the numbers of organisations who used computers until there were enough qualified software staff around to support the expansion. It appears that in recognition of this fact they sold to existing computer users, who, because they already possessed the necessary expertise, employed minicomputers in other areas of their organisations, generally on separate tasks to those performed by the mainframe. For example, early versions of minicomputers were used for industrial and process control and machine tool control, tasks for which the mainframe was both too expensive and technically inappropriate.

Eventually it was the programmers themselves who solved the marketing problem. A new industry evolved, based on programmers themselves. It became known as the Software Industry and consists of software houses, systems houses and systems integraters. These organisations purchased the hardware from the minicomputer suppliers, occasionally added other peripherals such as printers and video display units from other preferred suppliers and then programmed the machine for an individual customer. This gave the customer the benefits of lower price and a 'turnkey' package where total responsibility was taken by the computing subcontractor. It offered the customer the overwhelming benefit of not necessarily having to set up a DP department. To the equipment supplier it meant he could keep his volume up because he was selling either to major users or a relatively small number of OEMers of system houses. The same factors enabled him to keep his marketing costs down because he only had to sell to a restricted clientele, generally on the same international basis as his mainframe counterpart. This gave the marketing and education responsibility to the new middleman, the systems house.

The reaction from the mainframe suppliers was tardy but predictable. Marketing costs were effectively cut. At best, they did not grow at the previous rates. Inevitably less evident effort was put into educating the market place, except for technical staff. Customer education, until this point either free, or at the worst, inexpensive, now began to be seen as a major item in the purchase of equipment from the mainframe supplier.

Whereas with the mainframe installation all specialist knowledge stopped at the DP department, with the systems house industry it often did not get that far (the past tense is inaccurate; the situation remains the same). Because of the cost competitiveness between local businesses in the systems house industry, marketing costs were, and are, kept to an absolute minimum. Formerly it might have been expected that several copies of full, reasoned and clear proposals would be provided by a mainframe supplier to a prospective client, to enable purchasing decisions to be made. In the Software House industry it is not unknown for the only exchange of information to be a 'gentlemen's agreement', a handshake and an invoice! Thus not only did the numbers of marketing educators decline, so did their quality; and so far nothing has effectively filled the vacuum.

The mainframe and minicomputer now have greater technical similarities. They are still marketed and supported in a different way and still offer differing price/performance characteristics. Whilst the minicomputer has extended the range of applications which were created by the mainframe there has been no resultant revolutionary breakthrough in computer applications. The reason is that the size, price and specifications of both main types of computer have only allowed them to be used in administrative data processing. The lack of contact between users and manufacturers has also had the effect of limiting knowledge to existing users and the immediate circle of prospective customers.

The microcomputer is likely to change this state of affairs but computer users of the future will still need to acquire a fundamental understanding of what a computer is, and is not, in order to take advantage of current technology.

In reality both the mainframe and the minicomputer are sophisticated electromechanical assemblies, containing computer logic, a variety of different types of memory devices, and a variety of transducers. In the case of the mini and mainframe the input transducers referred to could be the keys on the various keyboards and the reading devices for input media. An output transducer could be a disk read head. From the glossary it will be seen that a transducer is a device that converts physical variables, such as heat, pressure and so on, into observable measurement (and vice versa). This defines a keyswitch as the very simplest of pressure transducers, down is on – to a known pressure, and up is off.

It will be instantly recognised by anyone who has even the remotest contact with computers that they are, without exception, extremely rigorous in their demands on the presentation of data. Each piece of information must go into an exact space on a card or a video display unit, etc. It must occupy the whole of that space; it must contain only numeric characters, or an acceptable mix of alphabetic and numeric characters. There are stringent editing and balancing rules. Any commercial computer system only performs as well as the organisation and presentation of data allows.

If that restriction were to be removed, or a way of expanding the range of methods of presenting data could be found, the variety of uses to which the computer could be put would expand correspondingly.

The breakthrough in cost and performance of microprocessors and the range of solid state devices which help create the modern microcomputer, together with increasingly sophisticated and complex transducers have now created a situation where it is possible to install an assembly of sensors, industrial microcomputers and appropriate storage, together with suitable enclosures, cabling, switches and programs to perform a whole range of data processing, word processing, process control, industrial control and robotic tasks for considerably less cost than today's minicomputer.

These latest developments in microelectronics have increased the problems of education. The microprocessor manufacturers, often referred to as fabricators, have an even more distant relationship with the end users. There are very few fabrication plants outside the United States. Thus the product goes from the US plant to their local national importer. The national importer then sells it to one of a number of regional stockists who in turn sell it to the manufacturing concern, where it is to be used within a product. They of course either sell that product direct or through their own distribution system.

Where the microprocessor is to be used to control a process it is generally sold by the stockist to a small electronics firm or systems house. The infra structure to support modern microelectronics is by no means bedded down and established yet.

Thus the education and knowledge dilemma is deeper and wider. Technology is developing in so many new directions at a pace which is impossible for any individual to assimilate. There is now virtually no supplier education apart from lavish brochures and publications, often too specific to a supplier to be of general use. The education that the supplier does provide is once again for specialists; it is not cheap and it is obviously oriented towards his own products.

The vacuum will be filled in time. The seminar, conference and exhibition industries are growing apace. There is evidence that the professional education market will be a force to be reckoned with in the late 80's. Books, magazines, TV and video will all play their part in this process, however random.

Special languages

In his Rede lecture in 1959, C. P. Snow spoke of what he called the 'great divide' between scientists and writers, more generally between Science and the Arts. This gap, occasionally referred to as the 'culture gulf' or 'The Two Cultures', (the title of Snow's lecture) manifested itself in the increasing singularity of language and vocabulary of many of the specialised disciplines. Of course, everyone recognises the need for a code, or shorthand, between two people on the same wavelength; it reduces unnecessary communications. Specialisation has merely extended this process to embrace a whole range of different disciplines.

The boom in education and research has reached such proportions that it is now almost impossible to achieve anything other than a very cursory understanding of another discipline or profession. If a social scientist and a programmer, for example, were to discuss jobs with each other without any prior knowledge, they would need to create a hybrid language before any 'meaningful' communication could take place.

This is particularly true of what have come to be known as 'high technology' topics. Due to a succession of some of the most exciting developments in physics there appears to be an exponential growth in activity and knowledge in almost all aspects of science-based engineering. As a consequence the hardware cost of computing has reduced many times, through the efforts of the specialists. On the other hand, the cost of understanding the effects of the changes in technology and the people costs to make it work have kept pace with inflation, so that a new combination of factors faces today's computer user.

It is clear that no matter how cheap the computer hardware has become it is still dependent upon people to analyse the problem, write programs and operate the equipment. People cost more each year; the actual computer is likely to cost less each year, especially for the next few years.

Technological developements have also changed the rigid rules which previously governed data input, which in turn has led to the potential for a wider application of computers in all businesses. This in turn forces a wider range of people, many of whom are specialists in their own field, to embrace the newer technologies.