Microprocessor Development and Development Systems

Edited by
VINCENT TSENG

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Preface

With the growth of microprocessor applications, the need for development tools and aids is shown by the proliferation of microprocessor development systems (MDS) on offer. However, what constitutes a development system is not often clear. In addition, the dividing line between what may be called a development system and some microcomputers can be very fine.

The objective of this book is not merely to compare one system with another, but to examine closely the work which needs to be done for a microprocessor application development, with a view to identifying the critical stages and the tools/facilities to aid these stages. The approach, then, is to clarify what needs to be done in an application development and to explain the primary differences from developments in other, allied fields (e.g. computer software development). The need for a development system is explained, as well as the features which make the systems different from any other microcomputer.

Detailed discussions of the identified important facilities are given. Due to the different approaches from different manufacturers, leading authorities contribute to give their insights to the designs and reasons for their particular method of implementation (for example on the different architectures of systems). There is also a study of working without the use of development systems, to highlight and recommend possible enhancements or additions to current facilities, or to offer an alternative using equipment which the readers may already possess.

The book has been written at two levels to ensure fuller understanding of the need for correct development tools in a project, as well as the subtleties in the implementation of, or provision for these tools. The contributions can sometimes be very detailed and technical, whereas the first part of the book is at an introductory level, to which the readers can refer for clarity.

Most of all it is hoped that this work will help readers to understand what is involved in the process of a microprocessor application development, to identify and decide what is important for themselves and to have the knowledge to select the facilities necessary for the successful implementation of their own microprocessor application project.

Vincent Tseng

Authors' Biographies

Vincent Tseng

Vincent Tseng is recognised as one of the leading authorities on the subject of microprocessors and in particular microprocessor development systems (MDS) in England. He has presented numerous papers at international and national conferences and seminars. He has also had several papers published on the subject.

Vincent is Principal Consultant for Microcomputing at ICL (Dataskil), in Reading, England, where he started the company's work in micro technology and set up and specified the development facilities and equipment for the company. He holds a Master's degree in Automatic Control from UMIST (University of Manchester Institute of Science and Technology), and an Honours degree in Physics from Imperial College, London.

W. Conings

W. Conings gained a degree in Chemistry at the University of Brussels in 1971. He spent eight years at the same University in the Department of Chemical Engineering, focussing his attention mainly on the use of mini- and microcomputers for controlling chemical reactors that are operated in non-steady state conditions. In 1979 he joined Intel as an application engineer supporting Intel's growing line of software products. In 1980 he was given the responsibility to manage the European Systems Application Group. Today he is responsible for the marketing of Intel's OEM operating systems.

Bernard Lejeune

Bernard Lejeune received his degree in Electronics in 1976 with strong emphasis on microprocessor applications. He started his career in heavy industrial environment, developing new techniques for low frequency vibration measurement and analysis. He joined Intel in 1978 as a member of the technical support centre in Brussels covering the complete range of Intel systems products. He later on specialised in the in-circuit emulation product line, actively participating in the implementation of the Intel European service centre installed in the UK. He then moved to the training department, handling at first service training then general software courses. He has been instructing PL/M, PASCAL and RMX, the Intel real time multitasking operating system software for the last two years. He is now involved in teaching the new Intel 432 Micromainframe architecture and the ADA programming language.

Jack Kister

Jack Kister was awarded a BSEE degree at the University of Nebraska. In 1974 he joined the Monsanto Chemical Company as Instrument Engineer. From there he moved to his present position as Hardware Engineering Manager at Motorola Inc. where he has been responsible for the design management of the TEH MC68000 16-bit microcomputer development system. He is the author of six publications primarily on semiconductor chips.

Sam E. Lee

Sam Lee gained BSEE and MSEE degrees from Texas Tech University. He served a term as Vice President of Tau Beta Pi, and was honoured one year as the Eta Kappa Nu outstanding member. His masters report described a feasibility study of a method for nondestructive reliability testing of metalised mylar capacitors. He joined the Colorado Springs Division of the Hewlett-Packard Company in February 1969, as a Research and Development Engineer. Early assignments included the design of custom-integrated circuits for oscilloscope products. This lead to the exciting challenge of establishing the computer based test, characterization and process monitoring tools for a new captive bipolar i.c. facility for the division, as well as establishing a Computer Aided Artwork facility. In 1977 he became the Product Manager for the HP 64000 Logic Development System which was introduced in September 1979. At present he is developing new products based on the HP 64000 system.

Geoff Bristow

Geoff Bristow is currently Manager of one of the North European business entities of Texas Instruments – the Custom Microfunction Pcc. This group is responsible for speech, telecommunications and microcomputer devices (4, 8, and 16 bit) as well as custom products. His career began with a degree course at Imperial College in Electrical and Electronic Engineering and he was awarded the Royal Society of Arts Silver Medal for his combination of academic and social activities. He then moved on to a period of research at Peterhouse, Cambridge, leading to a PhD award. The subject of his research was 'Speech Training for the Deaf using Computer Colour Graphics'. Moving to Texas Instruments in 1979, he became the Product Marketing Engineer responsible for microprocessor components, and then became Product Marketing Manager for 16-bit microprocessor products in August 1980. In June 1981 he moved to his present assignment where he has overall product marketing, engineering and financial planning responsibility for TI's high volume mask programmed devices (the TMS1000, 2000, 7000 and 9940) and various other related product ranges such as speech synthesis and telecommunications.

Dave Wollen

Dave Wollen is currently Product Marketing Manager for microprocessors and systems for Texas Instruments Northern European Semiconductor Division in Bedford. He obtained his Honours degree in Physics from Imperial College, London. Dave developed his main interest in microprocessors and computers while a design engineer at Marconi Space and Defence Systems. His increasing use of software led him to return to Imperial College, where he obtained a Masters degree in Computer Science and studied several computer languages. His research project entailed the design of interactive software for three-dimensional computer graphics using a large CDC computer. Subsequently, he joined the European Microprocessor Technology Centre at TI, where he developed software based on TI's 16-bit TMS9900 family and 4-bit TMS1000 series of microcomputers, mainly for customer applications. He was appointed Microprocessor Systems Development Manager with responsibility for the new Microprocessor Systems Centre, a customer-funded group formed to develop larger microprocessor systems based on microcomputer boards and to form a pool of technical expertise in microprocessor applications. He then became a microprocessor systems specialist within Central Marketing. Before taking up his current position Dave was concerned with the marketing of TI's latest 16-bit microprocessors, the TMS9995 and the TI 99000 series under development. He belongs to the Institute of Physics and the British Computer Society.

Peter Vinson

On gaining an honours degree in Physics at the University of Surrey in 1973, Peter Vinson stayed on at Guildford to do research work in semiconductor physics. This research used high pressure effects on the high field properties of three–five semiconductor compounds as a tool to investigate the energy band structure of those materials. Industrial experience was also gained at this time as this work was partly carried out at STL Laboratories, Harlow, Essex and RRE, Malvern, Worcestershire. After the results of the research were presented at the bi-annual 'International Conference on the Physics of Semiconductors', Rome, 1976, Peter joined what is now Plessey Research (Caswell) Ltd., Towcester, Northants to work on microwave oscillators using two-terminal devices. At the start of 1978, he joined Texas Instruments Ltd., Bedford, joining a group working on systems engineering and bread-boarding of Teletext and Viewdata integrated circuits. In the middle of 1980 he transferred to the marketing group as a Product Marketing Engineer; initially with responsibility for development systems but later also for 9900 MOS processors and peripheral devices, and military microprocessors. More recently Peter has transferred to the Custom Microfunctions group, taking responsibility for the product engineering of TMS1000 microcomputers, speech and telecommunications devices.

Mike Mihalik

Mike Mihalik is the project leader of the 16-bit emulation program for the 8500 series of microcomputer development systems at Tektronix, Inc. His responsibilities are to manage the hardware and software design of emulators for the Intel 8086/8088, the Zilog Z8001 and Z8002, and the Motorola 68000. In addition, Mihalik managed the design of the recently introduced 4-channel microprocessor analyser, the trigger trace analyser (TTA). A graduate of Clarkson College of Technology, Potsdam, New York, with a bachelor's degree in Electrical Engineering, Mihalik joined Tektronix in 1975. Initially, he served as a design engineer for TM 500 modular instruments. While in TM 500, Mihalik completed the digital hardware design, and the design and implementation of the operating system firmware for the CG 551AP.

Previously, Mihalik has written three articles for *Electronic Design* magazine, one co-authored with Bob Francis of Tektronix, and an article for *Electronics Test* magazine.

Professor J. L. Alty

Professor Alty took an Honours degree in Physics in 1961 and spent four years completing a PhD in nuclear physics research. From 1966 he spent two years in the Metallurgy Department at Liverpool as Leverhulme Research Fellow carrying out research into the Hall Effect in alloys. In 1968 he joined IBM (UK) Ltd. first as a Systems Engineer on large operating systems, and later as an Account Executive marketing medium and large systems to local authorities and Government organisations. In 1972 he was appointed Director of the University of Liverpool Computer Laboratory. In 1977 he set up one of the first Microprocessor Support Units in the U.K. and later chaired the Computer Board Working Party on Microprocessors – the recommendations of which resulted in over £2 million being given to Universities to set up microprocessor units. He was appointed Professor in 1978 and has been a member of a number of Government Committees – the

Computer Board for Universities and Research Councils, the SRC Interactive Computer Facilities Committee, and a number of inter-University bodies.

Introduction

The invention of the microprocessor opened a new era of electronics and computing. The technology of fabrication, in the ability to integrate a very large number of components onto a tiny sliver of silicon took the world by storm. Inherent in the high degree of integration was a magnitude of complexity never before encountered in a component. Add to this the fact that the microprocessor is a programmable device, and the need for tools to aid application development soon becomes clear. There must be the facility to enable the user to program the microprocessor and to test out the system under development.

The early attempts at providing these tools, under the collective name of microprocessor development systems (MDS), were, not surprisingly, from microprocessor manufacturers. The systems were sometimes very basic, being no more than a single or a collection of circuit boards based around the microprocessors to be used. Being essentially a computer configuration, these fairly crude systems allowed entry of program code and the running of the program for testing purposes. But the requirement and demand from the users for better and more powerful development tools have seen the MDS evolve into various different forms. The newer generation of MDS are sophisticated and powerful computers in their own right and there are some innovative and original aids provided in their facilities.

There are currently over a dozen different makers offering MDS in varying forms, which, of course, all claim some advantage over the others. Many development systems appear to be radically different and this can be confusing for the potential user. Are we trying to compare apples with pears? Despite their differences, development systems should all have the same objective, that is to provide the user with the tools to aid in the development of a microprocessor application.

The aim of this book is to help the readers help themselves, by discussing the criteria with which to select a development system. This is best achieved by the examination of the development cycle and highlighting the important and critical stages. The tools which aid in the critical stages can then be identified and discussed in more detail.

Because of the differing approaches from different suppliers of MDS, I have asked for contributions from manufacturers of development systems to discuss specific topics on the MDS and we are privileged to have contributions from some of the leading authorities on the subject in the world. With the benefit of this insight we can get a clearer understanding of why certain things are (or have to be) done in certain ways.

For balance a contribution was also included discussing application development without development systems. This illustrates what can be achieved by using existing equipment and may also highlight areas for future development/enhancement in development systems. This is to make the reader aware that tools are available in forms other than those which are actually called microprocessor development systems. The contributions were chosen to give a balanced representation of the different approaches taken in providing aids to a common problem. Guidelines were given to each of the contributors to discuss the insights and the reasons for taking certain approaches, as opposed to giving merely a product description. They were encouraged, however, to use their own current systems as illustrative examples. There has been only minimal editing, so that the views, philosophies and concepts presented are those straight from the contributors.

The readership is likely to be of differing levels of knowledge, and the book had to be written so as to take account of this. The editor felt it was his responsibility to ensure a common basic level of understanding. Thus of necessity the first four chapters had to be written to a lower level. However, these chapters discuss in detail the essential principles in microprocessor application development and the need for the correct tools to do the job. An understanding of these principles is vital to be able to read the contributions, some of which can be very advanced and highly technical, since they are all from persons at the forefront of MDS technology. More advanced readers may feel confident enough to skip or scan the first four chapters, only referring back to them if there is some difficulty in understanding the contributions.

There is a leaning towards software in this book. This is not because we have underestimated, or wish to belittle the task of hardware development, but due to the concensus opinion of all the contributors, and the editor, that software is the critical element in microprocessor development. The concepts of software may not be fully understood by everyone, especially professionals and engineers outside of the computer and microprocessor industries.

As an aside, it may interest the readers that your author/editor found that the principles of project management, design and structuring as discussed in the book applied well to the organisation and writing of this book! And the excellent contributions received have been a real revelation of insight and understanding in the manufacturers' thoughts and reasonings. Since all the contributions and the general chapters written by your author/editor were done in parallel, separately, over the same period it was both surprising and gratifying to find how well they come together and complement each other. There are some general principles which have had better coverage in the contributions and, rather than rewriting some of my own chapters to cover these items, I have left them as they stand; after all, if I knew everything I would have written the book on my own!

Finally I hope that you, my readers, will find this book as beneficial as I have found it in writing and organising it.

Contents

CHAPTER 1

What is a Development System?

This chapter is intended as a simple and brief introduction to the components and facilities of a typical microprocessor development system (MDS). Its aim is to achieve common terminology.

The MDS

There are many microprocessor development systems available from different suppliers. They sometimes appear to be different physically, and certainly the manufacturers may claim some unique features. However, they do have in common the basic configuration, even if some of the actual electronic components which go to make up the system may be different. Fig. 1.1 shows what is generally accepted as the recognized configuration of an MDS.

Processor

At the centre of the system is the processor unit of the MDS. The processor unit usually consists of a microprocessor connected with memory, both read only memory (ROM) and random access memory (RAM), and input and output (I/O) circuitry – this is shown in fig. 1.2. This configuration is normally implemented on several printed circuit boards (PCB) and linked together via a rack system and a backplane 'motherboard' – this is done to allow flexibility and future addition of hardware features. There are variations to this, such as all of the processor unit circuitry incorporated on a single PCB, or in some cases more than one microprocessor is used for different functions. But basically this configuration constitutes that of a computer.

Console unit

For a user to access the MDS at least one console device has to be attached to the processor. The visual display unit (VDU) is commonly used for this function, although again there are variations where other devices may be employed, such as keyboard/printing terminals. Terminology sometimes used for consoles are KSR – keyboard send and receive, or ASR – asynchronous send and receive. The function that has to be fulfilled here is the capability to allow the user to enter data into the processor (e.g. a keyboard) and some means for the processor unit to indicate messages back to the user (e.g. a display of some form).

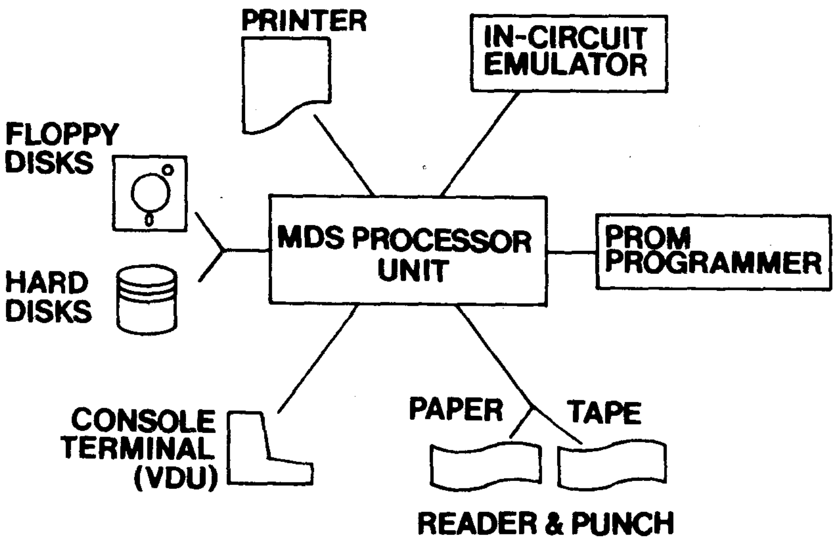

Fig. 1.1 Configuration of a typical microprocessor development system

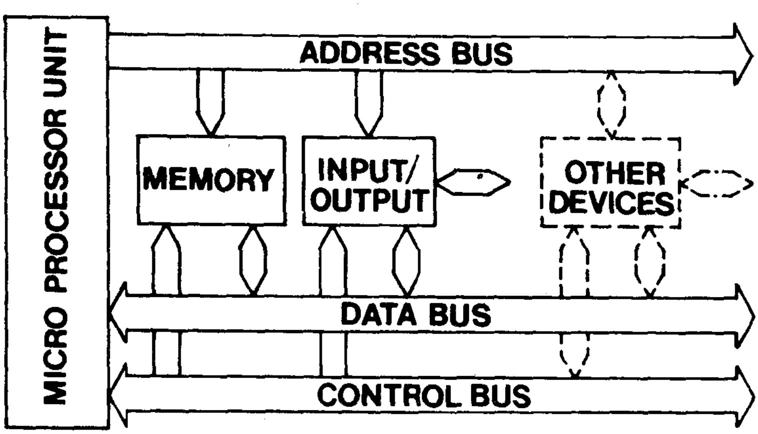

Fig. 1.2 Typical microcomputer configuration