

# Preface to the First Edition

Microprocessors and their microcontroller derivatives are a widespread, if rather invisible, part of the infrastructure of our twenty-first-century electronic and communications society. In 1998, it was estimated<sup>1</sup> that hidden in every home there were about 100 microcontrollers and microprocessors: in the singing birthday card, washing machine, microwave oven, television controller, telephone, personal computer and so on. About 20 more lurked in the average family car, for example, monitoring in-tire radio pressure sensors and displaying critical data through a control area network (CAN).

Around 4 billion such devices are sold each year to implement the intelligence of these “smart” electronic devices, ranging from smart egg-timers through to aircraft management systems. The evolution of the microprocessor from the first Intel device introduced in 1971 has revolutionised the structure of society, effectively creating the second Industrial Revolution at the beginning of the twenty-first century. Although the microprocessor is better known for its role in powering the ubiquitous PC, where raw computing power is the goal, sales of microprocessors such as the Intel Pentium represent only around 2% of the total volume. The vast majority of sales are of low-cost microcontrollers embedded into a dedicated-function digital electronic device, such as the smart card. Here the emphasis is on the integration of the core processor with memory and input/output resources in the one chip. This integrated computing system is known as a *microcontroller*.

In seeking to write a book in this area, the overall objective was to get the reader up-to-speed in designing small embedded microcontroller-based systems, rather than using microcontrollers as a vehicle to illustrate computer architecture in the traditional sense. This will hopefully give the reader confidence that, even at such an introductory level, he/she can design, construct, and program a complete working embedded system.

Given the practical nature of this material, real-world hardware and software products are used throughout to illustrate the material. The microcontroller market is dominated by devices that operate on 8-bit data (although 4- and 16-bit examples are available) like early microprocessors and unlike the 64-bit Intel Pentium and Motorola Power PC

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<sup>1</sup>New Scientist, vol. 59, no. 2141, 4 July 1998, p. 139.

“heavy brigade”. In contrast, the essence of the microcontroller lies in its high system-integration/low-cost profile. Power can be increased by distributing processors throughout the system. Thus, for example, a robot arm may have a microcontroller for each joint implementing simple local processes and communicating with a more powerful processor making overall executive decisions.

In choosing a target architecture, acceptance in the industrial market, easy availability, and low-cost development software have made the Microchip family one of the most popular choices as the pedagogic vehicle in learning microprocessor/microcontroller technology at all levels of electronic engineering from grade school to university. In particular, the reduced instruction set, together with the relatively simple innovative architecture, reduces the learning curve. In addition to their industrial and educational roles, the PIC<sup>®</sup> MCU families are also the mainstay of hobbyist projects, as a leaf through any electronics magazine will show.

Microchip, Inc., is a relatively recent entrant to the microcontroller market with its family of Harvard architecture PIC devices introduced in 1989. By 1999, Microchip was the second largest producer of 8-bit units—behind only Motorola.

This book is split into three parts. Part I covers sufficient digital, logic and computer architecture to act as a foundation for the microcontroller engineering topics presented in the rest of the text. Inclusion of this material makes the text suitable for stand-alone usage, as it does not require a prerequisite digital systems module.

Part II looks mainly at the software aspects of the mid-range PIC microcontroller family, its instruction set, how to program it at assembly and high-level C coding levels, and how the microcontroller handles sub-routines and interrupts. Although the 14-bit PIC family is the exemplar, both architecture and software are comparable to both the 12- and 16-bit ranges.

Part III moves on to the hardware aspects of interfacing and interrupt handling, with the integration of the hardware and software being a constant theme throughout. Parallel and serial input/output, timing, analog, and EEPROM data-handling techniques are covered. A practical build and program case study integrates the previous material into a working system, as well as illustrating simple testing strategies.

Sid Katzen  
University of Ulster at Jordanstown  
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Katzen, S.

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