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CHAPTER 7
Advanced Microprocessor Concepts

Computer architecture is central to the design of digital systems, because most digital systems are, at their core, computers surrounded by varying mixes of interfaces to the outside world. It is difficult to know at the outset of a project how advanced architectural concepts may figure into a design, because *advanced* does not necessarily mean expensive or complex. Many technologies that were originally developed for high-end supercomputers and mainframes eventually found their way into consumer electronics and other less-expensive digital systems. This is why a digital engineer benefits from a broad understanding of advanced microprocessor and computing concepts—a wider palette of potential solutions enables a more creative and effective design process.

This chapter introduces a wide range of technologies that are alluded to in many technical specifications but are often not understood sufficiently to take full advantage of their potential. What is a 200-MHz superscalar RISC processor with a four-way set associative cache? Some people hear the term RISC and conjure up thoughts of high-performance computing. Such imagery is not incorrect, but RISC technology can also be purchased for less than one dollar. Caching is another big computer term that is more common than many people think.

An important theme to keep in mind is that microprocessors and the systems that they plug into are inextricably interrelated, and more so than simply by virtue of their common physical surroundings. The architecture of one directly influences the capabilities of the other. For this reason, the two need to be considered simultaneously during the design process. Among many other factors, this makes computer design an iterative process. One may begin with an assumption of the type of microprocessor required and then use this information to influence the broader system architecture. When system-level constraints and capabilities begin to come into focus, they feed back to the microprocessor requirements, possibly altering them somewhat. This cycle can continue for several iterations until a design is realized in which the microprocessor and its supporting peripherals are well matched for the application.

7.1 RISC AND CISC

One of the key features used to categorize a microprocessor is whether it supports *reduced instruction set computing* (RISC—pronounced "risk") or *complex instruction set computing* (CISC—pronounced "sisk"). The distinction is how complex individual instructions are and how many permutations exist for the same basic instruction. In practical terms, this distinction directly relates to the complexity of a microprocessor's instruction decoding logic; a more complex instruction set requires more complex decoding logic. Some engineers believe that a microprocessor should exe-