PART VI

THEORETICAL UNDERPINNINGS AND FUTURE DIRECTIONS

Parts I through V addressed what reconfigurable architectures look like (Part I), how we can develop reconfigurable solutions (Parts I, II, IV, V), and, by example, where reconfigurable solutions can be particularly beneficial (Part V). In this, the final part of the book, we examine why reconfigurable architectures are beneficial and we gain insight into the areas where the benefits of reconfigurable solutions lie. We also observe technology trends and examine why reconfigurable architectures may become increasingly important over time. To support and ground these discussions, the following chapters delve into the technology basis from which we build these architectures, and their alternatives, and discuss physical issues including area, defects, faults, and manufacturing trends.

Chapter 36 constructs a simplified model of the architectural design space in which postfabrication programmable architectures (e.g., processors, FPGAs, VLIWs, SIMD arrays) are built. Using this model, the chapter illustrates the trade-offs inherent in different architectures and the impact these trade-offs have on the architectures' efficiency in implementing various applications. This simple analysis illuminates the appropriate roles for processors and FPGAs, underscores how we can use FPGAs efficiently, and suggests why, as component capacities continue to grow, reconfigurable architectures may be important for carrying out an ever-enlarging set of high-throughput tasks.

Chapters 37 and 38 explore how continued feature size scaling will influence the design of integrated circuits. As device feature sizes approach the atomic scale, our traditional techniques, abstractions, and solutions may no longer be appropriate. Manufacturing at the atomic scale demands higher regularity and produces less controlled structures. At the same time, physical imperfections (e.g., defects, faults, wear) occur at significantly higher rates. Postfabrication configurability appears to be an essential tool for dealing with these atomic-scale effects. This, too, suggests the growing importance of reconfigurable architectures for future technologies.

Chapter 37 addresses defect and fault tolerance. It shows how configurable designs can accommodate defects and suggests in what directions our design and usage paradigms should evolve in order to deal with increasing defect rates. The chapter also examines how transient faults will affect future configurable systems.

Chapter 38 further explores the impact of technologies in which feature sizes are measured in single-digit atomic widths. It reviews emerging atomic-scale technologies and shows how they can be assembled into a complete reconfigurable architecture.