# Preface

This is a book about component-based software engineering (CBSE). CBSE is the emerging discipline of the development of software components and the development of systems incorporating such components. Component-based systems are built by assembling components developed independently of the systems. To assemble components, a proprietary code that connects the components is usually needed. This code is often referred to as "glue code." In an ideal world of components the assembly process would be smooth and simple. The effort required to obtain the glue code would be practically negligible; a system incorporating components would know everything about them—their operational interfaces and their nonfunctional properties and the components would be exactly what the system needs; in short, components could be assembled as easily as Lego blocks.

In the real world, the component-based development process is complex and often difficult; systems are built from preexisting components when appropriate and possible and by developing a new code specific to the particular system. The system may know about the syntax of the operational interfaces of the components, but not necessarily their other properties. Developing the glue code can be costly—it may take longer to develop the glue code than the components concerned. Software components are in fact much harder to assemble than Lego blocks. Constructing software systems from components "is more like having a bathtub full of Tinkertoy, Lego, Erector, Lincoln Log, Block City, and six other incompatible kits—picking out parts that fit specific functions and expecting them to fit together" (Mary

Shaw, "Architectural Issues in Software Reuse: It's Not Just the Functionality, It's the Packaging," Presentation at the Symposium on Software Reusability, SSR'95). CBSE tries to make the real world as close as possible to the ideal world of component-based development. We have a long way to go to achieve this goal.

In spite of many difficulties, the component-based approach has achieved remarkable success in many domains. A majority of the software programs we use everyday take advantage of component-based technologies. Many classes of software, however, take a rudimentary approach to component-based methods. For these classes of software the specification of "how" is at least as important as the specification of "what." Examples of these classes of systems are reliable systems; safety-, business-, or mission-critical systems (also known as dependable systems); and embedded systems. The general-purpose component technologies currently available cannot cope with the nonfunctional (or more correctly extrafunctional) requirements of such systems. These additional requirements call for new technologies, new methods, and the specific approach of CBSE. This book describes the basic principles and the trends in research and practice of CBSE with an emphasis on dependable systems.

## Organization of This Book

The book is divided into parts, each of which explores a theme through the different chapters. Each part begins with a short introduction presenting its objective and an overview of the chapters. Although the parts and the chapters are relatively independent of each other, several principles apply to all. The first principle is *from general to specific*. The book begins with general parts related to software components, proceeds through topics such as processes related to CBSE, continues with domain-specific processes, and concludes with concrete case studies. The second principle is *from theoretical to practical issues*. Although the first chapters discuss theoretical topics such as component specifications, the last chapters give examples of the use of concrete component models. The third principle is *from simple to complex*. The first chapters discuss the elements of component-based development, the components, the middle parts describe systems built from components, and the final parts give complex examples of real component-based systems.

The book consists of seven parts:

- Part 1, *The Definition and Specification of Components*, gives an overall introduction to components and the basic terminology of component-based software engineering.
- Part 2, *Software Architecture and Components*, discusses different component models from the point of view of software architecture.
- Part 3, *Developing Software Components*, describes a component-based development process and certain methods for the successful design and specification of components.
- Part 4, *Using Software Components*, discusses problems related to component evaluation, integration, and testing.
- Part 5, *Software Product Lines,* provides an overview of software product-line architectures and gives a case study of a component model used in a product line.
- Part 6, *Real-Time Software Components*, discusses the principles and methods for building real-time, embedded, and safety-critical systems.
- Part 7, *Case Studies: CBD in Industrial Applications*, shows how the methods and theories described in the preceding parts of the book are implemented or utilized in concrete cases.

## Who Should Read This Book?

This book is directed toward several reader categories. Software developers and engineers will find the theory behind existing component models. The case studies will provide useful information about challenges, pitfalls, and successes in the practical use of component-based technologies. Experienced developers will find useful technical details in the last part of the book, while inexperienced developers can learn about the principles of CBSE. Project and company managers will be interested in the process and organizational aspects of component-based development, either for developing components or systems, with a focus on the reuse of components.

The book includes topics related to current research and to the state of the art of CBSE. For this reason, it will be of interest to researchers, either those beginning research in this field or those already involved. Extensive lists of references in each chapter provide broad insight into current trends. Finally, the book is appropriate as a course book, primarily for graduate students or undergraduate students in the later years of their studies.

## How to Use This Book

The different chapters have been written by different authors, experts in different areas. For this reason all chapters are relatively autonomous and can be read independently of each other. For a broader perspective of a topic, an entire part of interest can be read. This does not mean that the entire book shouldn't be read! It merely means that it is not necessary for the book to be read in the order in which it is organized. Those interested in basic principles and theories related to component models would be interested in the first parts, especially Chapters 1 through 5. As course literature, reading could begin with the first parts and a study of some of the chapters presenting case studies (i.e., Chapters 12, or 15 through 19). An experienced practitioner or researcher might be especially interested in these chapters. Chapters 2 and 6 through 10 are more theoretical in nature with many open questions and might therefore be of special interest to researchers and graduate students. Chapters 5, 11, 13, and 19 cover the component-based software life cycle and will be of special interest to project leaders or those working with development processes. Chapters 13 through 17 are related to real-time and dependable systems.

## Web Site

The book's Web site, http://www.idt.mdh.se/cbse-book, includes a set of presentation slides and additional material to support the use of this book in teaching and personal study. Instructors may freely use and modify the presentation material.

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