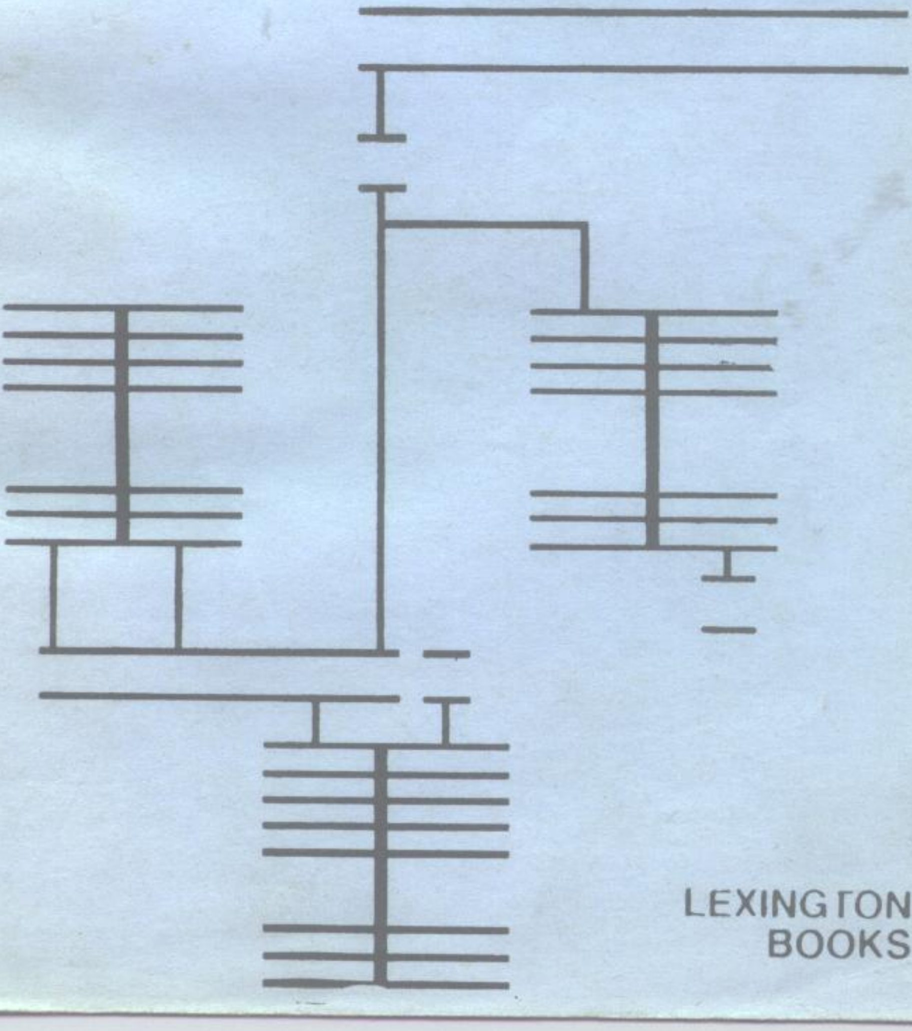
Yaohan Chu

# Software Blueprint and Examples



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# Software Blueprint and Examples

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# Preface and Acknowledgments

Software engineering is the application of engineering concepts, techniques, methodologies, principles, and practices to the development of software. A software blueprint is an application of the engineering blueprint to software. In traditional engineering methodology and practice, the engineer first develops a blueprint that describes the design of a product completely and understandably; the engineer, or another, then constructs the product according to the blueprint. This long-practiced methodology contrasts with the current practice of student programmers, who attempt to write code in the early stages of development without fully designing the software first.

The application of engineering methods and practices to software development implies (1) the separation of software design from software implementation and (2) a software-blueprint interface between software design and software implementation. In the nine chapters of this book, the methodology of the software blueprint is presented, software design is introduced, and six examples of the software blueprint are shown.

Many of the serious problems of today's software development can be attributed to the lack of a readable, concise, understandable, and complete design description. The software blueprint has been developed to be such a description. Chapter 1 presents the software blueprint methodology. A unique feature of this methodology is the design of software in three levels, described by corresponding software blueprints in three levels. These three levels are structured hierarchically and described in a uniform syntax. The description of a lexical scanner design is chosen to illustrate the software blueprint.

Chapter 2 first introduces the software development life-cycle, and then develops software design by taking an engineering approach. With this approach, five subjects are identified: software elements, software modules, software architecture, software design, and software design description. These subjects are analogous to the five subjects of computer design: computer elements, computer modules, computer architecture, computer design, and computer design description. This engineering approach gives a unified approach to the design of computer hardware and software. Software elements are identified by analyzing existing software; this is the first level of the formulation. Software elements are selected and organized into modules; this is the second level of the formulation. A software architecture is built up to represent a software organization; this is the third level of the formulation. A software design creates a software organization to meet the design specifications; this is the fourth level of the formulation. After the software design is completed, it needs to be formally

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but understandably described; this is the fifth level of the formulation. These five subjects—software elements, software modules, software architecture, software design, and software design description—are presented in detail.

Chapter 3 presents the design of an interactive direct-execution programming system. In a direct-execution programming system, the tokens of a high-level-language program are scanned and then directly executed token by token without compilation, linkage editing, or loading. This chapter first introduces three types of interactive programming systems. It next presents the conceptual design of the direct-execution programming system and shows the designs of the monitor, the text editor, the input processor, and the direct-execution processor. The monitor is the supervisor that communicates with the user by means of four monitor commands. It manages the text editor, the input processor, and the direct-execution processor. The text editor has six edit commands, and the input processor allows the user to input a source program from the terminal. The direct-execution processor, the heart of the system, accepts a small subset of ALGOL-60. The design is described by a level-A blueprint and a level-B blueprint.

Chapter 4 applies the structured-design technique to the design of an interactive text editor. The text consists of fixed-length lines organized into a doubly linked list structure. This text editor operates in two modes—input and edit—and includes a limited set of eleven edit commands. It has been broken down into twenty-two procedures organized in three levels. This structured design is described by a level-A blueprint and a level-C blueprint.

Chapter 5, a revised version of a file system originally written by Edward Raymond Cannon (a graduate of University of Maryland), presents the design of a disk-pack file system intended for a single user. This chapter describes the five file statements, the data structures and their formats, and the twenty-two procedures of the system. The level-A design is first developed and presented in a level-A software blueprint. The level-B design is then developed and presented in a level-B software blueprint. These two levels are designed and described using many diagrams.

The designs in chapters 6, 7, and 8 involve process synchronization, message communication, hardware/software interaction, and the like. Chapter 6 presents the design of an I/O system involving device drivers and interrupt handlers. The drivers and handlers are hardware dependent (they were designed for a PDP-11 computer system). These device drivers and interrupt handlers are used again in the designs in chapters 7 and 8. Software design language SDL-2, which will have a syntax compatible with SDL-1, is being developed for describing these constructs. Some constructs of SDL-2 are introduced and used in these three chapters.

Chapter 7 presents the design of an output spooling system that spools data records from a disk to a printer. This chapter introduces a buffer pool, buffer queues, and semaphore queues. Included in the design are the selected

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data structures, which include process control blocks, descriptors, semaphores, and I/O buffers. Four system processes are described: the disk buffer process, the printer buffer process, the sleep process, and the quit process. The scheduler, trap handler, device drivers, and interrupt handlers are designed. The design is intended for implementation on a PDP-11 computer system.

Chapter 8 sketches the design of a simple multiprogramming system making use of the I/O system of chapter 6 and the output spooling system of chapter 7. By using the process flow trace technique, the multiprogramming of processes can be observed in detail. The systems in chapter 6, 7, and 8 were projects in the senior course on operating systems at the Department of Computer Science at the University of Maryland.

Chapter 9 presents the software-design language SDL-1. This language is developed in concert with a formulation of software design given in chapter 2. SDL-1 was developed, above all, with design understandability in mind. Particular attention was paid to the visibility of the overall design structure. SDL-1 has constructs delineating data, control data, procedures, and reference structures. The control constructs and the design structure are simple, but the data constructs are rich in data types, data structures, and data operations. There are two types of statements; control flow statements and data flow statements. These describe the control flow and data flow of a software design. The syntax and semantics of SDL-1 are so formulated that the resulting design is a structured design.

This book presents an engineering (as opposed to a mathematical) approach to the design and description of software. The seven examples provided are of significant size and complexity. They are relevant and pedagogical, and they constitute a major part of the book. Implementations of these software designs in certain programming languages may become available.

*Software Blueprint and Examples* can be used in several areas of study. It can be used in colleges and universities as a textbook in a senior course on software design, or in a second- or third-year programming course in which the software blueprints are used for programming projects. The examples presented in this book can be used as software implementation projects in courses on subjects such as compilers, interpreters, systems programming, and operating systems. It can also serve as a textbook in a software-engineering laboratory or as a self-study reference for programmers in the software industry who are relatively new to software engineering.

## Acknowledgments

I wish to acknowledge that the design examples in chapters 6, 7, and 8 were originated by Dr. Virgil Gligor of the Department of Computer Science of

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