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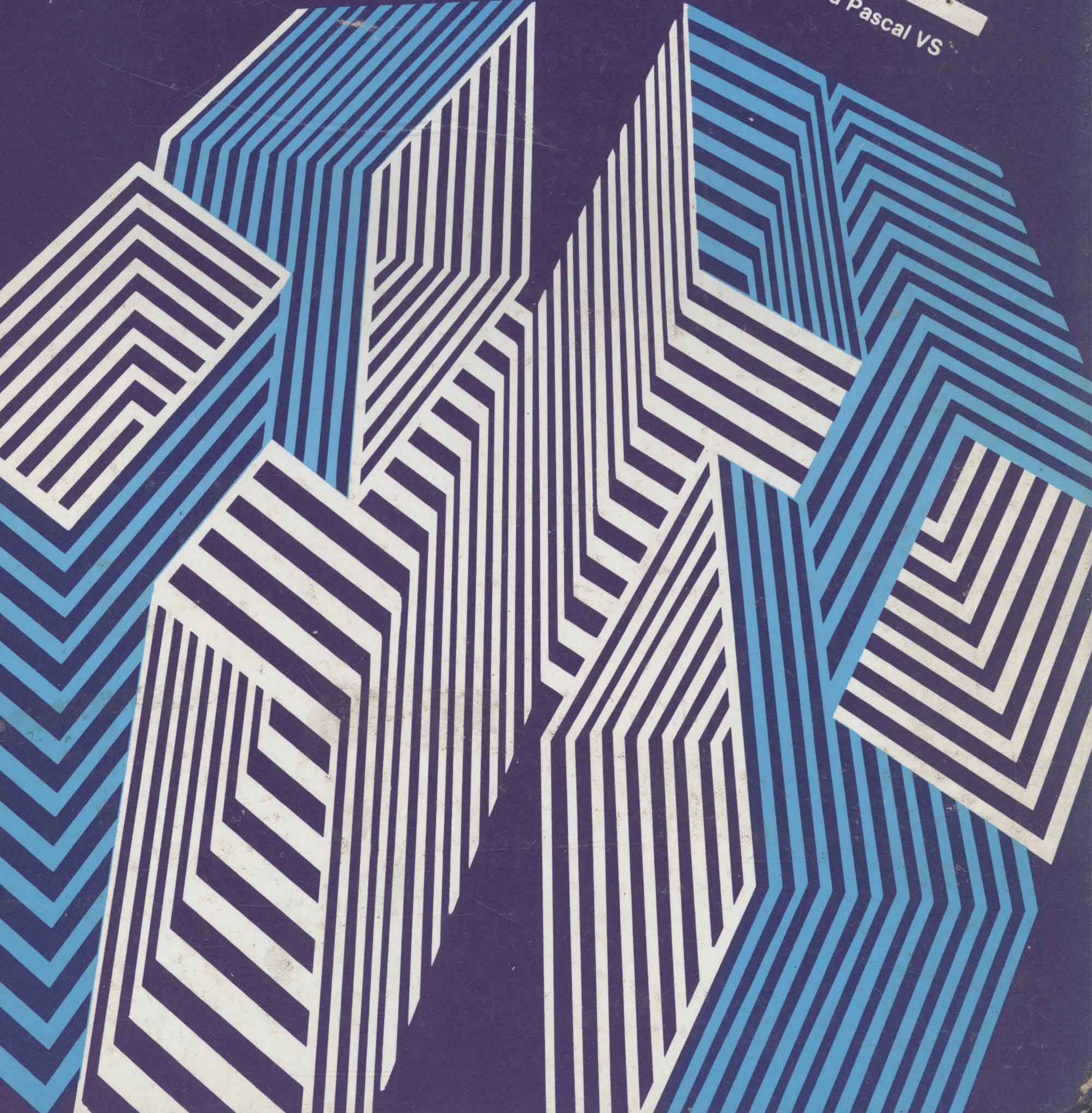
Text and Reference with Waterloo Pascal and Pascal VS

John B Moore



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Text and Reference with Waterloo Pascal and Pascal VS

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To Barb

- a very special person

Preface

Pascal is rapidly becoming one of the most widely used programming languages in the world. This growth is due to a number of factors, most important of which is the discipline which the rules of the language impose upon the programmer. These rules, when coupled with good programming style, result in high-quality programs.

Goals. The purpose of this book is to decribe how to use the Pascal language correctly and effectively. It is a comprehensive description of standard Pascal. It is intended for the person who wants to make a systematic study of the language and who, when finished, requires a solid reference.

Assumptions. It assumes the reader has no previous programming experience. Readers already familiar with programming concepts and/or another programming language can quickly read those paragraphs and explanations related to algorithm development and focus on the attributes of Pascal. Problems and exercises are taken from a wide variety of subject areas.

Pedagogy. The examples chosen to illustrate each component of the language are as simple as possible. In this way the reader can concentrate on the programming concept without becoming enmeshed in the logic needed to solve the illustrative problem. The examples are complete programs. All have been run and tested using the Waterloo Pascal processor which accepts standard Pascal.

The material is organized so that the reader may proceed sequentially through the entire text. Each topic is presented using a four-step sequence. (1) Here's what we are trying to do; (2) Here's how we can do it with our existing knowledge; (3) Here's a better way to do it; (4) Here's what we did. Each chapter begins with questions which the chapter answers and concludes with a summary of the key concepts and important programming skills presented.

Exercise questions are found throughout. These test the reader's understanding immediately following the presentation of new material. In the author's view, these exercises are one of the most efficient ways to imbed new knowledge. A variety of programming problems is found at the end of each chapter. They range in difficulty from very simple to complex. Some involve simple mathematical peculiarities which stimulate the reader's curiosity. Others are designed to massage the programming knowledge developed in the chapter.

Throughout the book, emphasis is placed on good programming style. Indentation rules, naming conventions and commenting guidelines are explicitly stated and consistently followed.

Organization. The book is divided into three parts: Statements and Values, Data Structures and Dynamic Variables, and Appendices.

Part I is a description of the statements which are used to process the three basic kinds of values -- numbers, characters and Boolean (true-false) values.

Chapter 1 describes the five-step sequence which is followed when a computer is used to assist the problem-solving process. The first example results in a complete program which the student may enter and run. Sufficient programming detail is presented in the three example algorithms and programs to allow a reader to solve a wide variety of simple problems using the examples as prototypes. Attention is devoted to the existence of errors and the understanding of diagnostic messages.

Chapter 2 begins the rigorous study of numeric processing. Constants, variables, value assignments and simple input-output are covered in detail.

Chapter 3 describes Boolean values and operations and then shows how they are used in the decision-making statements of the Pascal language.

Chapter 4 illustrates, compares and contrasts the three statements for loop control.

Chapter 5 explains character and text processing. It also summarizes input-output using READ and WRITE with the standard files INPUT and OUTPUT. The difference between numeric and non-numeric input-output is one of the most difficult parts of the Pascal language to learn. Consequently, detailed examples and explanations are given.

Chapter 6, extends the reader's knowledge of types to include the enumerated and subrange types. A summary of the processing rules for all scalar types is provided.

Chapters 7 and 8 describe functions and procedures respectively. Functions, being simpler, are explained first. Particular attention is paid to rules of scope and the meaning of the terms global and local identifiers. Chapter 8 shows how procedures differ from functions both in form and purpose. The last section of the chapter provides guidelines for partitioning algorithms into procedures. It also suggests criteria for choosing the nesting structure of blocks.

Part II of the book begins with an overview of data structures in general and Pascal data structures in particular. Conceptual differences among arrays, records, sets and files are emphasized.

Chapters 10 through 13 describe the four predefined structures available in the language. Arrays, having the most utility, are described first. The material describing records and files builds on the knowledge already gained. Sets are described in Chapter 13. An understanding of other data structures is not necessary to use sets and may be studied independently of arrays, records and files.

The final chapter describes the use of pointer variables. Individuals not familiar with memory concepts and indirect addressing often find the use of pointers one of the more difficult programming ideas to grasp. Consequently, a very simple example is presented early in the chapter to show the mechanics of their use. This leads to a discussion of the two most common kinds of data structures requiring pointers, namely linked lists (of which stacks and queues are specific instances) and trees. Examples are provided which demonstrate the use of binary trees in information retrieval applications.

Part III of the book contains six appendices. The first two provide a reference for character sets, standard identifiers, operators and the syntax of the language. Appendix C provides details of the Waterloo Pascal compiler. Appendices D and E summarize those features of Pascal/VS and IBM Pascal for the IBM Personal Computer which are not part of standard Pascal. Appendix F gives a number of suggestions for reducing debugging time and for improving memory and execution-time efficiency.

No one writes a book without a lot of help. I would like to thank Kay Harrison for her excellent work in entering the original, readable(?) draft of the manuscript and for making innumerable changes in subsequent versions. Mike Ruwald designed the Script macros used to format the text. Jim Dodd found many typographical errors and made excellent editorial suggestions. For errors that may yet be present, I take full

responsibility.

To you the reader, I hope you find this a useful and enjoyable book. I have tried to keep your needs in mind from start to finish.

Waterloo, Ontario Canada John B. Moore

Preface to the Student

This is a book that teaches you how to speak a language -- a language which permits you to use a computer to help solve problems. The language is called Pascal. It was originally developed by a professor to help students learn the principles of computer programming. Because he designed the language so well, it has rapidly become one of the most widely-used languages in the world.

Reading a book about computer programming is like reading a book about playing the piano -- there is only so much you can learn without intense practice. To become fluent in the use of the Pascal language, you must practise, experiment and test your kncwledge continually. Good luck and good programming.

Part I:

Statements and Values

Contents

CHAPTER 1: GETTING STARTED

Questions Answered in this Chapter:

1. What is a computer?

2. Why do we use them?

3. How do we use them?

1.1 WHAT CAN A COMPUTER DO?

Computers are attributed with many remarkable powers. However, all computers, from the large ones used to control the space flights to the micro-sized ones you can hold in your hand, are simply collections of electronic components which have three basic capabilities.

First, they have circuits which perform the four basic arithmetic operations denoted by the symbols + - * /. An asterisk or star indicates multiplication; two times three for example is written as 2*3. The slash symbol represents division. For example, the value of 7/5 is 1.4. When two integers are being divided, you can request that "integer division" be performed meaning that the remainder is ignored. Integer division is denoted by "DIV". Therefore the expression "15 DIV 4" has a value of 3, not 3.75. Chapter 2 contains a detailed description of arithmetic operations.

Second, computers have circuits which make decisions. Their decision making capabilities are not such that they can answer a question such as "Will it rain next Tuesday?" or "Who would win a war between Russia and China?" The decision making capabilities of a computer are limited to deciding

1. if one number is less than, equal to, or greater than another number

2. if one character (letter, digit or symbol) comes before, is the same as, or comes after another character in dictionary order

Third, computers have circuits for performing input and output operations. That is, they are able to accept input in the form of instructions and data from human beings. (By data we mean the numbers and characters manipulated by the instructions.) And computers would still be useless machines if we were unable to get the results out of the computer in a form that humans can understand. Thus computers have circuits for sending signals to printers and display screens.

Since all computers have only these three limited capabilities -- arithmetic, decision making and input-output, it is only natural to ask the following question.

1.2 WHY DO WE USE THEM?

There are three reasons why computers are so widely used.

<u>Speed.</u> First, computers are fast. How fast is fast? A powerful computer can perform several million instructions per second. If you or I were to do five million additions of ten digit numbers it would take us -- working a forty hour week -- about four years. Speeds for decision making are also measured in MIPS (millions of instructions per second) but speeds for many input and output operations are thousands of times slower because mechanical motion of cards and paper is often involved. A typical high speed printer for example prints 1000 lines of output per minute. Information can be sent over a standard telephone line at about 10 words per second -- about 1/25 of the rate of a high speed printer.

<u>Accuracy and Reliability.</u> In spite of newspaper headlines such as "Computer Fails Student", incorrect statements from credit card companies and other horror stories of computer foul-ups, you and I realize that it is seldom the machines that make mistakes -- it is the people who make the errors. Computers are remarkably accurate and operate for months, performing billions of operations without an error! Because they are man-made, they occasionally break down and have to be repaired.

<u>A Big Problem = A Set of Little Problems.</u> The most important reason computers are so widely used is that almost all big problems can be solved by solving a set of little problems -- one after the other. If each of these little problems is so simple that it can be solved using the limited capabilities of the computer, then we end up solving the big problem. For example, doing the payroll for a large corporation is indeed a big problem. But in order to solve this problem we need only