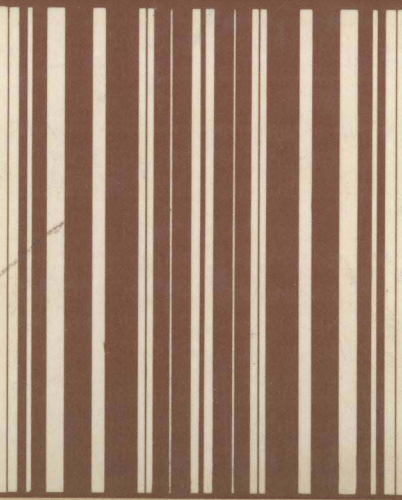
CONCEPTUAL PROGRAMMING USING BASIC



Allen Baker
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Library of Congress Cataloging in Publication Data

Baker, Allen.
Conceptual programming using BASIC.

Includes index.
1. Basic (Computer program language) 2. Electronic digital computers—Programming. 3. Problem solving—Data processing. I. Hamrick, Kathy. II. Title. III. Title: Conceptual programming using B.A.S.I.C.
QA76.73.B3B34 1984 001.64'24 83-9533
ISBN 0-13-166678-9

Editorial/production supervision and interior design: *Service to Publishers, Inc.*
Cover design: *20/20 Services Inc. (Mark Berghash)*
Manufacturing buyer: *Gordon Osbourne*

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-166678-9

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Whitehall Books Limited, *Wellington, New Zealand*

CONCEPTUAL PROGRAMMING USING BASIC

Dedicated to the memory of
Dr. Jerry Sue Townsend

PREFACE

This text departs from the traditional approach used to teach BASIC. Its emphasis is on teaching the student a generalized approach to problem solving with BASIC as an added bonus rather than teaching BASIC with some problem-solving skills thrown in. We first teach the student to solve a problem by decomposing it into separately solvable components and examining the relationships each component has with the others. BASIC instructions are introduced after the student has mastered these problem-solving techniques, and even then, they are introduced simply as a means of translating the solution into a language the computer can understand.

The data flow diagram is the tool for problem decomposition. It is not a flowchart and should not be viewed as one. It is, rather, a pictorial representation of the disjoint components required to solve a problem and the relationship each component has with the others. Using this picture as a guide, the student can describe (using a pseudolanguage) the transformations that convert input data flows into the output data requirement of the problem. The pseudolanguage is mechanically translated into BASIC to produce the final BASIC program.

We have observed that students are most comfortable initially with simple problems that perform a single, nonrepetitive task. Beginning students appear to think in terms of single-line statement relationships. As the student gains experience, however, he or she appears to progress to another level where the thought process involves instruction blocks. These blocks may contain complex selection or repetitive processes.

Chapters 1 through 7 deal with nonrepetitive problems. Chapter 8 introduces repetition and procedurally related blocks of code. Beginning with Chapter 8, the student must begin thinking in terms of program modules and blocks of code. The instructor should provide encouragement during this period.

We have used minimal BASIC throughout the text, not because we like the standard, but rather because of system compatibility. You are encouraged, however, to expand the syntax to take advantage of your particular computer system. Expanded data names, IF/THEN/ELSE, and CASE statements (if your system supports these) should be substituted and would provide a welcome improvement.

Acknowledgments

There are many people who have directly or indirectly provided support to this project. We first wish to thank M. Edward Pettit for his thorough review of the manuscript and helpful comments. Second, we wish to thank Beth Bryan and Fred Maynard for their comments and their help and Bill Bompart for his support. We also wish to thank our families, Karen, Greg, Richard, and David, and Gayle, Beth, and Ginger, for putting up with us while we pondered over these words. Finally, we thank Jerry Sue Townsend, whose encouragement and support made this project possible.

ALLEN BAKER
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CONTENTS

1

DECOMPOSING THE PROBLEM

If you were asked to examine the computer system shown in Figure 1.1 and to identify the most important component, you would probably respond, "The computer itself." Although the computer is an extremely important part of any automated system, it is not the most important. We can identify the important component by removing the computer from the picture. What remains? The problem to be solved.

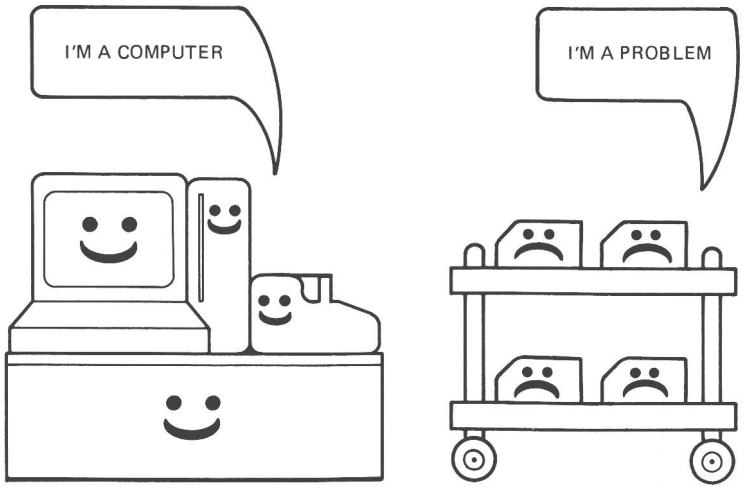

Figure 1.1 A COMPUTER SYSTEM

1.1 PROBLEMS AND THE COMPUTER

Not all problems can be solved by a computer. We can calculate utility bills, evaluate income tax returns, and even regulate the temperature in office buildings. We cannot, however, evaluate the quality of life, calculate the physical attraction of two people in love, or even regulate the economy of the United States. The characteristic separating the last three problems from the first three is that the first three can be precisely and thoroughly defined. If a solution to a problem can be defined precisely, then it can be implemented on a computer.

Since the problem and its solution are the most important components of any computer system, we should begin our study of computers by solving problems. Without properly developed problem-solving skills, the programmer cannot describe the problem and, therefore, cannot implement it on the computer.

1.2 PROBLEM DECOMPOSITION

A successful problem solver has learned that complex problems are only a composition of a certain number of simple problems. If he or she can decompose the complex problem into readily solvable simpler ones, the battle is won!

There are many ways to approach *problem decomposition.* You can divide the problem into components that are logically related, components that occur during the same period of time, components that form a control or procedural unit, or components that have other characteristics in common. The method you choose, however, has a tremendous effect on the complexity of your final solution.

The approach we will use to decompose a problem is based on the *flow of data* required to solve it. The data are traced from their input source, through appropriate transformations, to their output destination. This approach ignores the procedural aspect of the problem and concentrates on the flow of data.

The decomposition process starts with a statement of the whole problem to be solved. You must first determine what is known and what is required. We think of our known facts as *inputs* and our requirements as *outputs* in the problem-solving process. You can illustrate this idea graphically as shown in Figure 1.2.

The arrow into the *bubble* in Figure 1.2 represents the input data flow, and the arrow out of the bubble represents the output data flow. The bubble represents the *transformation* required to change the input into the output data flow. The graph is called a *data flow diagram.*

If the problem is a very simple one, you can describe the process

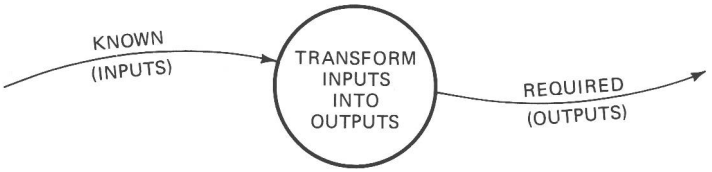

Figure 1.2 THE PROBLEM-SOLVING GRAPH

in a single bubble or transformation. Otherwise, you must decompose the problem into other, simpler transformations. In the remainder of this chapter, we examine problem decomposition using data flow diagrams.

Let us begin our study with a simple problem.

Problem 1.1

If Ed makes $3.75 per hour and works for 30 hours, what is Ed's gross pay?

The first thing you want to do is to make sure that you understand the problem. Your understanding is often enhanced if you list the inputs in one column and the outputs in another column:

INPUTS		OUTPUTS	
$3.75	ED'S RATE	?	ED'S GROSS PAY
30	ED'S HOURS WORKED		

The solution to the problem reduces to those processes or transformations that take the inputs and create the outputs. We can illustrate the solution to Problem 1.1 as shown in Figure 1.3.

Notice that bubble 1 in Figure 1.3 has not been defined. All we know is that if the problem can be solved (and in this case, it can), some transformation of the input items must occur to produce the output item. If we can describe that process, we can solve the problem, and we are done. Otherwise, we must decompose the process into simpler steps.

Let us look at the transformation as a kind of *black box*. The concept of a black box should be familiar to you even if you have never

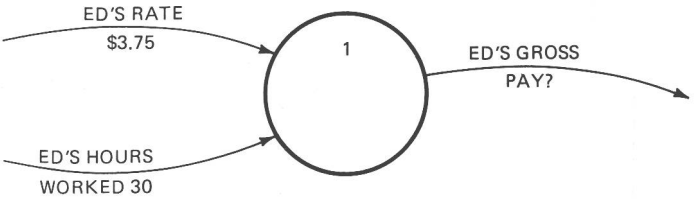

Figure 1.3 THE PROBLEM-SOLVING PROCESS

been exposed to the term. A television or an automobile can be considered a black box. You do not need to understand the workings of the inner components of either to use them. You simply input certain items (the turn of a knob or key) and experience certain outputs (a television picture or a running engine).

Using data flow diagrams as a decomposition tool allows you to defer examining the inside of the bubbles (black boxes) until later. In fact, we do not assign a name to the bubble until all input and output data flows have been established and the data flow names written above the arrows. We then choose a name that describes the transformation in terms of its input and output data flows. The name is formed by combining a strong action verb and a single object. From the input and output data flows shown in Figure 1.3, we could assign the name CALCULATE ED'S GROSS PAY to bubble 1.

The transformation for Problem 1.1 is a simple multiplication of rate times hours worked:

$$\$112.50 = \$3.75 \times 30$$

where $112.50 represents the gross pay that Ed would receive. The final data flow diagram showing the result of the transformation is illustrated in Figure 1.4.

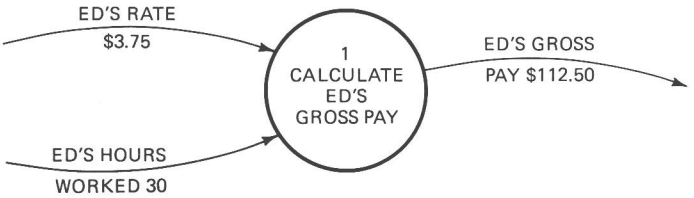

Figure 1.4 FINAL DATA FLOW DIAGRAM

The data flow diagram always represents a steady state of the problem. We are not concerned with iterations, controls, or simple error paths. We are concerned only with the flow of data as they move from the input source to the output. Looking inside the bubble will come later.

Let us consider a generalization of Problem 1.1. If we can work one case, we can work others.

Problem 1.2

If the hourly rate and hours worked are known, calculate the gross pay.

Again, let us list our inputs and outputs:

INPUTS	OUTPUTS
HOURLY RATE HOURS WORKED	GROSS PAY

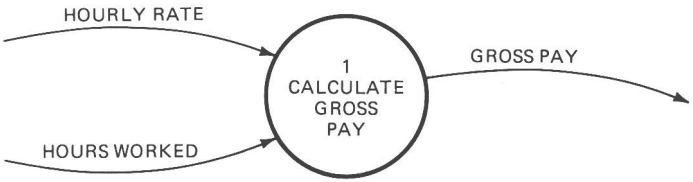

Figure 1.5 CALCULATE GROSS PAY

Our problem-solving process is to transform the inputs, HOURLY RATE and HOURS WORKED, into GROSS PAY. This process is illustrated in Figure 1.5. From our work with Problem 1.1, we know that GROSS PAY can be determined from HOURLY RATE and HOURS WORKED.

Suppose that we add a level of complexity to Problem 1.2 by requiring that net pay and gross pay be determined.

Problem 1.3

If a person's hourly rate, hours worked, and deductions are known, determine his or her net pay and gross pay.

Let us make sure that we understand Problem 1.3 by working with a specific case. Assume that Fred works 40 hours and receives $5.50 per hour. Assume further that Fred must pay $50 in deductions. Listing our inputs and outputs, we have:

INPUTS		OUTPUTS	
$5.50	FRED'S RATE	?	FRED'S NET PAY
$50	FRED'S DEDUCTIONS	?	FRED'S GROSS PAY
40	FRED'S HOURS		

Again, our problem is to transform the inputs into the required outputs. Fred's gross pay is 40 × $5.50, or $220. We must subtract his deductions of $50 from $220 to obtain his net pay of $170.

We can diagram Problem 1.3 as illustrated in Figure 1.6.

The transformation, however, cannot be named using an action verb and a single object. Further decomposition is required. The output, NET PAY, can be determined from the inputs, DEDUCTIONS and

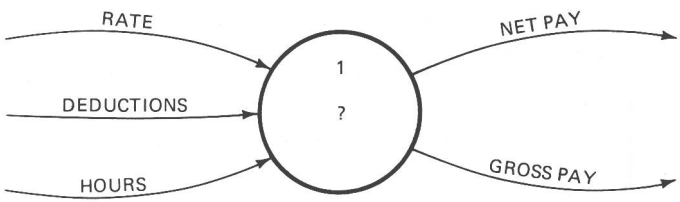

Figure 1.6 DIAGRAM OF PROBLEM 1.3