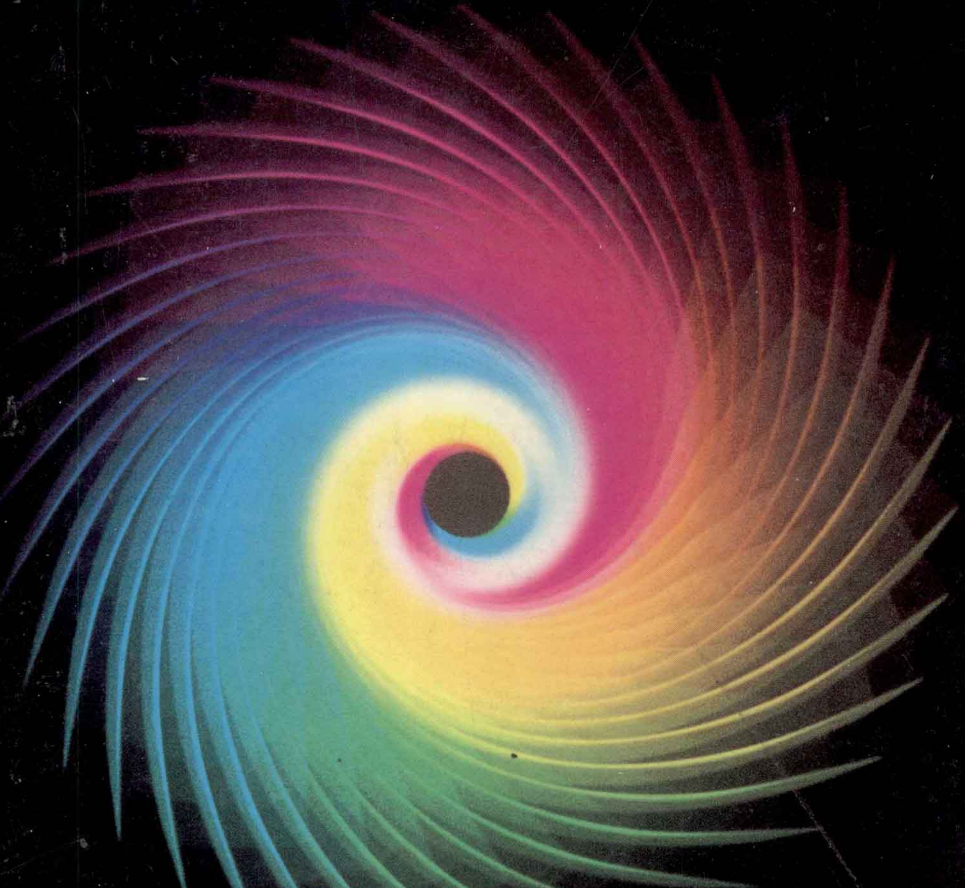
COBOL



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COBOL

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Preface

Three of the most troublesome topics for beginning COBOL students are programming logic, debugging, and tables. This text attempts to deal more fully with these topics.

The text is built around one business system, an order system. Our objective is to allow the student to become so familiar with the files used they can concentrate on the COBOL instead of a variety of record descriptions. Using a variety of program design tools, the system builds from simple listings through extracts, control breaks, table handling, edits, updates, and sorts.

Debugging is emphasized from diagnostics to data exceptions. For the more common diagnostics a list of items the student should check is provided. For data exceptions and usage emphasis on IBM storage types is used. The use of trace and display are encouraged for solving logic problems.

There never seems to be enough material in a text about tables to satisfy a beginning student. We have tried to include more information about structure, loading, accessing, and printing tables with the hope the student will be able to find an example that fits the current problem they are trying to program.

Material on the 1985 standard is included as the associated topic is covered. It is, however, differentiated so it can be used or not based on its availability.

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Audrey Longhurst

BRIEF CONTENTS

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CHAPTER 1

Introduction to Programming in COBOL

This chapter presents introductory material which is necessary to begin learning the COBOL programming language. It includes an introduction to COBOL, program development, data organization, and COBOL topics.

The introduction to COBOL covers the history and characteristics of COBOL.

Program development is the process by which programs are created. Coverage of program development includes the development process, analysis tools and techniques, structured programming, and design tools.

Data organization involves the storage of data on files, including a description of the files, access methods, storage media, physical considerations, and file description techniques.

Included among COBOL topics are basic information about COBOL, the compilation process, and an overview of the COBOL language.

INTRODUCTION TO COBOL

The History of COBOL

The development of COBOL began in 1959 with the creation of the Conference on Data System Languages (CODASYL). CODASYL was created because of a need for a common programming language for use in business applications. CODASYL's objective was to create a language which would not be the property of any particular computer manufacturer, yet could be adopted by a wide range of manufacturers. In 1960 CODASYL published a document which described its newly developed language, COBOL. (COBOL is an acronym for Common Business Oriented Language.)

In 1968 the first standard version of COBOL was approved (USA Standard COBOL 1968). The 1968 standard was revised and updated, and in 1974 a new standard was approved (American National Standard COBOL 1974). In 1985 there was another revision, and a new standard was approved (American National Standard COBOL 1985). It is this revision process which keeps the COBOL language current.

Characteristics of COBOL

COBOL is an English-like programming language. It uses English words and relatively few symbols. Because of this, it is a very readable language. To an extent, nonprogrammers can read and understand a COBOL program. This also allows a COBOL program to be self-documenting. It is usually a simple matter to determine the function of a COBOL program from an examination of the program itself. Therefore, a COBOL program requires little additional documentation.

COBOL is a business-oriented language and has extensive data and file-handling capabilities. COBOL's ability to manipulate data makes it a good language for dealing with the vast amounts of data which businesses process. COBOL's ability to handle numbers is not as strong. Where extensive and complex calculations are required, as in scientific applications, there are other languages which are better suited to the task.

PROGRAM DEVELOPMENT

The Development Process

In creating a computer program, the development process is the same regardless of which programming language is used. The development process may be divided into the phases of (1) analysis, (2) design, (3) coding, and (4) testing. Depending on the size and complexity of the programming project, a different person (or group of people) might be responsible for each of the phases, or one person might complete the entire process alone.

Analysis

The development process begins with a problem to be solved. The analyst meets with the people who have requested a computerized solution to their problem to determine their requirements. He or she then analyzes the current existing and computerized systems that relate to the problem. With this information, the analyst determines the input, output, and processing requirements for the program. In general, the analyst will produce documents which describe these requirements. These documents usually include program specifications, input layouts, output layouts, and system flowcharts. These documents are described later in this chapter.

Design

The designer begins with the information gathered during the analysis phase and develops the logic which will be used to solve the problem. The processing requirements are divided into smaller and smaller pieces until the logical flow is described for the entire program.

Several design tools are available which are useful for describing program logic. These tools include flowcharts, pseudocode, Warnier-Orr diagrams, Nassi-Schneiderman charts, Chapin charts, hierarchy charts, and IPO diagrams. The tool used for design may be mandated by the institution; if not, it will depend upon the preferences of the designer.

Coding

Coding is the process of translating the logic design into programming language code. Each step of the logic must be converted into code which conforms to the rules of the language. In many programming languages, including COBOL, each piece of data used by the program must also be described. If the logic design is complete and comprehensive, coding will consist only of translating the design to fit the syntax of the programming language.

Testing

After a program is coded, it must be tested in order to discover and correct any errors that might have occurred during the analysis, design, and coding phases. Testing involves converting the program into machine language. In COBOL, a commercially available program (a COBOL compiler) is used to convert the program into machine language. A computer cannot run a program unless it is in machine language. Two types of errors may be uncovered during testing: syntax errors and errors causing incorrect output.

Syntax Errors

Syntax errors occur when the program code violates a rule of the programming language. A syntax error might be caused by a typographical error, a misspelling, or a misunderstanding of the rules of the language. For example, a syntax error would occur if the word MVOE were used instead of the word MOVE. It may not be possible to run a program that has syntax errors.

Errors Causing Incorrect Output

Once syntax errors have been removed from the program, the program is executed to determine whether it produces correct output. Test data must be carefully prepared to assure thorough testing of the program. All possible combinations of data, correct and incorrect, should be tested, and the output must be carefully examined to locate any errors which might be present. If the output is incorrect, the program is debugged. Debugging is the process of locating and removing program errors. Incorrect output may be caused by coding errors or by errors in the logic of the program.

Analysis Tools and Techniques

Analysis begins when a user group (such as the accounting or marketing department) approaches the data processing department and asks for assistance in obtaining information necessary to solve a business problem. The analyst then meets with the user group to determine its requirements and analyzes the systems (both manual and computerized) the group is currently working with. Then the analyst explores the options available to solve the problem and determines which option should be used. The analyst will usually put this solution into writing using program specifications, input/output layouts, and system flowcharts.

Program Specifications

A program specification is a document which is produced during the analysis phase. It describes the requirements of the program to be written and is used as the basis for designing, coding, and testing the program.

The contents of a program specification will vary greatly from installation to installation. Usually, a program specification will include the program name, program function, input and output file descriptions, processing requirements, and output requirements. For example, the order processing department might approach the data processing department with a request for a printed report which will list all orders. The analyst then determines the requirements for the report, determines that the needed data is available on an existing file, and produces the program specification shown in Figure 1–1.

The program specification consists of the following elements:

Program Name The program is given a name by which it will be recognized by the computer system. The program name is usually created using a set of naming standards which are in place at the installation.

Program Function The function and purpose of the program are described, in order to give an overview of the program.

File Descriptions Often, a program must use or create data which exists outside of the program. This data is stored in files. (Files are discussed in greater detail later in the chapter.) Each file which will be used in the program is described in the file description section. The description provides basic information about the file, including the name of the file and whether the file is used as input to the program or as output from the program.

Processing Requirements There are no processing requirements in the example of Figure 1–1. When included, however, processing requirements provide an overview of the logic needed in the program, including whatever manipulation of the data and mathematical formulas are necessary.

Output Requirements The content and format required for the output are described.

PROGRAM SPECIFICATION

Program Name: LISTING

Program Function:

The program will produce a printed listing of all orders from the ORDER FILE.

Input Files:

I. ORDER-FILE

INPUT DEVICE:	DISK
FILE ORGANIZATION:	SEQUENTIAL
RECORD LENGTH:	70 BYTES
FILE SEQUENCE:	ASCENDING ON BRANCH / SALES REP

Output Files:

I. PRINT-FILE

OUTPUT DEVICE:	PRINTER
RECORD LENGTH:	133 BYTES

Output Requirements:

Each record read from the order file should be printed on one line of the output report. All fields from the input record are to be included on the output.

The following are formatting requirements for the report:

1. The first page of the report should contain:
   (a) a main heading which includes the company name and report name.
   (b) column headings which describe the items which are printed underneath.
2. The detail lines should include all fields from the input.
3. The detail lines should be double spaced.
4. Do not include provisions for page overflow.

FIGURE 1–1

Input/Output Layouts

Input and output layouts are usually included with the program specification. They describe the data items which are or will be stored on the files. Layouts for the ORDER-FILE and PRINT-FILE of Figure 1–1 are shown in Figures 1–2 and 1–3. Input/output layouts are discussed in greater detail later in the chapter.

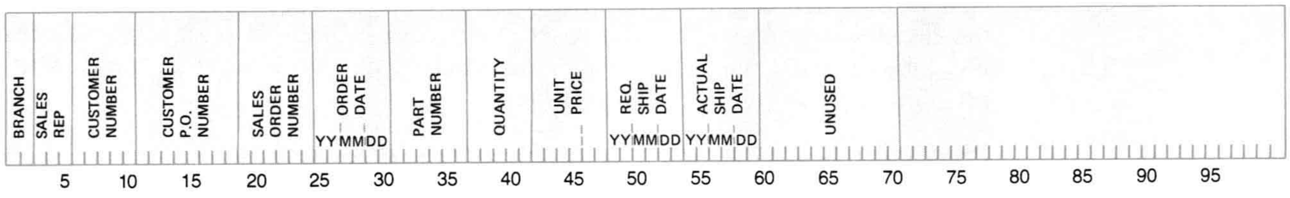
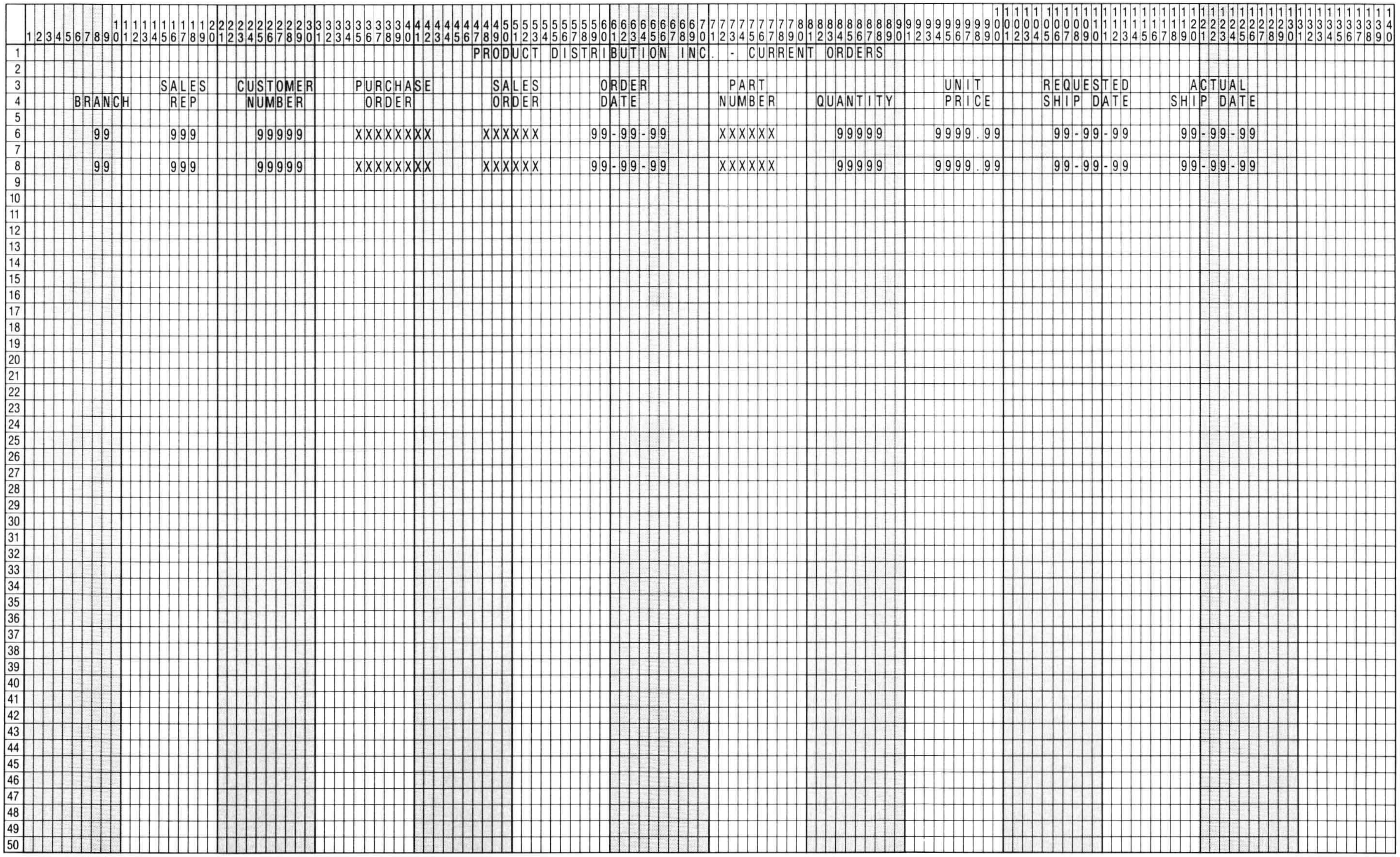


FIGURE 1–2

System Flowcharts

A system flowchart describing the flow of data through the system may be included with the program specification. Each symbol on the flowchart represents a file or



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                                              PRODUCT DISTRIBUTION INC. - CURRENT ORDERS

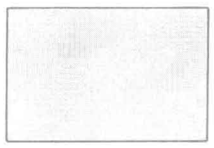
              SALES   CUSTOMER     PURCHASE     SALES      ORDER        PART                  UNIT      REQUESTED      ACTUAL
     BRANCH    REP     NUMBER       ORDER       ORDER      DATE       NUMBER    QUANTITY     PRICE     SHIP DATE    SHIP DATE

       99      999      99999      XXXXXXXX    XXXXXX     99-99-99    XXXXXX      99999     9999.99     99-99-99     99-99-99

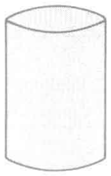
       99      999      99999      XXXXXXXX    XXXXXX     99-99-99    XXXXXX      99999     9999.99     99-99-99     99-99-99
```

FIGURE 1–3

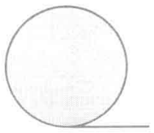
a program. Flowlines and arrows are used to show the relationships between the files and the programs. The following symbols are used in system flowcharting.


Process Symbol

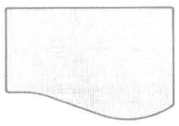
This symbol indicates an entire program. In a system flowchart, the name of the program is written inside the box.


Magnetic Disk Symbol

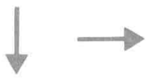
This symbol is used to indicate a file which is or will be stored on magnetic disk. The name of the file is written inside the symbol.


Magnetic Tape Symbol

This symbol is used to indicate a file which is or will be stored on magnetic tape. The name of the file is written inside the symbol.


Document Symbol

This symbol indicates an output file which is a document (i.e., a printed report) or an input function where the input is obtained from a source document. The name of the document is written inside the symbol.


Flowlines

Flowlines are used to connect the symbols used in a system flowchart. The arrowhead indicates the direction of data flow.

Figure 1–4 shows the system flowchart for the LISTING program of Figure 1–1. A process symbol is used to represent the program. The program name, LISTING, is written inside this symbol. Flowlines are used to connect the input and output files to the program. The input file is stored on magnetic disk and is called the ORDER FILE. The document symbol is used for the output and indicates that the output is in printed form. The output file is called the CURRENT ORDER REPORT.