

# Chapter 3

## Systems Documentation Techniques

### Learning Objectives

After studying this chapter, you should be able to:

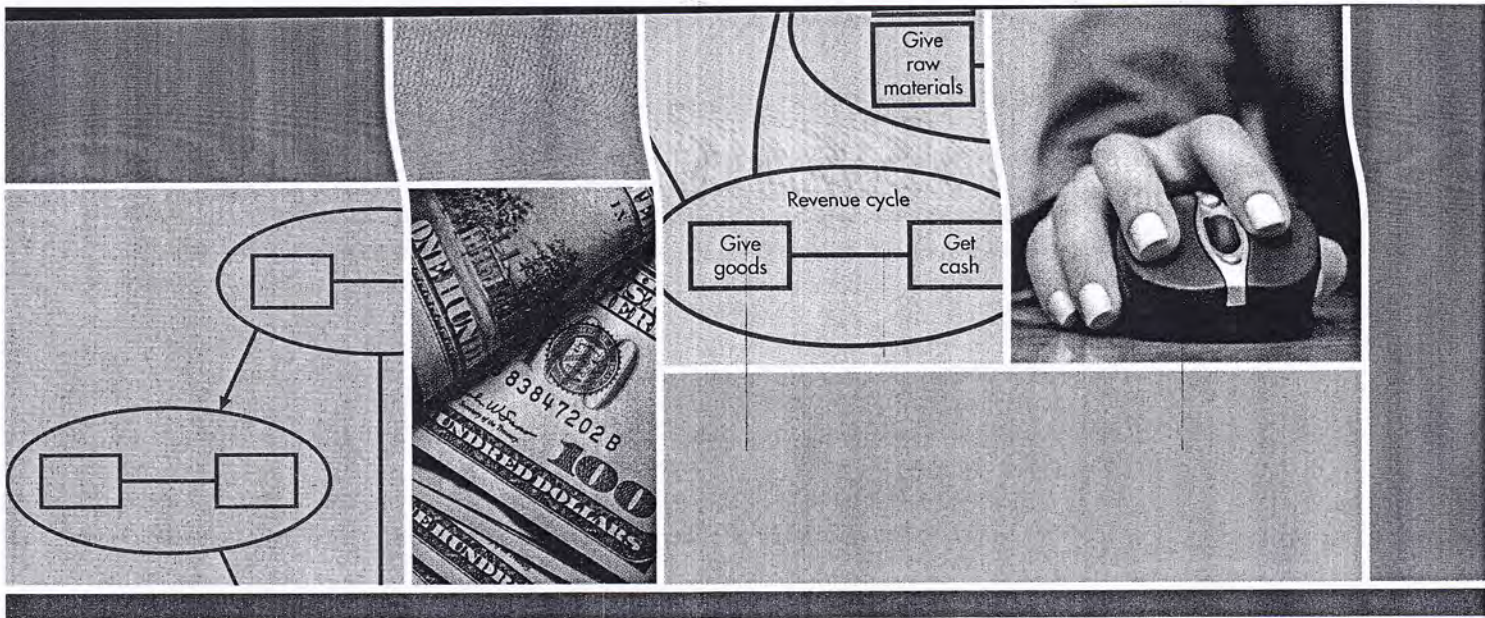
1. Prepare and use data flow diagrams to understand, evaluate, and document information systems.
2. Prepare and use flowcharts to understand, evaluate, and document information systems.

### INTEGRATIVE CASE S&S

What a hectic few months it has been for Ashton Fleming! He helped S&S get started, helped get S&S through its weeklong grand opening, and was swamped with processing all the transactions from the highly successful grand opening. Because of its rapid growth, S&S has outgrown the initial rudimentary AIS that Ashton selected. Lacking time and expertise, Ashton has engaged Computer Applications (CA), a systems consulting firm, to help S&S select and install a new and more powerful AIS.

During Ashton's first meeting with Kimberly Sierra, CA's manager, she asked about S&S's system requirements and management's expectations. Ashton had yet to think through these issues, so he could not answer her specifically. When she asked how S&S's system worked, Ashton plunged into a discussion about the use of various company documents, but Kimberly seemed unable to absorb his detailed explanations. Ashton thought that part of his discussion was helpful, but overall it was irrelevant to the issue at hand.

Ashton came away impressed by CA and Kimberly. He also realized the need to understand S&S's information requirements more clearly. From his days as an auditor, Ashton knew the value of good system documentation in helping unfamiliar users both understand and evaluate a system. Good system documentation would be a big help to him and Kimberly, as well as to Scott and Susan as they evaluate the current and proposed systems.



After sharing his conclusions with Susan and Scott, they enthusiastically approved Ashton's plan to document the current and proposed systems. They supported his taking a leadership role in moving toward a new system and were especially interested in diagrams or charts that would document the existing system and help them understand and evaluate it.

## Introduction

**Documentation** encompasses the narratives, flowcharts, diagrams, and other written materials that explain how a system works. This information covers the who, what, when, where, why, and how of data entry, processing, storage, information output, and system controls. Popular means of documenting a system include diagrams, flowcharts, tables, and other graphical representations of information. These are supplemented by a *narrative description* of the system, a written step-by-step explanation of system components and interactions. In this chapter, we explain two common systems documentation tools: data flow diagrams and flowcharts.

Documentation tools are important on the following levels:

1. At a minimum, you must be able to *read* documentation to determine how a system works.
2. You may need to *evaluate* internal control systems documentation to identify strengths and weaknesses and recommend improvements. Or, you may need to evaluate documentation for a proposed system to determine whether it meets the company's needs.
3. More skill is needed to *prepare* internal control documentation or documentation that shows how an existing or proposed system operates.

This chapter discusses the following documentation tools:

1. **Data flow diagram (DFD)**, a graphical description of data sources, flows, processes, storage, and destinations
2. **Document flowchart**, a graphical description of the flow of documents and information between departments or areas of responsibility
3. **System flowchart**, a graphical description of the relationship among the input, processing, and output in an information system
4. **Program flowchart**, a graphical description of the sequence of logical operations a computer performs as it executes a program

Accountants use documentation techniques extensively. Auditing standards require that independent auditors understand the automated and manual internal control procedures an entity uses.

One good way to gain this understanding is to use flowcharts to document the internal control system, because such graphic portrayals more readily reveal weaknesses and strengths.

The Sarbanes-Oxley Act (SOX) of 2002 requires an internal control report in public company annual reports that (1) states that management is responsible for establishing and maintaining an adequate internal control structure and (2) assesses the effectiveness of the company's internal controls. SOX also specifies that a company's auditor must evaluate management's assessment of the company's internal control structures and attest to its accuracy. The auditor's attestation should include a specific notation about significant defects or material noncompliance found during internal control tests. This means that both the company and its auditors have to document and test the company's internal controls. To do so, they must be able to prepare, evaluate, and read different types of documentation, such as flowcharts.

Documentation tools are also used extensively in the systems development process. In addition, the team members who develop information systems applications often change, and documentation tools help the new team members get up to speed quickly.

According to one study, 62.5% of information systems professionals use DFDs and 97.6% use flowcharts. Over 92% of users were satisfied with the use of both DFDs and flowcharts and use both.

Documentation is easier to prepare and revise when a software package is used. Once a few basic commands are mastered, users can quickly and easily prepare, store, revise, and print presentation-quality documentation.

The documentation tools in this chapter are used throughout the book. They are also tested on professional examinations, and learning about them better prepares you for these examinations.





## Data Flow Diagrams

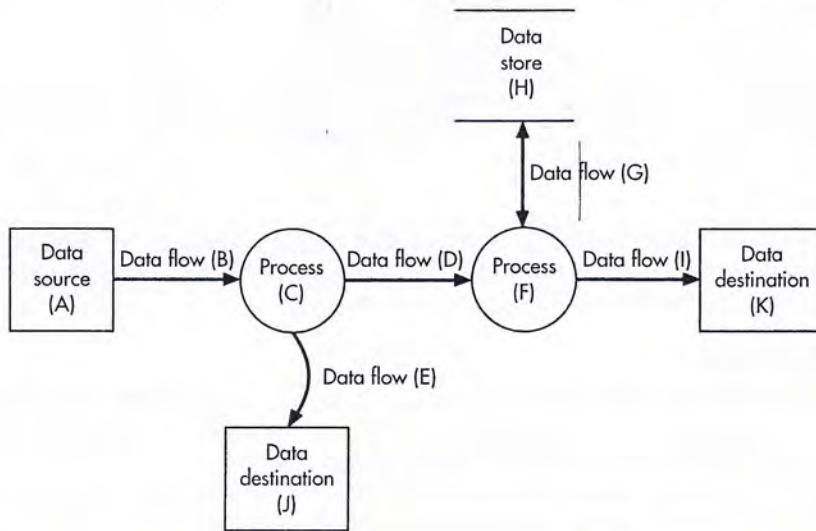
A *data flow diagram (DFD)* graphically describes the flow of data within an organization. It uses the symbols shown in Figure 3-1 to represent four basic elements: data sources and destinations, data flows, transformation processes, and data stores. For example, Figure 3-2 shows that the input to process C is data flow B, which comes from data source A. The outputs of process C are data flows D and E. Data flow E is sent to data destination J. Process F uses data flows D and G as input and produces data flows I and G as output. Data flow G comes from and returns to data store H. Data flow I is sent to data destination K.

Figure 3-3 assigns specific titles to each of the processes depicted in Figure 3-2. Figures 3-2 and 3-3 will be used to examine the four basic elements of a DFD in more detail.

A *data source* and a *data destination* are entities that send or receive data that the system uses or produces. An entity can be both a source and a destination. They are represented by squares, as illustrated by items A (customer), J (bank), and K (credit manager) in Figure 3-3.

**FIGURE 3-1**  
Data Flow Diagram  
Symbols

Symbol	Name	Explanation
	Data sources and destinations	The people and organizations that send data to and receive data from the system are represented by square boxes. Data destinations are also referred to as <i>data sinks</i> .
	Data flows	The flow of the data into or out of a process is represented by curved or straight lines with arrows.
	Transformation processes	The processes that transform data from inputs to outputs are represented by circles. They are often referred to as <i>bubbles</i> .
	Data stores	The storage of data is represented by two horizontal lines.

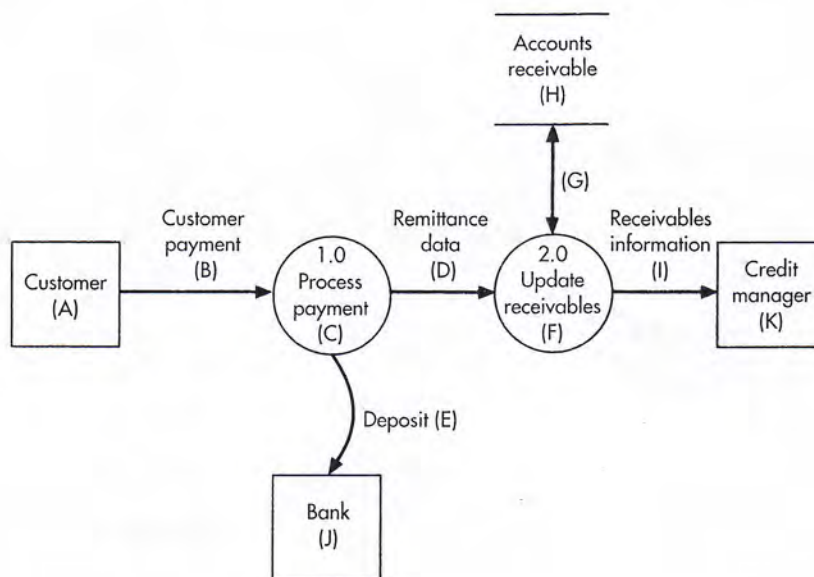


**FIGURE 3-2**  
Basic Data Flow Diagram Elements

A *data flow* is the movement of data among processes, stores, sources and destinations. Data that pass between data stores and a source or destination must go through a data transformation process. Data flows are labeled to show what information is flowing. The only exception is data flow between a process and a data store, such as data flow G in Figure 3-3, because the data flow is usually obvious. In data flow G, data from the accounts receivable file is retrieved, updated, and stored back in the file. Other data flows in Figure 3-3 are B (customer payment), D (remittance data), E (deposit), and I (receivables information).

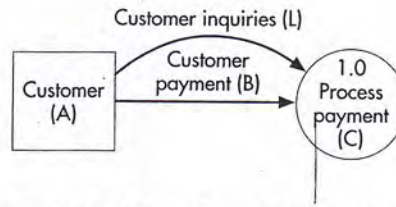
If two or more data flows move together, a single line is used. For example, data flow B (customer payment) consists of a payment and remittance data. Process 1.0 (process payment) splits them and sends them in different directions. The remittance data (D) is used to update accounts receivable records, and the payment (E) is deposited in the bank. If the data flow separately, two lines are used. For example, Figure 3-4 shows two lines because customer inquiries (L) do not always accompany a payment (B). If represented by the same data flow, the separate elements and their different purposes are obscured, and the DFD is more difficult to interpret.

*Processes* represent the transformation of data. Figure 3-3 shows that process payment (C) splits the customer payment into the remittance data and the check, which is deposited in the bank. The update receivables process (F) uses remittance (D) and accounts receivable (H) data to update receivable records and send receivables information to the credit manager.



**FIGURE 3-3**  
Data Flow Diagram of Customer Payment Process

**FIGURE 3-4**  
Splitting Customer Payments and Inquiries



A *data store* is a repository of data. DFDs do not show the physical storage medium (such as a server or paper) used to store the data. As shown in Figure 3-3, data stores (H) are represented by horizontal lines, with the name of the file written inside the lines.

**Subdividing the DFD**

DFDs are subdivided into successively lower levels to provide ever-increasing amounts of detail, because few systems can be fully diagrammed on one sheet of paper. Also, users have differing needs, and a variety of levels can better satisfy differing requirements.

The highest-level DFD is referred to as a *context diagram* because it provides the reader with a summary-level view of a system. It depicts a data processing system and the entities that are the sources and destinations of system inputs and outputs. For example, Ashton drew Figure 3-5 to document payroll processing procedures at S&S. The payroll processing system receives time card data from different departments and employee data from human resources. The system processes these data and produces (1) tax reports and payments for governmental agencies, (2) employee paychecks, (3) a payroll check deposited in the payroll account at the bank, and (4) payroll information for management.

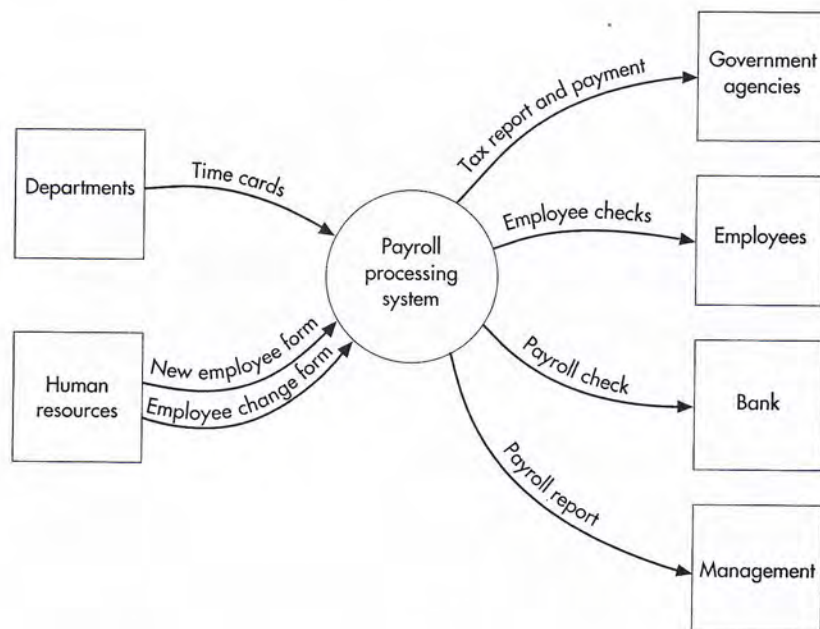
Ashton used the description of S&S's payroll processing procedures in Table 3-1 to decompose the context diagram into successively lower levels, each with an increasing amount of detail. Read this description and determine the following:

- How many major data processing activities are involved?
- What are the data inputs and outputs of each activity (ignoring all references to people, departments, and document destinations)?

The narrative in Table 3-1 describes five data processing activities:

1. Updating the employee/payroll master file (first paragraph).
2. Handling employee compensation (second, fifth, and sixth paragraphs). Later in this chapter, you will see a breakdown of this activity into smaller parts in a lower-level DFD.
3. Generating management reports (third paragraph).

**FIGURE 3-5**  
Context Diagram for S&S Payroll Processing



**TABLE 3-1 Narrative Description of Payroll Processing at S&S**

When employees are hired, they complete a new-employee form. When a change to an employee's payroll status occurs, such as a raise or a change in the number of exemptions, the human resources department completes an employee change form. A copy of these forms is sent to payroll. These forms are used to create or update the records in the employee/payroll file and are then stored in the file. Employee records are stored alphabetically.

Some S&S employees are paid a salary, but most are hourly workers who record their time on time cards. At the end of each pay period, department managers send the time cards to the payroll department. The payroll clerk uses the time card data, data from the employee file (such as pay rate and annual salary), and the appropriate tax tables to prepare a two-part check for each employee. The clerk also prepares a two-part payroll register showing gross pay, deductions, and net pay for each employee. The clerk updates the employee file to reflect each employee's current earnings. The original copy of the employee paychecks is forwarded to Susan. The payroll register is forwarded to the accounts payable clerk. The time cards and the duplicate copies of the payroll register and paychecks are stored by date in the payroll file.

Every pay period, the payroll clerk uses the data in the employee/payroll file to prepare a payroll summary report for Susan so that she can control and monitor labor expenses. This report is forwarded to Susan, with the original copies of the employee paychecks.

Every month, the payroll clerk uses the data in the employee/payroll file to prepare a two-part tax report. The original is forwarded to the accounts payable clerk, and the duplicate is added to the tax records in the payroll file. The accounts payable clerk uses the tax report to prepare a two-part check for taxes and a two-part cash disbursements voucher. The tax report and the original copy of each document are forwarded to Susan. The duplicates are stored by date in the accounts payable file.

The accounts payable clerk uses the payroll register to prepare a two-part check for the total amount of the employee payroll and a two-part disbursements voucher. The original copy of each document is forwarded to Susan, and the payroll register and the duplicates are stored by date in the accounts payable file.

Susan reviews each packet of information she receives, approves it, and signs the checks. She forwards the cash disbursements vouchers to Ashton, the tax reports and payments to the appropriate governmental agency, the payroll check to the bank, and the employee checks to the employees. She files the payroll report chronologically.

Ashton uses the payroll tax and the payroll check cash disbursement vouchers to update the general ledger. He then cancels the journal voucher by marking it "posted" and files it numerically.

4. Paying taxes (fourth paragraph).
5. Posting entries to the general ledger (last paragraph).

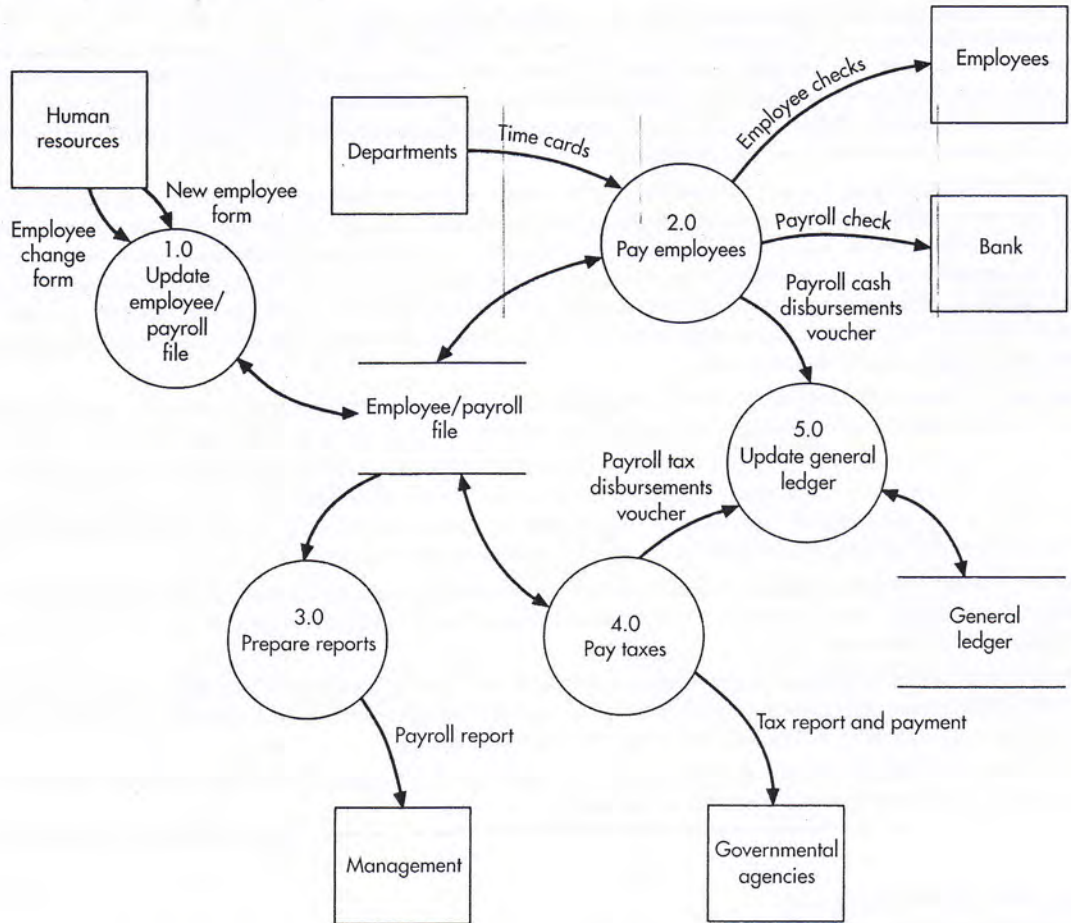
The five activities and all data inflows and outflows are shown in Table 3-2.

Ashton exploded his context diagram and created the Level 0 DFD (called level 0 because there are zero meaningful decimal points—1.0, 2.0, etc.) shown in Figure 3-6. Notice that some data inputs and outputs have been excluded from this DFD. For example, in process 2.0, the data inflows and outflows that are not related to an external entity or to another process are not depicted (tax tables and payroll register). These data flows are internal to the "pay employees" activity and are shown on the next DFD level.

**TABLE 3-2 Activities and Data Flows in Payroll Processing at S&S**

Activities	Data Inputs	Data Outputs
Update employee/payroll file	New employee form Employee change form	Updated employee/payroll file
Pay employees	Time cards Employee/payroll file Tax rates table	Employee checks Payroll register Updated employee/payroll file Payroll check Payroll cash disbursements voucher
Prepare reports	Employee/payroll file	Payroll report
Pay taxes	Employee/payroll file	Tax report Tax payment Payroll tax cash disbursements voucher Updated employee/payroll file
Update general ledger	Payroll tax cash disbursements voucher Payroll cash disbursements voucher	Updated general ledger

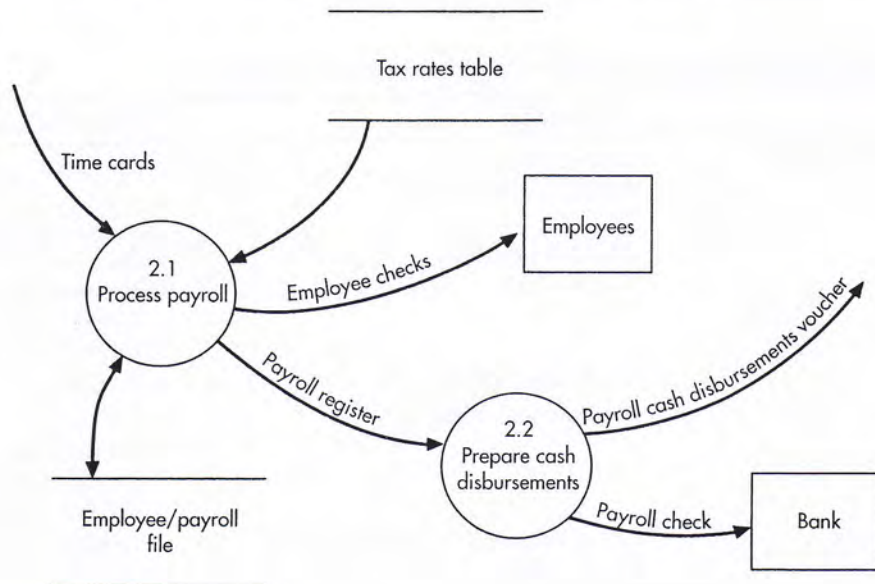
**FIGURE 3-6**  
Level 0 DFD for S&S payroll processing



Ashton exploded process 2.0 (pay employees) to create a Level 1 DFD (it has one meaningful decimal place—2.1, 2.2, etc.). Figure 3-7 provides more detail about the data processes involved in paying employees, and it includes the tax rates table and the payroll register data flow omitted from Figure 3-6. In a similar fashion, each of the Figure 3-6 processes could be exploded, using a Level 1 DFD, to show a greater level of detail.

Some general guidelines for developing DFDs are shown in Focus 3-1.

**FIGURE 3-7**  
Level 1 DFD for Process 2.0 in S&S Payroll Processing




**FOCUS**  
3-1

**Guidelines for Drawing a DFD**

1. **Understand the system.** Observe organization information flows, and interview the individuals who use and process the data.
2. **Ignore certain aspects of the system.** A DFD is a diagram of the origins, flow, transformation, storage, and destinations of data. All control processes and actions are ignored. Only very important error paths are included; unimportant error paths are ignored. Determining how the system starts and stops is not shown.
3. **Determine system boundaries.** Determine what to include and exclude. Include all relevant data elements in the DFD, because excluded items will not be considered during system development.
4. **Develop a context diagram.** A context diagram depicts system boundaries. In the diagram's center is a circle with the name of the system. Outside entities the system interacts with directly are in boxes on either side, connected by data flows depicting the data passed between them. DFDs in successively more detail depict data flows in the system.
5. **Identify data flows.** Identify all data flows entering or leaving the system's boundary, including where the data originate and its final destination. A significant movement of information is usually a data flow. All data flows come from and go to a transformation process, a data store (file), or a source or destination. Data flows can move in two directions, shown as a line with arrows on both ends (see G in Figure 3-3).
6. **Group data flows.** A data flow can consist of one or more pieces of datum. Data elements that always flow together should be grouped together and shown as one data flow until they are separated. If the data do not always flow together, show them as separate data flows.
7. **Identify transformation processes.** Place a circle wherever work is required to transform one data flow into another. All transformation processes should have one or more incoming and outgoing data flows.
8. **Group transformation processes.** Transformation processes that are logically related or occur at the same time and place should be grouped together. Never combine unrelated items into a single transformation process. If data are not processed together, or are sometimes processed differently, then separate them.
9. **Identify all files or data stores.** Identify each temporary or permanent data repository, and identify each data flow into and out of it.
10. **Identify all data sources and destinations.** Include them on the DFD.
11. **Name all DFD elements.** Except for data flows into or out of data stores (the data store name is usually sufficient to identify the data flow), data elements should be given unique and descriptive names representing what is known about them. Naming data flows first forces you to concentrate on the all-important data flows, rather than on the processes or stores. Processes and data stores typically take their names from the data inflows or outflows. Choose active and descriptive names, such as "update inventory" and "validate transaction," rather than "input data" or "update process." Process names should include action verbs such as *update*, *edit*, *prepare*, *reconcile*, and *record*.
12. **Subdivide the DFD.** A cluttered DFD is hard to read and understand. If you have more than five to seven processes on a page, decompose the context diagram into high-level processes. Explode these high-level processes into successively lower-level processes.
13. **Give each process a sequential number.** Giving each process a sequential number (lower to higher) helps readers navigate among the DFD levels.
14. **Repeat the process.** Work through data flows several times. Each subsequent pass helps refine the diagram and identify the fine points. Organize the DFD to flow from top to bottom and from left to right.
15. **Prepare a final copy.** Do not allow data flow lines to cross over each other; if necessary, repeat a data store or destination. Place the name of the DFD, the date prepared, and the preparer's name on each page.

## Flowcharts

A *flowchart* is an analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner. Flowcharts use a standard set of symbols to describe pictorially the transaction processing procedures a company uses and the flow of data through a system. The symbols used to create flowcharts are shown in Figure 3-8.

Flowcharting was introduced by industrial engineers in the 1950s as a way of (1) recording how business processes are performed and documents flow and (2) analyzing how to improve processes and document flows. Soon internal auditors began using flowcharts in operational audits to better understand their company's business processes. Later, external auditors began

using flowcharts to evaluate their clients' internal controls. Flowcharts became even more important when the Sarbanes-Oxley Act required companies to document their business processes and internal controls.

Flowcharts have significant advantages. A pictorial representation is much easier to understand than a narrative description. Both the auditor and the business owner can use the flowchart as a working tool during discussions. For an experienced flowcharter using a computerized drawing tool, flowcharts provide an easy way to capture and record data during interviews, and they can be easily and quickly revised.






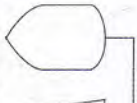



Flowcharts do have some disadvantages. Some people do not like or understand them. Many are poorly drawn and therefore not as helpful as they should be. They are time-consuming to prepare if the flowcharter is not trained properly.








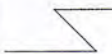




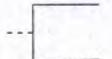
Early flowcharts were drawn using a flowcharting template, a piece of hard, flexible plastic on which symbols have been die cut. Most flowcharts are now drawn using a software program such as Visio. Flowcharts can also be drawn using Microsoft Word, Excel, or PowerPoint.

Flowcharting symbols are divided into four categories, as shown in Figure 3-8:

1. **Input/output symbols** represent devices or media that provide input to or record output from processing operations.
2. **Processing symbols** show what types of devices are used to process data or indicate when processing is performed manually.
3. **Storage symbols** represent the devices used to store data.
4. **Flow and miscellaneous symbols** indicate the flow of data, where flowcharts begin or end, where decisions are made, and when to add explanatory notes to flowcharts.

**FIGURE 3-8**  
Common flowcharting  
symbols

Symbol	Name	Explanation
<b>Input/Output Symbols</b>		
	Document	A document or report.
	Multiple copies of one document	Illustrated by overlapping the document symbol and printing the document number on the face of the document in the upper right corner
	Input/output; Journal/ledger	Any input or output function on a program flowchart. Also used to represent accounting journals and ledgers in a document flowchart
	Display	Information displayed by an online output device such as a terminal, monitor, or screen
	Online keying	Data entry by online devices, such as a terminal or personal computer
	Terminal or personal computer	The display and online keying symbols are used together to represent terminals, personal computers, and other electronic devices capable of both input and output
	Transmittal tape	Manually prepared control totals; used for control purposes to compare to computer-generated totals
<b>Processing Symbols</b>		
	Computer processing	A computer-performed processing function; usually results in a change in data or information
	Manual operation	A processing operation performed manually

Symbol	Name	Explanation
	Auxiliary operation	A processing function performed by a device that is not a computer
	Off-line keying	An operation utilizing an off-line keying device (e.g., key to disk, off-line cash register)
<b>Storage Symbols</b>		
	Magnetic disk/drive	Data stored on a magnetic disk or drive
	Magnetic tape	Data stored on a magnetic tape
	File	File of documents manually stored and retrieved; following letters indicate file-ordering sequence: N = numerically, A = alphabetically, D = by date
<b>Flow and Miscellaneous Symbols</b>		
	Document or processing flow	Direction of processing or document flow; normal flow is down and to the right
	Data/information flow	Direction of data/information flow; often used to show data copied from one document to another
	Communication link	Transmission of data from one geographic location to another via communication lines
	On-page connector	Connects the processing flow on the same page; its usage avoids lines crisscrossing a page
	Off-page connector	An entry from, or an exit to, another page
	Terminal	A beginning, end, or point of interruption in a process or program; also used to indicate an external party
	Decision	A decision-making step; used in a program flowchart to show branching to alternative paths
	Annotation	Addition of descriptive comments or explanatory notes as clarification

**FIGURE 3-8**  
(continued)

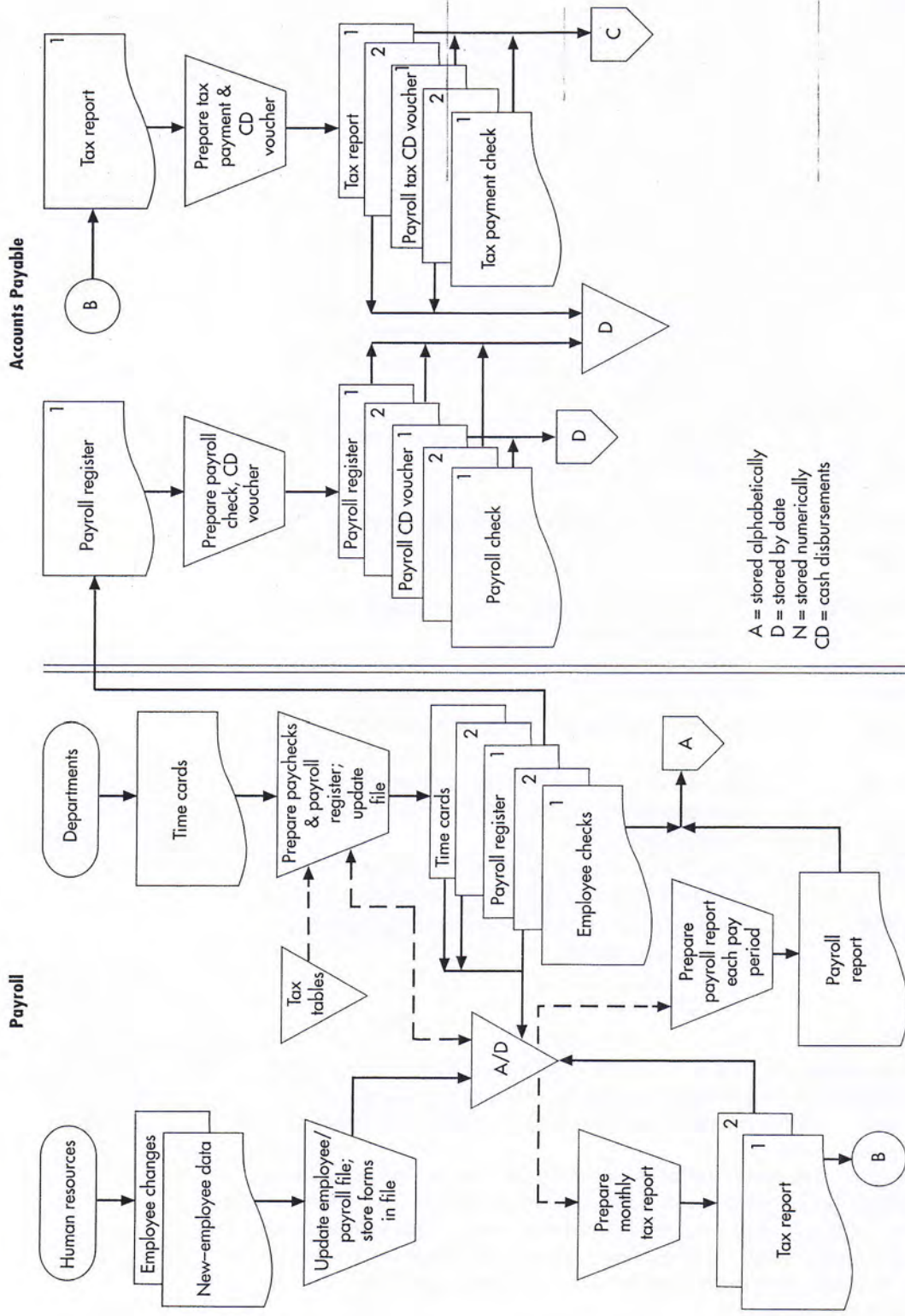
### Document Flowcharts

A *document flowchart* illustrates the flow of documents and information among areas of responsibility within an organization. They trace a document from its cradle to its grave, showing where each document originates, its distribution, its purpose, its disposition, and everything that happens as it flows through the system.

A document flowchart is particularly useful in analyzing internal control procedures. Document flowcharts that describe and evaluate internal controls are often referred to as *internal control flowcharts*. They can reveal system weaknesses or inefficiencies, such as inadequate communication flows, unnecessary complexity in document flows, or procedures responsible for causing wasteful delays. Document flowcharts prepared as part of the systems design process should be included in system documentation.

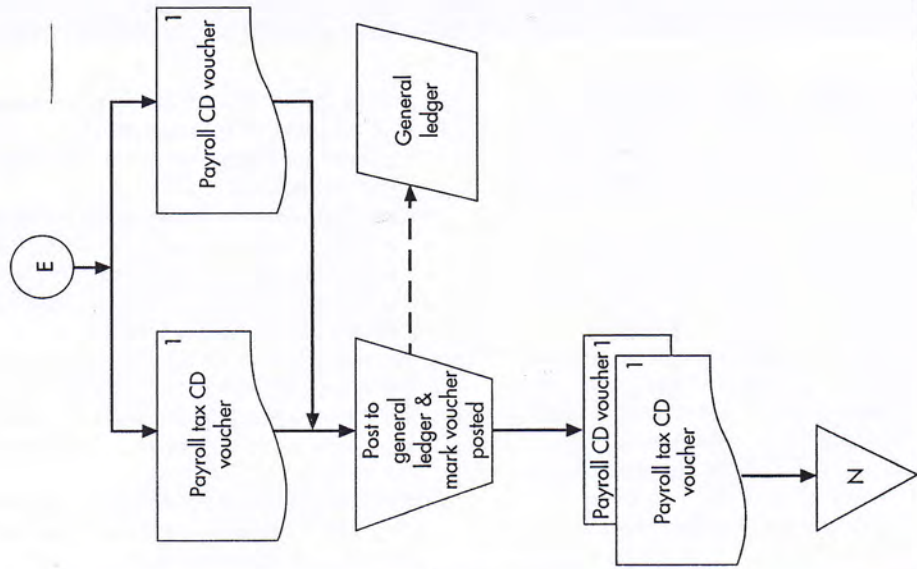
The document flowchart that Ashton developed for the payroll process at S&S, as described in Table 3-1 and 3-2, is shown in Figure 3-9.

General guidelines for preparing flowcharts that are readable, clear, concise, consistent, and understandable are presented in Focus 3-2 (see page 80).



**FIGURE 3-9**  
Document Flowchart of Payroll Processing at S&S

General Ledger (Ashton)



Management (Susan)

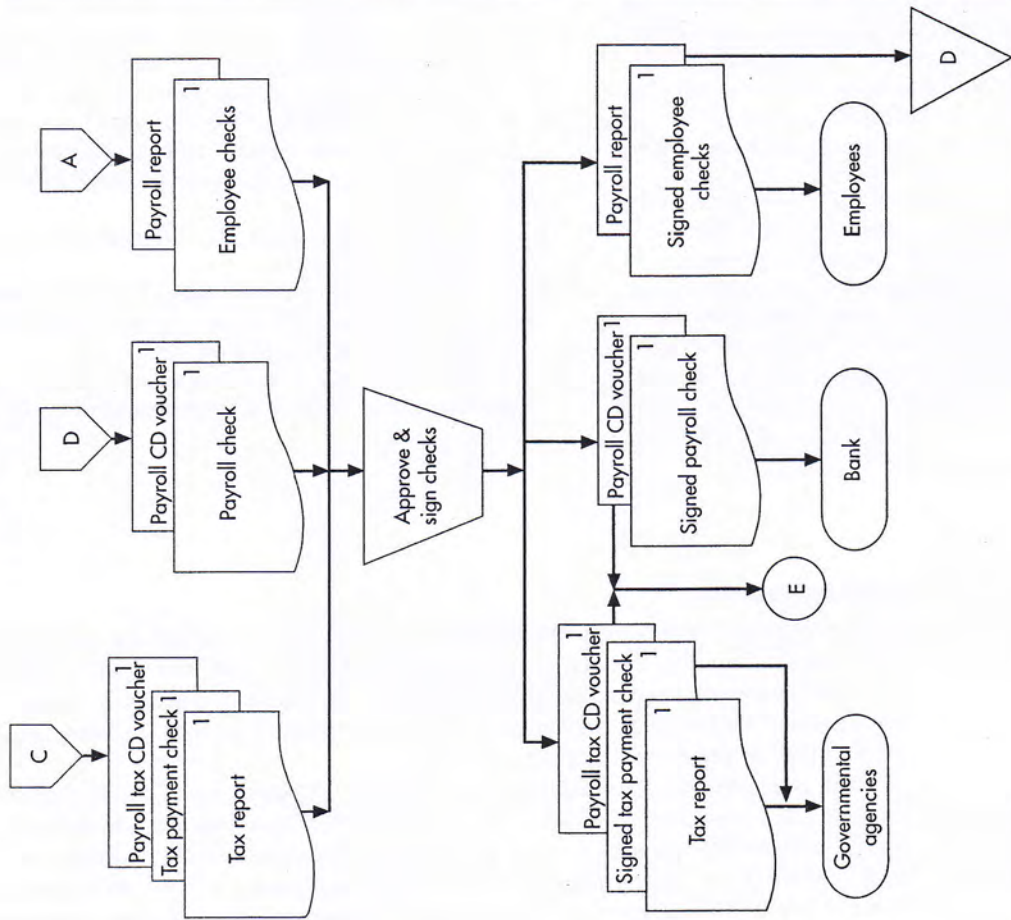


FIGURE 3-9 (continued)


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3-2

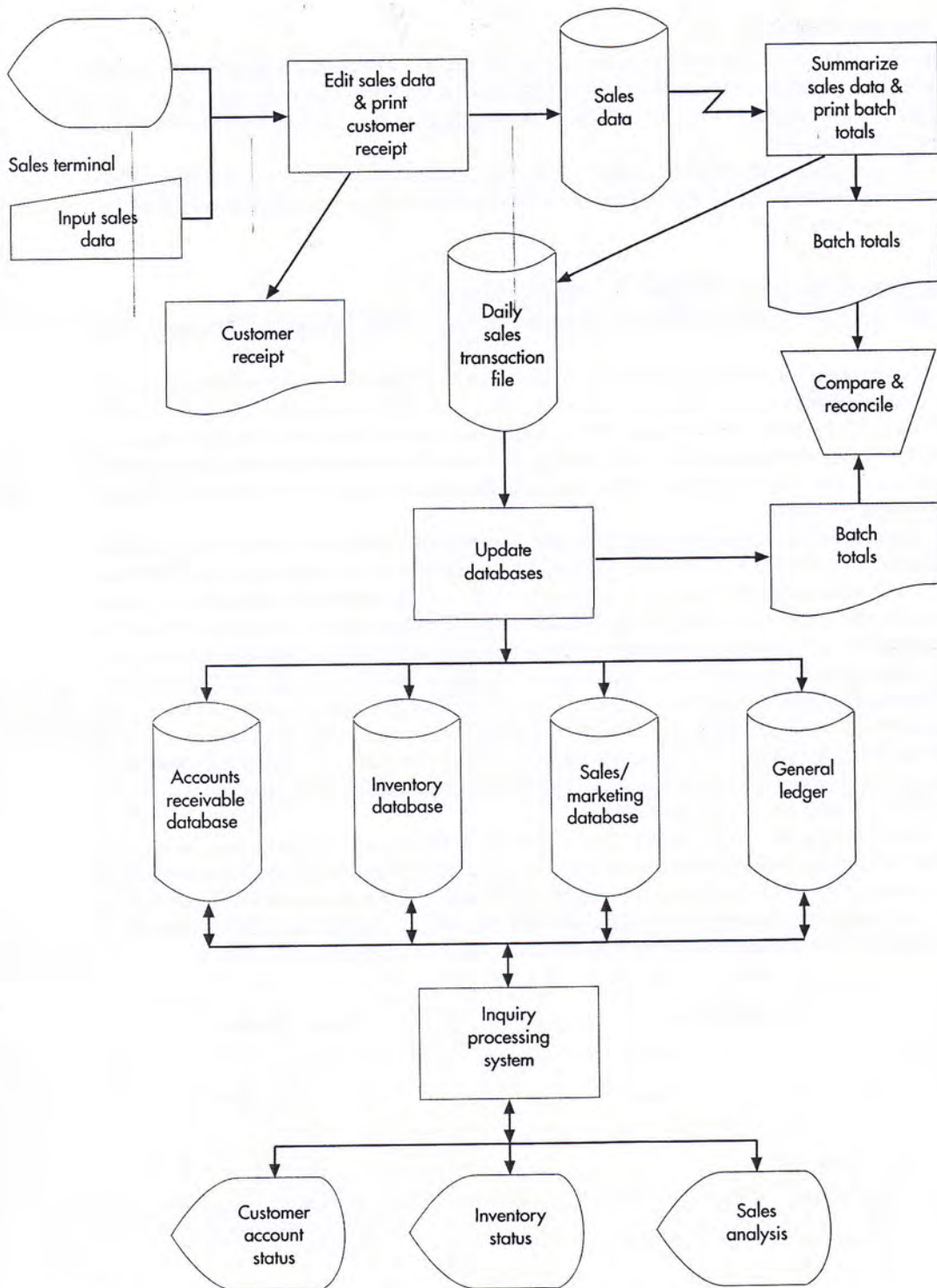
**Guidelines for Preparing Flowcharts**

1. **Understand a system before flowcharting it.** Interview users, developers, auditors, and management, or have them complete a questionnaire. Read a narrative description of the system, or walk through system transactions.
2. **Identify the entities to be flowcharted.** Identify departments, job functions, and external parties. Identify documents and information flows, as well as the activities or processes performed on the data.
3. **Divide the flowchart into columns.** When several departments or functions need to be shown, divide the flowchart into columns and label each one. Flowchart the activities of each entity in its respective column.
4. **Flowchart the normal flow of operations.** Ensure that all procedures and processes are in proper order. Identify exception procedures using the annotation symbol.
5. **Organize flowchart.** Design the flowchart so that information flows from top to bottom and from left to right.
6. **Give the flowchart a clear beginning and ending.** Designate where each document originates, and show the final disposition of all documents so that there are no loose ends that leave the reader dangling.
7. **Use standard flowcharting symbols drawn with a template or a computer.**
8. **Clearly label all symbols.** Write a description of the input, process, or output inside the symbol. If the description will not fit, use the annotation symbol.
9. **Multiple copies of documents.** For multiple copies of a document, place document numbers in the top right-hand corner of the symbol. The number should accompany the symbol as it moves through the system.
10. **Manual processing symbol.** Each manual processing symbol should have an input and an output. Do not directly connect two documents, except when moving from one column to another. When a document is moved to another column, it is often best to show the document in both.
11. **Page connectors.** Use off-page connectors to move from one flowchart page to another. Consider using on-page connectors to avoid excess flow lines and thereby produce a neat-looking page. Clearly label all connectors to avoid confusion.
12. **Use arrowheads on all flow lines.** Do not assume the reader will know the direction of the flow.
13. **Multiple pages.** If a flowchart cannot fit on a single page, clearly label the pages as follows: 1 of 3, 2 of 3, and so on.
14. **Show documents or reports in the column where they are created.** Then show them moving to another column for further processing.
15. **Files.** Show data entered into or retrieved from a computer file as passing through a processing operation (a computer program) first. Draw a line from a document to a file to indicate that it is being filed. A manual process is not needed to show a document entering a file.
16. **Draw a rough sketch of the flowchart.** Be more concerned with capturing content than with making a perfect drawing. Few systems can be flowcharted in a single draft.
17. **Redesign the flowchart.** Avoid clutter and a large number of crossed lines.
18. **Verify the flowchart's accuracy.** Review it with the people familiar with the system. Be sure all uses of flowcharting conventions are consistent.
19. **Draw a final copy of the flowchart.** Place the flowchart name, date, and preparer's name on each page.

### System Flowcharts

*System flowcharts* depict the relationships among system input, processing, and output. A system flowchart begins by identifying system inputs and their origins. The input is followed by the processing performed on the data. The resulting new information is the output component, which can be stored for later use, displayed on a screen, or printed on paper. In many instances, the output from one process is an input to another.

The sales processing system flowchart in Figure 3-10 represents Ashton's proposal to capture sales data using state-of-the-art sales terminals. These terminals will edit the sales data and print a customer receipt. All sales data will be stored in a sales data file on a disk. At the end of each day, the data will be forwarded to S&S's computers, where it will be summarized and batch totals will be printed. A batch total is the sum of a numerical item contained in each transaction being processed. An example is total sales for all sales transactions. The summary data will then be processed, and batch totals will again be generated and printed. These amounts will be compared with the batch totals generated prior to processing, and all errors and exceptions will be reconciled. The accounts receivable, inventory, and sales marketing databases and the general ledger will be updated. Users can access the files at any time by using an inquiry processing



**FIGURE 3-10**  
System Flowchart of Sales Processing at S&S

system. This system will produce standard reports and allow users to access the data needed for special analyses.

System flowcharts are an important systems analysis, design, and evaluation tool. They are universally employed in systems work and provide an immediate form of communication among workers. The system flowchart is an excellent vehicle for describing information flows and procedures within an AIS.

### Program Flowcharts

A *program flowchart* illustrates the sequence of logical operations performed by a computer in executing a program. The relationship between system and program flowcharts is shown in Figure 3-11. A program flowchart describes the specific logic used to perform a process shown on a system flowchart.

Program flowcharts employ a subset of the symbols shown in Figure 3-8. Once designed and approved, the program flowchart serves as the blueprint for coding the computer program.

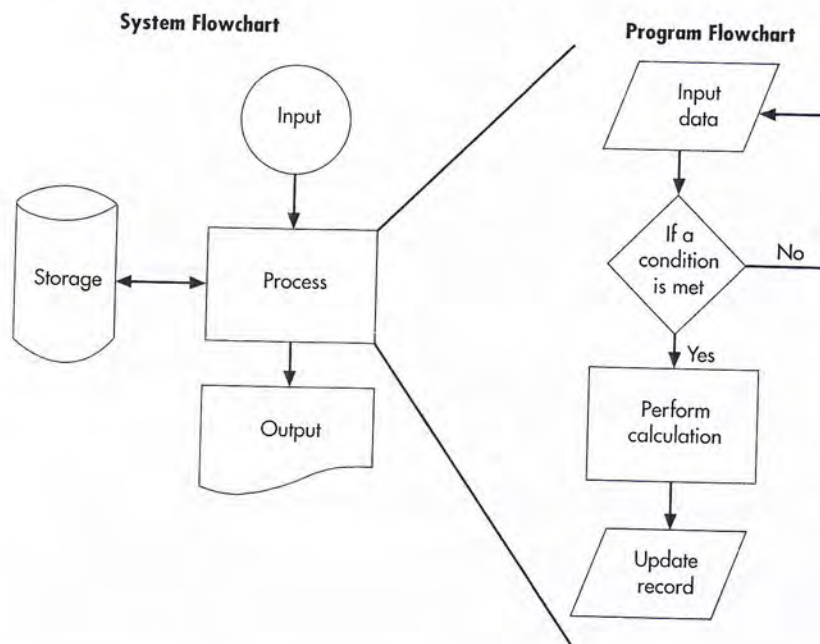
## Summary and Case Conclusion

Ashton prepared the DFDs and flowcharts of S&S's payroll processing system (Figures 3-6, 3-7, and 3-9) to document and explain the operation of the existing system. He was pleased to see that Scott and Susan were able to grasp the essence of the system from this documentation. The DFDs indicated the logical flow of data, and the flowcharts illustrated the physical dimensions of the system: The origin and final disposition and the interworkings of the documents in each department were clear.

Susan and Scott agreed that Ashton should document the remainder of the system. The documentation would help all of them understand the current system. It would also help Ashton and the consultants design the new system. In fact, the payroll documentation had already helped them identify a few minor changes they wanted to make in their system. Using the information from Figure 3-9, Susan now understands why the payroll clerk sometimes had to borrow the only copy of the payroll report that was prepared. She thus recommended that a second copy be made and kept in the payroll department. Susan also questioned the practice of keeping all the payroll records in one employee/payroll file. To keep the file from becoming unwieldy, she recommended that it be divided into three files: personal employee data, pay period documentation, and payroll tax data. A discussion with the payroll clerk verified that this approach would make payroll processing easier and more efficient.

Over the next few weeks, Ashton documented the remaining accounting cycles. This process helped him identify inefficiencies and unneeded reports. He also found that some system documents were inadequately controlled. In addition, he got several ideas about how an automated system could help him reengineer the business processes at S&S. By substituting technology for human effort, outdated processes and procedures could be eliminated to make the system more effective.

**FIGURE 3-11**  
Relationship Between  
System and Program  
Flowcharts



When Ashton completed his analysis and documentation of the current system, Susan and Scott asked him to continue his work in designing a new system. To do that, Ashton must thoroughly understand the information needs of the various employees in the company. Then he can design a new system using the tools that were explained in this chapter. Systems development is discussed in Chapters 20 through 22).

## Key Terms

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documentation 69	data flow 71	document flowchart 77
narrative description 69	process 71	internal control flowchart 77
data flow diagram (DFD) 70	data store 72	system flowchart 80
data source 70	context diagram 72	program flowchart 82
data destination 70	flowchart 75	

# AIS IN ACTION

## Chapter Quiz

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- A DFD is a representation of which of the following?
  - relationship among modules, data, and programs of an AIS
  - flow of data in an organization
  - decision rules in a computer program
  - computer hardware configuration
- Documentation methods such as DFDs and flowcharts save both time and money, adding value to an organization.
  - True
  - False
- Which of the following statements is FALSE?
  - Flowcharts make use of many symbols.
  - A flowchart emphasizes the flow of documents or records containing data.
  - DFDs help convey the timing of events.
  - Both a and b are false.
- A DFD consists of the following four basic elements: data sources and destinations, data flows, transformation processes, and data stores. Each is represented on a DFD by a different symbol.
  - True
  - False
- Which of the following is NOT one of the guidelines that should be followed in naming DFD data elements?
  - Process names should include action verbs such as *update*, *edit*, *prepare*, and *record*.
  - Make sure the names describe all the data or the entire process.
  - Name only the most important DFD elements.
  - Choose active and descriptive names.
- The documentation skills that accountants require vary with their job function. However, they should at least be able to do which of the following?
  - Read documentation to determine how the system works.
  - Critique and correct documentation that others prepare.
  - Prepare documentation for a newly developed information system.
  - Teach others how to prepare documentation.

7. Which of the following statements is FALSE?
  - a. A flowchart is an analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner.
  - b. Flowcharts use a standard set of symbols to describe pictorially the flow of documents and data through a system.
  - c. Flowcharts are easy to prepare and revise when the designer utilizes a flowcharting software package.
  - d. A system flowchart is a narrative representation of an information system.
  - e. A program flowchart shows the logic used in computer programs.
8. Which of the following flowcharts illustrates the flow of information among areas of responsibility in an organization?
  - a. program flowchart
  - b. computer configuration chart
  - c. system flowchart
  - d. document flowchart
9. Which of the following is NOT one of the recommended guidelines for making flowcharts more readable, clear, concise, consistent, and understandable?
  - a. Divide the flowchart into columns with labels.
  - b. Flowchart all information flows, especially exception procedures and error routines.
  - c. Design the flowchart so that flow proceeds from top to bottom and from left to right.
  - d. Show the final disposition of all documents to prevent loose ends that leave the reader dangling.
  - e. Make sure that each manual processing symbol has an input and an output.
10. How are data sources and destinations represented in a data flow diagram?
  - a. as a square
  - b. as a curved arrow
  - c. as a circle
  - d. as two parallel lines
  - e. none of the above

## Comprehensive Problem

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### Accuflow Cash Disbursements Process

SoftData, a vendor, sends an invoice to Accuflow for data warehousing support services. The invoice is sent directly to Megan Waters, the accounts payable clerk, who manually records the invoice in the accounts payable subsidiary ledger. Once the invoice is recorded, it is forwarded to Stan Phillips, the cash disbursements clerk, for processing. Stan prepares a check to pay the invoice and sends the check and invoice to John Sterling, the company treasurer. John approves and signs the check and cancels the invoice. John then mails the check back to SoftData and returns the canceled invoice to Stan for recording in the cash disbursements journal and filing. Once a week, Megan manually posts disbursements from the cash disbursements journal to the accounts payable subsidiary ledger.

### Required

Prepare a document flowchart, a context diagram, a level 0 data flow diagram, and a level 1 data flow diagram for the Accuflow cash disbursement process. To maximize learning from this problem, do your best to solve it before looking at the solution at the end of the chapter.

## Discussion Questions

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- 3.1. Identify the DFD elements in the following narrative: A customer purchases a few items from a local grocery store. Jill, a salesclerk, enters the transaction in the cash register and takes the customer's money. At closing, Jill gives both the cash and the register tape to her manager.
- 3.2. Do you agree with the following statement: "Any one of the systems documentation procedures can be used to adequately document a given system"? Explain.

- 3.3. Compare the guidelines for preparing flowcharts and DFDs. What general design principles and limitations are common to both documentation techniques?
- 3.4. Your classmate asks you to explain flowcharting conventions using real-world examples. Draw each of the major flowchart symbols from memory, placing them into one of four categories: input/output, processing, storage, and flow and miscellaneous. For each symbol, suggest several uses.

## Problems

- 3.1. Prepare flowcharting segments for each of the following operations:
- processing transactions stored on magnetic tape to update a master file stored on magnetic tape
  - processing transactions stored on magnetic tape to update a database stored on a magnetic disk
  - converting source documents to magnetic tape using a computer-based optical character reader (OCR)
  - processing OCR documents online to update a database on magnetic disk
  - reading data from a magnetic disk into the computer to be printed on a report
  - using a computer or terminal to key data from source documents to a file stored on a magnetic disk
  - manually sorting and filing invoices numerically
  - using a terminal to enter source document data and send it to a remote location where an online processing system records it in a database stored on magnetic disk
  - a scheduled automatic backup of an internal hard drive to an external hard drive
  - using a terminal to query customer sales data maintained on a magnetic disk
  - entering employee hours recorded on time cards in the payroll transaction file maintained on disk and updating wage data maintained on the payroll master file
  - using a terminal to access a price list maintained on disk to complete a purchase order. An electronic copy of the purchase order is sent to the vendor and a backup copy is printed and filed by vendor name
  - updating an airline reservation on a Web-based airline reservation system from a home computer



- 3.2. The Happy Valley Utility Company uses turnaround documents in its computerized customer accounting system. Meter readers are provided with preprinted computer forms, each containing the account number, name, address, and previous meter readings. Each form also contains a formatted area in which the customer's current meter reading can be marked in pencil. After making their rounds, meter readers turn in batches of these documents to the computer data preparation department, where they are processed by a mark-sense document reader that transfers their contents to magnetic tape.

This magnetic tape file is used as input for two computer runs. The first run sorts the transaction records on the tape into sequential order by customer account number. On the second run, the sorted transaction tape is processed against the customer master file, which is stored on a magnetic disk. Second-run outputs are (1) a printed report listing summary information and any erroneous transactions detected by the computer and (2) customer bills printed in a special OCR-readable font. Bills are mailed, and customers are requested to return the stub portion along with payment.

Customer payments are received in the mailroom and checked for consistency against the returned remittance stubs. Checks are then sent to the cashier's office. The mailroom provides the computer data preparation department with three sets of records: (1) stubs with compatible amounts, (2) stubs with differing amounts, and (3) a list of amounts received from customers, without stubs. For the latter two types of records, data preparation personnel use a special off-line keying device to prepare corrected stubs. An

OCR document reader reads all the stubs and sends the data to the company's computer. The computer updates the customer master file to post the payment amounts. Two printed outputs from this second process are (1) reports listing erroneous transactions and summary information and (2) past-due customer balances.

#### Required

- a. Draw a system flowchart of the billing operations, commencing with the computer preparation of the meter reading forms and ending with the mailing of customer bills.
  - b. Draw a system flowchart depicting customer payments processing, starting with the mailroom operations and ending with the two printed reports.
- 3.3. The Dewey Construction Company processes its payroll transactions to update both its payroll master file and its work-in-process master file in the same computer run. Both files are stored on magnetic disk.

Job time tickets are keyed onto a tape using an off-line key-to-tape encoder. The tape is then processed to update the files. The processing run also produces a payroll register on magnetic tape, employee paychecks and earnings statements, and a printed report listing error transactions and summary information.

#### Required

Prepare a system flowchart of the process described.

- 3.4. Prepare a document flowchart to reflect how ANGIC Insurance Company processes its casualty claims. The process begins when the claims department receives a notice of loss from a claimant. The claims department prepares and sends the claimant four copies of a proof-of-loss form on which the claimant must detail the cause, amount, and other aspects of the loss. The claims department also initiates a record of the claim, which is sent with the notice of loss to the data processing department, where it is filed by claim number.

The claimant must fill out the proof-of-loss forms with an adjuster's assistance. The adjuster must concur with the claimant on the estimated amount of loss. The claimant and adjuster each keep one copy of the proof-of-loss form. The adjuster files his copy numerically. The adjuster sends the first two copies to the claims department. Separately, the adjuster submits a report to the claims department, confirming the estimates on the claimant's proof-of-loss form.

The claims department authorizes a payment to the claimant, forwards a copy of the proof-of-loss form to data processing, and files the original proof-of-loss form and the adjuster's report alphabetically. The data processing department prepares payment checks and mails them to the customers, files the proof-of-loss form with the claim record, and prepares a list of cash disbursements, which it transmits to the accounting department.

- 3.5. Beccan Company is a discount tire dealer operating 25 retail stores in the metropolitan area. The company operates a centralized purchasing and warehousing facility and employs a perpetual inventory system. All purchases of tires and related supplies are placed through the company's central purchasing department to optimize quantity discounts. The tires and supplies are received at the central warehouse and distributed to the retail stores as needed. The perpetual inventory system at the central facility maintains current inventory records, designated reorder points, and optimum order quantities for each type and size of tire and other related supplies. Beccan uses the following five documents in its inventory control system.

- **Retail stores requisition.** The retail stores submit a retail store requisition to the central warehouse when they need tires or supplies. The warehouse shipping clerks fill the orders from inventory and authorize store deliveries.
- **Purchase requisition.** The inventory control clerk prepares a purchase requisition when the quantity on hand for an item falls below the designated reorder point and forwards it to the purchasing department.
- **Purchase order.** The purchasing department prepares a purchase order when items need to be ordered and submits it to an authorized vendor.

- **Receiving report.** The warehouse department prepares a receiving report when ordered items are received from vendors. The receiving clerk indicates the vendor's name and the date and quantity of the shipment received.
- **Invoice.** An invoice is received from vendors, specifying the amounts Beccan owes.

The following departments are involved in Beccan's inventory control system:

- **Inventory control department.** Responsible for the maintenance of all perpetual inventory records, including quantity on hand, reorder point, optimum order quantity, and quantity on order for each item carried.
- **Warehouse department.** Maintains the physical inventory of all items carried in stock. All orders from vendors are received (receiving clerk) and all distributions to retail stores are filled (shipping clerks) in this department.
- **Purchasing department.** Places all orders for items needed by the company.
- **Accounts payable department.** Maintains all open accounts with vendors and other creditors, in addition to processing payments.

### Required

- Prepare a document flowchart that indicates the interaction and use of these documents among all departments at Beccan Company's central facility. It should provide adequate internal control over the receipt, issuance, replenishment, and payment of tires and supplies. You may assume that there are a sufficient number of document copies to ensure that the perpetual inventory system has the necessary basic internal controls.
  - Using the flowcharting conventions discussed in Focus 3-2, critique the instructor provided CMA solution. List all the ways the CMA solution violates those flowcharting guidelines. (*CMA Examination, adapted*)
- 3.6. As the internal auditor for No-Wear Products, you have been asked to document the company's payroll processing system. Based on your documentation, No-Wear hopes to develop a plan for revising the current system to eliminate unnecessary delays in paycheck processing. The head payroll clerk explained the system:

The payroll processing system at No-Wear Products is fairly simple. Time data are recorded in each department using time cards and clocks. It is annoying, however, when people forget to punch out at night, and we have to record their time by hand. At the end of the period, our payroll clerks enter the time card data into a payroll file for processing. Our clerks are pretty good—though I've had to make my share of corrections when they mess up the data entry.

Before the payroll file is processed for the current period, human resources sends us personnel changes, such as increases in pay rates and new employees. Our clerks enter this information into the payroll file. Usually, when mistakes get back to us, it's because human resources is recording the wrong pay rate or an employee has left and the department forgets to remove the record.

The data are processed and individual employee paychecks are generated. Several reports are generated for management—though I don't know what they do with them. In addition, the government requires regular federal and state withholding reports for tax purposes. Currently, the system generates these reports automatically, which is nice.

### Required

- Prepare a context diagram and level 0 DFD to document the payroll processing system at No-Wear Products.
  - Prepare a document flowchart to document the payroll processing system at No-Wear Products.
- 3.7. Ashton Fleming has decided to document and analyze the accounts payable process at S&S so the transition to a computerized system will be easier. He also hopes to improve

any weaknesses he discovers in the system. In the following narrative, Ashton explains what happens at S&S:

Before S&S pays a vendor invoice, the invoice must be matched against the purchase order used to request the goods and the receiving report that the receiving department prepares. Because all three of these documents enter the accounts payable department at different times, a separate alphabetical file is kept for each type of document. The purchase orders that are forwarded from purchasing are stored in a purchase order file. The receiving reports are stored in a receiving report file. When vendor invoices are received, the accounts payable clerk records the amount due in the accounts payable file and files the invoices in the vendor invoice file.

S&S pays all accounts within 10 days to take advantage of early-payment discounts. When it is time to pay a bill, the accounts payable clerk retrieves the vendor invoice, attaches the purchase order and the receiving report, and forwards the matched documents to Ashton Fleming.

Ashton reviews the documents to ensure they are complete, prepares a two-part check, forwards all the documents to Susan, and records the check in the cash disbursements journal.

Susan reviews the documents to ensure that they are valid payables and signs the checks. She forwards the check to the vendor and returns the documents and the check copy to the accounts payable clerk. The clerk files the documents alphabetically in a paid invoice file. At the end of every month, the accounts payable clerk uses the accounts payable ledger to prepare an accounts payable report that is forwarded to Susan. After she is finished with the report, Susan files it chronologically.

### Required

- a. Prepare a context diagram and a level 0 DFD to document accounts payable processing at S&S.
  - b. Prepare a document flowchart to document accounts payable processing at S&S.
- 3.8. Since opening its doors in Hawaii two years ago, Oriental Trading has enjoyed tremendous success. Oriental Trading purchases textiles from Asia and resells them to local retail shops. To keep up with the strong demand, Oriental Trading is expanding its local operations, including a new information system to handle the tremendous increase in purchases.

The following is a summary of your interviews with department supervisors who interact with the acquisition/payment system:

A purchase requisition is sent from the inventory system to Sky Ishibashi, a purchasing department clerk. Sky prepares a purchase order using the vendor and inventory files and mails it to the vendor. The vendor returns a vendor acknowledgment to Sky indicating receipt of the purchase order. Sky then sends a purchase order notification to Elei Mateaki, an accounts payable clerk.

When the receiving department accepts vendor goods, the inventory system sends Elei a receiving report. Elei also receives invoices from the various vendors. He matches the invoices with the purchase order notification and the receiving report and updates the accounts payable master file. Elei then sends a payment authorization to the accounting department. There, Andeloo Nonu prepares and mails a check to the vendor. When the check is issued, the system automatically updates the accounts payable master file and the general ledger.

### Required

- a. Develop a context diagram and a level 0 DFD of the acquisition/payment system at Oriental Trading.
  - b. Prepare a document flowchart to document the acquisition/payment system at Oriental Trading.
- 3.9. Ashton Fleming has asked you to develop a comprehensive DFD for the cash receipts system. Ashton's narrative of the system follows:

Customer payments include cash received at the time of purchase and payments received in the mail. At day's end, the treasurer endorses all checks and prepares a

deposit slip for the checks and the cash. A clerk deposits the checks, cash, and deposit slip at the local bank each day. When checks are received as payment for accounts due, a remittance slip is included with the payment. The remittance slips are used to update the accounts receivable file at the end of the day. The remittance slips are stored in a file drawer by date.

Every week, a cash receipts report and an aged trial balance are generated using the accounts receivable ledger. The cash receipts report is sent to Scott and Susan. A copy of the aged trial balance is sent to the credit and collections department.

### Required

- a. Develop a context diagram and a level 0 DFD for the cash receipts system at S&S.
  - b. Prepare a document flowchart for the cash receipts system at S&S.
- 3.10. A mail-order skin and body care company advertises in magazines. Magazine subscribers initiate most orders by completing and sending coupons directly to the company. The firm also takes orders by phone, answers inquiries about products, and handles payments and cancellations of orders. Products that have been ordered are sent either directly to the customer or to the company's regional offices that handle the required distribution. The mail-order company has three basic data files, which contain customer mailing information, product inventory information, and billing information based on invoice number. During the next few years, the company expects to become a multimillion-dollar operation. Recognizing the need to computerize much of the mail-order business, the company has begun the process by calling you.

### Required

Draw a context diagram and at least two levels of DFDs for the preceding operations.

- 3.11. The local college requires that each student complete a registration request form and mail or deliver it to the registrar's office. A clerk enters the request into the system. The system checks the accounts receivable subsystem to ensure that no fees are owed. Next, for each course, the system checks the student transcript to ensure that he or she has completed the course prerequisites. Then the system checks class position availability and adds the student's Social Security number to the class list.

The report back to the student shows the result of registration processing: If the student owes fees, a bill is sent and the registration is rejected. If prerequisites for a course are not fulfilled, the student is notified and that course is not registered. If the class is full, the student request is annotated with "course closed." If a student is accepted into a class, then the day, time, and room are printed next to the course number. Student fees and total tuition are computed and printed on the form. Student fee information is interfaced to the accounts receivable subsystem. Course enrollment reports are prepared for the instructors.

### Required

- a. Prepare a context diagram and at least two levels of DFDs for this operation.
  - b. Prepare a document flowchart for this operation.
- 3.12. Charting, Inc., a new audit client of yours, processes its sales and cash receipts documents in the following manner:
1. **Payment on account.** Each morning a mail clerk in the sales department opens the mail and prepares a remittance advice (showing customer and amount paid) if one is not received. The checks and remittance advices are forwarded to the sales department supervisor, who reviews each check and forwards the checks and remittance advices to the accounting department supervisor.
 

The accounting department supervisor, who also functions as credit manager (approving new credit and credit limits), reviews all checks for payments on past-due accounts. He forwards the checks and remittance advices to the accounts receivable clerk, who arranges the advices in alphabetical order. The remittance advices are posted directly to the accounts receivable ledger. The checks are endorsed and the



total is posted to the cash receipts journal. The remittance advices are filed chronologically. After receiving the cash from the previous day's cash sales, the accounts receivable clerk prepares the daily deposit slip in triplicate. The third copy of the deposit slip is filed by date, and the second copy and the original accompany the bank deposit.

2. **Sales.** Sales clerks prepare sales invoices in triplicate. The original and the second copy are presented to the cashier. The sales clerk retains the third copy in the sales book. When a sale is for cash, the customer pays the sales clerk, who gives the money to the cashier with the invoice copies.

The cashier approves a credit sale from an approved credit list after the sales clerk prepares the three-part invoice. After receiving the cash or approving the invoice, the cashier validates the original copy of the sales invoice and gives it to the customer. At the end of each day, the cashier recaps the sales and cash received and forwards the cash and the second copy of the sales invoices to the accounts receivable clerk.

The accounts receivable clerk balances the cash received with cash sales invoices and prepares a daily sales summary. The credit sales invoices are posted to the accounts receivable ledger, and then all invoices are sent to the inventory control clerk in the sales department for posting to the inventory control cards. After posting, the inventory control clerk files all invoices numerically. The accounts receivable clerk posts the daily sales summary to the cash receipts and sales journals and files the sales summaries by date.

The cash from cash sales is combined with the cash received on account to make up the daily bank deposit.

3. **Bank deposits.** The bank validates the deposit slip and returns the second copy to the accounting department, where the accounts receivable clerk files it by date.

Monthly bank statements are reconciled promptly by the accounting department supervisor and filed by date.

### Required

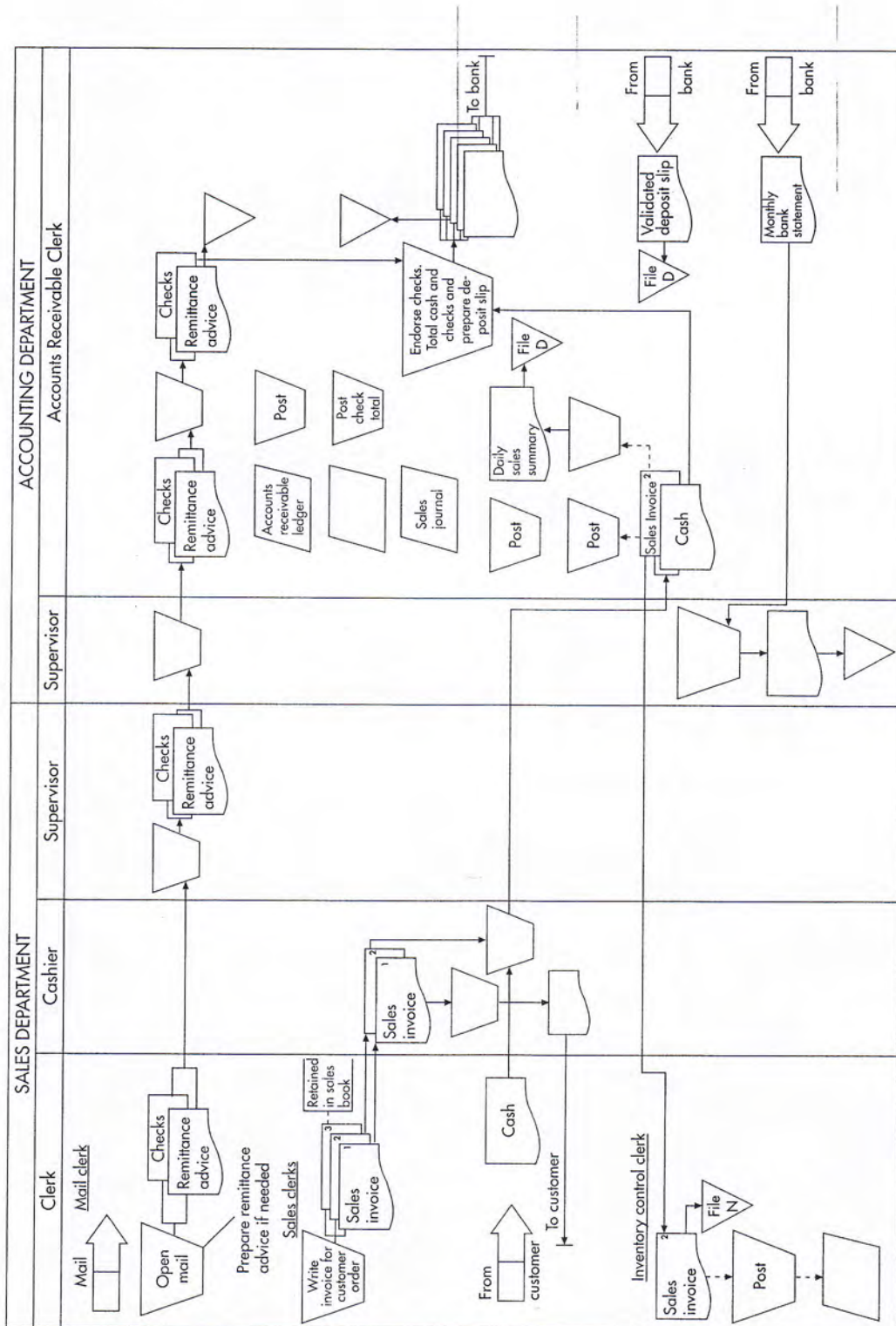
You recognize weaknesses in the existing system and believe a document flowchart would be beneficial in evaluating the client's internal control in preparing for your examination of the financial statements.

- a. Complete the flowchart given in Figure 3-12, for sales and cash receipts of Charting, Inc., by labeling the appropriate symbols and indicating information flows.
  - b. Using the guidelines for preparing flowcharts in Focus 3-2 and the flowcharting symbols shown in Figure 3-8, critique the flowchart shown in Figure 3-12. List the ways the flowchart violates the guidelines or uses improper symbols. (*CPA Examination, adapted*)
- 3.13. A partially completed flowchart appears in Figure 3-13. The flowchart depicts the credit sales activities of the Bottom Manufacturing Corporation.

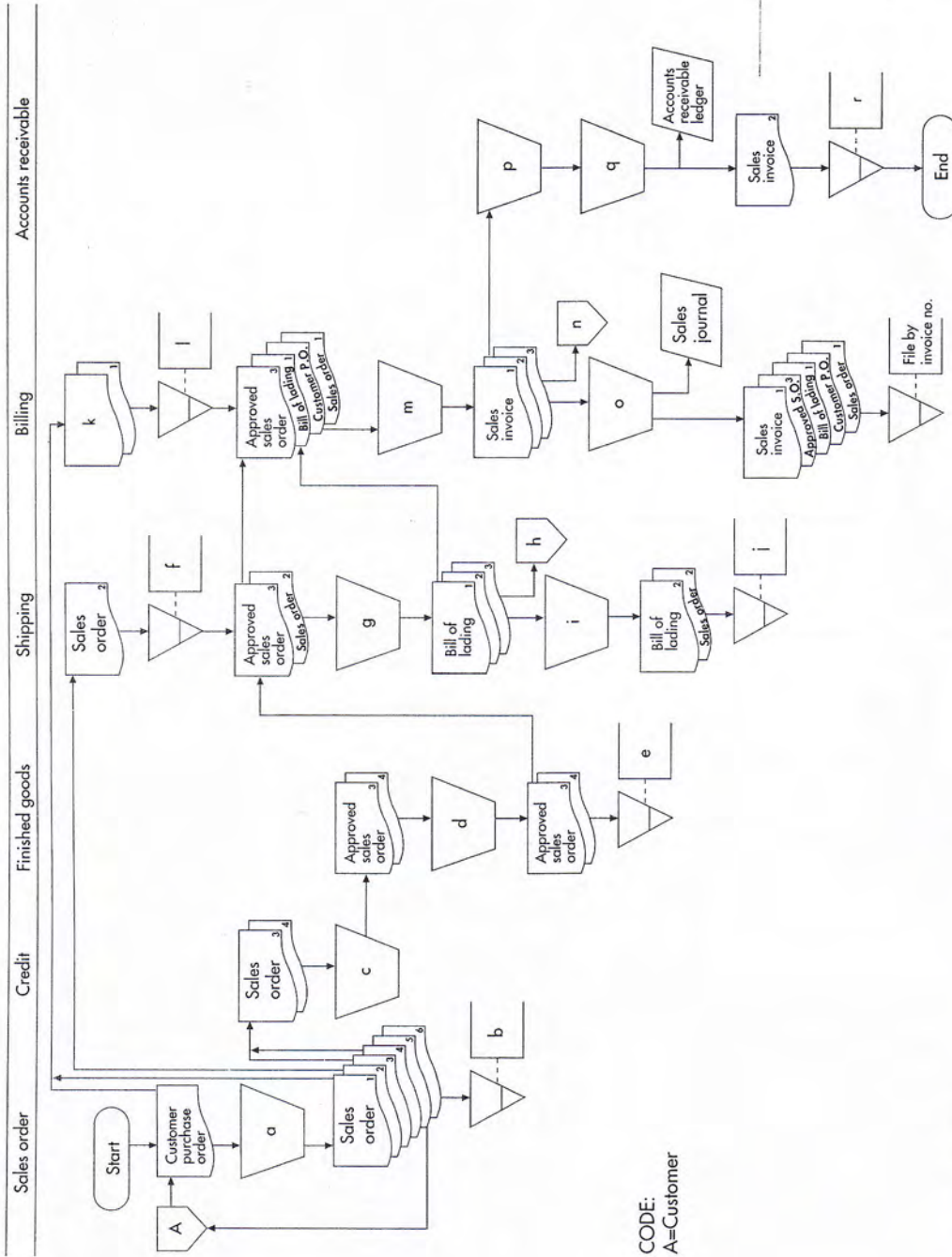
When a customer's purchase order is received, a six-part sales order is prepared and distributed as follows:

- Copy 1—Billing copy, to billing department
- Copy 2—Shipping copy, to shipping department
- Copy 3—Credit copy, to credit department
- Copy 4—Stock request copy, to credit department
- Copy 5—Customer copy, to customer
- Copy 6—Sales order copy, filed in sales order department

When each copy of the sales order reaches the appropriate department or destination, it calls for specific internal control procedures and related documents. Some procedures and related documents are indicated on the flowchart; others are labeled by the letters *a* to *r*.



**FIGURE 3-12**  
Charting, Inc., Flowchart for Sales and Cash Receipts



**FIGURE 3-13**  
Bottom Manufacturing Corporation Flowchart of Credit Sales Activities

**Required**

- a. List the procedures or the internal documents that are labeled letters *c* to *r* in the flowchart of Bottom Manufacturing Corporation's charge sales system. Organize your answer as follows (Note that the explanations of the letters *a* and *b* in the flowchart are entered as examples):

Flowchart Symbol Letter	Procedures or Internal Document
a	Prepare six-part sales order.
b	File by order number.

- b. Using the guidelines for preparing flowcharts in Focus 3-2 and the flowcharting symbols shown in Figure 3-8, critique the flowchart shown in Figure 3-13. List the ways the flowchart violates the guidelines or uses improper symbols. (*CPA Examination, adapted*)

- 3.14. Prepare a context diagram and a level 0 data flow diagram for each of the following situations.



- a. Prepare and file a tax return with the tax owed to the Internal Revenue Service.
- b. A customer pays an invoice with a check. Accounts receivable is updated to reflect the payment. The check is recorded and deposited into the bank.
- c. A customer places an online order to purchase merchandise. The order is approved, filled, and sent to the customer with an invoice.
- d. An inventory request is received by the purchasing department. The purchasing department prepares and sends a purchase order to the appropriate vendor.
- e. A vendor invoice is received, reviewed, and compared against the appropriate purchase order, then paid and filed.
- f. A bill of lading for ordered inventory is received from a vendor, recorded, checked against the appropriate purchase order, and filed.

- 3.15. Melanie is doing a study on various weight-loss plans and needs to determine an individual's weight status by calculating his body mass index. To calculate a person's body mass index, height must be measured in meters and weight measured in kilograms. The index is calculated by dividing a person's weight by the square of his height. The result is then compared to the following scale to determine the person's weight status: Below 18.5 = underweight; 18.5–24.5 = normal weight; over 25.0 = overweight. Five hundred people have agreed to participate in Melanie's study. With so many calculations to perform, she would like a computer program that will do this calculation for her. She decides to prepare a flowchart to help her properly design the computer program.



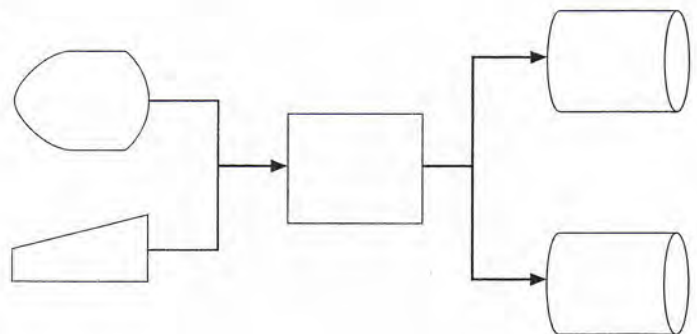
**Required**

Prepare a program flowchart to help Melanie program this process.

- 3.16. Match the flowchart, context diagram, or data flow diagram segments in the right column to an appropriate description in the left column.

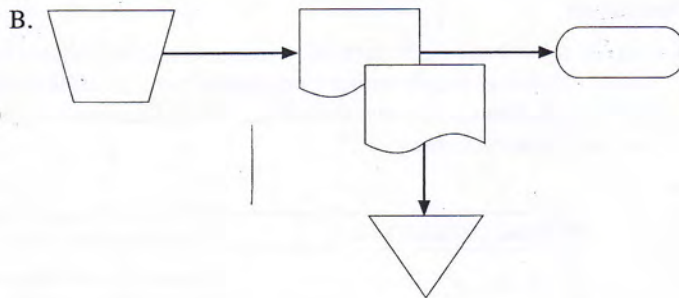
1. Statements are prepared and sent to customers from data contained in the accounts receivable data store.

A.

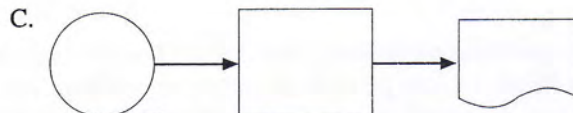


(continued)

2. A customer sends a sales invoice to the accounts payable process.



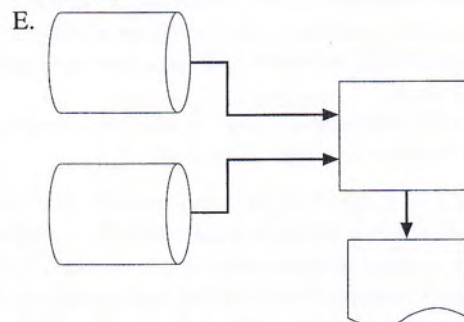
3. A check is manually prepared from data on a vendor invoice.



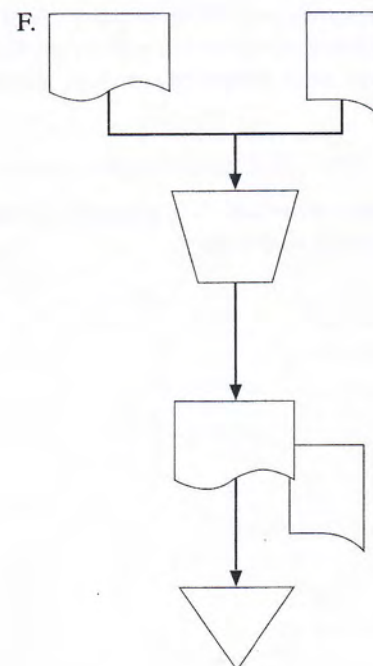
4. The cash receipt process updates the cash receipts data store.



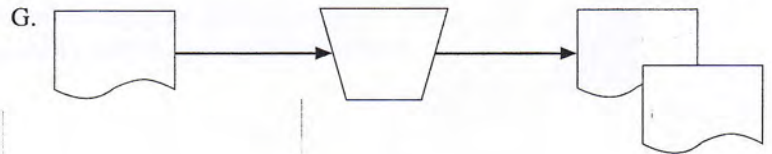
5. A sales invoice is manually prepared and sent to a customer.



6. A report is prepared from data stored on magnetic tape.



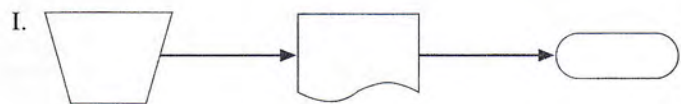
7. Billing data are entered online and used to update the sales order file and the customer master file.



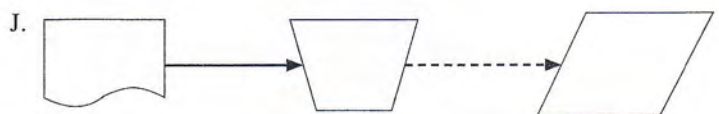
8. Data from a cancelled invoice are used to update the cash disbursements ledger.



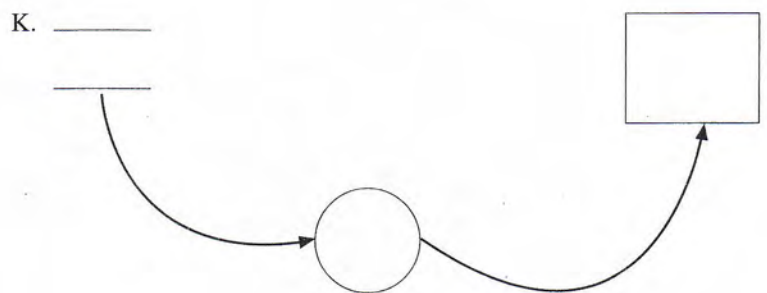
9. A sales order is prepared manually. Copy 1 is sent to the warehouse, and copy 2 is filed.



10. An accounts receivable aging report is prepared from the accounts receivable master file and the cash receipts master file, both stored on disk.

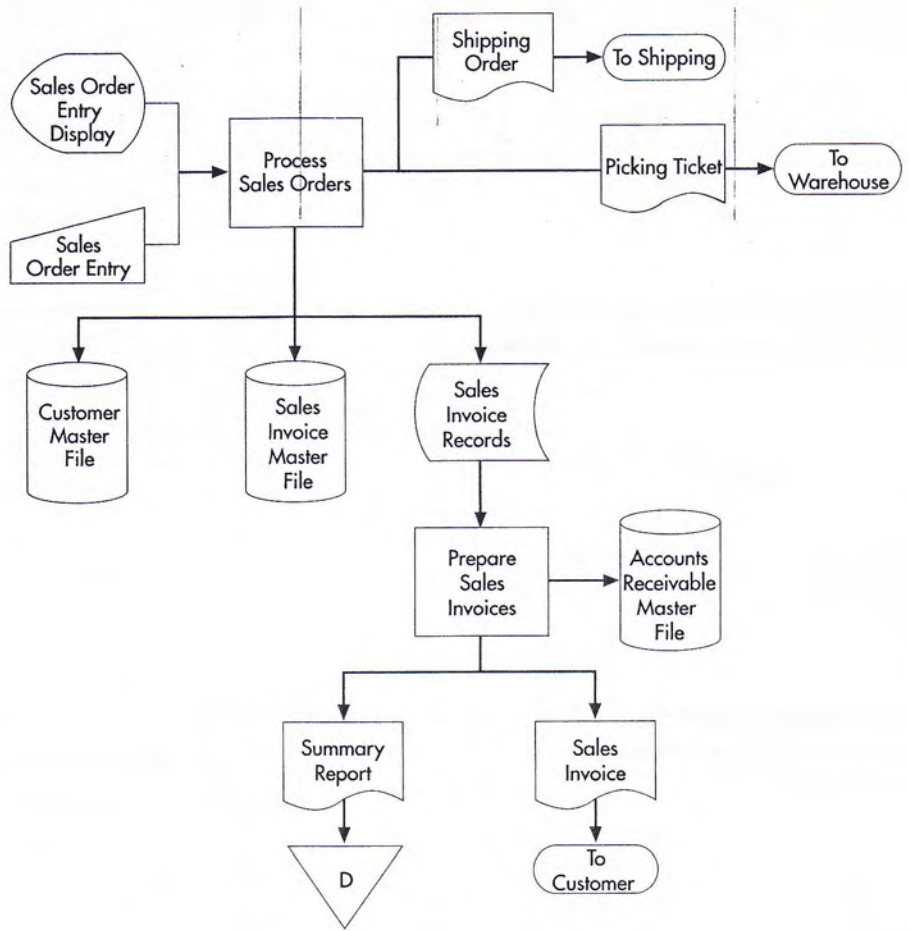


11. An error listing and batch total are compared and filed.

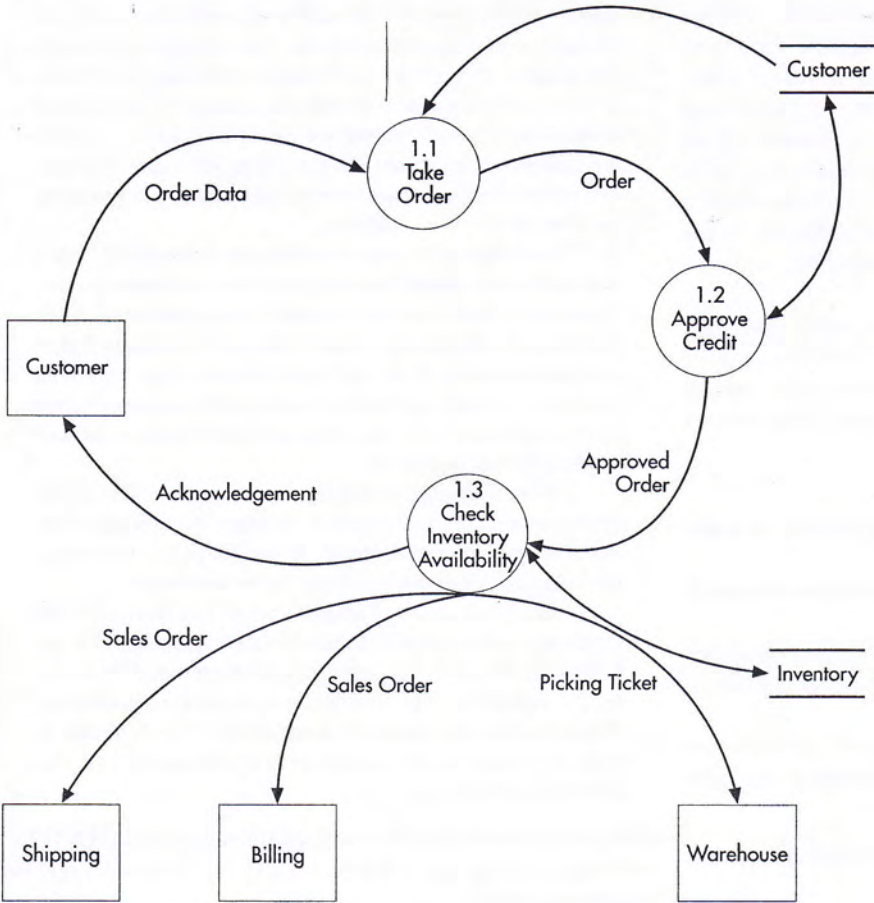




3.17. Replicate the following flowchart in Visio, Microsoft Word, Microsoft Excel, or some other documentation software package.



3.18. Replicate the following data flow diagram in Visio, Microsoft Word, Microsoft Excel, or some other documentation software package.



### Case 3-1 Dub 5

You are the systems analyst for the Wee Willie Williams Widget Works (also known as Dub 5, which is a shortened version of 5 Ws). Dub 5 has been producing computer keyboard components for more than 20 years and has recently signed an exclusive 10-year contract to provide the keyboards for all Dell personal computers. As the systems analyst, you have been assigned the task of developing a level 0 DFD for Dub 5's order processing system. You have finished gathering all the information you need to develop the first-pass DFD and now want to complete the diagram.

Customer orders, which are all credit sales, arrive via e-mail and by phone. When an order is processed, a number of other documents are prepared. You have diagrammed the overall process and the documents produced, as shown in the context diagram shown below.

The following documents are created:

- Order processing creates a packing slip, which the warehouse uses to fill the order.
- A customer invoice is prepared and sent once the goods have been shipped.
- When orders are not accepted, an order rejection is sent to the customer, explaining why the order cannot be filled.
- A receivables notice, which is a copy of the customer invoice, is sent to the accounting department so accounts receivable records can be updated.

ensure that the amount falls within the credit limit. If either of these conditions is not met, the order is sent to the credit department. If an order meets both conditions, the order-processing clerk enters it into the system on a standard order form. The information on the form is used to update the company's customer file (in which the name, address, and other information are stored), and the form is placed in the company's open order file.

When the credit department receives a rejected order, the credit clerk determines why the order has been rejected. If the credit limit has been exceeded, the customer is notified that the merchandise will be shipped as soon as Dub 5 receives payment. If the customer has not been approved for credit, a credit application is sent to the customer along with a notification that the order will be shipped as soon as credit approval is granted.

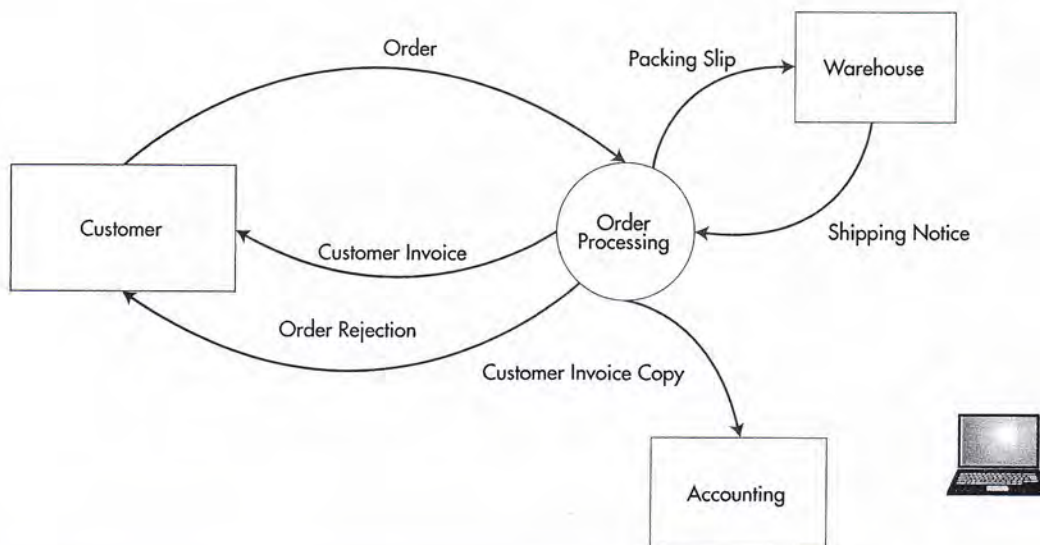
Before preparing a packing slip, the system checks the inventory records to determine whether the company has the products ordered on hand. If the items are in stock, a packing slip is prepared and sent to the warehouse.

Once notification of shipped goods has been received from the warehouse, a customer invoice is prepared. A copy is filed by the order processing department, another is sent to the customer, and another is sent to the accounting department so that accounts receivables can be updated. A note is placed in the customer file indicating that the invoice has been sent.

After reviewing your notes, you write the following narrative summary:

When an order comes in, the order processing clerk checks the customer's credit file to confirm credit approval and

From the information presented, complete a Level 0 DFD for order processing and a Level 1 DFD for the credit review process for Dub 5.



# AIS IN ACTION SOLUTIONS

## Quiz Key

1. A DFD is a representation of which of the following?
  - a. relationship among modules, data, and programs of an AIS [Incorrect. A flowchart represents the relationship among modules, data, and programs.]
  - ▶ b. flow of data in an organization [Correct.]
  - c. decision rules in a computer program [Incorrect. A DFD is a graphical representation of how data move through an organization. Decision rules are objective statements specific to computer programs.]
  - d. computer hardware configuration [Incorrect. This relates to how various parts of a computer fit together.]
2. Documentation methods such as DFDs and flowcharts save both time and money, adding value to an organization.
  - ▶ a. True [Correct. A picture is worth a thousand words: An individual may learn more and learn it more quickly by studying the DFD or flowchart of a system than by reading a narrative description of the same system.]
  - b. False [Incorrect]
3. Which of the following statements is FALSE?
  - a. Flowcharts make use of many symbols. [Incorrect. The statement is true. See Figure 3-8 for an illustration of the many symbols used in flowcharts.]
  - b. A document flowchart emphasizes the flow of documents or records containing data. [Incorrect. The statement is true. The reason it is called a document flowchart is that it shows the flow of documents or records containing data.]
  - ▶ c. DFDs help convey the timing of events. [Correct. DFDs show data movement, but not necessarily the timing of the movement.]
  - d. Both a and b are false. [Incorrect. As explained above, a and b are true statements.]
4. A DFD consists of the following four basic elements: data sources and destinations, data flows, transformation processes, and data stores. Each is represented on a DFD by a different symbol.
  - ▶ a. True [Correct. The four elements of DFDs are illustrated in Figure 3-1.]
  - b. False [Incorrect]
5. Which of the following is NOT one of the guidelines that should be followed in naming DFD data elements?
  - a. Process names should include action verbs such as *update*, *edit*, *prepare*, and *record*. [Incorrect. Action verbs should be used to name process data elements. See item 11 in Focus 3-1.]
  - b. Make sure the names describe all the data or the entire process. [Incorrect. Data element names should reflect what is known about the element. See item 11 in Focus 3-1.]
  - ▶ c. Name only the most important DFD elements. [Correct. All data elements should be named, with the exception of data flows into data stores, when the inflows and outflows make naming the data store redundant. See item 11 in Focus 3-1.]
  - d. Choose active and descriptive names. [Incorrect. Active and descriptive names should be used in naming data elements. See item 11 in Focus 3-1.]
6. The documentation skills that accountants require vary with their job function. However, all accountants should at least be able to do which of the following?
  - ▶ a. Read documentation to determine how the system works. [Correct. All accountants should at least be able to read and understand system documentation.]
  - b. Critique and correct documentation that others prepare. [Incorrect. Although senior accountants may critique and correct documentation prepared by junior accountants, at a minimum all accountants need to be able to read and understand documentation.]

- c. Prepare documentation for a newly developed information system. [Incorrect. Some accountants may need to develop internal control documentation, but system developers and analysts normally prepare systems documentation.]
  - d. Teach others how to prepare documentation. [Incorrect. Most accountants will not be asked to teach documentation skills.]
7. Which of the following statements is FALSE?
- a. A flowchart is an analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner. [Incorrect. This is the definition of a flowchart given previously in the text.]
  - b. Flowcharts use a standard set of symbols to describe pictorially the flow of documents and data through a system. [Incorrect. The symbols used for flowcharting are shown in Figure 3-8.]
  - c. Flowcharts are easy to prepare and revise when the designer utilizes a flowcharting software package. [Incorrect. There are a number of good flowcharting software packages that make it easy to draw and modify flowcharts.]
  - ▶ d. A system flowchart is a narrative representation of an information system. [Correct. A flowchart is a graphical rather than a narrative representation of an information system.]
  - e. A program flowchart shows the logic used in computer programs. [Incorrect. A program flowchart illustrates program logic and the structure of the program.]
8. Which of the following flowcharts illustrates the flow of information among areas of responsibility in an organization?
- a. program flowchart [Incorrect. A program flowchart documents a computer program.]
  - b. computer configuration chart [Incorrect. A computer configuration chart illustrates how computer hardware is arranged and implemented.]
  - c. system flowchart [Incorrect. A system flowchart illustrates the relationship among inputs, processes, and outputs of a system, not areas of responsibility.]
  - ▶ d. document flowchart [Correct. A document flowchart traces the life of a document from its cradle to its grave as it works its way through the areas of responsibility within an organization.]
9. Which of the following is NOT one of the recommended guidelines for making flowcharts more readable, clear, concise, consistent, and understandable?
- a. Divide the flowchart into columns with labels. [Incorrect. Dividing the flowchart into columns helps make it more readable, clear, concise, consistent, and understandable. See item 3 in Focus 3-2.]
  - ▶ b. Flowchart all information flows, especially exception procedures and error routines. [Correct. Including all exception procedures and error routines clutters the flowchart and makes it difficult to read and understand. See item 4 in Focus 3-2.]
  - c. Design the flowchart so that flow proceeds from top to bottom and from left to right. [Incorrect. Flowcharts should be prepared so that they are read like a book. See item 5 in Focus 3-2.]
  - d. Show the final disposition of all documents to prevent loose ends that leave the reader dangling. [Incorrect. All documents should be placed either in a file or sent to another entity. See item 6 in Focus 3-2.]
  - e. Make sure that each manual processing symbol has an input and an output. [Incorrect. A manual process must have an input and an output. Without an input, nothing can be processed; and without an output, there is no evidence of processing. See item 10 in Focus 3-2.]
10. How are data sources and destinations represented in a data flow diagram?
- ▶ a. as a square [Correct. See Figure 3-1.]
  - b. as a curved arrow [Incorrect. A curved arrow represents a data flow. See Figure 3-1.]
  - c. as a circle [Incorrect. A circle represents a process. See Figure 3-1.]
  - d. as two parallel lines [Incorrect. Two parallel lines represent a data store. See Figure 3-1.]
  - e. as none of the above [Incorrect. Option a is correct.]

## Comprehensive Problem Solution



### Flowchart

The first step in preparing a document flowchart is to become familiar with the problem. The next step is to identify the primary actors or major players. In this problem there are three major players: Megan Waters (accounts payable clerk), Stan Phillips (cash disbursement clerk), and John Sterling (treasurer). Since we are documenting Accuflow's cash disbursement process, we are not interested in the internal workings of the vendor, SoftData. As a result, we do not include it as one of our major players. Now that we have identified the major players, we can list their functions in Table 3-3. Note that forwarding to and receiving from the next major player are not considered functions in preparing document flowcharts.

We will now explain, step by step, how to create the document flowchart solution for Accuflow shown in Figure 3-14. To document the functions of the three major players, divide the document flowchart into three columns, one for each player. It is usually best to arrange the columns in the order in which they occur and to use the primary function of the major player as the column name. Because the accounts payable clerk receives the invoice from the vendor, we place her in the first column. After the accounts payable clerk records the invoice, she sends it to the cash disbursements clerk, who prepares a check and sends it to the treasurer. Therefore, the cash disbursements clerk should be in the second column, and the treasurer should be in the last column, as illustrated in Figure 3-14.

Because the process begins with an invoice from an external party (a vendor), a terminal symbol with the term "From Vendor" is placed in the upper left portion of the Accounts Payable Clerk column. Next, a document symbol with the words "Vendor Invoice" printed inside it is placed below the terminal symbol. An arrow representing the document's flow and the order of operations connects the two symbols.

According to the narrative, Megan manually records the invoice in the accounts payable subsidiary ledger. Thus, a manual process symbol with the words "Record Invoice" is placed below the invoice document symbol, and the two symbols are connected with an arrow. Then, a journal/ledger symbol, also called an input/output symbol, is placed to the side of the manual process. Because only information from the invoice is used to update the accounts payable subsidiary ledger, a dotted arrow is used to connect the two symbols. A new vendor invoice symbol is drawn below the record invoice symbol.

Because the vendor invoice moves from the accounts payable clerk to the cash disbursements clerk, the vendor invoice symbol is placed at the top of the cash disbursements column with an arrow connecting the two representations of the same document. We redraw the vendor invoice symbol in the cash disbursements clerk column to make the flowchart easier to read.

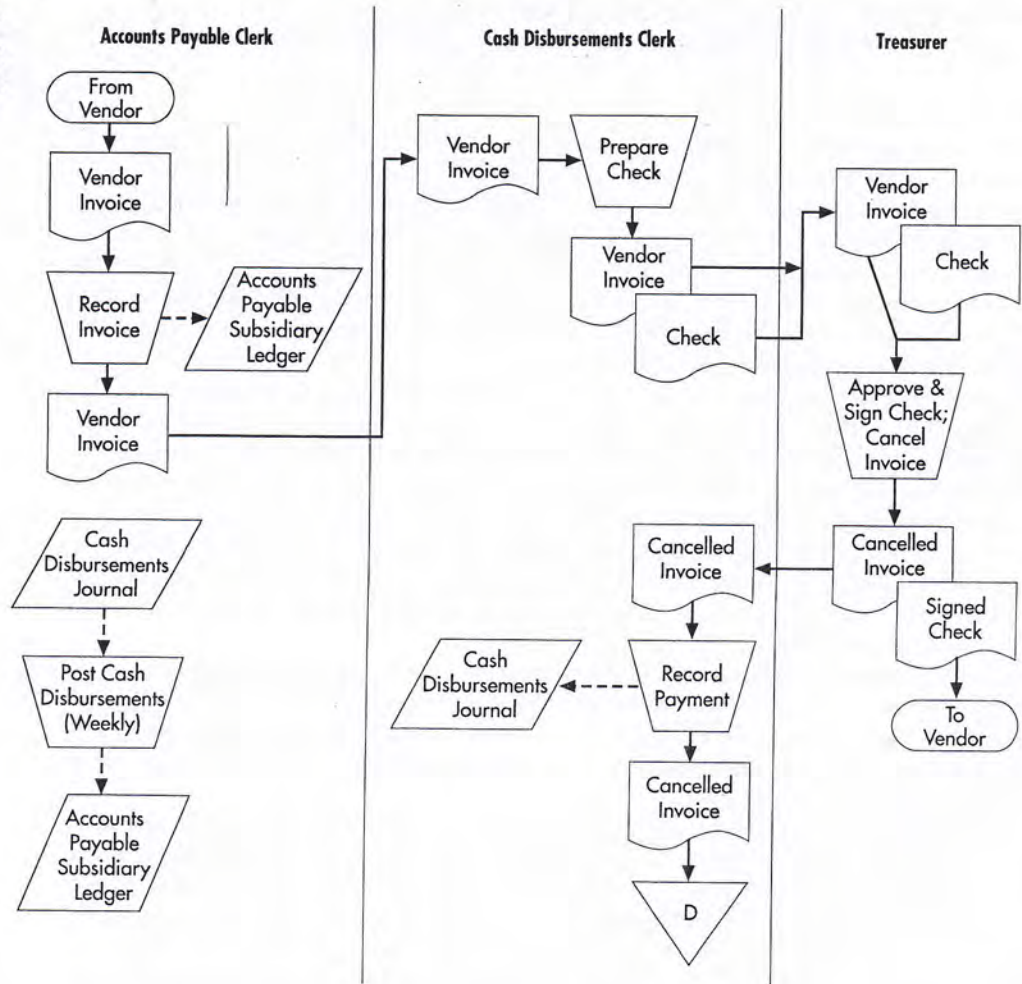
To show that the cash disbursement clerk prepares a check to pay the vendor invoice, a manual process symbol with "Prepare Check" inside it is placed next to the vendor invoice. We could have placed it below the invoice symbol but put it beside it to save space. Two document symbols are placed below the manual process for the vendor invoice and the newly prepared check.

The cash disbursements clerk then sends the invoice and check to the treasurer. As a result, the vendor invoice and check appear in the Treasurer column. A manual symbol with "Approve & Sign Check; Cancel Invoice" inside is used to show that the check is signed and the invoice is cancelled. The documents are again shown in the flowchart, this time with new titles (Cancelled Invoice and Signed Check) to show the changed nature of the documents. The treasurer sends the signed check to the vendor, which is illustrated using a terminal symbol with words "To Vendor" written in it.

**TABLE 3-3 Accuflow's Table of Functions**

Accounts Payable Clerk (Megan Waters)	Cash Disbursements Clerk (Stan Phillips)	Treasurer (John Sterling)
Receives invoice	Prepares check	Approves and signs check
Records invoice	Records cash disbursement	Cancels invoice
Posts cash disbursement	Files cancelled invoice	Mails check

**FIGURE 3-14**  
Accuflow's Document Flowchart



The cancelled invoice is used to record the cash disbursement in the cash disbursements journal, so it is sent back to the middle column (Cash Disbursements). A manual process symbol with "Record Payment" inside it and a dotted arrow are used to show that the disbursement is recorded in the cash disbursements journal, represented by a journal/ledger symbol. To illustrate that the cancelled invoice is filed by date, it is shown, using appropriate arrows, as exiting the record payment manual process and entering a file. A "D" is placed in the file symbol to indicate that the documents are filed by date.

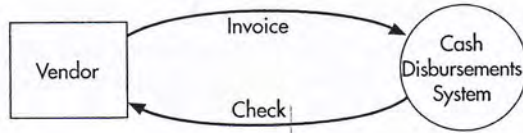
Each week, the accounts payable clerk manually posts entries from the cash disbursements journal to the accounts payable subsidiary ledger. To show this, the cash disbursements journal symbol is reproduced in the accounts payable clerk column, and a manual process symbol with the words "Post Cash Disbursements (Weekly)" is placed under it. Dotted arrows show information from this journal being entered into the accounts payable subsidiary ledger.

This completes the document flowchart for the Accuflow Company's cash disbursements process.

**Context Diagram**

A context diagram is an overview of the information process being documented. As such, a context diagram includes a single transformation process (circle or bubble) and the data sources and data destinations that send or receive data directly from the transformation process. Thus, the first step in preparing a context diagram is to draw a single circle or bubble and then label it with a name that best describes the process being documented. In this case, "Cash Disbursements System" effectively describes the process (see Figure 3-15).

The next step is to draw and label squares for the entities that either send data to the cash disbursements process or receive data from the cash disbursements process. In this example, there is



**FIGURE 3-15**  
Accuflow's Context Diagram

a single entity—the vendor that acts as both a source and a destination of data to/from the cash disbursements process. In other processes, an outside entity could be just a source or a destination of data, and there could be more than one source or destination of data.

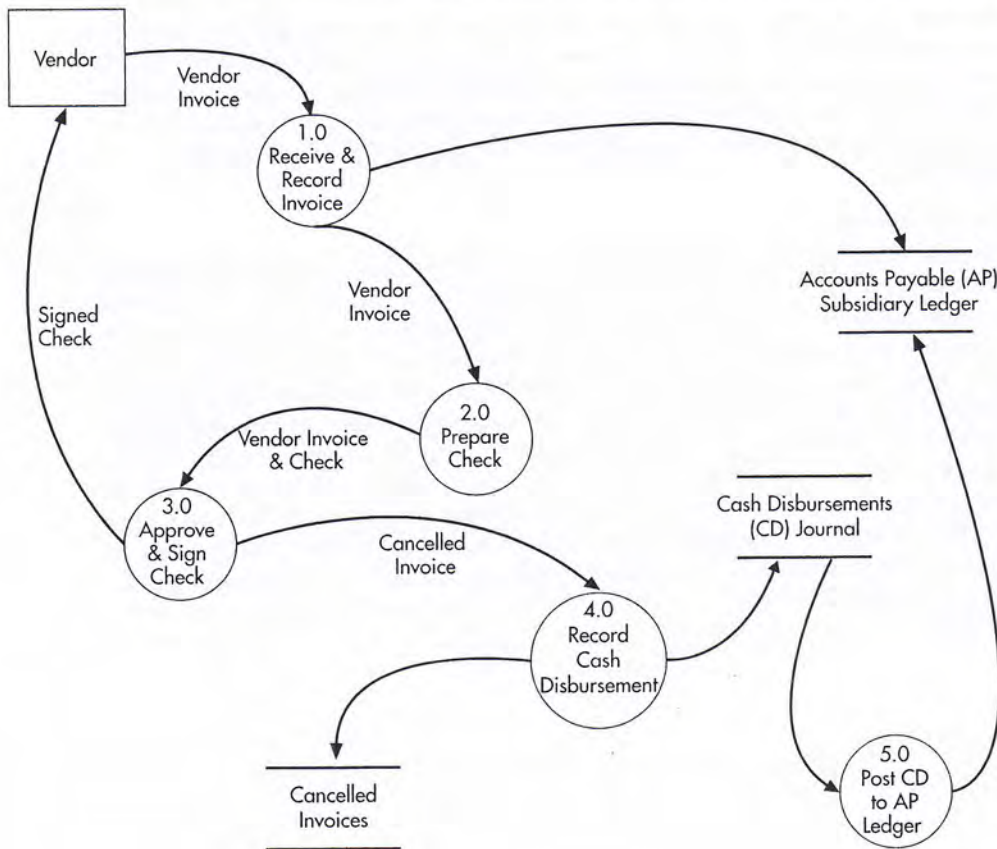
The last step is to connect the process (circle) with the source/destination (square) with arrows representing data flows. In this case, we have two arrows representing an invoice sent to Accuflow's cash disbursement process and a check sent to the vendor from Accuflow.

**Level 0 Data Flow Diagram**

In the context diagram, we saw the entire cash disbursements process in one bubble. In a level 0 DFD, we break down the cash disbursements process into its major functions. In reading the narrative, we find the following five primary steps in the cash disbursements process at Accuflow:

1. Receive vendor invoice and record payable
2. Prepare the check
3. Sign and send the check and cancel the invoice
4. Record the cash disbursement
5. Post the cash disbursements to the accounts payable ledger

Each of these processes is represented by a circle or bubble in Figure 3-16. Since this is the level 0 DFD, we assign each of these processes a real number, with the first digit after the decimal point being a zero. We also place the circles in the order that the data should flow in the process. As a result, "Receive and Record Invoice" is assigned process 1.0, "Prepare Check" is assigned process 2.0, "Approve and Sign Check" is 3.0, "Record Cash Disbursement" is 4.0, and "Post Cash Disbursement to Accounts Payable Ledger" is 5.0. This numbering system allows us to



**FIGURE 3-16**  
Accuflow's Level 0 Data Flow Diagram

decompose these processes into more detailed subprocesses and still keep a consistent numbering system. Thus, if we needed to decompose process 3.0 to a more detailed level, we could assign subprocess bubbles as 3.1, 3.2, 3.3, etc. We can even provide greater detail by decomposing process 3.1 into subprocesses 3.1.1, 3.1.2, 3.1.3, etc.

Next, we place the data sources and data destinations on the level 0 DFD. Because we had only one data source and destination (i.e., the vendor), we draw a square and label it "Vendor." It is very important that we reconcile back to the context diagram when we prepare the different levels of DFDs. That is, the same data sources and destinations that appeared on the context diagram must also appear on the level 0 DFD. No new data sources and destinations may appear on the level 0 DFD. If, when preparing the level 0 DFD, you discover that a data source/destination is necessary to document the system properly, then you must revise the context diagram with the new data source/destination, because the context diagram should represent the entire process.

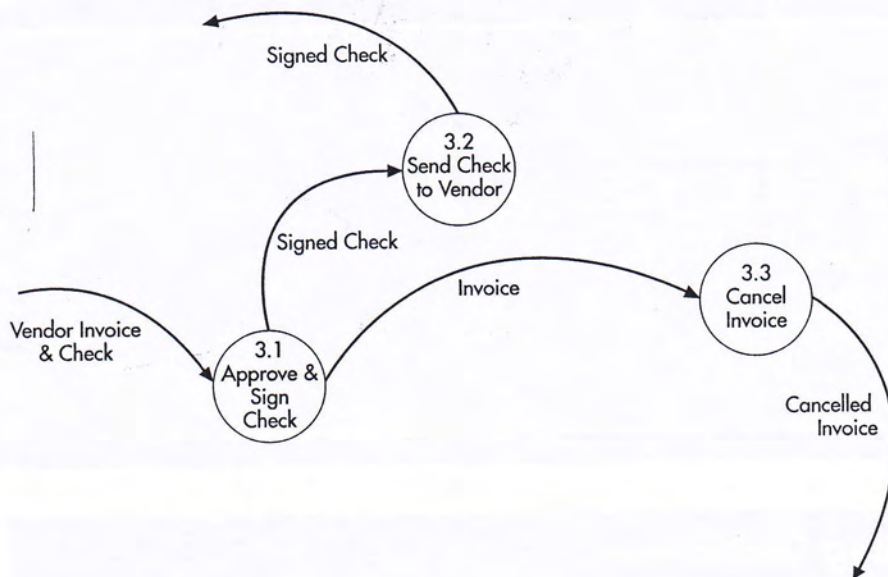
Once the data source/destinations and processes are drawn, we then connect them by drawing the arrows between the appropriate symbols. These arrows represent the data moving or flowing from one process to another and from one source or destination to or from a particular process. Accordingly, we have a vendor invoice moving from the vendor to the "Receive and Record Invoice" process and from that process to the "Prepare Check" process. The vendor invoice and a check move from the "Prepare Check" process to the "Approve and Sign Check" process. We also have arrows leaving process 3.0 to represent the signed check being sent to the vendor and the cancelled invoice going to process 4.0, "Record Cash Disbursements."

Some processes require that data be stored. As a result, we also draw any necessary files or data stores. The level 0 DFD is the first time data stores appear in a DFD set. (Note: Data stores should not be represented on a context diagram.) Data store labels should identify the data being sent to or from it. As a result, labeling the data flows to or from data stores is normally unnecessary. Data stores are prepared by drawing two parallel lines and inserting the name of the data store between the parallel lines.

In Figure 3-16 we have three data stores: the cash disbursements journal, accounts payable subsidiary ledger, and the cancelled invoices data store. Because the cash disbursements journal is updated in process 4.0, a data flow is sent from the process 4.0 circle to the cash disbursements journal data store. To show that the accounts payable ledger is updated when invoices are received (process 1.0), an arrow is drawn from that process to the accounts payable ledger. To show that accounts payable is updated with data from the cash disbursements journal (process 5.0), a data flow arrow is drawn from the cash disbursements data store to process 5.0, and another data flow arrow is drawn from process 5.0 to the accounts payable subsidiary ledger data store. The update takes place weekly, but unlike document flowcharts, a DFD does not indicate the timing of data flows.

### Level 1 Data Flow Diagram

When additional detail is needed to document data flows, a process bubble may be decomposed further. As indicated in Focus 3-1, to be clear, understandable, and easy to read, a DFD should contain no more than seven process bubbles. In the Accuflow example, we broke the company's data flows into five main processes. Each of these five processes can be further decomposed. To illustrate this, we will decompose process 3.0. The narrative indicates that the treasurer approves and signs the prepared check, sends it to the vendor, and cancels the invoice to prevent duplicate payments. Therefore, we will break down process 3.0 into process 3.1 (approve and sign check), 3.2 (send check to vendor), and 3.3 (cancel invoice). To display the three processes, we draw three circles and label them as shown on Figure 3-17. We also draw the data flows and label them. Notice that the vendor data source/destination is not needed on the level 1 DFD since it is already shown on level 0. Since it would clutter the DFD, and because we are showing greater detail on the level 1 than on the level 0 for one particular process, we do not replicate all of the processes and data stores in the level 0 DFD.



**FIGURE 3-17**  
Accuflow's Level 1 Data Flow Diagram