Bonus Chapter 2 — Flow Charting

Introduction

Intro text

Objectives

Upon completion of this chapter's exercises, you should be able to:
- Recognize common flowcharting symbols.
- Explain how flow lines work and their default behavior.
- Interpret a flowchart with the symbols of terminal, process, decision, and parallel operations.

Prerequisites

This bonus chapter stands alone and may be optionally included anywhere in your studies.

What is a Flowchart?

Flowcharts are one of the classical approaches for modeling and analyzing processes. The flowchart allows one to break a process down into smaller process and link the sub-processes in a structured manner.

Because of the graphic nature of the flowchart they are often used to communicate very complex processes to non-technical people and as a tool to better understand a process before implementation.

Flowcharts have been around for decades and have generally been used in Computer software design. Because of the ease of use and the ability to draw a picture of a process, using these techniques, the flowchart has also been adapted by many other disciplines.

The reasons to flowchart are many

- Communication:
    The graphic nature of a flowchart allows it to be read by the technical and non-technical user. A picture is worth a 1000 words...

- Effective Analysis:
    Graphical tool to allow the analyst to see the big picture of a process.
- Efficient Implementation:
    By acting as a blue-print or road map the coder/builder it makes many tasks in implementation easier.
- Proper Debugging:
    By testing each of the defined processes and decision points we can insure that the system matches the flowchart.
- Easier Maintenance:
    The flow chart allows the maintainer a direct connection to the original architect/analyst to better understand the system.
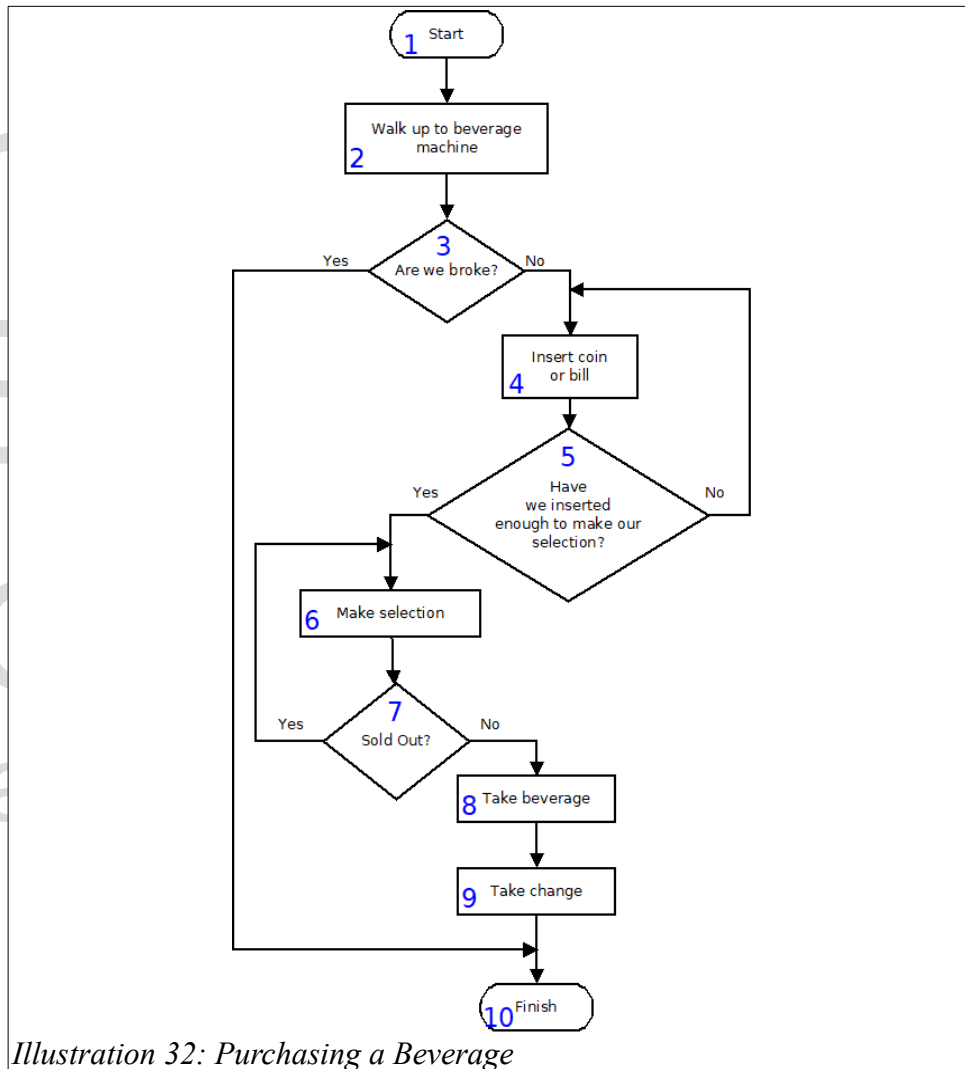
Soda Machine Example

Lets start by showing a sample flowchart. This chart goes through the detailed process of purchasing a drink from a soda machine.

Illustration 32: Purchasing a Beverage

The soda machine example shows several of the basic symbols used in this type of diagram, including: Terminal, Decision, Process, and Flow Lines.

Let's walk step by step through this example. The above diagram has been drawn with its symbols numbered from 1 to 10. The following narrative will step through the process beginning at the "Start" terminator (#1). If a step does not tell you to go to a specific step, then proceed to the next one.

1 — Start the process of buying a drink from a vending machine.
2 — Walk up to the machine.
3 — Do you have enough cash to buy a refreshing drink?
      Yes: Follow the arrow to #4.
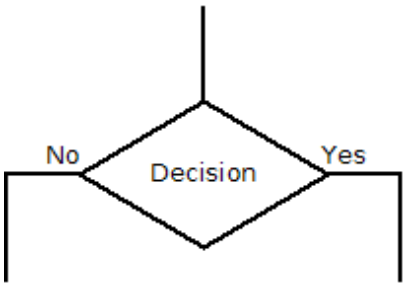   No: Follow the arrow to #10.

4 — Put a coin or bill into the machine.
5 — Have you inserted money enough to make the purchase?
      Yes: Follow the arrow to #6.
      No: Follow the arrow to #4 and insert more money.
6 — Make a selection.
7 — Is your selection is sold-out?
      Yes: Follow the arrow back to #6 and make another selection.
      No: Follow the arrow to #8.
8 — Remove your drink from the machine.
9 — Remove any change from the machine.
10 — We are done.

The picture was not quite worth a thousand words but...

Most Common Symbols

The following table contains a list of the most commonly used symbols in a flowchart. A vast majority of flowcharting tasks can be accomplished with just these three symbols.

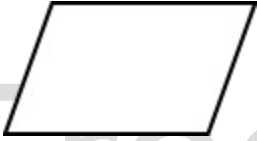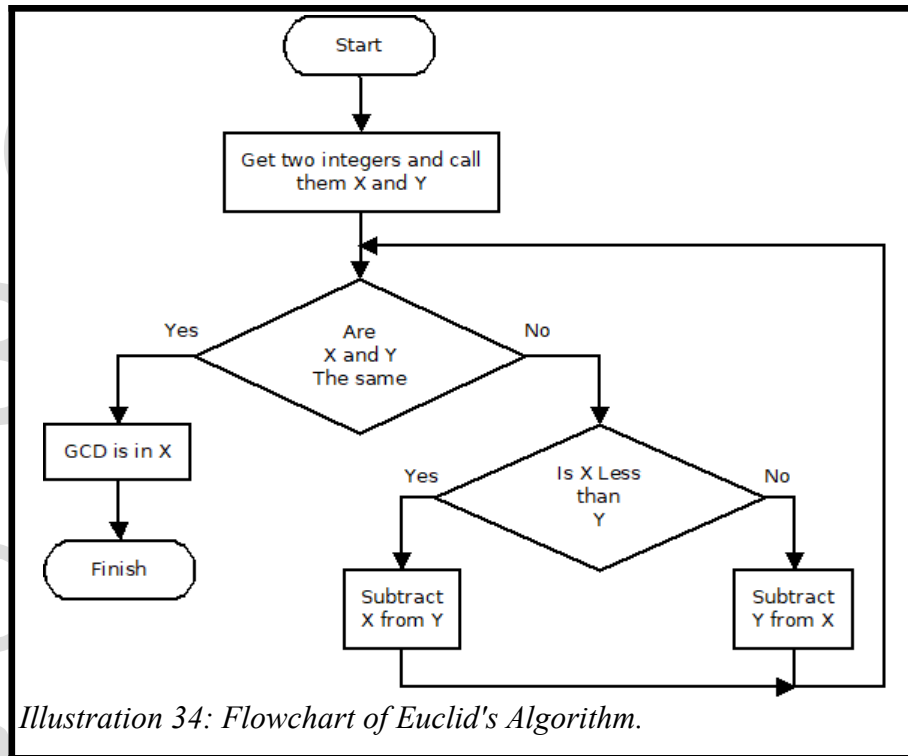| Symbol	Name	Description
	Terminal	This symbol is used to denote the start and finish of the process being described. There is always one "Start" and one "Finish". These are also called Triggers and Targets. Only one flow (in or out) is used with the terminal.
	Simple Decision	The diamond represents a place in the process where a decision is to be made. A simple decision asks a Boolean (yes/no) question. There may be only one flow into a decision and two flows out. The flows out should be labeled Yes/No, Good/Bad, Pass/Fail, or something similar.
	Process	The rectangle represents an action to be taken. The action may be as simple as a single machine (assembly) instruction but may be as complex as another entire system. Only ONE flow should exit a process.

Lines or Flows

Connecting the symbols on the flow chart are lines that represent the order or "flow". The flow lines will flow from **left-to-right** or **top-to-bottom** if they do not have arrow heads on them. Some flowcharts include arrow heads on every line.

Illustration 33: Flowchart Crossing Flows

If two flow lines cross, they do not intersect. The flow simply continues along the straight line. These should be avoided when laying out your flowchart, but sometimes they can not be avoided.

Two flows may join into a single output. Remember the left-to-right and top-to-bottom rules when you see a "T" shape.

Lastly, three flows may join at a "+" or an "X" if one pair of flows have arrows showing that the flow does not continue across the other flow.

Euclid's Algorithm Example

One of the most elegant algorithms in mathematics is Euclid's Algorithm for finding the Greatest Common Divisor (GCD). It can be stated simply as: With two numbers, subtract the smallest from the largest until they are the same; the remaining number is the GCD.

We can draw Euclid's algorithm with the following flowchart.
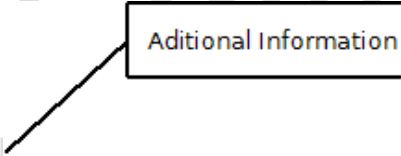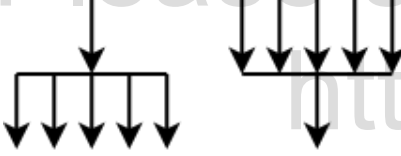
Illustration 34: Flowchart of Euclid's Algorithm.

More Symbols

The following table contains a list of several more commonly used symbols in a flowchart. These symbols allow for more complex decisions, parallel operations, adding notes to your chart, and spanning pages.

Symbol	Name	Description
	Complex Decision	A diamond may also be used to represent a decision or question that has multiple possible results. The sample diagram shows 4 choices, but any number greater than 3 may be drawn. An example could be types of shoes: casual, dress, sport and work.
	Input / Output	The Input/Output symbol represents data being

	(IO)	moved into or out of the system or task being defined. Only ONE flow should enter or exit an IO.
	Connector	The connector symbol is used to simplify the flow lines. If a flow line becomes too long and must cross several other flow lines you may break the line with a connector. Only ONE flow should exit a connector.
	Off Page Connector	The Off Page Connector works like the connector except it tells the reader that the other end of this connector is on another page of the diagram. Only ONE flow should exit an off page connector.
	Annotation	The annotation symbol is used to add extra explanatory text about another symbol.
	Parallel Mode	The parallel mode connector allows the process to be split into several flows that can be accomplished at the same time. This is especially helpful to chart systems that have sections that may be done independently of each other.

Bicycle Built For Two Example

To re-enforce the idea of flowcharting lets look at another example.
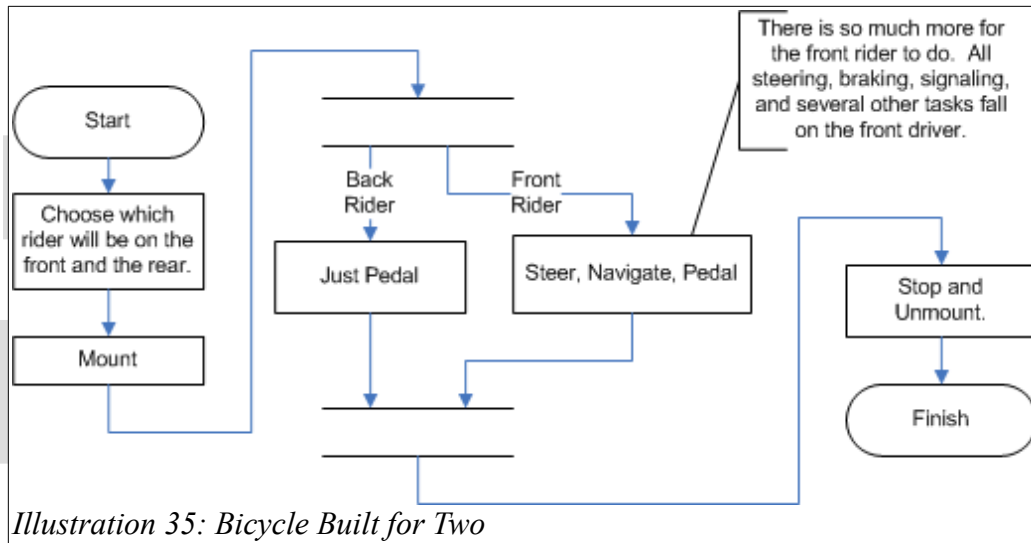
Illustration 35: Bicycle Built for Two

This chart gives a very high level overview of the task of riding a bicycle build for two. In this example there are two riders, and each has specific duties. The front rider has the duties of steering, pedaling, and navigating while the back rider pedals and back-seat drives. Because the riders are doing their jobs independently and in parallel we split the system flow into two streams, one for each rider. At the end of the ride the streams are rejoined so that both riders are stopping at the same time.

This illustration also introduces the Annotation symbol. Annotations are used to supply more detail than is appropriate for a basic understanding the symbol. A high level flow chart, like this example, does not need to define every single task or action to clarify the system. It is important to keep that in mind the end-user and the detail they require, when labeling symbols.

What's For Dinner Example

Illustration 36: What's for Dinner - Complex Decision
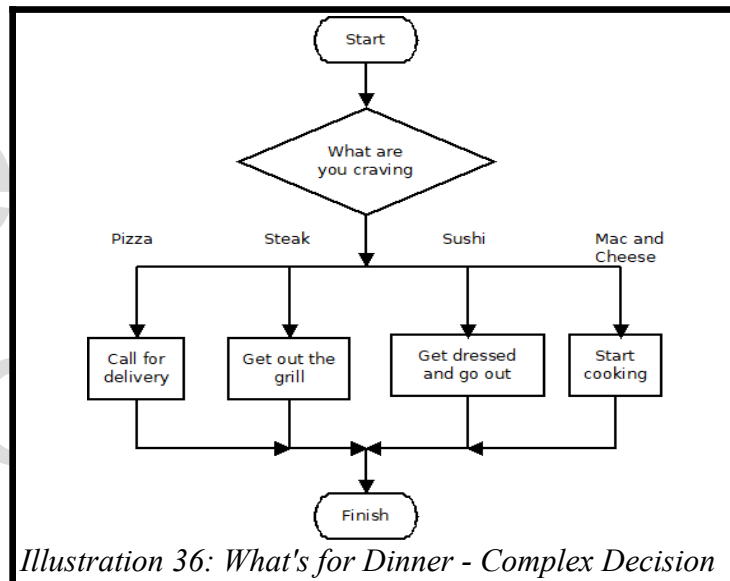
Even More Flowcharting Symbols

The following table lists a few of the many other less used flowchart symbols, their names, and a description of their use.

	Communication Link	The Communication Link symbol represents the motion of data to or from an external source into a Process, IO, or Decision. Communications may be unidirectional or bidirectional.
	Document	This represents a piece of paper. It may be a report the system creates, reads, or any other non digital document.
	Display	This represents the user display screen. If a program needs to display a message or requires input from the user keyboard this symbol is used.

	Storage	This represents an on-line disk or database storage location. Data may be saved or read from this location. Often one system will use data created by another system and saved to disk.

Now lets look at an example using a data source, and communication links.

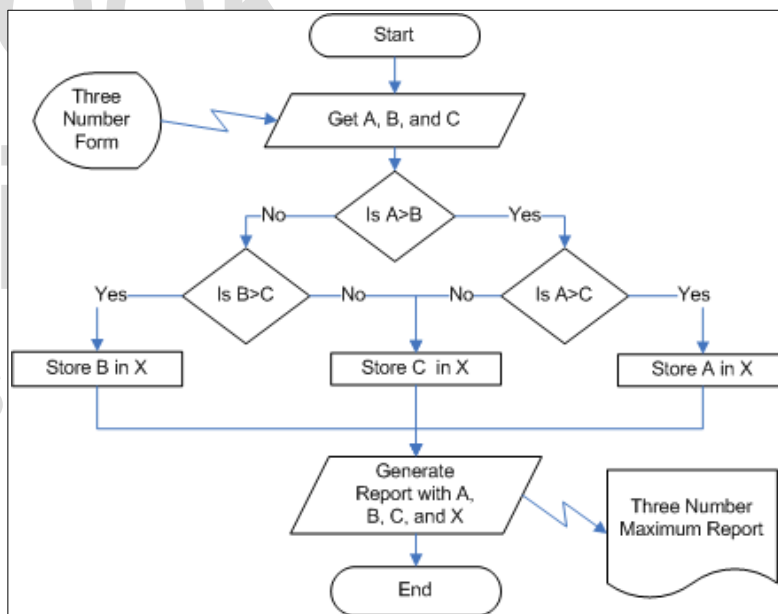## User Input and Report Example

Illustration 37: Get Three Numbers and Print the Highest

As we can see in illustration 3. We have user input into the "Three Number Form" entering the system and a report entitled "Three Number Maximum Report" exiting the system. The data entering or exiting this system may be from or going to another system.

How to Draw a Flowchart

The following is a guide for creating a flowchart. This is only a recommendation for getting started, there are as many ways to approach a flowchart as there are people and problems.

1. Describe the task to be charted. Usually this takes form of a one line description or title, like "How

to ...”
2. Start at the single beginning and work to the single End.
3. Document each step you you take.
4. Remember the level of the complexity of this chart. Each process may spawn a sub-chart to more fully describe it.

Tips for Clear Flowcharting

*   Put yourself in the position of the reader.
*   Try to anticipate the reader's problems in understanding the chart.
*   Make the mainline of each flowchart easily recognizable.
*   Do not chart every detail of the system (program).
*   Leave sufficient white space (especially margins) on your document so that it does not become too crowded.
*   Use the connector symbol to reduce confusing intersections or crossings of flow lines.
*   Keep the text in the symbols brief. Use the annotation symbol if additional detail is necessary.
*   TEST YOUR FLOWCHART. Walk through it and be sure it is correct.

Limitations of Flowcharting

*   For very complex systems a detailed diagram may become overly complex and difficult to use. You may overcome this by starting with a high-level diagram and create separate diagrams for each of the hi-level processes.
*   Alterations, modifications, and distribution may be difficult for hand drawn flowcharts. Tools like VISIO, DIA, and others almost remove this limitation.

Summary

Goes here

Important Terms

• annotation	• connector	• flow
• arrow	• decision	• flowchart
• communication link	• display	• input
• complex decision	• document	• output

- • parallel mode
- • process

- • right to left
- • storage

- • terminal
- • top to bottom

Exercises

Here

Word Search

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e t p v w p t c i i m t r u i · f l
g h t e o l f o t v d t i o z t l p
t t o n p · r m r r t · g m n e o a
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a u z f s t g o r b l p f l o w y f
p r o c e s s n c i i n u r n r e ·
c o m m u n i c a t i o n · l i n k
o d o c u m e n t · y a r l · o l o
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annotation, arrow, communication link, complex decision, connector, decision, display, document, flow, flowchart, input, output, parallel mode, process, right to left, storage, terminal, top to bottom

Exercises

References

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