

Chapter Thirteen

Programming Languages and Program Development

Discovering Computers 2012

**Your Interactive Guide
to the Digital World**



Objectives Overview

Differentiate between machine and assembly languages

Identify and discuss the purpose of procedural programming languages, and describe the features of C and COBOL

Identify and discuss the characteristics of these object-oriented programming languages and program development tools

Identify the uses of other programming languages and program development tools

Describe various ways to develop Web pages

Objectives Overview

Identify the uses of popular multimedia authoring programs

List the six steps in the program development life cycle

Differentiate between structured design and object-oriented design

Explain the basic control structures and design tools used in designing solutions to programming problems

Computer Programs and Programming Languages

- A **computer program** is a series of instructions that directs a computer to perform tasks
 - Created by a **programmer** using a **programming language**

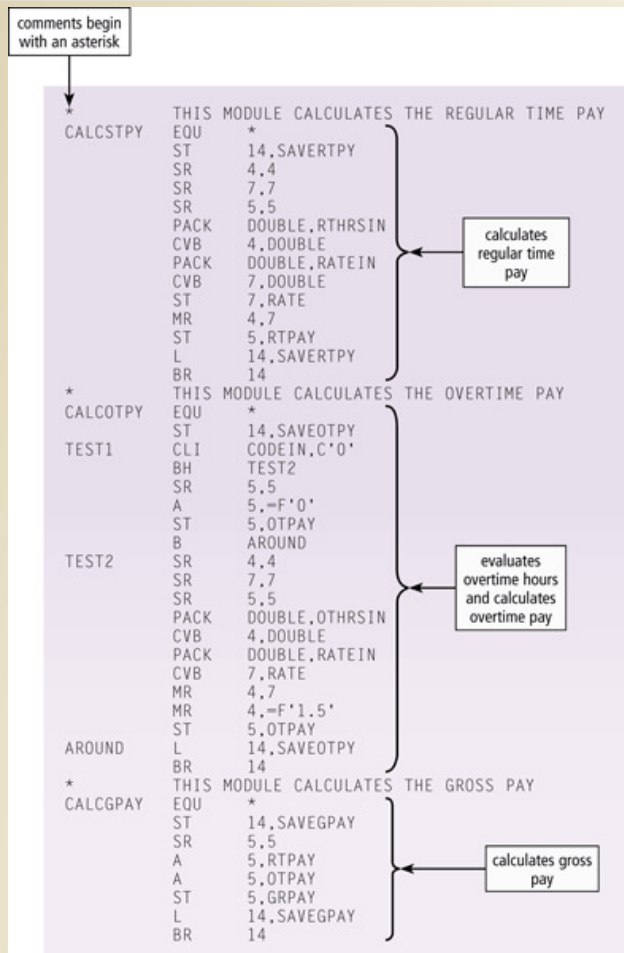


Low-Level Languages

- **Machine language** is the first generation of programming languages
- Only language the computer directly recognizes

0000DE	5A50	35AA			015AC
0000E2	47F0	2100		00102	
000102	1B77				
000104	5870	304E			01050
000108	1C47				
00010A	4E50	30D6			010D8
00010E	F075	30D6	003E	010D8	0003E
000114	4F50	30D6			010D8
000118	5050	3052			01054
00011C	58E0	30B6			010B8
000120	07FE				
					00122
000122	50E0	30BA			010BC
000126	1B55				
000128	5A50	304E			01050
00012C	5B50	3052			01054
000130	5050	305A			0105C
000134	58E0	30BA			010BC
000138	07FE				

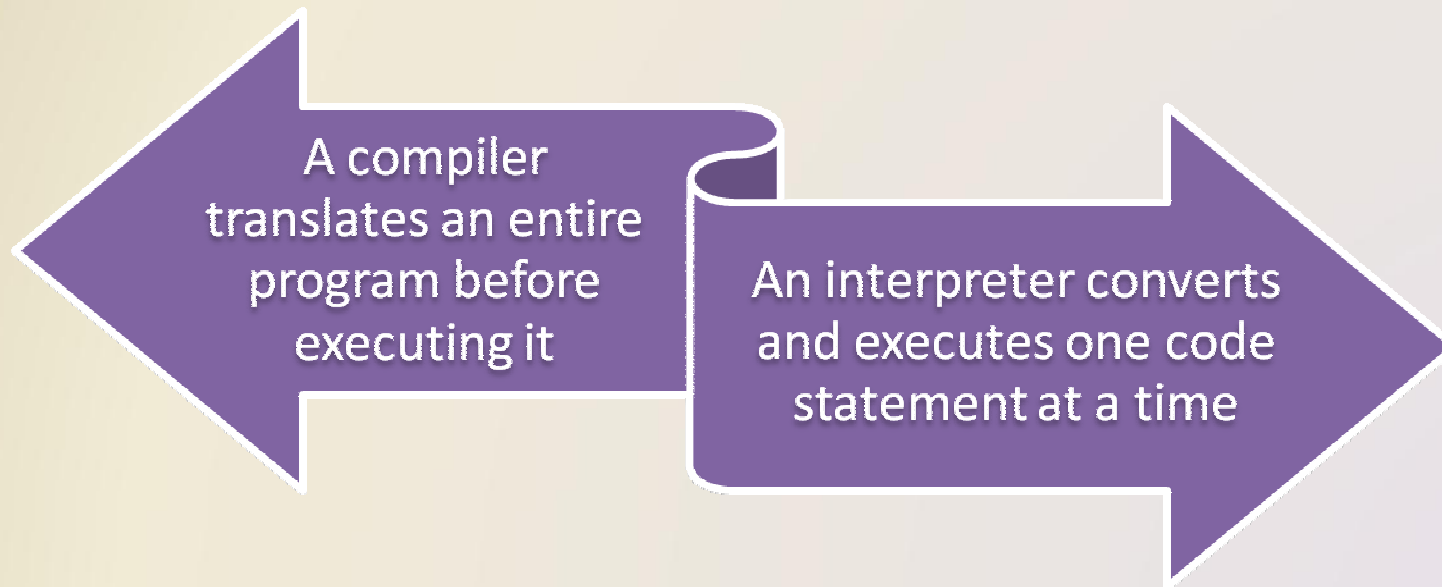
Low-Level Languages



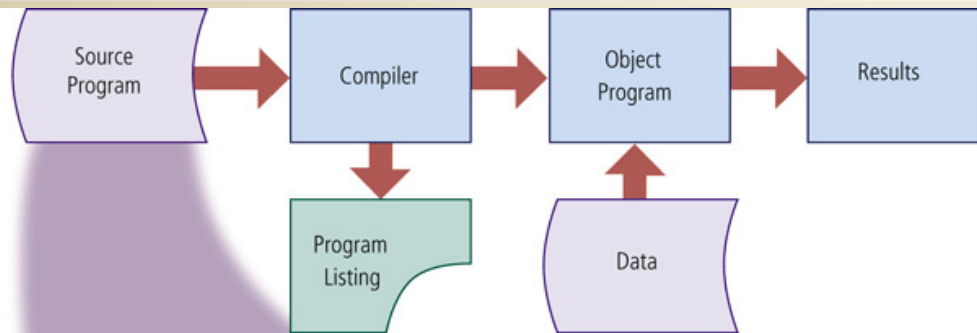
- **Assembly language** is the second generation of programming languages
- Programmer writes instructions using symbolic instruction codes
- A **source program** contains the code to be converted to machine language

Procedural Languages

- In a **procedural language**, the programmer writes instructions that tell the computer what to accomplish and how to do it
 - **Third-generation language (3GL)**



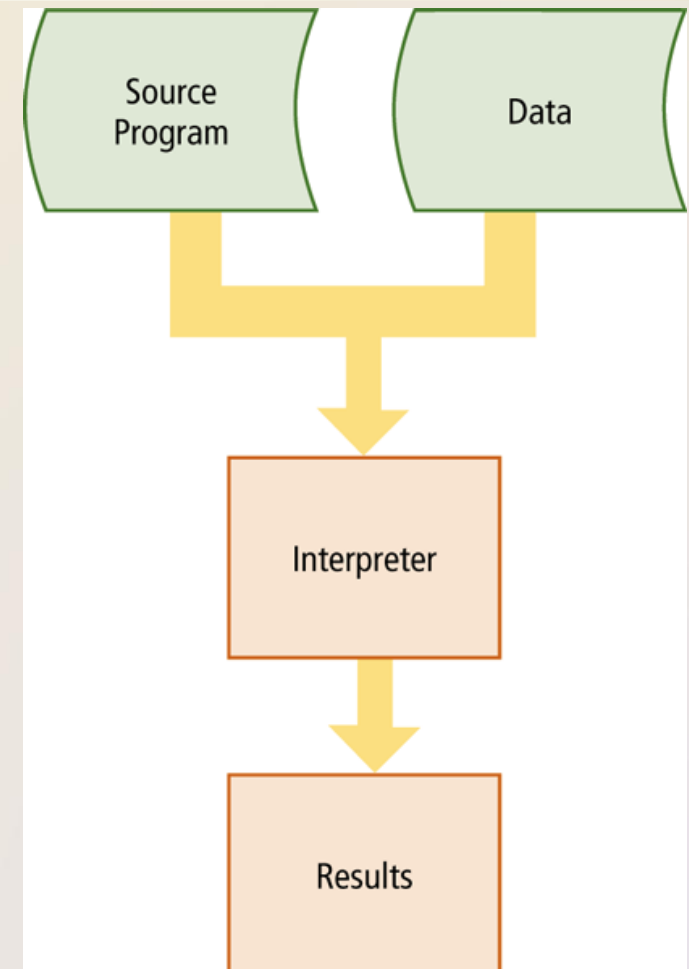
Procedural Languages



```
* COMPUTE REGULAR TIME PAY
MULTIPLY REGULAR-TIME-HOURS BY HOURLY-PAY-RATE
  GIVING REGULAR-TIME-PAY.

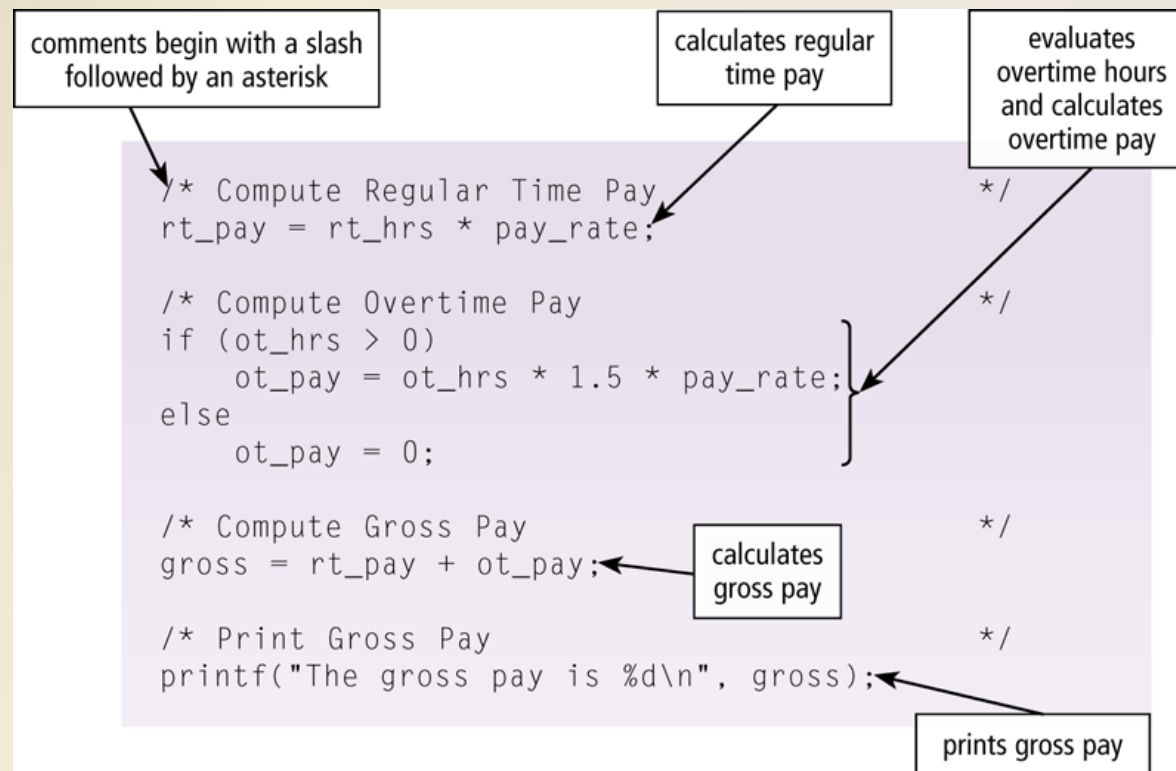
* COMPUTE OVERTIME PAY
IF OVERTIME-HOURS > 0
  COMPUTE OVERTIME-PAY = OVERTIME-HOURS * 1.5 * HOURLY-PAY-RATE
ELSE
  MOVE 0 TO OVERTIME-PAY.

* COMPUTE GROSS PAY
ADD REGULAR-TIME-PAY TO OVERTIME-PAY
  GIVING GROSS-PAY.
```



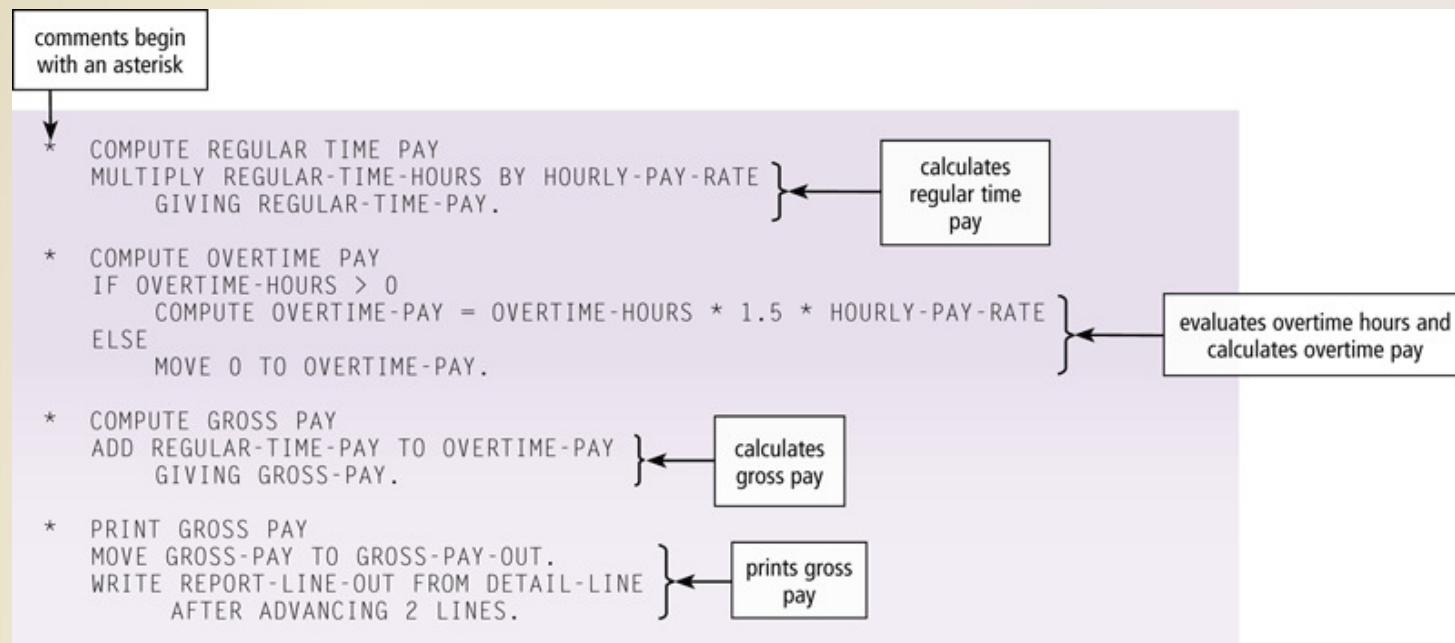
Procedural Languages

- The **C** programming language is used to write many of today's programs



Procedural Languages

- **COBOL** (COmmon Business-Oriented Language) is designed for business applications, but easy to read because of the English-like statements



Object-Oriented Programming Languages and Program Development Tools

- An **object-oriented programming (OOP) language** allows programmers the ability to reuse and modify existing objects
- Other advantages include:

Objects can be
reused

Programmers
create applications
faster

Work well in a
RAD environment

Most program
development tools
are **IDEs**

Object-Oriented Programming Languages and Program Development Tools

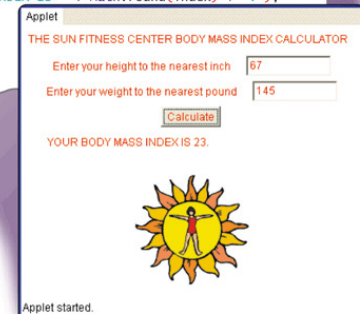
- **Java** is an object-oriented programming language developed by Sun Microsystems
- The Just-in-time (JIT) compiler converts the bytecode into machine-dependent code

```
public class BodyMassApplet extends Applet implements ActionListener
{
    //declare variables
    Image logo; //declare an Image object
    int inches, pounds;
    double meters, kilograms, index;

    //construct components
    Label companyLabel = new Label("THE SUN FITNESS CENTER BODY MASS INDEX CALCULATOR");
    Label heightLabel = new Label("Enter your height to the nearest inch ");
    TextField heightField = new TextField(10);
    Label weightLabel = new Label("Enter your weight to the nearest pound ");
    TextField weightField = new TextField(10);
    Button calcButton = new Button("Calculate");
    Label outputLabel = new Label("Click the Calculate button to see your Body Mass Index.");

    inches = Integer.parseInt(heightField.getText());
    pounds = Integer.parseInt(weightField.getText());
    meters = inches / 39.36;
    kilograms = pounds / 2.2;
    index = kilograms / Math.pow(meters,2);
    outputLabel.setText("YOUR BODY MASS INDEX IS " + Math.round(index) + ".");

    public void paint(Graphics g)
    {
        g.drawImage(logo, 125, 160, this);
    }
}
```



Object-Oriented Programming Languages and Program Development Tools

- The Microsoft **.NET** Framework allows almost any type of program to run on the Internet or an internal business network, as well as computers and mobile devices
- Features include:

CLR (Common
Language
Runtime)

Classes

Object-Oriented Programming Languages and Program Development Tools

- **C++** is an extension of the C programming language
- **C#** is based on C++ and was developed by Microsoft
- **F#** combines the benefits of an object-oriented language with those of a functional language

```
// portion of a C++ program that allows users to create
// a new zip code from a string or a number and expand
// zip codes, as appropriate, to a 10-digit number

ZipC::ZipC( const unsigned long zipnum )
{
    ostringstream strInt;
    strInt << zipnum;
    code = strInt.str();
}

const string ZipC::getCode()
{
    return code;
}

void ZipC::setCode(const string newCode)
{
    code = newCode;
}

void ZipC::expand( const string suffix )
{
    if(code.length() == 5 &&          // small size?
       suffix.length() == 4)         // length ok?
    {
        code += "-";
        code.append(suffix);
    }
}
```

Object-Oriented Programming Languages and Program Development Tools

Visual Studio is Microsoft's suite of program development tools

Visual Basic is based on the BASIC programming language

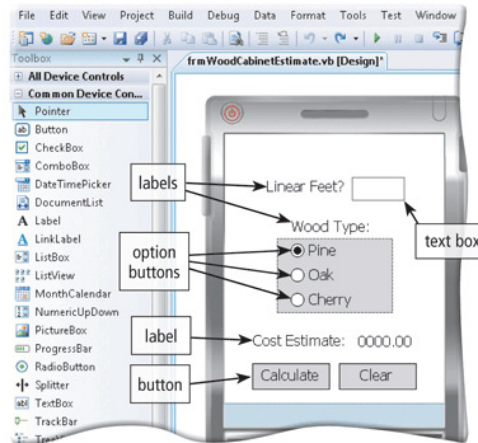
Visual C++ is based on C++

Visual C# combines the programming elements of C++ with an easier, rapid-development environment

Object-Oriented Programming Languages and Program Development Tools

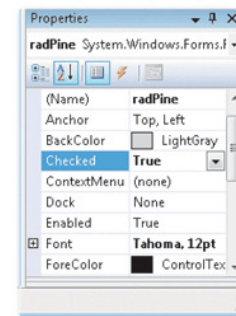
Step 1

The developer designs the user interface, such as for the mobile device shown here. Linear Feet is a text box in which the user enters data. Pine, Oak, and Cherry are option buttons the user can click to choose the wood type. Calculate and Clear are buttons. All other objects are labels.



Step 2

The developer assigns properties to each object. Objects include text boxes, option buttons, buttons, labels, and the form itself.



Step 4

The developer tests the program. The Cost Estimate is displayed after the user clicks the Calculate button.



Step 3

The developer writes code to define the action of each event the user triggers.

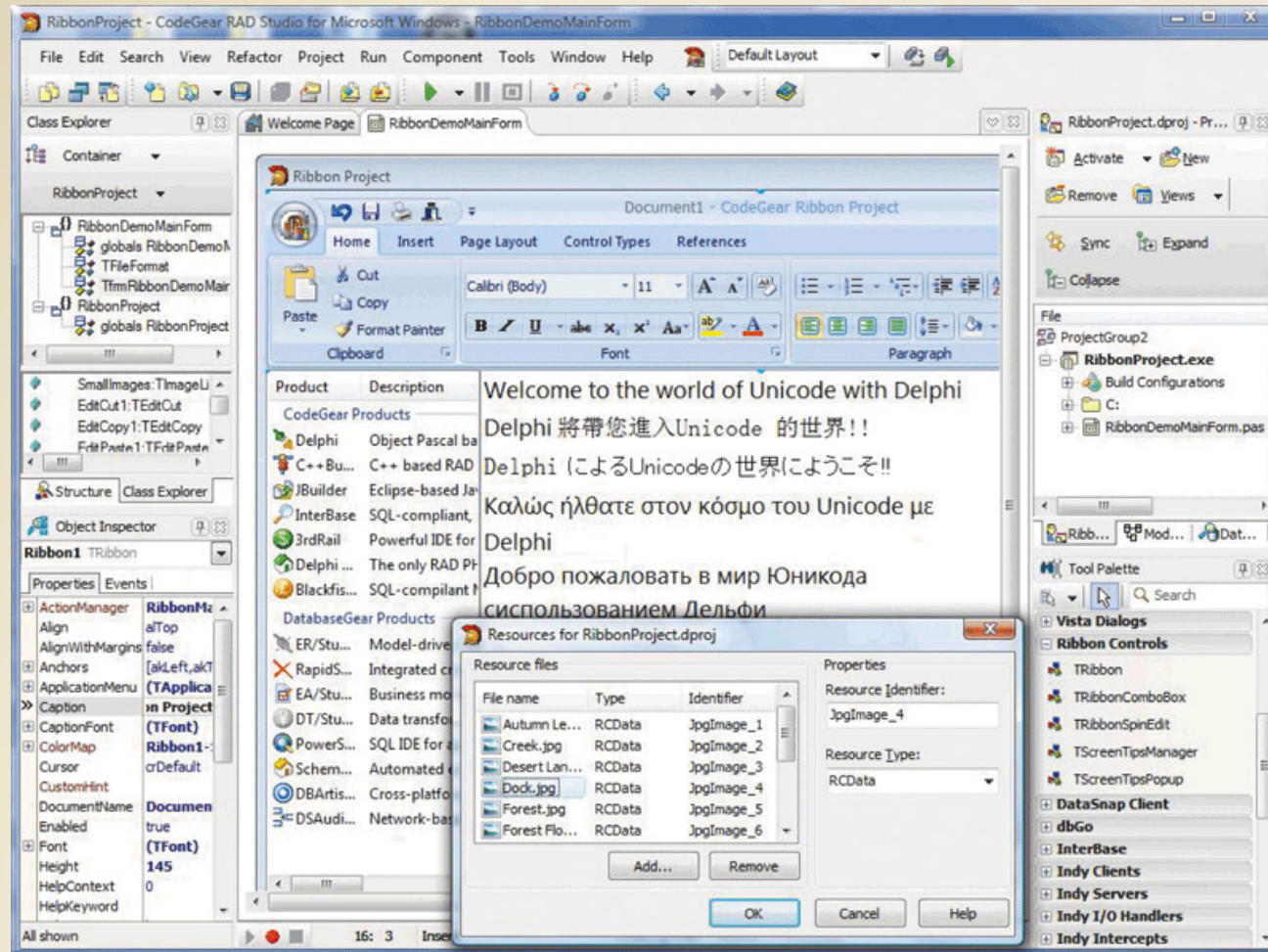
```
14 Private Sub btnCalculate_Click(ByVal sender As System.Object, ByVal e As
15 EventArgs) Handles btnCalculate.Click
16     ' The btnCalculate event handler calculates the estimated cost of
17     ' cabinets based on the linear feet and the wood type.
18
19     ' Declaration Section
20     Dim decLinearFeet As Decimal
21     Dim decCostPerFoot As Decimal
22     Dim decCostEstimate As Decimal
23     Dim decPineCost As Decimal = 100D
24     Dim decOakCost As Decimal = 150D
25     Dim decCherryCost As Decimal = 250D
26
27     ' Did user enter a numeric value?
28     If IsNumeric(Me.txtLinearFeet.Text) Then
29         decLinearFeet = Convert.ToDecimal(Me.txtLinearFeet.Text)
30
31         ' Is Linear Feet greater than zero
32         If decLinearFeet > 0 Then
33             ' Determine cost per foot of wood
34             If Me.radPine.Checked Then
35                 decCostPerFoot = decPineCost
36             ElseIf Me.radOak.Checked Then
37                 decCostPerFoot = decOakCost
38             ElseIf Me.radCherry.Checked Then
39                 decCostPerFoot = decCherryCost
40             End If
41             ' Calculate and display the cost estimate
42             decCostEstimate = decLinearFeet * decCostPerFoot
43             Me.lblCostEstimate.Text = decCostEstimate.ToString("C")
44         Else
45             ' Error message if not a numeric value
46         End If
47     End If
48 End Sub
```


Object-Oriented Programming Languages and Program Development Tools

A **visual programming language** is a language that uses a visual or graphical interface for creating all source code

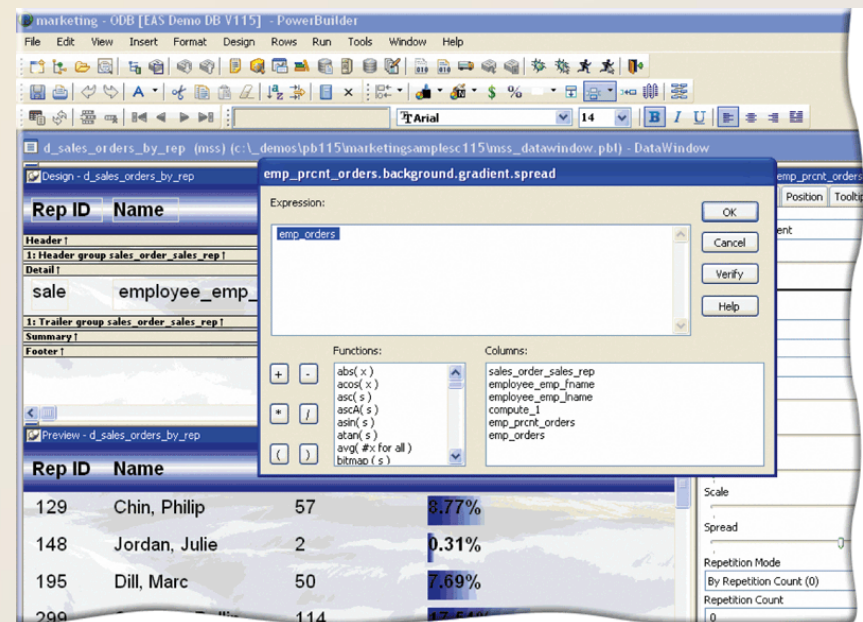
Borland's **Delphi** is a powerful program development tool that is ideal for building large-scale enterprise and Web applications in a RAD environment

Object-Oriented Programming Languages and Program Development Tools



Object-Oriented Programming Languages and Program Development Tools

- **PowerBuilder** is a powerful program development RAD tool
- Best suited for Web-based, .NET, and large-scale enterprise object-oriented applications



Other Programming Languages and Development Tools

- A **4GL** (fourth-generation language) is a **nonprocedural language** that enables users and programmers to access data in a database
 - One popular 4GL is **SQL**

```
SELECT LAST_NAME, FIRST_NAME, GROSS_PAY
FROM EMPLOYEE
WHERE OVERTIME_HOURS > 0
ORDER BY LAST_NAME;
```

LAST_NAME	FIRST_NAME	GROSS_PAY
Antiqua	Martin	780.00
Charles	Leslie	715.00
Guillan	Anita	847.50
:		
:		
:		

Other Programming Languages and Development Tools

- Classic programming languages include:

Ada	ALGOL	APL	BASIC
Forth	FORTRAN	HyperTalk	LISP
Logo	Modula-2	Pascal	PILOT
PL/1	Prolog	RPG	Smalltalk

Other Programming Languages and Development Tools

- An **application generator** is a program that creates source code or machine code from a specification of the required functionality
 - Often bundled as part of a DBMS

The image displays two screenshots of a web-based 'Employee Form' application. The left screenshot shows the form with empty input fields for General, Phone Numbers, and Address. The right screenshot shows the form populated with data for an employee named Kara Bergner.

Employee Form - General Tab

Field	Value
First Name	Kara
Last Name	Bergner
Company	Western Electronics
Job Title	Sales Representative
Phone Numbers	
Business Phone	309-555-2020
Home Phone	309-555-1828
Mobile Phone	309-555-9898
Fax Number	309-555-9899
Address	
Street	50 Spencer Boulevard
City	Highland
State/Province	IL
Zip/Postal Code	60604
Country/Region	USA

Employee Form - Phone Numbers Tab

Field	Value
Business Phone	309-555-2020
Home Phone	309-555-1828
Mobile Phone	309-555-9898
Fax Number	309-555-9899

Employee Form - Address Tab

Field	Value
Street	50 Spencer Boulevard
City	Highland
State/Province	IL
Zip/Postal Code	60604
Country/Region	USA

Other Programming Languages and Development Tools

- A **macro** is a series of statements that instructs an application how to complete a task
- You usually create the macro in one of two ways:
 - Record the macro with a macro recorder
 - Write the macro

Other Programming Languages and Development Tools

(VBA macro)

```
Microsoft Visual Basic for Applications - Car_Loan_Calculator.xlsm - [Sheet1 (Code)]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Type a question for help
Ln 36, Col 8
CommandButton1 Click
' New Auto Loan Button Macro
' Date Created: 12/16/2012
' Run from: Loan Analysis Sheet by clicking button labeled New Auto Loan
' Function: When executed, this macro accepts loan data which causes Excel to calculate
' a new monthly payment and other loan information.
Private Sub CommandButton1_Click()
    Range("C3:C8").Select
    Selection.ClearContents
    Range("C3").Value = InputBox("Car model?", "Enter")
    CarPrice = InputBox("Price of car?", "Enter")
    Do While CarPrice < 12000 Or CarPrice > 80000
        CarPrice = InputBox("Price of car must be >= $12,000 and <= $80,000")
    Loop
    Range("C4").Value = CarPrice

    DownPayment = InputBox("Down Payment?", "Enter")
    Do While DownPayment < 1500 Or DownPayment > 55000
        DownPayment = InputBox("Down payment must be >= $1,500 and <= $5,500")
    Loop
    Range("C5").Value = DownPayment

    Range("C6").Value = "=price - down payment"

    InterestRate = InputBox("Interest Rate in %?", "Enter") / 100
    Do While InterestRate < 0.03 Or InterestRate > 0.22
        InterestRate = InputBox("Interest Rate must be >= 3% and <= 22%")
    Loop
    Range("C7").Value = InterestRate

    TimeinYears = InputBox("Time in Years?", "Enter")
    Do While TimeinYears < 1 Or TimeinYears > 9
        TimeinYears = InputBox("Time in years must be >= 1 and <= 9")
    Loop
    Range("C8").Value = TimeinYears
    Range("C13").Select
End Sub
```

(macro dialog box in Excel window)

macro dialog box

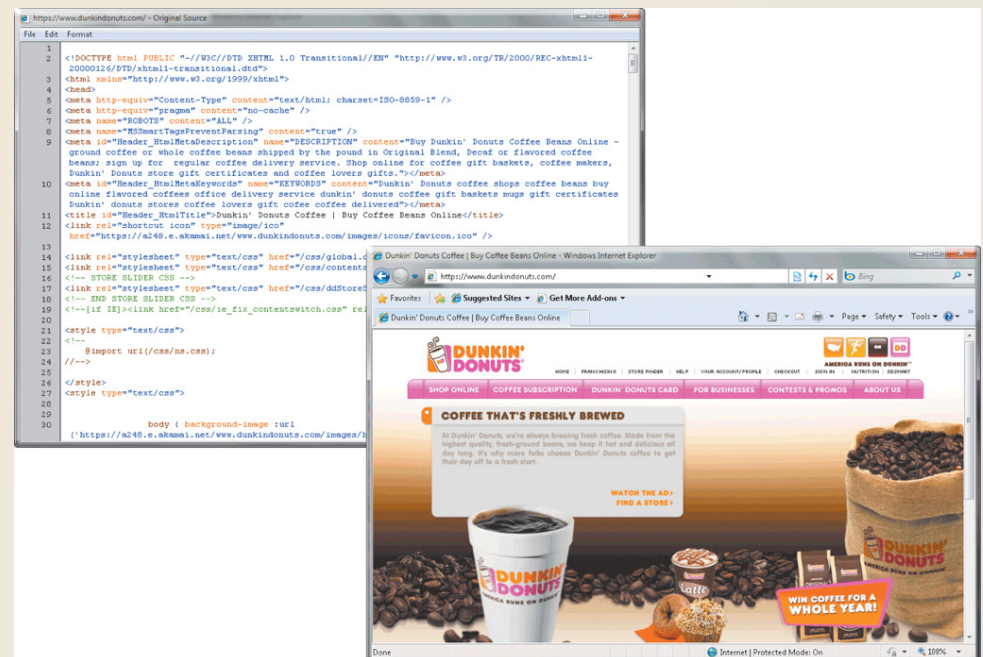
My Loan Calculator	
Date	January-12
Car model	Lexus
Price	\$62,000.00
Down Payment	\$12,750.00
Loan Amount	\$49,250.00
Interest Rate	8.50%
Years	6
Monthly Payment	\$875.59
Total Interest	\$13,792.15
Total Cost	\$75,792.15

New Loan

clicking New Loan button causes macro to run

Web Page Development

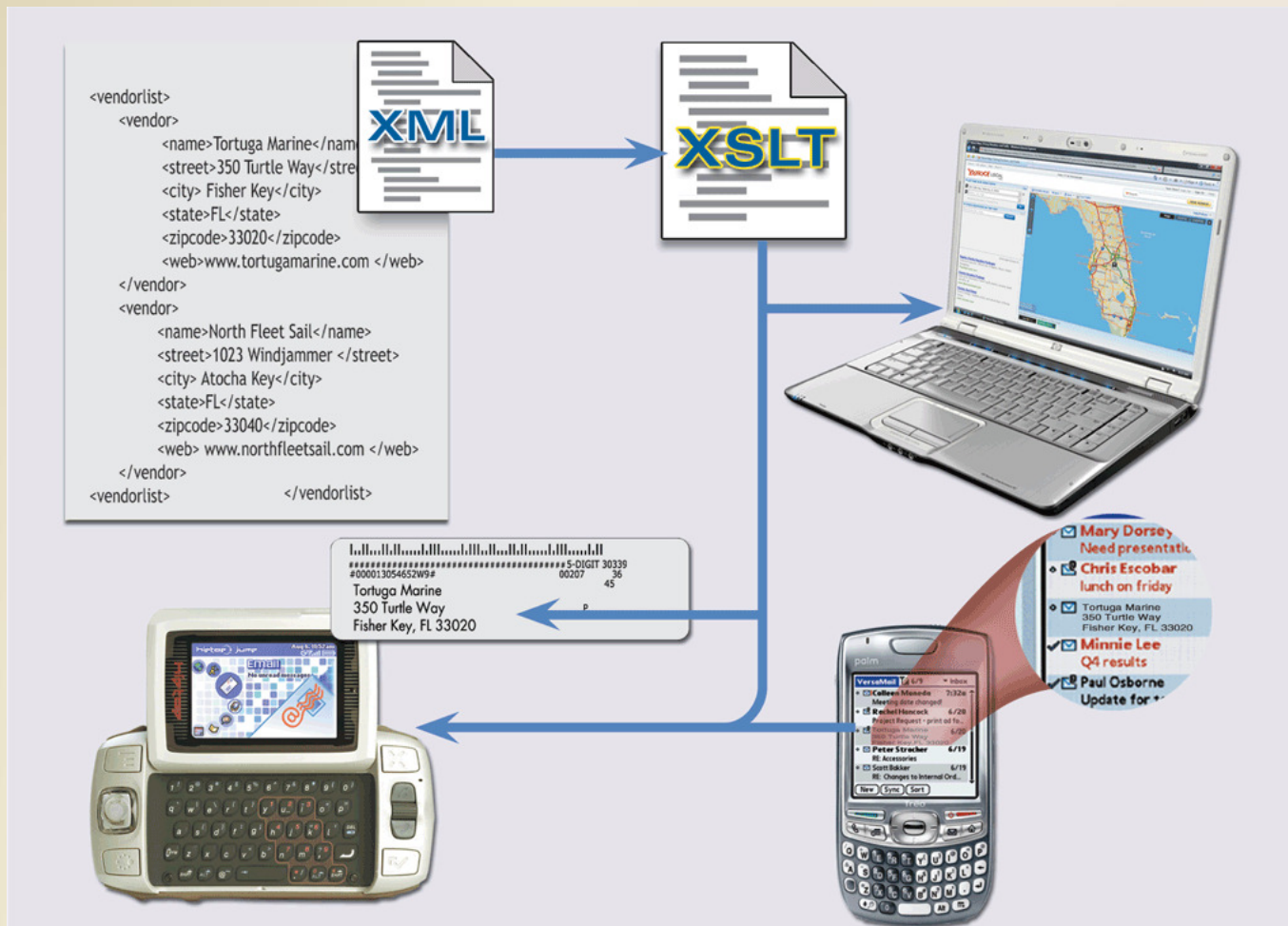
- **HTML** is a special formatting language that programmers use to format documents for display on the Web
- **XHTML** is a markup language that allows Web sites to be displayed more easily on mobile devices



Web Page Development

- **XML** allows Web developers to create customized tags and use predefined tags to display content appropriately on various devices
 - **WML** is a subset of XML and is used to design pages for microbrowsers
- Two applications of XML are **RSS 2.0** and **ATOM**

Web Page Development



Web Page Development

- Web browsers can execute short programs to add interactive elements to Web pages
- To send and receive information between your computer and a Web server, these programs use the CGI (common gateway interface)

Scripts

Applets

Servlets

**ActiveX
controls**

Web Page Development

How a CGI Script Works



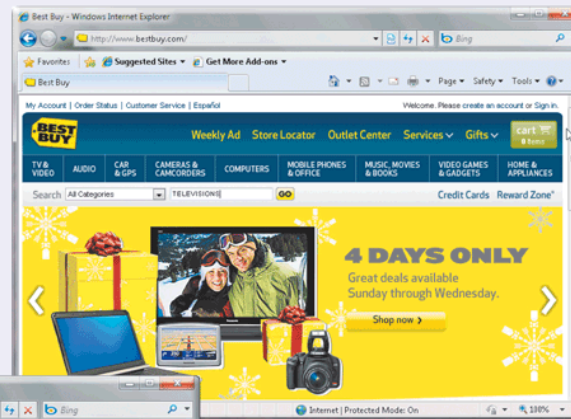
Web server

Step 1

The programmer stores the CGI program in a special folder on the Web server, such as /cgi-bin.

Step 2

The Webmaster creates a link between the CGI program and Web page. When a user displays the Web page, the CGI program automatically starts.



Step 3

When a user submits a request, it is sent to the CGI program. The CGI program contacts the database and requests information for the user. In this case, it looks for televisions at an online store.

Database



Step 4

The CGI program receives information from the database, assembles it in markup language format, and sends it to the user's Web browser.

Web Page Development

- Programmers write scripts, applets, servlets, or ActiveX controls using a variety of languages



JavaScript

Perl

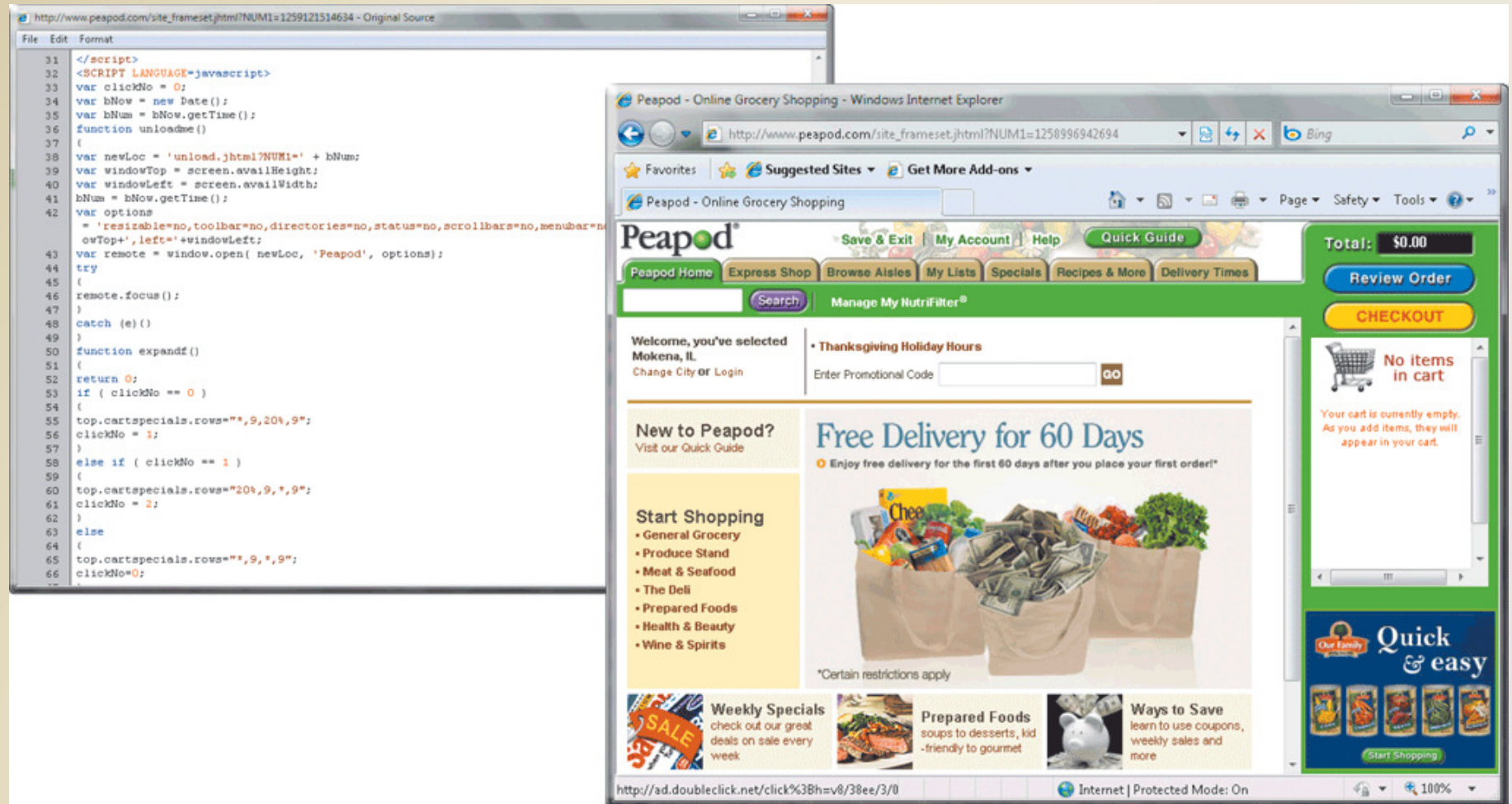
PHP

Rexx

Tcl

VBScript

Web Page Development



Web Page Development

Dynamic HTML (DHTML) allows Web developers to include more graphical interest and interactivity

- Cascading style sheets (CSS) contain the formats for how a particular object should be displayed

Ruby on Rails (RoR) provides technologies for developing object-oriented, database-driven Web sites

Web Page Development

- Web 2.0 allows Web sites to provide a means for users to:

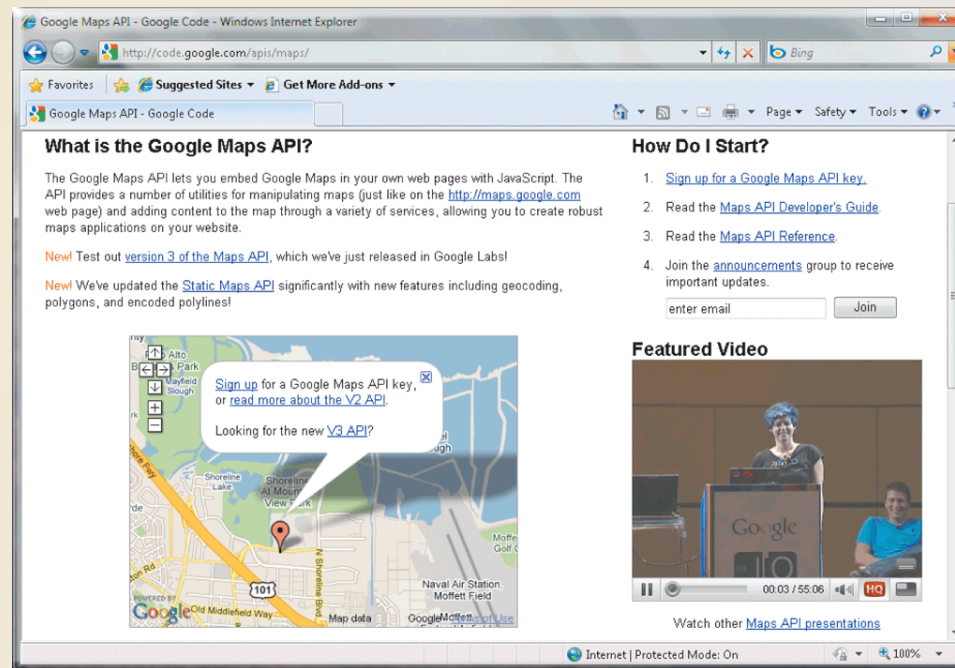
Share personal
information

Allow users to
modify Web site
content

Have application
software built
into the site

Web Page Development

- Most Web 2.0 sites use APIs
 - An API enables programmers to interact with an environment such as a Web site or operating system



Web Page Development

- **Web page authoring software** can create sophisticated Web pages that include images, video, audio, animation, and other effects

Dreamweaver

**Expression
Web**

Flash

**SharePoint
Designer**

Multimedia Program Development

- **Multimedia authoring software** allows programmers to combine text, graphics, animation, audio, and video in an interactive presentation

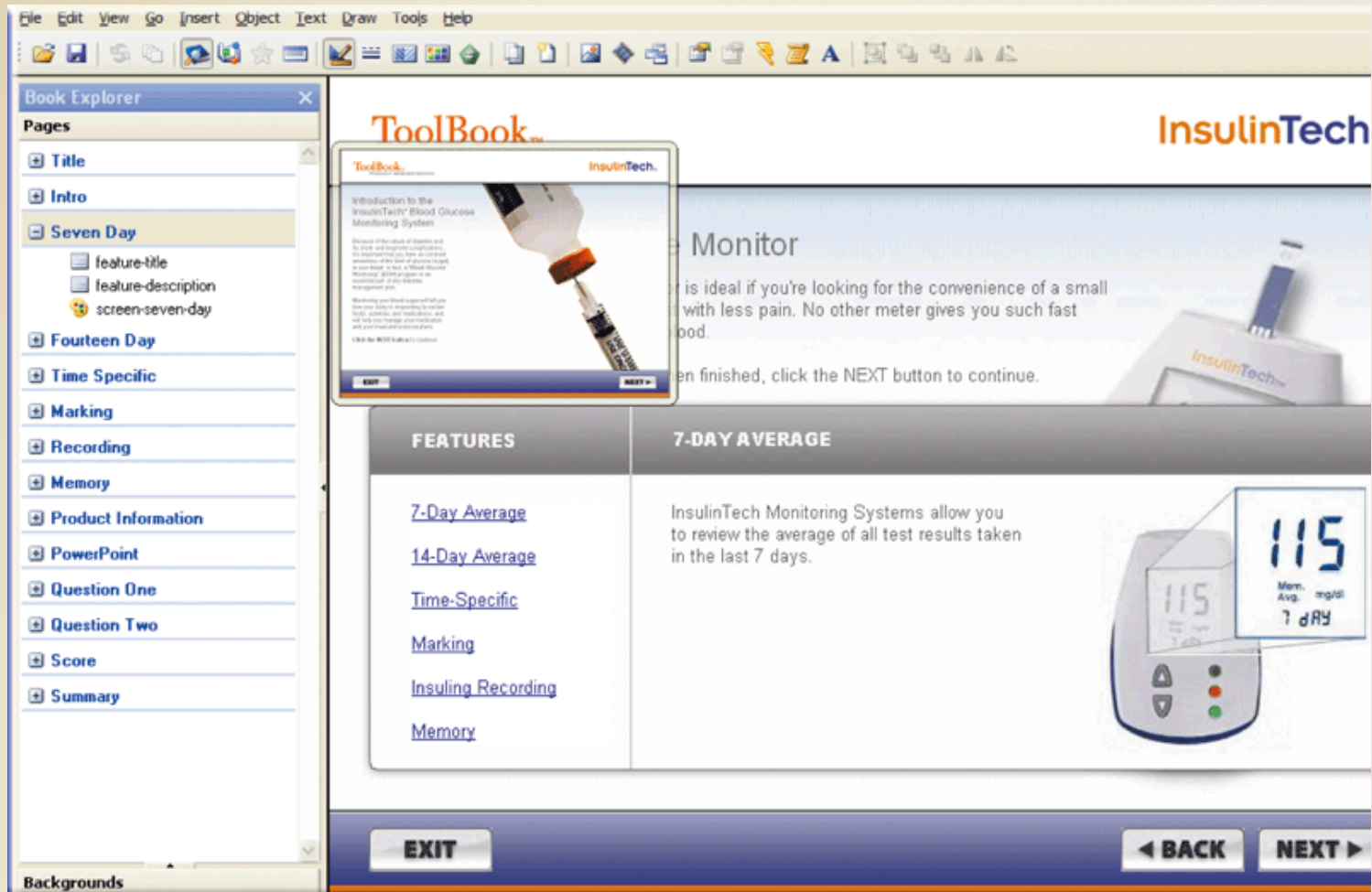
The logo for ToolBook is a purple parallelogram with the word "ToolBook" in white, bold, sans-serif font centered inside.

ToolBook

The logo for Director is a purple parallelogram with the word "Director" in white, bold, sans-serif font centered inside.

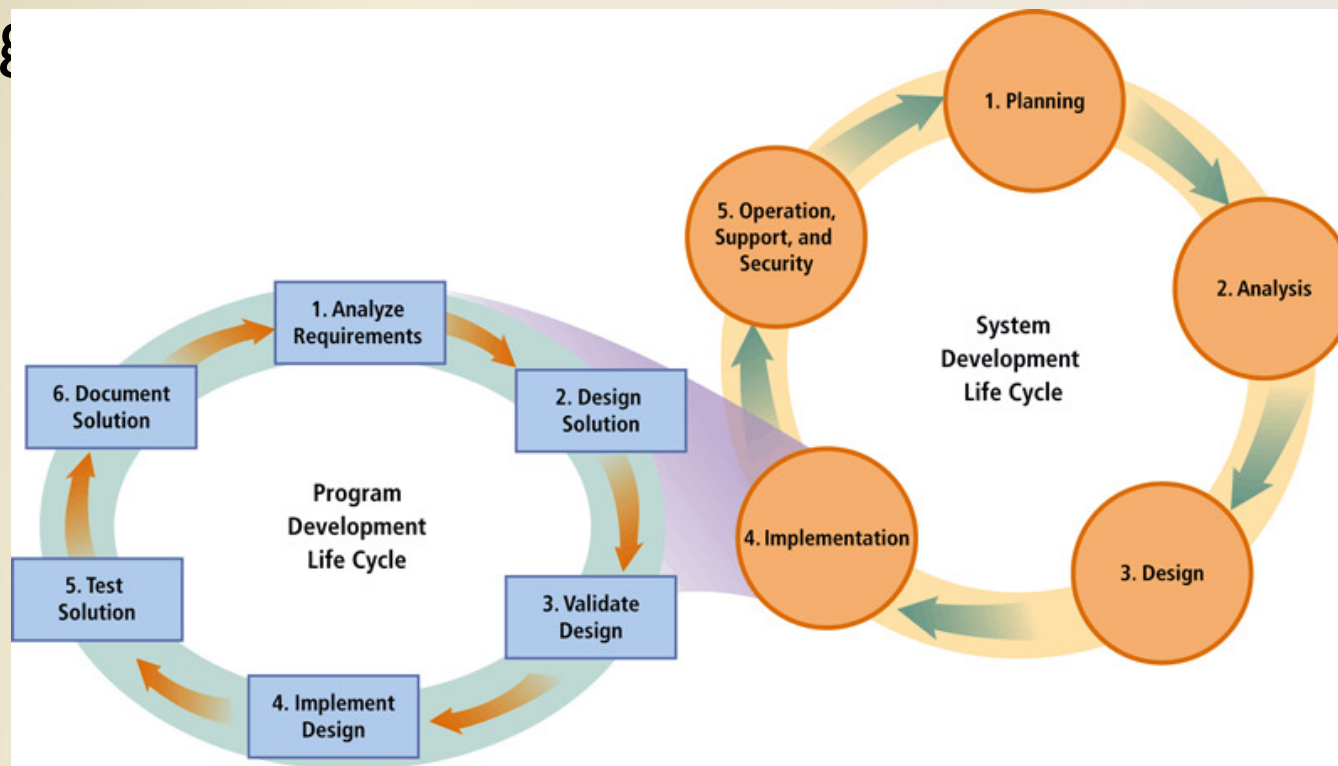
Director

Multimedia Program Development



Program Development

- **Program development** consists of a series of steps programmers use to build computer programs



Step 1 – Analyze Requirements

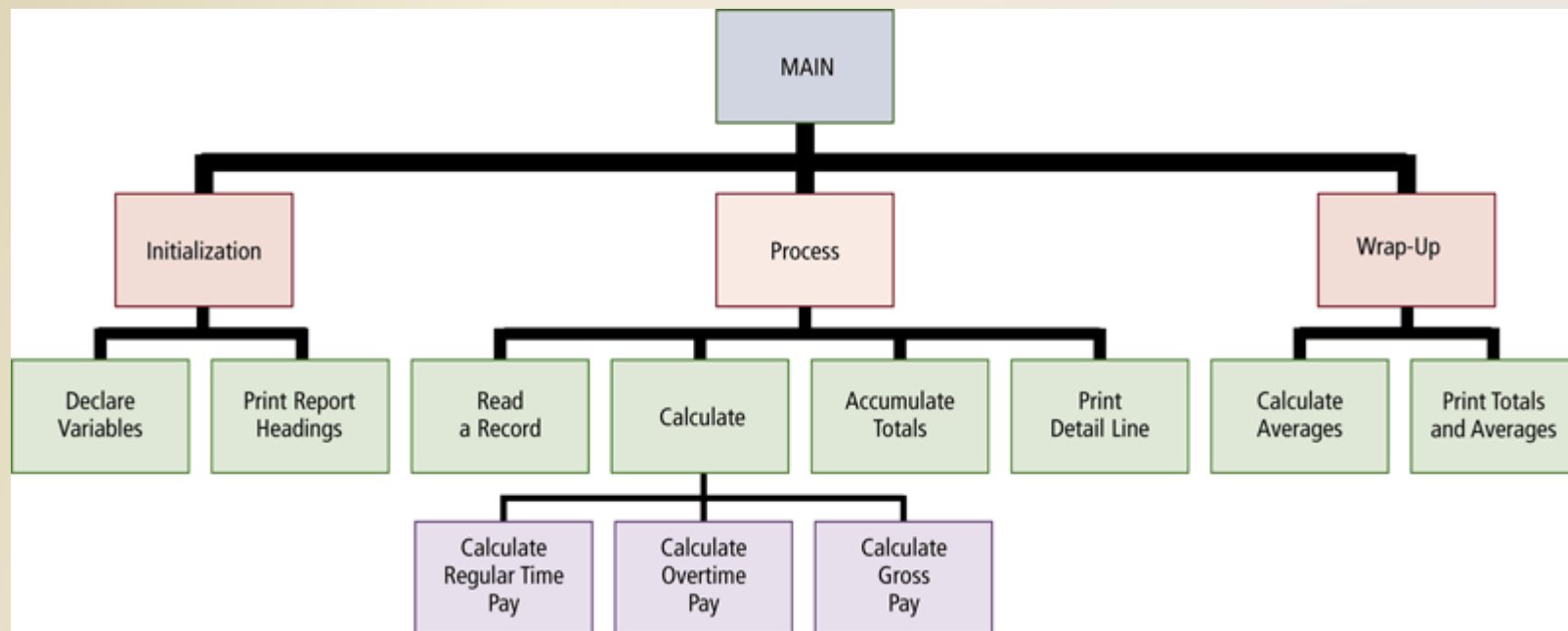
- To initiate program development, programmer:
 - Reviews the requirements
 - Meets with the systems analyst and users
 - Identifies input, processing, and output
 - IPO chart

IPO Chart		
Input	Processing	Output
Regular Time Hours Worked	Read regular time hours worked, overtime hours worked, hourly pay rate.	Gross Pay
Overtime Hours Worked	Calculate regular time pay.	
Hourly Pay Rate	If employee worked overtime, calculate overtime pay.	
	Calculate gross pay.	
	Print gross pay.	

Step 2 – Design Solution

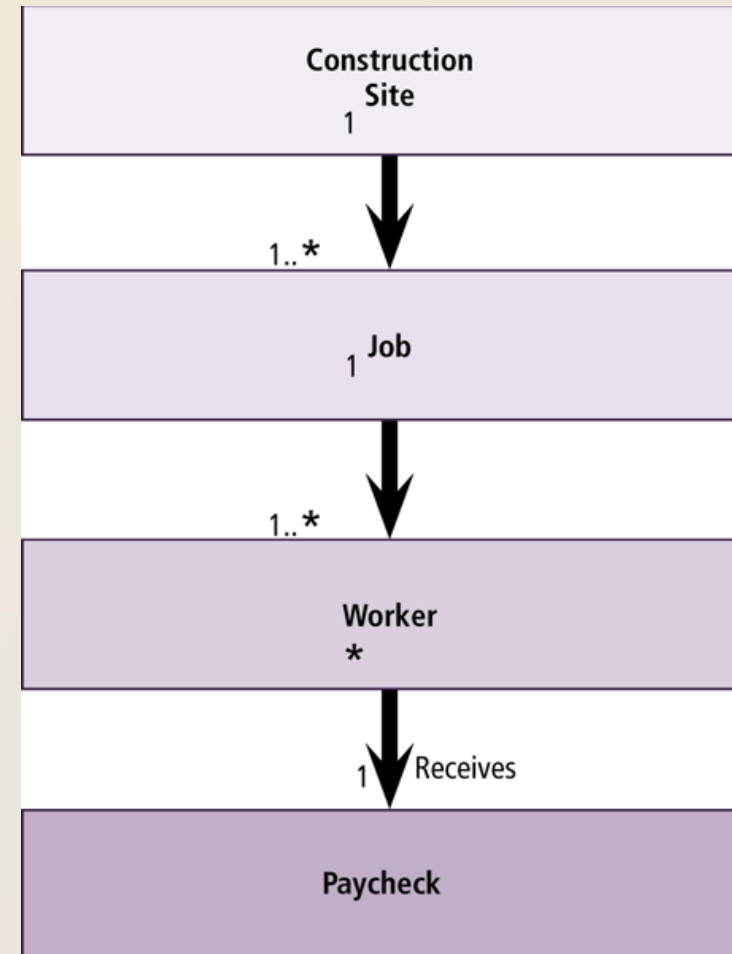
- Design a solution algorithm
- In **structured design**, the programmer typically begins with a general design and moves toward a more detailed design
- Programmers use a **hierarchy chart** to show program modules graphically

Step 2 – Design Solution



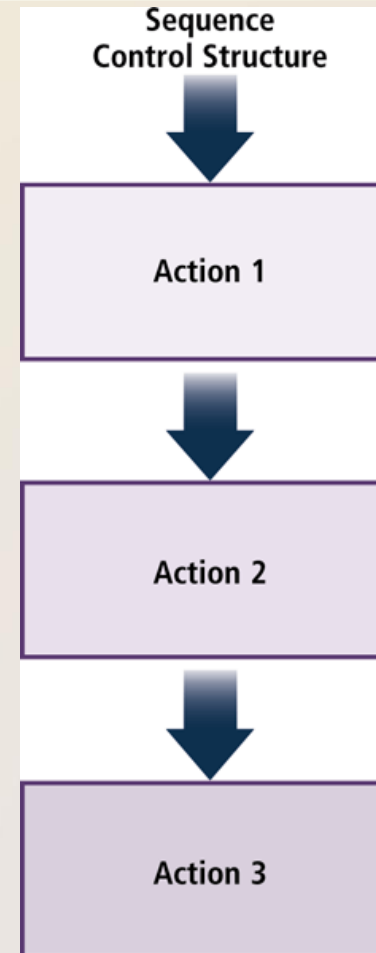
Step 2 – Design Solution

- With **object-oriented (OO)** design, the programmer packages the data and the program into a single object
 - Encapsulation

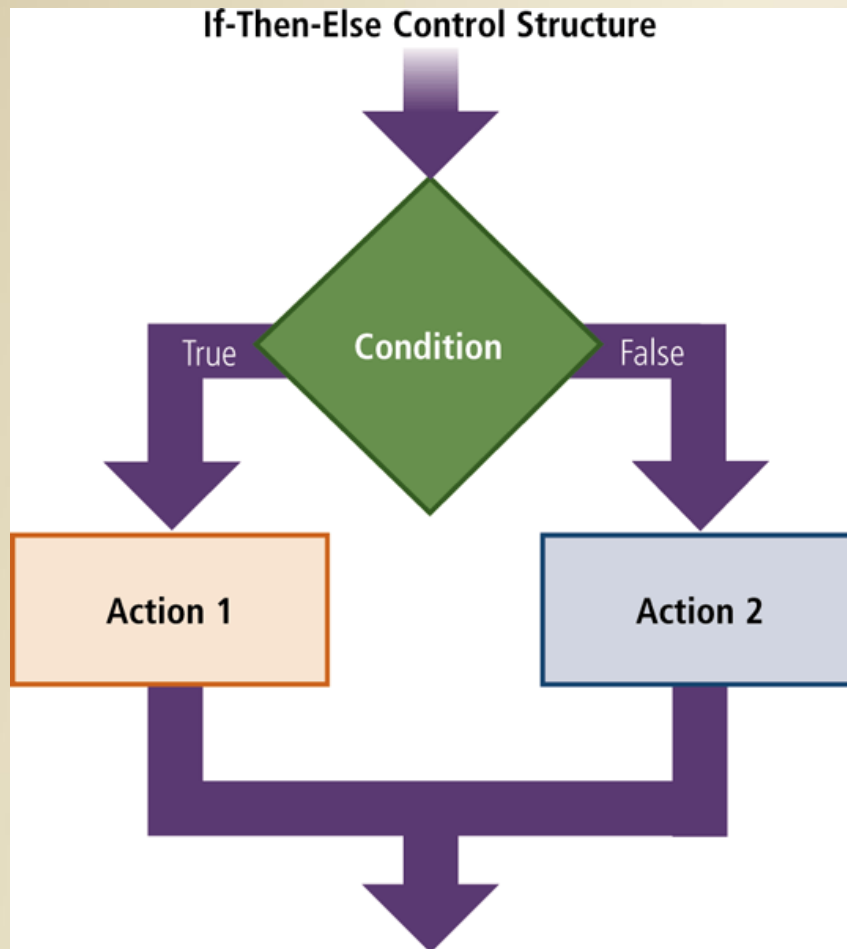


Step 2 – Design Solution

- The sequence control structure shows one or more actions following each other in order

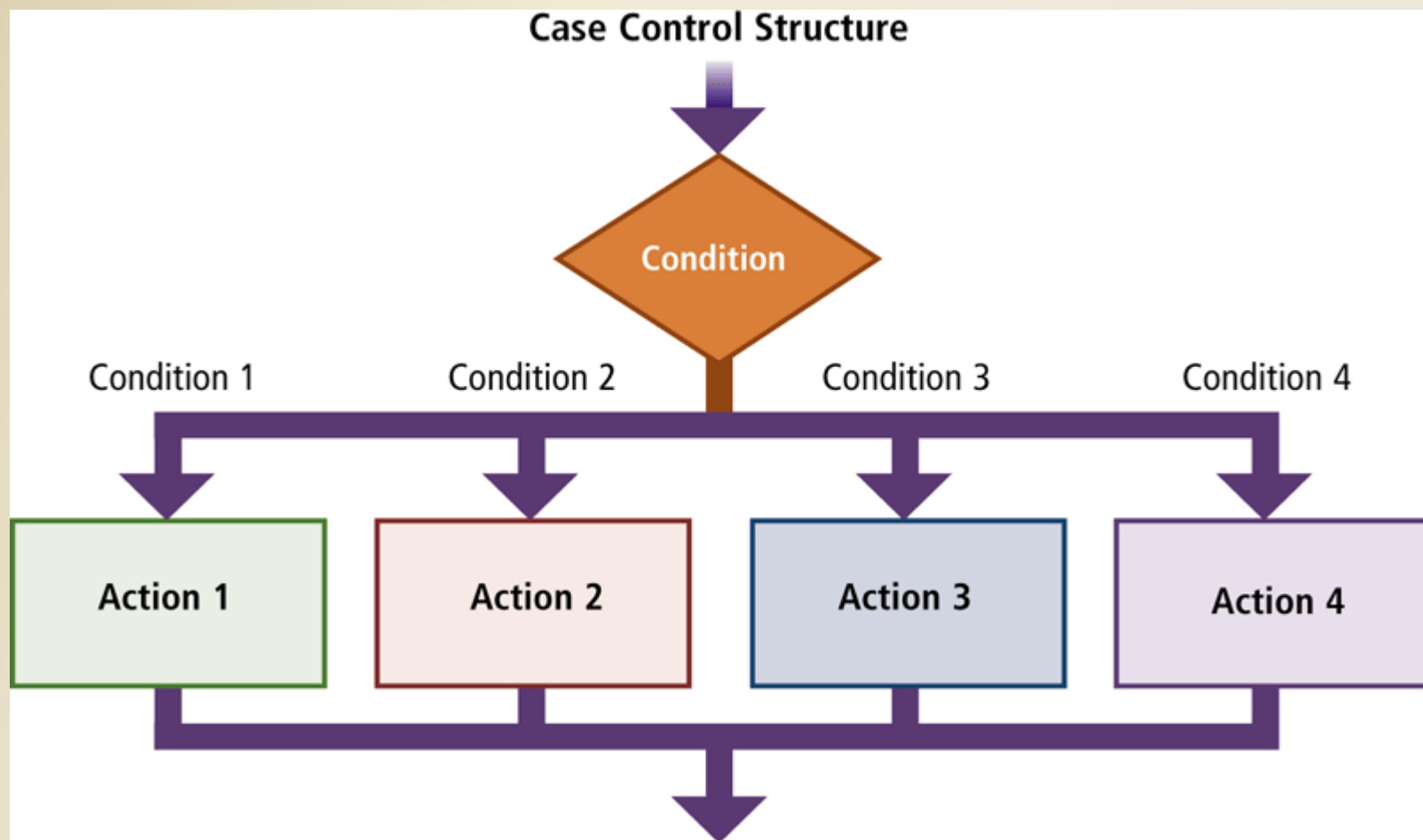


Step 2 – Design Solution



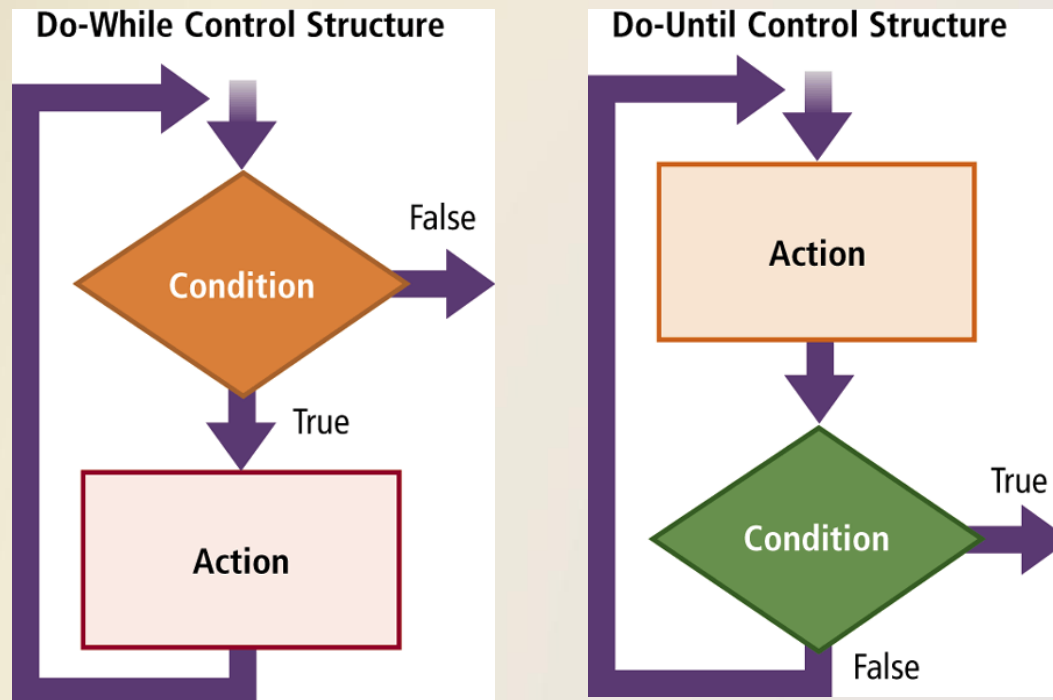
- The selection control structure tells the program which action to take, based on a certain condition
 - If-then-else
 - Case

Step 2 – Design Solution



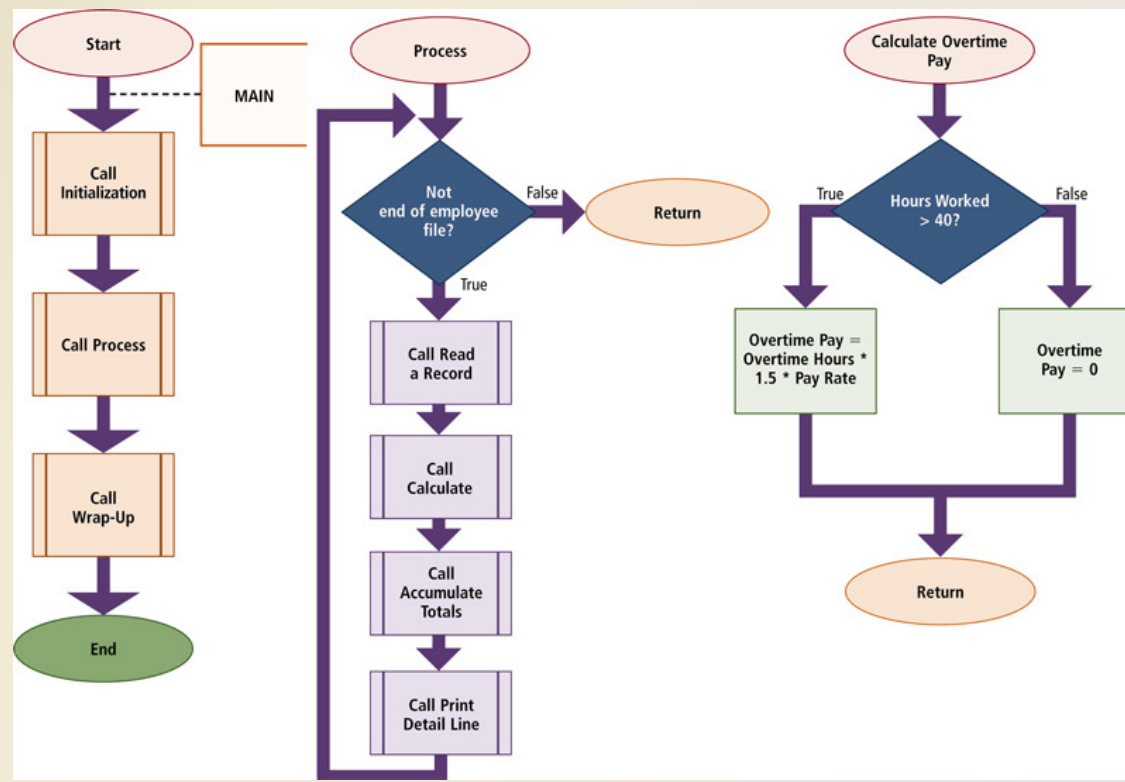
Step 2 – Design Solution

- The repetition control structure enables a program to perform one or more actions repeatedly as long as a certain condition is met



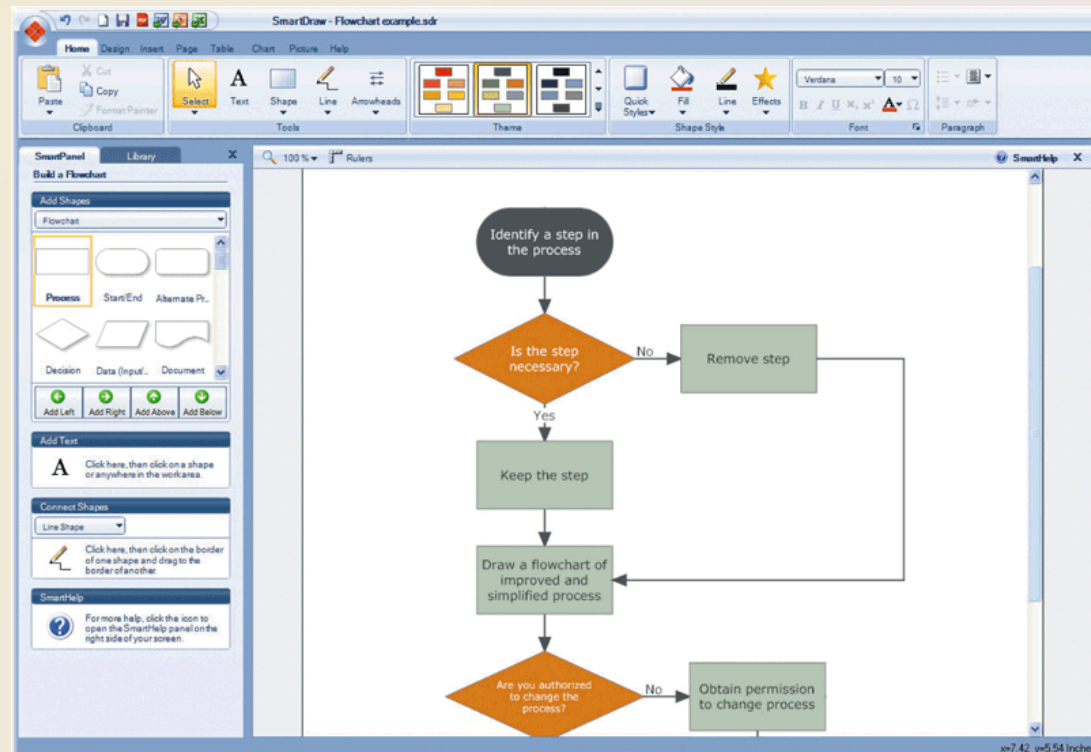
Step 2 – Design Solution

- A program **flowchart** graphically shows the logic in a solution algorithm



Step 2 – Design Solution

- **Flowcharting software** makes it easy to modify and update flowcharts
 - SmartDraw
 - Visio



Step 2 – Design Solution

- Pseudocode uses a condensed form of English to convey program logic

```
MAIN MODULE:

    CALL Initialization
    CALL Process
    CALL Wrap-Up

END

PROCESS MODULE:

    DO WHILE Not EOF
        CALL Read a Record
        CALL Calculate
        CALL Accumulate Totals
        CALL Print Detail Line
    ENDDO

RETURN

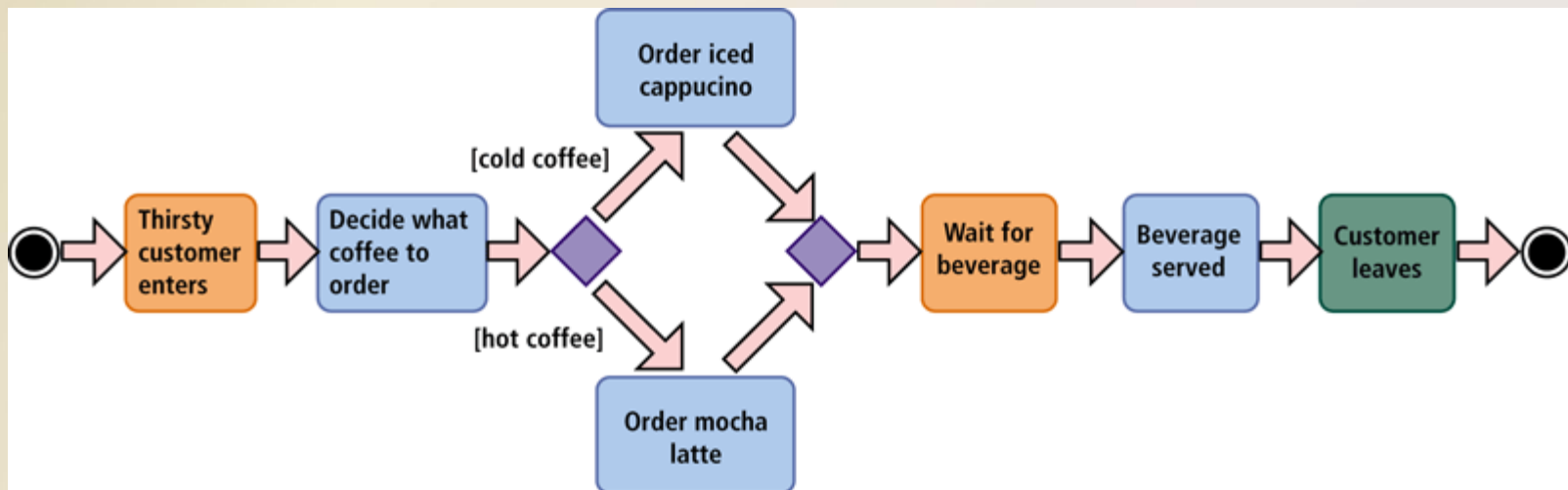
CALCULATE OVERTIME PAY MODULE:

    IF Hours Worked > 40 THEN
        Overtime Pay = Overtime Hours
            * 1.5 * Pay Rate
    ELSE
        Overtime Pay = 0
    ENDIF

RETURN
```

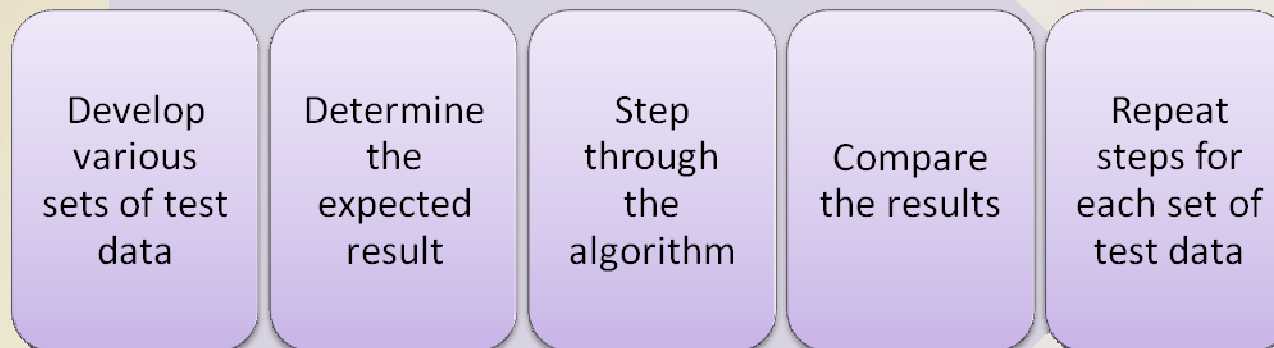
Step 2 – Design Solution

- UML (Unified Modeling Language) has been adopted as a standard notation for object modeling and development



Step 3 – Validate Design

- Check for **logic errors** using **test data**



Step 4 – Implement Design

- **Implementation** of the design includes using a program development tool that assists the programmer by:
 - Generating or providing some or all code
 - Writing the code that translates the design into a computer program
 - Creating the user interface
- Extreme programming is a strategy where programmers immediately begin coding and testing solutions as soon as requirements are defined

Step 5 – Test Solution

The goal of program testing is to ensure the program runs correctly and is error free

- Errors include syntax errors and logic errors
- **Debugging** the program involves removing the bugs
- A **beta** is a program that has most or all of its features and functionality implemented

Step 6 – Document Solution

- In documenting the solution, the programmer performs two activities:



Review the
program code



Review all the
documentation

Summary

Various programming languages used to create computer programs

A variety of Web development and multimedia development tools

Steps in the program development life cycle and tools used to make this process efficient

Chapter Thirteen

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**Your Interactive Guide
to the Digital World**

Chapter 13 Complete

