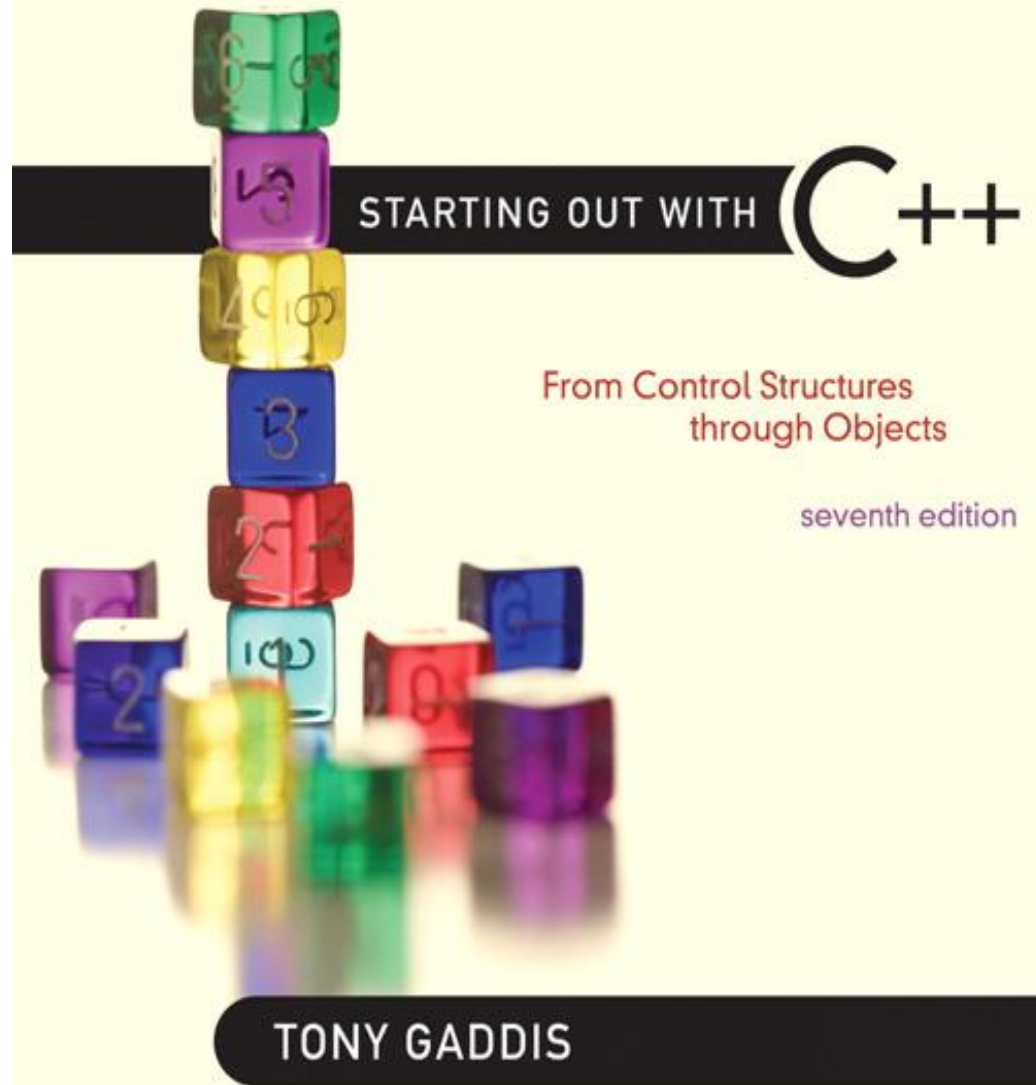


Chapter 6:

Functions

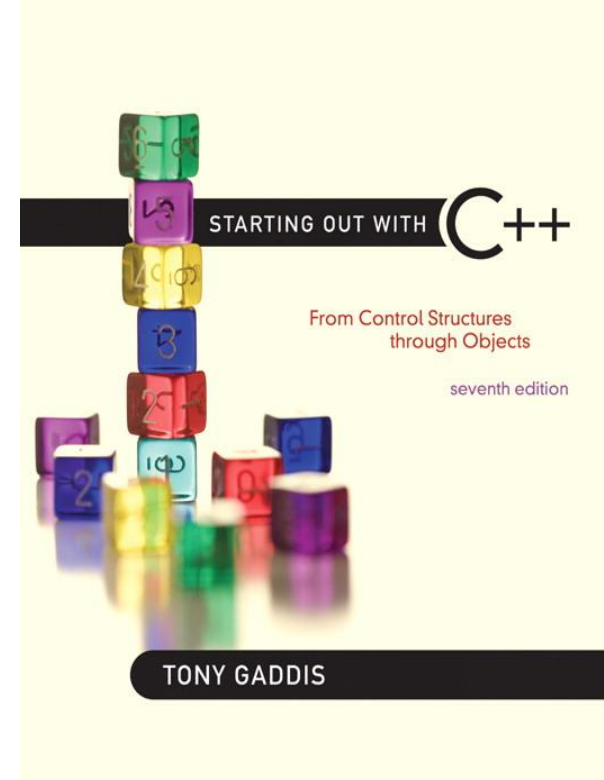


Addison-Wesley
is an imprint of

PEARSON

Copyright © 2012 Pearson Education, Inc.

6.1



Modular Programming

Modular Programming

- Modular programming: breaking a program up into smaller, manageable functions or modules
- Function: a collection of statements to perform a task
- Motivation for modular programming:
 - Improves maintainability of programs
 - Simplifies the process of writing programs

[illegible]

```
graph TD; Entry(( )) --> Main["int main() { statement; statement; statement; }"]; Main --> F2["void function2() { statement; statement; statement; }"]; Main --> F3["void function3() { statement; statement; statement; }"]; Main --> F4["void function4() { statement; statement; statement; }"];
```

The diagram illustrates the execution flow of a program. It starts with a main function, which then calls four sub-functions in sequence. Each function is represented by a box containing its code and a label. The main function is at the top, followed by function 2, function 3, and function 4. Arrows indicate the flow from the main function to each sub-function.

int main()
{
 statement;
 statement;
 statement;
}

main function

void function2()
{
 statement;
 statement;
 statement;
}

function 2

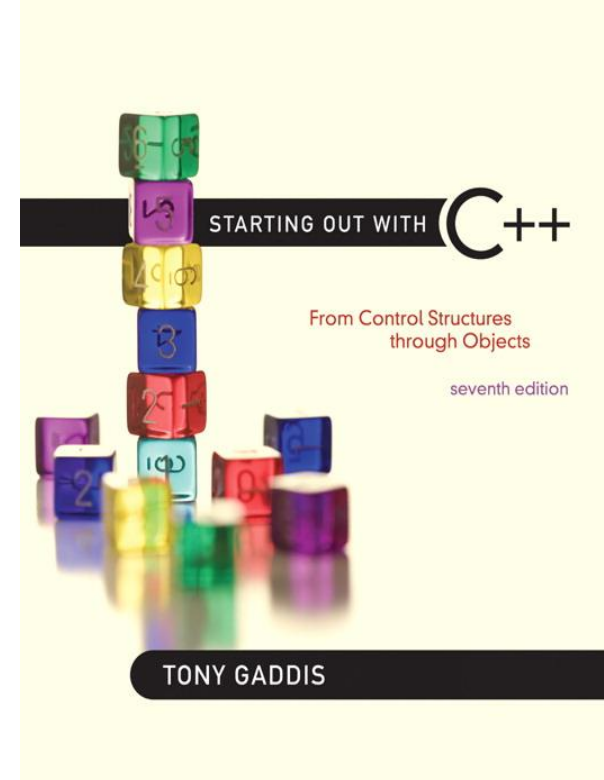
void function3()
{
 statement;
 statement;
 statement;
}

function 3

void function4()
{
 statement;
 statement;
 statement;
}

function 4

6.2



Defining and Calling Functions

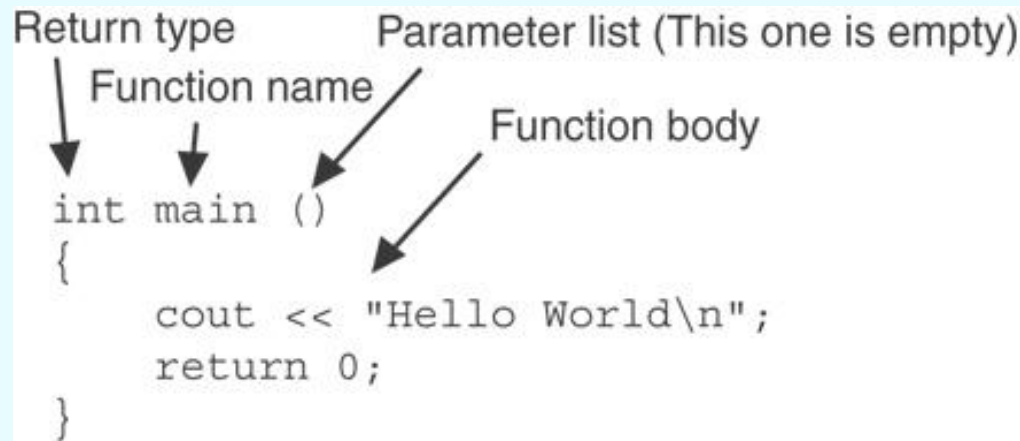
Defining and Calling Functions

- Function call: statement causes a function to execute
- Function definition: statements that make up a function

Function Definition

- Definition includes:
 - return type: data type of the value that function returns to the part of the program that called it
 - name: name of the function. Function names follow same rules as variables
 - parameter list: variables containing values passed to the function
 - body: statements that perform the function's task, enclosed in { }

Function Definition



The diagram shows a C++ function definition for `main`. Arrows point from labels to parts of the code: 'Return type' points to `int`, 'Function name' points to `main`, 'Parameter list (This one is empty)' points to `()`, and 'Function body' points to the code inside the curly braces.

```
int main ()  
{  
    cout << "Hello World\n";  
    return 0;  
}
```

Note: The line that reads `int main()` is the *function header*.

Function Return Type

- If a function returns a value, the type of the value must be indicated:

```
int main()
```

- If a function does not return a value, its return type is `void`:

```
void printHeading()  
{  
    cout << "Monthly Sales\n";  
}
```

Calling a Function

- To call a function, use the function name followed by `()` and `;`
`printHeading();`
- When called, program executes the body of the called function
- After the function terminates, execution resumes in the calling function at point of call.

Functions in Program 6-1

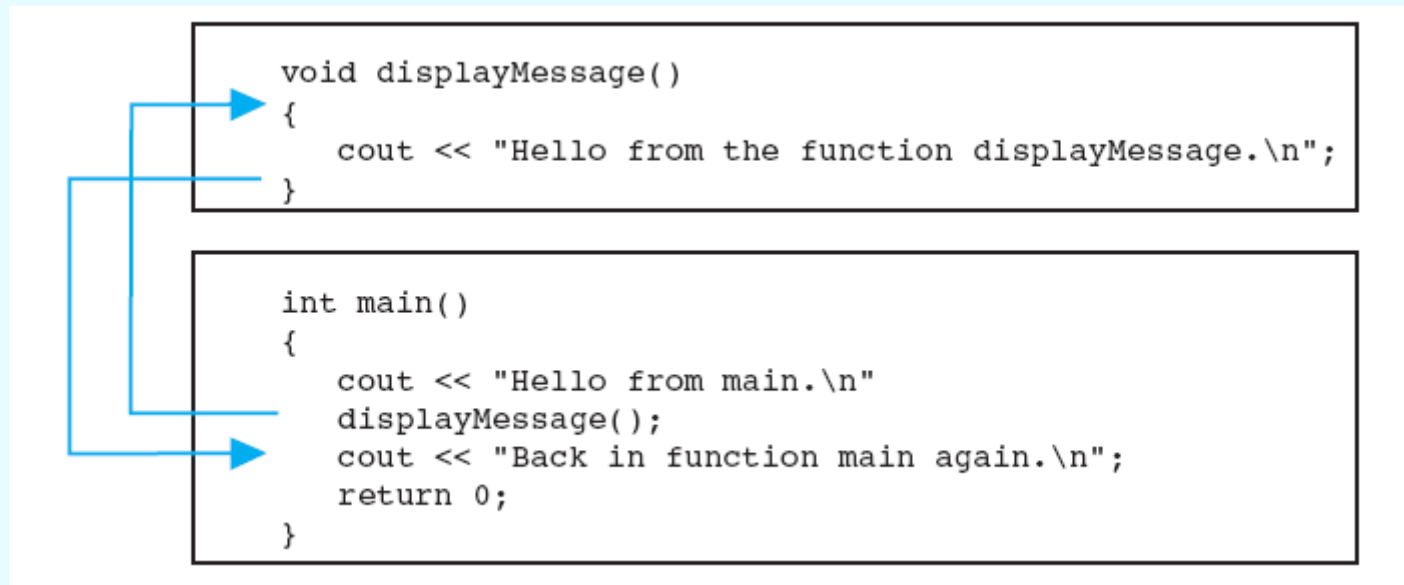
Program 6-1

```
1  // This program has two functions: main and displayMessage
2  #include <iostream>
3  using namespace std;
4
5  //*****
6  // Definition of function displayMessage *
7  // This function displays a greeting. *
8  //*****
9
10 void displayMessage()
11 {
12     cout << "Hello from the function displayMessage.\n";
13 }
14
15 //*****
16 // Function main *
17 //*****
18
19 int main()
20 {
21     cout << "Hello from main.\n";
22     displayMessage();
23     cout << "Back in function main again.\n";
24     return 0;
25 }
```

Program Output

```
Hello from main.
Hello from the function displayMessage.
Back in function main again.
```

Flow of Control in Program 6-1

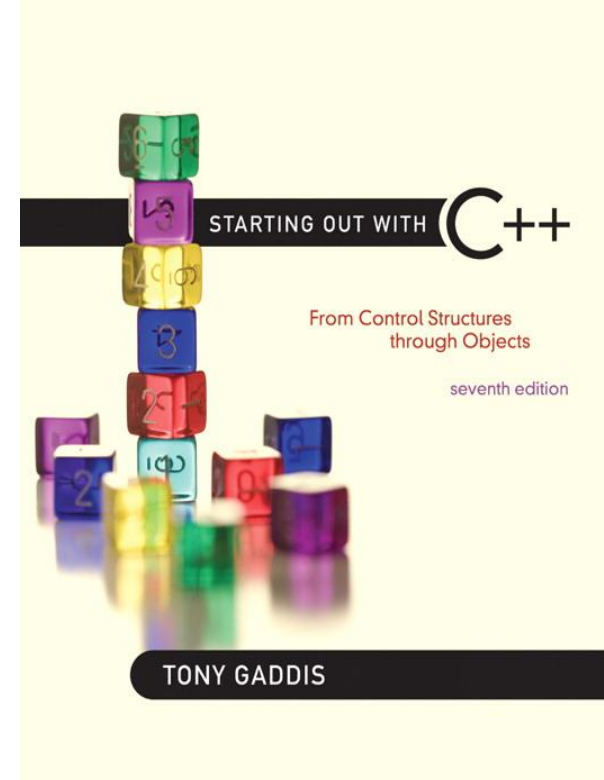


Calling Functions

- `main` can call any number of functions
- Functions can call other functions
- Compiler must know the following about a function before it is called:
 - name
 - return type
 - number of parameters
 - data type of each parameter

6.3

Function Prototypes



Function Prototypes

- Ways to notify the compiler about a function before a call to the function:
 - Place function definition before calling function's definition
 - Use a function prototype (function declaration) – like the function definition without the body
 - Header: `void printHeading()`
 - Prototype: `void printHeading();`

Program 6-5

```
1  // This program has three functions: main, First, and Second.
2  #include <iostream>
3  using namespace std;
4
5  // Function Prototypes
6  void first();
7  void second();
8
9  int main()
10 {
11     cout << "I am starting in function main.\n";
12     first();    // Call function first
13     second();   // Call function second
14     cout << "Back in function main again.\n";
15     return 0;
16 }
17
```

(Program Continues)

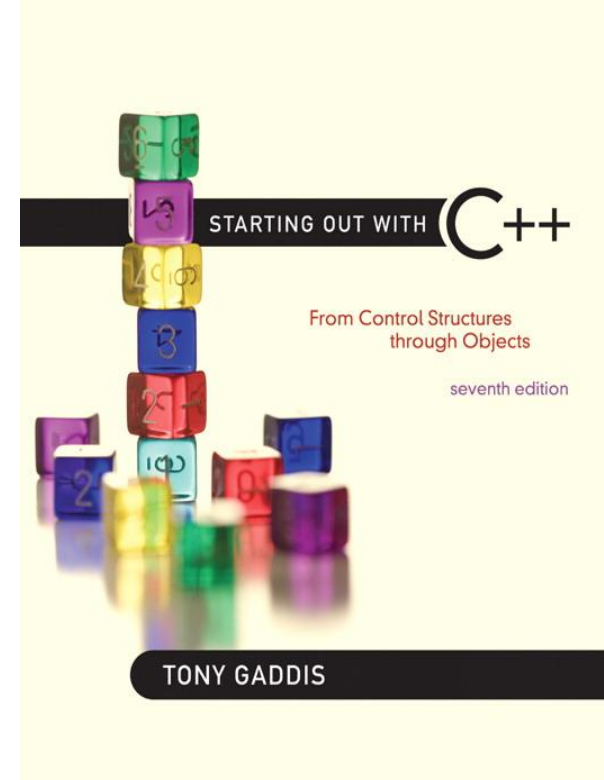
Program 6-5 (Continued)

```
18  //*****
19  // Definition of function first.      *
20  // This function displays a message.  *
21  //*****
22
23  void first()
24  {
25      cout << "I am now inside the function first.\n";
26  }
27
28  //*****
29  // Definition of function second.     *
30  // This function displays a message.  *
31  //*****
32
33  void second()
34  {
35      cout << "I am now inside the function second.\n";
36  }
```

Prototype Notes

- Place prototypes near top of program
- Program must include either prototype or full function definition before any call to the function – compiler error otherwise
- When using prototypes, can place function definitions in any order in source file

6.4



Sending Data into a Function

Sending Data into a Function

- Can pass values into a function at time of call:

```
c = pow(a, b);
```

- Values passed to function are arguments
- Variables in a function that hold the values passed as arguments are parameters

A Function with a Parameter Variable

```
void displayValue(int num)
{
    cout << "The value is " << num << endl;
}
```

The integer variable `num` is a parameter.
It accepts any integer value passed to the function.

Program 6-6

```
1  // This program demonstrates a function with a parameter.
2  #include <iostream>
3  using namespace std;
4
5  // Function Prototype
6  void displayValue(int);
7
8  int main()
9  {
10     cout << "I am passing 5 to displayValue.\n";
11     displayValue(5); // Call displayValue with argument 5
12     cout << "Now I am back in main.\n";
13     return 0;
14 }
15
```

(Program Continues)

Program 6-6

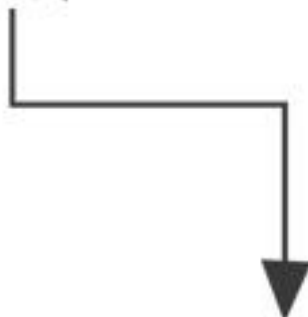
(continued)

```
16  //*****
17  // Definition of function displayValue.          *
18  // It uses an integer parameter whose value is displayed. *
19  //*****
20
21  void displayValue(int num)
22  {
23      cout << "The value is " << num << endl;
24  }
```

Program Output

```
I am passing 5 to displayValue.
The value is 5
Now I am back in main.
```

```
displayValue(5);  
  
void displayValue(int num)  
{  
    cout << "The value is " << num << endl;  
}
```

A diagram consisting of a vertical line descending from the closing parenthesis of the function call 'displayValue(5);', followed by a horizontal line to the right, and then a vertical line ending in a downward-pointing arrowhead that points to the opening curly brace of the function definition 'void displayValue(int num) {'. This indicates the flow of execution from the call to the function body.

The function call in line 11 passes the value 5 as an argument to the function.

Other Parameter Terminology

- A parameter can also be called a formal parameter or a formal argument
- An argument can also be called an actual parameter or an actual argument

Parameters, Prototypes, and Function Headers

- For each function argument,
 - the prototype must include the data type of each parameter inside its parentheses
 - the header must include a declaration for each parameter in its ()

```
void evenOrOdd(int);    //prototype  
void evenOrOdd(int num) //header  
evenOrOdd(val);        //call
```

Function Call Notes

- Value of argument is copied into parameter when the function is called
- A parameter's scope is the function which uses it
- Function can have multiple parameters
- There must be a data type listed in the prototype `()` and an argument declaration in the function header `()` for each parameter
- Arguments will be promoted/demoted as necessary to match parameters

Passing Multiple Arguments

When calling a function and passing multiple arguments:

- the number of arguments in the call must match the prototype and definition
- the first argument will be used to initialize the first parameter, the second argument to initialize the second parameter, etc.

Program 6-8

```
1  // This program demonstrates a function with three parameters.
2  #include <iostream>
3  using namespace std;
4
5  // Function Prototype
6  void showSum(int, int, int);
7
8  int main()
9  {
10     int value1, value2, value3;
11
12     // Get three integers.
13     cout << "Enter three integers and I will display ";
14     cout << "their sum: ";
15     cin >> value1 >> value2 >> value3;
16
17     // Call showSum passing three arguments.
18     showSum(value1, value2, value3);
19     return 0;
20 }
21
```

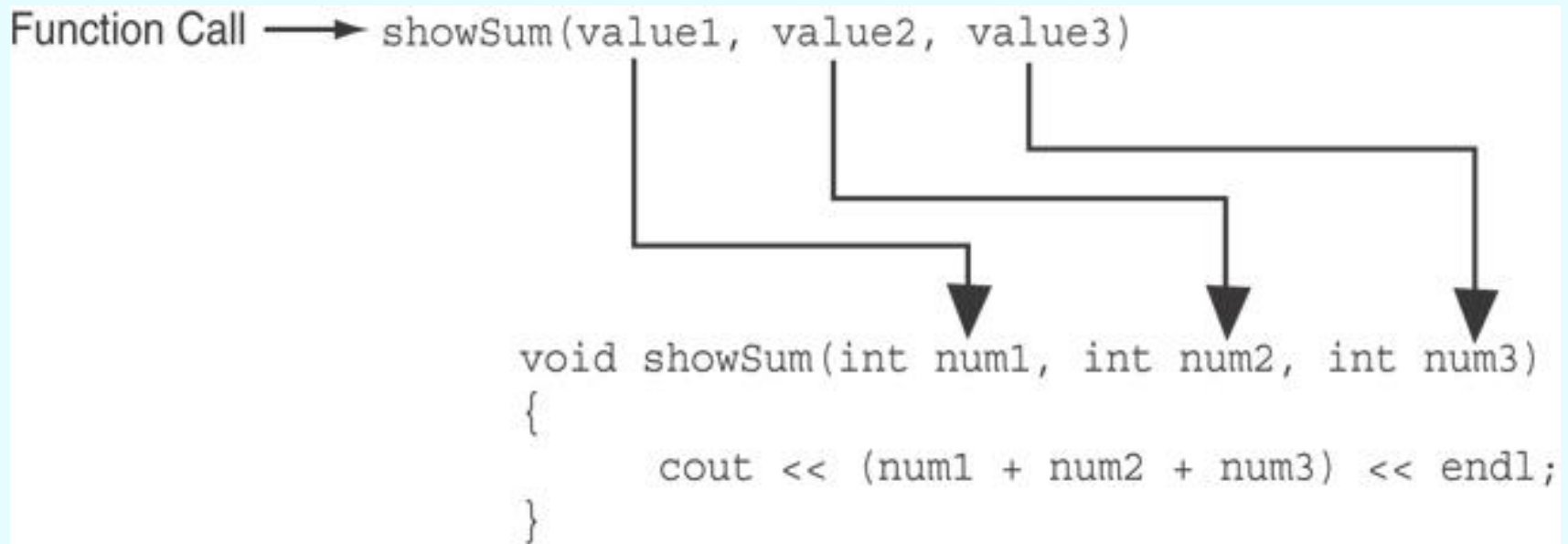
(Program Continues)

Program 6-8 (Continued)

```
22  /*******
23  // Definition of function showSum.
24  // It uses three integer parameters. Their sum is displayed.
25  /*******
26
27  void showSum(int num1, int num2, int num3)
28  {
29      cout << (num1 + num2 + num3) << endl;
30  }
```

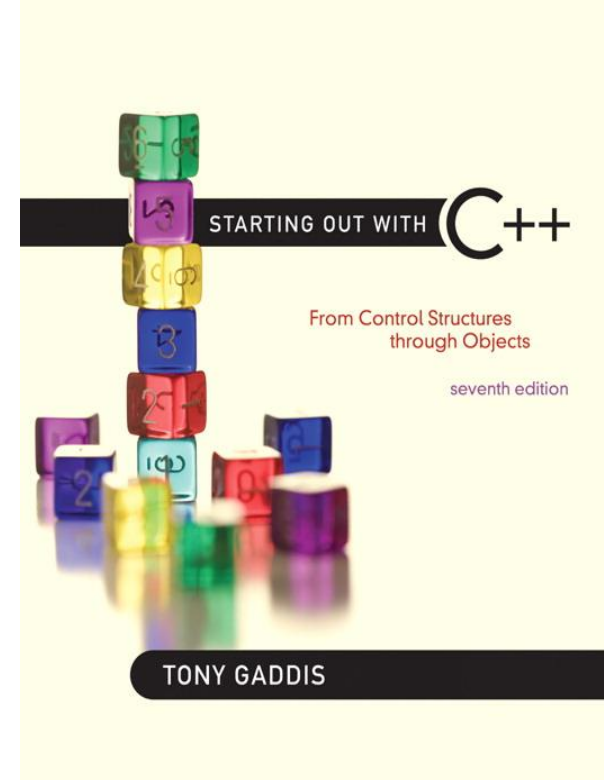
Program Output with Example Input Shown in Bold

Enter three integers and I will display their sum: **4 8 7 [Enter]**
19



The function call in line 18 passes `value1`, `value2`, and `value3` as arguments to the function.

6.5



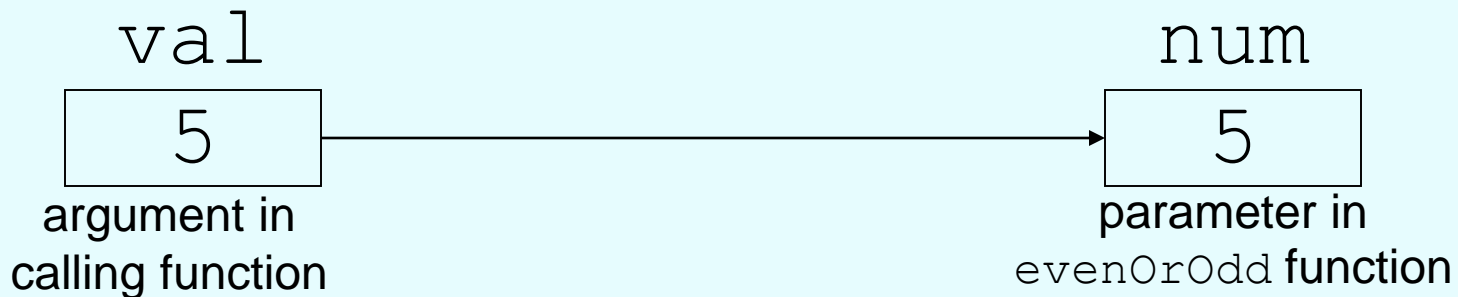
Passing Data by Value

Passing Data by Value

- Pass by value: when an argument is passed to a function, its value is copied into the parameter.
- Changes to the parameter in the function do not affect the value of the argument

Passing Information to Parameters by Value

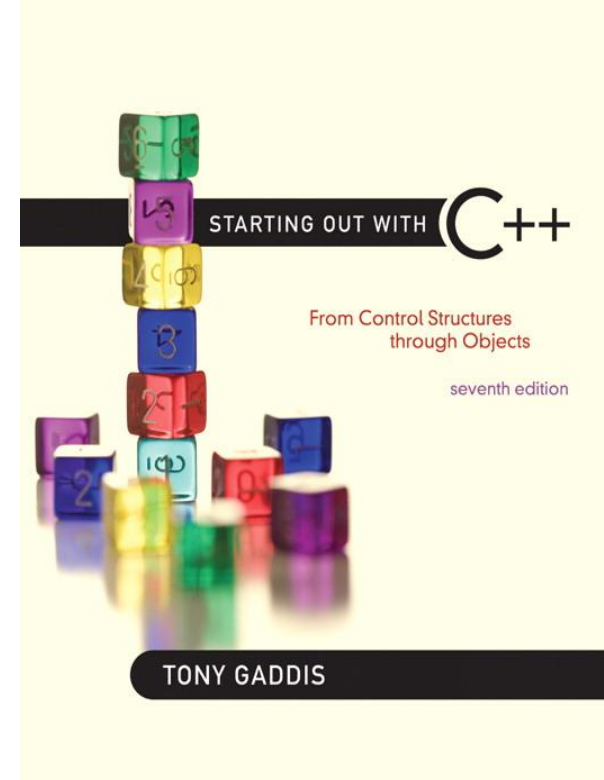
- **Example:** `int val=5;`
`evenOrOdd(val);`



- `evenOrOdd` can change variable `num`, but it will have no effect on variable `val`

6.6

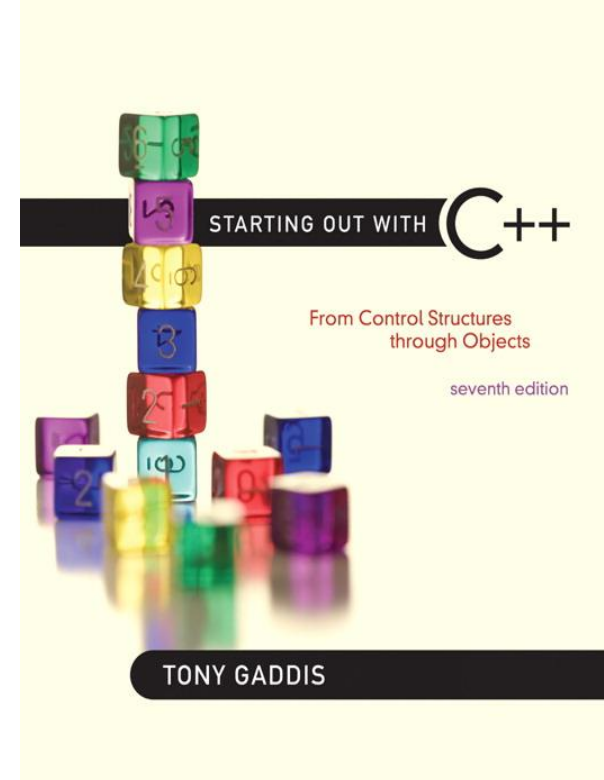
Using Functions in Menu-Driven Programs



Using Functions in Menu-Driven Programs

- Functions can be used
 - to implement user choices from menu
 - to implement general-purpose tasks:
 - Higher-level functions can call general-purpose functions, minimizing the total number of functions and speeding program development time
- *See Program 6-10 in the book*

6.7



The `return` Statement

The `return` Statement

- Used to end execution of a function
- Can be placed anywhere in a function
 - Statements that follow the `return` statement will not be executed
- Can be used to prevent abnormal termination of program
- In a `void` function without a `return` statement, the function ends at its last `}`

Program 6-11

```
1  // This program uses a function to perform division. If division
2  // by zero is detected, the function returns.
3  #include <iostream>
4  using namespace std;
5
6  // Function prototype.
7  void divide(double, double);
8
9  int main()
10 {
11     double num1, num2;
12
13     cout << "Enter two numbers and I will divide the first\n";
14     cout << "number by the second number: ";
15     cin >> num1 >> num2;
16     divide(num1, num2);
17     return 0;
18 }
```

(Program Continues)

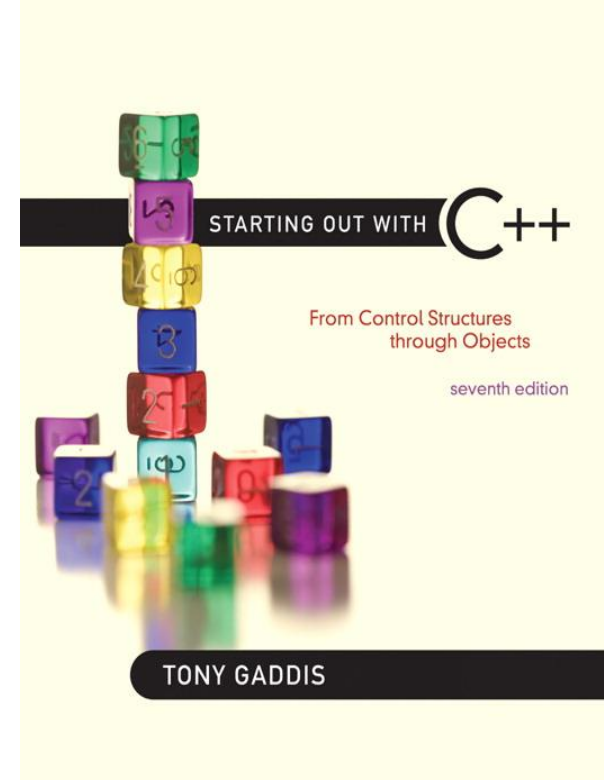
Program 6-11(Continued)

```
20 //*****
21 // Definition of function divide. *
22 // Uses two parameters: arg1 and arg2. The function divides arg1*
23 // by arg2 and shows the result. If arg2 is zero, however, the *
24 // function returns. *
25 //*****
26
27 void divide(double arg1, double arg2)
28 {
29     if (arg2 == 0.0)
30     {
31         cout << "Sorry, I cannot divide by zero.\n";
32         return;
33     }
34     cout << "The quotient is " << (arg1 / arg2) << endl;
35 }
```

Program Output with Example Input Shown in Bold

Enter two numbers and I will divide the first
number by the second number: **12 0 [Enter]**
Sorry, I cannot divide by zero.

6.8



Returning a Value From a Function

Returning a Value From a Function

- A function can return a value back to the statement that called the function.
- You've already seen the `pow` function, which returns a value:

```
double x;  
x = pow(2.0, 10.0);
```


Returning a Value From a Function

- In a value-returning function, the `return` statement can be used to return a value from function to the point of call. Example:


```
int sum(int num1, int num2)
{
    double result;
    result = num1 + num2;
    return result;
}
```

A Value-Returning Function

Return Type



```
int sum(int num1, int num2)
{
    double result;
    result = num1 + num2;
    return result;
}
```



Value Being Returned

A Value-Returning Function

```
int sum(int num1, int num2)
{
    return num1 + num2;
}
```

Functions can return the values of expressions, such as `num1 + num2`

Program 6-12

```
1  // This program uses a function that returns a value.
2  #include <iostream>
3  using namespace std;
4
5  // Function prototype
6  int sum(int, int);
7
8  int main()
9  {
10     int value1 = 20,    // The first value
11         value2 = 40,    // The second value
12         total;          // To hold the total
13
14     // Call the sum function, passing the contents of
15     // value1 and value2 as arguments. Assign the return
16     // value to the total variable.
17     total = sum(value1, value2);
18
19     // Display the sum of the values.
20     cout << "The sum of " << value1 << " and "
21         << value2 << " is " << total << endl;
22     return 0;
23 }
```

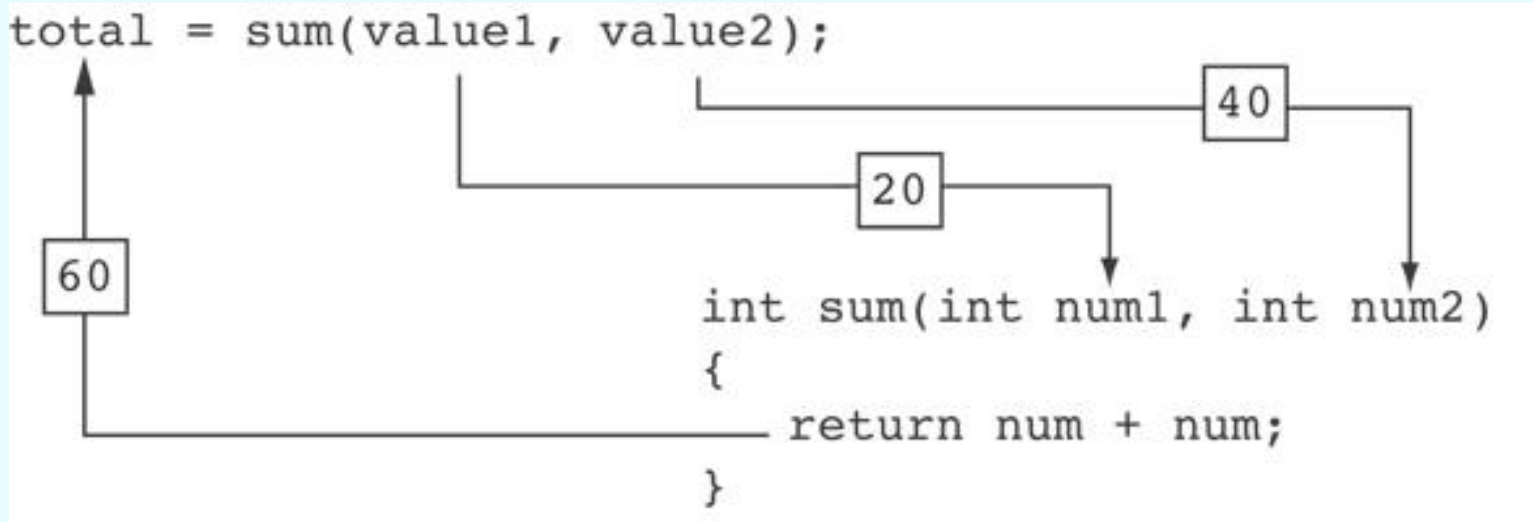
(Program Continues)

Program 6-12 (Continued)

```
24
25  /*******
26  // Definition of function sum. This function returns *
27  // the sum of its two parameters.                      *
28  /*******
29
30  int sum(int num1, int num2)
31  {
32      return num1 + num2;
33  }
```

Program Output

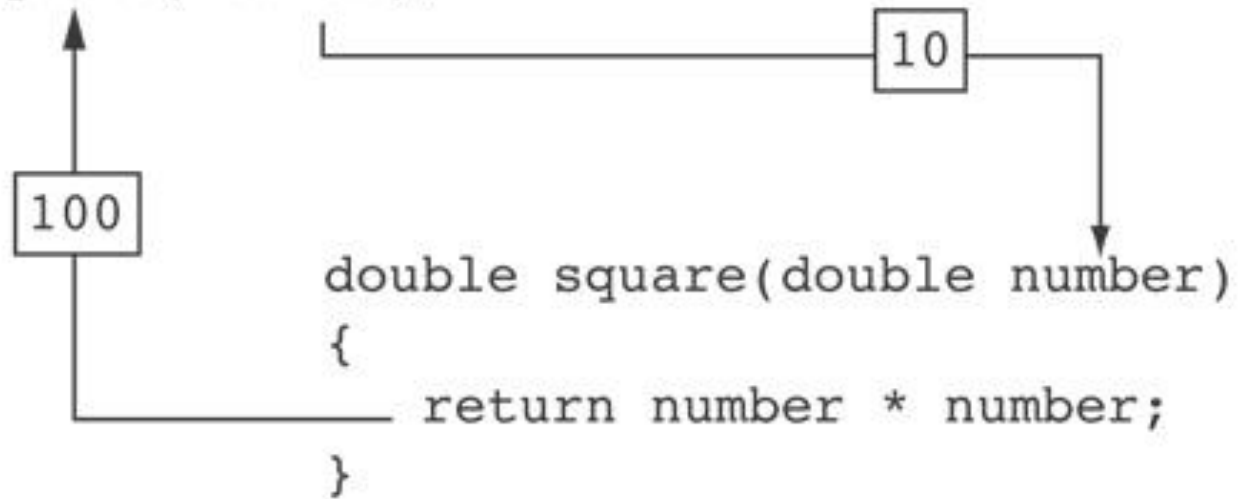
The sum of 20 and 40 is 60



The statement in line 17 calls the `sum` function, passing `value1` and `value2` as arguments. The return value is assigned to the `total` variable.

Another Example, from Program 6-13

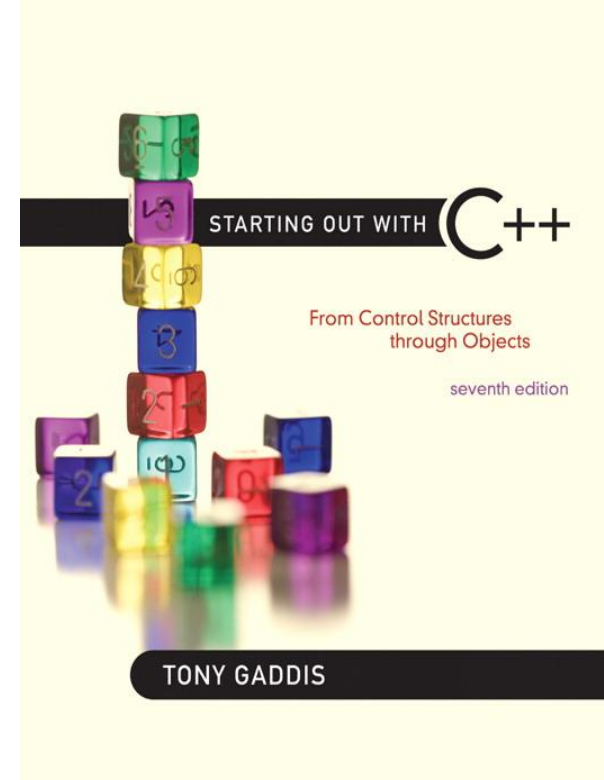
```
area = PI * square(radius);
```



Returning a Value From a Function

- The prototype and the definition must indicate the data type of return value (not `void`)
- Calling function should use return value:
 - assign it to a variable
 - send it to `cout`
 - use it in an expression

6.9



Returning a Boolean Value

Returning a Boolean Value

- Function can return `true` or `false`
- Declare return type in function prototype and heading as `bool`
- Function body must contain `return` statement(s) that return `true` or `false`
- Calling function can use return value in a relational expression

Program 6-15

```
1  // This program uses a function that returns true or false.
2  #include <iostream>
3  using namespace std;
4
5  // Function prototype
6  bool isEven(int);
7
8  int main()
9  {
10     int val;
11
12     // Get a number from the user.
13     cout << "Enter an integer and I will tell you ";
14     cout << "if it is even or odd: ";
15     cin >> val;
16
17     // Indicate whether it is even or odd.
18     if (isEven(val))
19         cout << val << " is even.\n";
20     else
21         cout << val << " is odd.\n";
22     return 0;
23 }
24
```

(Program Continues)

```

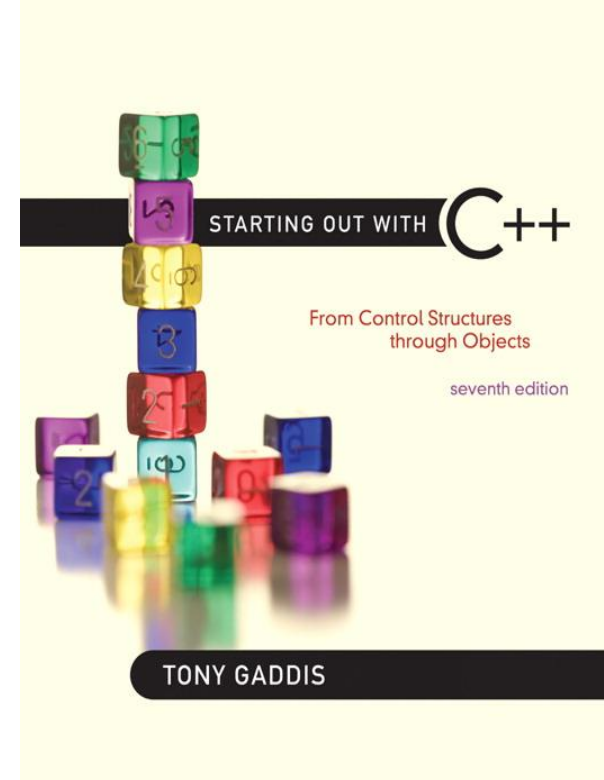
25  //*****
26  // Definition of function isEven. This function accepts an      *
27  // integer argument and tests it to be even or odd. The function *
28  // returns true if the argument is even or false if the argument  *
29  // is odd. The return value is a bool.                             *
30  //*****
31
32  bool isEven(int number)
33  {
34      bool status;
35
36      if (number % 2 == 0)
37          status = true; // The number is even if there is no remainder.
38      else
39          status = false; // Otherwise, the number is odd.
40      return status;
41  }

```

Program Output with Example Input Shown in Bold

Enter an integer and I will tell you if it is even or odd: **5 [Enter]**
 5 is odd.

6.10



Local and Global Variables

Local and Global Variables

- Variables defined inside a function are *local* to that function. They are hidden from the statements in other functions, which normally cannot access them.
- Because the variables defined in a function are hidden, other functions may have separate, distinct variables with the same name.

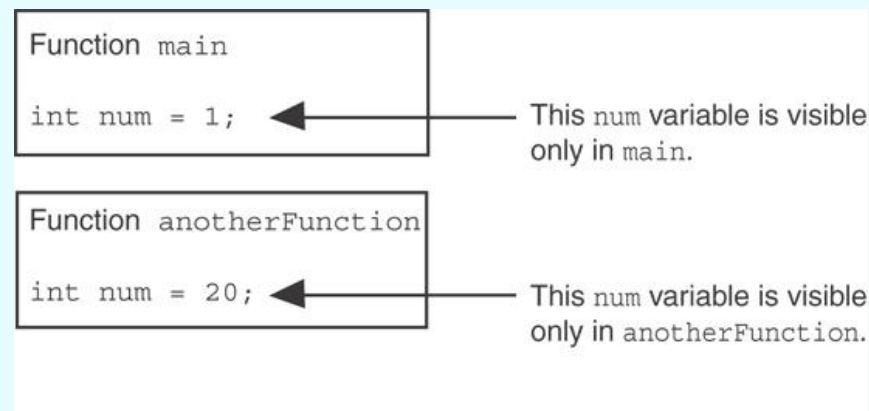
Program 6-16

```
1 // This program shows that variables defined in a function
2 // are hidden from other functions.
3 #include <iostream>
4 using namespace std;
5
6 void anotherFunction(); // Function prototype
7
8 int main()
9 {
10     int num = 1;    // Local variable
11
12     cout << "In main, num is " << num << endl;
13     anotherFunction();
14     cout << "Back in main, num is " << num << endl;
15     return 0;
16 }
17
18 //*****
19 // Definition of anotherFunction *
20 // It has a local variable, num, whose initial value *
21 // is displayed. *
22 //*****
23
24 void anotherFunction()
25 {
26     int num = 20;    // Local variable
27
28     cout << "In anotherFunction, num is " << num << endl;
29 }
```

Program Output

```
In main, num is 1  
In anotherFunction, num is 20  
Back in main, num is 1
```

When the program is executing in `main`, the `num` variable defined in `main` is visible. When `anotherFunction` is called, however, only variables defined inside it are visible, so the `num` variable in `main` is hidden.



Local Variable Lifetime

- A function's local variables exist only while the function is executing. This is known as the *lifetime* of a local variable.
- When the function begins, its local variables and its parameter variables are created in memory, and when the function ends, the local variables and parameter variables are destroyed.
- This means that any value stored in a local variable is lost between calls to the function in which the variable is declared.

Global Variables and Global Constants

- A global variable is any variable defined outside all the functions in a program.
- The scope of a global variable is the portion of the program from the variable definition to the end.
- This means that a global variable can be accessed by *all* functions that are defined after the global variable is defined.

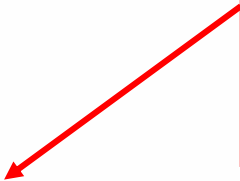
Global Variables and Global Constants

- You should avoid using global variables because they make programs difficult to debug.
- Any global that you create should be *global constants*.

Program 6-19

```
1 // This program calculates gross pay.
2 #include <iostream>
3 #include <iomanip>
4 using namespace std;
5
6 // Global constants
7 const double PAY_RATE = 22.55;    // Hourly pay rate
8 const double BASE_HOURS = 40.0;  // Max non-overtime hours
9 const double OT_MULTIPLIER = 1.5; // Overtime multiplier
10
11 // Function prototypes
12 double getBasePay(double);
13 double getOvertimePay(double);
14
15 int main()
16 {
17     double hours,           // Hours worked
18           basePay,          // Base pay
19           overtime = 0.0,   // Overtime pay
20           totalPay;         // Total pay
```

Global constants defined for values that do not change throughout the program's execution.



The constants are then used for those values throughout the program.

```
29      // Get overtime pay, if any.
30      if (hours > BASE_HOURS)
31          overtime = getOvertimePay(hours);
```

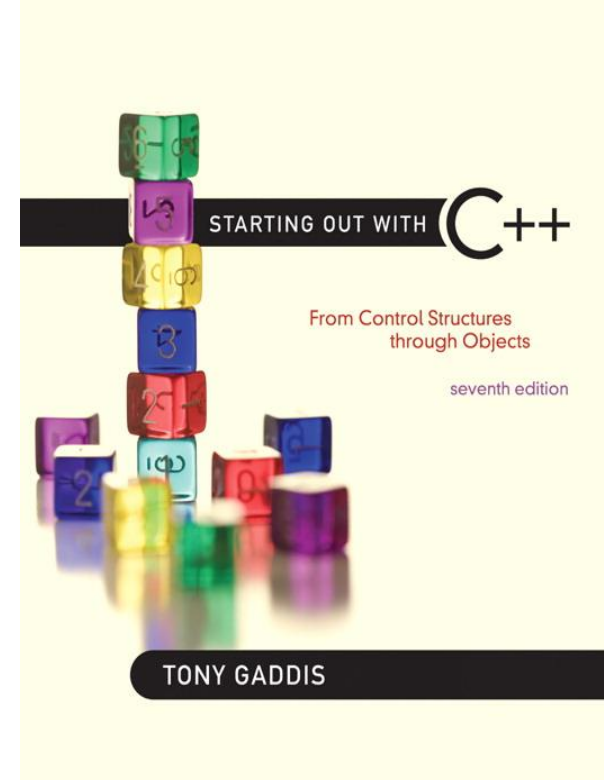
```
56      // Determine base pay.
57      if (hoursWorked > BASE_HOURS)
58          basePay = BASE_HOURS * PAY_RATE;
59      else
60          basePay = hoursWorked * PAY_RATE;
```

```
75      // Determine overtime pay.
76      if (hoursWorked > BASE_HOURS)
77      {
78          overtimePay = (hoursWorked - BASE_HOURS) *
79                          PAY_RATE * OT_MULTIPLIER;
--      }
```

Initializing Local and Global Variables

- Local variables are not automatically initialized. They must be initialized by programmer.
- Global variables (not constants) are automatically initialized to 0 (numeric) or `NULL` (character) when the variable is defined.

6.11



Static Local Variables

Static Local Variables

- Local variables only exist while the function is executing. When the function terminates, the contents of local variables are lost.
- `static` local variables retain their contents between function calls.
- `static` local variables are defined and initialized only the first time the function is executed. `0` is the default initialization value.

Program 6-21

```
1  // This program shows that local variables do not retain
2  // their values between function calls.
3  #include <iostream>
4  using namespace std;
5
6  // Function prototype
7  void showLocal();
8
9  int main()
10 {
11     showLocal();
12     showLocal();
13     return 0;
14 }
15
```

(Program Continues)

Program 6-21 *(continued)*

```
16 //*****
17 // Definition of function showLocal. *
18 // The initial value of localNum, which is 5, is displayed. *
19 // The value of localNum is then changed to 99 before the *
20 // function returns. *
21 //*****
22
23 void showLocal()
24 {
25     int localNum = 5; // Local variable
26
27     cout << "localNum is " << localNum << endl;
28     localNum = 99;
29 }
```

Program Output

```
localNum is 5
localNum is 5
```

In this program, each time `showLocal` is called, the `localNum` variable is re-created and initialized with the value 5.

A Different Approach, Using a Static Variable

Program 6-22

```
1  // This program uses a static local variable.
2  #include <iostream>
3  using namespace std;
4
5  void showStatic(); // Function prototype
6
7  int main()
8  {
9      // Call the showStatic function five times.
10     for (int count = 0; count < 5; count++)
11         showStatic();
12     return 0;
13 }
14
```

(Program Continues)

Program 6-22 *(continued)*

```
15  //*****
16  // Definition of function showStatic.          *
17  // statNum is a static local variable. Its value is displayed *
18  // and then incremented just before the function returns.      *
19  //*****
20
21  void showStatic()
22  {
23      static int statNum;
24
25      cout << "statNum is " << statNum << endl;
26      statNum++;
27  }
```

Program Output

```
statNum is 0
statNum is 1
statNum is 2
statNum is 3
statNum is 4
```

← **statNum is automatically initialized to 0. Notice that it retains its value between function calls.**

If you do initialize a local static variable, the initialization only happens once. See Program 6-23.

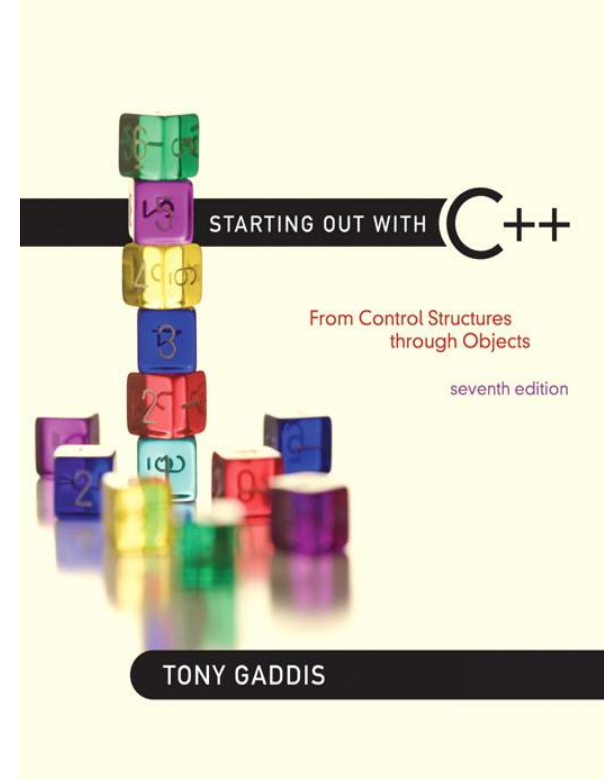
```
16  /*******  
17  // Definition of function showStatic. *  
18  // statNum is a static local variable. Its value is displayed *  
19  // and then incremented just before the function returns. *  
20  /*******  
21  
22  void showStatic()  
23  {  
24      static int statNum = 5;  
25  
26      cout << "statNum is " << statNum << endl;  
27      statNum++;  
28  }
```

Program Output

```
statNum is 5  
statNum is 6  
statNum is 7  
statNum is 8  
statNum is 9
```

6.12

Default Arguments



Default Arguments

A Default argument is an argument that is passed automatically to a parameter if the argument is missing on the function call.

- Must be a constant declared in prototype:

```
void evenOrOdd(int = 0);
```

- Can be declared in header if no prototype
- Multi-parameter functions may have default arguments for some or all of them:

```
int getSum(int, int=0, int=0);
```

Default arguments specified in the prototype

Program 6-24

```
1  // This program demonstrates default function arguments.
2  #include <iostream>
3  using namespace std;
4
5  // Function prototype with default arguments
6  void displayStars(int = 10, int = 1);
7
8  int main()
9  {
10     displayStars();           // Use default values for cols and rows.
11     cout << endl;
12     displayStars(5);         // Use default value for rows.
13     cout << endl;
14     displayStars(7, 3);      // Use 7 for cols and 3 for rows.
15     return 0;
16 }
```

(Program Continues)

Program 6-23 (Continued)

```
18 //*****
19 // Definition of function displayStars.          *
20 // The default argument for cols is 10 and for rows is 1.*
21 // This function displays a square made of asterisks.  *
22 //*****
23
24 void displayStars(int cols, int rows)
25 {
26     // Nested loop. The outer loop controls the rows
27     // and the inner loop controls the columns.
28     for (int down = 0; down < rows; down++)
29     {
30         for (int across = 0; across < cols; across++)
31             cout << "*";
32         cout << endl;
33     }
34 }
```

Program Output

Default Arguments

- If not all parameters to a function have default values, the defaultless ones are declared first in the parameter list:

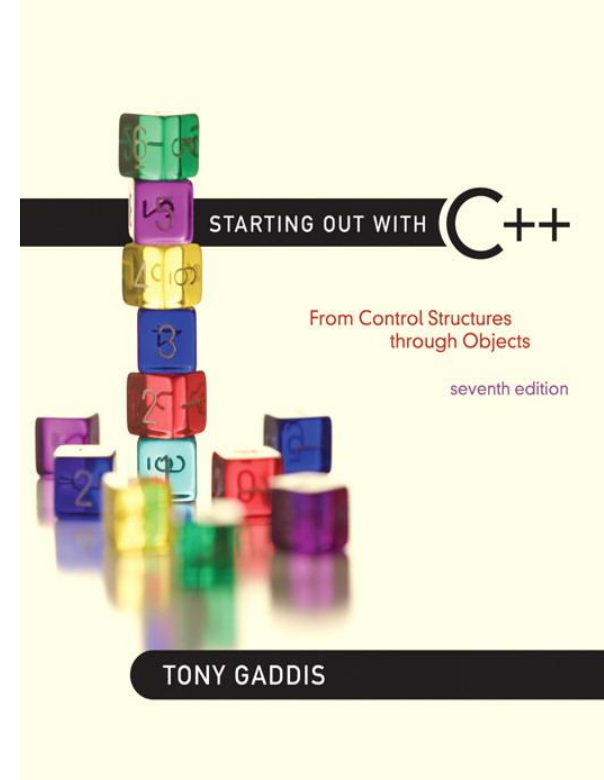
```
int getSum(int, int=0, int=0); // OK  
int getSum(int, int=0, int);   // NO
```

- When an argument is omitted from a function call, all arguments after it must also be omitted:

```
sum = getSum(num1, num2);      // OK  
sum = getSum(num1, , num3);    // NO
```

6.13

Using Reference Variables, Pointers as Function Parameters



Using Reference Variables as Parameters

- A mechanism that allows a function to work with the original argument from the function call, not a copy of the argument
- Allows the function to modify values stored in the calling environment
- Provides a way for the function to 'return' more than one value

Passing by Reference

- A reference variable is an alias for another variable
- Defined with an ampersand (&)

```
void getDimensions(int&, int&);
```
- Changes to a reference variable are made to the variable it refers to
- Use reference variables to implement passing parameters *by reference*

Program 6-25

The & here in the prototype indicates that the parameter is a reference variable.

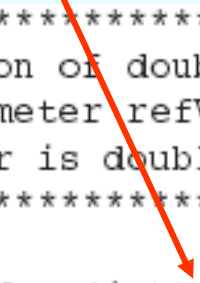
```
1  // This program uses a reference variable as a function
2  // parameter.
3  #include <iostream>
4  using namespace std;
5
6  // Function prototype. The parameter is a reference variable.
7  void doubleNum(int &);
8
9  int main()
10 {
11     int value = 4;
12
13     cout << "In main, value is " << value << endl;
14     cout << "Now calling doubleNum..." << endl;
15     doubleNum(value);
16     cout << "Now back in main. value is " << value << endl;
17     return 0;
18 }
19
```

Here we are passing value by reference.

(Program Continues)

Program 6-25 (Continued)

The & also appears here in the function header.



```
20  /*******  
21  // Definition of doubleNum. *  
22  // The parameter refVar is a reference variable. The value *  
23  // in refVar is doubled. *  
24  /*******  
25  
26  void doubleNum (int &refVar)  
27  {  
28      refVar *= 2;  
29  }
```

Program Output

```
In main, value is 4  
Now calling doubleNum...  
Now back in main. value is 8
```

Reference Variable Notes

- Each reference parameter must contain &
- Space between type and & is unimportant
- Must use & in both prototype and header
- Argument passed to reference parameter must be a variable – cannot be an expression or constant
- Use when appropriate – don't use when argument should not be changed by function, or if function needs to return only 1 value

Pointer Variables

- Pointer variable : Often just called a pointer, it's a variable that holds an address
- Because a pointer variable holds the address of another piece of data, it "points" to the data

Pointer Variables

- Definition:

```
int *intptr;
```

- Read as:

“intptr can hold the address of an int”

- Spacing in definition does not matter:

```
int * intptr;    // same as above
```

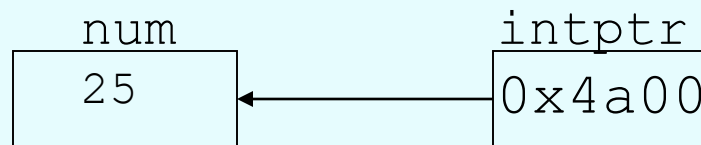
```
int*  intptr;    // same as above
```

Pointer Variables

- Assigning an address to a pointer variable:

```
int *intptr;  
intptr = &num;
```

- Memory layout:



address of num: 0x4a00

```
1  // This program stores the address of a variable in a pointer.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int x = 25;      // int variable
8      int *ptr;        // Pointer variable, can point to an int
9
10     ptr = &x;        // Store the address of x in ptr
11     cout << "The value in x is " << x << endl;
12     cout << "The address of x is " << ptr << endl;
13     return 0;
14 }
```

Program Output

The value in x is 25

The address of x is 0x7e00

The Indirection Operator

- The indirection operator (*) dereferences a pointer.
- It allows you to access the item that the pointer points to.

```
int x = 25;  
int *intptr = &x;  
cout << *intptr << endl;
```



This prints 25.

```

1 // This program demonstrates the use of the indirection operator.
2 #include <iostream>
3 using namespace std;
4
5 int main()
6 {
7     int x = 25;    // int variable
8     int *ptr;      // Pointer variable, can point to an int
9
10    ptr = &x;      // Store the address of x in ptr
11
12    // Use both x and ptr to display the value in x.
13    cout << "Here is the value in x, printed twice:\n";
14    cout << x << endl;    // Displays the contents of x
15    cout << *ptr << endl; // Displays the contents of x
16
17    // Assign 100 to the location pointed to by ptr. This
18    // will actually assign 100 to x.
19    *ptr = 100;
20
21    // Use both x and ptr to display the value in x.
22    cout << "Once again, here is the value in x:\n";
23    cout << x << endl;    // Displays the contents of x
24    cout << *ptr << endl; // Displays the contents of x
25    return 0;
26 }

```

Program Output

```

Here is the value in x, printed twice:
25
25
Once again, here is the value in x:
100
100

```


Pointers as Function Parameters

- A pointer can be a parameter
- Works like reference variable to allow change to argument from within function
- Requires:
 - 1) asterisk * on parameter in prototype and heading
`void getNum(int *ptr); // ptr is pointer to an int`
 - 2) asterisk * in body to dereference the pointer
`cin >> *ptr;`
 - 3) address as argument to the function
`getNum(&num); // pass address of num to getNum`

Example

```
void swap(int *x, int *y)
{
    int temp;
    temp = *x;
    *x = *y;
    *y = temp;
}
```

```
int num1 = 2, num2 = -3;
swap(&num1, &num2);
```

```

1  // This program uses two functions that accept addresses of
2  // variables as arguments.
3  #include <iostream>
4  using namespace std;
5
6  // Function prototypes
7  void getNumber(int *);
8  void doubleValue(int *);
9
10 int main()
11 {
12     int number;
13
14     // Call getNumber and pass the address of number.
15     getNumber(&number);
16
17     // Call doubleValue and pass the address of number.
18     doubleValue(&number);
19
20     // Display the value in number.
21     cout << "That value doubled is " << number << endl;
22     return 0;
23 }
24

```

(Program Continues)

```

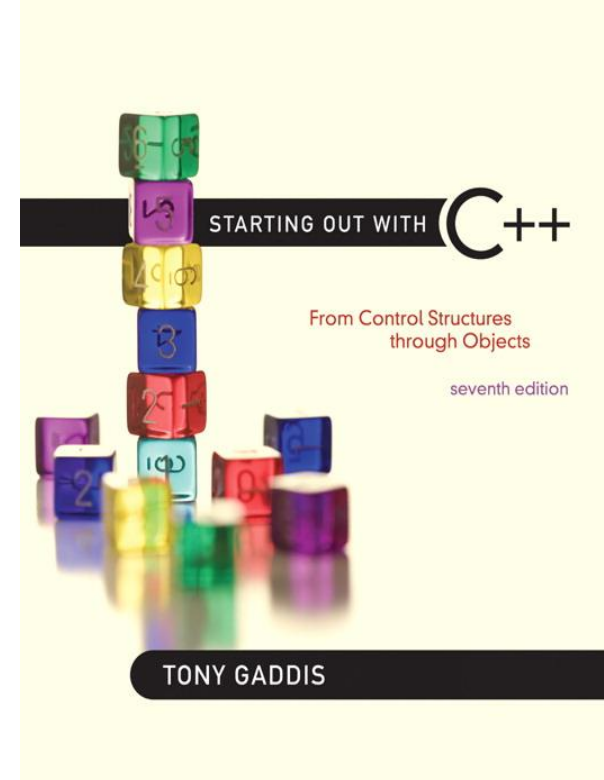
25  //*****
26  // Definition of getNumber. The parameter, input, is a pointer. *
27  // This function asks the user for a number. The value entered  *
28  // is stored in the variable pointed to by input.                *
29  //*****
30
31  void getNumber(int *input)
32  {
33      cout << "Enter an integer number: ";
34      cin >> *input;
35  }
36
37  //*****
38  // Definition of doubleValue. The parameter, val, is a pointer. *
39  // This function multiplies the variable pointed to by val by    *
40  // two.                                                            *
41  //*****
42
43  void doubleValue(int *val)
44  {
45      *val *= 2;
46  }

```

Program Output with Example Input Shown in Bold

Enter an integer number: **10 [Enter]**
That value doubled is 20

6.14



Overloading Functions

Overloading Functions

- Overloaded functions have the same name but different parameter lists
- Can be used to create functions that perform the same task but take different parameter types or different number of parameters
- Compiler will determine which version of function to call by argument and parameter lists

Function Overloading Examples

Using these overloaded functions,

```
void getDimensions(int);                // 1
void getDimensions(int, int);           // 2
void getDimensions(int, double);        // 3
void getDimensions(double, double);    // 4
```

the compiler will use them as follows:

```
int length, width;
double base, height;
getDimensions(length);                // 1
getDimensions(length, width);         // 2
getDimensions(length, height);        // 3
getDimensions(height, base);          // 4
```

Program 6-27

```
1 // This program uses overloaded functions.
2 #include <iostream>
3 #include <iomanip>
4 using namespace std;
5
6 // Function prototypes
7 int square(int);
8 double square(double);
9
10 int main()
11 {
12     int userInt;
13     double userFloat;
14
15     // Get an int and a double.
16     cout << fixed << showpoint << setprecision(2);
17     cout << "Enter an integer and a floating-point value: ";
18     cin >> userInt >> userFloat;
19
20     // Display their squares.
21     cout << "Here are their squares: ";
22     cout << square(userInt) << " and " << square(userFloat);
23     return 0;
24 }
```

The overloaded functions have different parameter lists

Passing a double

Passing an int

(Program Continues)

Program 6-27 (Continued)

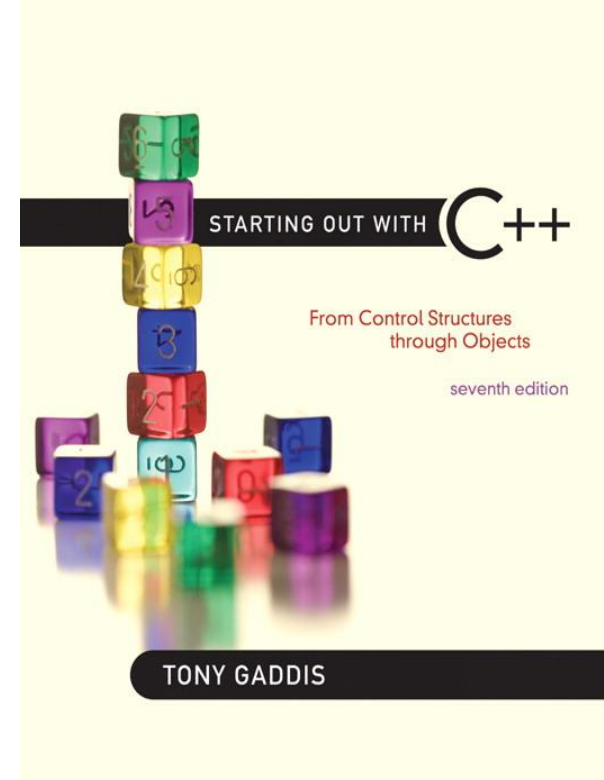
```
26  //*****
27  // Definition of overloaded function square.
28  // This function uses an int parameter, number. It returns the
29  // square of number as an int.
30  //*****
31
32  int square(int number)
33  {
34      return number * number;
35  }
36
37  //*****
38  // Definition of overloaded function square.
39  // This function uses a double parameter, number. It returns
40  // the square of number as a double.
41  //*****
42
43  double square(double number)
44  {
45      return number * number;
46  }
```

Program Output with Example Input Shown in Bold

Enter an integer and a floating-point value: **12 4.2** [Enter]

Here are their squares: 144 and 17.64

6.15



The `exit()` Function

The `exit()` Function

- Terminates the execution of a program
- Can be called from any function
- Can pass an `int` value to operating system to indicate status of program termination
- Usually used for abnormal termination of program
- Requires `cstdlib` header file

The `exit()` Function

- Example:

```
exit(0);
```

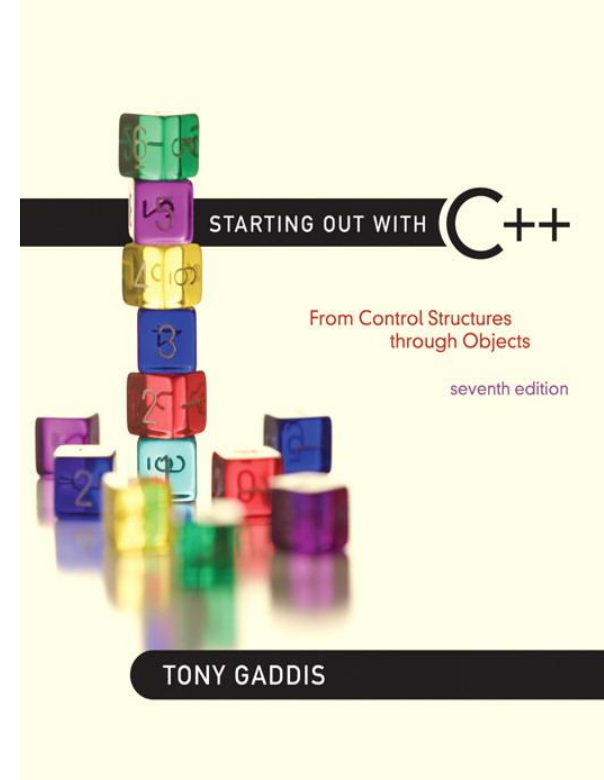
- The `cstdlib` header defines two constants that are commonly passed, to indicate success or failure:

```
exit(EXIT_SUCCESS);
```

```
exit(EXIT_FAILURE);
```

6.16

Stubs and Drivers



Stubs and Drivers

- Useful for testing and debugging program and function logic and design
- Stub: A dummy function used in place of an actual function
 - Usually displays a message indicating it was called. May also display parameters
- Driver: A function that tests another function by calling it
 - Various arguments are passed and return values are tested