

FIFTH EDITION

Starting Out with

C++

*From Control Structures  
through Objects*

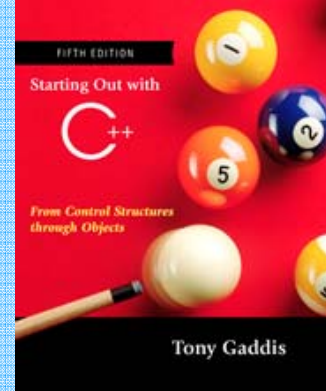
Tony Gaddis



# Chapter

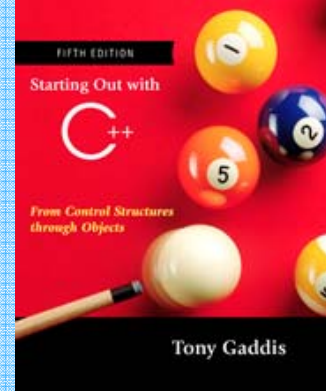
# 6

## Functions

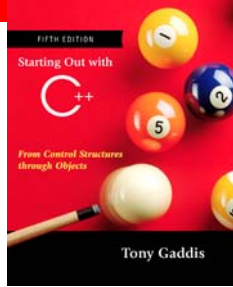


# 6.1

## Modular Programming



# Modular Programming



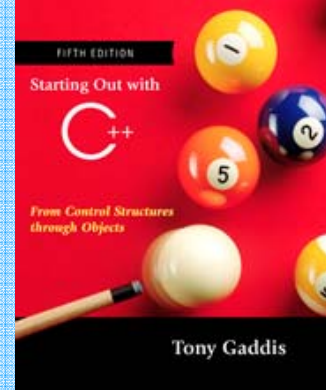
- Modular programming: breaking a program up into smaller, manageable functions or modules
- Function: a collection of statements to perform a task
- Motivation for modular programming:
  - Improves maintainability of programs
  - Simplifies the process of writing programs

[illegible]

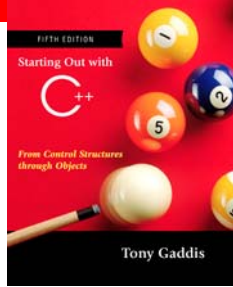
<pre>int main() {     statement;     statement;     statement; }</pre>	main function
<pre>void function2() {     statement;     statement;     statement; }</pre>	function 2
<pre>void function3() {     statement;     statement;     statement; }</pre>	function 3
<pre>void function4() {     statement;     statement;     statement; }</pre>	function 4

# 6.2

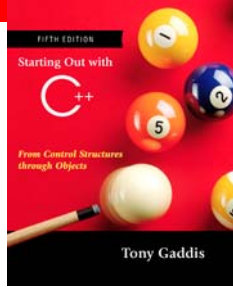
## Defining and Calling Functions



# Defining and Calling Functions



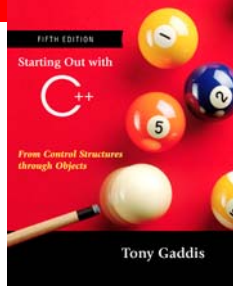
- Function call: statement causes a function to execute
- Function definition: statements that make up a function



# 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

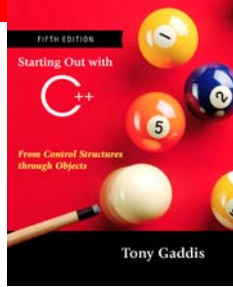
Return type      Parameter list (This one is empty)

Function name

Function body

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

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



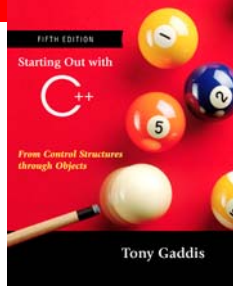
# Function Return Type

- 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";  
}
```

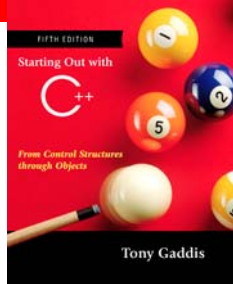


# Calling a Function

- 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.

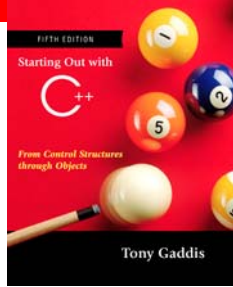


## Program 6-1

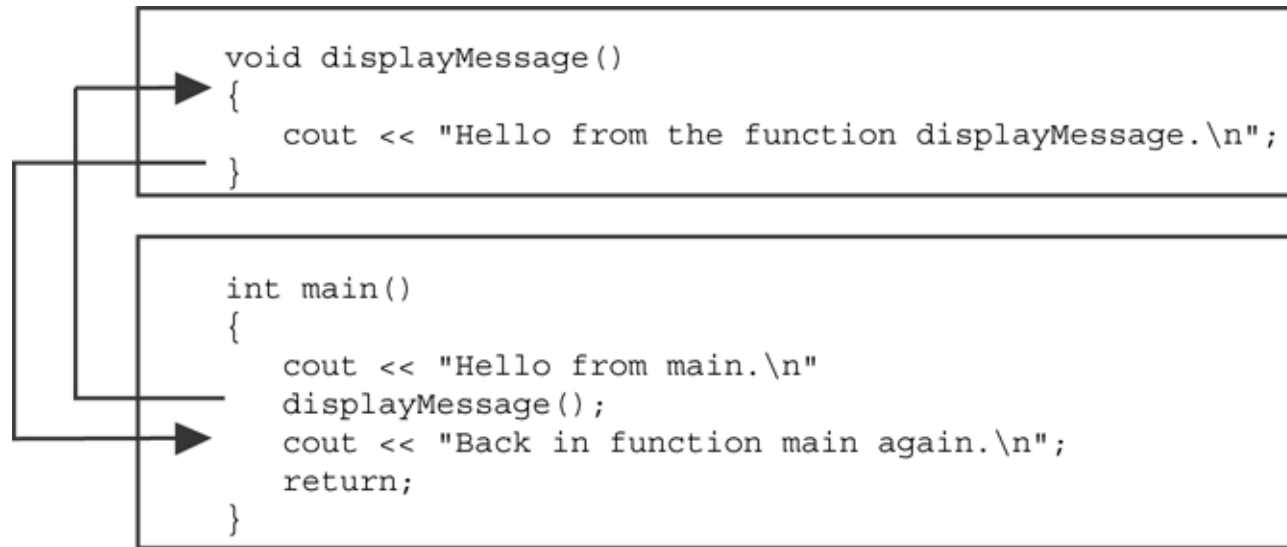
```
1  // This program has two functions: main and displayMessage
2  #include <iostream>
3  using namespace std;
4
5  //*****
6  // Definition of function displayMessage *
7  // This function displays a greeting.      *
8  //*****
9
10 void displayMessage()
11 {
12     cout << "Hello from the function 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 }
```

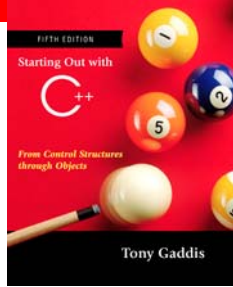
## Program Output

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



# Flow of Control in Program 6-1



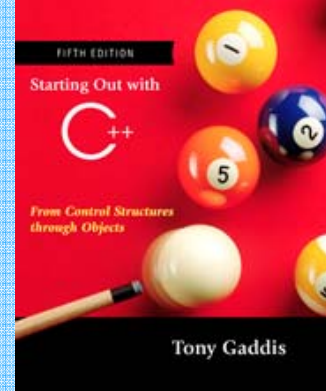


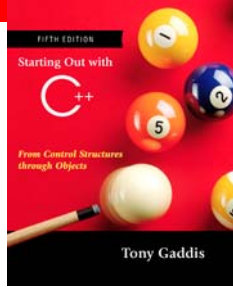
# Calling Functions

- `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

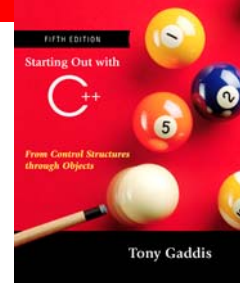




# Function Prototypes

- 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( ) ;`





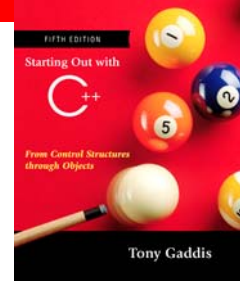
### Program 6-5

```
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
```

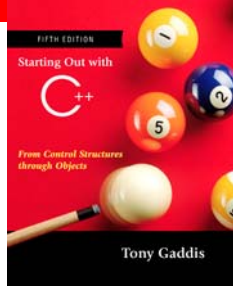
*(Program Continues)*

# 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  }
```



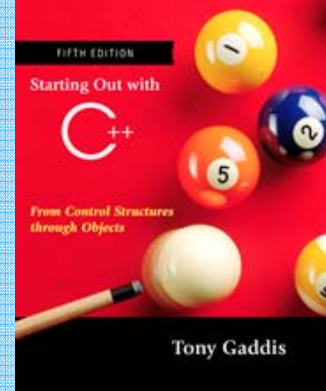
# Prototype Notes



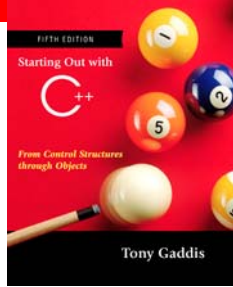
- Place prototypes near top of program
- Program must include either prototype or full function definition before any call to the function – compiler error otherwise
- When using prototypes, can place function definitions in any order in source file

# 6.4

## Sending Data into a Function

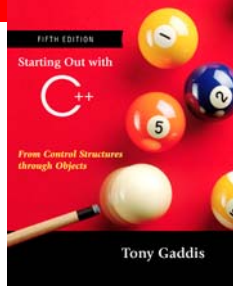


# Sending Data into a Function



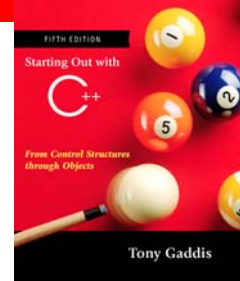
- Can pass values into a function at time of call:  
$$c = \text{pow}(a, b);$$
- Values passed to function are arguments
- Variables in a function that hold the values passed as arguments are parameters

# A Function with a Parameter Variable



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

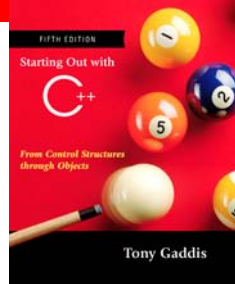
The integer variable `num` is a parameter.  
It accepts any integer value passed to the function.



### 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**

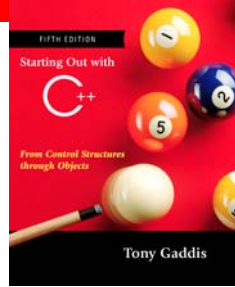
```
I am passing 5 to displayValue.
The value is 5
Now I am back in main.
```



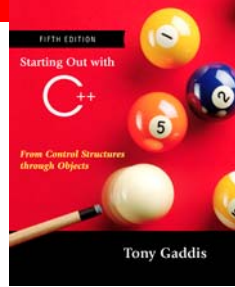


# Other Parameter Terminology

- 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



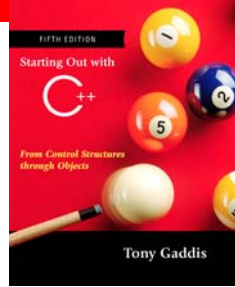
# Parameters, Prototypes, and Function Headers



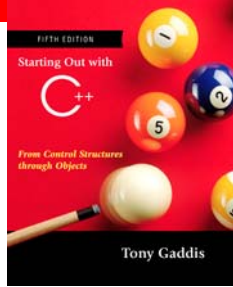
- For each function argument,
  - the prototype must include the data type of each parameter inside its parentheses
  - the header must include a declaration for each parameter in its ( )

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

# Function Call Notes



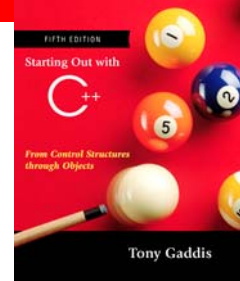
- Value of argument is copied into parameter when the function is called
- A parameter's scope is the function which uses it
- Function can have multiple parameters
- There must be a data type listed in the prototype ( ) and an argument declaration in the function header ( ) for each parameter
- Arguments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

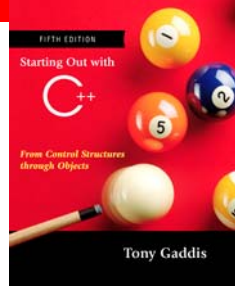


## Program 6-8

```
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)*

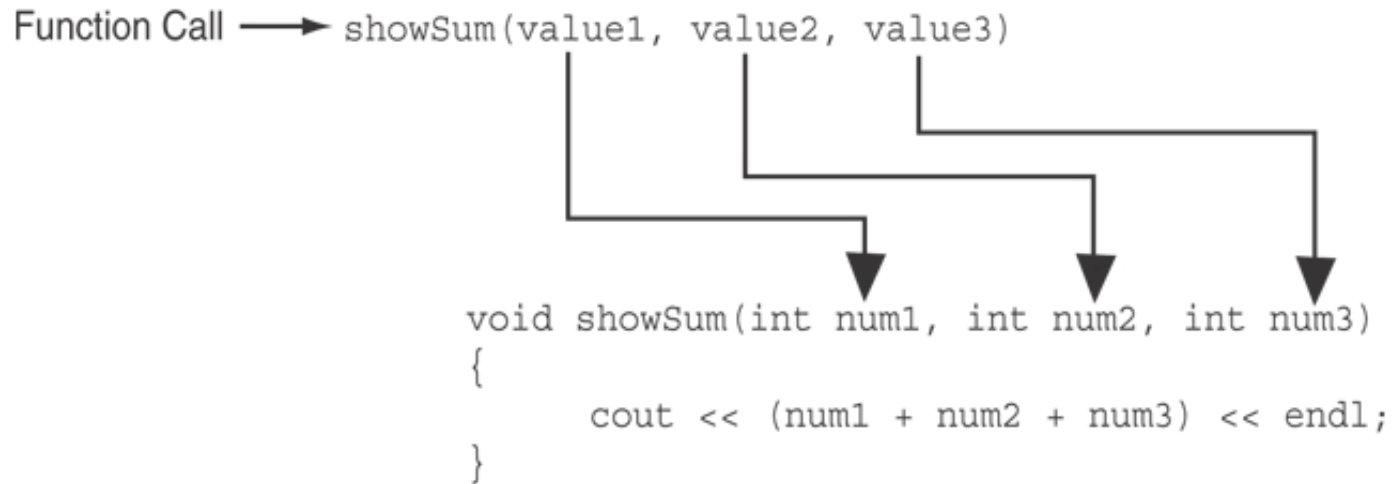
# Program 6-8 (Continued)



```
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

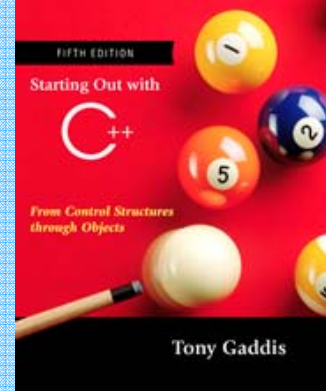


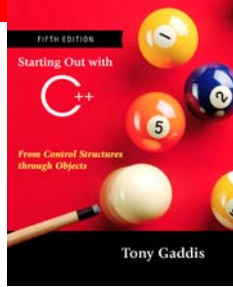
The function call in line 18 passes value1, value2, and value3 as arguments to the function.



# 6.5

## Passing Data by Value

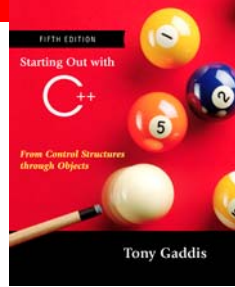




# Passing Data by Value

- 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



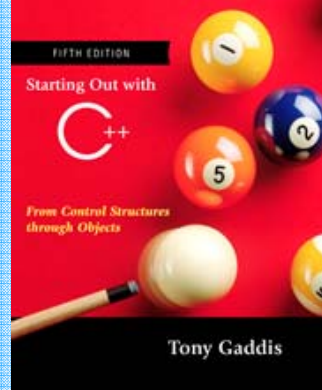
- Example: `int val=5;`  
`evenOrOdd(val);`



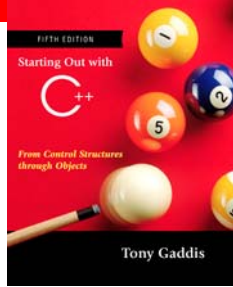
- `evenOrOdd` can change variable `num`, but it will have no effect on variable `val`

# 6.6

## Using Functions in Menu-Driven Programs



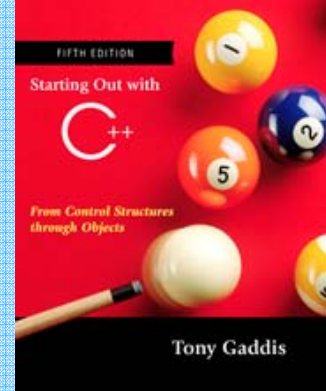
# Using Functions in Menu-Driven Programs



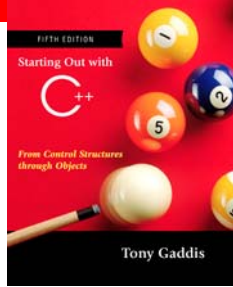
- Functions can be used
  - to implement user choices from menu
  - to implement general-purpose tasks:
    - Higher-level functions can call general-purpose functions, minimizing the total number of functions and speeding program development time
- *See Program 6-10 in the book*

# 6.7

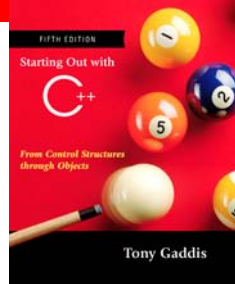
## The return Statement



# 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 `}`

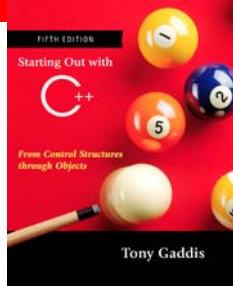


## Program 6-11

```
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)

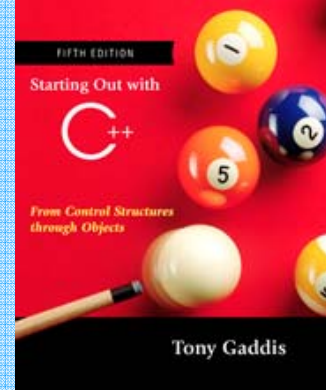
```
20  /*******
21  // Definition of function divide.
22  // Uses two parameters: arg1 and arg2. The function divides arg1*
23  // by arg2 and shows the result. If arg2 is zero, however, the *
24  // function returns.
25  /*******
26
27  void divide(double arg1, double arg2)
28  {
29      if (arg2 ==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

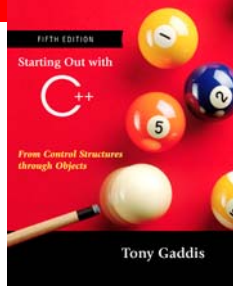
### Program Output with Example Input Shown in Bold

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

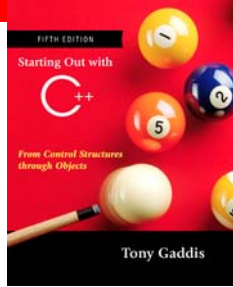




# Returning a Value From a Function

- 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:

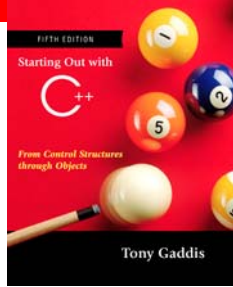
```
double x;  
x = pow(2.0, 10.0);
```



# 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;
}
```

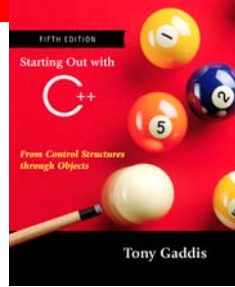


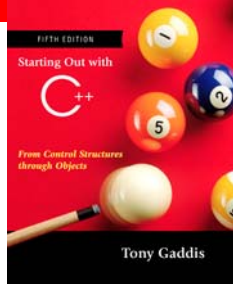
## Value Being Returned

# A Value-Returning Function

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

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

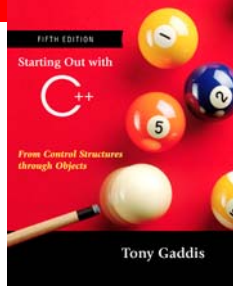




## Program 6-12

```
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)*



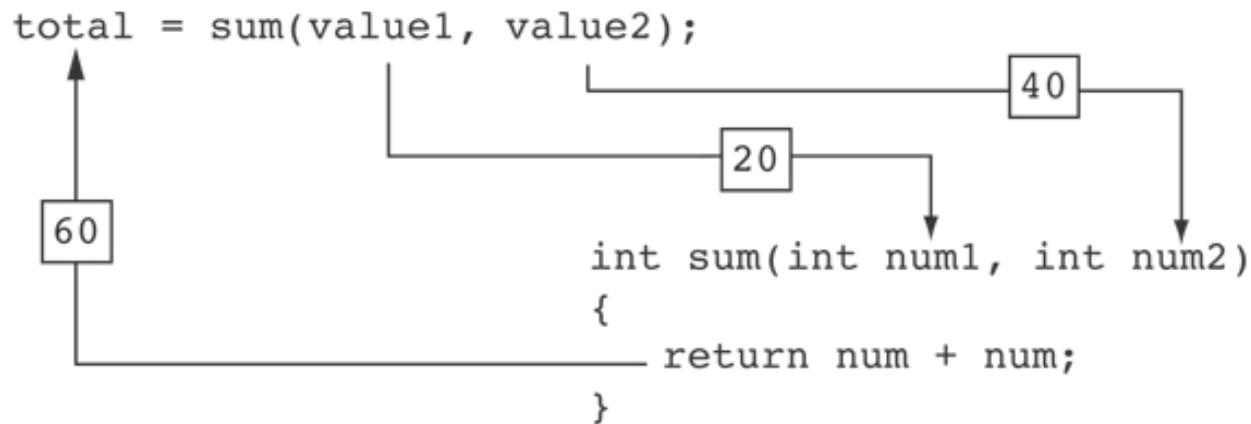
## Program 6-12 (Continued)

```
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

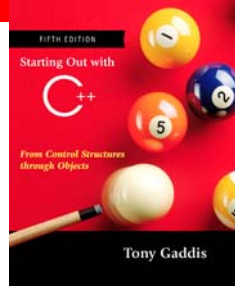
The sum of 20 and 40 is 60



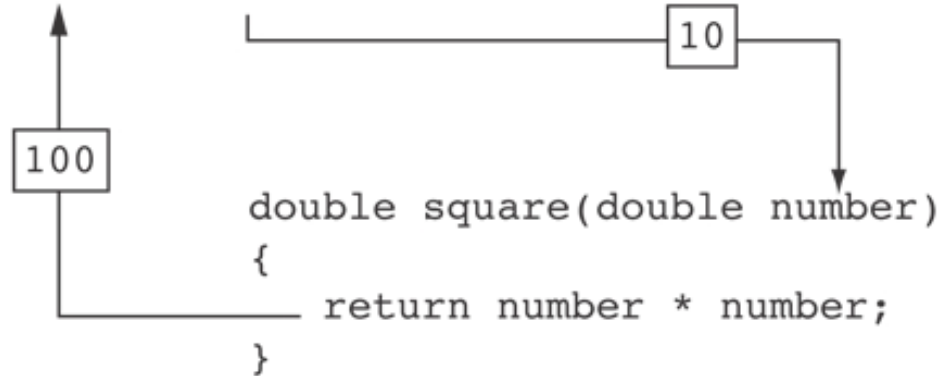


The statement in line 17 calls the `sum` function, passing `value1` and `value2` as arguments. The return value is assigned to the `total` variable.

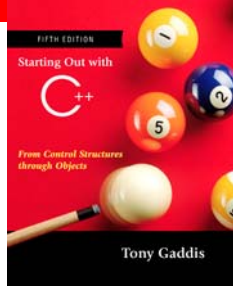
# Another Example, from Program 6-13



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



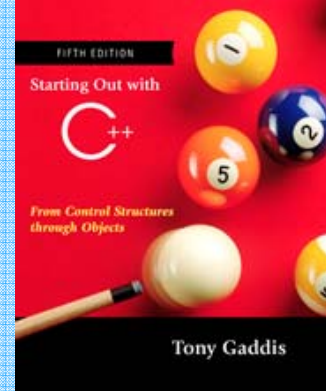
# Returning a Value From a Function

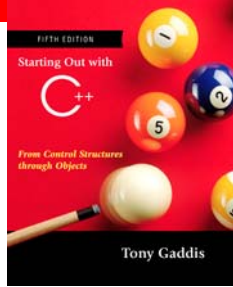


- The prototype and the definition must indicate the data type of return value (not `void`)
- Calling function should use return value:
  - assign it to a variable
  - send it to `cout`
  - use it in an expression

# 6.9

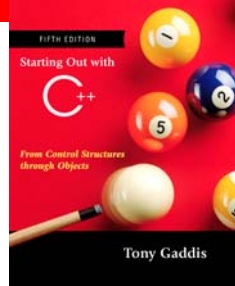
## Returning a Boolean Value





# Returning a Boolean Value

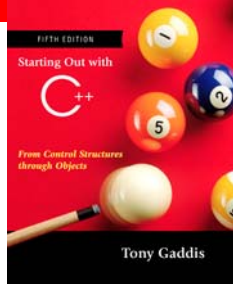
- Function can return `true` or `false`
- Declare return type in function prototype and heading as `bool`
- Function body must contain `return` statement(s) that return `true` or `false`
- Calling function can use return value in a relational expression



## Program 6-14

```
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
```

*(Program Continues)*

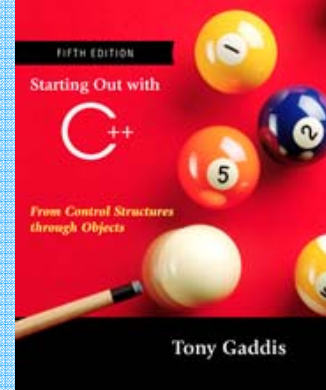


### Program 6-14 (continued)

```
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
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 an bool.                          *
30 //*****
31
32 bool isEven(int number)
33 {
34     bool status;
35
36     if (number % 2)
37         status = false;    // number is odd if there's a remainder.
38     else
39         status = true;     // Otherwise, the number is even.
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.



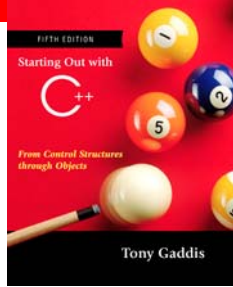
6.10

## Local and Global Variables





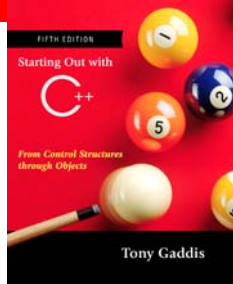
# Local and Global Variables

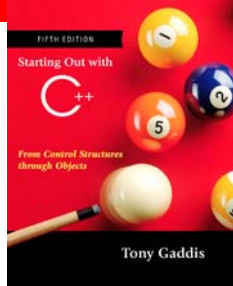


- Variables defined inside a function are *local* to that function. They are hidden from the statements in other functions, which normally cannot access them.
- Because the variables defined in a function are hidden, other functions may have separate, distinct variables with the same name.

## Program 6-15

```
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 }
```

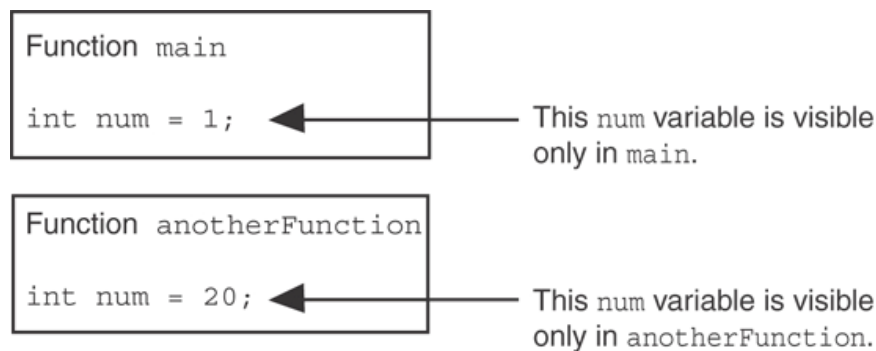


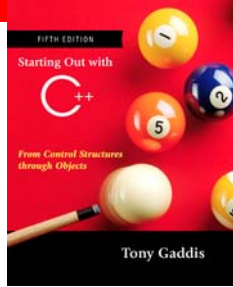


### Program Output

```
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.

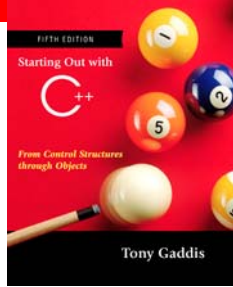




# Local Variable Lifetime

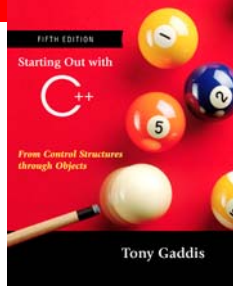
- A function's local variables exist only while the function is executing. This is known as the *lifetime* of a local variable.
- When the function begins, its local variables and its parameter variables are created in memory, and when the function ends, the local variables and parameter variables are 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 6-18

```

1  // This program calculates gross
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

```

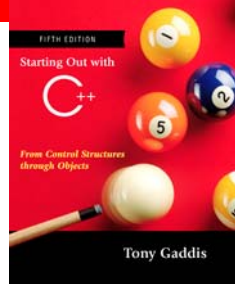
Global constants  
defined for values that do not  
change throughout the  
program's execution.

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

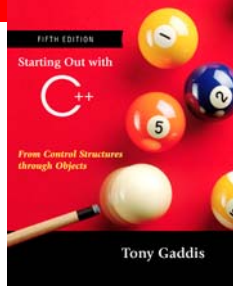
```
29      // Get overtime pay, if any.
30      if (hours > BASE_HOURS)
31          overtime = getOvertimePay(hours);
```

```
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;
--      }
```

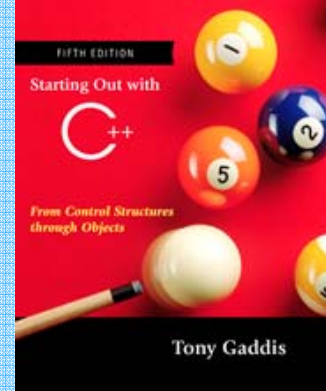






# Initializing Local and Global Variables

- 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.

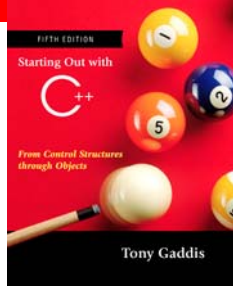


6.11

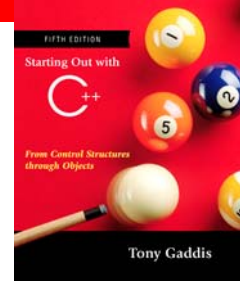
# Static Local Variables

■

# Static Local Variables



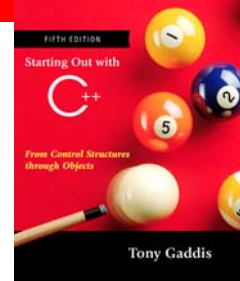
- Local variables only exist while the function is executing. When the function terminates, the contents of local variables are lost.
- `static` local variables retain their contents between function calls.
- `static` local variables are defined and initialized only the first time the function is executed.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



## Program 6-20

```
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 6-20 (continued)

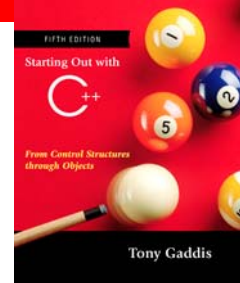
```
16  //*****
17  // Definition of function showLocal. *
18  // The initial value of localNum, which is 5, is displayed. *
19  // The value of localNum is then changed to 99 before the *
20  // function returns. *
21  //*****
22
23  void showLocal()
24  {
25      int localNum = 5; // Local variable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

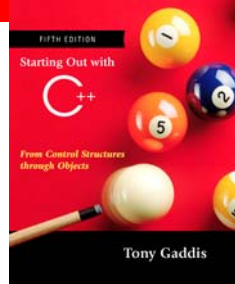
# A Different Approach, Using a Static Variable



## Program 6-21

```
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 6-21 (continued)

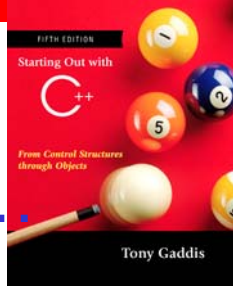
```
15  /*******
16  // Definition of function showStatic.                *
17  // statNum is a static local variable. Its value is displayed *
18  // and then incremented just before the function returns.    *
19  /*******
20
21  void showStatic()
22  {
23      static int statNum;
24
25      cout << "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 6-22..



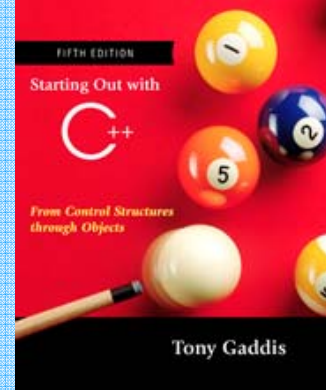
### **Program 6-22**     *(continued)*

```
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
```

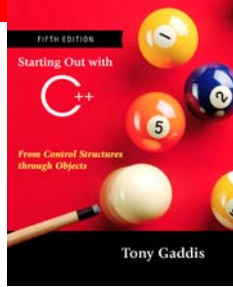




6.12

## 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 6-23

```
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

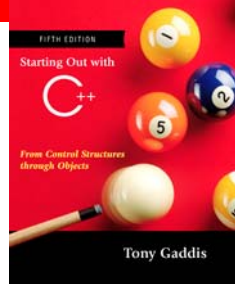
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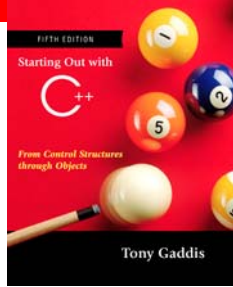
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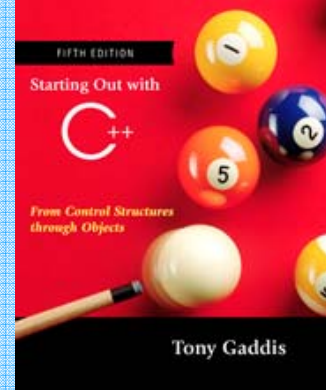


# Default Arguments

- 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:

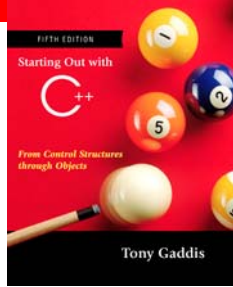
```
sum = getSum(num1, num2);      // OK  
sum = getSum(num1, , num3);   // NO
```



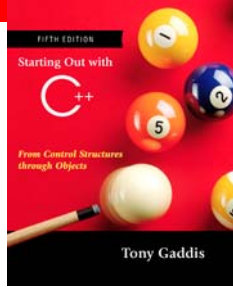
6.13

## Using Reference Variables as 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



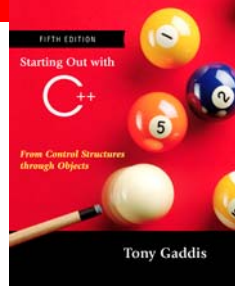
# Passing by Reference

- 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*



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

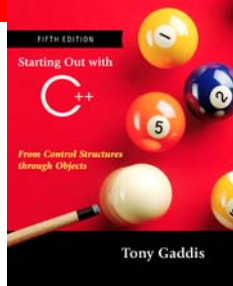


### Program 6-24

```
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)*



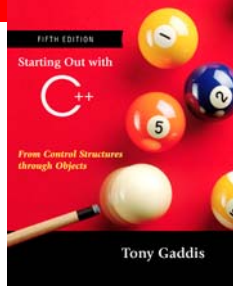
## Program 6-24 (Continued)

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  }
```

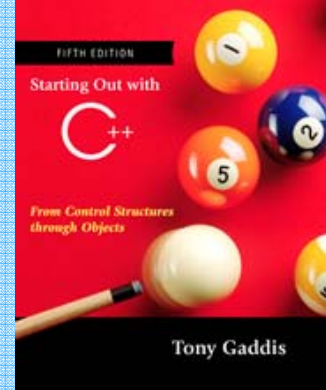
### Program Output

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



# Reference Variable Notes

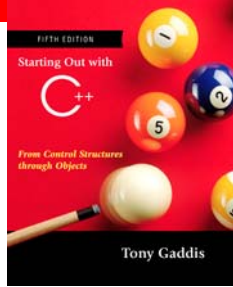
- Each reference parameter must contain &
- Space between type and & is unimportant
- Must use & in both prototype and header
- Argument passed to reference parameter must be a variable – cannot be an expression or constant
- Use when appropriate – don't use when argument should not be changed by function,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



6.14

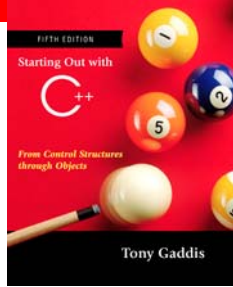
# Overloading Functions





# 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



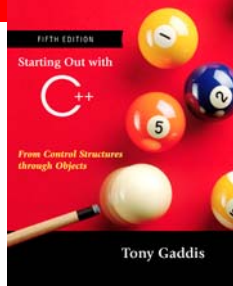
# Function Overloading Examples

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 6-26

```
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

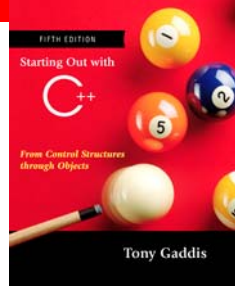
(Program Continues)

# Program 6-26 (Continued)

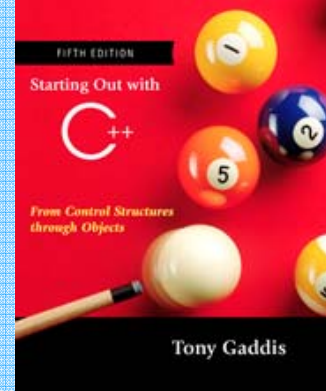
```
26  /*******
27  // Definition of overloaded function square.
28  // This function uses an int parameter, number. It returns the
29  // square of number as an int.
30  /*******
31
32  int square(int number)
33  {
34      return number * number;
35  }
36
37  /*******
38  // Definition of overloaded 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







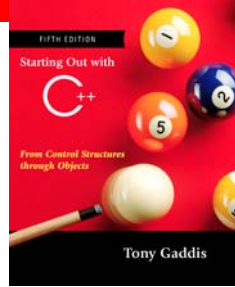
6.15

## The `exit()` Function

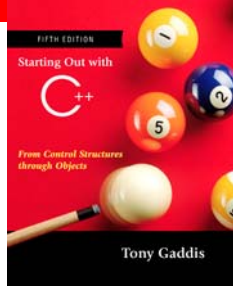


# The `exit()` Function

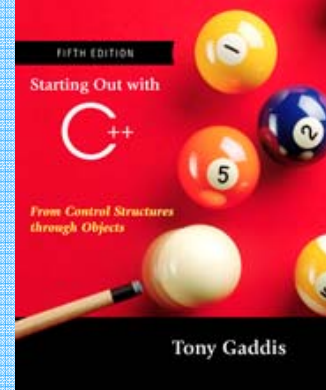
- Terminates the execution of a program
- Can be called from any function
- Can pass an `int` value to operating system to indicate status of program termination
- Usually used for abnormal termination of program
- Requires `cstdlib` header file



# The `exit()` Function



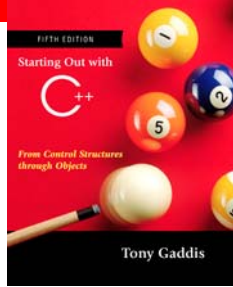
- Example:  
`exit(0);`
- The `cstdlib` header defines two constants that are commonly passed, to indicate success or failure:  
`exit(EXIT_SUCCESS);`  
`exit(EXIT_FAILURE);`



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