W6.1

- Destructors
- Data Members and Member Functions
- Returning a Reference to a Private Data Member
- Default Memberwise Copy
- Software Reusability

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6.12 Using Destructors

- Destructors
 - Are member function of class
 - Perform termination housekeeping before the system reclaims the object's memory
 - Complement of the constructor
 - Name is tilde (~) followed by the class name (i.e., ~Time)
 - Recall that the constructor's name is the class name
 - Receives no parameters, returns no value
 - One destructor per class
 - · No overloading allowed

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6.13 When Constructors and Destructors Are Called

- Constructors and destructors called automatically
 - Order depends on scope of objects
- Global scope objects
 - Constructors called before any other function (including main)
 - Destructors called when main terminates (or exit function called)
 - Destructors not called if program terminates with abort
- Automatic local objects
 - Constructors called when objects are defined
 - Destructors called when objects leave scope
 - i.e., when the block in which they are defined is exited
 - Destructors not called if the program ends with exit or abort

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6.13 When Constructors and Destructors Are Called

- Static local objects
 - Constructors called when execution reaches the point where the objects are defined
 - Destructors called when main terminates or the exit function is called
 - Destructors not called if the program ends with abort

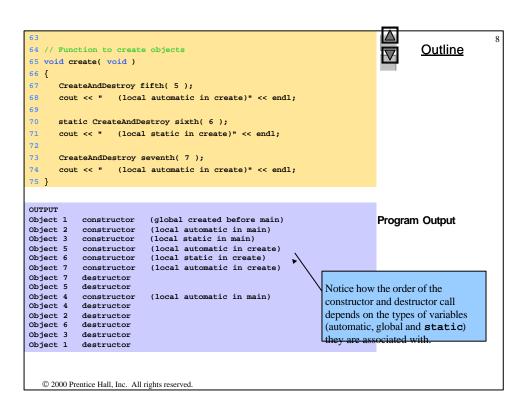
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◀

```
// Fig. 6.9: create.h
                                                                                   Outline
2 // Definition of class CreateAndDestroy.
3 // Member functions defined in create.cpp.
4 #ifndef CREATE_H
                                                                          1. Create a header file
5 #define CREATE_H
                                                                         1.1 Include function
                                                                         prototypes for the destructor and
7 class CreateAndDestroy {
8 public:
                                                                         constructor
   CreateAndDestroy( int ); // constructor
10 ~CreateAndDestroy();
                                // destructor
11 private:
12
    int data;
13 };
15 #endif
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```

```
16 // Fig. 6.9: create.cpp
                                                                                 Outline
17 // Member function definitions for class CreateAndDestroy
18 #include <iostream>
                                                                        2. Load the header file
                                                                        2.1 Modify the
20 using std::cout;
                                                                        constructor and
                                                                        destructor
21 using std::endl;
23 #include "create.h"
25 CreateAndDestroy::CreateAndDestroy( int value )
26 {
                                                           Constructor and Destructor changed to
                                                           print when they are called.
   cout << "Object " << data << " constructor";
28
29 }
31 CreateAndDestroy::~CreateAndDestroy()
   { cout << "Object " << data << " destructor " << endl; }
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```

```
// Fig. 6.9: fig06_09.cpp
34 // Demonstrating the order in which constructors and
                                                                                  Outline
35 // destructors are called.
36 #include <iostream>
                                                                         3. Create multiple
                                                                         objects of varying
38 using std::cout;
                                                                         types
39 using std::endl;
40
41 #include "create.h"
42
43 void create( void ); // prototype
45 CreateAndDestroy first( 1 ); // global object
46
47 int main()
48 {
49
      cout << " (global created before main)" << endl;</pre>
50
                                         // local object
51
      CreateAndDestroy second( 2 );
52
     cout << " (local automatic in main)" << endl;</pre>
53
54
      static CreateAndDestroy third( 3 ); // local object
     cout << " (local static in main)" << endl;</pre>
55
56
57
      create(); // call function to create objects
58
59
     CreateAndDestroy fourth( 4 );
                                           // local object
      cout << " (local automatic in main)" << endl;</pre>
60
61
      return 0;
```



6.14 Using Data Members and Member Functions

• Member functions

- Allow clients of the class to set (i.e., write) or get (i.e., read) the values of private data members
- Example:

Adjusting a customer's bank balance

- private data member balance of a class BankAccount could be modified through the use of member function computeInterest
- A member function that sets data member interestRate could be called setInterestRate, and a member function that returns the interestRate could be called getInterestRate
- Providing set and get functions does not make private variables public
- A set function should ensure that the new value is valid

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6.15 A Subtle Trap: Returning a Reference to a Private Data Member

- Reference to an object
 - Alias for the name of the object,
 - May be used on the left side of an assignment statement, makes perfectly acceptable *lvalue*.
 - Reference can receive a value, which changes the original object as well
- Returning references
 - public member functions can return non-const references to private data members
 - Should be avoided, breaks encapsulation
- Please avoid using references in this way, very, very bad!!!

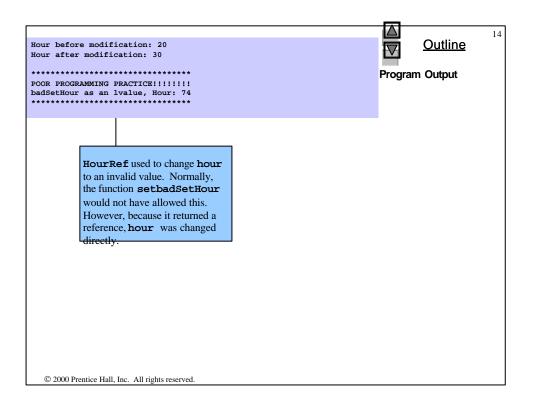
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```
// Fig. 6.11: time4.h
                                                                              Outline
2 // Declaration of the Time class.
3 // Member functions defined in time4.cpp
                                                                     1. Define class
5 // preprocessor directives that
                                                                     1.1 Function
6 // prevent multiple inclusions of header file
                                                                     prototypes
7 #ifndef TIME4_H
8 #define TIME4_H
                       Notice how member function
                                                                     1.2 Member variables
                       badSetHour returns a reference
10 class Time {
                       (int & is the return type).
11 public:
12 Time( int = 0, int = 0, int = 0);
void setTime( int, int );
int getHour();
   int &badSetHour( int ); // DANGEROUS reference return
15
16 private:
17
    int hour;
18 int minute;
19
   int second;
20 };
21
22 #endif
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```

```
23 // Fig. 6.11: time4.cpp
                                                                                               12
                                                                                 Outline
24 // Member function definitions for Time class.
25 #include "time4.h"
                                                                        1. Load header
27 // Constructor function to initialize private data.
28 // Calls member function setTime to set variables.
                                                                        1.1 Function definitions
29 // Default values are 0 (see class definition).
30 Time::Time( int hr, int min, int sec )
31 { setTime( hr, min, sec ); }
32
33 // Set the values of hour, minute, and second.
34 void Time::setTime( int h, int m, int s )
35 {
    hour = ( h >= 0 && h < 24 ) ? h : 0;
37
     minute = ( m >= 0 && m < 60 ) ? m : 0;
    second = ( s >= 0 && s < 60 ) ? s : 0;
38
39 }
40
41 // Get the hour value
42 int Time::getHour() { return hour; }
                                                           badSetHour returns a
43
                                                           reference to the
44 // POOR PROGRAMMING PRACTICE:
                                                           private member
45 // Returning a reference to a private data member.
                                                            variable hour.
46 int &Time::badSetHour( int hh )
                                                            Changing this reference
47 {
                                                           will alter hour as well.
48
     hour = ( hh >= 0 \&\& hh < 24 ) ? hh : 0;
49
50
     return hour; // DANGEROUS reference return
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```

```
Fig. 6.11: fig06_11.cpp
                                                                                                  13
                                                                                   Outline
53 // Demonstrating a public member function that
54 // returns a reference to a private data member.
55 // Time class has been trimmed for this example.
                                                                          1.2 Declare reference
56 #include <iostream>
58 using std::cout;
                                                                          2. Change data using a
                                      Declare Time object t and
59 using std::endl;
                                      reference hourRef that is
                                                                          reference
61 #include "time4.h"
                                      assigned the reference returned by
62
                                      the call t.badSetHour(20).
                                                                         3. Output results
63 int main()
64 {
65
                                           Hour before modification: 20
      Time t:
      int &hourRef = t.badSetHour( 20 );
66
                                                                Alias used to set the value
67
                                                                of hour to 30 (an invalid
68
      cout << "Hour before modification: " << hourRef;
                                                                value).
     hourRef = 30; // modification with invalid value
cout << "\nHour after modification: " << t.getHour();</pre>
69
70
71
                                                  Hour after modification: 30
72
      // Dangerous: Function call that returns
      // a reference can be used as an lvalue!
t.badSetHour(12) = 74;
                                                                Function call used as an lvalue
     Cout << "\n\n************************\n"
<< "POOR PROGRAMMING PRACTICE!!!!!!\n"
75
                                                                and assigned the value 74
76
                                                                (another invalid value).
77
           << "badSetHour as an lvalue, Hour: "
78
           << t.getHour()
           79
80
                                                               POOR PROGRAMMING PRACTICE!!!!!!!
82 }
                                                               badSetHour as an lvalue, Hour: 74
                                                              *******
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```



6.16 Assignment by Default Memberwise Copy

- Assigning objects
 - An object can be assigned to another object of the same type using the assignment operator (=)
 - Member by member copy
- Objects may be
 - Passed as function arguments
 - Returned from functions (call-by-value default)

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// Fig. 6.12: fig06_12.cpp 16 **Outline** // Demonstrating that class objects can be assigned 3 // to each other using default memberwise copy 4 #include <iostream> 1. Define class 6 using std::cout; using std::endl; 1.1 Define member functions 9 // Simple Date class Date(int = 1, int = 1, int = 1990); // default constructor void print(); 14 private: 15 int month; 16 int day; int year; 18 }; 20 // Simple Date constructor with no range checking 21 Date::Date(int m, int d, int y) 22 { 23 month = m; 24 day = d; year = y; 25 26 } 28 // Print the Date in the form mm-dd-yyyy 29 void Date::print() 30 { cout << month << '-' << day << '-' << year; }</pre> © 2000 Prentice Hall, Inc. All rights reserved.

```
Outline
33 {
      Date date1( 7, 4, 1993 ), date2; // d2 defaults to 1/1/90
34
                                                                         2. Create Date objects
35
                                                                         2.1 Memberwise copy
      date1.print();
      cout << "\ndate2 = ";
                                                                         3. Print values
      date2.print();
     date2 = date1; // assignment by default memberwise copy
      cout << "\n\nAfter default mer
42
                                      erwise copy, date2 = ";
43
      date2.print();
                                      date2 set equal to date1,
      cout << endl;
                                      and all member variables
                                     are copied.
      return 0;
47 }
date1 = 7-4-1993
                                                                          Program Output
date2 = 1-1-1990
After default memberwise copy, date2 = 7-4-1993
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```

6.17 Software Reusability

- Software resusability
 - Implementation of useful classes
 - Class libraries exist to promote reusability
 - Allows for construction of programs from existing, well-defined, carefully tested, well-documented, portable, widely available components
 - Speeds development of powerful, high-quality software

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