# *OBJECT-ORIENTED DESIGN*

## *LESSON PLAN*
## *and*
## *STUDENT WORKBOOK*

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**Course Number 20-260-634-901**

## Contents

*This Lesson Plan and Student Workbook gives the reading assignments, homework assignments (homework problems and papers), and study guides for this course. If you miss any classes, you can catch up by following this Lesson Plan and Student Workbook.*

### Reading Assignments, Course Text, and Lecture Notes

All reading assignments are from the course text and the lecture notes. The course text is:

> Grady Booch, *Object-Oriented Design with Applications*, Benjamin-Cummings Publishing Company, 1991, ISBN 0-8053-0091-0

The lecture notes were prepared by Richard Conn and are available at Kinko's. Ask for them by course number.

Each section of the Lesson Plan and Student Workbook includes a homework assignment, which is to be turned in for a grade, and a series of study guide questions.

### Homework

Place your name and the identification number, e.g., 4-1, on the first page of your homework assignment or paper.

### Schedule, Grading, and Materials List

The Cover pages to the Lecture Notes contain a copy of this information. In addition, each student is given a copy of these Cover pages and this Lesson Plan and Student Workbook on the first day of class.

## Object-Oriented Design -- The Need

***Objectives of this Module***

l    Present and discuss the need for Object-Oriented Design (OOD) and Object-Oriented Programming (OOP).

***Reading Assignment***

Lecture Notes, *Need*

***Homework Assignments Due to the Beginning of the Next Module***

None

***Study Guide***

3    What is a fundamental problem with software when new versions of complex software artifacts, such as compilers, are released?

3    How can this problem be overcome?

3    Name some of the major evolutionary steps in the field of Software Engineering since 1960.

3    How are performance problems overcome as new technology emerges?

3    Why was Object-Oriented Programming developed?

# 1. Software and Software Engineering

*Objectives of this Module*

l    Present and discuss the idea that software is much more than just code -- *engineered* software is composed of *controlled configuration items* which include documents, data, and code

l    Present and discuss the history of software development, including its evolution into a business

l    Present and discuss many of the problems with doing software development, particularly when there is more than one person involved

l    Present and discuss many myths about software development and explain why some of these myths are fallacies

l    Present and discuss several different software engineering paradigms, showing different methods for developing engineered software:

    m   Classic "waterfall" method
    m   Rapid prototyping
    m   Spiral method
    m   Fourth generation method

    l    Present and discuss some of the technologies used in the support of software engineering:

    m   *Computer-Aided Software Engineering* (CASE)
    m   Ada programming language
    l    Introduce the concepts of complexity, Object-Oriented Requirements Analysis (OORA), and Object-Oriented Design (OOD)

*Reading Assignment*

Lecture Notes, *Module 1*
Booch, *Chapter 1*

*Homework Assignments Due at the Beginning of the Next Module*

None

*Study Guide*

3    What is *software engineering*?

3    What is *software* from the perspective of Software Engineering?

3    Explain the failure curve for software.  Why is it so different from the failure curve for hardware?

3    What are the various *software configuration items* that compose an item of engineered software?  When are they usually produced during the classical software engineering processes?

3    Explain the five aspects identified in the course of the industrial view of software.

3    What are the phases of the classic "waterfall" model of the software engineering development process?  What are the problems with this model?

3    What are the phases of the prototyping model of the software engineering development process?

3    What are the phases of the Spiral Model of the software engineering development process?  How do other models fit into the Spiral Model?

3    What three phases of activity are common to all software engineering development processes?

3    Describe the *Capability Maturity Model for Software*.

3    Why was the Ada language developed?  What are some of its key features which help it meet its goals?

3    What is *industrial-strength software*?  What are its attributes?

3    Explain the canonical form of a complex system.

3    What are the purpose and elements of the design of a complex system?

## 2. Design Methodologies and Graphical Notation

*Objectives of this Module*

l   Present and discuss many of the common diagram notations used during requirements analysis and design:
   m   Data Flow Diagrams (DFD's)
   m   Function Diagrams
   m   State Transition Diagrams (STD's)
   m   Entity Relationship Diagrams (ERD's)
   m   Object Interaction Diagrams (OID's)
   m   Booch Diagrams
   l   Present and discuss the concept of the Data Dictionary and its content
l   Present and discuss several common design methodologies
   m   Data Flow-Oriented Design
   m   Data Structure-Oriented Design
   m   Object-Oriented Design
   m   Real-Time Design

*Reading Assignment*

Lecture Notes, *Module 2*

*Homework Assignments Due at the Beginning of the Next Module*

2-1. Study the Ada Traffic Management System described in Chapter 12 of the text. Draw an ERD and a DFD of the system.

*Study Guide*

3   What do *Data Flow Diagrams* tell us?  What are the elements of a DFD?
3   What does a *Data Dictionary* tell us?
3   What do *Function Diagrams* tell us?  What are the elements of a Function Diagram?
3   What do *State Transition Diagrams* tell us?  What are the elements of an STD?
3   What do *Entity Relationship Diagrams* tell us?  What are the elements of an ERD?
3   What do *Object Interaction Diagrams* tell us?  What are the elements of an OID?
3   What do *Booch Diagrams* tell us?  What are the elements of a Booch Diagram?
3   Compare and contrast the Data Flow-Oriented Design, Object-Oriented Design, and Real-Time Design methodologies.

## 3. The Object Model

*Objectives of this Module*

l    Present and discuss the concept of the Object Model and its evolution

l    Introduce the terms Object-Oriented Analysis (OOA), Object-Oriented Requirements Analysis (OORA), Object-Oriented Design (OOD), and Object-Oriented Programming (OOP)

l    Present and discuss the elements of the Object Model

l    Present and discuss the benefits and applications of the Object Model, particularly in the creation of industrial-strength software

*Reading Assignment*

Booch, *Chapter 2*

*Homework Assignments Due at the Beginning of the Next Module*

3-1. Examine the Ada programming language and write a paper on how Ada supports the development of concurrent objects.  At a minimum, answer the following questions in your paper:

   l  What program unit in the Ada language supports concurrency?

   l  How do concurrent objects communicate in Ada?

   l  How are asynchronous events, like interrupts, tied into the concurrent mechanism of Ada?

3-2. A book is an object that consists of a table of contents, an index, and a body of text, divided into chapters and appendices.  We experience instances of the book class every day of our lives.  Devise an object-oriented model of a book.  Be sure to describe the state information, the attributes of the book, and the behaviors associated with the book.  Be sure to cover the four major elements of the model in your description.

*Study Guide*

3    How do the different generations of programming languages differ in a topological sense?

3    What is an object?

3    What is meant by the terms *Object-Oriented Programming, Object-Oriented Design,* and *Object-Oriented Analysis*?  How are these activities related?

3    Explain why no single programming paradigm is best for all kinds of applications.

3    What is the *Object Model*?  What are the elements of the *Object Model*?  Be able to go into detail on these topics.

## 4. Classes and Objects

*Objectives of this Module*
l    Obtain a more complete understanding of classes and objects, the basic building blocks of software systems developed using object-oriented methods
l    Present and discuss the nature of an object
l    Present and discuss the concept of relationships between objects
l    Present and discuss the nature of a class
l    Present and discuss the concept of relationships between classes
l    Present and discuss relationships between classes and objects and the role of classes and objects in object-oriented design
l    Present and discuss the concept of building classes and objects (abstractions) with quality in mind, including heuristics for choosing operations, relationships, and implementations of classes and objects

*Reading Assignment*
Booch, *Chapter 3*

*Homework Assignments Due at the Beginning of the Next Module*
4-1. Review the Ada Traffic Management System in Chapter 12 of the book.  List the classes described in this problem, including their attributes and behaviors.  Show how the classes relate to each other.

4-2. Write a paper on the software issues involved in invoking a method.  Discuss the issues involved in method invocation as a static activity in conventional programming languages.  Discuss the issues and problems of method invocation as a dynamic activity in object-oriented programming languages, such as C++.

*Study Guide*
3    What is an *object*?  What is not an *object*?
3    What are the properties of an object?
3    How do objects relate to each other?
3    What is a *class*?  What is not a *class*?
3    What are the components of an interface to a class?
3    How do classes relate to each other?
3    Define and explain the term *polymorphism*.
3    Define and explain the term *inheritance*.
3    What is a *Metaclass*?
3    How do classes and objects relate to each other?
3    How is the quality of an abstraction measured?
3    How are quality abstractions created?

## 5. Classification

### *Objectives of this Module*
l    Present and discuss the idea that proper classification is very important to an object-oriented design and how and why it is difficult to obtain a proper classification
l    Present and discuss approaches to identifying classes and objects
l    Present and discuss approaches to identifying key abstractions and mechanisms

### *Reading Assignment*
Booch, *Chapter 4*

### *Homework Assignments Due at the Beginning of the Next Module*
5-1.  Write a paper discussing the problem of classification in general, using your own words.  Cover the major topics presented in Chapter 4 of the text.  Your paper may be no longer than 2000 words.

### *Study Guide*
3    What is meant by *classification*?
3    Why is it so hard to classify things?
3    Compare and contrast three methods of classification.
3    What roles do *Object-Oriented Analysis* and *Domain Analysis* play in classifying objects?
3    What is a *key abstraction*?
3    What is a *mechanism*?

## 6. The Notation

### *Objectives of this Module*

l    Present and discuss the basic elements of the notation needed for Object-Oriented Design:

- m   Class Diagrams
- m   State Transition Diagrams
- m   Object Diagrams
- m   Timing Diagrams
- m   Module Diagrams
- m   Process Diagrams
- l  Present and discuss ways to apply the notation

### *Reading Assignment*

Booch, *Chapter 5*

### *Homework Assignments Due at the Beginning of the Next Module*

6-1. Write an Ada package specification for the class of text file objects.  Be sure to include a reasonable collection of methods, no less than ten.  In the private section, be sure to include a type definition showing the attributes of a file object.  Include a reasonable collection of attributes, no less than five.

6-2. Solve problem 6-1, but use the C++ language to place the information in a class interface description.

### *Study Guide*

3    Explain the various models of *Object-Oriented Design*.
3    What are the products of OOD?
3    What are the purposes of the various notations described in the book?

## 7. The Process and the Pragmatics

*Objectives of this Module*

l    Present and discuss the process of Object-Oriented Design, identifying the activities
and products produced during the four steps:

    m   Identifying Classes and Objects

    m   Identifying the Semantics of Classes and Objects

    m   Identifying the Relationships Among Classes and Objects

    m   Implementing Classes and Objects

    l  Present and discuss the pragmatics of Object-Oriented Design, including the
    experiences to be encountered on a live OOD project and the resources required

l    Review the benefits and risks of Object-Oriented Design and present and discuss
ways to transition from other design methodologies to an Object-Oriented Design
methodology in a pragmatic fashion

*Reading Assignment*

Booch, *Chapter 6*
Booch, *Chapter 7*

*Homework Assignments Due at the Beginning of the Next Module*

None

*Study Guide*

3    What is meant by the term *Round-Trip Gestalt Design*?

3    Explain in detail the process of *Object-Oriented Design*, the *Spiral Model* of software
engineering, and how they relate to each other.  Include details on the role of OOD in the
software life cycle.

3    What is the recommended composition of a development team which is employing
OOD?

3    What are the recommended ways of measuring the progress of an object-oriented
project?  What are the products of an object-oriented project?

3    What is meant by *Quality Assurance*?

3    What are the recommended tools to support OOD?

3    Be able to discuss the benefits and risks of OOD.