A Set of CS 1 Labs Utilizing Graphical Objects and Inheritance

Peter Andrews
William Slough

Duane Broline
Nancy Van Cleave

Eastern Illinois University
Department of Mathematics
Overview

- **Cohoon & Davidson**: *C++ Program Design*
- Math 2170 — CS 1
- Multi-part Weekly Labs
- Graphics
- Themes
- Object–Oriented
Cohoon & Davidson

C++ Program Design: An Introduction to Programming and Object–Oriented Design

Graphics Package: EzWindows

• Object–Oriented
• Engaging
• Allows Animation
• Provides Immediate Feedback
Background

- EIU: A regional university
- Department of Mathematics
- Students: Pre–Engineering, Math, Math Ed, and CS
- Teaching Team
Math 2170 — CS 1

- Lab-based
- Uses C++
- Two 50-minute lectures per week
- One 100-minute lab per week
- Co-requisite: Calc I
Lab Components

• Reference to Reading (text and handouts)
• Preview Exercises, Submission Sheet
• Lab Exercises
• Makefile
• Lab Check-off Sheet
• Gradesheet
• Follow-up Programming Exercise
Example—Week 5 Lab

Laboratory 5

Key Concepts

- EzWindows graphics
- Classes: RandomInt, Position, SimpleWindow, RectangleShape, RaySegment, and CircleShape
- Using messages with classes
Week 5 Lab

Lab Preview Reading

- Class and Library Descriptions manual (written by team)
- §3.9
- All program listings in appendix
Week 5 Lab

Lab Preview
Exercises
★ 1. Locating RectangleShapes on a grid
Lab Preview
Exercises—continued
★ 2. How to declare a specific RectangleShape
★ 3. How to display that RectangleShape in a graphics window
4. Various position displacement expressions (★ parts b & c) needed for lab exercises
Week 5 Lab

Lab Exercises
1. Download, uncompress lab files
2. Compile, execute **lab5a.cpp**
Week 5 Lab

√ 3. Add RectangleShapes in corners, change window size
Week 5 Lab

4. `lab5b.cpp`: Compile, Execute, Observe...
Week 5 Lab

5. Add a green bar behind circle
Week 5 Lab

6. Add a red bar below the box... Oops
Week 5 Lab

√ 6. Add a red bar below the box...
Week 5 Lab

7. Complete the red frame around the box...
Week 5 Lab

7. Now the sides... Oops
7. Try again... Oops
√ 7. Voilá, the framed box
Week 5 Lab

8. **lab5c.cpp**: Compile, Execute, Observe...
9. Delete arrowheads, modify width
10. Add bisecting lines
√ 11. Add Label in window center
Week 5 Lab

Lab Followup—given skeleton program…
Get four percentages, declare and draw four corner squares, declare and draw connecting ray segments
Week 5 Homework

Create the figure shown below—get center and diameter of large circle from user:

![Diagram of a circle with centers and diameters marked](image-url)
Themes

Concepts are:

- Introduced in lecture and lab (already coded)
- Expanded upon following week (need to modify)
- Significant student involvement by third week
- Use in new context; from “scratch”
Input File Theme

1. Present concept
   - “hardcoded” file name
   - code already present in lab exercise(s)
   - loop to read file contents (int, string) in place

2. Expand on concept
   - code present in lab exercise(s)
   - modify to obtain filename from user
   - modify to get character at a time

3. Follow-up requires code from “scratch”
Function Theme

1. Practice—Predefined functions—Messages to objects

2. Practice
   - EzWindows classes and messages
   - sleep function (delay execution for animation)

3. Practice—library functions: math, ctype, iomanip

4. Practice—header files, pre-compiled implementation
   - focus on interface
   - testing
Function Theme—Continued

5. Completing function implementations

6. Writing functions with reference parameters, function templates

7. Completing/Writing member functions
File Processing–Bar Chart–Scaling Themes

Follow–up 6: statistics about text file, bar chart scaled to window

Follow–up 7: scale a Lissajous curve to fit background

Follow–up 10: two–pass processing of file of integers, represent as bar chart scaled to window

Follow–up 12: approximating the area under a curve, display as RectangleShapes scaled to window
Inheritance Theme

Week 3: window coordinates, spiral coordinates (no graphics)

Week 5: EzWindows classes RectangleShape, RaySegment

Week 6: graphing a spiral, drawing a checkerboard

Week 9: completing class messages for: SmartSquareShape and MovingSquareShape
Week 10: completing class messages for: FramedRectangleShape, Board, GameBoard, and Piece

- Follow-up: interactive Tic–Tac–Toe
- Project: FractalBoard — using JuliaColor to rewrite GetBlockColor()
Graphics Theme

Week 3: Window coordinate system

Week 5: Introduction to EzWindows classes
RectangleShape, RaySegment

Week 6: Checkerboard using nested loops

Week 7: Bar Chart, string file statistics; first animation

Week 8: Lissajous Curve—animated

Week 9: Derived SquareShape classes, animation
Week 10: Derived Board classes

Week 11: Derived Grid class

Week 12: Bar Chart, int file statistics

Week 13: Area Under a Curve
Conclusion

• Cohesive and comprehensive
• Basic concepts of C++, reinforced by themes
• Incorporates object–oriented aspects of C++
• Graphics—good for visual learners; interesting
Homework 7 – Chaos Game
Homework 7 – Chaos Game
Homework 7 – Final Results