LabVIEW Object Oriented Programming

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Agenda

- **About Bloomy Controls**
- Object Orientation Concepts
- Benefits of Object Oriented Programming
- Real-Life Examples
- Common Concerns
- Questions

Who is Bloomy Controls?

Bloomy Controls is a full service integrator providing turnkey systems, consulting, and training for Test and Measurement systems.

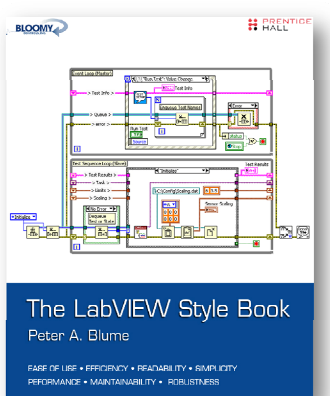
- Founded in 1991
- Windsor, CT; Marlborough, MA; Fort Lee, NJ
- Industry Leader in NI LabVIEW development
- NI **Select** Alliance Partner
- 12 Certified LabVIEW Architects
- CSIA (Control Systems Integrators Association) Certified Member

csia CERTIFIED

NATIONAL INSTRUMENTS™ Select Alliance Partner

BLOOMY CONTROLS, INC.

LabVIEW Style Experts



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- Best practice for developing quality LabVIEW applications
- Over 200 style rules
  - Ease of use
  - Efficiency
  - Readability
  - Simplicity
  - Performance
  - Maintainability
  - Reliability
- Companion website at www.bloomy.com/lvstyle

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Object Orientation

- A software engineering methodology / philosophy
- Break a system down into discrete, independent entities (or "Objects") with a single, distinct role or responsibility
- Accepted as one of the best techniques for modeling complex systems
- Promotes greater reliability, flexibility and maintainability in programming

All About The Phrasing

- Consider these descriptions from a recent NI Virtual User Group presentation:

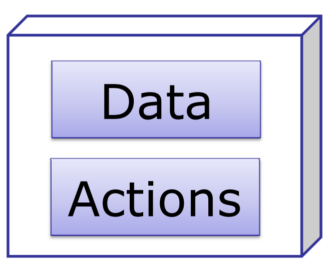
"**We** want to test each board at the end of an assembly line to make sure each is functional. **We** want to send an email to management for any failed tests"

and

"**We** want the **assembly line** to produce boards. Each **board** should test itself for functionality and report any problem. The **log** should send an email to management for any failed tests"

What is an Object

- Data and actions are grouped together into one self-contained unit called an "Object"



- An object's definition is known as a "class"

OOP In LabVIEW = LVOOP

- An Object is similar to a cluster
  - Cluster + Library (lvlib) + magic
- Objects are defined in terms of their "class"
- Classes are defined in LVClass files and contain:
  - A data-type (the "cluster of private class data", or "class cluster")
  - A list of "member" VIs
  - A description of what the wire should look like
  - Inheritance Information (more on this later)
- Native to LabVIEW 8.20+ (PCs), and LabVIEW 2009 (Real-Time and FPGA)

In LabVIEW…

DEMO: Creating a class

- Goal: An object to represent a shape in a drawing application
- What should a particular shape know about itself?
  - It's location
  - It's color / style
- What should any shape be able to do?
  - Allow its color and style to be programmatically changed
  - Draw itself on a LabVIEW 2D Picture Control

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Benefits: Scope and Encapsulation

- A VI's scope is a description as to where that VI can be used
- Change implementation without affecting other parts of your program – **"Encapsulation"**
- Helps limit an object to a specific, single role as we
- Classes have four scope levels:
  - **Public**
  - **Private**
  - Protected (talk about this later)
  - Community (outside the scope of this presentation)
- Allows you to have internal functionality that does not have to be checked against all use-cases (e.g. can presume that an array is sorted and has 10 elements)

Benefits: Scope

DEMO: Using Scope

- How to mark parts of our class as Private
- Task:
  - Restrict the number of colors that can be used to one of a discrete list
  - Code to convert color name into raw color value should be internal to the class so that we can make presumption / change the values later

Benefits: Inheritance

- Classes can have "parents" and "children" (also known as "ancestors" and "descendants")
  - A circle **is a kind of** shape, or a circle is a **descendant** of shape
- A child class automatically knows the same information and can do the same actions as its parent, along with anything else more specific
- Allows common code to be developed once
  - Child VIs need only add new, or replace ("override") functionality that is different from the parent
  - Less repetition = more reliability

Benefits: Inheritance

- An object can flow down any of it's own wires or any of it's parents wires.
  - LabVIEW keeps track of what object is actually on a wire at a given point
  - E.g. a **circle** can travel along a **shape** wire and can use **shape** VIs.
- LabVIEW will select the correct VI at **RUNTIME** (e.g. parent's X.vi or child's X.vi)
  - Called Runtime Polymorphism or **Dynamic Dispatch**
  - LabVIEW will choose the correct functionality for you

Benefits: Inheritance

DEMOS: Inheritance and Dynamic Dispatch

- Task:
  - Create a Circle class that inherits from Shape
- Demonstrate LabVIEW selecting correct VI at runtime

Benefits: Good Style

- Encapsulation and modularity are key pillars of Bloomy Controls' Style Guidelines, even without LVOOP
  - Drivers and other modules should encapsulate key functionality and function as independent entities
- Why not let LVOOP do the hard work for you?
  - Very low overhead
  - Enforces modularity through scope protections
  - Allows you, the developer to control how your code is used.
  - Built in versioning can allow your program to automatically adjust for new versions of a class.

Benefits Summary

- Encourages good design
  - Enforces encapsulation and protects data
  - Forces code to be used as the developer intended
- Permits run-time polymorphism
  - Allows interface to be defined regardless of implementation
- Can lead to better, more stable code
  - Code can be based on thoroughly tested starting point
  - Scalable without affecting existing software

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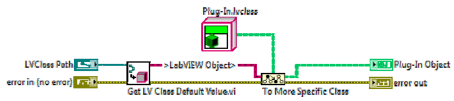
Real Life Use Cases: Drivers

- Most logical use case – many devices carry out the same functionality in different ways.
- A class allows the functionality for an application to be defined, regardless of implementation
- Hardware can be easily replaced without any changes in main application code
- I created a motor framework that would allow 3 different kinds of motor to be used with a system
- A "Virtual Motor" was also created to allow the system to be tested **without the hardware present**

Use Case: Plug-Ins

- Classes can be dynamically loaded from a path



- Created software to manage data from multiple devices that communicated the same kind of data over different interfaces (including RS232, USB, and Wireless Ethernet).
- Software architected so that each type of device has its driver dynamically loaded as a plug-in.
- Allows new devices to be added to software without rebuilding EXE.

Use Case: Test Data

- Allows a common set of test data to be defined and then extended for specific tests
- All tests have the following data:
  - Operator
  - Start Time
  - Pass / Fail
  - Failure Reason
- Other tests (e.g. resistance test) will have additional values
- Test reports can list the pass/fail results of all tests regardless of the type of test run
- Test specific code inserted the data into the system's database according to the type of test.

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Common Concerns

- A LOT of VIs
  - Each interface, interaction and data manipulation becomes its own VI, leading to many small Vis
- DESIGN IS CRITICAL
  - More design effort is required up front and, because classes are independent, changing a parent class VI may require changing many child VIs *(upfront design is not necessarily a bad thing…)*

Development Time?

- Like any engineered system, LVOOP requires up an front design effort
- Pay-offs are a function of re-use and code-simplicity
  - Less prone to bugs and can be independently tested
  - Inheritance can dramatically reduce time needed for similar components
  - Code can be more easily reused within the same as well as other applications
- Do not have to hard code all aspects of your software up front
  - E.g. an application has a motor replaced with an alternative brand that uses an ActiveX driver instead of RS232
  - Customer needs a new test type that you couldn't predict when you first created the app

> **"Definition 1.1: Development time** includes the hours required to develop, document, test, modify, and maintain an application **throughout its entire life cycle."**
> (LabVIEW Style Book, P. Blume)

Conclusion

LabVIEW Object Oriented Programming offers a powerful set of tools to help you:

- Simplify the process of designing applications
- Create code that is more modular through encapsulation and scope control
- Leverage language-level tools to help ensure that your code is used as intended
- Define functionality at runtime, instead of having to hard code how your application will run
- Improve maintainability by allowing implementations to change without affecting the overall application
- Design software that can grow

Any Questions?

"A VI outside a class is a gun without a safety. Data outside a class is a target"

A message from LabVOOP R&D (courtesy of LAVA member "Aristos Queue")

Contact Bloomy Controls

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Additional Resources

- LAVA Object-Oriented Forum
  - http://lavag.org/forum/26-object-oriented-programming/
- LabVIEW Object-Oriented Programming: The Decisions Behind the Design
  - http://zone.ni.com/devzone/cda/tut/p/id/3574
- NI Large Application Development Group
  - http://decibel.ni.com/content/groups/large-labview-application-development
- Bloomy Controls website
  - http://www.bloomy.com