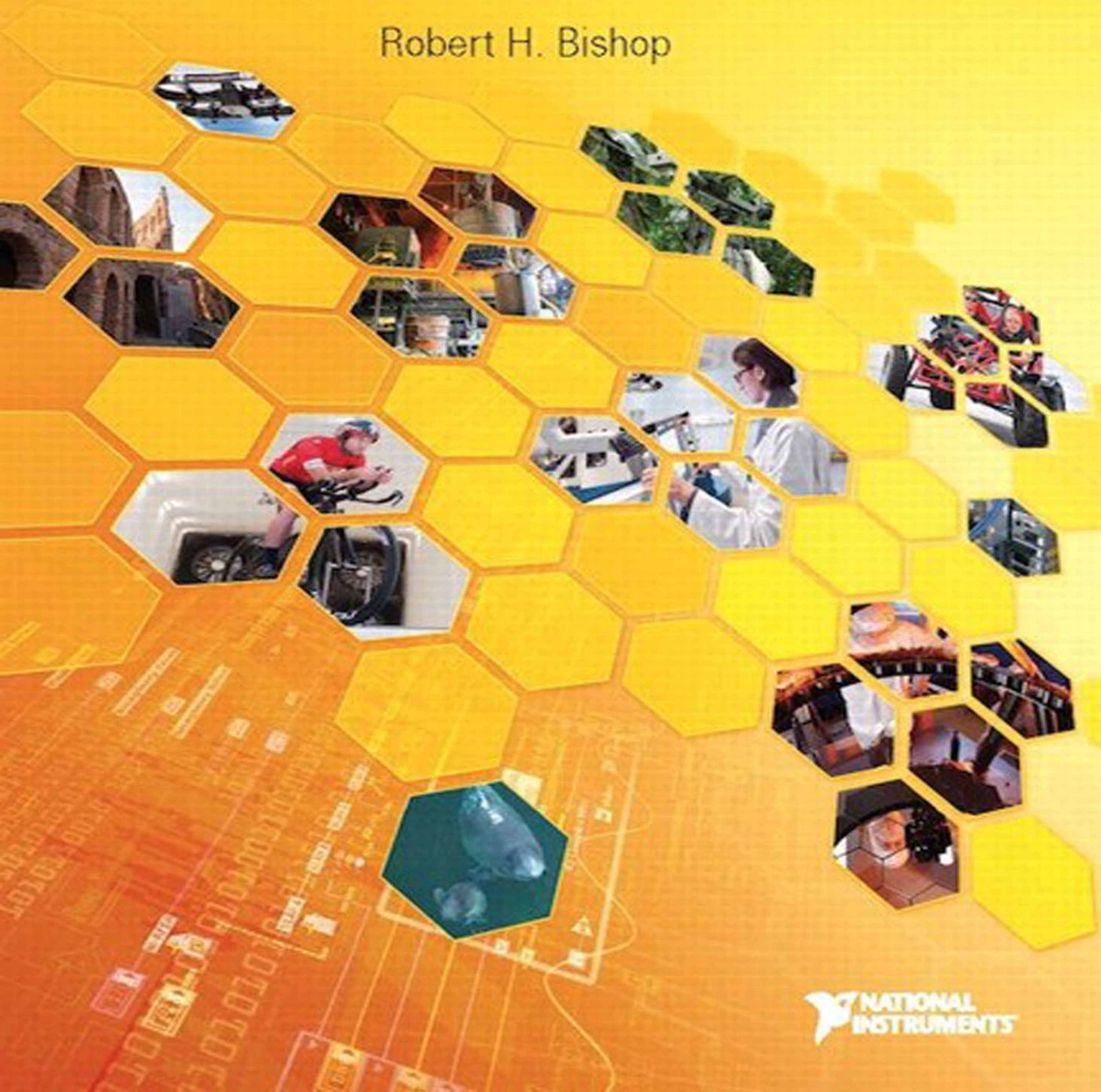
Learning With LabVIEW™

Robert H. Bishop



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Robert H. Bishop

Marquette University

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To my parents, W. Robert Bishop
and Anna Maria DiPietro Bishop

CONTENTS

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P R E F A C E

Learning with LabVIEW™ is the textbook that accompanies the *LabVIEW Student Edition* from National Instruments, Inc. This textbook, as well as the LabVIEW software, has undergone a significant revision from the previous edition. *Learning with LabVIEW* teaches basic programming concepts in a graphical environment and relates them to real-world applications in academia and industry. Understanding and using the intuitive and powerful LabVIEW software is easier than ever before. As you read through the book and work through the examples, we hope you will agree that this book is more of a personal tour guide than a software manual.

The LabVIEW graphical development environment was built specifically for applications in engineering and science, with built-in functionality designed to reduce development time for design and simulation in signal processing, control, communcations, electronics and more. The *LabVIEW Student Edition* delivers all the capabilities of the full version of LabVIEW, widely considered the industry standard for design, test, measurement, automation, and control applications. With LabVIEW, students can design graphical programming solutions to their homework problems and laboratory experiments—an ideal tool for science and engineering applications—that is also fun to use! The *LabVIEW Student Edition* affords students the opportunity for self-paced learning and independent project development.

The goal of this book is to help students learn to use LabVIEW on their own. With that goal in mind, this book is very art-intensive with over 400 figures in all. That means that there are numerous screen captures in each section taken from a typical LabVIEW session. The figures contain additional labels and pointers added to the LabVIEW screen captures to help students understand what they are seeing on their computer screens as they follow along in the book.

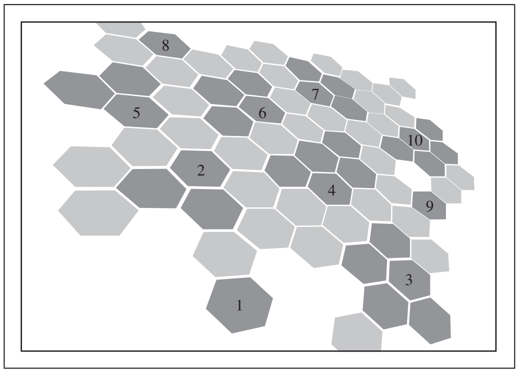
The most effective way to use *Learning with LabVIEW* is to have a concurrent LabVIEW session in progress on your computer and to follow along with the steps in the book. A directory of virtual instruments has been developed by the author exclusively for use by students using *Learning with LabVIEW* and is available on **www.pearsonhighered.com/bishop**. These virtual instruments complement the material in the book. In most situations, the students are asked to develop the virtual instrument themselves following instructions given in the book, and then compare their solutions with the solutions provided by the author to obtain immediate feedback. In other cases, students are asked to run a specified virtual instrument as a way to demonstrate an important LabVIEW concept.

GAINING PRACTICAL EXPERIENCE AND SOLVING REAL-WORLD PROBLEMS

With higher education emphasizing hands-on laboratory experience, many educational institutions have improved their laboratory facilities in order to increase student exposure to practical problems. College graduates are gaining vital experience in acquiring and analyzing data, constructing computer-based simulations of physical systems, and multipurpose computer programming. LabVIEW offers a powerful, efficient, and easy-to-use development environment, allowing educators to teach their students a wide range of topics with just one open, industry-standard tool. It can also transform the way engineers, scientists, and students around the world design, prototype, and deploy cutting-edge technology. Customers and students at more than 25,000 companies and schools are using LabVIEW and modular hardware from National Instruments to simplify technology development and increase productivity. From testing next-generation gaming systems to creating breakthrough medical devices, the resulting innovative technologies are impacting millions of people worldwide.

The cover of this edition of *Learning with LabVIEW* shows ten interesting application areas that use LabVIEW in the solution process.

1. Marine Mammals
2. Cycling Speed
3. NASA Microshutters
4. Cancer Lab
5. Roman Amphitheater
6. Nucor Steel Plant
7. La Selva Rainforest
8. ARV Drone
9. Tumor Treatment
10. Autonomous Vehicle



1. Marine Mammals

LabVIEW was used to develop a reliable data acquisition system that can collect and analyze ultrasonic signals produced by killer whales to perform live audio monitoring and movement tracking to study how the marine mammals use echolocation in their natural habitat.

2. **Cycling Speed**
   Using LabVIEW, NI hardware, and off-the-shelf components, a unique wind tunnel was created to conduct continuous loops of development and testing for cyclists and their bikes by evaluating and optimizing their riding positions.
3. **NASA Microshutters**
   The challenge of synchronizing the motion of a magnet moving more than 1 meter per second with the opening and closing of tens of thousands of tiny microelectromechanical system microshutters was addressed for application on the James Webb space telescope to enable the next stepping-stone toward understanding the universe.
4. **Cancer Lab**
   LabVIEW helps advance a unique and more accurate form of cancer treatment where accelerated charged particles can precisely target deep-seated cancer cells opening new perspectives for patients with respect to surgery or traditional radiotherapy.
5. **Roman Amphitheater**
   Building a distributed monitoring system to identify structural damage and reduce seismic risk of the Arena di Verona—one of the largest open-air opera theaters in the world built in the first century—involved creating a data acquisition system to communicate with existing measurement sensors in the theatrer that continuously monitors signals from sensor devices, tracks changes in a crack and the onset of structural vibrations related to environmental changes.
6. **Nucor Steel Plant**
   Employing LabVIEW programmable automation controllers has led to a tenfold increase in efficiency and drastically reduced the facility automation costs for steel recycling that reduces the amount of energy consumed while improving safety for workers.
7. **La Selva Rainforest**
   Employing a wide range of wireless environmental measurements using a single device that provides robotic control, remote configuration, and data sharing over the Web, researchers in Costa Rica are testing a hypothetical explanation of the exchange of CO2 and other materials between the forest floor and the atmosphere—the so-called "gap theory."
8. **ARV Drone**
   A unique LabVIEW application is used to control an unmanned aerial vehicle, acquire the images taken by its cameras, and process the images with NI vision hardware in areas only viewable and accessible by air for fast

detection of casualties in difficult-to-access areas, such as earthquake and collapsed-building sites.

9. **Tumor Treatment**
   Using NI hardware and software, a new medical device was created to treat breast tumors in a less invasive and nearly painless procedure, dramatically reducing the emotional and physical discomfort of patients undergoing tumor treatment.
10. **Autonomous Vehicle**
    A semiautonomous vehicle was developed using LabVIEW software and hardware that allows a blind driver to successfully navigate, control speed, and avoid collision through a secure driving course.

THE *LABVIEW STUDENT EDITION* SOFTWARE

The *LabVIEW Student Edition* software package is a powerful and flexible instrumentation, analysis, and control software platform for PCs running Microsoft Windows or Apple Macintosh OS X when installed using the MacOS Boot Camp application or a virtual machine environment. The student edition is designed to give students early exposure to the many uses of graphical programming. LabVIEW not only helps reinforce basic scientific, mathematical, and engineering principles, but it encourages students to explore advanced topics as well. Students can run LabVIEW programs designed to teach a specific topic, or they can use their skills to develop their own applications. LabVIEW provides a real-world, hands-on experience that complements the entire learning process.

WHAT'S NEW WITH THE LABVIEW STUDENT EDITION?

The demand for LabVIEW in colleges and universities has led to the development of *LabVIEW Student Edition* based on the industry version of LabVIEW. This is a new and significant software revision that delivers all of the graphical programming capabilities of the full edition. With the student edition, students can design graphical programming solutions for their classroom problems and laboratory experiments on their personal computers. The *LabVIEW Student Edition* features include the following:

- Express VIs that bring interactive, configuration-based application design for acquiring, analyzing, and presenting data.
- Interactive measurement assistants to make creating data acquisition and instrument control applications easier than ever.
- Full LabVIEW advanced analysis capability.

- Full compatibility with all National Instruments data acquisition and instrument control hardware.
- Support for all data types used in the LabVIEW Full Development System.

New LabVIEW software features introduced in this new edition of *Learning with LabVIEW* include:

- Updated editing and manipulations of wires including Owned Labels and Align/Distribute Wires, and you can now wire an error cluster directly to Boolean functions.
- Enhancements in creating subVIs including Create SubVI from Selection that automatically builds the connector pane and front panel of the subVI; and the icon and connector pane that is always visible for easier subVI wiring and icon editing.
- New editing features including new ways to view Control and Function palettes, the ability to change parameters of multiple objects at one time, and you can now right-click a cluster constant and select View Cluster As Icon from the shortcut menu to reduce the size of cluster constants on the block diagram.
- Improved programming constructs including automatically concatenating arrays leaving loops and conditionally processing loop outputs.
- A redesigned Getting Started window to allow ready access to the resources you need to use LabVIEW emphasizing common tasks, such as creating projects and opening existing files, and presents less common tasks, such as downloading additional drivers and products, through submenus.

This latest edition of *Learning with LabVIEW* also features:

- A myDAQ Building Blocks section in each chapter to provide the opportunity to apply the concepts introduced in the chapter using the myDAQ hardware.
- New relaxed readings that illustrate how students, engineers, and scientists are using LabVIEW to solve real-world problems.
- Information on how to become a certified LabVIEW user for career advancement and employment opportunities.

ORGANIZATION OF LEARNING WITH LABVIEW

This textbook serves as a LabVIEW resource for students. The pace of instruction is intended for both undergraduate and graduate students. The book is comprised of 11 chapters and should be read sequentially when first learning LabVIEW. For more experienced students, the book can be used as a reference book by using the index to find the desired topics. The 11 chapters are as follows:

CHAPTER 1: LabVIEW Basics—This chapter introduces the LabVIEW environment and helps orient students when they open a virtual instrument. Concepts such as windows, toolbars, menus, and palettes are discussed.

CHAPTER 2: Virtual Instruments—The components of a virtual instrument are introduced in this chapter: front panel, block diagram, and icon/connector pair. This chapter also introduces the concept of controls (inputs) and indicators (outputs) and how to wire objects together in the block diagram. Express VIs are introduced in the chapter.

CHAPTER 3: Editing and Debugging Virtual Instruments—Resizing, coloring, and labeling objects are just some of the editing techniques introduced in this chapter. Students can find errors using execution highlighting, probes, single-stepping, and breakpoints, just to name a few of the available debugging tools.

CHAPTER 4: SubVIs—This chapter emphasizes the importance of reusing code and illustrates how to create a VI icon/connector. It also shows parallels between LabVIEW and text-based programming languages.

CHAPTER 5: Structures—This chapter presents loops, case structures, and flat sequence structures that govern the execution flow in a VI. The Formula Node is introduced as a way to implement complex mathematical equations.

CHAPTER 6: Arrays and Clusters—This chapter shows how data can be grouped, either with elements of the same type (arrays) or elements of a different type (clusters). This chapter also illustrates how to create and manipulate arrays and clusters.

CHAPTER 7: Charts and Graphs—This chapter shows how to display and customize the appearance of single and multiple charts and graphs.

CHAPTER 8: Data Acquisition—The basic characteristics of analog and digital signals are discussed in this chapter, as well as the factors students need to consider when acquiring and generating these signals. This chapter introduces students to the Measurement and Automation Explorer (MAX) and the DAQ Assistant.

CHAPTER 9: Strings and File I/O—This chapter shows how to create and manipulate strings on the front panel and block diagram. This chapter also explains how to write data to and read data from files.

CHAPTER 10: NI LabVIEW MathScript RT Module—This chapter introduces the interactive MathScript environment, which combines a mathematics-oriented text-based language with the intuitive graphical dataflow programming of LabVIEW. Both the interactive MathScript environment for command line computation and the MathScript Node for integrating textual scripts within the LabVIEW block diagram are discussed.

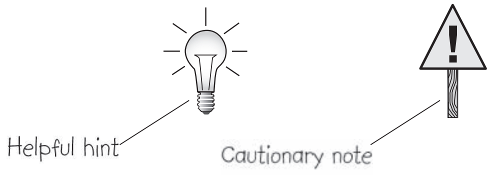
CHAPTER 11: Analysis—LabVIEW can be used in a variety of ways to support analysis of signals and systems. Several important analysis topics are discussed in this chapter, including how to use LabVIEW for signal generation, signal processing, linear algebra, curve fitting, formula display on the front panel, differential equations, finding roots (zero finder), and integration and differentiation.

APPENDIX A: Instrument Control—The components of an instrument control system using a GPIB or serial interface are presented in this appendix. Students are introduced to the notion of instrument drivers and of using the Measurement and Automation Explorer (MAX) to detect and install instrument drivers. The Instrument I/O Assistant is introduced.

APPENDIX B: LabVIEW Developer Certification—Discusses the certification process to validate your expertise, beginning with the Certified LabVIEW Associate Developer (CLAD), continuing with the Certified LabVIEW Developer (CLD), and culminating with the Certified LabVIEW Architect (CLA). It includes a CLAD introductory-level certification practice test with complete answers, along with information on additional resources to help you prepare for the examination.

The important pedagogical elements in each chapter include the following:

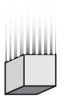
1. A brief table of contents and a short preview of what to expect in the chapter.
2. A list of chapter goals to help focus the chapter discussions.
3. Margin icons that focus attention on a helpful hint or on a cautionary note.



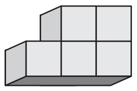
4. An end-of-chapter summary and list of key terms.

5. Sections entitled **Building Blocks** near the end of each chapter present the continuous development and modification of a virtual instrument for calculating and generating a pulse-width modulated signal. The student is expected to construct the VIs based on the instructions given in the sections. The same VI is used as the starting point and then improved in each

subsequent chapter as a means for the student to practice with the newly introduced chapter concepts.



BUILDING BLOCK



6. At the end of each chapter, we include a **myDAQ Building Blocks** section to provide the opportunity to apply the concepts introduced in the chapter using the myDAQ hardware. Each myDAQ Building Blocks exercise will help you build a project that will involve controlling LEDs and reading temperature from a thermistor to create a temperature monitoring system. As with the Building Blocks, the same VI is used as the starting point and then improved in each subsequent chapter as a means for the student to apply the chapter concepts in a my DAQ hardware environment.

7. Many worked examples are included in each chapter including several new examples introduced in this edition. In most cases, students construct the VIs discussed in the examples by following a series of instructions given in the text. In the early chapters, the instructions for building the VIs are quite specific, but in the later chapters, students are expected to construct the VIs without precise step-by-step instructions. Of course, in all chapters, working versions of the VIs are provided for all examples in the Learning directory included as part of the *LabVIEW Student Edition*. Here is a sample of the worked examples:
   - Temperature system demonstration.
   - Solving a set of linear differential equations.
   - Building your first virtual instrument.
   - Computing area, diameter, and radius of a circle.
   - Computing and graphing the time value of money.
   - Studying chaos using the logistic difference equation.
   - Acquiring data.
   - Writing ASCII data to a file.

8. A section entitled *Relaxed Reading* that describes how LabVIEW is being utilized to solve interesting real-world problems. The material is intended to give students a break from the technical aspects of learning LabVIEW and to stimulate thinking about how LabVIEW can be used in various other situations.
9. End-of-chapter exercises, problems, and design problems reinforce the main topics of the chapter and provide practice with LabVIEW.

ORIGINAL SOURCE MATERIALS

Learning with LabVIEW was developed with the aid of important references provided by National Instruments. The main references are the various LabVIEW help manuals found at the website www.ni.com/manuals. They provide information on LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools. You can access this same material in LabVIEW by selecting **Help≫LabVIEW Help** (see Chapter 1 of this book for more details on accessing the LabVIEW help). By design, there is a strong correlation between some of the material contained in the various LabVIEW help manuals and the material presented in this book. Our goal here has been to refine the information content and make it more accessible to students learning LabVIEW on their own.

OPERATING SYSTEMS AND ADDITIONAL SOFTWARE

It is assumed that the reader has a working knowledge of either the Windows or the Mac OS X operating system. If your computer experience is limited, you may first want to spend some time familiarizing yourself with your computer in order to understand the operation of your Mac or PC. You should know how to access pull-down menus, open and save files, download software from the Internet, and use a mouse. You will find previous computer programming experience helpful—but not necessary.

A set of virtual instruments has been developed by the author for this book. You will need to obtain the Learning directory from the companion website to this book at Prentice Hall:

http://www.pearsonhighered.com/bishop

For more information, you may also want to visit the NI Student Edition website at

http://www.ni.com/labviewse

All of the VI examples in this book were tested by the author an HP Elite-Book running Windows 7. Obviously, it is not possible to verify each VI on all the available Windows and Macintosh platforms that are compatible with LabVIEW so if you encounter platform-specific difficulties, please let us know.

If you would like information on upgrading to the LabVIEW Professional Version, please write to

National Instruments
att.: Academic Sales
11500 North Mopac Expressway
Austin, TX 78759

or visit the National Instruments website: **http://www.ni.com**

LIMITED WARRANTY

ACKNOWLEDGMENTS

Thanks to all the folks at National Instruments for their assistance and input during the development of *Learning with LabVIEW*. A very special thanks to Gretchen Edelmon and Jayme Walton of NI for providing day-to-day support during the final months of the project. Thanks also go to the following reviewers: Austin B. Asgill, Southern Polytechnic State University; Jeff Doughty, Northeastern University; Buford Furman, San Jose State University; R. Glynn Holt, Boston University; Thomas Koon, Binghamton University; Milivoje Kostic, Northern Illinois University; Jay Porter, Texas A&M University; and Yi Wu, Penn State University. Finally, I wish to express my appreciation to Lynda Bishop for assisting me with the manuscript preparation, for providing valuable comments on the text, and for handling my personal day-to-day activities associated with the entire production.

KEEP IN TOUCH!

The author and the staff at Pearson and at National Instruments would like to establish an open line of communication with the users of the *LabVIEW Student Edition*. We encourage students to e-mail the author with comments and suggestions for this and future editions.

Keep in touch!

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Learning with LabVIEW™

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CHAPTER 1

LabVIEW Basics

Welcome to the *LabVIEW Student Edition*! **LabVIEW** is a powerful and complex programming environment. Once you have mastered the various concepts introduced in this book you will have the ability to develop applications in a graphical programming language and to develop virtual instruments for design, control, and test engineering. This introductory chapter provides a basic overview of LabVIEW and its components.

GOALS

1. Installation of the *LabVIEW Student Edition*.
2. Familiarization with the basic components of LabVIEW.
3. Introduction to front panels and block diagrams, shortcut and pull-down menus, palettes, VI libraries, and online help.

1.1 SYSTEM CONFIGURATION REQUIREMENTS

The *LabVIEW Student Edition* textbook bundle includes the LabVIEW Student Edition software for Windows 8.1/8/7/Vista/XP and Mac OS X, when installed using the MacOS Boot Camp application or a virtual machine environment. This textbook without software is available under the name *Learning with LabVIEW.*

Windows 8.1/8/7/Vista (32 bit and 64 bit), Windows XP SP3 (32 bit)

Processor:	Pentium III/Celeron 866 MHz or equivalent minimum
	Pentium 4/M or equivalent recommended
RAM:	256 MB minimum; 1 GB recommended
Screen Resolution:	1024 × 768 pixels
Operating System:	Windows 7/Vista/XP
Disk Space:	3.67 GB (includes default drivers from the NI Device Drivers DVD)

Macintosh OS X 10.3 or later

Windows Application:	Mac OS Boot Camp, virtual machine application, or Windows emulator
Processor:	Intel-based processor
RAM:	256 MB minimum; 1 GB recommended
Screen Resolution:	1024 × 768 pixels
Operating System:	Mac OS X (10.3 or later)
Disk Space:	1.2 GB on the Windows partition (for the complete installation excluding drivers)

1.2 INSTALLING THE *LABVIEW STUDENT EDITION*

Disable any automatic virus detection programs before you install. Some virus detection programs interfere with the installation program.

Windows

1. Log on as an administrator or as a user with administrator privileges.
2. Download and install LabVIEW using the detailed instructions found on this webpage: from http://www.ni.com/white-paper/13413/en/. If you plan

to use NI data acquisition hardware such as NI myDAQ, be sure to download and install the hardware drivers as described in step 3 of the installation instruction page. Use the serial number printed on the inside cover to activate the software.

3. Detailed instructions for activation are included in the installation instructions as well as on this page: http://www.ni.com/white-paper/14146/en/.
4. After installation, check your hard disk for viruses and enable any virus detection programs you disabled.
5. To use the *LabVIEW Help*, the Measurement & Automation Explorer (MAX) interactive help system, and the NI Example Finder, you must have Microsoft Internet Explorer 5.0 or later.

LabVIEW relies on a licensing activation process to obtain an activation code. The Activation Wizard is a part of the NI License Manager that takes you through the steps of enabling software to run on a machine. If you have questions regarding activation, visit the NI website at http://www.ni.com/labviewse/.

Macintosh

1. To install the downloaded LabVIEW Student Edition software on your Mac Computer, you will need a Mac Computer that supports the Mac OS Boot Camp application or a virtual machine environment, and a licensed copy of the Microsoft Windows operating system.
2. Boot the Mac OS computer into Windows or launch the Windows virtual machine.
3. Follow the instructions for Windows installation in the section above.

The LabVIEW installation folder might contain the following items:

- *cintools—Tools for calling C object code from LabVIEW*
- *AppLibs—(LabVIEW Professional Development System). Contains stub for stand-alone applications.*

Refer to LabVIEW Help for a complete list of the folders installed in LabVIEW directory structure.

1.3 THE LABVIEW ENVIRONMENT

LabVIEW is short for **Lab**oratory **V**irtual **I**nstrument **E**ngineering **W**orkbench. It is a powerful and flexible graphical development environment created by the folks at National Instruments—a company that creates hardware and software products that leverage computer technology to help engineers and scientists take measurements, control processes, and analyze and store data. National Instruments was founded over thirty-five years ago in Austin, Texas by James Truchard (known as Dr. T), Jeffrey Kodosky, and William Nowlin. At the time, all three were working on sonar applications for the U.S. Navy at the Applied Research Laboratories at The University of Texas at Austin. Searching for a way to connect test equipment to DEC PDP-11 computers, Dr. T decided to develop an interface bus. He recruited Jeff and Bill to join him in his endeavor, and together they successfully developed LabVIEW and the notion of a "virtual instrument." In the process they managed to infuse their new company—National Instruments—with an entrepreneurial spirit that still pervades the company today.

Engineers and scientists in research, development, production, test, and service industries as diverse as automotive, semiconductor, aerospace, electronics, chemical, telecommunications, and pharmaceutical have used and continue to use LabVIEW to support their work. LabVIEW is a major player in the area of testing and measurements, industrial automation, and data analysis. For example, SpaceX uses LabVIEW in a variety of mission applications, including the Falcon 9 rocket that carried the Dragon spacecraft into space. The Dragon is a free-flying reusable spacecraft that was the first commercially built vehicle to dock with the International Space Station and demonstrate a cargo resupply mission. This book is intended to help you learn to use LabVIEW as a programming tool and to serve as an introduction to the power of graphical programming and the myriad applications to which it can be applied.

LabVIEW programs are called **Virtual Instruments**, or VIs for short. LabVIEW is different from text-based programming languages (such as Fortran and C) in that LabVIEW uses a graphical programming language, known as the G programming language, to create programs relying on graphic symbols to describe programming actions. LabVIEW uses a terminology familiar to scientists and engineers, and the graphical icons used to construct programs in G are easily identified by visual inspection. You can learn LabVIEW even if you have little programming experience, but you will find knowledge of programming fundamentals helpful. If you have never programmed before (or maybe you have programming experience but have forgotten a few things) you may want to review the basic concepts of programming before diving into the G programming language.

LabVIEW provides an extensive library of virtual instruments and functions to help you in your programming. The MathScript RT Module environment is discussed in detail in Chapter 10. The MathScript RT Module provides a text-based command line environment complementing the LabVIEW graphical programming environment. Users have the capability to make quick calculations or computations at a LabVIEW command line prompt. The MathScript RT Module also enables users to integrate their scripts with LabVIEW block diagrams, easily mixing graphical programming and powerful user interfaces with text-based scripts. LabVIEW contains application-specific libraries for data acquisition (discussed in Chapter 8), file input/output (discussed in Chapter 9), and data analysis (discussed in Chapter 11). It includes conventional program debugging tools with which you can set breakpoints, single-step through the program, and animate the execution so you can observe the flow of data. Editing and debugging VIs is the topic of Chapter 3. LabVIEW has a set of VIs for data presentation on various types of charts and graphs. Chapter 7 discusses the process of presenting data on charts and graphs.

The LabVIEW system consists of LabVIEW application executable files and many associated files and folders. LabVIEW uses files and directories to store information necessary to create your VIs. Some of the more important files and directories are:

1. The LabVIEW executable. Use this to launch LabVIEW.
2. The vi.lib directory. This directory contains libraries of VIs such as data acquisition, instrument control, and analysis VIs; it must be in the same directory as the LabVIEW executable. Do not change the name of the vi.lib directory, because LabVIEW looks for this directory when it launches. If you change the name, you cannot use many of the controls and library functions.
3. The examples directory. This directory contains many sample VIs that demonstrate the functionality of LabVIEW.
4. The user.lib directory. This directory is where you can save VIs you have created, and they will appear in the LabVIEW **Functions** palette.
5. The instr.lib directory. This directory is where your instrument driver libraries are placed if you want them to appear in the **Functions** palette.
6. The Learning directory. This file contains a library of VIs that you will use with the *Learning with LabVIEW* book.

The files in the Learning *directory must be downloaded from the site http://www.pearsonhighered.com/bishop. You can access the Pearson Higher Education website through the Internet using any standard Web browser.*

1.4 THE GETTING STARTED SCREEN

When you launch LabVIEW by double-clicking on its icon, the Getting Started screen appears as in Figure 1.1. The Getting Started window provides ready access to LabVIEW resources to enhance the ease of use. Creating projects and opening existing files—some of the more common tasks—can be easily

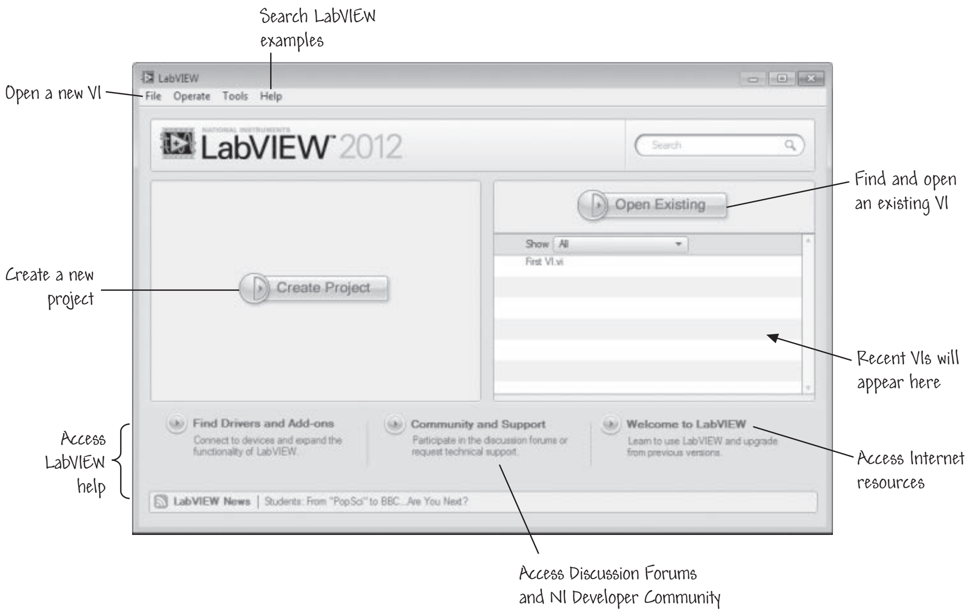
Search LabVIEW examples
Open a new VI
Find and open an existing VI
Create a new project
Recent VIs will appear here
Access LabVIEW help
Access Internet resources
Access Discussion Forums and NI Developer Community
File Operate Tools Help
LabVIEW 2012
Search
Open Existing
Create Project
Show All
First VI.vi
Find Drivers and Add-ons
Connect to devices and expand the functionality of LabVIEW.
Community and Support
Participate in the discussion forums or request technical support.
Welcome to LabVIEW
Learn to use LabVIEW and upgrade from previous versions.
LabVIEW News | Students: From "PopSci" to BBC...Are You Next?

FIGURE 1.1
The Getting Started screen.

accomplished through the use of the handy buttons front and center in the window. Reaching online resources is made much easier by having access to submenus on the Getting Started window that link to NI resources to download additional drivers and products and connect to discussion forums and developer communities. The Getting Started screen contains a navigation dialog box that includes introductory material and common commands. The dialog box includes a menu that allows users to quickly create new projects, select among the most recently opened LabVIEW files, find examples, and search the LabVIEW Help. The upper section of the Getting Started screen contains *file* functions, such as creating a new VI or for opening an existing VI. Across the lower section are *resource* functions. Information and resources are reachable from the Getting Started screen to help you learn about LabVIEW using online manuals and tutorials, with convenient access to Internet links providing news, technical content, example programs, and training information from the National Instruments website. These categories are dynamically populated with a list of articles relating to LabVIEW.

On the Getting Started screen you can:

- Click on **File≫New** to open the **New** dialog box to create a blank VI or one based on a VI template.
- Click on **Open Existing** to open an existing VI by browsing to find the desired file, or select a VI from the list of recently used VIs.

On the lower section of the screen you can:

- **Find Drivers and Add-ons:** Link to resources to search for NI Device Drivers, connect to the NI Instrument Device Driver to install drivers for connected instruments, and search for LabVIEW add-ons to expand functionality.
- **Community and Support:** Access NI discussion forums and developer communities.
- **Welcome to LabVIEW:** Access resources to help with LabVIEW and learn more about new features as they become available.

Throughout this book, use the left mouse button (if you have one) unless we specifically tell you to use the right one.

Searching the LabVIEW Examples

In this exercise you will search through the list of example VIs and demonstrations that are included with the *LabVIEW Student Edition*. Open the LabVIEW application and get to the Getting Started screen. The search begins at the LabVIEW Getting Started screen by selecting **Find Examples**, as shown in Figure 1.2. The NI Example Finder screen displays the numerous examples available with LabVIEW, as illustrated in Figure 1.3. The examples can be

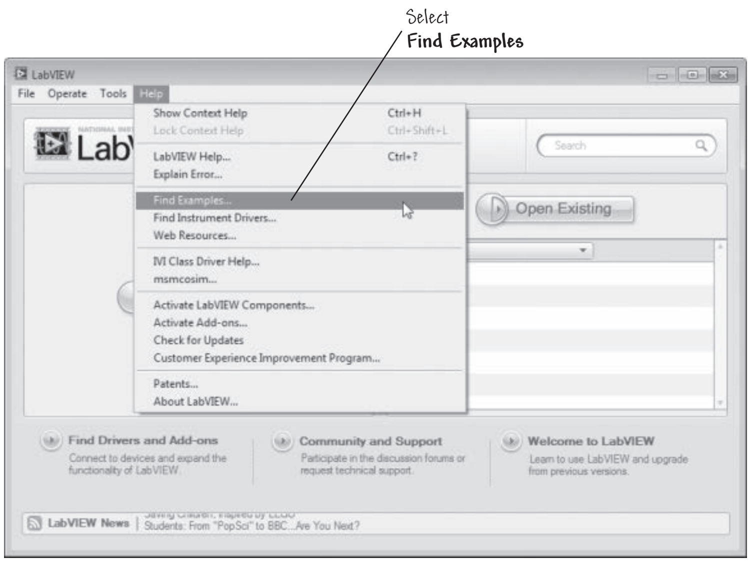
Select
Find Examples
LabVIEW
File Operate Tools Help
Show Context Help Ctrl+H
Lock Context Help Ctrl+Shift+L
LabVIEW Help... Ctrl+?
Explain Error...
Find Examples...
Find Instrument Drivers...
Web Resources...
IVI Class Driver Help...
msmcosim...
Activate LabVIEW Components...
Activate Add-ons...
Check for Updates
Customer Experience Improvement Program...
Patents...
About LabVIEW...
Search
Open Existing
Find Drivers and Add-ons
Connect to devices and expand the functionality of LabVIEW.
Community and Support
Participate in the discussion forums or request technical support.
Welcome to LabVIEW
Learn to use LabVIEW and upgrade from previous versions.
LabVIEW News
Students: From "PopSci" to BBC...Are You Next?

FIGURE 1.2
LabVIEW examples.

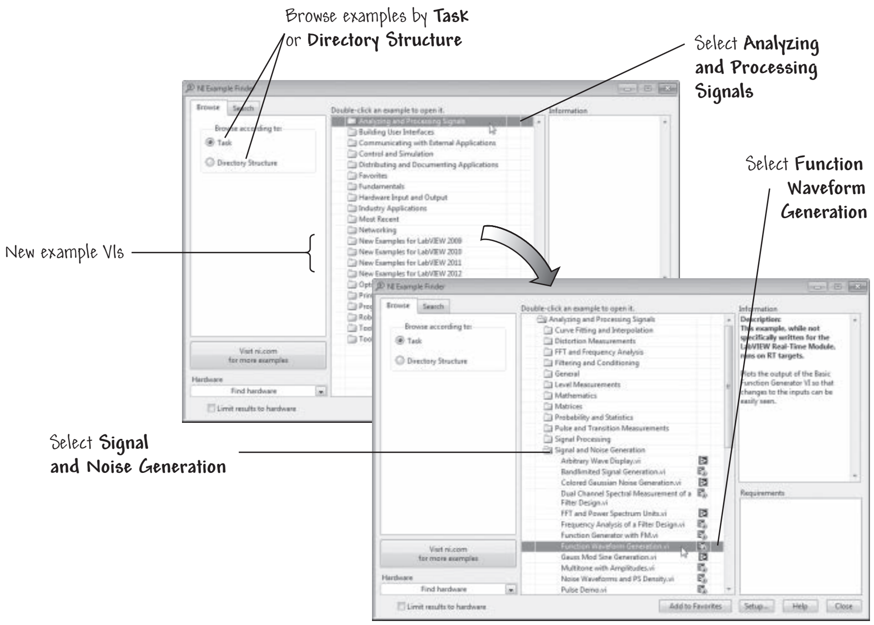
Browse examples by **Task** or **Directory Structure**
Select **Analyzing and Processing Signals**
Select **Function Waveform Generation**
New example VIs
Select **Signal and Noise Generation**
NI Example Finder
Browse
Search
Browse according to:
Task
Directory Structure
Double-click an example to open it.
Analyzing and Processing Signals
Building User Interfaces
Communicating with External Applications
Control and Simulation
Distributing and Documenting Applications
Favorites
Fundamentals
Hardware Input and Output
Industry Applications
Most Recent
Networking
New Examples for LabVIEW 2009
New Examples for LabVIEW 2010
New Examples for LabVIEW 2011
New Examples for LabVIEW 2012
Curve Fitting and Interpolation
Distortion Measurements
FFT and Frequency Analysis
Filtering and Conditioning
General
Level Measurements
Mathematics
Matrices
Probability and Statistics
Pulse and Transition Measurements
Signal Processing
Signal and Noise Generation
Arbitrary Wave Display.vi
Bandlimited Signal Generation.vi
Colored Gaussian Noise Generation.vi
Dual Channel Spectral Measurement of a Filter Design.vi
FFT and Power Spectrum Units.vi
Frequency Analysis of a Filter Design.vi
Function Generator with FM.vi
Function Waveform Generation.vi
Gauss Mod Sine Generation.vi
Multitone with Amplitudes.vi
Noise Waveforms and PS Density.vi
Pulse Demo.vi
Information
Description:
This example, while not specifically written for the LabVIEW Real-Time Module, runs on RT targets.
Plots the output of the Basic Function Generator VI so that changes to the inputs can be easily seen.
Requirements
Visit ni.com for more examples
Hardware
Find hardware
Limit results to hardware
Add to Favorites
Setup...
Help
Close

FIGURE 1.3
The NI Example Finder.

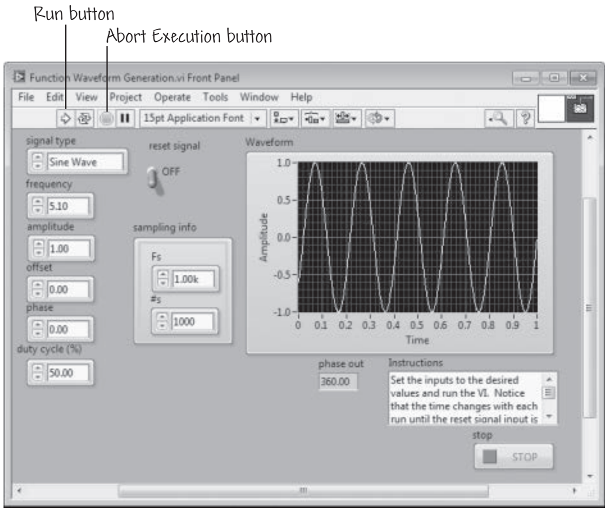

FIGURE 1.4
The Function Waveform Generation front panel.

browsed by Task or by Directory Structure. In Figure 1.3, the examples are sorted by Task. As indicated in Figure 1.3, on the **Browse** tab of the **NI Example Finder** you can find **New Examples for LabVIEW** associated with each new update to LabVIEW. These VIs are examples demonstrating new features of the current version of LabVIEW.

To reach the desired example—in this case, we are searching for the Function Waveform Generation—select **Analyzing and Processing Signals**, as shown in Figure 1.3. Selecting **Signal and Noise Generation** and **Function Waveform Generation** opens up the associated virtual instrument (VI) (more on VIs in Chapter 2). Just for fun, you can start the VI running and see what happens. Start the VI by clicking on the **Run** button, as shown in Figure 1.4. Stop the VI by clicking on the **Stop** button. Try it! ◆

1.5 PANEL AND DIAGRAM WINDOWS

An untitled front panel window appears when you select **File≫New VI** from the Getting Started screen. The front panel window is the interface to your VI code and is one of the two LabVIEW windows that comprise a virtual instrument. The other window—the block diagram window—contains program code that exists in a graphical form (such as icons, wires, etc.).

Front panels and block diagrams consist of graphical objects that are the G programming elements. Front panels contain various types of controls and indicators (that is, inputs and outputs, respectively). Block diagrams contain terminals corresponding to front panel controls and indicators, as well as constants, functions, subVIs, structures, and wires that carry data from one object to another. Structures are program control elements (such as For Loops and While Loops).

Figure 1.5 shows a front panel and its associated block diagram. You can find the virtual instrument First VI.vi shown in Figure 1.5 in the Chapter 1 folder within the directory Learning. That VI can be located by choosing **Open Existing** on the Getting Started screen and navigating to the Chapter1 folder in the Learning directory and then selecting First VI.vi. Once you have the VI front panel open, find the **Run** button on the panel toolbar and click on it. Your VI is now running. You can turn the knob and vary the different inputs and watch the output changes reflected in the graph. Give it a try! If you have difficulty getting things to work, then just press ahead with the material in the next sections and come back to this VI when you are ready.

1.5.1 Front Panel Toolbar

A toolbar of command buttons and status indicators that you use for controlling VIs is located on both the front panel and block diagram windows. The front panel toolbar and the block diagram toolbar are different, although they do each contain some of the same buttons and indicators. The toolbar that appears at the top of the front panel window is shown in Figure 1.6.

While the VI is executing, the **Abort Execution** button appears. Although clicking on the abort button terminates the execution of the VI, as a general rule you should avoid terminating the program execution this way and either let the