## Contents in Brief

### Preface
xvii

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 1</td>
<td>Introduction to Programming and Visual Basic</td>
<td>1</td>
</tr>
<tr>
<td>Chapter 2</td>
<td>Creating Applications with Visual Basic</td>
<td>41</td>
</tr>
<tr>
<td>Chapter 3</td>
<td>Variables and Calculations</td>
<td>125</td>
</tr>
<tr>
<td>Chapter 4</td>
<td>Making Decisions</td>
<td>233</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>Lists and Loops</td>
<td>309</td>
</tr>
<tr>
<td>Chapter 6</td>
<td>Procedures and Functions</td>
<td>379</td>
</tr>
<tr>
<td>Chapter 7</td>
<td>Multiple Forms, Modules, and Menus</td>
<td>429</td>
</tr>
<tr>
<td>Chapter 8</td>
<td>Arrays and More</td>
<td>499</td>
</tr>
<tr>
<td>Chapter 9</td>
<td>Files, Printing, and Structure</td>
<td>573</td>
</tr>
<tr>
<td>Chapter 10</td>
<td>Working with Databases</td>
<td>631</td>
</tr>
<tr>
<td>Chapter 11</td>
<td>Developing Web Applications</td>
<td>711</td>
</tr>
<tr>
<td>Chapter 12</td>
<td>Classes, Collections, and Inheritance</td>
<td>767</td>
</tr>
<tr>
<td>Appendix A</td>
<td>Advanced User Interface Controls and Techniques</td>
<td>829</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Windows Presentation Foundation (WPF)</td>
<td>843</td>
</tr>
<tr>
<td>Appendix C</td>
<td>Converting Mathematical Expressions to Programming Statements</td>
<td>851</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Answers to Checkpoint</td>
<td>853</td>
</tr>
<tr>
<td>Appendix E</td>
<td>Glossary</td>
<td>871</td>
</tr>
<tr>
<td>Appendix F</td>
<td>Function and Method Reference</td>
<td>F-1</td>
</tr>
<tr>
<td>Appendix G</td>
<td>Binary and Random-Access Files</td>
<td>G-1</td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td>883</td>
</tr>
<tr>
<td></td>
<td>Credits</td>
<td>909</td>
</tr>
</tbody>
</table>
Contents

Preface  xvii

Chapter 1  Introduction to Programming and Visual Basic  1
1.1 Computer Systems: Hardware and Software ................................................. 1
1.2 Programs and Programming Languages ......................................................... 4
TUTORIAL 1-1: Running the Wage Calculator application ..................................... 8
TUTORIAL 1-2: Running an application that demonstrates event handlers ............ 10
1.3 More about Controls and Programming ......................................................... 11
TUTORIAL 1-3: Running an application that demonstrates various controls .......... 12
1.4 The Programming Process ............................................................................. 16
1.5 Visual Studio ................................................................................................. 20
TUTORIAL 1-4: Starting Visual Studio and setting up the environment ................. 20
TUTORIAL 1-5: Starting a new Visual Basic project ........................................... 24
TUTORIAL 1-6: Becoming familiar with Visual Studio ......................................... 33
Summary 35 • Key Terms 36 • Review Questions and Exercises 36 • Programming Challenges 40

Chapter 2  Creating Applications with Visual Basic  41
2.1 Getting Started with Forms and Controls ..................................................... 41
2.2 Creating the GUI for Your First Visual Basic Application: The Hello World Application ................................................................. 52
TUTORIAL 2-1: Creating the GUI for the Hello World application ....................... 53
2.3 Writing the Code for the Hello World Application ......................................... 59
TUTORIAL 2-2: Writing code for the Hello World application ............................... 62
2.4 More About Label Controls ........................................................................... 68
2.5 Creating Multiple Event Handlers .................................................................... 76
TUTORIAL 2-3: Creating the Language Translator application .............................. 77
2.6 Making Sense of IntelliSense .......................................................................... 80
2.7 PictureBox Controls ...................................................................................... 81
TUTORIAL 2-4: Creating the Guess the President application ............................... 84
TUTORIAL 2-5: Writing Click event handlers for PictureBox controls .................. 87
2.8 The Visible Property ...................................................................................... 90
TUTORIAL 2-6: Creating the Card Flip application .............................................. 91
2.9 Writing the Code to Close an Application’s Form .......................................... 94
TUTORIAL 2-7: Adding an Exit button to the Guess the President application .......... 95
2.10 Comments, Blank Lines, and Indentation .................................................... 98
2.11 Dealing with Errors ..................................................................................... 99
2.12 Displaying User Messages at Runtime ....................................................... 102
TUTORIAL 2-8: Displaying Message Boxes ......................................................... 103
### Chapter 3 Variables and Calculations 125

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Gathering Text Input</td>
</tr>
<tr>
<td>3.2</td>
<td>Variables and Data Types</td>
</tr>
<tr>
<td>3.3</td>
<td>Performing Calculations</td>
</tr>
<tr>
<td>3.4</td>
<td>Mixing Different Data Types</td>
</tr>
<tr>
<td>3.5</td>
<td>Formatting Numbers and Dates</td>
</tr>
<tr>
<td>3.6</td>
<td>Class-Level Variables</td>
</tr>
<tr>
<td>3.7</td>
<td>Exception Handling</td>
</tr>
<tr>
<td>3.8</td>
<td>More GUI Details</td>
</tr>
<tr>
<td>3.9</td>
<td>The Load Event</td>
</tr>
<tr>
<td>3.10</td>
<td>Focus on Program Design and Problem Solving: Building</td>
</tr>
<tr>
<td>3.11</td>
<td>More About Debugging: Locating Logic Errors</td>
</tr>
<tr>
<td>3.12</td>
<td>Single-stepping through an application’s code at runtime</td>
</tr>
</tbody>
</table>

### Chapter 4 Making Decisions 233

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>The Decision Structure</td>
</tr>
<tr>
<td>4.2</td>
<td>The If...Then Statement</td>
</tr>
<tr>
<td>4.3</td>
<td>The If...Then...Else Statement</td>
</tr>
<tr>
<td>4.4</td>
<td>The If...Then...ElseIf Statement</td>
</tr>
<tr>
<td>4.5</td>
<td>Nested If Statements</td>
</tr>
</tbody>
</table>
Contents

ix

Tutorial 4-4: Completing an application with a nested If statement ........................................ 251
4.6 Logical Operators .............................................................................................................. 253
4.7 Comparing, Testing, and Working with Strings ............................................................ 259
Tutorial 4-5: Examining an application that performs string comparisons .................................. 262
Tutorial 4-6: Completing a string searching application ......................................................... 267
4.8 The Select Case Statement .............................................................................................. 270
Tutorial 4-7: Examining Crazy Al's Sales Commission Calculator application .................................. 273
4.9 Introduction to Input Validation ....................................................................................... 276
Tutorial 4-8: Examining an application that uses TryParse for input validation ....................... 278
4.10 Focus on GUI Design: Radio Buttons and Check Boxes ................................................. 281
Tutorial 4-9: Completing an application with radio buttons and check boxes ............................ 283
4.11 Focus on Program Design and Problem Solving: Building the Health Club Membership Fee Calculator Application ...................................... 284
Tutorial 4-10: Building the Health Club Membership Fee Calculator application ..................... 290

Summary 294 • Key Terms 295 • Review Questions and Exercises 296 • Programming Challenges 301

Chapter 5  Lists and Loops 309

5.1 Input Boxes ...................................................................................................................... 309
5.2 List Boxes ....................................................................................................................... 311
Tutorial 5-1: Creating list boxes .......................................................................................... 316
5.3 Introduction to Loops: The Do While Loop ..................................................................... 320
Tutorial 5-2: Completing an application that uses the Do While loop ................................... 321
Tutorial 5-3: Modifying the Do While Demo application to use a posttest loop ...................... 325
Tutorial 5-4: Using a loop to keep a running total .................................................................. 327
Tutorial 5-5: Examining an application that uses a user-controlled loop ................................. 329
5.4 The Do Until and For . . . Next Loops ............................................................................. 331
Tutorial 5-6: Examining an application that uses the Do Until loop ...................................... 332
Tutorial 5-7: Examining an application that uses the For . . . Next loop ................................. 336
Tutorial 5-8: Completing an application that uses the For . . . Next loop ................................. 337
5.5 Nested Loops .................................................................................................................. 341
5.6 Multicolumn List Boxes, Checked List Boxes, and Combo Boxes ..................................... 342
Tutorial 5-9: Creating combo boxes ..................................................................................... 346
5.7 Random Numbers .......................................................................................................... 348
Tutorial 5-10: Creating the Coin Toss application .................................................................... 350
5.8 Simplifying Code using the With . . . End With Statement ................................................. 352
5.9 ToolTips .......................................................................................................................... 353
Tutorial 5-11: Adding ToolTips to an application .................................................................... 354
5.10 Focus on Program Design and Problem Solving: Building the Vehicle Loan Calculator Application .................................................................................................................. 355
Tutorial 5-12: Building the Vehicle Loan Calculator application .............................................. 358

Summary 363 • Key Terms 364 • Review Questions and Exercises 364 • Programming Challenges 370
Chapter 6  **Procedures and Functions 379**

6.1  Procedures ................................................................. 380

TUTORIAL 6-1: Examining an application with a procedure ........................................... 380

TUTORIAL 6-2: Creating and calling procedures ............................................................... 383

6.2  Passing Arguments to Procedures ....................................................................... 387

TUTORIAL 6-3: Examining an application that demonstrates passing an argument to a procedure .......................................................... 389

TUTORIAL 6-4: Working with ByVal and ByRef ............................................................... 392

6.3  Functions ........................................................................... 395

TUTORIAL 6-5: The Sale Price Calculator application ......................................................... 396

6.4  More about Debugging: Stepping Into, Over, and Out of Procedures and Functions ......................................................... 403

TUTORIAL 6-6: Practicing the Step Into command .............................................................. 404

TUTORIAL 6-7: Practicing the Step Over command .............................................................. 405

TUTORIAL 6-8: Practicing the Step Out command .............................................................. 405

6.5  Focus on Program Design and Problem Solving: Building the Bagel and Coffee Price Calculator Application ................................................. 407

TUTORIAL 6-9: Building the Bagel House application .......................................................... 412

Summary 416 • Key Terms 416 • Review Questions and Exercises 417 • Programming Challenges 420

Chapter 7  **Multiple Forms, Modules, and Menus 429**

7.1  Multiple Forms ................................................................. 429

TUTORIAL 7-1: Creating an application with two forms ...................................................... 437

TUTORIAL 7-2: Completing an application that displays modal and modeless forms .......................................................... 440

TUTORIAL 7-3: Accessing a control on a different form ...................................................... 446

7.2  Modules ........................................................................... 451

TUTORIAL 7-4: Examining an application that uses a module ............................................. 454

7.3  Menus .............................................................................. 461

TUTORIAL 7-5: Building a menu ......................................................................................... 468

7.4  Focus on Problem Solving: Building the High Adventure Travel Agency Price Quote Application ......................................................... 473

TUTORIAL 7-6: Building the High Adventure Travel Agency Price Quote application .......................................................... 475

Summary 481 • Key Terms 482 • Review Questions and Exercises 482 • Programming Challenges 487

Chapter 8  **Arrays and More 499**

8.1  Arrays ............................................................................. 499

TUTORIAL 8-1: Using an array to hold a list of random lottery numbers ......................... 504

TUTORIAL 8-2: Using an array to hold a list of names entered by the user ......................... 507

TUTORIAL 8-3: Completing an application that uses array elements in a calculation .......................................................... 510

8.2  Array Processing Techniques ............................................................................. 514

TUTORIAL 8-4: Using parallel arrays ................................................................................. 518
Chapter 9  Files, Printing, and Structures  573

9.1  Using Files ................................................................. 573
TUTORIAL 9-1: Completing an application that writes data to a file  578
TUTORIAL 9-2: Completing an application that reads a file  583
TUTORIAL 9-3: Creating a Simple Text Editor application  587
9.2  The OpenFileDialog, SaveFileDialog, FontDialog, and ColorDialog Controls  593
TUTORIAL 9-4: Creating a Simple Text Editor application  597
9.3  The PrintDocument Control ...................................... 606
TUTORIAL 9-5: Adding printing capabilities to the Simple Text Editor application  608
9.4  Structures ................................................................. 613
TUTORIAL 9-6: Examining an application with a structure  616
Summary  618 • Key Terms  618 • Review Questions and Exercises  619 • Programming Challenges  625

Chapter 10  Working with Databases  631

10.1  Database Management Systems .................................. 631
10.2  Database Concepts .................................................. 632
10.3  DataGridView Control .............................................. 636
TUTORIAL 10-1: Showing a database table in a DataGridView control  637
TUTORIAL 10-2: Sorting and updating the SalesStaff table  645
10.4  Data-Bound Controls ................................................ 648
TUTORIAL 10-3: Binding a DataGridView to the SalesStaff table  653
TUTORIAL 10-4: Binding individual controls to the SalesStaff table  655
TUTORIAL 10-5: Displaying the Karate Members table in a ListBox Control  659
# Contents

**TUTORIAL 10-6:** Inserting *Karate* member payments ............................................. 662

**TUTORIAL 10-7:** Adding a total to the *Insert Karate Payments* application ................................................................. 666

10.5 Structured Query Language (SQL) .............................................................. 667

**TUTORIAL 10-8:** Filtering rows in the *SalesStaff* table ........................................... 675

10.6 Focus on Problem Solving: *Karate School Management* Application ................................................................. 677

**TUTORIAL 10-9:** Creating the *Karate School Manager* startup form ................ 680

**TUTORIAL 10-10:** Adding the *Membership / List All* function to the *Karate School Manager* ................................................................. 681

**TUTORIAL 10-11:** Adding the *Membership / Add New Member* function to the *Karate School Manager* ................................................................. 684

**TUTORIAL 10-12:** Adding the *Membership / Find Member* function to the *Karate School Manager* ................................................................. 686

**TUTORIAL 10-13:** Adding the *Payments / All Members* function to the *Karate School Manager* ................................................................. 688

10.7 Introduction to LINQ .................................................................................. 695

10.8 Creating Your Own Database ........................................................................ 696

**TUTORIAL 10-14:** Creating the *Movie* database and the *Films* table ............... 697

Summary 701 • Key Terms 702 • Review Questions and Exercises 703 • Programming Challenges 706

---

**Chapter 11 Developing Web Applications  711**

11.1 Programming for the Web ......................................................................... 711

11.2 Creating ASP.NET Applications .............................................................. 715

**TUTORIAL 11-1:** Creating the *Click* application ............................................. 719

11.3 Web Server Controls .................................................................................. 724

**TUTORIAL 11-2:** *Student Picnic* application ............................................... 726

11.4 Designing Web Forms ............................................................................... 734

**TUTORIAL 11-3:** Signing up for a *Kayak Tour* ................................................. 737

11.5 Applications with Multiple Web Pages ...................................................... 741

**TUTORIAL 11-4:** Adding a description form to the *Kayak Tour* application ................................................................. 742

11.6 Using Databases ....................................................................................... 743

**TUTORIAL 11-5:** Displaying the *Karate Members* table in a GridView ............ 747

**TUTORIAL 11-6:** Updating the *Karate Members* table .................................... 751

Summary 760 • Key Terms 761 • Review Questions and Exercises 763 • Programming Challenges 765

---

**Chapter 12 Classes, Collections, and Inheritance  767**

12.1 Classes and Objects ................................................................................... 767

12.2 Creating a Class ......................................................................................... 770

**TUTORIAL 12-1:** Creating the *Student Data* application .................................. 784

12.3 Collections ............................................................................................... 788

12.4 Focus on Problem Solving: Creating the *Student Collection* Application ................................................................. 794

**TUTORIAL 12-2:** Completing the *Student Collection* application .................... 794
12.5 The Object Browser ................................................................. 799
TUTORIAL 12-3: Using the Object Browser ......................................... 799
12.6 Introduction to Inheritance .......................................................... 801
TUTORIAL 12-4: Completing an application that uses inheritance .......... 808
Summary 815 • Key Terms 816 • Review Questions and Exercises 817 •
Programming Challenges 824

Appendix A Advanced User Interface Controls and Techniques ........ 829
Appendix B Windows Presentation Foundation (WPF) ......................... 843
Appendix C Converting Mathematical Expressions to Programming Statements .............................................................. 851
Appendix D Answers to Checkpoints .................................................. 853
Appendix E Glossary ........................................................................ 871
Appendix F Function and Method Reference ...................................... F-1
Appendix G Binary and Random-Access Files ..................................... G-1
Index ............................................................................................ 883
Credits .......................................................................................... 909
## LOCATIONS OF VIDEONOTES IN THE TEXT

### Chapter 1
- Forms, Controls, and Properties, p. 9
- Event-Driven Programming, p. 10
- Starting Visual Studio and Setting Up the Environment, p. 20
- Starting a New Visual Basic Project, p. 24
- Becoming Familiar with Visual Studio, p. 33
- Solving the Sales Tax Problem, p. 40

### Chapter 2
- Creating the GUI for the Hello World application, p. 53
- Responding to Events, p. 59
- Writing the code for the Hello World application, p. 62
- Creating the Language Translator application, p. 77
- Using IntelliSense, p. 80
- The Latin Translator Problem, p. 120

### Chapter 3
- Building the *Date String* application, p. 128
- Introduction to Variables, p. 131
- Problem Solving with Variables, p. 142
- Converting TextBox Input, p. 153
- Exception Demonstration, p. 173
- *Salary Calculator* project with exception handling, p. 177
- Building a *Kayak Rental* Application, p. 217
- The *Miles per Gallon Calculator* Problem, p. 224

### Chapter 4
- The *If... Then* Statement, p. 235
- The *If...Then...Else* Statement, p. 241
- Completing an application that uses the *If...Then...Else* statement, p. 242
- Completing an application that uses the *If...Then...ElseIf* statement, p. 245
- Completing an application with a nested If statement, p. 251
- Validating Input with *TryParse*, p. 278
- Improving the *Kayak Rental* Application, p. 296
- The *Roman Numeral Converter* Problem, p. 301

### Chapter 5
- The *Do While* Loop, p. 320
- Completing an application that uses the *Do While* loop, p. 321
- Using a posttest loop, p. 325
- The *For...Next* Loop, p. 334
- Improving the *Kayak Rental* Application, p. 364
- The *Sum of Numbers* Problem, p. 370
## Chapter 6
- Creating and calling procedures, p. 383
- Passing Arguments to Procedures, p. 387
- Functions, p. 395
- The Sale Price Calculator application, p. 396
- Practicing the Step Into command, p. 404
- Improving the Kayak Rental Application, p. 417
- The Retail Price Calculator Problem, p. 420

## Chapter 7
- Creating and Displaying a Second Form, p. 431
- Creating an application with two forms, p. 437
- Creating a Menu, p. 461
- Adding menus and forms to the Kayak Rental Application, p. 482
- The Astronomy Helper Problem, p. 497

## Chapter 8
- Accessing Array Elements with a Loop, p. 502
- Using an array to hold a list of names entered by the user, p. 507
- Using array elements in a calculation, p. 510
- Using Arrays to Look Up Information in the Kayak Rental Application, p. 561
- Finding the largest and smallest values in an array, p. 566
- Adding students to clubs, p. 569
- The Lottery Simulation, p. 571

## Chapter 9
- Writing Data to a File, p. 575
- Reading Data from a File, p. 581
- Detecting the end of a file, p. 588
- Files and Colors in the Kayak Rental Application, p. 619

## Chapter 10
- The DataGridView Control, p. 636
- Data-Bound Controls, p. 648
- Binding individual controls to the SalesStaff table, p. 655
- Adding a Database to the Kayak Rental Application, p. 703
- The Kayak Browser Problem, p. 706
- The Karate Payments by a Single Member Problem, p. 709

## Chapter 11
- Creating a Simple Web Application, p. 716
- The Student Picnic application, p. 726
- Building a Movie Tracking Application, p. 762
- The Stadium Seating Problem, p. 765

## Chapter 12
- Creating a Class, p. 771
- Creating and using a Collection, p. 788
- Completing the Student Collection application, p. 794
- Kayak Rental Application with Classes, p. 817
- The Motor Class Problem, p. 825
Preface

Welcome to Starting Out with Visual Basic, Eighth Edition. This edition has been revised and updated for Visual Studio 2017. It is intended for use in an introductory programming course. It is designed for students who have no prior programming background, but even experienced students will benefit from its depth of detail and the chapters covering databases, Web applications, and other advanced topics. The book is written in clear, easy-to-understand language and covers all the necessary topics of an introductory programming course. The text is rich in concise, practical, and real-world example programs, so the student not only learns how to use the various controls, constructs, and features of Visual Basic, but also learns why and when to use them.

A Look at Visual Basic: Past and Present

The first version of Visual Basic was introduced in 1991. Prior to its introduction, writing a GUI interface for an application was no small task. Typically, it required hundreds of lines of C code for even the simplest Hello World program. Additionally, an understanding of graphics, memory, and complex system calls was often necessary. Visual Basic was revolutionary because it significantly simplified this process. With Visual Basic, a programmer could visually design an application’s user interface. Visual Basic would then generate the code necessary to display and operate the interface. This allowed the programmer to spend less time writing GUI code and more time writing code to perform meaningful tasks.

The evolution of Visual Basic from version 1 to version 6 followed a natural progression. Each new release was an improved version of the previous release, providing additional features and enhancements. Visual Basic versions offered backward compatibility, where code written in an older version was compatible with a newer version of the Visual Basic development environment.

In 2002, Microsoft released a new object-oriented software platform known as .NET. The .NET platform consists of several layers of software that sit above the operating system and provide a secure, managed environment in which programs can execute. In addition to providing a managed environment for applications to run, .NET also provided new technologies for creating Internet-based programs and programs that provide services over the Web. Along with the introduction of the .NET platform, Microsoft introduced a new version of Visual Basic known as VB .NET 2002, which allowed programmers to write desktop applications or Web applications for the .NET platform.

VB .NET was not merely a new and improved version of VB 6, however. VB .NET was a totally new programming environment, and the Visual Basic language was dramatically revised. The changes were substantial enough that programs written in earlier versions of Visual Basic were not compatible with VB .NET. Microsoft provided a utility that could be used to convert older Visual Basic applications to the new VB .NET syntax, but the results were not always perfect. Although this was frustrating for some Visual Basic developers, Microsoft reasoned the changes were necessary to ensure that Visual Basic continued to evolve as a modern, professional programming environment.
Microsoft has continued to enhance and improve Visual Basic by regularly releasing new versions. The versions, which are named after the year in which they were released, are Visual Basic 2003, Visual Basic 2005, Visual Basic 2008 and so forth. At the time this book was written, the current release was Visual Basic 2017. You can see a complete list of the enhancements that have been made to this version of Visual Basic, as well as past versions, on this web page: msdn.microsoft.com/en-us/library/we86c8x2.aspx.

**Organization of the Text**

The text teaches Visual Basic step-by-step. Each chapter covers a major set of programming topics, introduces controls and GUI elements, and builds knowledge as the student progresses through the book. Although the chapters can be easily taught in their existing sequence, there is some flexibility. The following diagram suggests possible sequences of instruction.

![Diagram](image)

Chapters 1 through 7 cover the fundamentals of program design, flow control, modular programming, and the most important Visual Basic controls. The instructor may then continue in any order with Chapters 8, 9, 10, or 12. Part of Chapter 11 relies on database concepts, so it should be covered after Chapter 10.

**Brief Overview of Each Chapter**

**Chapter 1: Introduction to Programming and Visual Basic.** This chapter provides an introduction to programming, the programming process, and Visual Basic. GUI programming and the event-driven model are explained. The components of programs, such as keywords, variables, operators, and punctuation are covered, and tools such as flowcharts and pseudocode are presented. The student gets started using the Visual Basic environment in a hands-on tutorial.

**Chapter 2: Creating Applications with Visual Basic.** In this chapter the student learns to create forms with labels, buttons, and picture boxes and learns to modify control properties. The student is introduced to Visual Basic code, and learns to write simple event-driven applications that respond to button clicks, or provide interaction through clickable images. This chapter introduces the Visual Studio Help system, and provides a tutorial on simple debugging. The importance of commenting code is also discussed.

**Chapter 3: Variables and Calculations.** Variables, constants, and the Visual Basic data types are introduced. The student learns to gather input and create simple arithmetic statements. The intricacies of GUI design are introduced as the student learns about grouping controls with group boxes, assigning keyboard access keys, and setting the tab order. The student is introduced to exceptions and learns to write simple exception handlers. Debugging techniques for locating logic errors are covered.
Chapter 4: Making Decisions. The student learns about relational operators and how to control the flow of a program with the If...Then, If...Then...Else, and If...Then...ElseIf statements. Logical operators are introduced, and the Select Case statement is covered. Important applications of these constructs are discussed, such as testing numeric values, strings, and determining if a value lies within a range, and validating user input. Several string-handling functions and string methods are discussed. Radio buttons and check boxes are also introduced.

Chapter 5: Lists and Loops. This chapter begins by showing the student how to use input boxes as a quick and simple way to gather input. Next, list boxes and combo boxes are introduced. The chapter covers repetition control structures: the Do While, Do Until, and For...Next loops. Counters, accumulators, running totals, and other loop-related topics are discussed. The student also learns how to generate random numbers.

Chapter 6: Procedures and Functions. The student learns how and why to modularize programs with general-purpose procedures and functions. Arguments, parameters, and return values are discussed. Debugging techniques for stepping into and over procedures are introduced.

Chapter 7: Multiple Forms, Modules, and Menus. This chapter shows how to add multiple forms to a project and how to create a module to hold procedures and functions that are not associated with a specific form. It covers creating a menu system, with commands and submenus that the user may select from.

Chapter 8: Arrays and More. This chapter discusses both single dimension and multidimensional variable arrays. Many array programming techniques are presented, such as summing all the elements in an array, summing all the rows or columns in a two-dimensional array, searching an array for a specific value, sorting arrays, and using parallel arrays. The Enabled property, timer controls, and control anchoring and docking are also covered.

Chapter 9: Files, Printing, and Structures. This chapter begins by discussing how to save data to sequential text files and then read the data back into an application. The OpenFileDialog, SaveFileDialog, FontDialog, and ColorDialog controls are introduced. The PrintDocument control is discussed, with a special focus on printing reports. The chapter shows the student how to create user-defined data types with structures.

Chapter 10: Working with Databases. This chapter introduces basic database concepts. The student learns how to display a database table in a DataGridView control and write applications that display, sort, and update database data. The Structured Query Language (SQL) is introduced. An application that shows how to display database data in list boxes, text boxes, labels, and combo box is presented. The chapter concludes with an overview of Language Integrated Query (LINQ).

Chapter 11: Developing Web Applications. This chapter shows the student how to create ASP.NET applications that run on Web Browsers such as Internet Explorer, Chrome, Firefox, and Safari. Using Microsoft Visual Studio, or Microsoft Visual Web Developer, the student learns how to use Web server controls and Web forms to build interactive, database-driven Web applications.

Chapter 12: Classes, Collections, and Inheritance. This chapter introduces classes as a tool for creating abstract data types. The process of analyzing a problem and determining its classes is discussed, and techniques for creating objects, properties, and methods are introduced. Collections are presented as structures for holding groups of objects. The Object Browser, which allows the student to see information about the
classes, properties, methods, and events available to a project, is also covered. The chapter concludes by introducing inheritance, and shows how to create a class that is based on an existing class.

**Appendix A: Advanced User Interface Controls and Techniques.** Discusses many of the more advanced controls available in Visual Basic, as well as several helpful programming techniques. This appendix also provides a summary of common user interface design guidelines.

**Appendix B: Windows Presentation Foundation (WPF).** Introduces the student to the Windows Presentation Framework (WPF), and includes a tutorial in which the student creates a simple WPF application.

**Appendix C: Converting Mathematical Expressions to Programming Statements.** Shows the student how to convert a mathematical expression into a Visual Basic programming statement.

**Appendix D: Answers to Checkpoints.** Students may test their progress by comparing their answers to Checkpoints with the answers provided. The answers to all Checkpoints are included.

**Appendix E: Glossary.** Provides a glossary of the key terms presented in the text.

The following appendixes can be downloaded from the book’s companion Web site at www.pearson.com/gaddis.

**Appendix F: Visual Basic Function and Method Reference.** Provides a reference for the functions and methods that are covered in the text. The exceptions that may be caused by these functions and methods are also listed.

**Appendix G: Binary and Random-Access Files.** Describes programming techniques for creating and working with binary and random-access data files.

**Features of the Text**

**Concept Statements.** Each major section of the text starts with a concept statement. This statement concisely summarizes the meaning of the section.

**Tutorials.** Each chapter has several hands-on tutorials that reinforce the chapter’s topics. Many of these tutorials involve the student in writing applications that can be applied to real-world problems.

**VideoNotes.** A series of online videos, developed specifically for this book, are available for viewing at http://www.pearson.com/gaddis. Icons appear throughout the text alerting the student to videos about specific topics.

**Checkpoints.** Checkpoints are questions placed at intervals throughout each chapter. They are designed to query the student’s knowledge immediately after learning a new topic. Answers to all the Checkpoints are provided in Appendix D.

**Notes.** Notes are short explanations of interesting or often misunderstood points relevant to the topic being discussed.

**Tips.** Tips advise the student on the best techniques for approaching different programming problems and appear regularly throughout the text.

**Warnings.** Warnings caution the student about certain Visual Basic features, programming techniques, or practices that can lead to malfunctioning programs or lost data.
Review Questions and Exercises. In the tradition of all Gaddis texts, each chapter presents a thorough and diverse set of review questions and exercises. These include traditional fill-in-the-blank, true or false, multiple choice, and short answer questions. There are also unique tools for assessing a student’s knowledge. For example, Find the Error questions ask the student to identify syntax or logic errors in brief code segments. Algorithm Workbench questions ask the student to design code segments to satisfy a given problem. There are also What Do You Think? questions that require the student to think critically and contemplate the topics presented in the chapter.

Programming Challenges. Each chapter offers a pool of programming exercises designed to solidify the student’s knowledge of the topics at hand. In most cases, the assignments present real-world problems to be solved. When applicable, these exercises also include input validation rules.

Supplements

Student

The following supplementary material is bundled with the book:

- Source code and files required for the chapter tutorials are available at the book’s companion website: www.pearson.com/gaddis.

Instructor

The following supplements are available to qualified instructors:

- Answers to all Review Questions in the text
- Solutions for all Programming Challenges in the text
- PowerPoint presentation slides for every chapter
- Test bank
- Test generation software that allows instructors to create customized tests

For information on how to access these supplements, visit the Pearson Education Instructor Resource Center at http://www.pearson.com.

Online Practice and Assessment with MyLab Programming

MyLab Programming is a web-based service that helps students fully grasp the logic, semantics, and syntax of programming. Through practice exercises and immediate, personalized feedback, MyLab Programming improves the programming competence of beginning students who often struggle with the basic concepts and paradigms of popular high-level programming languages. A self-study and homework tool, the MyLab Programming course for Visual Basic consists of roughly two hundred small practice exercises covering introductory topics such as variables, calculations, decision statements, loops, procedures, arrays, and more. For students, the system automatically detects errors in the logic and syntax of their code submissions and offers targeted hints that enable students to figure out what went wrong. For instructors, a comprehensive gradebook tracks correct and incorrect answers and stores the code inputted by students for review.
Preface

For a full demonstration, to see feedback from instructors and students, or to get started using MyLab Programming in your course, visit www.pearson.com/mylab/programming.

Web Resources

Self-assessment quizzes, PowerPoint slides, source code files, and glossary flashcards are available on the Companion Website for Starting Out with Visual Basic at www.pearson.com/gaddis.

Acknowledgments

There were many helping hands in the development and publication of this text. The authors would like to thank the following faculty reviewers for their helpful suggestions and expertise:

Achla Agarwal, Bossier Parrish Community College
Ronald Bass, Austin Community College
Ronald Beuchemin, Springfield Technical Community College
Zachary T. Beers, Microsoft Corporation
Robert M. Benavides, Collin County Community College District
Paul T. Bladke, Edmonds Community College
Douglas Bock, Southern Illinois University at Edwardsville
Skip Bottom, J. Sargeant Reynolds Community College
Harold Broberg, Indiana Purdue University
Nancy Burns, Professor of Computer Science, Chipola College
Arthur E. Carter, Radford University
Mara Casado, State College of Florida, Manatee-Sarasota
Joni Catanzaro, Louisiana State University
Jesse Cecil, College of the Siskiyous
Dr. Robert Coil, Cincinnati State Community and Technical College
Mohammad Dadashzadeh, Oakland University
Travis Dalton, Columbia College (SC)
Carol A. DesJardins, St. Clair County Community College
Sallie Dodson, Radford University
William J. Dorin, Indiana University
Robert Ekblaw, SUNY Albany
Rose M. Endres, City College of San Francisco
Jean Evans, Brevard Community College
Mark Fienup, University of Northern Iowa
Pierre M. Fiorini, PhD, University of Southern Maine
Arlene Flerchinger, Chattanooga State Technical Community College
Lawrence Fudella, Erie Community College
Gail M. Gehrig, Florida Community College at Jacksonville
Jayanta Ghosh, Florida Community College

Martha Gibson, Central Texas College
Iskandar Hack, Indiana University—Purdue University at Fort Wayne
Tom Higginbotham, Southeastern Louisiana University
Dennis Higgins, SUNY Oneonta
David M. Himes, Oklahoma State University, Okmulgee
Greg Hodge, Northwestern Michigan College
Corinne Hoisington, Central Virginia Community College
Jackie Horton, University of Vermont
May-Chuen Hsieh, Southwest Tennessee Community College
Lee A. Hunt, Collin County Community College
Darrel Karbginsky, Chemeketa Community College
Frank J. Kreimendahl, University of New Hampshire
Herb Kronholm, Mid-State Technical College
Phil Larschan, Tulsa Community College
Linda Lau, Longwood University
Art Lee, Lord Fairfax Community College
Joo Eng Lee-Partridge, Central Connecticut State University
Jing Liu, Southeastern Louisiana University
Juan Marquez, Mesa Community College
Gary Marrer, Glendale Community College
Norman McNeal, Dakota County Technical College
George McOuat, Hawaii Pacific University
Joseph Merrell
Sylvia Miner, Florida International University
Billy Morgan, Holmes Community College
Joan P. Mosey, Point Park College
Solomon Negash, Kennesaw State University
Robert Niels, Cincinnati State Community and Technical College
Gregory M. Ogle
Christopher J. Olson, Dakota State University
The authors would like to thank their families for their tremendous support throughout this project. We would also like to thank everyone at Pearson who is part of the editorial, production, and marketing team. We are extremely fortunate to have Matt Goldstein as our editor. He has guided us through the delicate process of updating this book many times. We are also fortunate to have Demetrius Hall and Yvonne Vannatta as our marketing managers. Their hard work is truly inspiring, and they do a great job of getting this book out to the academic community. The production team, led by Amanda Brands, worked tirelessly to make this book a reality. Thanks to you all!

About the Authors

Tony Gaddis is the principal author of the Starting Out with series of textbooks. Tony has 20 years of experience teaching computer science courses at Haywood Community College in North Carolina. He is a highly acclaimed instructor who was previously selected as North Carolina's Community College Teacher of the Year, and has received the Teaching Excellence award from the National Institute for Staff and Organizational Development. Besides Visual Basic books, the Starting Out with series includes introductory books on programming logic and design, Alice, the C++ programming language, Java™, Python, Microsoft® Visual C#®, and MIT App Inventor, all published by Pearson.

Kip Irvine holds M.S. (computer science) and D.M.A. (music composition) degrees from the University of Miami. He was formerly on the faculty at Miami-Dade Community College, and is retired from the School of Computing and Information Sciences at Florida International University. His published textbooks include COBOL for the IBM Personal Computer, Assembly Language for x86 Processors, C++ and Object-Oriented Programming, and Advanced Visual Basic .NET.
Attention Students

Installing Visual Studio

To complete the tutorials and programming problems in this book, you need to install Visual Studio 2017 on your computer.

We recommend that you download Visual Studio Community 2017 from the following Web site, and install it on your system:

www.visualstudio.com

Visual Studio Community 2017 is a free, full-featured development environment, and is a perfect companion for this textbook.

**NOTE:** If you are working in your school’s computer lab, there is a good chance that Microsoft Visual Studio has already been installed. If this is the case, your instructor will show you how to start Visual Studio.

Installing the Student Sample Program Files

The Student Sample Program files that accompany this book are available for download from the book’s companion Web site at:

http://www.pearson.com/gaddis

These files are required for many of the book’s tutorials. Simply download the Student Sample Program files to a location on your hard drive where you can easily access them.
MyLab Programming

Through the power of practice and immediate personalized feedback, MyLab Programming™ helps students master programming fundamentals and build computational thinking skills.

PROGRAMMING PRACTICE

With MyLab Programming, your students will gain first-hand programming experience in an interactive online environment.

IMMEDIATE, PERSONALIZED FEEDBACK

MyLab Programming automatically detects errors in the logic and syntax of their code submission and offers targeted hints that enables students to figure out what went wrong and why.

GRADUATED COMPLEXITY

MyLab Programming breaks down programming concepts into short, understandable sequences of exercises. Within each sequence the level and sophistication of the exercises increase gradually but steadily.

DYNAMIC ROSTER

Students’ submissions are stored in a roster that indicates whether the submission is correct, how many attempts were made, and the actual code submissions from each attempt.

PEARSON eTEXT

The Pearson eText gives students access to their textbook anytime, anywhere.

STEP-BY-STEP VIDEONOTE TUTORIALS

These step-by-step video tutorials enhance the programming concepts presented in select Pearson textbooks.

For more information and titles available with MyLab Programming, please visit www.pearson.com/mylab/programming.

Copyright © 2018 Pearson Education, Inc. or its affiliate(s). All rights reserved. HELO88173 • 11/15