

The C# Programmer's Study Guide (MCSD)

Exam: 70-483



Ali Asad
Hamza Ali

Apress®

The C# Programmer's Study Guide (MCSD)

Ali Asad
Sialkot, Pakistan

Hamza Ali
Sialkot, Pakistan

ISBN-13 (pbk): 978-1-4842-2859-3
DOI 10.1007/978-1-4842-2860-9

ISBN-13 (electronic): 978-1-4842-2860-9

Library of Congress Control Number: 2017944951

Copyright © 2017 by Ali Asad and Hamza Ali

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

Trademarked names, logos, and images may appear in this book. Rather than use a trademark symbol with every occurrence of a trademarked name, logo, or image we use the names, logos, and images only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

The use in this publication of trade names, trademarks, service marks, and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Cover image designed by FreePik

Managing Director: Welmoed Spahr
Editorial Director: Todd Green
Acquisitions Editor: Celestin Suresh John
Development Editor: Anila Vincent and Laura Berendson
Technical Reviewer: Syed Lakhtey Hussnain
Coordinating Editor: Sanchita Mandal
Copy Editor: Larissa shmailo
Compositor: SPi Global
Indexer: SPi Global
Artist: SPi Global

Distributed to the book trade worldwide by Springer Science+Business Media New York, 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail rights@apress.com, or visit <http://www.apress.com/rights-permissions>.

Apress titles may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Print and eBook Bulk Sales web page at <http://www.apress.com/bulk-sales>.

Any source code or other supplementary material referenced by the author in this book is available to readers on GitHub via the book's product page, located at www.apress.com/978-1-4842-2859-3. For more detailed information, please visit <http://www.apress.com/source-code>.

Printed on acid-free paper

*Dedicated to my family (Mama[**Samina**], Papa[**Asad**], brother[**Hamza**],
sisters [**Rimsha, Aima, Azma**]); and to my dearest friend, **Sundus Naveed**.
Thank you for supporting me and believing in me. Most importantly, you guys never tried
to change me; instead, you gave me the confidence and the freedom to work on my dreams.
For that, I'm eternally grateful. Thank you!!!*

—Ali Asad

*Dedicated to my father [**Muhammad Arif**], who always encourages and supports
me to learn and deliver knowledge, and my whole family (Mother [**Yasmeen Tahira**],
my brothers [**Adil Ali** and **Awais Ali**], my sister-in-law [**Noureen Azmat**],
my cute niece [**Zoha Adil**], my sisters [**Iram Suhaib** and **Aqsa Hamid**],
and my beloved fiancée [**Zunaira Shafqat Ali**].)*

—Hamza Ali

Contents at a Glance

About the Authors.....	xix
About the Technical Reviewer	xxi
Acknowledgments	xxiii
Introduction	xxv
Foreword	xxix
■ Chapter 1: Fundamentals of C #	1
■ Chapter 2: Types in C#	39
■ Chapter 3: Getting Started with Object Oriented Programming	65
■ Chapter 4: Advance C#	95
■ Chapter 5: Implementing Delegates & Events	153
■ Chapter 6: Deep Dive into LINQ.....	177
■ Chapter 7: Manage Object Life Cycle.....	197
■ Chapter 8: Multithreaded, Async & Parallel Programming.....	207
■ Chapter 9: Exception Handling and Validating Application Input.....	271
■ Chapter 10: File I/O Operations	291
■ Chapter 11: Serialization and Deserialization	305
■ Chapter 12: Consume Data	319
■ Chapter 13: Working with Cryptography	347

■ **Chapter 14: Assembly and Reflection..... 365**

■ **Chapter 15: Debugging and Diagnostics 395**

■ **Chapter 16: Practice Exam Questions 423**

Index..... 467

Contents

About the Authors.....xix

About the Technical Reviewerxxi

Acknowledgmentsxxiii

Introductionxxv

Forewordxxix

■ Chapter 1: Fundamentals of C # 1

Program Structure & Language Fundamentals 1

 First Program in C#.....2

 Variables & Data Types5

 Operator in C#.....6

 Expression in C#7

 Type Casting8

 var keyword.....9

 Array in C#9

Implement Program Flow 15

 Decision Structure 15

 Decision Operators 19

 Loops in C# 20

 Jump Statements in C# 23

Methods in C# 28

 Named Argument.....29

 Optional Argument.....29

 Pass by Reference with ref Keyword.....30

Pass by Reference with out Keyword	31
Use Params Array to Pass Unlimited Method Argument.....	32
Summary	33
Code Challenges.....	33
Practice Exam Questions.....	35
■ Chapter 2: Types in C#	39
Understand Types	39
Create Types	39
Enum	40
Struct.....	42
Class	45
Types and Memory Management	48
Value Type	48
Reference Type	48
Heap	48
Stack.....	49
Register	50
Special Types in C#	50
System.Object Type	50
Anonymous Type.....	51
Dynamic Type	52
Nullable Type	53
Static Type	54
Type Conversion	56
Implicit Type Conversion.....	56
Explicit Type Conversion	56
User Defined Type Conversion	57
Summary	59
Code Challenges.....	60
Practice Exam Questions.....	60

■ Chapter 3: Getting Started with Object Oriented Programming	65
Introduction to Object Oriented Programming.....	65
OOP in a PIE.....	66
Encapsulation.....	66
Access Specifiers	66
Data Protection	70
Inheritance	75
Multi Level Inheritance	76
Abstract Class	77
Interface	78
Implement interface implicitly	79
Implement interface explicitly	80
Polymorphism	81
Static Polymorphism.....	81
Dynamic Polymorphism.....	87
Summary.....	89
Code Challenges.....	90
Practice Exam Questions.....	91
■ Chapter 4: Advance C#	95
Boxing and Unboxing.....	95
Boxing.....	95
Unboxing.....	96
Performance of Boxing & Unboxing.....	97
Generics	97
Constraints on Generic Type Parameters.....	98
Generic Methods.....	104
Collection	106
System.Collections	106
System.Collections.Generic	112
System.Collections.Concurrent.....	120

Implement Framework Interface	120
IEnumerable & IEnumerable<T>	120
IEnumerator & IEnumerator<T>	124
ICollection & ICollection<T>	129
IList & IList<T>	130
IComparable & IComparable<T>	132
IComparer & IComparer<T>	135
IEquatable<T>	138
Working with Strings	140
StringBuilder	141
StringReader	141
StringWriter	142
Enumerate String Methods	143
String.Format Method	147
Summary	150
Code Challenges	150
Practice Exam Questions	150
■ Chapter 5: Implementing Delegates & Events	153
Delegate	153
Multicast Delegate	154
Common Built-in Delegates	157
Variance in Delegate	161
Problems with Delegate	163
Anonymous Method	164
Lambda Expression	166
Event	168
Use Built-in Delegates to Implement Events	170
Advantages of Events	174
Summary	174
Code Challenges	175
Practice Exam Questions	175

■ Chapter 6: Deep Dive into LINQ	177
Introduction to LINQ	177
Why we use LINQ.....	177
Types of LINQ.....	178
Understanding LINQ Operators	178
Filtering Operator.....	179
Projection Operator.....	179
Joining Operator	179
Grouping Operator	180
Partition Operator	180
Aggregation	180
Understand LINQ Syntax	181
Method Syntax.....	181
Query Syntax	182
Working with LINQ Queries	183
C# Features to Support LINQ	183
Parts of Query Operation	184
LINQ Operators to Query Data.....	186
LINQ to XML	191
Create XML data	191
Update XML data	192
Read XML data	193
Summary	194
Code Challenges	195
Practice Exam Questions	195
■ Chapter 7: Manage Object Life Cycle	197
Fundamentals of Object Life Cycle	197
Creation of an Object.....	197
Deletion of an Object	197

Fundamentals of .NET Garbage Collection	198
When Garbage Collection Run	198
Garbage Collector and Managed Heap	198
Generations	198
Steps Involved in Garbage Collection	199
Manage Unmanaged Resource	199
Implement IDisposable to Release Unmanaged Resource	199
Call Dispose Inside try/finally Block	200
Call Dispose Inside Using Statement.....	201
Disposable Pattern	202
Memory Leaks.....	203
Manage Memory Leaks	203
Summary	204
Code Challenges.....	204
Practice Exam Questions.....	204
■ Chapter 8: Multithreaded, Async & Parallel Programming.....	207
Working with Threads	207
Create and Start a Thread.....	208
Thread.Join().....	210
Foreground & Background Thread.....	211
Pass a Parameterize Method to a Thread	214
Thread.Sleep(milliseconds)	215
ThreadPriority	216
ThreadStatic	218
Thread Pool.....	221
Working with Tasks	223
Create and Run a Task	224
Create and Run a Task<Result>	228
Wait for One or More Task	234
Chain Multiple Tasks with Continuations.....	240
Nested Task	243

Synchronization of Variables in Multithreading	245
Dead Lock.....	249
CancellationToken	251
Making UI Responsive	253
How to Make UI Responsive with Async and Await	254
Prevent Application from Cross Threading	259
Parallel Programming.....	260
Concurrent Collection	260
Parallel.For & Parallel.Foreach	263
PLINQ	265
Summary	266
Code Challenges.....	267
Practice Exam Questions.....	267
■ Chapter 9: Exception Handling and Validating Application Input	271
Introduction to Exception	271
Handling Exception.....	272
try-catch	272
try-catch (ExceptionType ex)	273
try-catch (ExceptionType)	275
try-catch-finally	276
try-finally	278
Use Multiple Catch Blocks to Handle Multiple Exceptions.....	279
Throwing Exceptions	280
Re-throwing an Exception	282
Throwing an Exception with an Inner Exception	283
Creating Custom Exceptions	284
Validating Application Input.....	285
Regular Expressions	285
Summary	289
Code Challenges.....	289
Practice Exam Questions.....	290

- **Chapter 10: File I/O Operations 291**
 - Working with Drive 291
 - Working with Directories..... 292
 - Directory and DirectoryInfo 292
 - Working with Files..... 294
 - File and FileInfo 294
 - Working with Stream..... 295
 - FileStream 296
 - MemoryStream 298
 - BufferedStream 298
 - Working with File Reader and Writer..... 299
 - StringReader and StringWriter 299
 - BinaryReader and BinaryWriter 299
 - StreamReader and StreamWriter 300
 - Communication over the Network..... 300
 - Working with asynchronous File I/O..... 301
 - Async and Await in File I/O 301
 - Summary..... 302
 - Code Challenges..... 303
 - Practice Exam Questions..... 303
- **Chapter 11: Serialization and Deserialization 305**
 - Serialization and Deserialization 305
 - Serialization 305
 - Deserialization 305
 - Pictorial Representation 305
 - Explanation 306
 - Binary Serialization 307
 - Using Binary Serializer 307
 - XML Serialization..... 308
 - Using XML Serializer..... 309
 - UsingDataContract Serializer..... 312

JSON Serialization	313
Using DataContractJsonSerializer	313
Using JavaScriptSerializer	314
Custom Serialization	315
Using ISerializable	315
Serialization Performance Comparison	316
Summary	317
Code Challenges.....	317
Practice Exam Questions.....	317
■ Chapter 12: Consume Data	319
Working with a Database	319
ADO.NET.....	319
Data Providers	320
Connection.....	320
Command	323
Conceptual parts of ADO. NET	323
Connected Layer.....	323
Disconnected Layer	326
Entity Framework	328
Consume XML and JSON Data	335
XML Data	335
JSON Data	337
Working with Web Services.....	337
ASMX Web Service	337
WCF Web Service.....	343
WCF web service vs. ASMX Web Service	343
Summary	344
Code Challenges.....	344
Practice Exam Questions.....	344

- **Chapter 13: Working with Cryptography 347**
 - Cryptography..... 347
 - Encryption 347
 - Cryptanalysis 348
 - Pictorial Representation 348
 - Types of Encryption 349
 - Symmetric Encryption 349
 - Asymmetric Encryption 351
 - Implement Key management 353
 - Symmetric Keys..... 353
 - Asymmetric Keys..... 353
 - Encrypt Stream..... 354
 - Working with ProtectedData Class 355
 - Protect()..... 355
 - Unprotect..... 356
 - Manage and Create Digital Certificates..... 357
 - Create and Install Certificate 357
 - Working with System.Security Namespace 357
 - Code Access Security (CAS)..... 358
 - Declarative..... 358
 - Imperative..... 358
 - Hashing 358
 - Salt Hashing 360
 - Choosing an appropriate Algorithm..... 360
 - Working with SecureString Class..... 361
 - Summary..... 362
 - Code Challenges..... 363
 - Practice Exam Questions..... 363

■ Chapter 14: Assembly and Reflection.....	365
Introduction to Assemblies.....	365
When Code is Compiled.....	365
Types of Assembly	365
Uses of Assembly	366
Creating and Using Custom Assembly.....	366
Dynamic Link Library (.DLL).....	366
Executable (.EXE).....	370
WinMD Assembly.....	371
Create WinMD Assembly.....	371
Global Assembly Cache (GAC)	372
Install an Assembly in GAC	372
AssemblyInfo.cs.....	373
Reflection in C#	375
Working with Reflection	375
Attributes in C#.....	385
Create a Custom Attribute	385
Use ILdasm.exe to View Assembly Content.....	392
Summary.....	393
Code Challenges.....	393
Practice Exam Questions.....	393
■ Chapter 15: Debugging and Diagnostics	395
Debugging	395
Choose appropriate Build Type	397
Creating and Managing Compiler Directives	398
Understand PDBs and Symbols	401

Diagnostics.....	402
Instrumenting an Application.....	402
Logging and Tracing	403
Profiling the Application.....	411
Summary.....	419
Code Challenges.....	420
Practice Exam Questions.....	420
■ Chapter 16: Practice Exam Questions	423
Objective 1: Manage Program Flow.....	423
Objective 2: Create and Use Types	431
Objective 3: Debug Application and Implement Security.....	443
Objective 4: Implement Data Access	451
Index.....	467

About the Authors



Ali Asad is one of the top C# programmers of Pakistan. He is a Microsoft Specialist (MS) in C# since 2015. In Pakistan, he is well known for his popular Microsoft C# Certification training, which helped so many students to pass their Microsoft Certification Exams.

Ali is an active community member; he speaks about *Game Development* and *C# Programming* at different conferences and workshops.

You can reach out to Ali Asad through:

- twitter.com/imaliasad
- facebook.com/imaliasad
- linkedin.com/in/imaliasad
- imaliasad@outlook.com



Hamza Ali is a Microsoft Specialist (MS in C#) since 2015 and an independent trainer teaching .NET technologies and the Cloud platform in general, and Microsoft C# certification training and ASP.NET MVC, in particular. Hamza is also exercising his expertise in JaSol Technologies (emerging Software House in Market own by him) as CTO.

He speaks at different tech talks and gives sessions on different tools and technologies, and frameworks including ASP.NET Core, Angularjs, Reactjs, Visual Studio Team Services, WCF Services, and Web APIs, using his expertise and experience.

You can reach out to Hamza Ali through:

- linkedin.com/in/hamzaali2
- facebook.com/hamZaali.003
- hamzaaliarif@hotmail.com
- twitter.com/arreez11

About the Technical Reviewer



Syed Lakhtey Hussnain is a Software Engineer in a wide range of applications with solid experience in developing web applications (including ERPs, CRMs) with ASP.NET MVC. Lakhtey is working as a Technology Strategist with Senior Development team from Barracuda Inc. to reconstruct entire web application that serves the business purposes. Lakhtey has also been working as a trainer in a Startup called '7Colors' where he gave trainings to his community members on .NET certifications. He is also a Microsoft Certified Solution Developer in Web Applications and AppBuilder.

Lakhtey has his deep interest in Music and Art and enjoys it a lot. Lakhtey lives in Kharian, Pakistan with his Parents.

Lakhtey can be reached at:

- lakhtey_hussnain@hotmail.com
- <https://twitter.com/lakhtey22>
- <https://www.facebook.com/hassan.lakhtey>
- <https://www.linkedin.com/in/lakhtey/>

Acknowledgments

Ali Asad: It is my honor and privilege to have worked with Apress. I'd like to thank each person who contributed a lot to the book:

- To **Celestin Suresh John** for providing me the opportunity to write this book.
- To **Sanchita Mandal** for your tremendous support and coordination that helped me a lot in the writing process.
- To my co-author **Hamza Ali** for your great partnership. Without your support, this book wouldn't get the quality that it has now.
- To **Syed Lakhtey Hussnain** for your technical reviewing skills. It helped me to correct the mistakes I made.
- To **David V Cobin** for taking the time to read this book and providing your valuable foreword.
- To the entire team at **Apress**, who made this book possible.

There are people in life who are special, who inspire you, support you and make you the person you are today. I have been so blessed for having such people in my life, because without them I wouldn't be able to write this book.

- To **Ali Raza** (AlizDesk) for guiding me to take the Microsoft Certification Exam.
- To **Mubashar Raffique** for supporting me in the academy, where we trained students and professionals for their Microsoft Certification Exams.
- To **Usman Ur Rehman** for all your valuable advice and support that helped me a lot during my time working at the Microsoft Innovation Center, Lahore.
- To **Faqeeha Riaz** for doing my semester assignments and helping me to prepare for final exams because, without your support, I wouldn't be able to give my complete focus to this book.
- To my parents (Mama[**Samina**], Papa[**Asad**]) for giving me the freedom to do good work in life.
- Last but not least, to **Sundus Naveed** for all your patience, support, and love.

Hamza Ali: I am honored to work with **Apress**, one of the quality-oriented book publishers. I'd like to acknowledge the contributions done by:

- **Celestin Suresh John:** for providing the opportunity to write this book.
- **Sanchita Mandal:** for your committed and continuous support to maintain and complete the book on time.
- **Ali Asad:** my co-author, for your big contribution along with your support to write, complete, and maintain the quality of the book and, obviously, the opportunity for the book.
- **Syed Lakhtey Hussnain:** for technical review and pointing out some deep mistakes, which improved the quality.
- **David V Cobin:** for writing the foreword for this book.
- **Zunaira Shafqat Ali:** for your support and understanding throughout the process of book writing.

I'd also like to thank:

- **my family:** for encouragement and support.
- **Ali Imran:** for support and guidance.
- **Mubashar Rafique:** for availability and useful thoughts.

Introduction

This book covers basic to advanced-level knowledge required to pass the Exam 70-483. It covers the usage and techniques used for professional development.

This book covers all the objectives listed in the official syllabus for Exam 70-483.

This book is suitable for students or readers who have a basic knowledge of C#, to lead them to an advanced level fit for experienced developers.

Target Audience

Students or readers with a basic understanding of C# and the learner beyond this stage are the target audience. Microsoft recommends one year of experience in C# before appearing for Exam 70-483, but this book (with its synced and basic to advanced explanation structure) leads basic, intermediate, or advanced-level students or developers to that level where they can easily appear for the Exam 70-483 with satisfactory preparation that also helps for concepts' clarity.

This book prepares readers for Exam 70-483 and, by passing this exam, “Microsoft Certified Professional” and “Microsoft Specialist: Programming in C#” certificates are awarded by Microsoft.

Content Covered

This book covers the content listed in the official syllabus for Exam 70-483 along with the building block topics related to official contents, so that synchronicity can be maintained and readers can understand the content step-by-step.

This book uses C# 5.0 and .NET Framework 4.5 in its content and examples. Exam-type questions for each chapter are also covered by this book to give readers better understandability, as well as Exam Challenges to improve the coding skills of readers.

Book Requirements

To read and implement code examples, you will need:

- A system (PC) with Windows 10
- Microsoft Visual Studio 2015 Community (this edition is freely available) Or above.
You can download this version from the following link:

<https://www.visualstudio.com/downloads/>

Structure of Book

The book is structured so that the knowledge base builds gradually. The chapter's structure is as follows:

- Each chapter contains the objective to cover.
- Real world examples to clear the concepts of readers.
- Mapping of real world examples into code.
- Notes and tips from authors for best practices.
- Useful resources links added where required.
- At the end, exam structured MCQs are given to test the capability of the reader based on his/her understanding of the chapter.

Each chapter is mapped to 4 main objectives of Exam 70-483 with respect to its contents. The objectives are:

1. Manage Program Flow 25-30%
2. Create & Use Types 25-30%
3. Debug Application & Implement Security 25-30%
4. Implement Data Access 25-30%

The objectives (with their sub-objectives) explained in this book with respect to chapters are:

Manage Program Flow 25-30%

This objective explains how you can use simple C# programs that execute all its logic from top to bottom, and also use complex C# programs that do not have a fixed program flow. In this objective, we'll cover following sub-objectives:

1. Implement Multithreading and Asynchronous Processing. (Chapter [8](#))
2. Manage Multithreading. (Chapter [8](#))
3. Implement Program Flow. (Chapter [1](#))
4. Create and Implement Events and Callbacks. (Chapter [5](#))
5. Implement Exception Handling. (Chapter [9](#))

Create & Use Types 25-30%

This objective explains the default type system in .NET and explains how you can use it in a simple C# program. This objective also explains how you can create your custom types by using struct, enums, and classes, and use them effectively to create complex C# programs by using object-oriented principles. In this objective, we'll cover the following sub-objectives:

1. Create Types. (Chapter [2](#))
2. Consume Types. (Chapter [2](#))
3. Enforce Encapsulation. (Chapter [3](#))

4. Create & Implement Class Hierarchy. (Chapter 3)
5. Find, Execute, and Create Types at Runtime. (Chapter 14)
6. Manage Object Lifecycle. (Chapter 6)
7. Manipulate Strings. (Chapter 4)

Debug Application & Implement Security 25-30%

This objective explains how you can debug an application by validating user inputs, managing assemblies, etc. Also, you'll learn how to secure your application by implementing different encryption techniques (i.e., symmetric and asymmetric) and much more. In this objective, we'll cover the following sub-objectives:

1. Validate Application Input. (Chapter 9)
2. Perform Symmetric & Asymmetric Encryption. (Chapter 13)
3. Manage Assemblies. (Chapter 14)
4. Debug an Application. (Chapter 15)
5. Implement Diagnostics in an Application. (Chapter 15)

Implement Data Access 25-30%

This objective explains how you can use .NET libraries to manipulate data in a file system. It explains how you can use LINQ to query data, use ADO.NET to access a database, and much more. In this objective, we'll cover the following sub-objectives:

1. Perform I/O Operations. (Chapter 10)
2. Consume Data. (Chapter 12)
3. Query and Manipulate Data and Objects by Using LINQ. (Chapter 6)
4. Serialize and Deserialize Data. (Chapter 11)
5. Store Data in and Retrieve Data from Collections. (Chapter 4)

Keep in Touch

We have created a small and effective community on a Facebook group for readers of this book. We highly encourage you to join our Facebook group so, if you face any problem, feel free to post questions or start a discussion related to Microsoft Certification Exam 70-483 at: <https://www.facebook.com/groups/Exam70483/>.

Foreword

As a professional developer for multiple decades, I have seen and been involved in many different certification programs. Microsoft has invested heavily in a set of exams and certifications that are indicative of a candidate's ability to apply the relevant knowledge to real world situations.

When I was first approached about writing a foreword for this book on the 70-483 Exam, I was cautious. Over the years, I have seen far too many publications that do not provide any real understanding of the underlying material. However, upon receipt of the draft for this book, those concerns were eliminated.

The chapters contain topics ranging from the very basic to advanced C# language capabilities, using a combination of narrative text and code samples. Even if you are a seasoned C# developer, starting preparation for the exam from the beginning is highly recommended.

The Exam policies and FAQ page on the Microsoft site specifically states: "The best way to prepare for an exam is to practice the skills." I encourage all readers of this book to also spend hands-on time with the material; fire up Visual Studio, enter the sample code, write some little programs of your own related to the capability, and use the debugger to step through the code.

With the material in this book, the diligent reader should be well on their way to the level of understanding needed to do well on the 70-483 Exam. Even if your immediate focus is not on certification, there are always learning, review, and reference needs that can be addressed by keeping a copy of this book handy.

David V. Corbin
President/Chief Architect
Dynamic Concepts Development Corp.