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978-0-133-74679-2 - Using CRC Cards: An Informal Approach to Object-Oriented Development

Nancy M. Wilkinson

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*An Informal Approach to  
Object-Oriented Development*

Nancy M. Wilkinson

*AT&T Bell Laboratories*



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*To Liz,  
for a lifetime of love and laughter*

## *About the Author*

**N**ANCY M. WILKINSON, an expert in the use of C++ and object-oriented design, has been with AT&T Bell Laboratories since 1979. In her current position with the Software Development Technology Group, Wilkinson has led an object-oriented design and programming consulting effort within AT&T. She developed a CRC card course and company wide C++ programming guidelines. She has also developed tools to transition C to C++ code and to ensure compliance with C++ coding standards. Prior to this, Wilkinson was a member of the Languages Tools group in Bell Labs. There, she was a part of the cfront development team for AT&T C++ Language Releases 2.1 and 3.0. She has had numerous titles published in technical journals and magazines, including *C++ Report*, and she writes a column for *Report on Object Analysis and Design* (SIGS Publications). She has also given CRC card workshops at numerous conferences, such as Object Expo and C++ World.

Wilkinson received a bachelor's degree in mathematics from Gettysburg College, Gettysburg, Pennsylvania, and a master's degree in computer science from Stevens Institute of Technology, Hoboken, New Jersey.

## Series Introduction

THE Advances in Object Technology series seeks to present readers with books that provide incisive and timely information relating to object-oriented programming and programming languages, object-oriented requirements, object-oriented domain analysis, and object-oriented design. In addition, testing, metrics, formal methods and applications of object technology to areas including object-oriented databases, real-time systems, emergent computation, neural networks, and object-oriented distributed systems will be featured. The books are aimed at practicing software development professionals, programmers, educators, and students in computer-related disciplines.

*Using CRC Cards* is an important book. Nancy Wilkinson's years of experience at AT&T Bell Labs have provided the practical experience in using C++ and designing object-oriented systems that comes through in this book. Her superb writing skills make this a most pleasurable book to read. Even if you consider yourself an experienced C++ programmer, you will benefit tremendously from the insight that Nancy Wilkinson presents relating CRC analysis and design to C++ implementation. Relatively little has been written about CRC analysis and design, although it is a widely used and important process. I believe that this book will emerge as a classic for anyone interested in this important technique.

*Richard S. Wiener*  
Series Editor

## Foreword

**D**ESIGNERS WILL BENEFIT from adding informal modeling techniques to their repertoire. Since Ward Cunningham and Kent Beck wrote about them in their 1989 OOSPLA paper, CRC cards have been used by many. Brian Wilkerson, Laura Wiener, and I introduced CRC cards to a broader audience when we wrote about responsibility-driven design in *Designing Object-Oriented Software* (Prentice Hall) in 1990. In 1995, CRC cards are used extensively in teaching and when exploring early design ideas. CRC cards are an important modeling technique. Since CRC cards are informal, little has been written about their effective use. Instead, much has been communicated by word of mouth; people have earned their livelihood teaching and mentoring on CRC use. With this book, Nancy Wilkinson has advanced CRC card techniques. She describes how a hypothetical design team analyzes, designs, and thinks about objects. She carries us from analysis to implementation using CRC cards. This book is an important contribution to the lore and wisdom of CRC card use.

CRC cards embody a simple concept; they should be easy to use. Indeed, they have been readily adopted by many. Yet, some groups fail to use them successfully. There are several reasons why. In some cases, teams are simply struggling with understanding object concepts and design principles. In this book, Nancy takes us through the design of a sample library application; her book will give new designers plenty of direction and fodder for study.

Others find CRC cards too inflexible, too informal, or too limited. If you share these opinions, I urge you to reconsider them as you read this book. By their very nature, CRC cards aren't big enough to hold all your design and modeling ideas. They were never intended to tell the entire design story. Developers should be comfortable supplementing more formal design methods with CRC modeling sessions.

As Nancy points out, CRC cards can be a flexible tool that aids any group's object modeling activities. When cards are adapted to fit a group's methods and practices, they



become an integral part of their design process. Over the years, I have collected stories about how people have modified CRC cards. Some have written implementation details, such as encapsulated state, on card backs. When cards are face up, this information is concealed, reinforcing the good design practice of hiding implementation details inside objects. I worked with a team that kept cards in a plastic box. The team leader passed out cards to members at the start of each modeling session. When computerized versions of CRC cards became available, they still preferred the informality of their design box.

I've worked with teams that kept lists of issues and lists of unassigned responsibilities. As they worked through design scenarios, these lists grew and shrank, and their CRC card decks expanded. Others have developed their model individually, then used CRC cards to walk a group through their design, keeping it at a fairly high level. Many have taped index cards to white boards, then drawn and redrawn message arrows between cards until they were satisfied. It was easy then to double check whether each card supported responsibilities used in an interaction sequence.

My colleagues and I have evolved our use of CRC cards. Today, backs of CRC cards are nearly as important as their faces; they are a place for recording seeds of ideas about our objects' roles, stereotypical behavior, and potential utility. Certain adaptations do not work as well as others. Replacing each card with an 8½" × 11" sheet of paper is not effective. It is much harder to assume the role of a big flimsy paper object. Instead, designers tend to fill up their paper objects with isolated details and ignore exploring different ways to divvy up responsibilities among objects.

Computerized CRC tools, while useful, do not replace interactive modeling sessions. There is something magical about waving cards in the air, grouping them in different ways to contrast their behaviors, or simulating a message send by shoving one card toward another. Computer tools often seem flat and lifeless by comparison.

Passing a rubber-banded deck of 200 cards off to a developer for implementation is unthinkable. Yet, some don't hesitate to hand off 200 pages of CASE-tool generated output, even if it is unintelligible. People need to communicate design intentions in a variety of ways; many of these ways will remain unsupported by even the cleverest tool vendor. Beware of using paper in lieu of face-to-face communications!

However, computerized design tools fill in where cards alone fall short. It is hard to share a CRC card design with a broad audience. Designs need to be recorded, communicated, and commented upon; on-line tools can greatly aid in this process. In her book, Nancy describes a process for using CRC cards. I encourage you to use them in the spirit in which they were created—an informal mechanism for developing and communicating object designs.

*Rebecca J. Wirfs-Brock*

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## Preface

*The whole difference between construction and creation is exactly  
this: that a thing constructed can only be loved after it is constructed;  
but a thing created is loved before it exists.*

—G. K. Chesterton, Preface to  
*Pickwick Papers*, by Charles Dickens

FOR THE PAST few years, several of my colleagues and I have been using CRC cards to help spread the use of object-oriented techniques throughout AT&T. I have conducted CRC card workshops to initiate software professionals into the world of object-oriented modeling. I have helped project teams use CRC cards for problem modeling brainstorm sessions to collect object data as input for their formal processes. And I have facilitated CRC card design sessions, using the cards to guide teams through object-oriented design. I have also helped some of these groups make the transition from CRC cards to C++.

When asked for CRC card references during these sessions, I pointed to various articles on the technique as well as to the chapters of some excellent books. But I never had

any one book at my disposal that fully explained CRC cards and how they could be used throughout the product life cycle. Especially lacking was guidance regarding how the design on the cards could be best implemented in a C++ program. This lack of material did not seem strange to me at first, because I thought CRC cards were too simple a technique to warrant a whole book. But as I worked with more and more projects, I came to realize that practical information was needed about the CRC card process and how it contributes to object-oriented development at each stage of the software life cycle.

This book is the result of that realization, and the desire to codify my collective experience. I still think that CRC cards are too simple a technique to justify an epic volume (indeed, this is one of their biggest strengths). Therefore, I have tried to write a concise and manageable book which (like CRC cards) gets the point across without overwhelming the reader.

I believe this book will appeal to a wide audience, one that includes neophytes in object-oriented modeling who hope to use CRC cards to learn about objects; experienced object-oriented developers who want to learn how to use CRC cards to provide input to, or augment, their formal methodologies; and experienced software professionals who prefer informal techniques and want to understand how to use CRC cards at every stage of a project (in their design, in documenting a design that uses CRC cards, and in turning the design into C++ code). In essence, this book should be of interest to anyone who would like to participate in or facilitate a CRC card session.

## *Acknowledgments*

*W*. Somerset Maugham once said, “There are three rules for writing. . . . Unfortunately, no one knows what they are.” I learned that the most important rule is to have the support and encouragement of family and friends. I would also like to thank colleagues with whom I have shared sessions and numerous discussions about CRC cards, including Cecilia Castillo, Jim Coplien, George Logothetis, Dennis Mancl, Jim Rowland, and Gregg Vesonder. I would especially like to thank Gregg, my boss, for supporting my writing in spite of the effect it had on my “day” job. I am indebted to my editors, Peter Arnold, Richard Wiener, and especially Deirdre Griese, for guidance through my first foray into publishing. Deirdre’s energy, patience, and humor have made it a much less painful process than it might otherwise have been.

I want to thank Rebecca Wirfs-Brock and Timothy Budd for giving me permission to share their words of wisdom in this book. This was especially meaningful to me because the books they wrote were the ones that sparked my initial interest in and understanding of objects and object-oriented design.

Thanks also go to my reviewers: Dave Annatone, Steve Bilow, Karen Brown, Liz Flanagan, Jim Rowland, Gregg Vesonder, and Richard Wiener. I owe special thanks to Liz for reviewing the earliest draft of the manuscript and putting up with my disappointment when she did not think it was perfect the very first time. Her many insightful comments, suggestions, and words of encouragement have helped to make this a far better book.

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