



C++ Templates: The Complete Guide

By David Vandevorde, Nicolai M. Josuttis

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Templates are among the most powerful features of C++, but they are too often neglected, misunderstood, and misused. *C++ Templates: The Complete Guide* provides software architects and engineers with a clear understanding of why, when, and how to use templates to build and maintain cleaner, faster, and smarter software more efficiently. *C++ Templates* begins with an insightful tutorial on basic concepts and language features. The remainder of the book serves as a comprehensive reference, focusing first on language details, then on a wide range of coding techniques, and finally on advanced applications for templates. Examples used throughout the book illustrate abstract concepts and demonstrate best practices. Readers learn: The exact behaviors of templates How to avoid the pitfalls associated with templates Idioms and techniques, from the basic to the previously undocumented How to reuse source code without threatening performance or safety How to increase the efficiency of C++ programs How to produce more flexible and maintainable software This practical guide shows programmers how to exploit the full power of the template features in C++.

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Editorial Review

From the Back Cover

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- How to produce more flexible and maintainable software

This practical guide shows programmers how to exploit the full power of the template features in C++.

The companion Web site at <http://www.josuttis.com/tmplbook/> contains sample code and additional updates.

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About the Author

David Vandevoorde is an engineer at the Edison Design Group. He is an active member of the ANSI C++ Standards Committee, and a cofounder of the newsgroup `comp.lang.c++.moderated`. A graduate of the Brussels Free University and the Rensselaer Polytechnic Institute, his interests include algorithm development, programming languages, and teaching. See www.vandevoorde.com.

Nicolai M. Josuttis is an independent technical consultant who designs object-oriented software for the telecommunications, traffic, finance, and manufacturing industries. He is an active member of the C++ Standards Committee Library Working Group. Nicolai has written several books on object-oriented programming and C++. See www.josuttis.com.

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The idea of templates in C++ is more than ten years old. C++ templates were already documented in 1990 in the *Annotated C++ Reference Manual* or so-called "ARM" (see EllisStroustrupARM) and they had been described before that in more specialized publications. However, well over a decade later we found a dearth of literature that concentrates on the fundamental concepts and advanced techniques of this fascinating, complex, and powerful C++ feature. We wanted to address this issue and decided to write the book about templates (with perhaps a slight lack of humility).

However, we approached the task with different backgrounds and with different intentions. David, an experienced compiler implementer and member of the C++ Standard Committee Core Language Working Group, was interested in an exact and detailed description of all the power (and problems) of templates. Nico, an "ordinary" application programmer and member of the C++ Standard Committee Library Working Group, was interested in understanding all the techniques of templates in a way that he could use and benefit from them. In addition, we both wanted to share this knowledge with you, the reader, and the whole community to help to avoid further misunderstanding, confusion, or apprehension.

As a consequence, you will see both conceptual introductions with day-to-day examples and detailed descriptions of the exact behavior of templates. Starting from the basic principles of templates and working up to the "art of template programming," you will discover (or rediscover) techniques such as static polymorphism, policy classes, metaprogramming, and expression templates. You will also gain a deeper understanding of the C++ standard library, in which almost all code involves templates.

We learned a lot and we had much fun while writing this book. We hope you will have the same experience while reading it. Enjoy!

Acknowledgments

This book presents ideas, concepts, solutions, and examples from many sources. In a way it does not seem fair that our names are the only ones on the cover. We'd like to thank all the people and companies who helped and supported us during the past few years. First, we'd like to thank all the reviewers and everyone else who gave us their opinion on early manuscripts. These people endow the book with a quality it would never have had without their input. The reviewers for this book were Kyle Blaney, Thomas Gschwind, Dennis Mancl, Patrick McKillen, and Jan Christiaan van Winkel. Special thanks to Dietmar Kuhl who meticulously reviewed and edited the whole book. His feedback was an incredible contribution to the quality of this book. We'd also like to thank all the people and companies who gave us the opportunity to test our examples on different platforms with different compilers. Many thanks to the Edison Design Group for their great compiler and their support. It was a big help during the standardization process and the writing of this book. Many thanks also go to all the developers of the free GNU and egcs compilers (Jason Merrill was especially responsive), and to Microsoft for an evaluation version of Visual C++ (Jonathan Caves, Herb Sutter and Jason Shirk were our contacts there).

Much of the existing "C++ Wisdom" was collectively created by the online C++ community. Most of that comes from the moderated Usenet groups `comp.lang.c++.moderated` and `comp.std.c++`. We are therefore especially indebted to the active moderators of those groups, who keep the discussions useful and constructive. We also much appreciate all those who over the years have taken the time to describe and explain their ideas for us all to share. The Addison Wesley team did another great job. We are most indebted to Debbie Lafferty (our editor) for her gentle prodding, good advice, and relentless hard work in support of this book. We're grateful also to Marina Lang who first sponsored this book within Addison Wesley. Susan Winer contributed an early round of editing that helped shape our later work.

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David's Acknowledgments

My wife Karina has been instrumental in this book coming to a conclusion and I am immensely grateful for the role that she plays in my life. Writing "in your spare time" quickly becomes erratic when many other activities vie for your schedule. Karina helped me to manage that schedule, taught me to say "No" in order to make the time needed to make regular progress in the writing process, and above all was amazingly supportive of this project. I thank God every day for her friendship and love.

I'm also tremendously grateful to have been able to work with Nico. Besides his directly visible contributions to the text, his experience and discipline moved us from my pitiful doodling to a well organized production. John "Mr. Template" Spicer and Steve "Mr. Overload" Adamczyk are wonderful friends and colleagues, but in my opinion they are (together) also the ultimate authority regarding the core C++ language. They clarified many of the trickier issues described in this book, and should you find an error in the description of a C++ language element, it is almost certainly attributable to my failing to consult with them.

Finally, I want to express my appreciation to those who were supportive of this project without necessarily contributing to it directly (the power of cheer cannot be understated). First are my parents: Their love for me and their encouragements make all the difference. And then, there are the numerous friends constantly asking "How is the book going?"; they too were a source of encouragement: Michael Beckmann, Brett and Julie Beene, Jarran Carr, Simon Chang, Ho and Sarah Cho, Christophe De Dinechin, Peter and Ewa Deelman, Neil and Tammy Eberle, Sassan Hazeghi, Vikram Kumar, Jim and Lindsay Long, Franklin Luk, Richard and Marianna Morgan, Ragu Raghavendra, Jim and Phuong Sharp, Gregg Vaughn, and John Wiegley.

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