C++20 for Lazy Programmers

Quick, Easy, and Fun C++ for Beginners

—

Second Edition

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Will Briggs

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Printed on acid-free paper

To the learners and readers. They tell me what's wrong, and what's right.

Table of Contents

About the Author

Will Briggs, PhD, is a professor of computer science at the University of Lynchburg in Virginia. He has 20+ years of experience teaching C++, 12 of them using earlier drafts of this book and about as many years teaching other languages including C, LISP, Pascal, PHP, PROLOG, and Python. His primary focus is teaching of late while also pursuing research in artificial intelligence.

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Introduction

Surely there's no shortage of C++ intro texts. Why write yet another?

I'm glad you asked.

Ever since moving from Pascal to C++ (back when dinosaurs roamed the Earth), I've been underwhelmed by available resources. I wanted something quirky and fun to read, with sufficient coverage and fun examples, like the old *Oh! Pascal!* text by Cooper and Clancy. Even a perfectly accurate text with broad coverage gives you nothing if you fall asleep when you read it. Well, nothing but a sore neck.

But the other reason, of course, is to promote laziness.

We all want our projects to be done more quickly, with less wailing and gnashing of teeth. Sometimes, it's said, you have to put your nose to the grindstone. Maybe, but I like my nose too well for that. I'd rather do things the easy way.

But the easy way isn't procrastinating and dragging my feet; it's to find something I love doing and do it well enough that it feels relatively effortless. It's producing something robust enough that when it does break down, it tells me exactly what the problem is, so I don't have to spend a week pleading with it to explain itself. It's writing code that I can use again and again, adapting it to a new use in hours instead of days.

Here's what you can expect in this book:

- A pleasant reading experience.
- Adequate coverage.
- Games, that is, use of the SDL (Simple DirectMedia Layer) graphics library, which makes it easy to get graphics programs working quickly. It isn't fair that Python and Visual Basic should get all the eye candy.[1] The SDL library is used through Chapter 12. After that, we'll mostly use standard I/O, so we can get practice with the more common console programs.

[1] "Eye candy": things that look good on the screen. See The New Hacker's Dictionary, available at the time of writing at www.catb.org/jargon/.

- An easy introduction to SDL's graphical magic, using the SSDL (*simple* SDL) library (see below).
- Sufficient examples—and they won't all be about actuarial tables or how to organize an address book. (See "A pleasant reading experience" above.)
- Antibugging sections throughout the text to point out common or difficult-to-trace errors and how to prevent them.
- For g++ programmers, instructions on using g++, the ddd/gdb debugger system, and Makefiles; for Visual Studio, use of the debugger and project files.
- Compliance with C++20, the latest standard, and the goodies it provides.
- Hands-on experience with advanced data types like strings, stacks, vectors, and lists – not by reading about them, but by building them yourself.
- An appreciation of laziness.
- A cool title. Maybe I could have tried to write a "For Dummies" book, but after seeing *Bioinformatics for Dummies,* I'm not sure I have what it takes.

Why SDL?

It's surely more enjoyable to make programs with graphics and WIMP[2]-style interaction than to merely type things in and print them out. There are a variety of graphical libraries out there. SDL, or Simple DirectMedia Layer, is popular, relatively easy to learn, portable between platforms, and fast enough for real-world work, as evidenced by its use in actual released games.

[2]WIMP: window, icon, mouse, pointer. What we're all used to.

Figure 1. *A game of Freeciv, which uses the SDL library*

Why SSDL?

…but although SDL is *relatively* easy, it's not simple enough to start on day 1 of programming with C++. SSDL – *simple* SDL – saves you from needing to know things we don't get to until Chapter 14[3] before doing basic things like displaying images (Chapter 2) or even printing a greeting (Chapter 1). It also hides the initialization and cleanup code that's pretty much the same every time you write a program and makes error handling less cumbersome.

You may want to keep using SSDL as is after you're done with this book, but if you decide to go on with SDL, you'll find you know a lot of it already, with almost nothing to unlearn: most SSDL function names are names from SDL with another "S" stuck on the front. We'll go into greater depth on moving forward with SDL in Chapter 29.

[3]Pointers.

(Free) software you will need

At the time of writing, Microsoft Visual Studio (Community Edition) for Windows is absolutely free, and g++ always is. So are the SSDL and SDL2 libraries; Microsoft Core fonts for the Web, which you'll need on Unix systems; and the GIMP deluxe graphics editing package. See Chapter 1 and Appendix A for help installing these essentials.

Programming with sound may not be practical over remote connections because of the difficulty of streaming sound. If using Unix emulation, you might check the emulator's sound capabilities – say, by playing a video.

If this is for a course…

C++20 for Lazy Programmers covers through pointers, operator overloading, virtual functions, templates, exceptions, STL (Standard Template Library), and everything you might reasonably expect in two semesters of C++ – plus extras at the end.

The SSDL library does take a small amount of time, but the focus is firmly on writing good C++ programs, with SSDL there just to make the programs more enjoyable. How many labs or projects do you have in which it's hard to stop working because it's so much fun? It may not happen with *all* these problems, but I do see it happen.

SDL also gives a gentle introduction to event-driven programming.

In the first 12 chapters, there is emphasis on algorithm development and programming style, including early introduction of constants.

After Chapter 12, the examples are in standard I/O, though SSDL is still an option for a few exercises and is used in Chapter 21 and (briefly) Chapters 25 and 26.

A normal two-semester sequence should cover approximately the following:

- Semester 1: The first 12 chapters, using SSDL; Chapter 13, introducing standard I/O. With some exceptions (`&` parameters, stream I/O, `constexpr`), this looks a lot like C, and includes variables, expressions, functions, control structures, arrays, and stream I/O.
- Semester 2: Chapters 14–22, using standard I/O, covering pointers, dynamic memory, character arrays, classes, operator overloading, templates, exceptions, virtual functions, multiple inheritance (briefly), and a taste of the Standard Template Library using vectors and linked lists.

Subsequent chapters cover material that wouldn't easily fit in two semesters, including more of the Standard Template Library, C programming, and advanced topics including the use of command-line arguments, bit manipulation, format strings, lambda functions, and smart pointers.

Online help

Here are some sites to go to for more information, with URLs correct at the time of writing:

SDL: `www.libsdl.org`. Click "Wiki." You'll find a reference for SDL functions.

SDL's helper libraries `SDL_Image`, `SDL_Mixer`, and `SDL_TTF`: `www.libsdl.org/projects/SDL_image/`, `www.libsdl.org/projects/SDL_mixer/`, and `www.libsdl.org/projects/SDL_ttf/`. In each case, click Documentation. You'll find references for their functions. If the websites have changed, doing a web search for the name of the library (e.g., `SDL_Image`) should get you there.

Legal stuff

CHAPTER 1

Getting Started

Most programs in the first half of this book use the SDL and SSDL graphics-and-games libraries,[1] on the theory that watching colorful shapes move across the screen and shoot each other is more interesting than printing text. Don't worry. When you're done, you'll be able to write programs both with and without this library – and if I have anything to say about it, you'll have had fun doing it.

If you've already chosen your platform, great. If not, here's my recommendation:

- If you just want to learn C++ on an easy and easily managed platform, Microsoft Visual Studio is great.
- If you are a Unix system administrator or have good access to one, and want to use that popular and powerful platform, go for it.
- To learn g++ and make – powerful tools from the Unix world – in Windows, with a relatively easy setup, use MinGW.

The programming won't differ much between platforms. But system setup can be an issue.

Initial setup

First, you'll need the source code for the textbook. You can access the code via the Download Source Code button located at `www.apress.com/9781484263051`.

Then unzip it. In Unix, the `unzip` command should work; in Windows, you can usually double-click it or right-click and choose Extract or Extract All.

[1]SDL provides graphics, sound, and friendly interaction including mouse input. SSDL, standing for *Simple* SDL, is a "wrapper" library that wraps SDL's functions in easier-to-use versions. Both libraries are described in more detail in the introduction.

W. Briggs, *C++20 for Lazy Programmers*, https://doi.org/10.1007/978-1-4842-6306-8_1

…in Unix

Getting around in Unix isn't in the scope of this book, but no worries. The basics of copying files, moving files, and so on are easy to pick up.[2]

Unix system administration is *way* beyond the scope of this book.[3] But installing SSDL is easy. In that folder you just unzipped

- Go into `external/SSDL/unix`, and type `make`. This builds SSDL in a place where programs in the source code will know where to find it.
- Go into `ch1/test-setup`.
- `cp Makefile.unix Makefile`
- `make`
- `./runx`

You should see (and hear) the program illustrated in Figure 1-1. (If not, something must be missing – please see Appendix A.) You might take a moment to try another program from `ch1`, like `1-hello`. Run it the same way you did `test-setup`.

[2]I recommend UNIX Tutorial for Beginners, at `www.ee.surrey.ac.uk/Teaching/Unix/`. Up through Tutorial 4 should be fine for now. Or search for your own.

[3]OK, I can't just let it go at that. Appendix A has suggestions on how to install the other tools you need (g++, SDL, etc.). But distributions of Unix vary, so it'll help to know what you're doing.

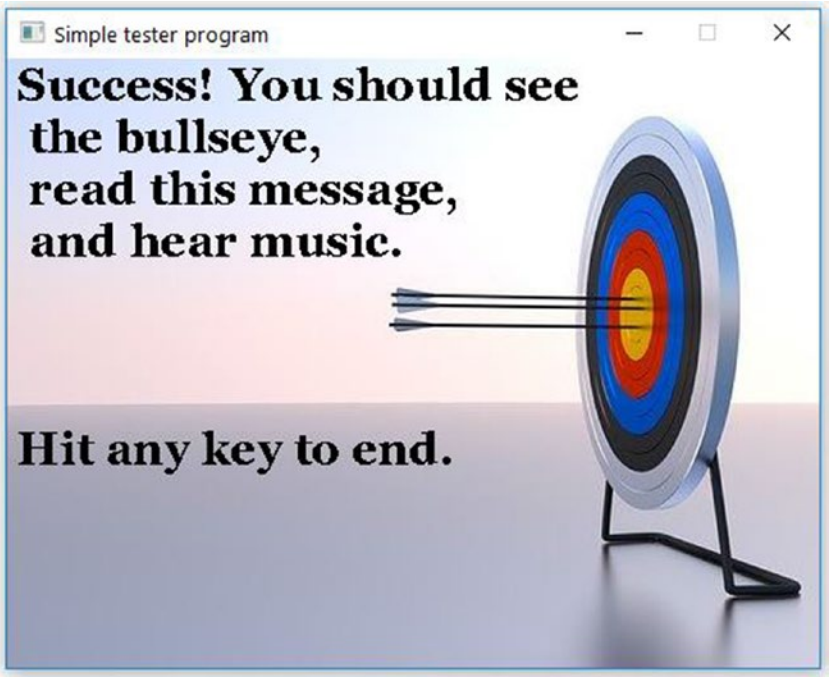


Figure 1-1. *Output of* `test-setup`

...in MinGW

You can find MinGW at sourceforge.net and other places. Try a web search on "MinGW download."

Once that's installed, have it add the basics for C++; start the MinGW Installation Manager (`mingw-get.exe`) and have it install, at least, `mingw32-gcc-g++-bin`, `mingw32-gdb-bin`, and `msys-make-bin`.

You *won't* need to install SDL or SSDL; they're in the source code you unzipped.

So let's try 'em out. Open the Windows command prompt (click the Start Menu and type `cmd`) and go to the source code's `ch1/test-setup` folder. Here's an easy way: in the window for that folder, click the folder icon left of the address bar, the part that shows something like `... > ch1 > test-setup`. It'll be replaced by a highlighted path like the one in Figure 1-2. Press Ctrl-C to copy it.

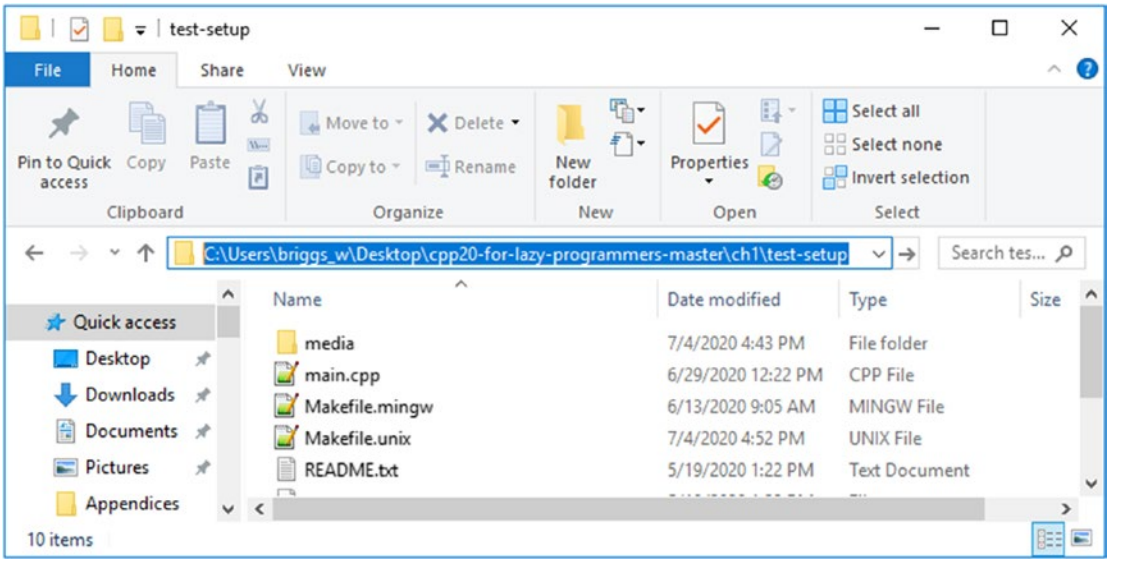


Figure 1-2. *Getting a path to use with the command prompt, in Windows*

In the command window, enter the first two characters of that path you copied (in my case, `C:`); then type `cd`, paste in the path (Ctrl-V), and press Enter again (see Figure 1-3).

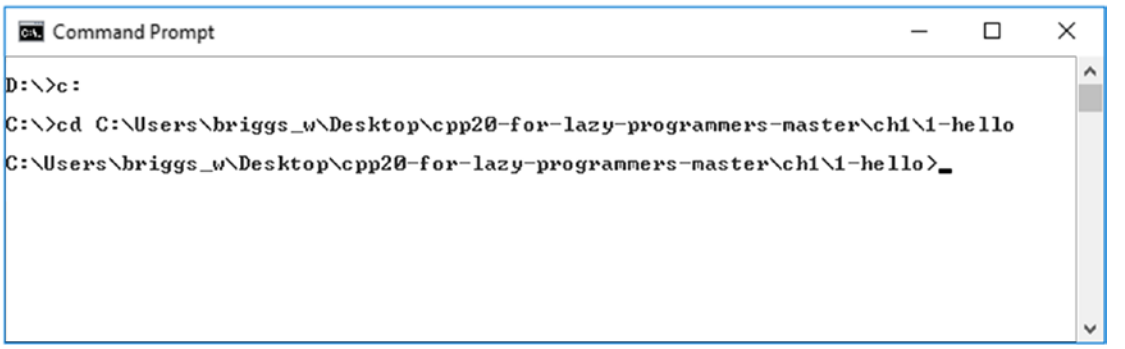


Figure 1-3. *Getting to the right folder in the command prompt*

Then

```
copy Makefile.mingW Makefile
make
bash runw
```

You should see (and hear) the program illustrated in Figure 1-1. (If not, see Appendix A.) You might take a moment to try another program from `ch1`, like `1-hello`. Run it the same way you did `test-setup`.

…in Microsoft Visual Studio

At the moment, Visual Studio is absolutely free. Go to Microsoft's download page (currently `visualstudio.microsoft.com/downloads/`) and download the Community Edition.

It'll take a long time to install. Be sure to put a check by Desktop development with C++ (Figure 1-4, upper right) – else, you'll have Visual Studio, all right, but it won't know C++.

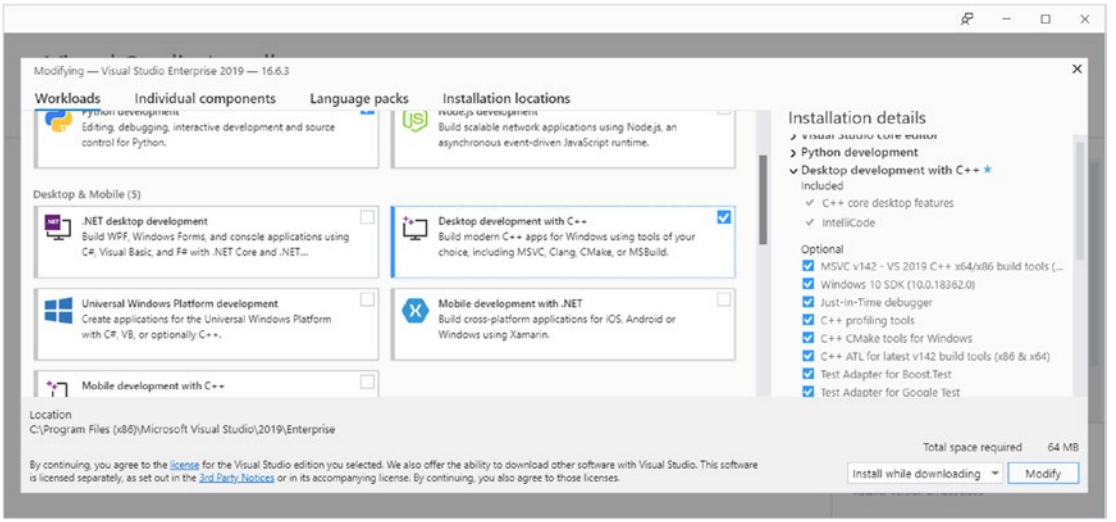
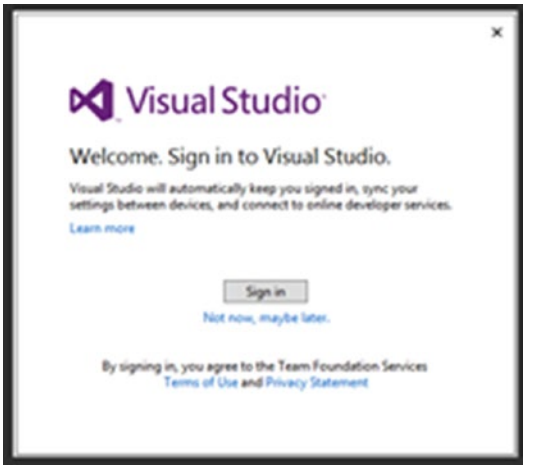


Figure 1-4. *Installing the C++ part of Visual Studio*

When it's installed, go to the book's source code folder, into the `ch1` subfolder; double-click the solution file, `ch1.sln` or `ch1`. (If it asks you to sign in and you're not ready to do that now, notice the line "Not now, maybe later.")

Now, in the Solution Explorer window (see Figure 1-5), you should see at the bottom a project named **test-setup**. Right-click it, and select Debug ➤ Start New Instance.



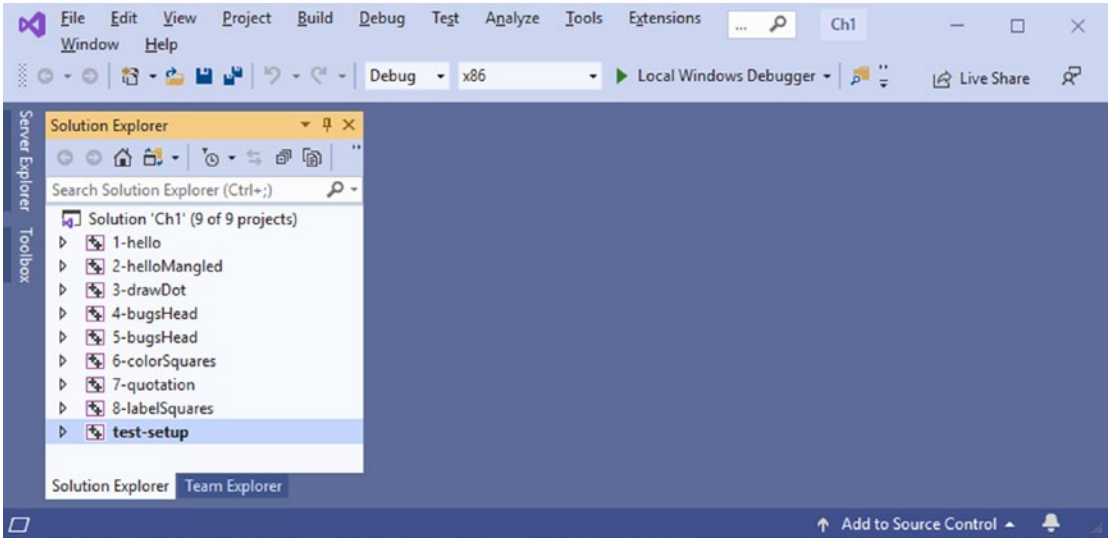


Figure 1-5. *The* `ch1` *solution in Visual Studio, with the* `test-setup` *project highlighted*

You should see and hear the program in Figure 1-1. (If not, see Appendix A.) You might take a moment to try another program from `ch1`, like `1-hello`. Run it the same way you did `test-setup`.

A simple program

It's wise to start small. Fewer things can go wrong.

So we'll begin with a simple program that writes "Hello, world!" on the screen. We'll take it line by line to see what's in it. (In the next section, we'll compile and run it. For now, sit tight.)

Example 1-1. "Hello, world!" is a classic program to start a new language with. (I think it's a law somewhere.) This program is in source code, in the `ch1` folder, as `1-hello`

```
// Hello, world! program, for _C++ for Lazy Programmers_
//   Your name goes here
//   Then the date[4]
```

[4]From here on, I'll put the title of the text, rather than name and date, because that's more useful for textbook examples. Ordinarily, name of programmer and date are better for keeping track of what was done and who to track down if it doesn't work.