some important concepts in program design and show how to use them to create C programs that are readable and maintainable.

Section 19.1 discusses how to view a C program as a collection of modules that provide services to each other. We'll then see how the concepts of information hiding (Section 19.2) and abstract data types (Section 19.3) can improve modules. By focusing on a single example (a stack data type), Section 19.4 illustrates how an abstract data type can be defined and implemented in C. Section 19.5 describes some limitations of C for defining abstract data types and shows how to work around them.

19.1 Modules

When designing a C program (or a program in any other language, for that matter), it's often useful to view it as a number of independent ***modules.*** A module is a collection of services, some of which are made available to other parts of the program (the ***clients***). Each module has an ***interface*** that describes the available services. The details of the module—including the source code for the services themselves—are stored in the module's ***implementation***.

In the context of C, "services" are functions. The interface of a module is a header file containing prototypes for the functions that will be made available to clients (source files). The implementation of a module is a source file that contains definitions of the module's functions.

To illustrate this terminology, let's look at the calculator program that was sketched in Sections 15.1 and 15.2. This program consists of the file `calc.c`, which contains the `main` function, and a stack module, which is stored in the files `stack.h` and `stack.c` (see the figure at the top of the next page). `calc.c` is a *client* of the stack module. `stack.h` is the *interface* of the stack module; it supplies everything the client needs to know about the module. `stack.c` is the *implementation* of the module; it contains definitions of the stack functions as well as declarations of the variables that make up the stack.

The C library is itself a collection of modules. Each header in the library serves as the interface to a module. `<stdio.h>`, for example, is the interface to a module containing I/O functions, while `<string.h>` is the interface to a module containing string-handling functions.

Dividing a program into modules has several advantages:

- ***Abstraction.*** If modules are properly designed, we can treat them as ***abstractions***; we know what they do, but we don't worry about the details of how they do it. Thanks to abstraction, it's not necessary to understand how the entire program works in order to make changes to one part of it. What's more, abstraction makes it easier for several members of a team to work on the same program. Once the interfaces for the modules have been agreed upon, the responsibility for implementing each module can be delegated to a partic-