

Understanding the Shell

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Now that you know a few shell basics, such as reaching the shell and rudimentary shell commands, it is time to explore the actual shell process. To understand the shell, you need to understand a few CLI basics.

A shell is not just a CLI. It is a complicated interactive running program. Entering commands and using the shell to run scripts can raise some interesting and confusing issues. Understanding the shell process and its relationships helps you resolve these issues or avoid them altogether.

This chapter takes you through learning about the shell process. You see how subshells are created and their relationship to the parent shell. The varied commands that create child processes are explored as well as built-in commands. You even read about some shell tips and tricks to try.

Exploring Shell Types

The shell program that the system starts depends on your user ID configuration. In the `/etc/passwd` file, the user ID has its default shell program listed in field #7 of its record. The default shell program is started whenever the user logs into a virtual console terminal or starts a terminal emulator in the GUI.

In the following example, user `christine` has the GNU bash shell as her default shell program:

```
$ cat /etc/passwd
[...]
Christine:x:501:501:Christine B:/home/Christine:/bin/bash
$
```

The bash shell program resides in the `/bin` directory. A long listing reveals `/bin/bash` (the bash shell) is an executable program:

```
$ ls -lF /bin/bash
-rwxr-xr-x. 1 root root 938832 Jul 18  2013 /bin/bash*
$
```

Several other shell programs are on this particular CentOS distribution. They include `tcsh`, which is based off the original C shell:

```
$ ls -lF /bin/tcsh
-rwxr-xr-x. 1 root root 387328 Feb 21  2013 /bin/tcsh*
$
```

Also, the Debian based version of the ash shell, `dash`, is included:

```
$ ls -lF /bin/dash
-rwxr-xr-x. 1 root root 109672 Oct 17  2012 /bin/dash*
$
```

Finally, a soft link (see Chapter 3) of the C shell points to the `tcsh` shell:

```
$ ls -lF /bin/csh
lrwxrwxrwx. 1 root root 4 Mar 18 15:16 /bin/csh -> tcsh*
$
```

Each of these different shell programs could be set as a user's default shell. However, due to the bash shell's popularity, it's rare to use any other shell as a default shell.

NOTE

A brief description of various shells was included in Chapter 1. You may be interested in learning even more about shells other than the GNU bash shell. Additional alternative shell information is in Chapter 23.

The *default interactive shell* starts whenever a user logs into a virtual console terminal or starts a terminal emulator in the GUI. However, another default shell, `/bin/sh`, is the *default system shell*. The default system shell is used for system shell scripts, such as those needed at startup.

Often, you see a distribution with its default system shell set to the bash shell using a soft link as shown here on this CentOS distribution:

```
$ ls -l /bin/sh
lrwxrwxrwx. 1 root root 4 Mar 18 15:05 /bin/sh -> bash
$
```

However, be aware that on some distributions, the default system shell is different than the default interactive shell, such as on this Ubuntu distribution:

```
$ cat /etc/passwd
[...]
christine:x:1000:1000:Christine,,,:/home/christine:/bin/bash
$
$ ls -l /bin/sh
lrwxrwxrwx 1 root root 4 Apr 22 12:33 /bin/sh -> dash
$
```

Note that the user, *christine*, has her default interactive shell set to */bin/bash*, the bash shell. But the default system shell, */bin/sh*, is set to the dash shell.

Tip

For bash shell scripts, these two different shells, default interactive shell and default system shell, can cause problems. Be sure to read about the important syntax needed for a bash shell script's first line in Chapter 11 to avoid these issues.

You are not forced to stick with your default interactive shell. You can start any shell available on your distribution, simply by typing its filename. For example, to start the dash shell, you can run it directly by typing the command ***/bin/dash***:

```
$ /bin/dash
$
```

It doesn't look like anything happened, but the dash shell program started. The *\$* prompt is a CLI prompt for the dash shell. You can leave the dash shell program by typing the command ***exit***:

```
$ exit
exit
$
```

Again, it looks like nothing happened. However, the dash shell program was exited. To understand this process, the next section explores the relationship between a login shell program and a newly started shell program.

Exploring Parent and Child Shell Relationships

The default interactive shell started when a user logs into a virtual console terminal or starts a terminal emulator in the GUI is a *parent shell*. As you have read so far in this book, a parent shell process provides a CLI prompt and waits for commands to be entered.

When the */bin/bash* command or the equivalent *bash* command is entered at the CLI prompt, a new shell program is created. This is a *child shell*. A child shell also has a CLI prompt and waits for commands to be entered.

Because you do not see any relevant messages when you type **bash** and spawn a child shell, another command can help bring clarity. The **ps** command was covered in Chapter 4. Using this with the **-f** option before and after entering a child shell is useful:

```
$ ps -f
UID          PID    PPID  C STIME TTY          TIME CMD
501          1841    1840  0 11:50 pts/0        00:00:00 -bash
501          2429    1841  4 13:44 pts/0        00:00:00 ps -f
$
$ bash
$
$ ps -f
UID          PID    PPID  C STIME TTY          TIME CMD
501          1841    1840  0 11:50 pts/0        00:00:00 -bash
501          2430    1841  0 13:44 pts/0        00:00:00 bash
501          2444    2430  1 13:44 pts/0        00:00:00 ps -f
$
```

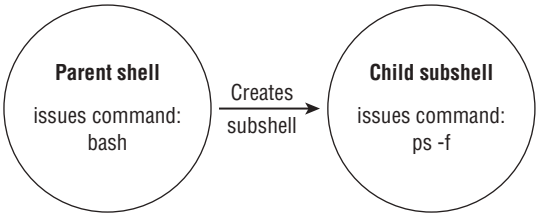
The first use of **ps -f** shows two processes. One process has a process ID of 1841 (second column) and is running the bash shell program (last column). The second process (process ID 2429) is the actual **ps -f** command running.

NOTE

A *process* is a running program. The bash shell is a program, and when it runs, it is a process. A running shell is simply one type of process. Therefore, when reading about running a bash shell, you often see the word “shell” and the word “process” used interchangeably.

After the command **bash** is entered, a child shell is created. The second **ps -f** is executed from within the child shell. From this display, you can see that *two* bash shell programs are running. The first bash shell program, the parent shell process, has the original process ID (PID) of 1841. The second bash shell program, the child shell process, has a PID of 2430. Note that the child shell has a parent process ID (PPID) of 1841, denoting that the parent shell process is its parent. Figure 5-1 diagrams this relationship.

FIGURE 5-1
Parent and child bash shell processes



When a child shell process is spawned, only some of the parent's environment is copied to the child shell environment. This can cause problems with items such as variables, and it is covered in Chapter 6.

A child shell is also called a *subshell*. A subshell can be created from a parent shell, and a subshell can be created from another subshell:

```
$ ps -f
UID          PID  PPID  C STIME TTY          TIME CMD
501          1841   1840  0 11:50 pts/0        00:00:00 -bash
501          2532   1841  1 14:22 pts/0        00:00:00 ps -f
$
$ bash
$
$ bash
$
$ bash
$
$ ps --forest
  PID TTY          TIME CMD
 1841 pts/0        00:00:00 bash
 2533 pts/0        00:00:00 \_ bash
 2546 pts/0        00:00:00 \_ bash
 2562 pts/0        00:00:00 \_ bash
 2576 pts/0        00:00:00 \_ ps
$
```

In the preceding example, the `bash` shell command was entered three times. Effectively, this created three subshells. The `ps --forest` command shows the nesting of these subshells. Figure 5-2 also shows this subshell nesting.

The `ps -f` command can be useful in subshell nesting, because it displays who is whose parent via the PPID column:

```
$ ps -f
UID          PID  PPID  C STIME TTY          TIME CMD
501          1841   1840  0 11:50 pts/0        00:00:00 -bash
501          2533   1841  0 14:22 pts/0        00:00:00 bash
501          2546   2533  0 14:22 pts/0        00:00:00 bash
501          2562   2546  0 14:24 pts/0        00:00:00 bash
501          2585   2562  1 14:29 pts/0        00:00:00 ps -f
$
```

The `bash` shell program can use command line parameters to modify the shell start. Table 5-1 lists the command line parameters available in `bash`.

FIGURE 5-2

Subshell nesting

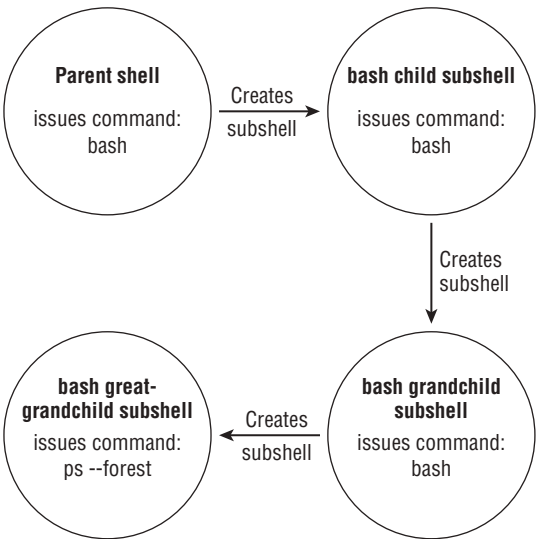


TABLE 5-1 The bash Command Line Parameters

Parameter	Description
-c string	Reads commands from string and processes them
-i	Starts an interactive shell, allowing input from the user
-l	Acts as if invoked as a login shell
-r	Starts a restricted shell, limiting the user to the default directory
-s	Reads commands from the standard input

You can find more help on the `bash` command and even more command line parameters by typing `man bash`. The `bash --help` command provides additional assistance as well.

You can gracefully exit out of each subshell by entering the `exit` command:

```
$ exit
exit
$
$ ps --forest
  PID TTY          TIME CMD
 1841 pts/0    00:00:00 bash
```

```

2533 pts/0    00:00:00  \_  bash
2546 pts/0    00:00:00  \_  bash
2602 pts/0    00:00:00  \_  ps
$
$ exit
exit
$
$ exit
exit
$
$ ps --forest
  PID  TTY          TIME CMD
 1841 pts/0    00:00:00  bash
 2604 pts/0    00:00:00  \_  ps
$

```

Not only does the `exit` command allow you to leave child subshells, but you can also log out of your current virtual console terminal or terminal emulation software as well. Just type **exit** in the parent shell, and you gracefully exit the CLI.

Another time a subshell can be created is when you run a shell script. You learn more about that topic in Chapter 11.

Also, you can spawn subshells without using the `bash` shell command or running a shell script. One way is by using a process list.

Looking at process lists

On a single line, you can designate a list of commands to be run one after another. This is done by entering a command list using a semicolon (;) between commands:

```

$ pwd ; ls ; cd /etc ; pwd ; cd ; pwd ; ls
/home/Christine
Desktop  Downloads  Music      Public     Videos
Documents  junk.dat  Pictures   Templates
/etc
/home/Christine
Desktop  Downloads  Music      Public     Videos
Documents  junk.dat  Pictures   Templates
$

```

In the preceding example, the commands all executed one after another with no problems. However, this is not a process list. For a command list to be considered a process list, the commands must be encased in parentheses:

```
$ (pwd ; ls ; cd /etc ; pwd ; cd ; pwd ; ls)
/home/Christine
Desktop    Downloads Music      Public     Videos
Documents  junk.dat  Pictures  Templates
/etc
/home/Christine
Desktop    Downloads Music      Public     Videos
Documents  junk.dat  Pictures  Templates
$
```

Though the parentheses addition may not appear to be a big difference, they do cause a very different effect. Adding parentheses and turning the command list into a process list created a subshell to execute the commands.

NOTE

A process list is a *command grouping* type. Another command grouping type puts the commands between curly brackets and ends the command list with a semicolon (;). The syntax is as follows: { *command*; }. Using curly brackets for command grouping does not create a subshell as a process list does.

To indicate if a subshell was spawned, a command using an environment variable is needed here. (Environment variables are covered in detail in Chapter 6). The command needed is `echo $BASH_SUBSHELL`. If it returns a 0, then there is no subshell. If it returns 1 or more, then there is a subshell.

First, the example using just a command list is executed with the `echo $BASH_SUBSHELL` tacked onto the end:

```
$ pwd ; ls ; cd /etc ; pwd ; cd ; pwd ; ls ; echo $BASH_SUBSHELL
/home/Christine
Desktop    Downloads Music      Public     Videos
Documents  junk.dat  Pictures  Templates
/etc
/home/Christine
Desktop    Downloads Music      Public     Videos
Documents  junk.dat  Pictures  Templates
0
```

At the very end of the commands' output, you can see the number zero (0) is displayed. This indicates a subshell was not created to execute these commands.

The results are different using a process list. The list is executed with `echo $BASH_SUBSHELL` tacked onto the end:

```
$ (pwd ; ls ; cd /etc ; pwd ; cd ; pwd ; ls ; echo $BASH_SUBSHELL)
/home/Christine
Desktop    Downloads Music      Public     Videos
Documents  junk.dat  Pictures  Templates
/etc
```



```

/home/Christine
Desktop    Downloads Music      Public    Videos
Documents  junk.dat  Pictures  Templates
1

```

In this case, the number one (1) displayed at the output's end. This indicates a subshell was indeed created and used for executing these commands.

Thus, a *process list* is a command grouping enclosed with parentheses, which creates a subshell to execute the command(s). You can even create a grandchild subshell by embedding parentheses within a process list:

```

$ ( pwd ; echo $BASH_SUBSHELL)
/home/Christine
1
$ ( pwd ; (echo $BASH_SUBSHELL))
/home/Christine
2

```

Notice in the first process list, the number one (1) is displayed indicating a child subshell as you would expect. However in the example's second process list, additional parentheses were added around the `echo $BASH_SUBSHELL` command. These additional parentheses caused a grandchild subshell to be created for the command's execution. Thus, a number two (2) was displayed indicating a subshell within a subshell.

Subshells are often used for multi-processing in shell scripts. However, entering into a subshell is an expensive method and can significantly slow down processing. Subshell issues exist also for an interactive CLI shell session. It is not truly multi-processing, because the terminal gets tied up with the subshell's I/O.

Creatively using subshells

At the interactive shell CLI, you have more productive ways to use subshells. Process lists, co-processes, and pipes (covered in Chapter 11) use subshells. They all can be used effectively within the interactive shell.

One productive subshell method in the interactive shell uses background mode. Before discussing how to use background mode and subshells together, you need to understand background mode itself.

Investigating background mode

Running a command in background mode allows the command to be processed and frees up your CLI for other use. A classic command to demonstrate background mode is the `sleep` command.

The `sleep` command accepts as a parameter the number of seconds you want the process to wait (sleep). This command is often used to introduce pauses in shell scripts. The command `sleep 10` causes the session to pause for 10 seconds and then return a shell CLI prompt:

```
$ sleep 10
$
```

To put a command into background mode, the `&` character is tacked onto its end. Putting the `sleep` command into background mode allows a little investigation with the `ps` command:

```
$ sleep 3000&
[1] 2396
$ ps -f
  UID          PID  PPID  C  STIME TTY          TIME CMD
christi+  2338    2337  0  10:13 pts/9        00:00:00 -bash
christi+  2396    2338  0  10:17 pts/9        00:00:00 sleep 3000
christi+  2397    2338  0  10:17 pts/9        00:00:00 ps -f
$
```

The `sleep` command was told to sleep for 3000 seconds (50 minutes) in the background (`&`). When it was put into the background, two informational items were displayed before the shell CLI prompt was returned. The first informational item is the background job's number (1) displayed in brackets. The second item is the background job's process ID (2396).

The `ps` command was used to display the various processes. Notice that the `sleep 3000` command is listed. Also note that its process ID (PID) in the second column is the same PID displayed when the command went into the background, 2396.

In addition to the `ps` command, you can use the `jobs` command to display background job information. The `jobs` command displays any user's processes (jobs) currently running in background mode:

```
$ jobs
[1]+  Running                  sleep 3000 &
$
```

The `jobs` command shows the job number (1) in brackets. It also displays the job's current status (running) as well as the command itself, (`sleep 3000 &`).

You can see even more information by using the `-l` (lowercase L) parameter on the `jobs` command. The `-l` parameter displays the command's PID in addition to the other information:

```
$ jobs -l
[1]+  2396 Running                  sleep 3000 &
$
```

When the background job is finished, its completion status is displayed:

```
[1]+  Done                  sleep 3000 &
$
```

Tip

Be aware that a background job's completion status won't necessarily wait till a convenient time to display itself. Don't let it surprise you when a job's completion status just suddenly appears on your screen.

Background mode is very handy. And it provides a method for creating useful subshells at the CLI.

Putting process lists into the background

As stated earlier, a process list is a command or series of commands executed within a subshell. Using a process list including `sleep` commands and displaying the `BASH_SUBSHELL` variable operates as you would expect:

```
$ (sleep 2 ; echo $BASH_SUBSHELL ; sleep 2)
1
$
```

In the preceding example, a two-second pause occurs, the number one (1) is displayed indicating a single subshell level (child subshell), and then another two-second pause occurs before the prompt returns. Nothing too dramatic here.

Putting the same process list into background mode can cause a slightly different effect with command output:

```
$ (sleep 2 ; echo $BASH_SUBSHELL ; sleep 2)&
[2] 2401
$ 1

[2]+  Done                  ( sleep 2; echo $BASH_SUBSHELL; sleep 2 )
$
```

Putting the process list into the background causes a job number and process ID to appear, and the prompt returns. However, the odd event is that the displayed number one (1), indicating a single-level subshell, is displayed by the prompt! Don't let this confuse you. Simply press the Enter key, and you get another prompt back.

Using a process list in background mode is one creative method for using subshells at the CLI. You can do large amounts of processing within a subshell and not have your terminal tied up with the subshell's I/O.

Of course, the process list of `sleep` and `echo` commands are just for example purposes. Creating backup files with `tar` (see Chapter 4) is a more practical example of using background process lists effectively:

```
$ (tar -cf Rich.tar /home/rich ; tar -cf My.tar /home/christine)&
[3] 2423
$
```

Putting a process list in background mode is not the only way to use subshells creatively at the CLI. Co-processing is another method.

Looking at co-processing

Co-processing does two things at the same time. It spawns a subshell in background mode and executes a command within that subshell.

To perform co-processing, the `coproc` command is used along with the command to be executed in the subshell:

```
$ coproc sleep 10
[1] 2544
$
```

Co-processing performs almost identically to putting a command in background mode, except for the fact that it creates a subshell. You'll notice that when the `coproc` command and its parameters were entered, a background job was started. The background job number (1) and process ID (2544) were displayed on the screen.

The `jobs` command allows you to display the co-processing status:

```
$ jobs
[1]+  Running                  coproc COPROC sleep 10 &
$
```

From the preceding example, you can see the background command executing in the subshell is `coproc COPROC sleep 10`. The `COPROC` is a name given to the process by the `coproc` command. You can set the name yourself by using extended syntax for the command:

```
$ coproc My_Job { sleep 10; }
[1] 2570
$
$ jobs
[1]+  Running                  coproc My_Job { sleep 10; } &
$
```

By using the extended syntax, the co-processing name was set to `My_Job`. Be careful here, because the extended syntax is a little tricky. You have to make sure that a space appears after the first curly bracket (`{}`) and before the start of your command. Also, you have to

make sure the command ends with a semicolon (;). And you have to ensure that a space appears after the semicolon and before the closing curly bracket (}).

NOTE

Co-processing allows you to get very fancy and send/receive information to the process running in the subshell. The only time you need to name a co-process is when you have multiple co-processes running, and you need to communicate with them all. Otherwise, just let the `coproc` command set the name to the default, `COPROC`.

You can be really clever and combine co-processing with process lists creating nested subshells. Just type your process list and put the command `coproc` in front of it:

```
$ coproc ( sleep 10; sleep 2 )
[1] 2574
$
$ jobs
[1]+  Running      coproc COPROC ( sleep 10; sleep 2 ) &
$
$ ps --forest
  PID TTY          TIME CMD
 2483 pts/12    00:00:00 bash
 2574 pts/12    00:00:00 \_  bash
 2575 pts/12    00:00:00 |   \_  sleep
 2576 pts/12    00:00:00 \_  ps
$
```

Just remember that spawning a subshell can be expensive and slow. Creating nested subshells is even more so!

Using subshells can provide flexibility at the command line as well as convenience. Understanding their behavior is important to obtaining this flexibility and convenience. Command behavior is also important to understand. In the next section, the behavior differences between built-in and external commands are explored.

Understanding Shell Built-In Commands

While learning about the GNU bash shell, you likely have heard the term built-in command. It is important to understand both shell built-in and non-built-in (external) commands. Built-in commands and non-built-in commands operate very differently.

Looking at external commands

An *external command*, sometimes called a filesystem command, is a program that exists outside of the bash shell. They are not built into the shell program. An external command program is typically located in `/bin`, `/usr/bin`, `/sbin`, or `/usr/sbin`.

The `ps` command is an external command. You can find its filename by using both the `which` and the `type` commands:

```
$ which ps
/bin/ps
$
$ type -a ps
ps is /bin/ps
$
$ ls -l /bin/ps
-rwxr-xr-x 1 root root 93232 Jan  6 18:32 /bin/ps
$
```

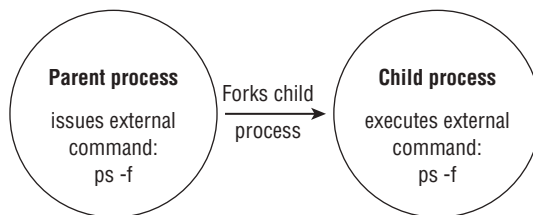
Whenever an external command is executed, a child process is created. This action is termed *forking*. Conveniently, the external command `ps` displays its current parent as well as its own forked child processes:

```
$ ps -f
UID          PID  PPID  C STIME TTY          TIME CMD
christi+    2743   2742  0 17:09 pts/9        00:00:00 -bash
christi+    2801   2743  0 17:16 pts/9        00:00:00 ps -f
$
```

Because it is an external command, when the `ps` command executes, a child process is created. In this case, the `ps` command's PID is 2801 and the parent PID is 2743. The bash shell process, which is the parent, has a PID of 2743. Figure 5-3 illustrates the forking that occurs when an external command is executed.

FIGURE 5-3

External command forking



Whenever a process must fork, it takes time and effort to set up the new child process's environment. Thus, external commands can be a little expensive.

NOTE

If you fork a child process or create a subshell, you can still communicate with it via signaling, which is extremely helpful in both the command line and in writing shell scripts. *Signaling* allows process communication via signals. Signals and signaling are covered in Chapter 16.

When using a built-in command, no forking is required. Therefore, built-in commands are less expensive.

Looking at built-in commands

Built-in commands are different in that they do not need a child process to execute. They were compiled into the shell and thus are part of the shell's toolkit. No external program file exists to run them.

Both the `cd` and `exit` commands are built into the bash shell. You can tell a command is built-in by using the `type` command:

```
$ type cd
cd is a shell builtin
$
$ type exit
exit is a shell builtin
$
```

Because they do not need to fork a child process to execute or open a program file, built-in commands are faster and more efficient. A list of GNU bash shell built-in commands is provided in Appendix A.

Be aware that some commands have multiple flavors. For example, both `echo` and `pwd` have a built-in command flavor as well as an external command flavor. These flavors are slightly different. To see multiple flavors for commands, use the `-a` option on the `type` command:

```
$ type -a echo
echo is a shell builtin
echo is /bin/echo
$
$ which echo
/bin/echo
$
$ type -a pwd
pwd is a shell builtin
pwd is /bin/pwd
```

```
$  
$ which pwd  
/bin/pwd  
$
```

Using the `type -a` command shows both types for each of the two commands. Note that the `which` command shows only the external command file.

TIP

To use the external command for a command that has multiple flavors, directly reference the file. For example, to use the `pwd` external command, type `/bin/pwd`.

Using the history command

A useful built-in command is the `history` command. The bash shell keeps track of the commands you have used. You can recall these commands and even reuse them.

To see a recently used commands list, just type the `history` command with no options:

```
$ history  
 1 ps -f  
 2 pwd  
 3 ls  
 4 coproc ( sleep 10; sleep 2 )  
 5 jobs  
 6 ps --forest  
 7 ls  
 8 ps -f  
 9 pwd  
10 ls -l /bin/ps  
11 history  
12 cd /etc  
13 pwd  
14 ls  
15 cd  
16 type pwd  
17 which pwd  
18 type echo  
19 which echo  
20 type -a pwd  
21 type -a echo  
22 pwd  
23 history
```

In this example, only the last 23 commands are shown. Typically, the last 1,000 commands are kept in history. That is lots of commands!

Tip

You can set the number of commands to keep in the bash history. To do so, you need to modify an environment variable called `HISTSIZE` (see Chapter 6).

You can recall and reuse the last command in your history list. This can save time and typing. To recall and reuse your last command, type `!!` and press the Enter key:

```
$ ps --forest
  PID TTY          TIME CMD
 2089 pts/0    00:00:00 bash
 2744 pts/0    00:00:00  \_ ps
$
$ !!
ps --forest
  PID TTY          TIME CMD
 2089 pts/0    00:00:00 bash
 2745 pts/0    00:00:00  \_ ps
$
```

When `!!` was entered, the bash shell first displayed the command it was recalling from the shell's history. After the command was displayed, it was executed.

Command history is kept in the hidden `.bash_history` file, which is located in the user's home directory. Be careful here. The bash command history is stored in memory and then written out into the history file when the shell is exited:

```
$ history
[...]
```

25	ps --forest
26	history
27	ps --forest
28	history

```
$
$ cat .bash_history
pwd
ls
history
exit
$
```

Notice when the `history` command is run, 28 commands are listed. In the example, the listing is snipped for brevity. However, when the `.bash_history` file is displayed, only four commands are listed, and they don't match the `history` command's list.

You can force the command history to be written to the `.bash_history` file before leaving a shell session. In order to force this write, use the `-a` option on the `history` command:

```
$ history -a
$
$ history
[...]
```

25	ps --forest
26	history
27	ps --forest
28	history
29	ls -a
30	cat .bash_history
31	history -a
32	history

```
$
$ cat .bash_history
[...]
```

ps --forest
history
ps --forest
history
ls -a
cat .bash_history
history -a

This time both listings need to be snipped because they are so long. Notice that contents from both the `history` command and the `.bash_history` file match, except for the very last command listed for the `history` command, because it came after the `history -a` command was issued.

NOTE

If you have multiple terminal sessions open, you can still append the `.bash_history` in each open session using the `history -a` command. However, the histories are not automatically updated for your other open terminal sessions. This is because the `.bash_history` file is read only when a terminal session is first started. To force the `.bash_history` file to be reread and a terminal session's history to be updated, use the `history -n` command.

You can recall any command from the history list. Just enter an exclamation point and the command's number from the history list:

```
$ history
[...]
```

13	pwd
14	ls
15	cd

```

16  type pwd
17  which pwd
18  type echo
19  which echo
20  type -a pwd
21  type -a echo
[...]
```

```

32  history -a
33  history
34  cat .bash_history
35  history

$
$ !20
type -a pwd
pwd is a shell builtin
pwd is /bin/pwd
$
```

Command number 20 was pulled from command history. Notice that similar to executing the last command in history, the bash shell first displays the command it is recalling from the shell's history. After the command is displayed, it is executed.

Using bash shell command history can be a great timesaver. You can do even more with the built-in `history` command. Be sure to view the bash manual pages for `history`, by typing **man history**.

Using command aliases

The `alias` command is another shell built-in command. A *command alias* allows you to create an alias name for common commands (along with their parameters) to help keep your typing to a minimum.

Most likely, your Linux distribution has already set some common command aliases for you. To see a list of the active aliases, use the `alias` command with the `-p` parameter:

```

$ alias -p
[...]
```

```

alias egrep='egrep --color=auto'
alias fgrep='fgrep --color=auto'
alias grep='grep --color=auto'
alias l='ls -CF'
alias la='ls -A'
alias ll='ls -aF'
alias ls='ls --color=auto'
$
```

Notice that, on this Ubuntu Linux distribution, an alias is used to override the standard `ls` command. It automatically provides the `--color` parameter, indicating that the terminal supports color mode listings.

You can create your own aliases using the `alias` command:

```
$ alias li='ls -li'
$
$ li
total 36
529581 drwxr-xr-x. 2 Christine Christine 4096 May 19 18:17 Desktop
529585 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Documents
529582 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Downloads
529586 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Music
529587 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Pictures
529584 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Public
529583 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Templates
532891 -rwxrw-r--. 1 Christine Christine   36 May 30 07:21 test.sh
529588 drwxr-xr-x. 2 Christine Christine 4096 Apr 25 16:59 Videos
$
```

After you define an alias value, you can use it at any time in your shell, including in shell scripts. Be aware that because command aliases are built-in commands, an alias is valid only for the shell process in which it is defined:

```
$ alias li='ls -li'
$
$ bash
$
$ li
bash: li: command not found
$
$ exit
exit
$
```

Fortunately, you can make an alias value permanent across subshells. The next chapter covers how to do that, along with environment variables.

Summary

This chapter discussed the complicated interactive program, the GNU bash shell. It covered understanding the shell process and its relationships, including how subshells are spawned and their relationship to the parent shell. We also explored commands that create child processes and commands that don't.

The default interactive shell is normally started whenever a user logs in to a terminal. The shell that the system starts depends upon a user ID configuration. Typically, it is `/bin/bash`. The default system shell, `/bin/sh`, is used for system shell scripts, such as those needed at startup.

A subshell or child shell can be spawned using the `bash` command. They are also created when a process list or the `coproc` command is used. Using subshells at the command line can allow for creative and productive use of the CLI. Subshells can be nested, spawning grandchild shells and great-grandchild shells. Creating a subshell is an expensive process as a new environment for the shell must be created as well.

Finally, the chapter looked at two different types of shell commands: built-in and external commands. External commands create a child process with a new environment, but a built-in command does not. This causes external commands to be more expensive to use. Because a new environment is not needed, built-in commands are more efficient and not affected by any environment changes.

Shells, subshells, processes, and forked processes are all affected by environment variables. How the variables affect and can be used within these different contexts are explored in the next chapter.