Sun Microsystems
Solaris UNIX

Student User Manual

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I. **Introduction**

This manual is primarily written for the beginning students in CS240 who are unfamiliar with the UNIX operating system. The main objective is to enable students to enter, compile, execute, and print their C/C++ software projects in the UNIX environment as quickly as possible. To this end, the same two simple programs used in our MS Visual C/C++ 6.0 manual -- the *Hello World* single-file program and the *Time* multiple-file project -- are used here for demonstration. A subset of frequently used UNIX commands and utilities especially those that are used for file management is also introduced. Because of its relative ease of use, the menu-driven *pico* editor is used for the demonstration instead of the more popular *vi* and *emacs* editors used in the industry. The *vi* and/or *emacs* can be learned quickly as soon as students become acquainted with the UNIX environment.

In order to access our powerful UNIX from a remote location such as from your home, it is strongly recommended that the users download and install *WS_FTP LE* and *puTTy*. *WS_FTP LE* is a file transfer utility that facilitates the file transfer between a home PC and the Department's UNIX server; *puTTy* is a Telnet program that facilitates remote access to our UNIX server from a home PC. Both *WS_FTP LE* and *puTTy* are shareware that can be downloaded from the Internet free of charge for educators and students. We first provide the downloading and installation procedure of these two software packages. We then demonstrate in detailed steps how a single-file and then a multiple-file program are entered, compiled and executed in the Solaris UNIX environment.

Note: Although the default settings for PuTTy display white text on a black background, in this document we use black text on a white background in order to save ink.

II. Downloading and Installation of *WS_FTP LE* and *puTTy*

1. Downloading the *putty* software: you may first use the google search engine to look for a putty download site by entering *putty* as the search word. Google displays the sites where a free download is available. For example, the following is the first among many sites.

   PuTTY: a free telnet/ssh client
   Open source SSH client with remote file copying support. [Win32 (Intel and Alpha)]
   www.chiark.greenend.org.uk/~sgtatham/**putty**/ - 5k - Cached - Similar pages

   Click on the hyperlink to go to the site and follow screen instructions to download the *putty.exe* software. Note that you may want to first create a folder to store the *putty* software or directly store it in the root directory of any drive of your choice. To install *putty*, simply double click the *putty.exe* file you have just downloaded. If the installation is successful, the *putty* icon shown below should appear on the desktop (if not, just copy it to the desktop from the Windows program menu). Double clicking on the *putty* icon initiates a remote login session to our Solaris UNIX server where one can gain full access to services provided by the UNIX system as will be discussed later in this user manual.

   The putty icon: Putty.exe

2. Downloading the *WS_FTP LE* software: Note that only the *LE* version, which stands for the "limited edition" version of the software is available free of charge for educators and students. Go to the google site and type in the search phrase *WS_FTP LE*, google displays sites where the software can be downloaded. For example, the following is the one possible site among many others.

   WS_FTP LE - Reviews and free downloads at Download.com
   WS_FTP LE - Transfer files over the Internet. - Review and free download at Download.com.
   www.download.com/3000-2160-1572132.html - 22k - Feb 2, 2006 - Cached - Similar pages

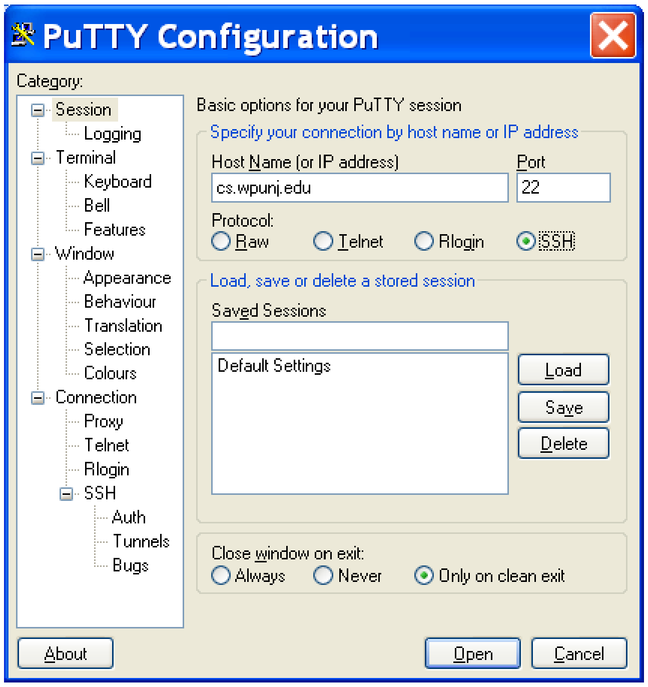
   Go to the site and then follow screen instructions to download the appropriate version of the *WS_FTP LE* software that is compatible with your operating system (e.g., Windows 2000, or XP, etc.). Note that you may be required to prove your student status by completing a questionnaire before the download can proceed. Again, the downloaded file may be stored in a pre-created a folder or simply in the root directory of a drive of your choice. To install *WS_FTP LE*, simply double click the downloaded file. If the installation is successful, the system displays the *WS_FTP* icon on the desktop (if not, just copy it from the Windows program menu) as shown below. To launch an FTP session, simply double click on the icon. The detailed operations of FTP will be discussed later in the manual.

   The WS_FTP LE icon: WS_FTP95 LE.hk

III. **Using *PuTTy***

The following demonstration shows the steps needed to connect a remote computer such as your home PC to the Solaris UNIX server maintained by the Department of Computer Science, William Paterson University.

1. Launching the PuTTY telnet software: Click on the *putty.exe* icon (assuming the putty.exe icon is displayed the desktop). The "puTTY Configuration" dialog box appears:



Basic options for your PuTTY session

Specify your connection by host name or IP address

Host Name (or IP address): cs.wpunj.edu

Port: 22

Protocol: Raw Telnet Rlogin [✓ SSH]

Load, save or delete a stored session

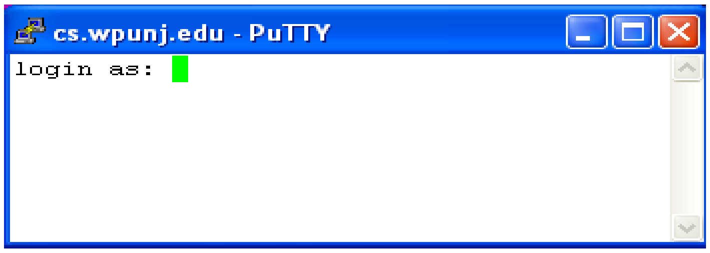
Saved Sessions

Default Settings

Close window on exit: Always Never [✓ Only on clean exit]

Figure 1 – PuTTY Configuration Window

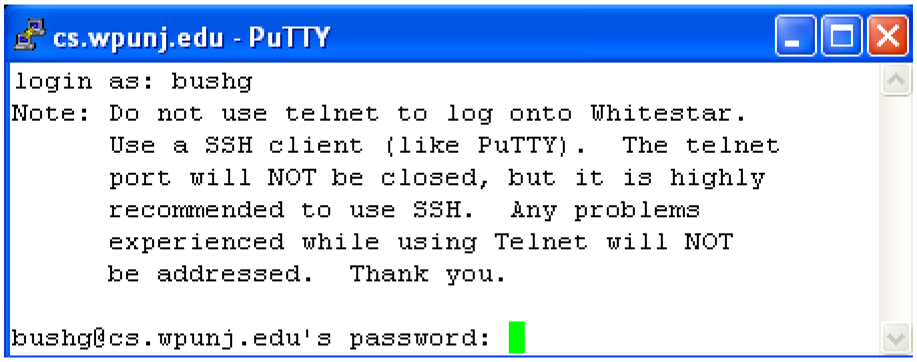
2. Entering the telnet connection information: Enter ***cs.wpunj.edu*** (the IP address of our UNIX server in the Coach House) in the "Host Name" box, then select ***SSH*** protocol as shown. Click on the ***open*** command button, the "cs.wpunj.edu – putty" login screen appears as shown below, you are now connected to the UNIX server and it prompts you to enter your *username*. Before you proceed to login, you may exercise the option of configuring the putty session (e.g., change background and text color, etc.) by clicking the PuTTY icon at the upper left corner and clicking on change settings. In the PuTTY configuration window click on Colors.



```
login as:
```

Figure 2 – The UNIX login screen.

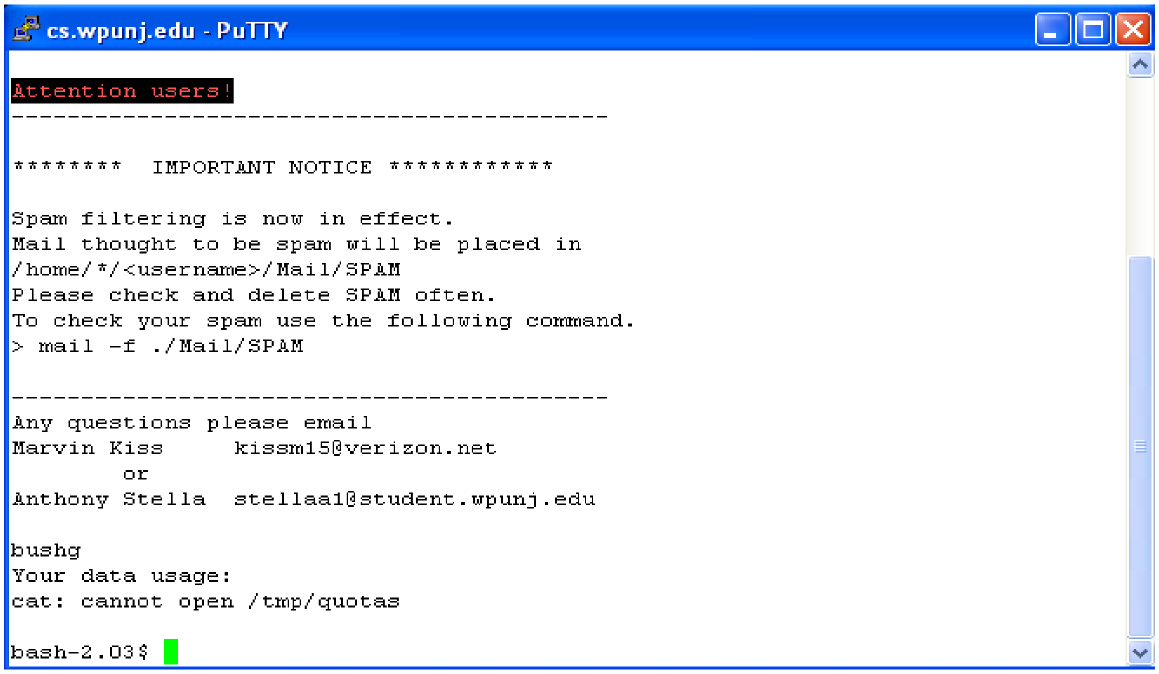
3. Entering the UNIX login information of the user: Enter your ***username*** where *bushg* is entered as shown in Figure – 3; your ***username*** is provided by your instructor; it usually consists of your last name plus the first character of your first name. If your last name contains 8 or more characters, then your ***username*** is the first 8 characters of your last name. Since UNIX is case-sensitive, all letters in the ***username*** must be entered in lower-case.



```
login as: bushg
Note: Do not use telnet to log onto Whitestar.
      Use a SSH client (like PuTTY).  The telnet
      port will NOT be closed, but it is highly
      recommended to use SSH.  Any problems
      experienced while using Telnet will NOT
      be addressed.  Thank you.

bushg@cs.wpunj.edu's password:
```

Figure – 3 UNIX login screen where username and password are entered.

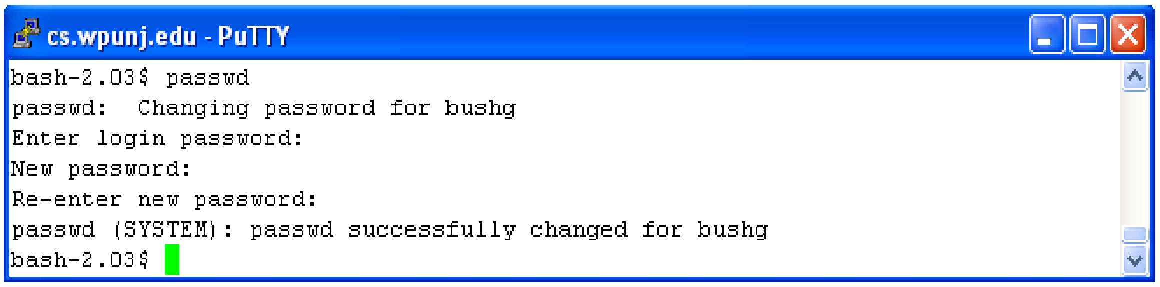
You are then prompted to enter your password. As a new user, you will be assigned a temporary password. As a protective measure, the password you entered is not displayed on the screen. If the username and password is correctly entered, you should see the UNIX screen similar to the one shown in Figure – 4, where *bash-2.03$* is the prompt from the popular Bourne again UNIX shell. At the prompt, you may enter any UNIX command including those that allow you to enter, compile, link, execute, and print the source code and output from your program.



```

Attention users!
-------------------------------------------

********  IMPORTANT NOTICE ************

Spam filtering is now in effect.
Mail thought to be spam will be placed in
/home/*/<username>/Mail/SPAM
Please check and delete SPAM often.
To check your spam use the following command.
> mail -f ./Mail/SPAM

-------------------------------------------
Any questions please email
Marvin Kiss      kissm15@verizon.net
        or
Anthony Stella  stellaa1@student.wpunj.edu

bushg
Your data usage:
cat: cannot open /tmp/quotas

bash-2.03$
```

Figure – 4 Successful login; UNIX displays prompt *bash-2.03$*

4. <u>Changing your password</u>: As a new user, the first thing we recommend you to do is to change your password. For security reasons, you may want to change your password periodically. To change the password, simply type in the UNIX command ***passwd*** (Note that ***passwd*** is actually a UNIX utility; for practical purpose, we make no distinction between a shell built-in and utility command in this user manual; both will are referred to as commands. Also note that the command name ***passwd*** is correctly spelled and there is no 'or' in passwd! at the UNIX shell prompt:



```
bash-2.03$ passwd
passwd:  Changing password for bushg
Enter login password:
New password:
Re-enter new password:
passwd (SYSTEM): passwd successfully changed for bushg
bash-2.03$
```

Figure -5 Use UNIX ***passwd*** command to change password.

Enter your current login password, press the *Enter* key, the system will then ask you to enter the new password, which must differ from your current password by at least three characters. Also, the password must contain at least six characters. To confirm your change, the system prompts you to enter your new password again.

<u>Important note</u>: it is highly recommended that you memorize your password, preferably write it down somewhere for future reference. In case you forget your password, it will burden the lab administrators to reset your password. Just like you, the lab administrators are students who have a lot of work to do!

In section IV, we provide a demo on how to enter, compile, link/edit, and execute a single file C++ program using the easy to use ***pico*** text editor and the famous ***gnu*** C++ compiler widely available in the public domain. We also demonstrate the use of a few frequently used UNIX commands such as ***mkdir*** (makes or creates a directory or folder)***, cd*** (changes the working directory or folder)***, pwd*** (displays or prints the working directory or the directory you are currently in), and ***ls*** (lists the contents of a directory).

Since almost all real world programs are developed and compiled as separate files, we provide in section V a demo which shows in detailed steps how a multi-file software project is compiled, linked, and executed.

For the convenience of users, we provide in section VI a list of UNIX commands frequently used by beginning level software developers.

IV. ***A single-file C++ project***

We demonstrate below in detailed steps how a single file program (*helloWorld.cpp*) is entered into the system via the ***pico*** editor (a UNIX utility or command!) and then compiled, linked, and executed using the famous gnu C++ compiler via the ***g++*** command.

1. Launching the ***pico*** text editor: The main reason we choose the ***pico*** editor for entering and editing C++ source code is its ease of use through a well-organized set of menus. It is available in the public domain for free download. To launch the *pico* editor, simply type *pico* at the UNIX prompt (***bash-2.03$*** on our system; it may look different on other UNIX systems) and the name of the file (*helloWorld.cpp* in this demo. Note that unlike Micorsoft Visual C++, no embedded space is allowed in a filename in UNIX.) and then press the *Enter* key. The system displays the *pico* editing screen within the PuTTY window, as shown in Figure – 6 below. Note that the file name *helloWorld.cpp* is displayed in the title bar of the *pico* editing window. The *pico* text editor is a menu-driven editor where the menu is displayed at the bottom of the screen. The '^' symbol in the menu means the holding down of the Ctrl key, thus ^c means holding down the Ctrl key and then pressing the letter c key.

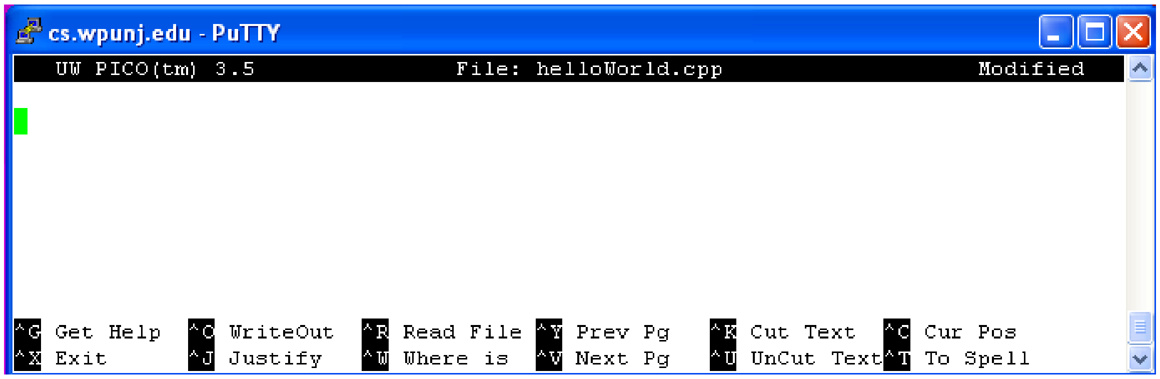
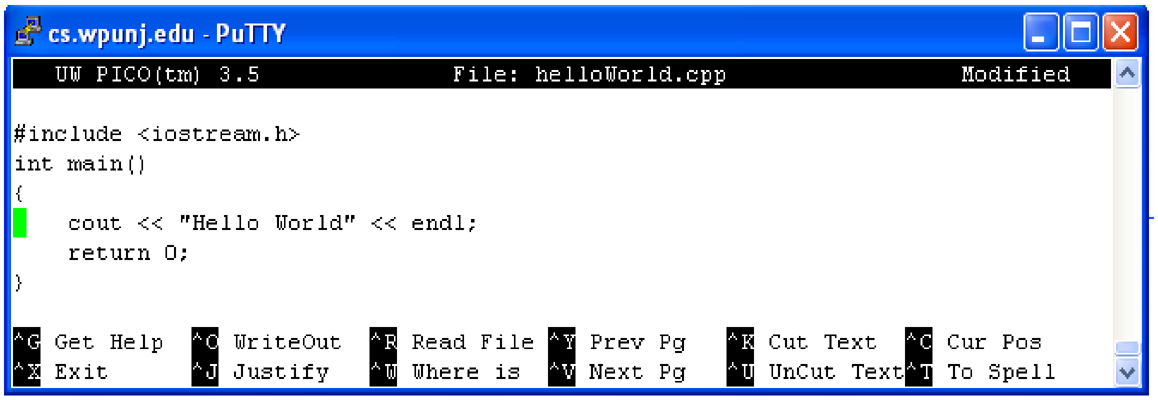


Figure 6 - The *pico* editing screen within the Putty window.

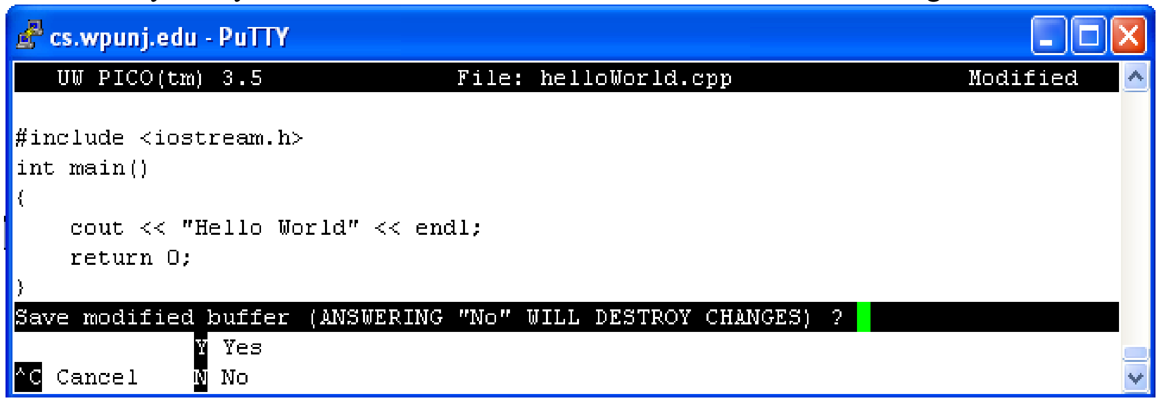
2. Entering the C++ source code for the *helloWorld.cpp* program: Type in the six lines for the *helloWorld.cpp* program as shown in Figure – 7 below.



```
#include <iostream.h>
int main()
{
    cout << "Hello World" << endl;
    return 0;
}
```

Figure 7 – The source code for the *helloWorld.cpp* program has been entered.

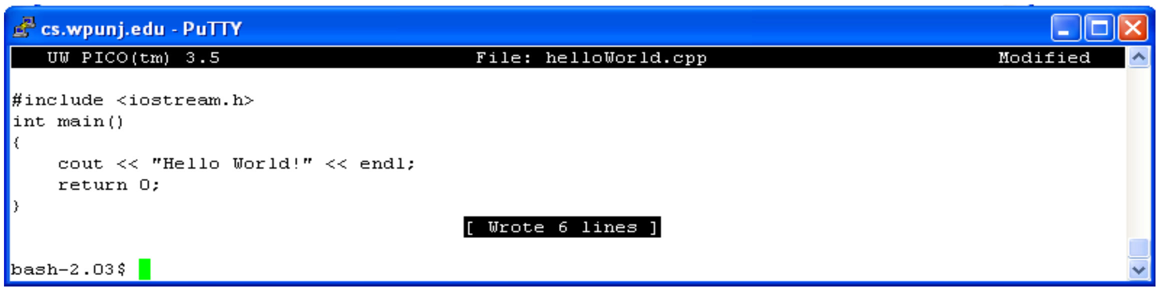
3. Saving the *helloWorld.cpp* program to disk: The source code you just entered is temporarily held in the buffer. To save it permanently on disk press ^x (Ctrl + x), the *pico* editor asks you if you want to "Save modified buffer …" as shown in Figure 8.



```
  UW PICO(tm) 3.5              File: helloWorld.cpp              Modified

#include <iostream.h>
int main()
{
    cout << "Hello World" << endl;
    return 0;
}
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
             Y Yes
^C Cancel    N No
```

Figure 8 – Pico editor asks if you want to save the buffer (your program).

Pressing 'Y', *pico* responds by requesting confirmation that the file is going to be stored under the filename *helloWorld.cpp*. Press the *Enter* key to confirm, *pico* returns control to the UNIX shell with the shell prompt bash-2.03$ shown in Figure – 9 below.



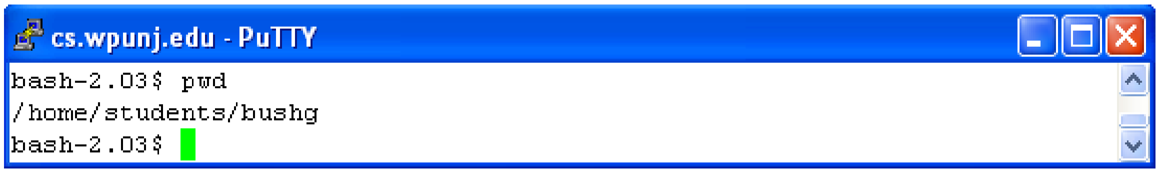
```
  UW PICO(tm) 3.5              File: helloWorld.cpp              Modified

#include <iostream.h>
int main()
{
    cout << "Hello World!" << endl;
    return 0;
}
                              [ Wrote 6 lines ]

bash-2.03$
```

Figure 9 - Back to the shell interface.

At this juncture, you may be wondering where is the file stored and how you are going to be able to find it so that you can compile and run it. It turns out that the *helloWorld.cpp* file has been saved to your current working directory or folder, the folder that the UNIX system assigned to you at the time you logged in. Similar to Microsoft Window's file system, you may create many folders and store your program in any of these folders as you wish. So before we show you how to compile and run the program, we introduce and demonstrate a few frequently used file-related commands including ***pwd*** (displays the current directory or folder), ***ls*** (lists the contents – file names and folder names – of a directory), ***cd*** (changes directory), ***mkdir*** (makes or creates a new directory or folder within the current folder), and ***mv*** (moves or changes the name of a file or folder). Other useful UNIX commands related to your programming classes are discussed and summarized in the Appendix.

4. Finding where you are with the ***pwd*** UNIX command: As discussed above, the ***pwd*** command displays or prints the current working directory or folder. Enter ***pwd*** at the shell prompt and press the *Enter* key, the system displays */home/students/bushg* as shown in Figure 10 below, where the leftmost slash / indicates the root directory of the file system;

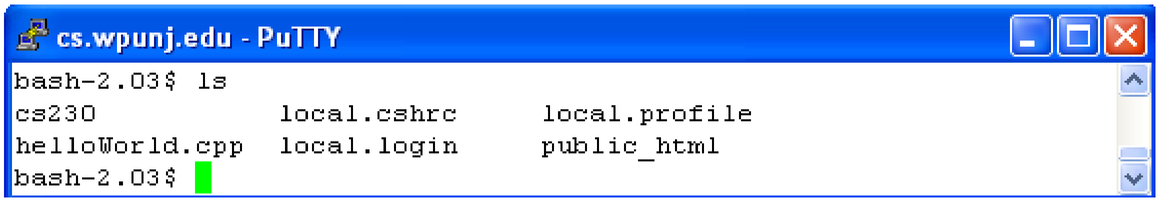
home is a folder or subdirectory in the root folder; *students* is a folder for student accounts in *home*; and *bushg* is the login name of a student. It is also the default working directory of that student. You will get a similar display with your login name as the name of your default folder. Clearly you can see that in UNIX, files are stored in folders and folders are organized in the tree-like or hierarchical order.



```
bash-2.03$ pwd
/home/students/bushg
bash-2.03$
```

Figure 10 – The ***pwd*** command displays the current working directory or folder.

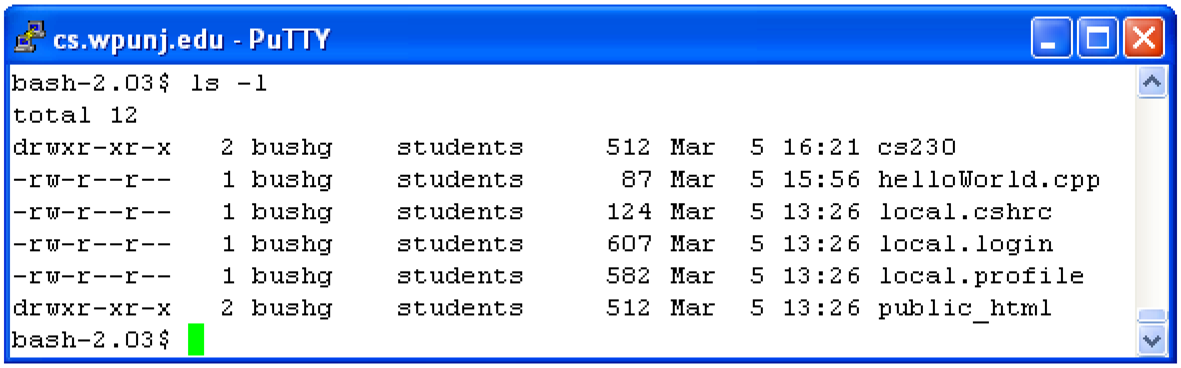
5. <u>Listing contents of a folder with the ***ls*** command</u>: The ***ls*** or list command lists all the files and folders contained within the current working directory or folder. Continue from the previous screen, enter ***ls*** at the shell prompt and press the *Enter* key, the UNIX system displays all the files and folders that have been previously created in the *bushg* working directory as shown in Figure 11 below. Notice the *helloWorld.cpp* we just entered is in the list.



```
bash-2.03$ ls
cs230           local.cshrc      local.profile
helloWorld.cpp  local.login      public_html
bash-2.03$
```

Figure 11 – The ***ls*** command displays all the file and folder names in the current folder.

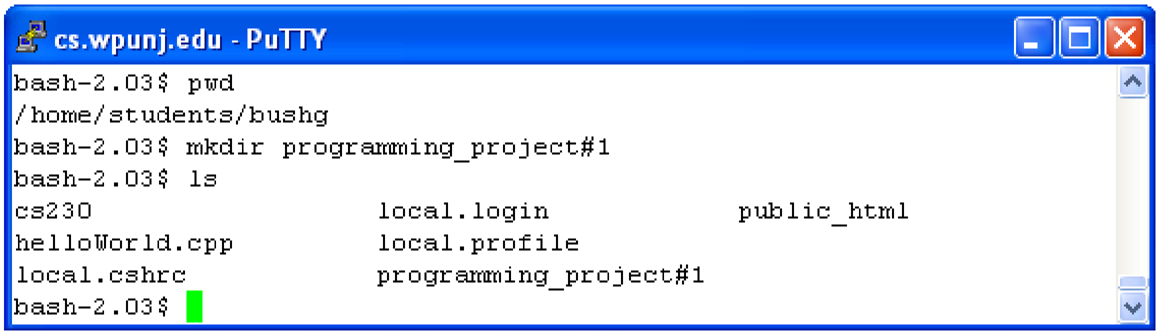
There are many names in Figure - 11 and there is no way of telling which of these names are associated with files or with folders. Modifying the ***ls*** command with a flag or switch –l (a dash followed by a lower case letter 'L' not numeral '1', where 'l' stands for 'long' or 'long format'), the system displays in Figure - 12 a whole lot more information including whether the name is associated with a file or a folder (the first letter 'd' in the first column of display indicates a folder), the size of the files, the time when the file or folder was created or last modified, etc. There are many other flags or switches that can be used to modify the meaning of the ***ls*** command, which are discussed in the Appendix.



```
bash-2.03$ ls -l
total 12
drwxr-xr-x   2 bushg    students     512 Mar  5 16:21 cs230
-rw-r--r--   1 bushg    students      87 Mar  5 15:56 helloWorld.cpp
-rw-r--r--   1 bushg    students     124 Mar  5 13:26 local.cshrc
-rw-r--r--   1 bushg    students     607 Mar  5 13:26 local.login
-rw-r--r--   1 bushg    students     582 Mar  5 13:26 local.profile
drwxr-xr-x   2 bushg    students     512 Mar  5 13:26 public_html
bash-2.03$
```

Figure 12 – The ***ls –l*** displays more information about what are stored in a folder.

6. Creating a new folder with the ***mkdir*** command: In a programming class such as CS240 or CS342, you are required to complete many programming projects and each of these programming projects may consist of multiple files. It is therefore highly desirable to store files belonging to a particular project in a separate folder where they can be easily and quickly located. The ***mkdir*** command allows you to create new folders in your current working directory, as illustrated below. Let's try to create a new folder named *programming_project#1* in the current working directory */home/students/bushg*. Type ***mkdir*** *programming_project#1* at the shell prompt and press the *Enter* key as shown in Figure 13.

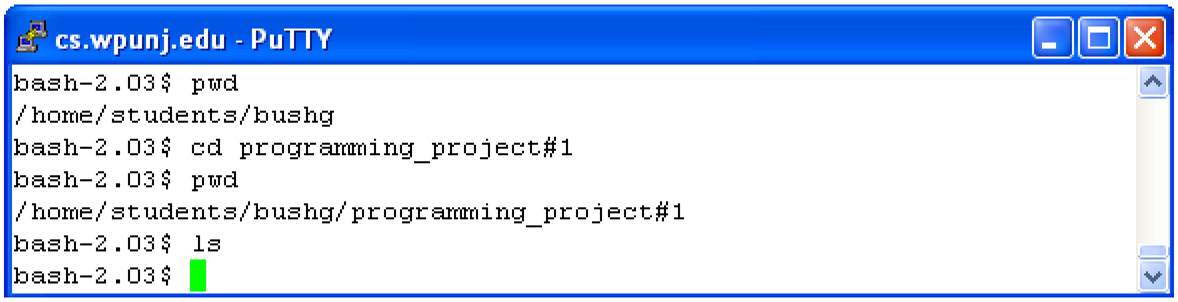


```
bash-2.03$ pwd
/home/students/bushg
bash-2.03$ mkdir programming_project#1
bash-2.03$ ls
cs230                 local.login           public_html
helloWorld.cpp        local.profile
local.cshrc           programming_project#1
bash-2.03$
```

Figure 13 – the ***mkdir*** command

To see if the new folder has indeed been created, we continue in Figure 13 and enter ***ls*** at the shell prompt, the system lists all the file and folder names as shown, and the new folder *programming_project#1* is indeed in the list. Opposite to ***mkdir*** is the ***rmdir*** command, which removes an existing folder. The usage of ***rmdir*** is discussed in the Appendix.

7. Moving between directories with the ***cd*** command: Without a 'path' (beyond the scope of this manual) that specifies the location of a folder, all new files are stored by UNIX in the current working folder. So if you just create a new folder and want to store files in it, you need to make the newly created folder your working folder, and it is easily done through the use of the ***cd*** or change directory command, as illustrated in Figure 14 below.

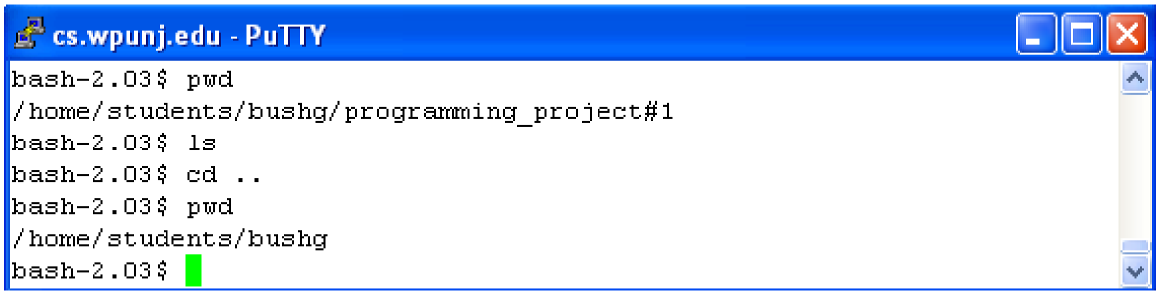


```
bash-2.03$ pwd
/home/students/bushg
bash-2.03$ cd programming_project#1
bash-2.03$ pwd
/home/students/bushg/programming_project#1
bash-2.03$ ls
bash-2.03$
```

Figure 14 – The ***cd*** command.

As shown in Figure 14, the ***pwd*** command displays */home/students/bushg* as the current working directory. We then type in ***cd*** *programming_project#1*, press the *Enter* key, and then enter the ***pwd*** command again. The system now displays

/home/students/bushg/programming_project#1 as the new working directory. Since we have not yet created any new files in it or moved any existing files to it, the following ***ls*** command results in nothing listed. To change the working directory from *programmingproject#1* to *bushg*, the 'parent' folder that contains it, simply type at the shell prompt the ***cd*** command, a space, and two dots or periods in a row then press the *Enter* key, as illustrated in Figure 15. The two dots here mean the 'parent' of the current working directory.

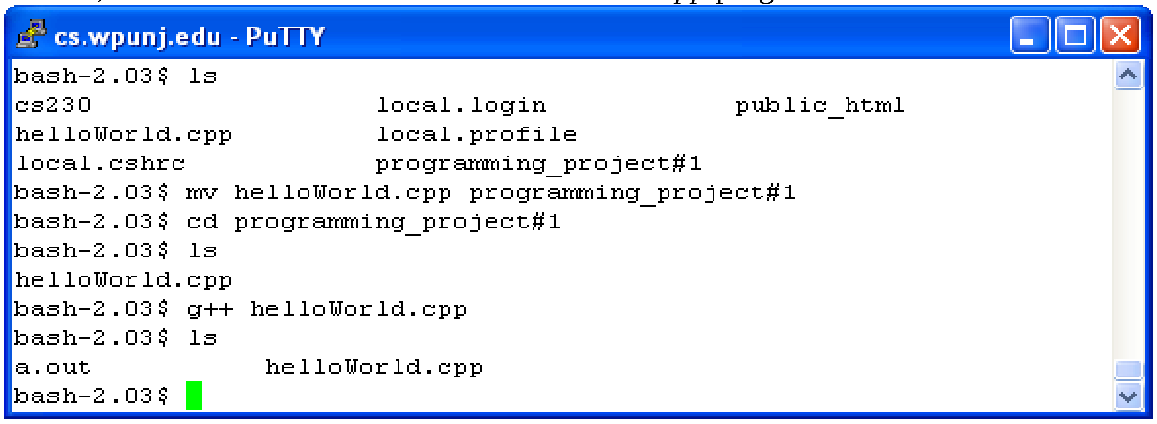


```
bash-2.03$ pwd
/home/students/bushg/programming_project#1
bash-2.03$ ls
bash-2.03$ cd ..
bash-2.03$ pwd
/home/students/bushg
bash-2.03$
```

Figure 15 – The ***cd* ..** command.

Note the above demonstrations allow you to move between a parent and a child directory. Since there can be a tree of folders of many levels, you may need to go through the above steps repeatedly in order to get to the desired folder. A quicker way to get to where you want requires the user to specify the 'path' that leads to the folder. A discussion of the path can be found in any UNIX textbook.

8. <u>Compiling and linking the C++ program using GNU C++ compiler: </u>We are now ready to compile and run the *helloWorld.cpp* program. Remember that the program file is stored in *bushg* folder. To make sure that the file is there, just enter the ***ls*** command as discussed before. The ***mv*** command is used to move the source file *helloWorld.cpp* to the *programming_project#1* folder. The ***cd*** command is used to change our working directory to the new folder. We next enter ***g++*** followed by the filename and then press the *Enter* key, the GNU C++ compiler compiles and then links (only if there are no compilation or syntax errors) the program with other modules referenced by the program to produced an *a.out* file as shown in Figure 16. The *a.out* file, also known as the *load* module, is an executable version of the *helloWorld.cpp* program.

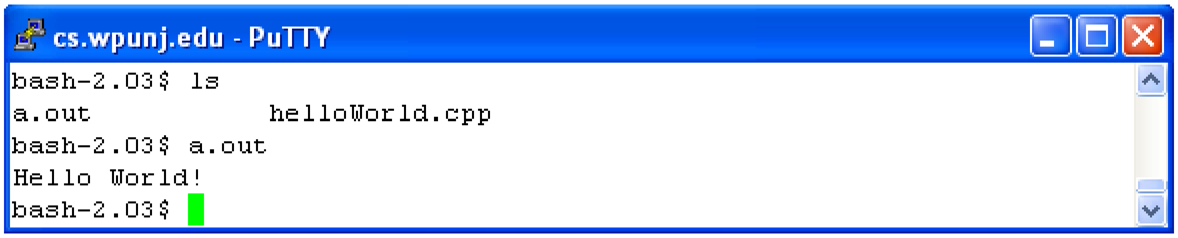


```
bash-2.03$ ls
cs230                  local.login             public_html
helloWorld.cpp         local.profile
local.cshrc            programming_project#1
bash-2.03$ mv helloWorld.cpp programming_project#1
bash-2.03$ cd programming_project#1
bash-2.03$ ls
helloWorld.cpp
bash-2.03$ g++ helloWorld.cpp
bash-2.03$ ls
a.out            helloWorld.cpp
bash-2.03$
```

Figure 16 – The g++ command that compiles and links the program.

Should there be any compilation or linkage errors, the system will display appropriate error messages, which are absent from Figure 16, indicating the executable *a.out* load module has been created in the working directory. Typing ***ls*** at the shell prompt confirms that the *a.out* file is there, as shown in Figure 16.

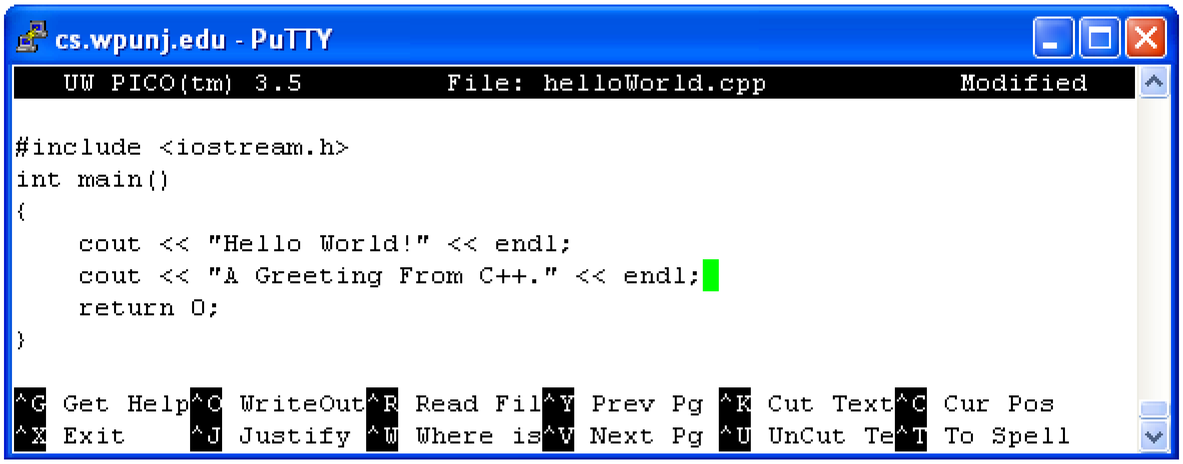
9. Executing the *a.out* load module: To execute the *a.out* module, simply type *a.out* at the shell prompt and press the *Enter* key. The single line output "Hello World!" is displayed on the screen as expected. This is shown in Figure 17 below.



```
bash-2.03$ ls
a.out            helloWorld.cpp
bash-2.03$ a.out
Hello World!
bash-2.03$
```

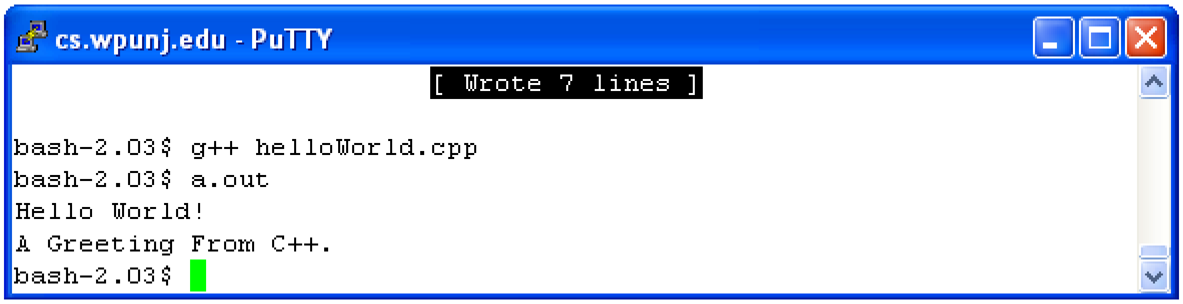
Figure 17 – After executing *a.out*, the output "Hello World!" is displayed.

10. Editing an existing file: What if you want to edit an existing program that you had previously stored? For example, you may want to add another line in the *helloWorl.cpp* file such that the program displays an additional line "A Greeting From C++." after the "Hello World!" phrase. Simple, just type ***pico*** followed by the filename *helloWorld.cpp* and press the *Enter* key. The *pico* text editor retrieves the stored file from disk and displays it on the screen for editing. Enter the addition line as illustrated in Figure 18. Compile and link the program again with the g++ command and execute the a.out load module. The screen shows the new result of execution with two output line lines. All these steps are displayed in Figures 18 and 19.



```
   UW PICO(tm) 3.5            File: helloWorld.cpp               Modified

#include <iostream.h>
int main()
{
    cout << "Hello World!" << endl;
    cout << "A Greeting From C++." << endl;
    return 0;
}

^G Get Help^O WriteOut^R Read Fil^Y Prev Pg ^K Cut Text^C Cur Pos
^X Exit    ^J Justify ^W Where is^V Next Pg ^U UnCut Te^T To Spell
```

Figure 18 – the pico editing window where a new line has been added.

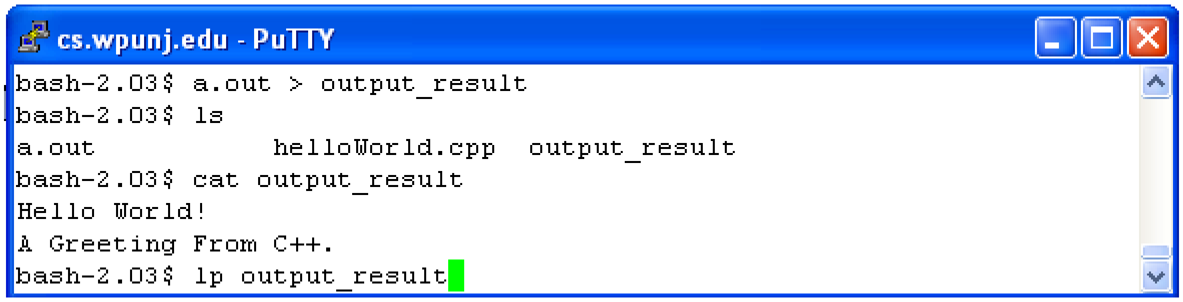


```
                       [ Wrote 7 lines ]

bash-2.03$ g++ helloWorld.cpp
bash-2.03$ a.out
Hello World!
A Greeting From C++.
bash-2.03$
```

Figure 19 – Output from the edited program.

11. Printing the C++ *helloWorld.cpp* source program: To print the source code is simple. Just type the ***lp*** (line printing) followed by the name of the file, *helloWorld.cpp*. This command will print the file on the default printer, *Colossus* in lab101a.

12. Printing the output result: As you've noted in Figures 17 and 19, the outputs are part of the screen display, mixed together with commands that you entered and the responses to these commands from the UNIX system. One way to separate the outputs from the screen display is to use the "redirection" feature of the UNIX system: you may ask the UNIX to send the program output to a separate text file with a name chosen by you. This is achieved through the use of the output redirection operator '>' as illustrated in Figure 20. Note that the output from the execution of *a.out* has been redirected (from the default monitor) to an arbitrarily named *output_result* disk file in the current working directory.



```
bash-2.03$ a.out > output_result
bash-2.03$ ls
a.out           helloWorld.cpp  output_result
bash-2.03$ cat output_result
Hello World!
A Greeting From C++.
bash-2.03$ lp output_result
```

Figure 20 – Output from the execution of *a.out* is directed *output_result* file.

You may use UNIX command such as ***cat*** (the catenation command) or ***pico*** editor to display the content of the *output_result* file. You can also use the ***lp*** command to print the contents of the file.

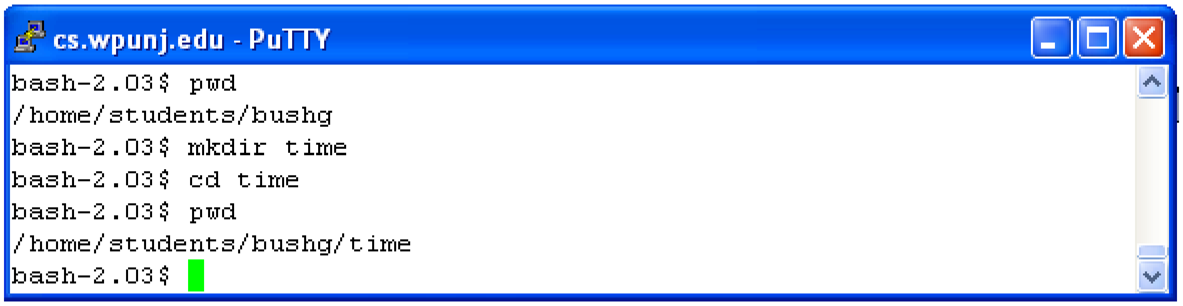
Notice: Never print an *a.out* file, since it contains binary data that will be unreadable by humans and result in a great waste of paper and ink.

The lab procedures presented thus far will enable you to run single-file programs found in most of the projects in CS230, some projects in CS240 and other computer courses. Since most real world programs consist of multiple files, we next discuss with a demo how a multiple-file program gets compiled and executed.

13. Logging out: To log out of the UNIX, type either *logout* or *exit* at the shell prompt and then press the *Enter* key. Holding down the *Ctrl* key and pressing *D* is another method.

V. A Multiple-file C++ Project

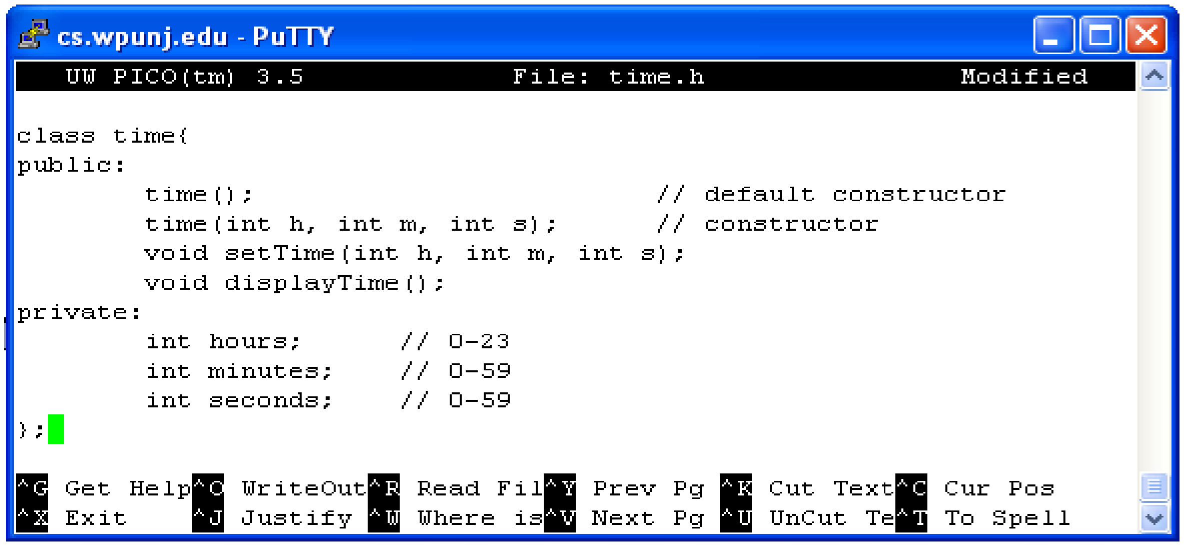
1. Creating a folder to store all files belonging to the program: In the below demonstration, we will use a *time* program to show how a multiple-file program is dealt with in the Solaris UNIX environment. The *time* program displays time of the day in standard format. The program is composed of three files: the ***time.h*** file**,** a user-defined header file that defines the interface of the *time* class; the ***time.cpp*** file**,** which implements all the functions defined in the *time* class; and the ***main.cpp*** file**,** the driver file that makes use of the *time* class. As discussed in section IV, it is convenient to create a separate directory used exclusively for the storage of all files of a program. Using the ***mkdir*** command, we create a new folder and name it *time* in the working directory of *bushg*. Figure 21 shows the **time** folder has been created within its parent *bushg* folder and through the use of ***cd*** command, the *time* folder has been made the current working directory.



```
bash-2.03$ pwd
/home/students/bushg
bash-2.03$ mkdir time
bash-2.03$ cd time
bash-2.03$ pwd
/home/students/bushg/time
bash-2.03$
```

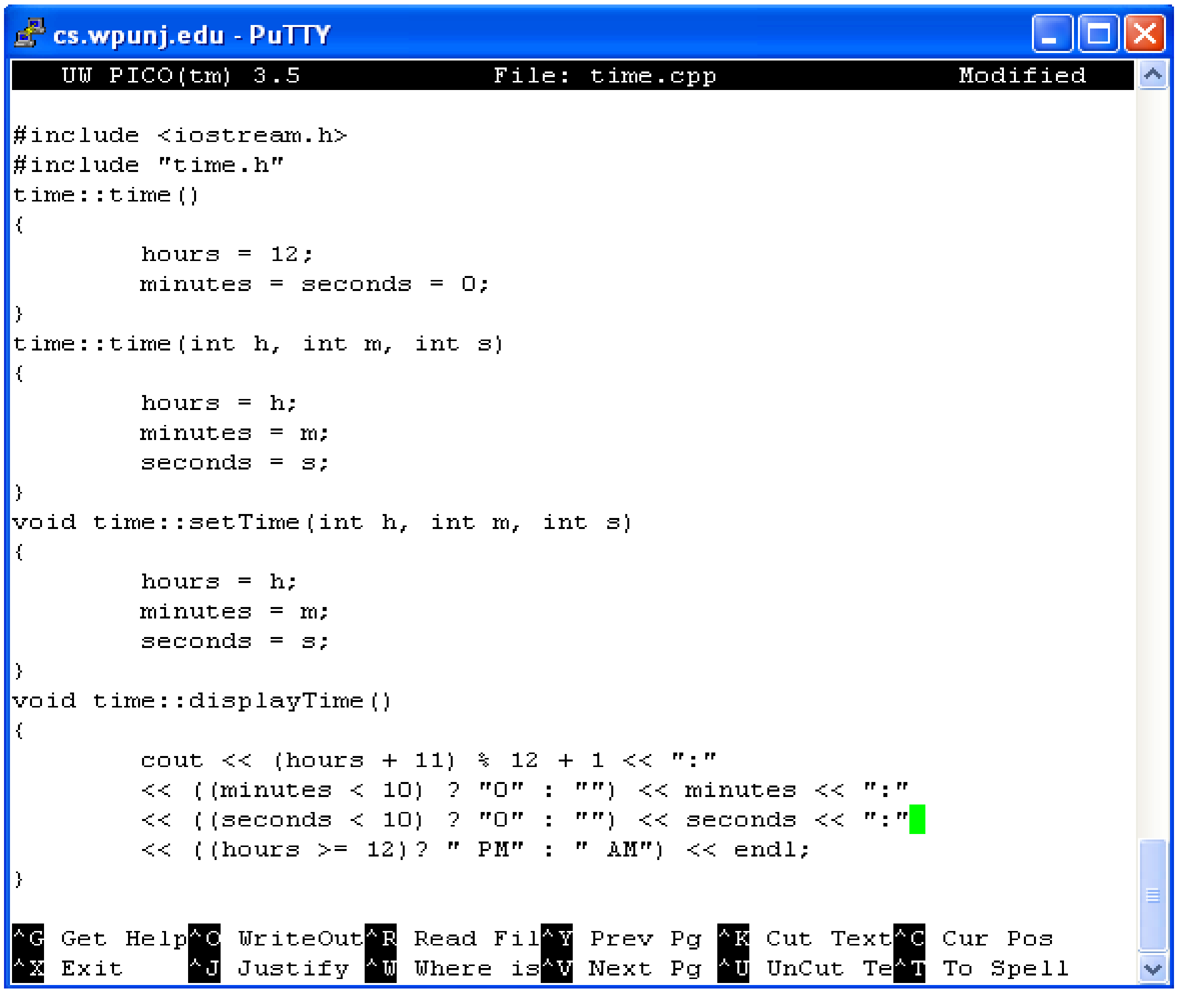
Figure 21 – Using the ***pwd*** command

2. Entering files: Using the ***pico*** editor, we separately entered the code for the three files mentioned above. Figure 22 through 24 displays the code for the ***time.h***, ***time.cpp***, and **main.cpp**, respectively. Note that you may open three ***pico*** windows (running three separate ***pico** processes*) in the same manner that you opened your first by logging in the UNIX multiple times. This way, you can work simultaneously with all three windows for three different files, which is very convenient especially during a debugging session.


cs.wpunj.edu - PuTTY
^G Get Help ^O WriteOut ^R Read Fil ^Y Prev Pg ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where is ^V Next Pg ^U UnCut Te ^T To Spell

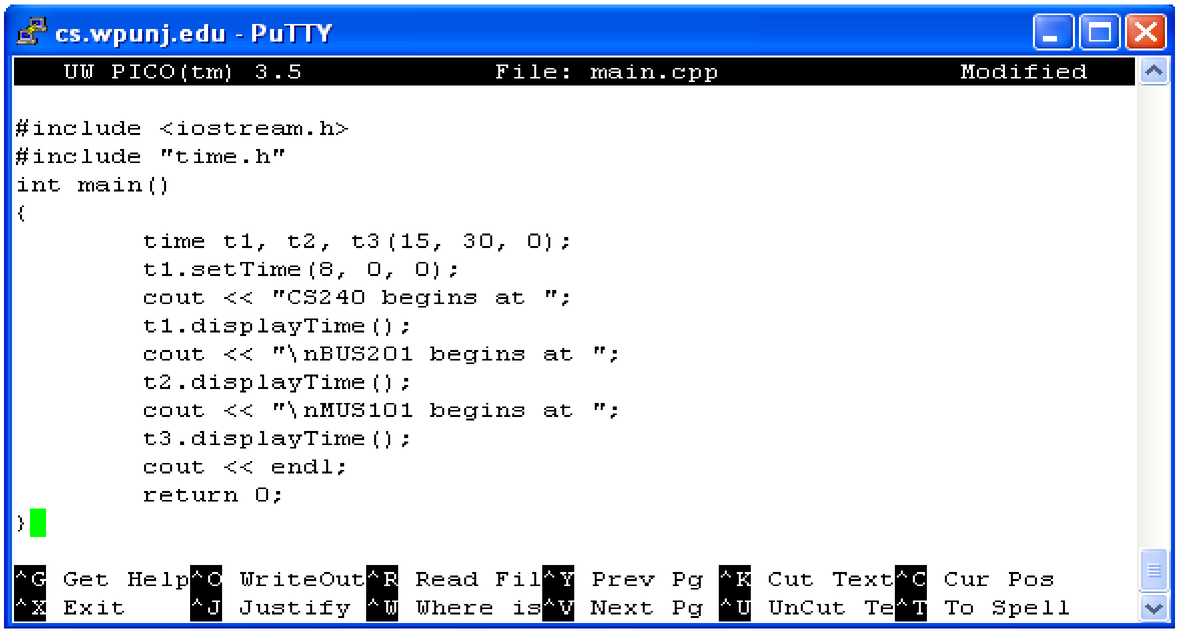
```
  UW PICO(tm) 3.5                    File: time.h                       Modified

class time{
public:
        time();                         // default constructor
        time(int h, int m, int s);      // constructor
        void setTime(int h, int m, int s);
        void displayTime();
private:
        int hours;      // 0-23
        int minutes;    // 0-59
        int seconds;    // 0-59
};
```

Figure 23 – Source code for the *time.h* file.



```
   UW PICO(tm) 3.5                File: time.cpp                Modified

#include <iostream.h>
#include "time.h"
time::time()
{
        hours = 12;
        minutes = seconds = 0;
}
time::time(int h, int m, int s)
{
        hours = h;
        minutes = m;
        seconds = s;
}
void time::setTime(int h, int m, int s)
{
        hours = h;
        minutes = m;
        seconds = s;
}
void time::displayTime()
{
        cout << (hours + 11) % 12 + 1 << ":"
        << ((minutes < 10) ? "0" : "") << minutes << ":"
        << ((seconds < 10) ? "0" : "") << seconds << ":"
        << ((hours >= 12)? " PM" : " AM") << endl;
}

^G Get Help^O WriteOut^R Read Fil^Y Prev Pg ^K Cut Text^C Cur Pos
^X Exit    ^J Justify ^W Where is^V Next Pg ^U UnCut Te^T To Spell
```

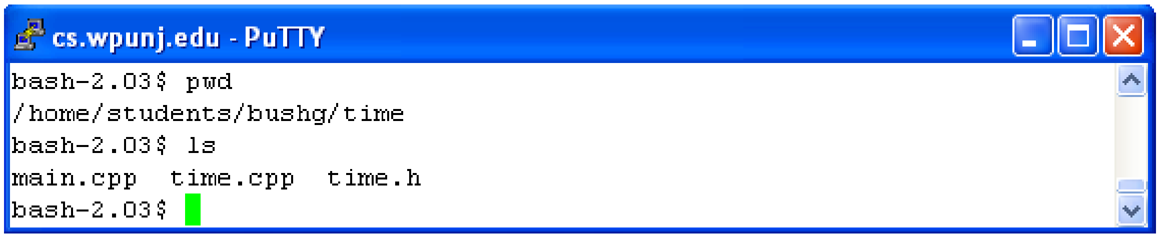
Figure 23 – Source code for the *time.cpp* file.



```
   UW PICO(tm) 3.5                File: main.cpp                Modified

#include <iostream.h>
#include "time.h"
int main()
{
        time t1, t2, t3(15, 30, 0);
        t1.setTime(8, 0, 0);
        cout << "CS240 begins at ";
        t1.displayTime();
        cout << "\nBUS201 begins at ";
        t2.displayTime();
        cout << "\nMUS101 begins at ";
        t3.displayTime();
        cout << endl;
        return 0;
}

^G Get Help^O WriteOut^R Read Fil^Y Prev Pg ^K Cut Text^C Cur Pos
^X Exit    ^J Justify ^W Where is^V Next Pg ^U UnCut Te^T To Spell
```

Figure 24 – Source code for the *main.cpp* file.

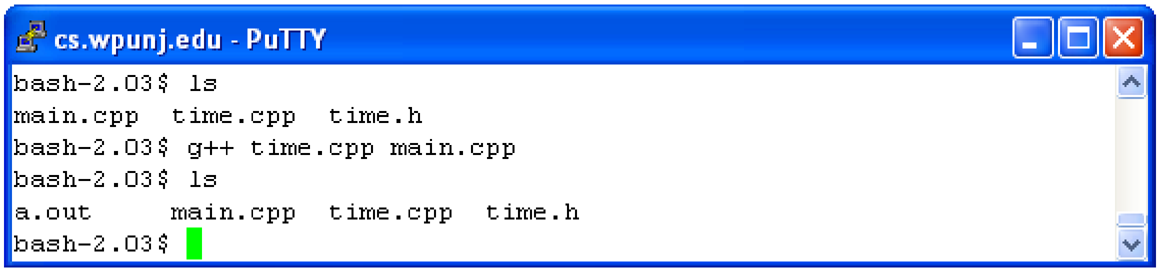
In the *time* folder, we now have three files ready to be processed, as shown in Figure 25 below.



```
bash-2.03$ pwd
/home/students/bushg/time
bash-2.03$ ls
main.cpp  time.cpp  time.h
bash-2.03$
```

Figure 25 – Three files are in the *time* folder.

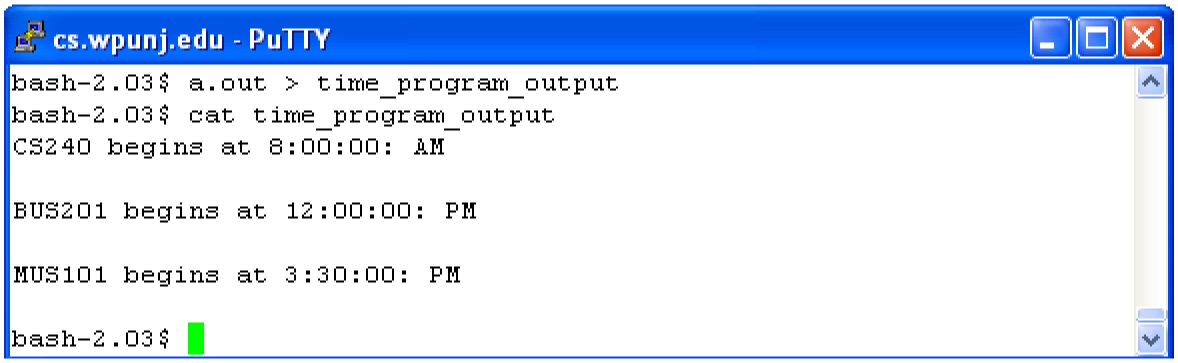
3. Compiling and linking files: To compile and link the three-file we have just entered, simply type ***g++*** *time.cpp main.cpp* and then press the *Enter* key. Notice that only files with *.cpp* extension appear after the ***g++*** command; the inclusion of the *time.h* header file is implied through the use of the C++ pre-processing directive *"#include "time"* in both the *time.cpp* and *main.cpp* files. Similar to a single file project, an executable load module *a.out* will be created if there are no compiling and linking errors in the program. Figure 26 shows the compilation and linking are successful and the *a.out* is produced in the same time working directory or folder.



```
bash-2.03$ ls
main.cpp  time.cpp  time.h
bash-2.03$ g++ time.cpp main.cpp
bash-2.03$ ls
a.out     main.cpp  time.cpp  time.h
bash-2.03$
```

Figure 26 – Load module *a.out* is created after successful compilation.

4. Executing the *a.out* load module: Type *a.out* at the shell prompt and use the output redirection operator > to direct the output of execution to an arbitrarily named file *time_program_output*. Figure 27 shows the contents of the *time_program_output* file that is produced.



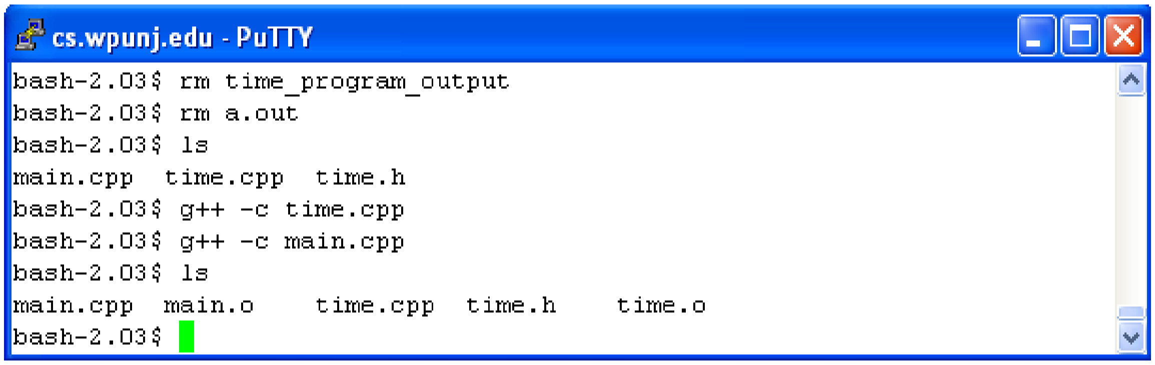
```
bash-2.03$ a.out > time_program_output
bash-2.03$ cat time_program_output
CS240 begins at 8:00:00: AM

BUS201 begins at 12:00:00: PM

MUS101 begins at 3:30:00: PM

bash-2.03$
```

Figure 27 – Output can be found in the *time_program_output* file.

5. Printing the source and the output files: Follow identical steps to print the contents of both the source and output files as described in steps 11 and 12 on page 13 for single file programs.

6. Editing an existing multiple-file project: Since all files belonging to the project have been placed in a folder, it is convenient to locate them and make necessary changes in a way described in step 10 on page 13 for the simple-file project.

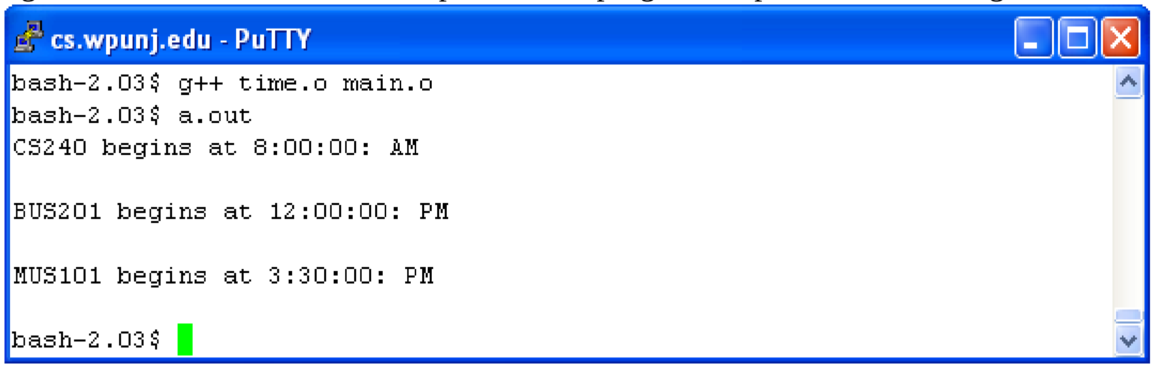
7. Compiling source files separately. When working with large programs with many source files it is often advantageous to compile each source file separately. Using the ***rm*** command we have removed the *a.out* and *time_program_output files*. Then we use the (compile only) ***–c*** option of the ***g++*** command to produce object modules from the two source files. See Figure 28.



```
bash-2.03$ rm time_program_output
bash-2.03$ rm a.out
bash-2.03$ ls
main.cpp  time.cpp  time.h
bash-2.03$ g++ -c time.cpp
bash-2.03$ g++ -c main.cpp
bash-2.03$ ls
main.cpp  main.o    time.cpp  time.h    time.o
bash-2.03$
```

Figure 28—Separate compilation of source files.

The next step is to use the ***g++*** compiler to produce the *a.out* file from the object files. Again we execute the *a.out* file to produce the program output as shown in Figure 29.



```
bash-2.03$ g++ time.o main.o
bash-2.03$ a.out
CS240 begins at 8:00:00: AM

BUS201 begins at 12:00:00: PM

MUS101 begins at 3:30:00: PM

bash-2.03$
```

Figure 29—Linking the object modules and executing.

By now, we have covered the basic knowledge and procedures needed to successfully compile, link, and execute a single-file as well as a multiple file C++ project in the Solaris UNIX environment. In the process, we have introduced several frequently used UNIX commands such as ***mkdir, rmdir, cd, pwd, ls, mv, lp, pico,*** and ***g++.*** In the following Appendix, we categorize some of the frequently used UNIX commands by their functions. We then provide a more detailed description and variations about the usage of these commands.

Appendix I: Frequently Used UNIX Commands

I. Frequently used commands grouped by their functions and sorted alphabetically. (based on the book "UNIX in a Nutshell", D. Gilly; O'Reilly & Associate, Inc.)

<u>File Management Commands</u>:

• ***cat***	Join files or display the contents of a file
• ***cd***	Change directory
• ***chmod***	Change access mode on files
• ***cp***	Copy files
• ***file***	Determine a file's type
• ***head***	Displays the first few lines of a file
• ***ln***	Create file aliases
• ***ls***	List files and directories
• ***mkdir***	Create or make a directory
• ***more***	Display contents of a file by screenful
• ***mv***	Move or rename a file or a directory
• ***pwd***	Print or display current working directory
• ***rm***	Remove files
• ***rmdir***	Remove directories
• ***tail***	Display the last few lines of a file
• ***wc***	Count lines, words, and characters in a file

<u>Programming Commands</u>:

• ***cc***	Compile and link a C program
• ***g++***	Compile and link a C++ program with the gnu compiler
• ***lex***	Perform lexical analysis of a file
• ***make***	Manage versions of a large programming projects
• ***yacc***	Convert a file containing context-free grammar into tables for subsequent processing

Text Editors or Text Editing Commands:

• ***cut***	Select column of a file for display
• ***pico***	A simple and easy to use menu-driven text editor
• ***sort***	Sort or merge files
• ***vi***	A command-driven full-screen text editor popular among professionals

Searching Commands:

• ***egrep***	Extended version of grep
• ***fgrep***	Search files for literal words
• ***find***	Search the system for file names
• ***grep***	Search files for text pattern

Miscellaneous Commands:

• ***cal***	displays the monthly calendar
• ***clear***	clear the screen
• ***date***	Display today's time and date
• ***finger***	Display information about individual users
• ***ftp***	To upload and download files
• ***kill***	Terminate a running command or a process
• ***lp***	Print the content of a file
• ***man***	Display information about a command
• ***passwd***	Change password
• ***ps***	Show processes
• ***talk***	Write to others online
• ***telnet***	Connect to another system
• ***who***	Display who are currently logged in

II. Detailed Syntax and Usage of a Few Commands Frequently Used in CS Programming Classes

• ***ls*** [*options*] [*names*]

If no *names* are given, all files and folders in the working directory are listed. If names are provided: if the name is a folder name, all files in the named folder are displayed; if it is a file name, the information about the file is displayed. The most useful *options* are listed below. Note that an option is an upper or lower case letter preceded by a hyphen '-'; if you specify more than one option, then only a single hyphen preceding the first option is needed.

<u>Options</u>

-a	List all files, including the hidden files (those preceeded by a '.' when displayed.)
-F	List all file and folder names and append a '/' to folder names, '*' to executable file names (such as *a.out*), and '@' to symbolic links.
-i	List inode of each file
-l	Long format listing, including file access permissions, ownership, size, creation or modification time, etc.
-r	List files in reverse order by name and by date
-t	List files by modification time, newest first.

• ***mv*** [*options*] *source* *target*

Move files and directories around on the system or to rename them, as illustrated below:

Source	***target***	***Result***
File	*name*	Rename file as *name*
File	Existing file	Overwrite existing file with source file
Directory	*name*	Rename directory as *name*
Directory	Existing directory	Move directory as a sub-directory of existing one
One or more file	Existing directory	Move all files to existing directory

<u>Options</u>

-i	Inquires; prompt for a y(yes) response before overwriting an existing target.

• ***rm*** [*options*] *files*

Delete one or more files in a directory. To remove a file, one must have write permission in the directory that contains the file, but one needs not have permission on the file itself.

<u>Options</u>

-r	If file is a directory or folder, remove the entire directory and all its contents, including subdirectories! So use it with care.

• ***chmod*** [*options*] *mode files*

Changes the access mode of one or more files. Only the owner of a file or a privileged user may change its mode. Create mode by concatenating the characters from *who, opcode,* and *permission*. *Who* is optional (if omitted, default is **a**); choose only one *opcode*.

Who	
u	User
g	Group
o	Other
a	All (default)

Opcode	
+	Add permission
-	Remove permission
=	Assign permission (and remove permission of the unspecified fileds)

Permission	
r	Read
w	Write
x	Execute

Examples:

Add execute-by-user permission to *file*: ***chmod u + x*** *file*

• ***make*** [*options*] [*target]*

Update one or more targets according to dependency instructions in a description file in the current directory. By default, this file is called *makefile* or *Makefile*.

Options	
-q	Query; return 0 if file is up-to-date; non-zero otherwise.

Appendix II

Useful UNIX Shell Command-Line Key Strokes

The following key strokes are to be used in the command-line operations only. The same key strokes in different environment, e.g., in the ***pico*** or ***vi*** editor may invoke totally different responses!

- Ctrl + D: logging out of a UNIX session; equivalent to typing *logout* or *exit* at the shell prompt and then pressing the *Enter* key.

- Ctrl + H: Deleting a character to the left of the cursor in the command line after the shell prompt; same as pressing the *Backspace* key.

- Ctrl + R: Redrawing the current command line.

- Ctrl + U: Deleting or killing the entire command line.

- Ctrl + W: Deleting a word to the left of the cursor in the command line.

- Ctrl + C: Terminating the execution of a shell command. (For example, when you typed ***man ls*** at the shell prompt, the UNIX displays in lengthy detail about the usage of the ***ls*** command. You may press Ctrl+C to terminate the screen display as soon as you've obtained the needed information about the ***ls*** command.)

- The arrow keys:

    - Top: Scrolling backward through previously entered commands at the shell prompt in a sequential manner. All previously entered commands are stored in the buffer.

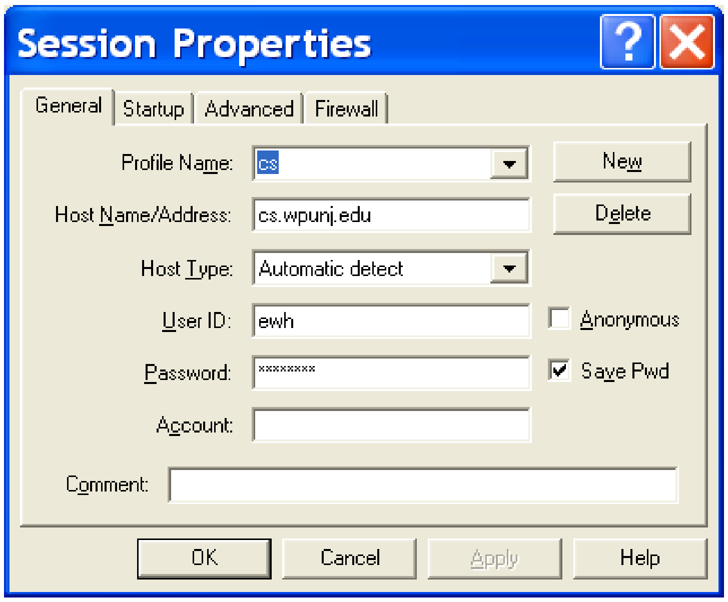
    - Down: Scrolling forward through commands stored in the buffer and stopping at the most-recently-entered command.

    - Left: Move the cursor to the character on its left in the command line.

    - Right: Move the cursor to the character on its right in the command line.

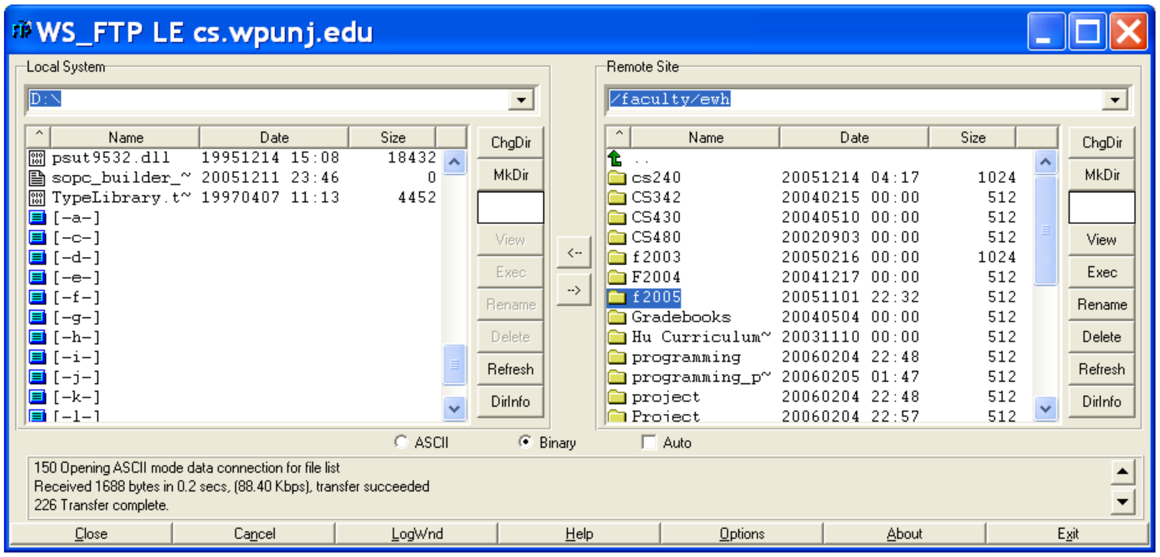
Appendix III: Uisng *WS_FTP LE*

Launching *WS_FTP LE*: Double click the *WS_FTP LE* icon on the desktop (copy it from the program menu to the desktop if the icon is not there), the system displays the ***Session Properties*** dialog box in Figure - A1 below:



Profile Name: cs
Host Name/Address: cs.wpunj.edu
Host Type: Automatic detect
User ID: ewh
Anonymous [ ]
Password: ********
Save Pwd [✓]
Account:
Comment:

Enter information as shown except you must enter your UNIX login name in the ***User ID*** box and your UNIX login password in the ***Password*** box. Click the ***OK*** button, the system displays the ***WS_FTP LE cs.wpunj.edu*** window in Figure - A2 below.



```
Local System: D:\
Name               Date             Size
psut9532.dll       19951214 15:08   18432
sopc_builder_~     20051211 23:46       0
TypeLibrary.t~     19970407 11:13    4452
[-a-]
[-c-]
[-d-]
[-e-]
[-f-]
[-g-]
[-h-]
[-i-]
[-j-]
[-k-]
[-l-]

Remote Site: /faculty/ewh
Name               Date             Size
..
cs240              20051214 04:17   1024
CS342              20040215 00:00    512
CS430              20040510 00:00    512
CS480              20020903 00:00    512
f2003              20050216 00:00   1024
F2004              20041217 00:00    512
f2005              20051101 22:32    512
Gradebooks         20040504 00:00    512
Hu Curriculum~     20031110 00:00    512
programming        20060204 22:48    512
programming_p~     20060205 01:47    512
project            20060204 22:48    512
Project            20060204 22:57    512
```

( ) ASCII [● Binary] [ ] Auto

```
150 Opening ASCII mode data connection for file list
Received 1688 bytes in 0.2 secs, (88.40 Kbps), transfer succeeded
226 Transfer complete.
```

The ***WS_FTP LE cs.wpunj.edu*** window consists of 2 two panes. The pane on the left displays the disk drives, directories, and files of your ***Local System*** (your home computer, for example); the pane on the right shows the directories and files of the Remote System (our UNIX server in the Coach House). You may select any file or files in any folder on any drive of your local PC and transfer them (uploading) to any of your folders on the UNIX server. You may also transfer any of your files from the UNIX server to your local PC. Once the files are selected, the transfer is effected by clicking the ***arrow*** icon in between the two panes.

In addition to file transfer, the *WS_FTP LE* is capable of performing many other functions for you by clicking on appropriate buttons. These buttons, including ***chdir, mkdir, exec, rename, delete,*** and ***refresh*** are grouped into a panel on the right side of each pane of the ***WS_FTP LE cs.wpunj.edu*** window. The use of these buttons is rather intuitive, so no attempt is made here to discuss it further.