Faculty of Computing, Engineering and Mathematical Sciences

MODULAR PROGRAMME

ASSESSMENT SPECIFICATION

Module Details

Module Code	Run	Module Title
UFEEHJ-30-2	08SEP/1 AY	Operating Systems and Systems Administration

Module Leader	Module Tutors
Ian Johnson	Nigel Gunton, Ian Johnson

Component and Element Number	Weighting: (% of the Module's assessment)
B1	25%

Element Description	Total Assignment time
Coursework - 1	18 hours + Lab Time

Dates

Date Issued to Students	Date to be Returned to Students
15th October 2008	21st January 2009

Submission Place	Submission Date	Submission Time
PROJECT ROOM - 2Q30 (Help Desk open 9.00 - 6.00pm)	11th December 2008	2.00 pm

Deliverables

As per attached specification

Module Leader Signature

Ian Johnson

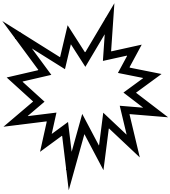
Overview

Even in these days of Graphical User Interfaces (GUIs) most modern operating systems still offer a command line interpreter, or shell. Many systems administrators are frequent users of command line interfaces, even on Windows XP!

From a learning point of view, command-line interfaces provide an opportunity to study the underlying operating system calls and to this end you will be developing a simple, restricted shell.

This assignment will be developed in stages and signed off by your lab tutor as you proceed.

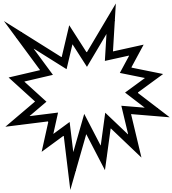
You will be expected to work on this during your lab sessions AND in your own time.



IMPORTANT!!

For fairness, and to encourage you to work consistently lab tutors have been advised to sign off one category of work at a time for each student. This is to ensure that everyone can be seen in a lab session. No sign-offs will be performed outside of scheduled classes.

IT IS YOUR RESPONSIBILITY TO ENSURE YOU ALLOW ADEQUATE TIME TO DEMONSTRATE YOUR WORK AND TO DO SO ON A WEEK BY WEEK BASIS



Requirements

To develop the following elements, initially as stand-alone programs, and **then to combine them into a simple shell**. It will pay to think ahead and to consider functions that will be common to all/many of the stand-alone versions. Your shell should provide a prompt, error/usage messages for the built-ins and pass other commands to the underlying system for execution.

Note:

- Credit will be awarded for the use of version control. A worksheet on using version control software is available on Nigel Gunton's web page.
- Credit will be awarded for robust error checking and the use of *perror()*

The elements required for this assignment together with the available marks are listed overleaf:

a. pwd

This should print, on ***stdout***, the path to the current directory.

(4 marks)

b. cd

This should take an optional path as an argument. If no argument is provided then the default behaviour is to change directory to the users home directory.

(6 marks)

c. ls

The 'list directory contents' command. It should accept the flags ***–a*** and ***–l*** and respond appropriately. RTFM for exact details. This component of the assignment has two parts, a written description of the issues involved and your actual code and demonstration.

In general, the ls component of this assignment has been poorly executed.
On Kenny a test directory exists. Your ls **MUST** be able to process this directory correctly:

```
irjohnso@kenny:/usr/local/stow/testfiles/lib/testfiles$ ls -la
total 4
drwxr-xr-x  4 root   root      4096 Oct 18  2005 ./
drwxr-sr-x  3 root   staff       22 Oct 19  2005 ../
drwxr-xr-x  2 root   root         6 Oct 18  2005 .a_hidden_dir/
-rw-r--r--  1 root   root         0 Oct 18  2005 .a_hidden_file
-rw-r--r--  1 root   root         0 Oct 17  2005 a
-rw-r--r--  1 root   root         0 Oct 18  2005 a_stupidly_long_filename_created_to_cause_buffer_overflows_in_the_unwary
-rw-r--r--  1 root     23784      0 Oct 17  2005 b
brw-r--r--  1 root   root    10, 10 Oct 17  2005 block
lrwxrwxrwx  1  32764 root         7 Dec 22  2005 brokenlink -> missing
-rw-r--r--  1 root   root         0 Oct 17  2005 c
crw-r--r--  1 root   root    30, 30 Oct 17  2005 char
d---------  2 root   root         6 Oct 18  2005 dir/
----------  1 root   root         0 Oct 18  2005 file
-rw-rwSrw-  1 root   users        0 Oct 18  2005 guid
lrwxrwxrwx  1  32764 users        7 Dec 22  2005 link -> oldfile
-rw-r--r--  1  32764 users        0 Aug 16  2003 oldfile
prw-r--r--  1 root   root         0 Oct 17  2005 pipe|
---sr-xrwx  1 root   root         0 Oct 18  2005 sticky*
--wS-w--w-  1 nobody nogroup      0 Oct 18  2005 suid
irjohnso@kenny:/usr/local/stow/testfiles/lib/testfiles$
```

This directory highlights most issues with respect to ls. Some key issues are:

- unresolvable UID/GID
- “unusual” permissions e.g. sticky, suid, sgid
- “unusual” types e.g. pipes, links and devices.
- unresolvable links.

You should make sure you are clear about the issues involved in dealing with these particular points, and any other issues involved in handling this directory, before starting on this component.

In particular the following points should be noted:

- links should be handled corrected in long format e.g.
  `4 lrwxrwxrwx  1 user users 4 Oct 17 17:24 link -> file`
  The date stamp should be the mod. time for the link and the -> and target printed.
- Devices (see ls /dev) should be handled correctly
- UID and GID values that cannot be resolved should be printed numerically

- Any combination of files, directories and flags should be accepted.
- The output should be sorted

(35 marks)

d. ps

Default behaviour is to list all processes owned by the user. It should accept the flag ***-A*** as an argument and list all current processes and their process Id's .

(17 marks)

e. kill

This command should respond as follows :

- kill ***pid*** send ***SIGTERM*** to process ***pid***
- kill –l list the signals sent by this command. Your version of kill should recognise SIGTERM, SIGKILL and SIGHUP. It should provide a list of both the names of the signals and their numbers. **RTFM section 7 signal**.
- kill ***signal pid*** send the specified signal to pid. It should recognise both the numeric value and the name of the signals.

(8 marks)

f. A basic shell

http://www.cs.ucsd.edu/classes/wi97/cse80/dumbshell.html provides a very simple shell. You may use this (The code is also attached). Your shell should at a minimum provide the capability to support executing commands. You may obviously develop your own shell, for which substantial credit under extras (h) will be given.

g. Integration of [a-e] within f

Your shell (or the dumbshell) should have the commands you have implemented as built-ins.

(10 marks)

h. Extras!

A further 20% is available, at the discretion of the markers, for outstanding work. These marks will be awarded for high quality original code, robust code and extensions to your shell.

Specifically, the implementation of <u>piping & redirection</u> will gain significant credit under this heading.

Version control will also gain credit under this heading.

Examples of work which could be worth extra credit would be adding functionality such as simple control structures (if, while, for), filename completion or history to your shell, or providing support for additional flags in ls. If you wish to extend your work consult your lab tutor.

(up to 20 marks)

Constraints

1. All code **MUST** be demonstrated and explained to your lab tutor before it will be signed off.

   Remember, **this is an individual assignment** and that assessment offences are taken seriously. This does not prevent you from discussing problems and ideas with your peers and you are encouraged to do so as long as the final result is your own work. If you use sections of code from other sources then they must be clearly identified and you will be expected to demonstrate your understanding of the code to your lab tutor.

   All work **MUST** be demonstrated before the hand-in date, in lab session time. Do not expect to turn up at the last lab and demonstrate everything.

2. **Undemonstrated code will forfeit all marks for that component**.

3. Support for system calls

   Possibly the best advice is Read The Friendly Manual ☺ All system calls are documented in section 2 of the manual. All C library functions are documented in section 3. ***man 2 syscalls*** will give you a list of system calls.

   System calls will be covered in Nigel Guntons lectures. There is also a very good web-site that covers much of the assignment material. (see the link from Nigel's home page).

Other Resources

WWW

Nigel Gunton's homepage (**http://www.cems.uwe.ac.uk/~ngunton**) has unix/linux system programming related links.

The linux documentation project, has too many resources to list!

Dead Trees

Stevens, Richard W; "***Advanced Programming in the Unix® Environment***", Addison-Wesley, 1993.

Rochkind, Marc J; "***Advanced Unix Programming***", Prentice Hall, 1985.

These are both excellent system level programming reference guides. Both of these books are not cheap, but provide a professional level reference that will last you through many years of your career.

Alternatively, the library is an excellent place to discover books!

Your lab tutor

These are often worth talking to ☺ and can provide support for C syntax etc.

Deliverables

Your sign-off sheet, signed and dated for all completed work.
Signed off code **DOES NOT INDICATE THAT MAXIMUM MARKS HAVE BEEN ACHIEVED**

A signed off copy of your description of the issues in handling the test directory for ls.

Copies of all code that has been demonstrated/explained to your tutor.

Student Number:

UFEEHJ-30-2	***Assignment 1 Checklist***		
	Comments	***Signed***	***Date***
pwd			
cd			
ls			
ps			
kill			
shell			
integration			
piping & redirection			
Extras!			

Other comments:

dumbshell.c

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#define       DEBUG         1
#define       MAXLINELEN    4096
#define       MAXARGS             128
#define       END_OF_LINE   0
#define       SEQ_OP        ';'
#define       SEQUENCE      1

struct cmd {
       struct cmd    *next;
       int           terminator;
       char          *exe_path;
       int           nargs;
       char          *arg[MAXARGS];
};

void   *ck_malloc(size_t   size)
{
       void   *ret = malloc(size);
       if (!ret) {
              perror("dumbshell:ck_malloc");
              exit(1);
       }
       return ret;
}

char   *skip_to_non_ws(char       *p)
{
       int    ch;
       while (ch = *p) {
              if (ch != ' ' && ch != '\t' && ch != '\n') return p;
              ++p;
       }
       return 0;
}

char   *skip_to_ws_or_sep(char    *p)
{
       int    ch;
       while (ch = *p) {
              if (ch == ' ' || ch == '\t' || ch == '\n') return p;
              if (ch == SEQ_OP) return p;
              ++p;
       }
       return 0;
}

struct cmd *parse_commands(char   *line)
{
       char          *ptr;
       int           ix;
       struct cmd    *cur;

       ptr = skip_to_non_ws(line);
       if (!ptr) return 0;
       cur = ck_malloc(sizeof *cur);
       cur->next = 0;
       cur->exe_path = ptr;
       cur->arg[0] = ptr;
       cur->terminator = END_OF_LINE;
       ix = 1;
       for (;;) {
              ptr = skip_to_ws_or_sep(ptr);
              if (!ptr) {
                     break;
              }
              if (*ptr == SEQ_OP) {
                     *ptr = 0;
                     cur->next = parse_commands(ptr+1);
                     if (cur->next) {
                            cur->terminator = SEQUENCE;
                     }
                     break;
              }
              *ptr = 0;
              ptr = skip_to_non_ws(ptr+1);
```

```
                if (!ptr) {
                        break;
                }
                if (*ptr == SEQ_OP) {
                        /* found a sequence operator */
                        cur->next = parse_commands(ptr+1);
                        if (cur->next) {
                                cur->terminator = SEQUENCE;
                        }
                        break;
                }
                cur->arg[ix] = ptr;
                ++ix;
        }
        cur->arg[ix] = 0;
        cur->nargs = ix;
        return cur;
}

void    execute(struct cmd  *clist)
{
        int     pid, npid, stat;

        pid = fork();
        if (pid == -1) {
                perror("dumbshell:fork");
                exit(1);
        }
        if (!pid) {
                /* child */
                execvp(clist->exe_path,clist->arg);
                fprintf(stderr,"No such command: %s\n",clist->exe_path);
                exit(1);
        }
        do {
                npid = wait(&stat);
                printf("Process %d exited with status %d\n",npid,stat);
        } while (npid != pid);
        switch (clist->terminator) {
        case SEQUENCE:
                execute(clist->next);
        }
}

void    free_commands(struct cmd   *clist)
{
        struct cmd   *nxt;

        do {
                nxt = clist->next;
                free(clist);
                clist = nxt;
        } while (clist);
}

char    *get_command(char   *buf,
                     int     size,
                     FILE    *in)
{
        if (in == stdin) {
                fputs("@ ",stdout); /* prompt */
        }
        return fgets(buf,size,in);
}

void    main(void)
{
        char         linebuf[MAXLINELEN];
        struct cmd   *commands;

        while (get_command(linebuf,MAXLINELEN,stdin) != NULL) {
                commands = parse_commands(linebuf);
                if (commands) {
                        execute(commands);
                        free_commands(commands);
                }
        }
}
```