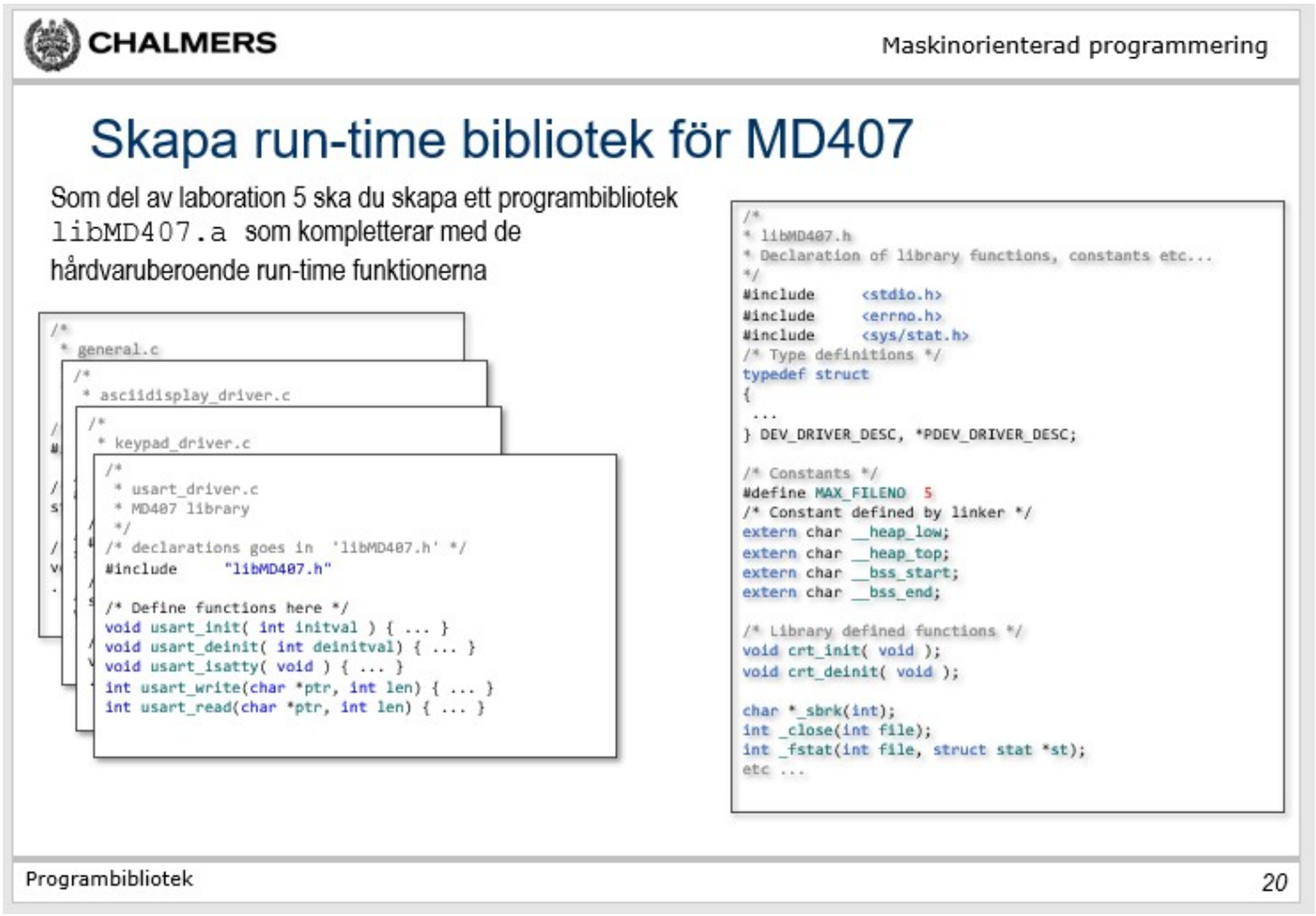
Förtydligande av bild 20, Lektion 14:




```
/*
* libMD407.h
* Typer och konstanter som används i hela programbiblioteket
*/
#include       <stdio.h>
#include       <errno.h>
#include       <sys/stat.h>
/* Type definitions */
#include <sys/stat.h>

typedef struct
{
  char name[16];
  int (*init) (int);
  void (*deinit) (int);
  int (*fstat)(struct stat *st);
  int (*isatty)(void);
  int (*open)(const char name,int flags,int mode);
  int (*close)(void);
  int (*lseek)(int ptr, int dir);
  int (*write)(char *ptr, int len);
  int (*read)(char *ptr, int len);
} DEV_DRIVER_DESC, *PDEV_DRIVER_DESC;

/* File handle constants */
enum {STDIN=0,STDOUT,STDERR,KEYPAD,ASCIIDISPLAY};
#define MAX_FILENO  ASCIIDISPLAY

/* Library defined functions */
int _isatty(int file);
```

```
/*
 *  libMD407
 *  general.c
 *  includes: _crt_init, _crt_deinit, _sbrk for malloc-support.
 *  template functions for stdio:
 */
#include       "libMD407.h"

extern DEV_DRIVER_DESC StdIn,StdOut,StdErr,KeyPad,AsciiDisplay;

PDEV_DRIVER_DESC device_table[MAX_FILENO+1] =
{
        &StdIn,
        &StdOut,
        &StdErr,
        &KeyPad,
        &AsciiDisplay,
};

static char *heap_end;
extern char __heap_low; /* Defined by the linker */
extern char __heap_top; /* Defined by the linker */
extern char __bss_start__;     /* Defined by the linker */
extern char __bss_end__;       /* Defined by the linker */

char * _sbrk(int incr) { ... }

void _crt_init() {
  char *s;
  PDEV_DRIVER_DESC fd;

  heap_end = 0;
  s = &__bss_start__;
  while( s < &__bss_end__ )
    *s++ = 0;
  s = &__heap_low;
  while( s < &__heap_top )
    *s++ = 0;
  for( int i = 0; i <= MAX_FILENO; i++ )
  {
    fd = device_table[i];
    if( fd && fd->init != 0)
      (void) fd->init( 0 );
   }
   /* NOTE: No printf buffering */
  (void)setvbuf(stdin, 0, _IONBF, 0);
  (void)setvbuf(stdout, 0, _IONBF, 0);
  (void)setvbuf(stderr, 0, _IONBF, 0);
}

void _crt_deinit() {
  PDEV_DRIVER_DESC fd;
  fflush(0); /* Will cause terminal flush... */
  for( int i = 0; i <= MAX_FILENO; i++ )
  {
    fd = device_table[i];
    if( fd && fd->deinit != 0)
      fd->deinit( 0 );
   }
}
/* Anm. parametrar till respektive device init/deinit är valbar */

/* STDIO-common functions */
int _close(int file) { return -1; }
int _open(const char *name, int flags, int mode) { return -1; }
int _fstat(int file, struct stat *st) { st->st_mode = S_IFCHR; return 0; }
int _lseek(int file, int ptr, int dir) { return 0;}

int _isatty(int file) {
  switch (file)
  {
      case STDIN: case STDOUT: case STDERR: return 1;
      default: return 0;
  }
 }

int _write(int file, char *ptr, int len) { ... }
int _read(int file, char *ptr, int len) { ... }
```

```
/*
 *      libMD407
 *  usart_driver.c
 *  USART driver
 *  Drivers for STDIN, STDOUT and STDERR
 */
#include        "libMD407.h"

/* Define functions here */
static int usart_init( int initval );
static void usart_deinit( int deinitval);
static int usart_write(char *ptr, int len);
static int usart_read(char *ptr, int len);

DEV_DRIVER_DESC StdIn =
{
  {"stdin"},
  usart_init,
  usart_deinit,
  0,
  _isatty,
  0,
  0,
  0,
  0,
  usart_read
};

DEV_DRIVER_DESC StdOut =
{
  {"stdout"},
  usart_init,
  usart_deinit,
  0,
  _isatty,
  0,
  0,
  0,
  usart_write,
  0
};
DEV_DRIVER_DESC StdErr =
{
  {"stderr"},
  usart_init,
  usart_deinit,
  0,
  _isatty,
  0,
  0,
  0,
  usart_write,
  0
};

/* USART types and constants definitions */
.....

/* USART implementation */

static int usart_init( int initval ) { ... }
static void usart_deinit( int deinitval){ ... }
static int usart_write(char *ptr, int len){ ... }
static int usart_read(char *ptr, int len){ ... }
```

```
/*
 *      libMD407
 *  keypad_driver.c
 *  Keypad connected to PD8-PD15
 *  Driver for KEYPAD
 */
#include        "libMD407.h"

static int keypad_init( int initval );
static void keypad_deinit( int deinitval);
static int keypad_read(char *ptr, int len);

DEV_DRIVER_DESC KeyPad =
{
  {"Keypad"},
  keypad_init,
  keypad_deinit,
  0,
  0,
  0,
  0,
  0,
  0,
  keypad_read
};

/* KEYPAD types and constants definitions */
...

/* Define functions here */
static int keypad_init( int initval ){ ... }
static void keypad_deinit( int deinitval){ ... }
static int keypad_read(char *ptr, int len){ ... }
```

```
/*
 *      libMD407
 *  asciidisplay_driver.c
 *  Display connected to PE
 *  Driver for ASCIIDISPLAY
 */
#include        "libMD407.h"

static int asciidisplay_init( int initval );
static void asciidisplay_deinit( int deinitval);
static int asciidisplay_write(char *ptr, int len);

DEV_DRIVER_DESC AsciiDisplay =
{
  {"AsciiDisplay"},
  asciidisplay_init,
  asciidisplay_deinit,
  0,
  0,
  0,
  0,
  0,
  asciidisplay_write,
  0
};

/* ASCIIDISPLAY types and constants definitions */
...

/* Define functions here */
static int asciidisplay_init( int initval ){ ... }
static void asciidisplay_deinit( int deinitval){ ... }
static int asciidisplay_write(char *ptr, int len){ ... }
```