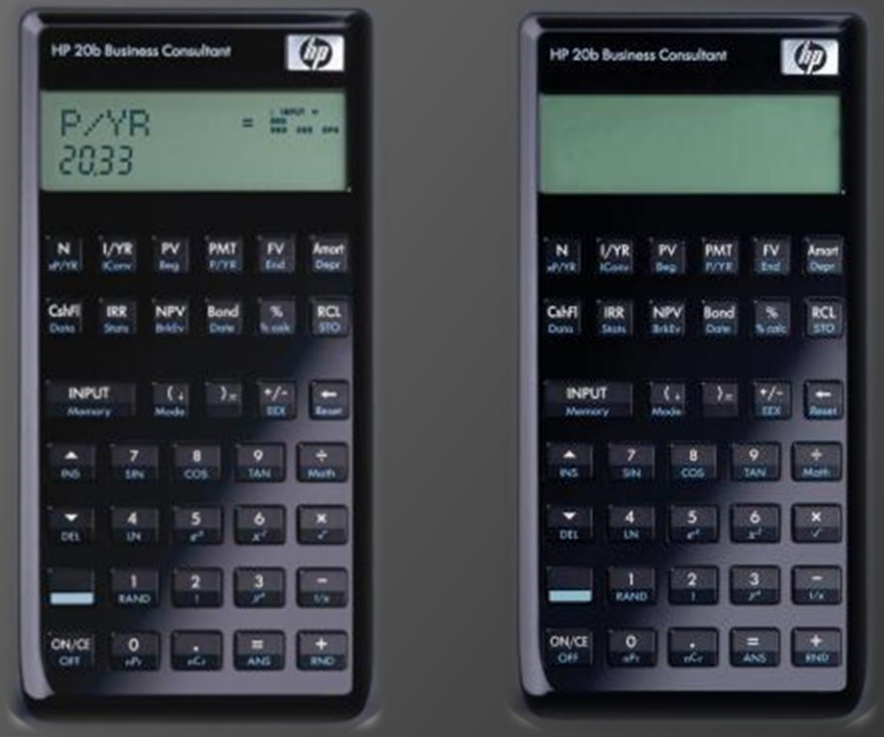
THE HP20B REVOLUTION



from left to right: the HP20b before and after development began

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user_guide() {

- if (entering a number) {
  - type the number from left to right;
    - // e.g. enter “21” as 2, then 1
  - to negate a number, press +/- ;
    - // this will also make a negative number positive
  - for (each digit you wish to eliminate) {
    - press the backspace key;
    - }
  - press ‘INPUT’ to store number;

user_guide() {

- if performing an operation
  - press “INPUT” following each number you wish to store in memory;
  - press any operation key (+, *, -, or /) to perform an operation using the last number in memory and the number on the screen;
  - understand the stack;
  - consult the following examples;

examples() {

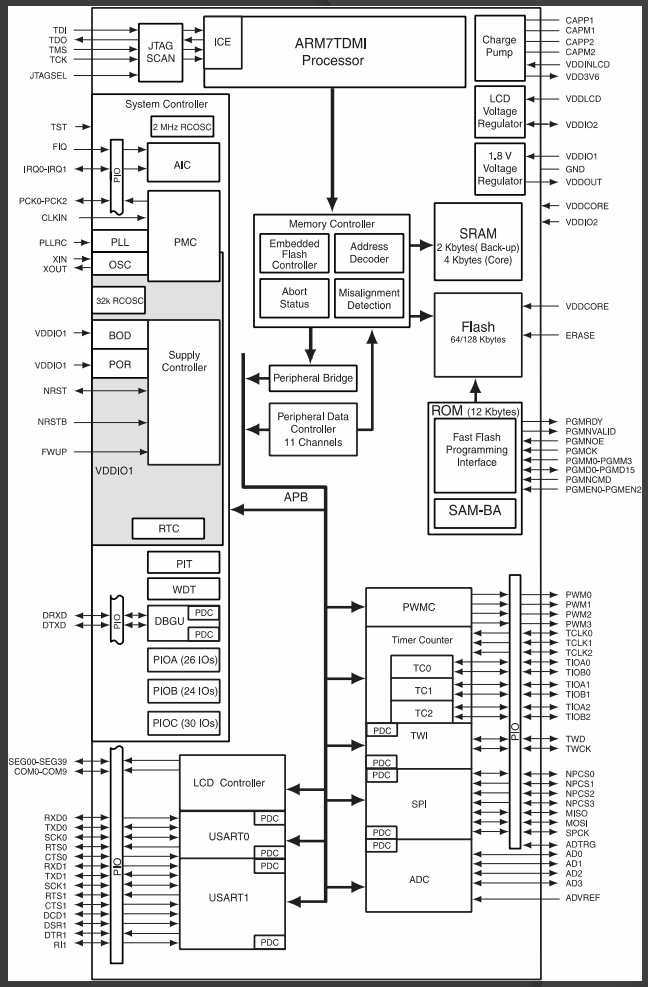
- To subtract 2 from 5:
  - 5
  - INPUT
  - 2
  - -
- Output:
  - 3

examples() {

- To perform (-2 * 3) + (21 / 7):
  - 2
  - +/-
  - INPUT
  - 3
  - *
  - INPUT
  - 2
  - 1
  - INPUT
  - 7
  - /
  - +
- Output: -3

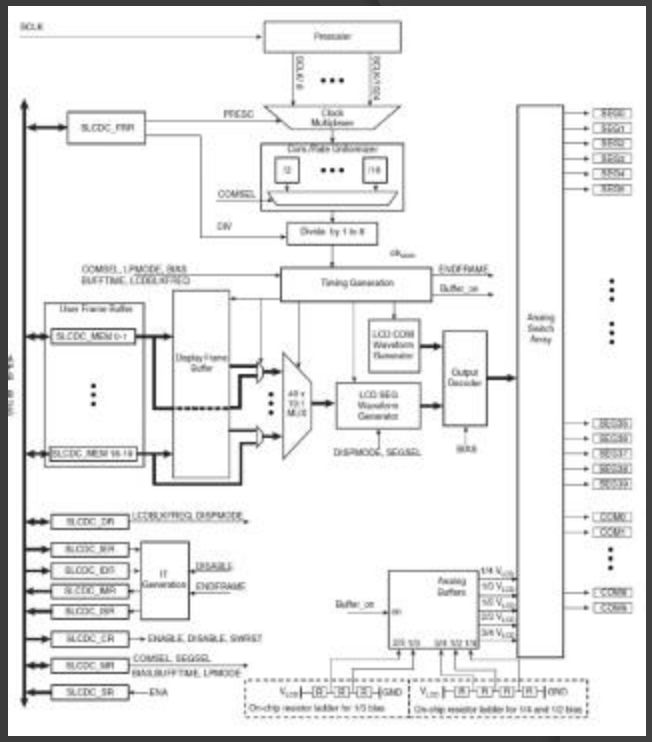
the_platform() {

- Atmel SAM7L Processor
  - Low power
  - 36 MHz
  - 128 KB flash memory
  - Peripheral support



the_platform() {

- The LCD
  - 12 spaces for numbers
  - Second row unused (by us)

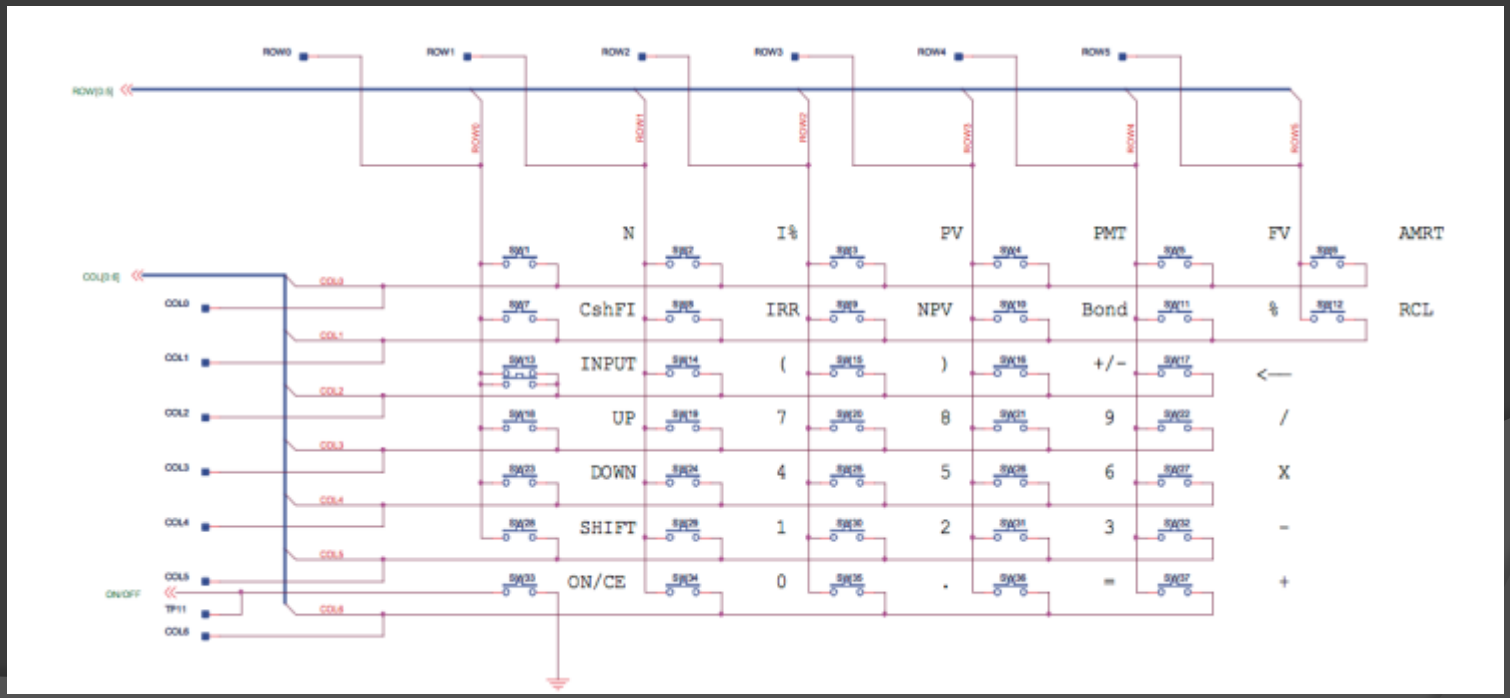



```
extern void lcd_put_char7(char ch, int col);

extern void lcd_init(void);
```

the_platform() {

- The Keyboard



Lab 1: Displaying an Integer

```
#define SEGMENTS 11

void display(int a)
{
    int index = 11;           // start with the rightmost LCD segment
    int isNeg = 0;            //  initially assume the number is not negative

    for (i = 0 ; i <= SEGMENTS ; i++) {
        lcd_put_char7(' ', i); // clear the screen
    }

    if (a == 0) {
          lcd_put_char7('0', index);
    } else {
      if (a < 0) {
            isNeg = 1;        // record that the number is negative, then
            a = -a;           // use only its magnitude
      }
      while (a != 0) { // while there are digits left to display
            int digit = a % 10;                  // find last digit,
            lcd_put_char7(digit + '0', index);   // display it, then
            a = (a - digit)/10;                  // remove it from 'a'
            index--;
      }
      if (isNeg == 1) lcd_put_char7('-', index);
    }
}
```

Lab 2: Scanning the Keyboard

```
char key[7][6] =    {'N', 'I', 'P', 'P', 'F', 'A'},
                    {'C', 'I', 'N', 'B', '%', 'R'},
                    {'I', '(', ')', '~', '<',  0 },
                    {'^', '7', '8', '9', '/',  0 },
                    {'v', '4', '5', '6', '*',  0 },
                    {'S', '1', '2', '3', '-',  0 },
                    { 0 , '0', '.', '=', '+',  0 } };

char keyboard_key(){
          keyboard_init();
          for (i = 0 ; i < 7 ; i++){
                    keyboard_column_low(i);
                    for (j = 0 ; j < 6 ; j++){
                              if(!keyboard_row_read(j)){
                                        return key[i][j];
                                        // do not check while key is down
                                        while(!keyboard_row_read(j)) {}
                              }
                    }
                    keyboard_column_high(i);
          }

          return 0; // when no key is down
}
```

Lab 3: Entering and Displaying Numbers

```
void keyboard_get_entry() {
        int c;
        int num = 0;
        while(1){
                while(keyboard_key()!= 0); // wait if no key is down
                while(keyboard_key() == 0); // wait while key is down
                c = keyboard_key();
                if (c >= '0' && c <= '9') {
                        num = num * 10 + (c - '0');
                } else if(c == '\b'){ // backspace
                        num = num/10;
                } else if(c == '~'){ // +/-
                        num = -num;
                } else if(((c == '\r') || (c == '/')) || (((c == '*') || (c == '-')) || (c == '+'))){
                        return;
                }
                display(num);
        }
}
```

Lab 4: An RPN Calculator

```
int divide(num,den)
{
        int quotient = 0;
        int neg = 0;
        if (num * den < 0) neg = 1;
        num = abs(num);
        den = abs(den);
        while (num >= den) {
                num = num - den;
                quotient++;
        }
        if (neg == 1) {
                quotient = quotient * -1;
        }
        return quotient;
}
```

Lab 4: An RPN Calculator

```
void keyboard_get_entry()
{
        int c;
        int digits = 0; // number of digits
        int num = 0; // number displayed
        int reset = 0;
        int stack[16];
        int ptr = 0; //how many values are saved in stack
        while(1){
                while(keyboard_key()!=-1); // wait if no key is down
                while(keyboard_key() == -1); // wait while key is down
                c = keyboard_key();
                if (c >= '0' && c <= '9') {
                        if (reset == 1){
                                num = 0;
                                digits = 0;
                                reset = 0;
                        }
                        if (digits < 9) {  //avoids overflow
                                if (num >= 0) num = num * 10 + (c - '0');
                                if (num < 0) num = num * 10 - (c - '0');
                                digits++;
                                if (num == 0){
                                        digits = 0; // do not count extra
0s
                                }
                        }
                } else if(c == '\b') {
                        num = num/10;
                        if (digits > 0) digits--;
                } else if(c == '~') {
```

Lab 4: An RPN Calculator

```
} else if(((c == '\r') || (c == '/')) || (((c == '*') || (c == '-')) || (c == '+')))
{   switch (c){
    case '\r': // INPUT
               stack[ptr] = num;
               ptr++;
               break;
    case '+':
               if (ptr >= 1) {
                         ptr--;
                         num = stack[ptr] + num;
               }
               break;
    case '-':
               if (ptr >= 1){
                         ptr--;
                         num = stack[ptr] - num;
               }
               break;
    case '*':
               if (ptr >= 1){
                         ptr--;
                         num = stack[ptr] * num;
               }
               break;
    case '/':
               if (ptr >= 1) {
                         ptr--;
                         num =
                         divide(stack[ptr],num);
               }
               break; ...
```

```
...                                    }
                              reset = 1;
                              }
                              display(num);
                    }
}
```

lessons_learned() {

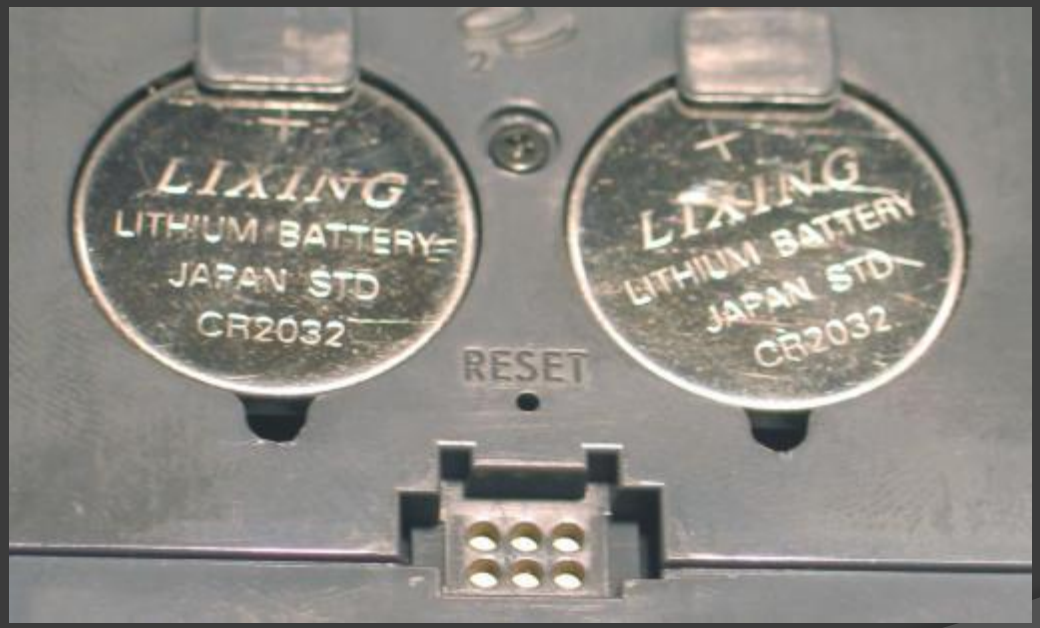
- Professor Edwards == the man

lessons_learned() {

- Communication
  - Coding in teams is hard
- Efficiency
  - Not embarrassing ourselves in code reviews
- Embedded systems
  - Computing without computers

criticism_of_course() {

- Too many hurricanes
- Discard dead batteries



}