Introduction:

Learning how to multiply two 3-bit numbers using assembly.

Equipment:

- Simon Board
- Atmel Studio 7

Procedure:

- Open Atmel Studio 7 and create a new assembly project.
- In order to do multiplication, addition is repeated multiple times.
- First PortA, and PortD are set to be inputs and outputs.
- By adding three to the register five times, the result will be equal to 3*5.
- Map the sum to PortD, the LEDs light up to represent 15.
- For part 2, use the first three buttons, and the last three buttons to then multiply and map the result to the LEDs.
- Use the input pins to determine what is being added and how many times.
- Since the LEDs for each pin in PortD are flipped, reverse the bits.
- Check if each bit was active then map it to the corresponding LED.
- Output the bits to the PortD to the LEDs.

Results:

The two 3 bit numbers were multiplied as expected by the written code.

Questions:

1. Use a register to store the carried bit.
2. The code could use less machine states and does not consider edge cases.

Conclusion:

I learned how to create a project in Atmel Studio 7 to multiply two 3 bit numbers. I also learned how to reverse bits to correctly output the bits to the LEDs.

Appendices:

```
;
; lab2.asm
;
; Created: 2/19/2020 9:59:22 AM
; Author : argk4
;

; port made configs
LDI R16, 0xFF
LDI R17, 0x00
OUT DDRD, R16
OUT PORTD, R16
OUT DDRA, R17
OUT PORTA, R16

MAIN:
```

```asm
    IN R20, PINA
    COM R20        ; switches are active low

    LDI R16, 0x00
    LDI R17, 0x00

    CLC
    ROR R20
    ROL R16
    CLC
    ROR R20
    ROL R16
    CLC
    ROR R20
    ROL R16

    LSR R20
    LSR R20

    ; serialization 3 times on R17
    IN R28, PINA
    CLC
    ROR R28
    ROL R17
    CLC
    ROR R28
    ROL R17
    CLC
    ROR R28
    ROL R17

    LDI R21, 0x00
MULT:
        ADD R21, R16
        DEC R17
        BRNE MULT

    ; Reverse bits of R20 into R22
    LDI R22, 0x00

    CLC
    ROR R21
    ROL R22

    CLC
    ROR R21
    ROL R22

    CLC
    ROR R21
    ROL R22

    LSR R21
    LSR R21

    ; Complement and output the Result to PORTD since active low
    COM R22
    OUT PORTD, R22
```

```
        CALL DELAY
        RJMP MAIN

DELAY:
        LDI R24, 255
        D1:
                LDI R25, 255
                D2:
                        LDI R26, 25
                        D3:
                                NOP
                                NOP
                                DEC R26
                                BRNE D3
                        DEC R25
                        BRNE D2
                DEC R24
                BRNE D1
                RET
```