Unsigned Binary Addition

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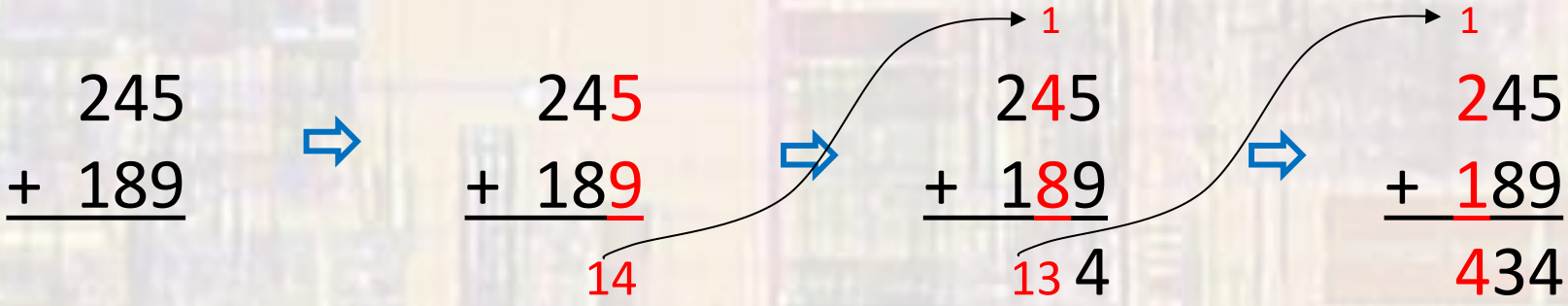
These slides introduce unsigned binary addition

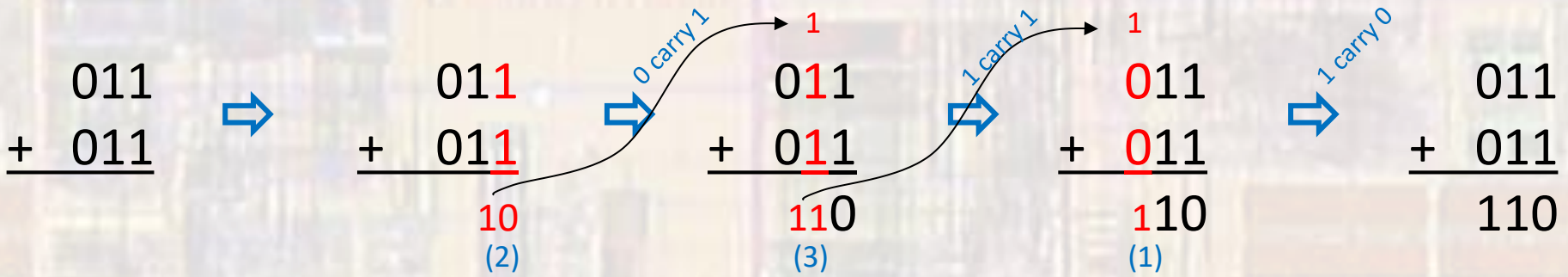
Unsigned Binary Addition

- Decimal Addition - Elementary school concepts
  - Add columns of numbers and keep track of the carry over to the next column
  - We normally use the decimal number system
    - Digits: 0-9
    - Carry over is in sets of 10



Unsigned Binary Addition

- Unsigned Binary Addition - Extend elementary school concepts
  - Add columns of numbers and keep track of the carry over to the next column
  - Use the binary number system
    - Digits: 0-1
    - Carry over is in sets of 2



Unsigned Binary Addition

- Unsigned Binary Addition - Examples

```
    1
  100101
+ 011001
 111110
```

```
  1 1 1 1
  101111
+ 001001
 111000
```

```
  1 1 1 1 1
  101111
+ 011001
 1001000
```

Depending on the situation – this may or may not be a problem

Unsigned Binary Addition

- Overflow
  - In elementary school we did not care how many digits the answer required

```
  745
+ 589
 1334
```

  - In unsigned binary addition – we are generally representing something that ultimately is to be executed in hardware
    - Our hardware cannot change the number of bits (wires) it can hold
    - We must establish a maximum number size (# of bits) and create an error when the result of the addition does not fit in this size
    - The error is called an overflow

6-bit numbers
6 wires for the result

```
  1 1 1 1 1
  101111
+ 011001
 1001000
```

Unsigned Binary Addition

- Overflow – Unsigned Binary

add 101111 to 011001

8 bit unsigned binary

```
  1  1 1 1 1
  00101111
+ 00011001
  01001000
```

No overflow

6 bit unsigned binary

```
  1 1 1 1 1
  101111
+ 011001
  1001000
```

Overflow

Unsigned Binary Addition

- Overflow – Interpretation

6 bit unsigned binary

```
  1 1 1 1 1
  101111    47
+ 011001    25
  1001000   72
```

Overflow

72 does not fit in 6 bit unsigned

Result in 6 bits is 8

6 bit
Unsigned Binary
Number Line