Why "Smart Products"?

Focuses on Microcomputers as Components
not
Controllers

Encompasses Mechatronics
What Makes Mechatronics Different?

- Intelligent Decision Making
- The Ability to adapt
- Cost Effectiveness
What Makes these Decisions?

Computers
Number Representations

Binary
10101010

Hexadecimal
$AA$

Converting
10101010

$ AA $
Number Terminology

MSB 10101010 LSB

Upper Nibble

Lower Nibble

Byte
Integer
Word
Modulo Arithmetic

11111111
+ 1
---
00000000

00000000
- 1
---
11111111
What's A

Microprocessor ?

Micro-Computer ?

Micro-Controller ?
Micro-Computer Components

- CPU
- Program Memory
- Scratchpad Memory
- Input/Output (I/O)
<table>
<thead>
<tr>
<th>Address</th>
<th>Contents</th>
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### What's in the Address Space?

<table>
<thead>
<tr>
<th><strong>Instructions</strong></th>
<th>Instructions to the microprocessor. Often referred to as 'Machine Language'</th>
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<tbody>
<tr>
<td><strong>Data</strong></td>
<td>Generally we put this there during the operation of our programs</td>
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<tr>
<td><strong>Control Registers</strong></td>
<td>These occupy space like memory, but are actually special locations that interact directly with the hardware of the microprocessor.</td>
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<td><strong>Ports</strong></td>
<td>A subset of the control registers, Ports generally offer direct control of the pins on the microprocessor.</td>
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Memory Map

- FFFF: EPROM
- E000 - DFFF: RAM/EPROM
- C000: E2PROM
- B7FF - B600: Registers
- B03F - B000: 
- 7FFF: RAM
- 6000: 
- 00FF - 0000: RAM
Program Memory Options

- MROM
- PROM
  - EPROM
    - Eraseable
  - OTP
- EEPROM (or E²PROM)
- FLASH EPROM
Scratchpad Memory Options

Static RAM
Battery Back-up

Dynamic RAM

Cache RAM
What Features Will You Find?

Parallel I/O

Programmable

Fixed Direction
What Features Will You Find?

Counters

Timers
  Simple
  Complex
  Outrageously Complex
What Features Will You Find?

Serial I/O

- Synchronous
- Asynchronous
What Features Will You Find?

A/D Converters

- 8 - Bit
- 10 - Bit
- Multi-Channel
What Features Will You Find?

D/A Converters

PWM
What Differentiates Micro-Controllers?

Feature Sets
Architecture
Physical Size
Cost
The Motorola 68HC11

Hi-Performance 8 - Bit Controller

8 - Bit Data Bus

Supports Hi-Level Languages

Comes in over 45 'Flavors'
68HC11 Memory

16 Bit Address Bus
   64K (65536) Byte Address Space

8 Bit Data Bus

2K (2048) Bytes EEPROM

256 Bytes RAM
68HC11 Parallel I/O

8 Bi-Directional Lines

8 Fixed Output Lines
68HC11 Timer System

16 Bit Free-Running Counter

Input Captures (3)

Output Compares (4)
68HC11 Pulse Accumulator

8 bits

Interrupt on Overflow
68HC11 Serial I/O

SPI (synchronous)

SCI (asynchronous)
68HC11 A/D Converter

8 bit (1:256) Resolution

8 Channels

2 banks of 4
The Development Process