



# Embedded Sensors – Small dimensions, big differences

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# Change – the only constant

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- Change is occurring faster than ever before
  - Caused primarily by technology advances
- The technology treadmill



# Process automation & controls

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- We moved during the last 50 years
  - From pneumatic controls (some still around)
  - To electronics (vacuum tubes) to transistors to integrated circuits
  - Direct Digital Controls (DDC) gave way to Distributed Control Systems (DCS)
  - Now we have networked PC-based control systems



# Discrete Automation

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- Contactors relays and motor controls became programmable logic controllers offering better alternatives for control
- PLCs are now a commodity business
- Software
  - Hard-wired relay-ladder-logic became programmable
  - Programmable via PC software
  - Embedded software



# New age connectivity

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- Every digital and analog I/O point is getting "connected"
- Eliminating the old "islands of automation"
- Introducing visions of vast arrays of interconnected "appliances".



# Smart “appliances”

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- Information needed from each product
  - History, part number, where purchased, when installed, by who, key characteristics, specifications, operating instructions, diagnostics, availability of spares, replacement alternatives, repair instructions, etc.
- In the past, this information would be in printed documentation, or with trained experts.
- In the future, the I/O appliance itself will contain all of the required “knowledge”, embedded within it and always accessible



# Technology Moves on

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- Today large, expensive and dumb
  - Sensors lack intelligence - they simply provide measurements for remote processing
- Tomorrow tiny, cheap and smart
  - MEMS and Nanotechnology will yield tiny, low cost, low power sensors
  - Tiny is important – scattered around to measure just about everything that you can imagine.
  - Low power – won't need to carry a large battery
  - Low-cost – numbers required will be enormous.



# Automation inflection points

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- Wireless sensors everywhere
- MEMS - Microelectromechanical systems
- NEMS - Nanotechnology
- Complex adaptive system (CAS)



# Wireless sensors everywhere

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- Wireless sensor networks will soon become as important as the Internet.
- Just as the Internet allows access to digital information anywhere, sensor networks will provide vast arrays of real-time, remote interaction with the physical world.
- The process monitoring and controls business will be generating significant growth in this new arena.



# Smart wireless networks

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- Will soon be everywhere around us
  - Collecting and processing vast amounts data
    - not just monitoring a few isolated sensors, but literally tens of thousands of intelligent sensor nodes
  - Providing not merely local measurements, but overall *patterns* of change.



# MEMS

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- Microelectromechanical systems (MEMS)
  - Semiconductor fabrication techniques
  - Miniature turbines, motors, gears, moving mirrors
  - Sensors, actuators, and displays
- Size and cost bring practical utilization
  - Tremendous number of old and new applications



# Nanotechnology

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- Small dimensions, big differences
  - At nanometer dimensions, the classical laws of physics change
  - New materials - smaller, stronger, tougher, lighter, resilient
- Practical nanotech materials
  - Different characteristics when "assembled" at a molecular level
  - Carbon nanotubes - strongest and most conductive fibers
  - Nano-structured membranes for efficient filtering of pollutants
- New gadgets galore
  - Today's supercomputer – tomorrow's wristwatch or PDA
  - Tiny, inexpensive nanosensors - wireless networks, medical diagnostics, chemical and biohazard detection
- Carbon nanotube transistors
  - Smaller than any possible silicon transistor, better performance
  - New ways of storing information



# NEMS

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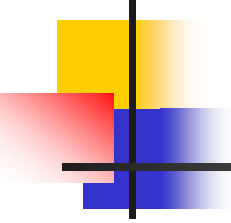
- Nanotechnology - products at atomic-scale
  - Nanoelectromechanical systems
  - Next step beyond MEMS
- Old-style metal bending, grinding and cutting will become obsolete
- Build-to-order
  - Materials with flawless internal structures
  - Stronger and lighter, less wear
- Electronics will get smaller and faster
  - Atomic-scale quantum effects – computing performance beyond today's wildest dreams



# Complex adaptive systems

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- New self-organizing, peer-to-peer networks
  - Intelligence resides directly in sensors and actuators
  - Eliminating large, complex, and ineffective centralized control systems
  - Today's PLC and PC-based controls & software will seem ineffective, expensive, and even archaic
  - CAS provides a level of effectiveness and robustness that is unprecedented
  - Old deterministic control architectures will disappear.



# New functions & applications

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- Within the next few years, significant new technology will provide completely new functions
  - Optimize widely spread processes
  - Provide vast productivity and quality improvements in process systems.



# Related Links

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- The Pervasive Internet & its effect on industrial automation:  
<http://jimpinto.com/writings/pervasive.html>
- Wireless Sensor Networks:  
<http://jimpinto.com/writings/sensornetworks.html>
- Network Choices - the Wireless Revolution:  
<http://jimpinto.com/writings/networkchoices.html>
- Pervasive Networks:  
<http://jimpinto.com/writings/pervasivenetworks.html>
- Near-term Nanotechnology:  
<http://jimpinto.com/writings/nearnanotech.html>
- JimPinto.com:  
<http://JimPinto.com>