2012 Cyber Physical Systems PI Meeting

CPS in Design & Manufacturing
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A Short ‘History’ of Manufacturing

- **Materials- and Process-Driven Manufacturing**
  - New materials demand process innovations
  - Stone-chipping to semiconductor fabrication

- **Metrology-Driven Manufacturing**
  - Precision of parts made > that of machine parts
  - A cycle of ever-increasing precision
  - Interchangeable parts to LIGO

- **Logistics-Driven Manufacturing**
  - Electric motors provided distributed power
  - Layout for material flow, not power access

- **Computer-Driven Manufacturing**
  - NC Machining (1952), CAD/CAM
  - Modeling and Simulation, MRP, Synthetic Biology
Current Role of the Internet in Manufacturing

• The CAD terminal is pervasive
  - Modern gateway to manufacturing
  - 100,000 CAD/CAM seats in US High Schools

• Manufacturing enterprises use internet communications
  - data transmission, collaborative design, ordering

• Improved web services promise reduced wait time
  - Estimated > 95% of part time in organizational handoffs

• Some manufacturing services available, within process
  - Rapid prototyping, NC machining, VLSI, PCBs…

• No analog to explosive expansion of web commerce
• Retailing, music, publishing have been transformed
  - Widely accessed by a creative public
The Manufacturing Mindset

• Highly skilled and experienced specialists
• Product must be 100% reliable, on-time and in-spec
  - A deciding factor for critical applications
  - Systems must respond predictably to every need
• Requires ‘command and control’ systems
• Top-down, expensive, complex, difficult to change
• The opposite of the web

But…
The ‘Internet Manufacturing’ Mindset

• System capabilities will evolve and increase with time
  - If some entrepreneurs can make money using them
  - Only a tiny fraction of apps will survive
• Small scale users exploit incremental capabilities
  - Key element is better tools than they have
  - They’ll make what the system can produce
  - Access increased by reduced cost of entry
  - Long odds of success for millions of ideas
• Large-scale users exploit proven capabilities
  - Adopt as the reliability threshold is crossed
  - Fortune 100 were not early web adopters