NSF NanoComputing Workshop

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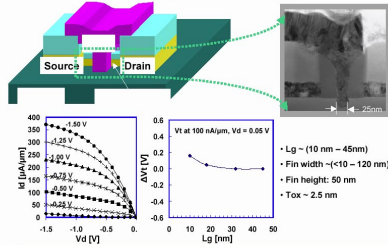## The 21st and a Half Century

▷ **The Century of NanoTechnology**
▷ **Promises of nanotechnology**
  ◆ Better engineered materials
  ◆ True genetic and bio-engineering at the DNA, cell, bacteria, protein and virus level
  ◆ Better devices for interacting between the 'real' and 'synthetic' (computed?) worlds
    ➤ Displays, sensors, direct organism interfaces
  ◆ Better devices for processing information
    ➤ Electronic switches, DNA, quantum, etc.
    ➤ Scaling beyond the end of the ITRS

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The End is Nigh???

The 18 nm Transistor

Source Drain

25nm

400 350 300 250 200 150 100 50 0

Id [µA/µm]

-1.50 V
-1.25 V
-1.00 V
-0.75 V
-0.50 V
-0.25 V

-1.5 -1.0 -0.5 0.
Vd [V]

0.6 0.4 0.2 0.0 -0.2 -0.4 -0.6

∆Vt [V]

Vt at 100 nA/µm, Vd = 0.05 V

0 10 20 30 40 50
Lg [nm]

• Lg ~ (10 nm – 45nm)
• Fin width ~(<10 – 120 nm)
• Fin height: 50 nm
• Tox ~ 2.5 nm

Deep Scaling - World's Shortest Gate Length FET (18 nm)
With Useful Electrical Characteristics (IEDM 1999)

DARPATech 2000

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What Does This Mean?

During the working lifetimes of our students, Solid State electronics will become the hotbed of innovation that magnetic transformer technology is today

▷ **How to prepare**
  ◆ Our Undergraduate students?
  ◆ Our Professional MS Graduate students?
  ◆ Our Ph.D. students?
  ◆ Ourselves, as we focus on problems with a five to twenty year horizon?
  ◆ The possible research agenda and organization of CISE?

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Random Thoughts

▷ **Education**
  ◆ Return to Fundamentals
    ➤ More Chemistry & Quantum Physics
    ➤ Less solid state
▷ **Research Agenda**
  ◆ Design of NanoComputers
  ◆ Better approaches for integrating the "real" and "synthetic" worlds
  ◆ Emergence of the discipline of NanoEngineering
    Science & Nature ➜ Product SpecSheet

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Workshop Output

▷ **Report to NSF**
  ◆ Topical focus for future CISE Nano Initiatives
    ➤ NSEC focus this year on "Manufacturing"
      ● How to arrive at a CISE-inclusive NSEC for next year. E.g. steer it towards a system focus.
    ➤ Other ways to determine Research Agenda
  ◆ How to encourage strong CS and CPE participation in NanoScience and NanoEngineering?
    ➤ E.g. Cross-disciplinary workshop
  ◆ How to better prepare the National Workforce for the Century of NanoTechnology?
    ➤ E.g. Supported education activities & infrastructure

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Possible Research Agendas

▷ **Abstractions**
  ◆ For Design Automation
▷ **Approaches**
  ◆ Nanotech-specific
    ➢ E.g. architectures that suit nanodevices
  ◆ More general
    ➢ E.g. RAS in high defect and high fault environments
▷ **"Outside the Box"**
  ◆ E.g. Sensor/computing integration
▷ **Cross-disciplinary activities**
  ◆ E.g. Algorithms for nanotech

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"Grand Challenge Problems"

▷ **Designing the 10^{13} transistor computer**
▷ **Seamless Man-Machine interface**
▷ **Nanosensor Sensor Net with local computation**
  ◆ Nanocentric Ubiquitous Computing
▷ **….**

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Education

▷ **Undergraduate**
▷ **Graduate (MS)**
▷ **Graduate (PhD)**

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