# College of Nanoscale Science & Engineering

UNIVERSITY AT ALBANY State University of New York

# A New Era in Nanotechnology Research: The Industry-University-Government Cooperative Model

May 18, 2010

Michael Liehr AVP Business Development, Alliances and Consortia Professor of Nanoengineering IBM Distinguished Engineer (ret.)







## **Keeping up with "More Moore"** R&D Versus Revenue. A Real Crisis



**R&D** cost rising much faster than revenue

"Tripling costs create elitism with very few haves and most have nots"



# **Semiconductor Industry Trend - Clustering**



Locations capable of leading-edge 300mm logic R&D:





Industry proprietary: Intel, IBM JDA, Taiwan (TSMC/UMC), South-Korea (Samsung)

**Michael Liehr** 



## Nano-Fabrication Technology Drives the next Industrial Revolution



#### Opening the field to smaller players in cooperative models

ensor



#### (Source: 2005 ITRS) Michael Liehr

cnse.albany.edu

(IEDM2002)

Frank Robertson, Intel Manager External Programs Albany Symposium, Lake George 2004



### High Tech Education A U.S. National Economic Crisis



National Science Foundation: "U.S. needs 2 million nanotech savvy workers by 2014."

Is enough being done? Not by a long shot!

Michael Liehr

cnse.albany.edu

**Source: Federal Bureau of Labor Statistics** 





# **CNSE Cross-Disciplinary Mission**

#### CNSE is dedicated to nanotechnology with constellations in:

- Nanoscience
- Nanoengineering
- Nanobioscience
- Nanoeconomics



*Vision* Leverage combined resources to establish effective partnerships that will enable <u>realization of *industry* technology</u> <u>roadmaps</u> and pioneering nanoscale research.

*Mission* Create a financially and technically competitive environment to <u>empower the nanoelectronics *industry*</u> with manufacturing advantages through vertically integrated partnerships.

Michael Liehr



#### **Shared State-of-the-Art Facilities**



**Michael Liehr** 



# State-of-the-Art Wafer Processing Capability

- Full complement of state-of-the-art 300mm wafer tools
- Designed for 32nm node & beyond but
  - ✓ Unit process, module and full flow capability.
  - Compatible with previous generations:
    - ✓ 65nm industry-standard low-power process
- Capacity of 25 integrated wafer starts per day.
  - ✓ 24/7 operation
  - Capacity upgrades readily possible













### **CNSE Alliance Model**



cnse.albany.edu

**Michael Liehr** 



# SEMATECH's Role

- Lead industry-wide initiatives
  - Set industry direction by building industry consensus and driving large industry projects
- Develop infrastructure and standards to bridge R&D to manufacturing
  - New / improved tools, materials, processes
  - Manufacturability is the driver for technical programs
- Drive manufacturing productivity and cost reduction
- Develop leading-edge technology
  - Foundation for industry breakthroughs





## **SEMATECH Success Factors**

- Commitment from top level executives, long-term support
  - Industry and government champions
- Industry leadership
  - Government-industry-university partnership
- A clear, pre-competitive mission
  - Accelerate commercialization by addressing common challenges, per industry roadmap
    - Building technology infrastructure
    - Strengthening manufacturing base
- Broad representation of industry, broad network of partners
  - Chipmakers and universities, national labs (Sandia, NIST), research institutes, equipment/materials manufacturers
- Leveraging of government and industry funds
- Member-driven organization
  - Assignees







Source: Sematech



# **Equipment Development Center @ CNSE**



**Michael Liehr** 



# IBM Joint Development Partnership Albany's Role





# **CNSE Proof-of-Concept Chip Strategy**



	In-house / Partner
Libraries and IP	License model
Mask build	Partner
Tape-out	Partner
Enablement (kit)	Partner
Models	Buy / Build capability
Characterization	Build capability / Partner
Groundrules, design manual	Build capability
Reliability	In-house
Feature development	In-house / Partner
Yield Management	In-house / Partner
Integration	In-house / Partner
OPC	Partner
PFA	In-house
Process Development	In-house / Partner
Equipment suppliers	Partner / In-house
Materials suppliers	Partner / In-house

#### **Testbeds and Infrastructure Development**

- Built on current and future open source masksets
- Multi-Project-Wafer (MPW) Concept university / SME opportunity
- Offering to start with 65nm industry standard bulk lowpower technology
  - Radio-frequency (RF) enabled
- 32nm capability under development
- Personalization options
- Tech transfer support into volume manufacturing



**Michael Liehr** 



# **3D Integration**

- The next step in subsystem integration
- The convergence of Silicon & Packaging
  Stepping stone for "More than Moore"
- Core packaging capability
  - 3Di w/ multi-wafer chip stack for 32 / 22 nm nodes
  - Far-BEOL semiconductor processing & C4 bump
  - Module bond, assembly & test



Combine partner silicon and packaging R&D teams to focus and develop the 3D Unit Process and Integrated flow.

#### **3DI Process Flow**







**Michael Liehr** 



#### **System-Level Operational Model**





**Michael Liehr** 



## **SRC and Sematech CNSE Strategy**





# **SRC Nanoelectronics Research Initiative**

Finding the Next Switch

Mission: Demonstrate novel computing devices capable of replacing the CMOS FET as a logic switch in the 2020 timeframe

- Find devices that show significant advantage over ultimate FETs and enable the industry to extend the historical cost and performance trends of scaling
- Leveraging industry, university, and both state & fed government funds, and driving university nanoelectronics infrastructure





# Nanobioscience

Biological systems are inherently nano in scale. **Nanobioscience** combines the tools, ideas and materials of nanoscience to address biologically relevant questions.



- Cancer
- Stem Cells
- Diagnostics
- Drug Delivery
- Biosensors
- Prosthetics
- Medical Devices









**Michael Liehr** 



#### **CNSE.** The Educational Programs





#### Preparing the Technical Workforce "GetNANO"

- Partners: Hudson Valley Community College and CNSE.
- Provides HVCC students with handson training in CNSE's cleanroom facilities.
- Makes New York's workforce "techready:" operate complex equipment in tech plants.



**Michael Liehr** 



# Summary

"More Moore" has led to an industry consolidation.

- Government-university-industry collaboration models are required in this increasingly complex and costly ecosystem.
- Ease of transfer into manufacturing is key to accelerating R&D timelines.
- SRC and Sematech play vital roles in providing novel concept pipelines and premanufacturing / infrastructure learning.
- "More than Moore" opens opportunities for SME partnership models.
  - Technological breakthroughs driven by smaller players have significant impact potential.
  - We expect game-changing developments in applying Nanotechnology to energy, biomedical and urban infrastructure.
  - The US must maintain a vibrant infrastructure in this field.
- Government-university-industry collaboration models have to provide education and training for future technical leaders
  - We have to inform and encourage support in the general population.