

The MIND Initiative

Overview and Opportunity

Indiana Economic Development
Association

June 13, 2008

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Project Future



An Edge Makes All The Difference

1679	LaSalle – <i>St. Lawrence to Mississippi</i>
1831	Shirley & Bog Iron
1832	Foundry – St Joe Ironworks
1852	Studebaker Blacksmith Shop
1868	Studebaker Manufacturing Co. – Wagons
1904	Studebaker – Autos
1895	Revra DePuy – Orthopedics
1906	1 st (US) Steel Plant – Gary Indiana
1913	Ford starts 1 st assembly line

**These events provided us
with a significant manufacturing edge**



An Edge Makes All The Difference

US Auto and Steel Industries

Subcontract Manufacturing and Services

Question:

In light of our transitioning economy, what is the biggest question facing the communities of the Midwest?

"Where do we find our next edge?"



Where Is Our Next Edge?

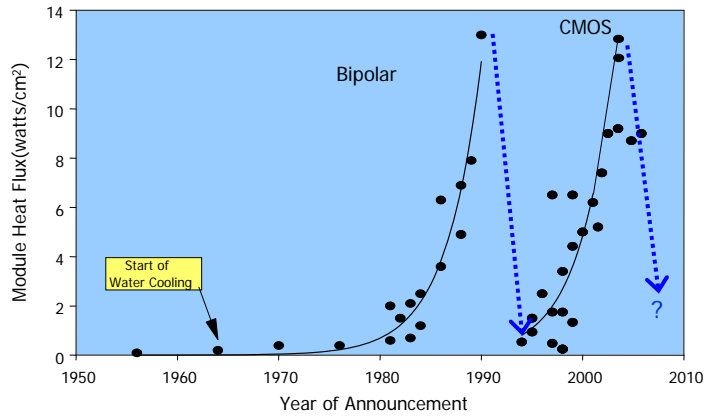
Something is happening in the world of high-speed electronics.

The U.S. (and world) semiconductor industry is about to hit a wall with it's silicon chip technology.

It is a power and size barrier

Something Is Happening

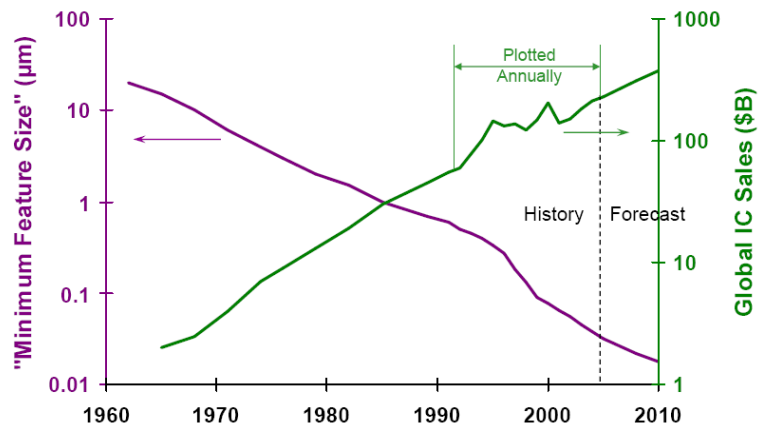
Power is The Problem *and it has happened before . . .*



Next 10-15 years: New technology enhancements
Continued CMOS shrinking, multi-core chips, 3D packaging, new memory devices, etc.

Something Is Happening

Scaling = Progress in Electronics



Smaller features → Better performance & cost/function → More apps → Larger market



Something Is Happening

When was the last time you bought a faster computer?

The world semiconductor industry is hotly in pursuit of the next logic device that will replace the current silicon chip



Something Is Happening

The US manufacturers have locked arms to win this race

The ***Semiconductor Research Corporation*** was been created to advance the research targeted at finding the new device.

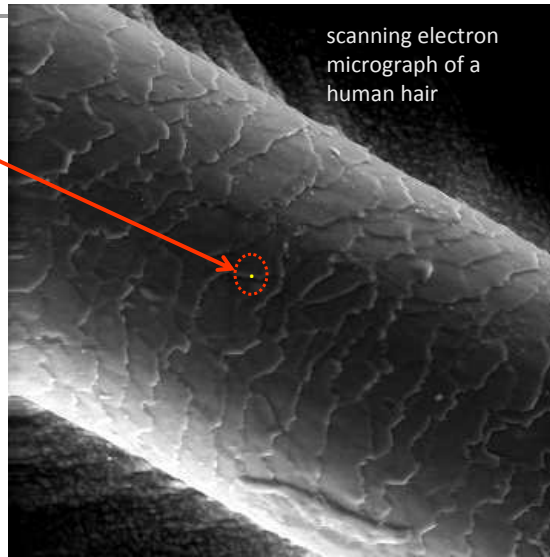
They are pursuing a NANO solution



Nanometer (10^{-9} m = 0.000,000,001 m)

**1 transistor switch would
fit in the dot.**

**6 million transistors on
the head of a pin**



<http://resolution.umn.edu/MMS/ProjectMICRO/Schools/Index.htm>
400 nm dot drawn at the center of a human hair



Corporate Partners

Six of the Semiconductor Research
Consortium's corporate partners have pooled
millions of dollars and created the
Nanoelectronics Research Institute



 Corporate Partners Driving Research



The Nanoelectronics Research Institute (NRI)

2006 - Three National Research Centers

Purpose:

Identify, develop and commercialize

the nanoscale logic device that will replace the current silicon chip

 Corporate Partners Driving Research



The Nanoelectronics Research Institute (NRI)

Created A Fourth National Center in 2008

Nanoelectronics • Architectures



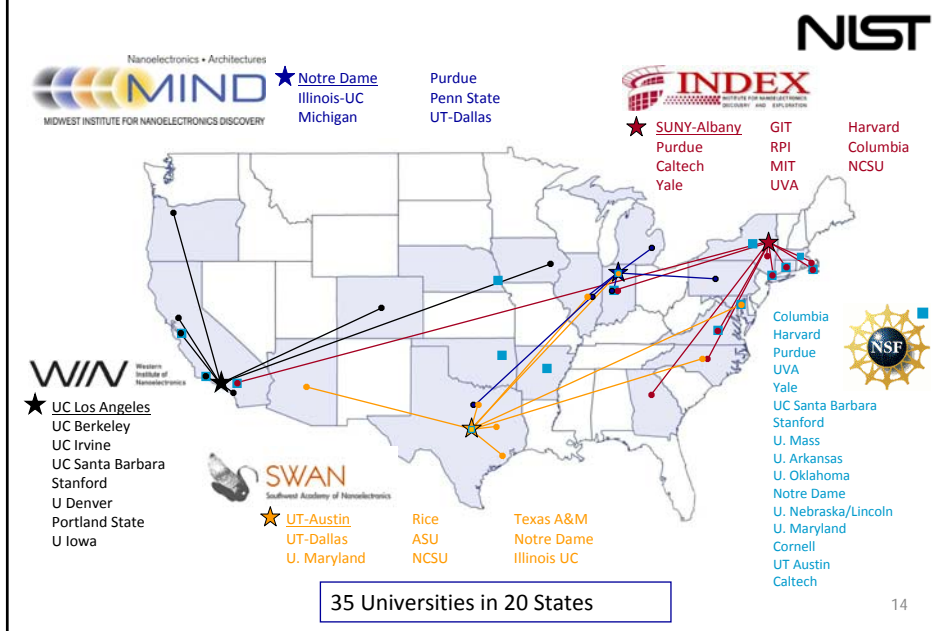
MIDWEST INSTITUTE FOR NANOELECTRONICS DISCOVERY



MIND is...

- Universities:
 - Notre Dame
 - Purdue
 - Michigan
 - Illinois
 - Penn State
- National labs:
 - National Institute of Standards and Technology (NIST)
 - Argonne National Laboratory
 - National High Magnetic Field Laboratory

NRI Funded Universities



Nanoelectronics — Energy-Efficient Devices

1-Dimensional nanowire interband tunnel transistors
Mayer et al. Penn State

Lateral field-effect tunnel

Energy Dissipation in Non-Equilibrium Systems
Pop et al. Illinois

Thermal Transport and Thermal Logic Gates
Chen et al. Purdue and NML

Vertical heterostructure tunnel transistors
Datta et al. Penn State

Full 3-D, 2-D, 1-D Quantum Transport Models
Klimeck et al. Purdue

Gated graphene resonant tunneling transistors
Jena et al. Notre Dame

Architectures for nanoscale magnetic logic devices
Niemier et al. Notre Dame

Graphene SpinFETs on Silicon
Ye et al. Purdue and UTD

Circuit design
Mazumdar et al. Notre Dame

National Lab Collaborations
NIST - Argonne - NML

Nanoelectronics • Architectures

Less Expensive

Faster

Energy Efficient

Smaller

Architectures — Energy-Efficient Systems

Comparison of NRI emerging device technologies for benchmarking and for comparison to CMOS technology

Why This Activity Is Unique

- Unlike most all other university-based research activities, this effort is not a great idea trying to find a sponsor or a home.
- Six of the world's leading semiconductor companies have chosen to actively engage **Indiana's** expertise in nanotechnology, and are waiting to immediately commercialize its results.



Why This Activity Is Unique -- *more*

- The industry change is upon us
 - Current physical and technological limitations REQUIRE the semi-conductor industry to change the basic building block of electronics and all of the devices that use electronics.
 - The NRI expects that the early-stage prototyping for the new device will begin within 3 to 5 years.
 - The NRI expects that the new device will displace the silicon chip within 12 years, by 2020



Why This Activity Is Unique -- *more*

- The change will be highly disruptive: introducing new materials, new manufacturing facilities, and new applications.
- The Midwest Institute is uniquely focusing upon the creation of the architectures that will allow the new device to be used in a wide variety of applications.
- This is a rare chance to step into a major prototyping role for a **trillion** dollar industry, an opportunity to engage with and host economic activity that has previously been a west, southwest and northeast activity.



MIND Will...

- Change the way the world works, and Indiana's researchers will be leading the way
- Fast-forward Indiana into a massive segment of the knowledge economy, and will give the state a new competitive edge on the world stage
- Enable communities around Indiana to participate and benefit



MIND Will Also...

- Precipitate significant investment
- Stimulate business growth
- Provide Indiana with an opportunity to establish the intellectual property and business relationships capable of transitioning large segments of its economy



The Bottom Line on MIND

Nanotechnology
may be more significant to
Indiana's economic future than
even the automotive, steel, and
pharmaceutical industries have been.



A Local Response

- Strong local government financial commitment
- Renewed and strengthened relations with Notre Dame, setting the stage for university-linked economic development - Creation of IP @ ND – Significant support for prototyping activities
- Massive new real estate development linking city and campus, including the reinvention of the former Studebaker Corridor
- Major expansion of research funding by Notre Dame
- Establishment of a community-wide strategic plan identifying those assets that must be modified if the community is to see research and commercialization create local employment



Indiana's Commitment

- Gov. Mitch Daniels announced MIND in March
- Bi-partisan legislative leadership support
- State Finance Committee hearing on \$12-million to support MIND's operating expenses



Will We Step Up?

Our involvement with this trillion+ industry can be a life-changing event for the economy of our communities, the State of Indiana, and the Midwest region



IEDA's Opportunity

Think of MIND and the transition occurring in nanoelectronics as a new strategy for economic growth and development

- For our state
- For our communities
- For our universities, colleges and tech colleges
- For our people



Our Challenge

- Recognize the economic power of leveraging Indiana's intellectual assets
- Increase support for the efforts of Indiana's universities to transfer their knowledge to the marketplace
- Create focused community and regional infrastructures that support research-based enterprises

- MIND is real and it is here...
- MIND signals a new economic era...
- MIND will challenge us...
- MIND will reward us...and
- MIND will transform us

If we rise to the opportunity it presents.