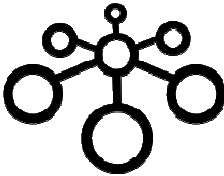


**ncn**  
nanoHUB.org

**Network for Computational Nanotechnology (NCN)**

*Purdue, Norfolk State, Northwestern, MIT, Molecular Foundry, UC Berkeley, Univ. of Illinois, UTEP*

## Interactive Online Curricula and Resources for 125,000 nanoHUB.org Users




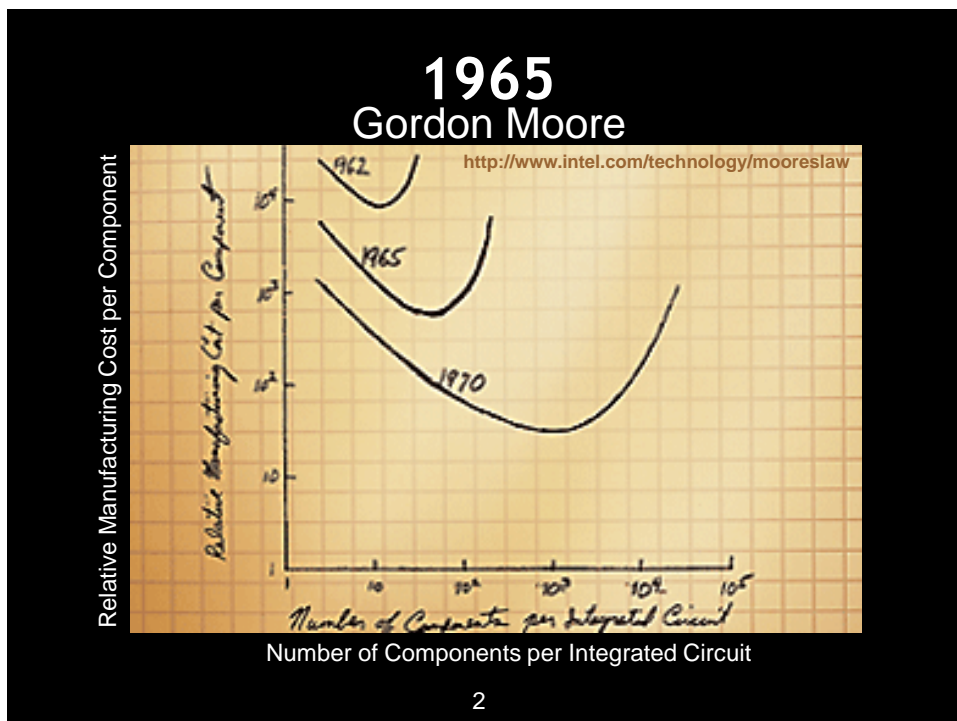
**ncn**  
nanoHUB.org

Gerhard Klimeck

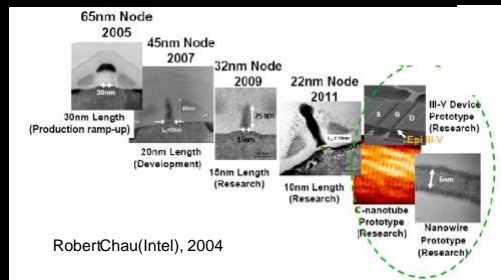
**Gerhard Klimeck**  
Director  
Network for Computational Nanotechnology (NCN)  
Electrical and Computer Engineering  
gekco@purdue.edu

University Materials Council Meeting  
Northwestern University, June 23, 2010



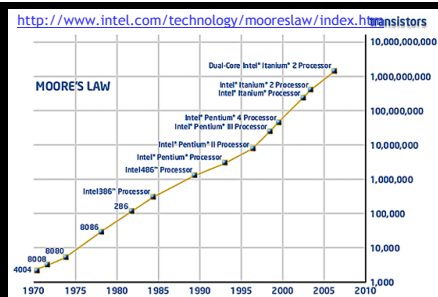


## Intel in 2009



*Device Size:*  
Tens of nanometers

**Stanford SUPREM**



*Device Integration:*  
>2 Billion

**Berkeley SPICE**

3

## Berkeley

Simulation Program with Integrated Circuit Emphasis.



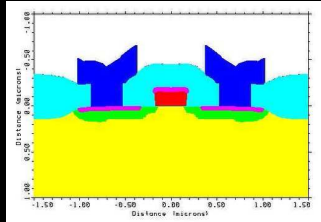
from: Larry Nagel, BCTM '96

- Started as a class project
- Developed as a teaching tool
- Quality control: pass Pederson
- Dissemination:
  - Public domain code
  - Pederson carried tapes along
  - Students took it along to industry and academia
- Released 1972

4

# Stanford

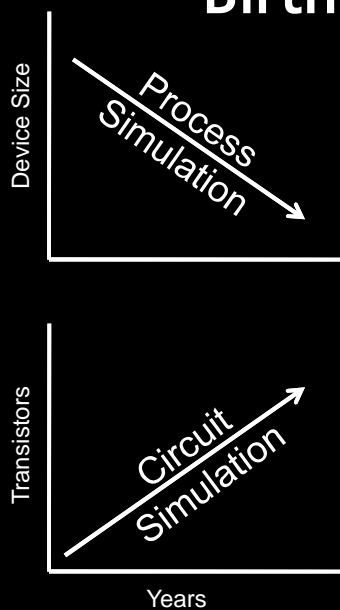
## Stanford University Process Modeling



- Stanford wanted to mimic Berkeley success
- Combine various existing models
- Dissemination:
  - Public domain code
  - Community workshops
  - Students took it along to industry and academia

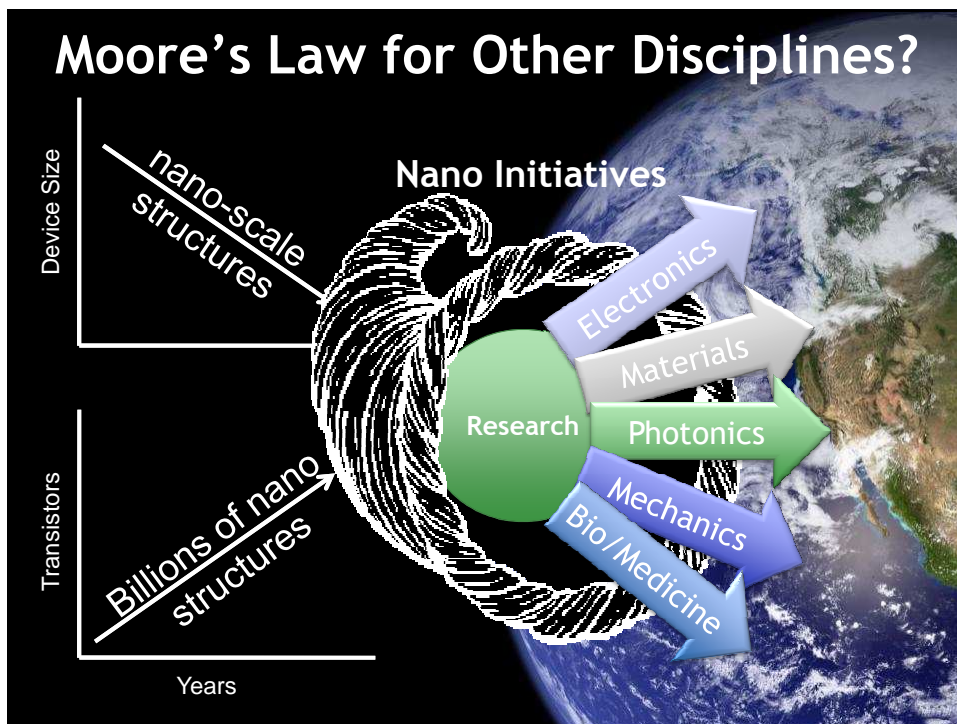
5

## Birth of an Industry

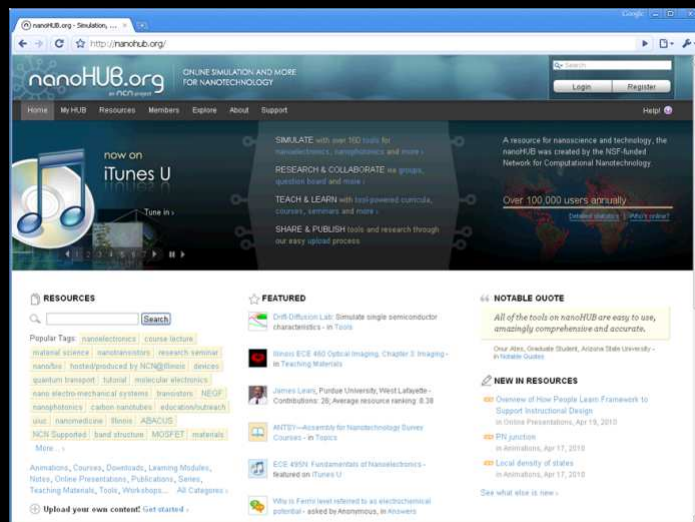


Intel Capitalization:  
**\$85B**  
 Total Industry:  
**\$280B**

6

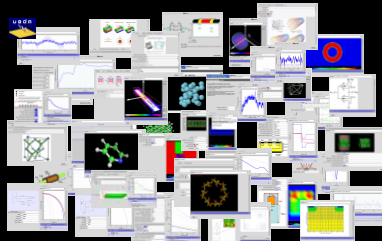


## It Happens Here





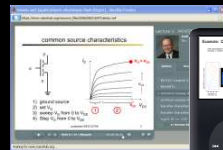
# Over 2,100 Resources!



170 tools



43 courses



1,557 seminars and teaching materials

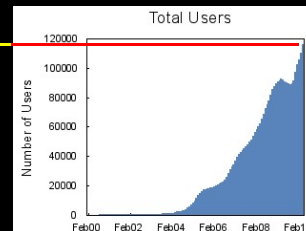


9

## World-Wide Community

**116,000 users worldwide**

As much traffic as [www.purdue.edu](http://www.purdue.edu)  
 Users at all Top 50 US Engr Schools  
 19% of all .edu domains  
 116 classes at 76 institutions in 2009  
 8,200 users ran 345,000 simulations



172 countries

Demo>>

10

# A course on nanophotonics

**nanoHUB.org** an ncn project ONLINE SIMULATION AND MORE FOR NANOTECHNOLOGY

Search  Login Register

Home My HUB Resources Members Explore About Support Help!


You are here: Members > Vladimir M. Shalaev > Usage

**Vladimir M. Shalaev**

Profile Contributions Usage Favorites

Table 1: Overview

Item	Value
Contributions:	24
Total "and more" Users Served:	20,631
Rank by Contributions:	18 / 731
First Contribution:	04 Oct 2005



**Introduction to semiconductor device education with ABACUS**

Assembly of Basic Applications for Coordinated Understanding of Semiconductors

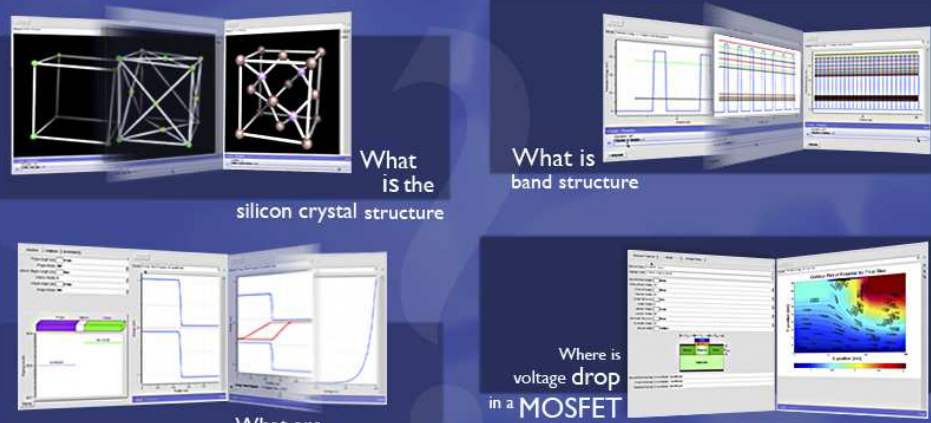
What is the silicon crystal structure

What is band structure

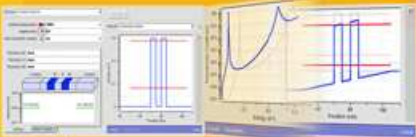
What are highly doped P/N-junctions

Where is voltage drop in a MOSFET

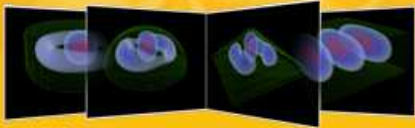
tutorials all lessons main



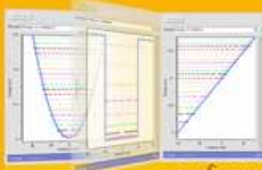
## Advancing Quantum Mechanics for Engineers with **AQME**



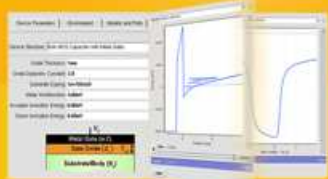
What is resonant tunneling



What is an artificial atom



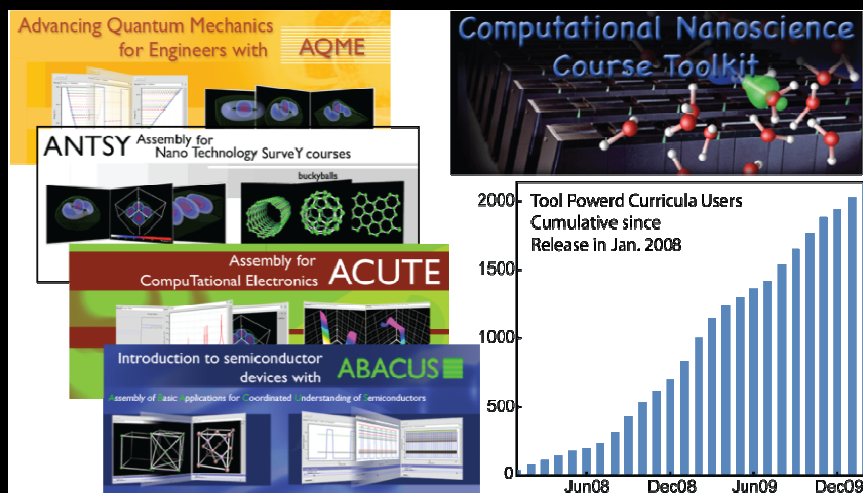
What is the relation between confinement potential and the state spectrum



What are MOSFET subbands

## Tool Powered Curricula

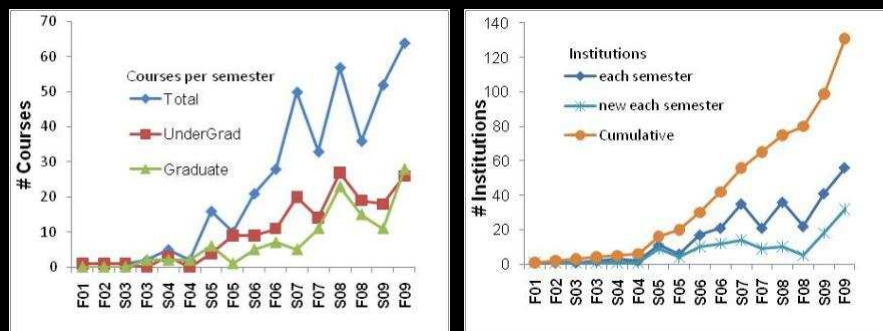
*“make abstract concepts more concrete”*



# Use in the classroom

In the year 2009:

116 classes; 76 institutions; 23 countries



## Work with Teachers

*Educational workshop:*

- November 5-6, 2009, Chicago Airport
- 11 faculty
- 11 institutions / 8 primarily serving minorities

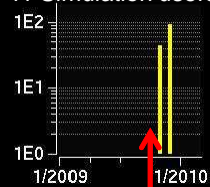


# Immediate Impact

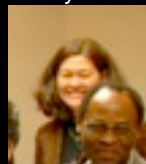
Hasina Huq  
UT Pan Am.



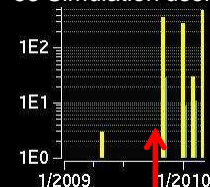
UT Pan Am.  
11 Simulation users



Tanya Faltens  
Cal Poly Pomona



Cal Poly Pomona  
53 Simulation users



## nanoHUB on iTunes U



Exclusive - Apple VP  
OK'ed



- one of 68 orgs



New  
York  
Public  
Library





# nanoHUB on iTunes U



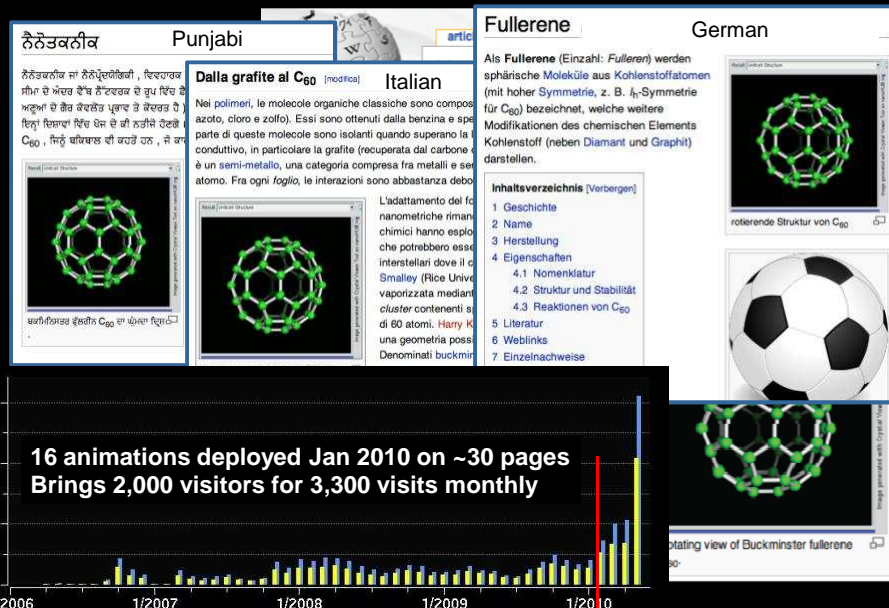
Nov 2009 start

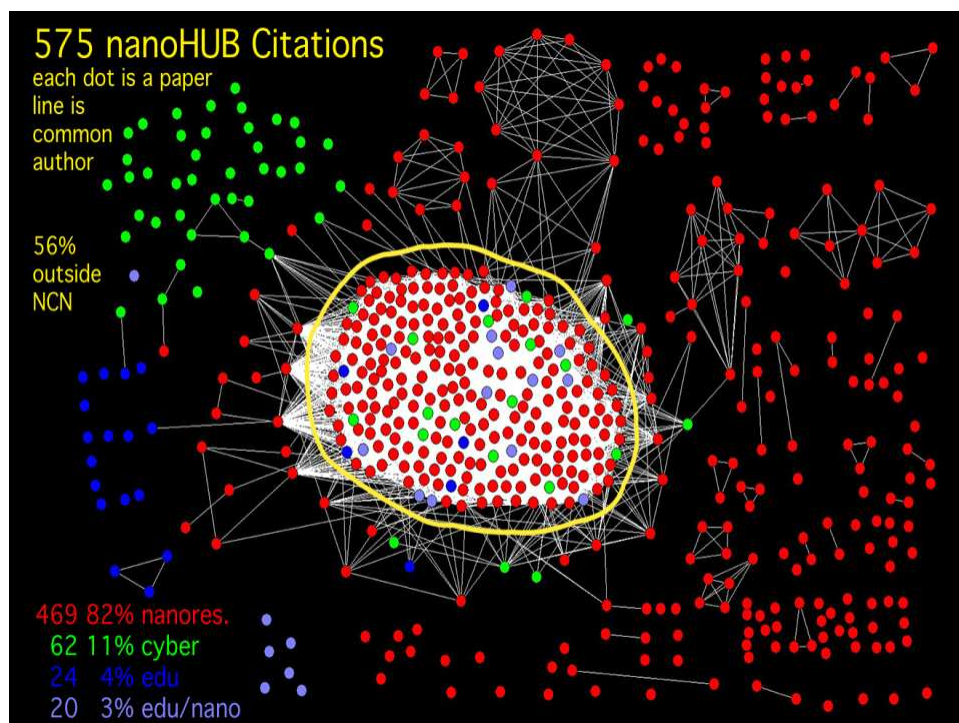
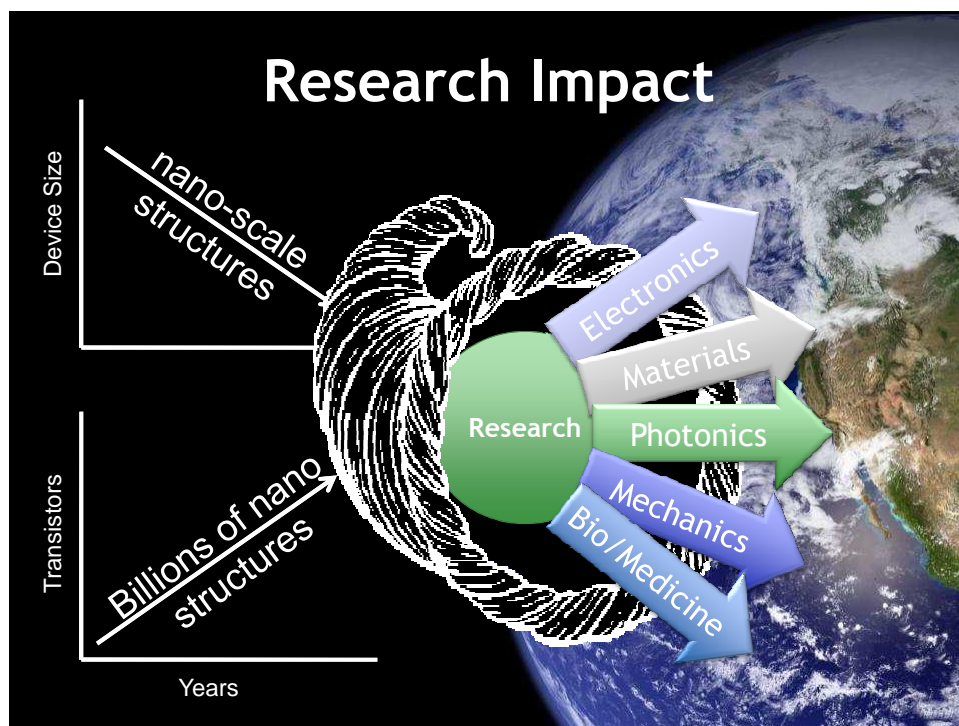
350 content items today

55,000 downloads

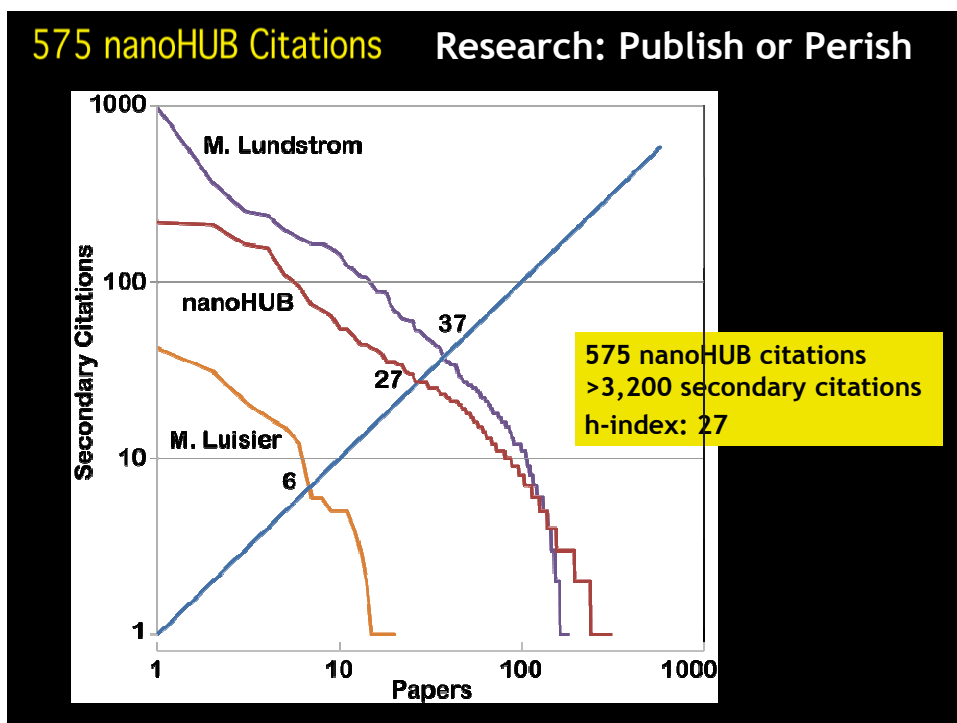
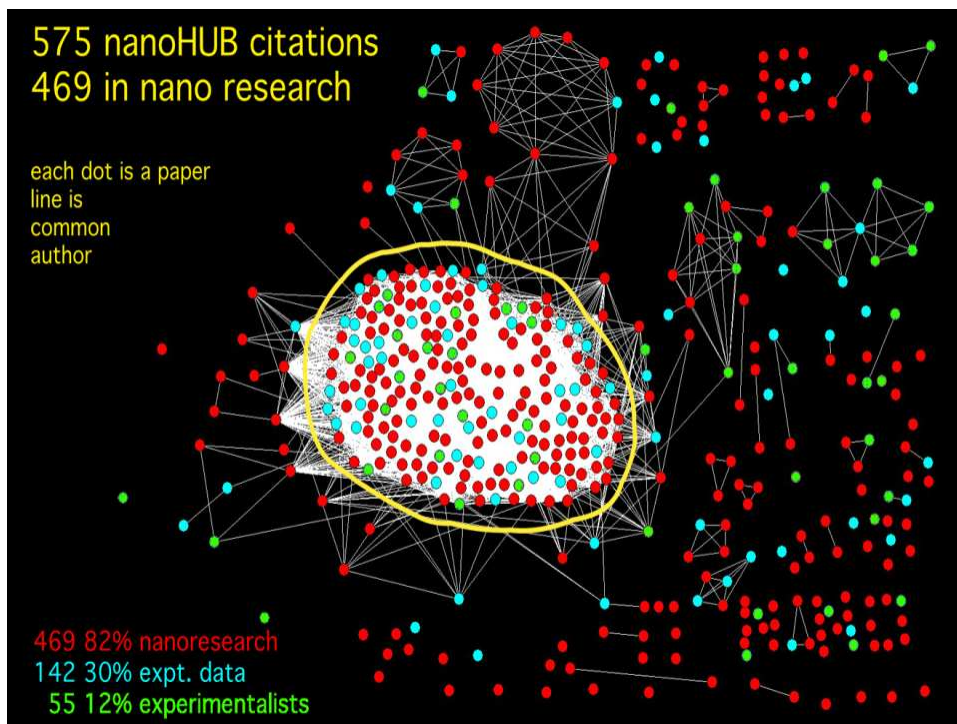
~10,000 downloads/month

# Wikipedia Contributions









# Use by Experimentalists: Schred

*TCAD simulations using SCHRED [15] or ISE, ....., were used to support our analysis and compute the inversion carrier profiles in the devices.*

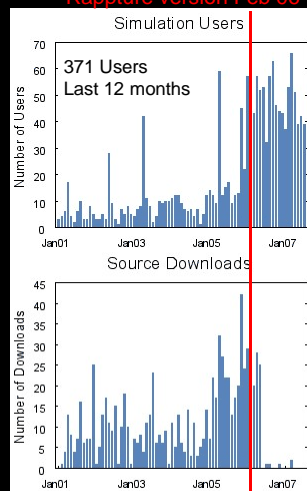
Effect of channel positioning on the  $1/f$  noise in silicon-on-insulator metal-oxide-semiconductor

M von Haartman, M Oestling,  
Journal of Applied Physics, 2007 - [link.aip.org...](http://link.aip.org...)

25

# Dual Use in Research and Education

Rappture version Feb 06

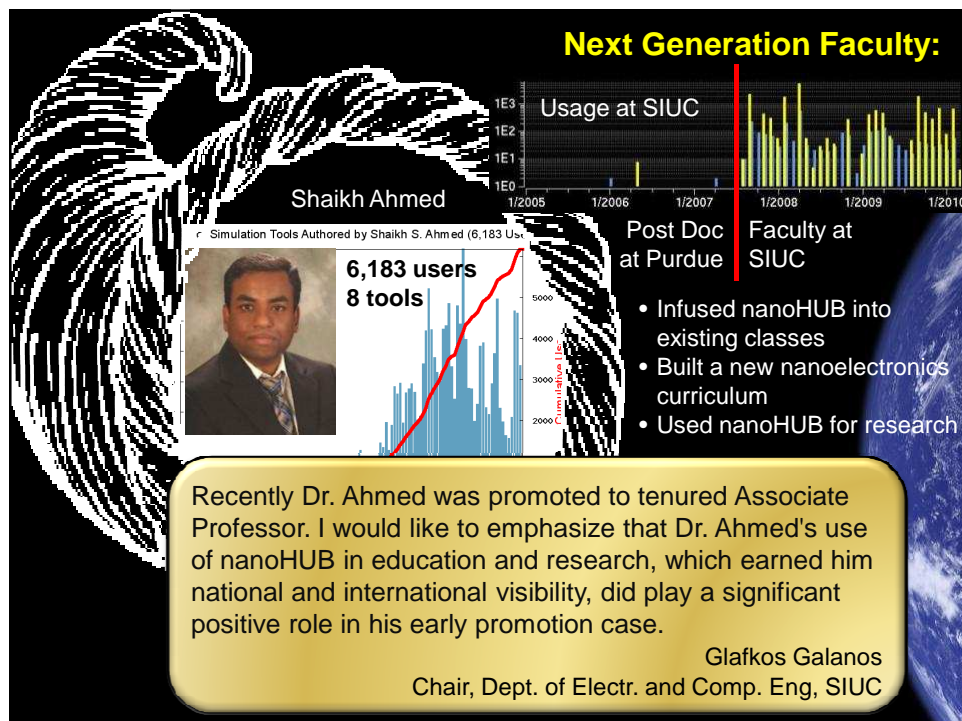


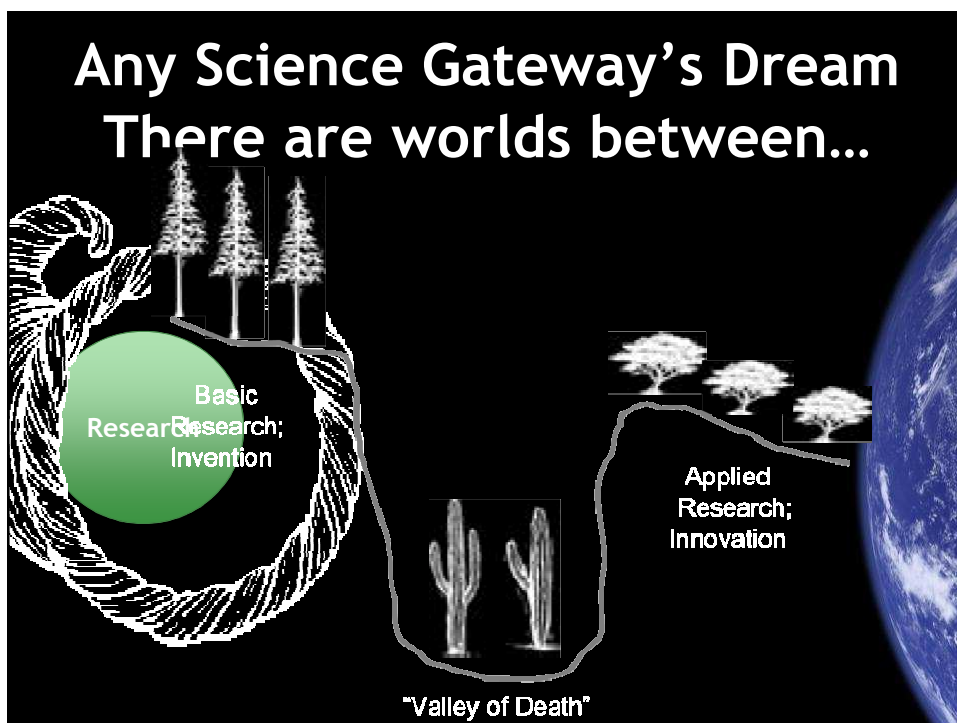
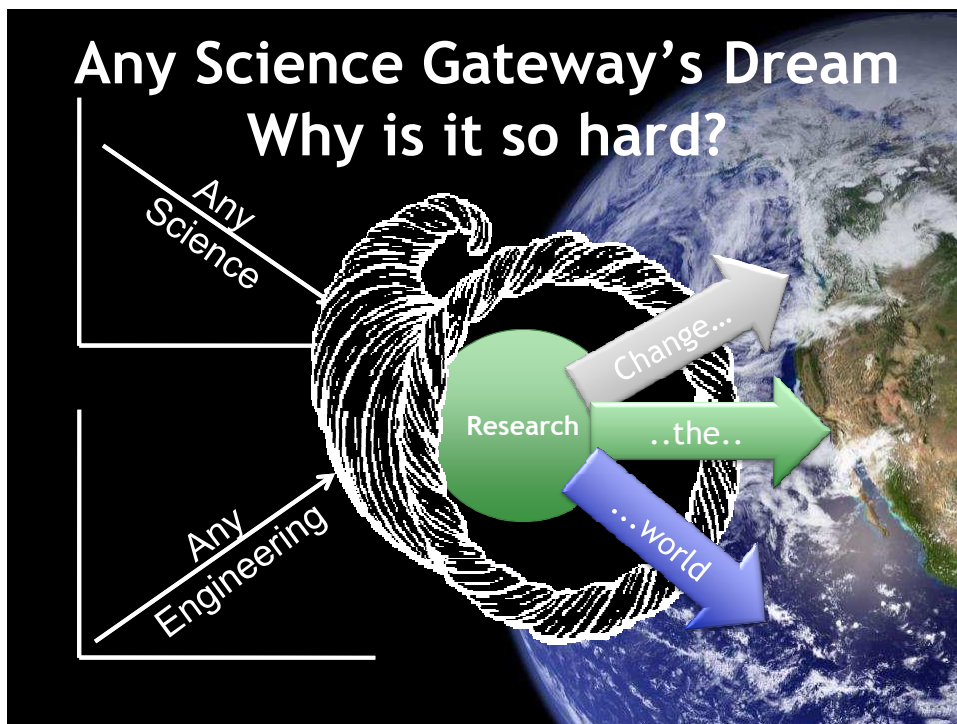
*TCAD simulations using SCHRED [15] or*

User Interfaces are  
absolutely critical!

- Same behavior across all similar converted tools
- User's don't have to download/install software

26

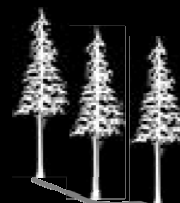
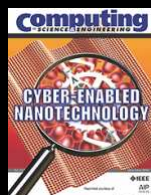
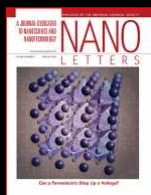




# 5 Criteria for Successful Science Gateways

## 1: Outstanding Science

“Stuff the world wants”



Leveraged Research

**\$5.1M**



Basic  
Research;  
Invention



## 2: Commitment to Dissemination

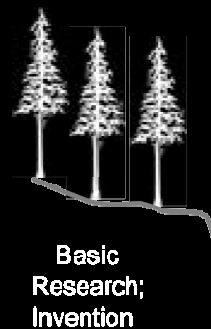
"faculty that want to give it away"

46 faculty

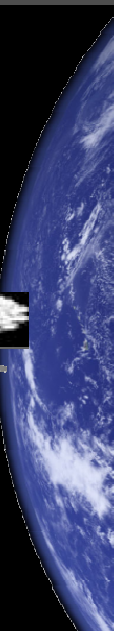
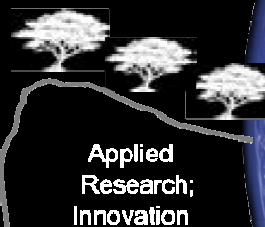
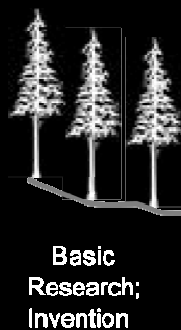


+ 6 site leads

106 grad students

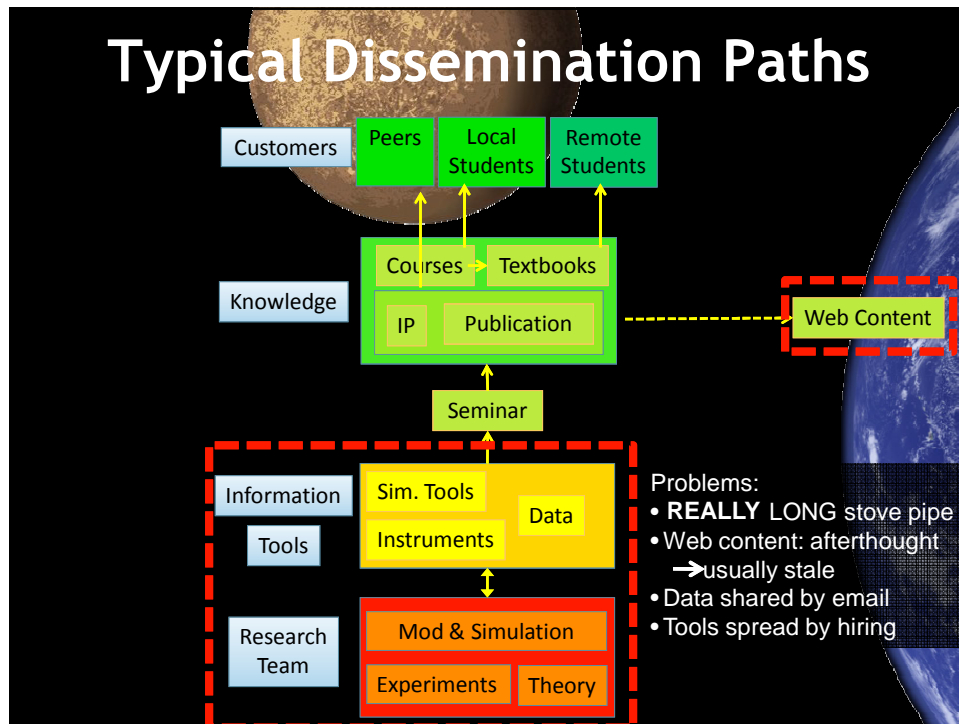


## 3: Technology for Dissemination

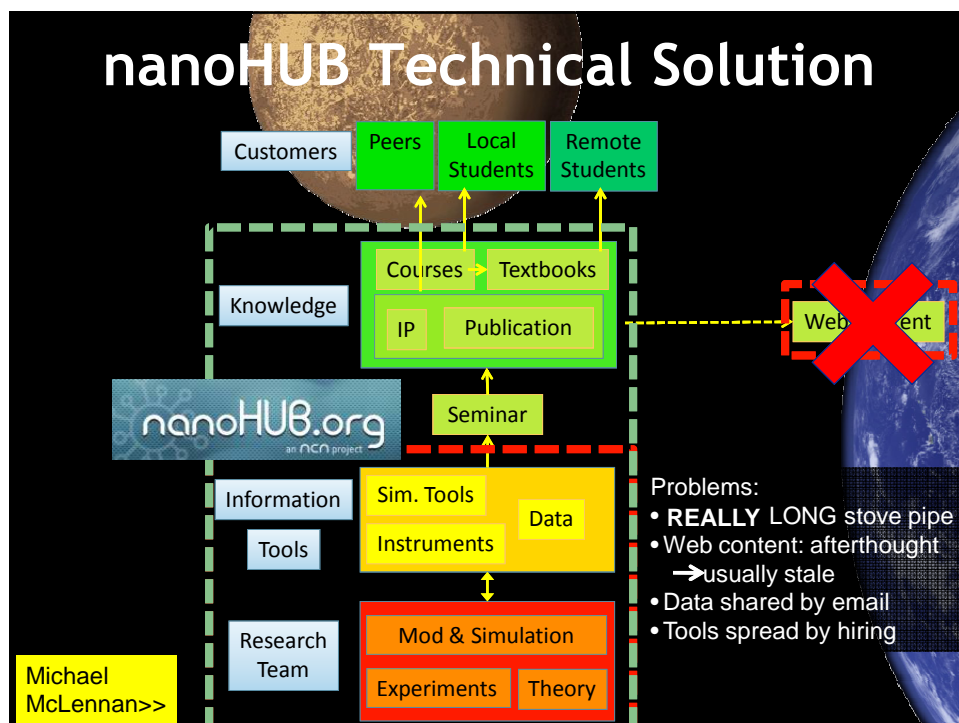




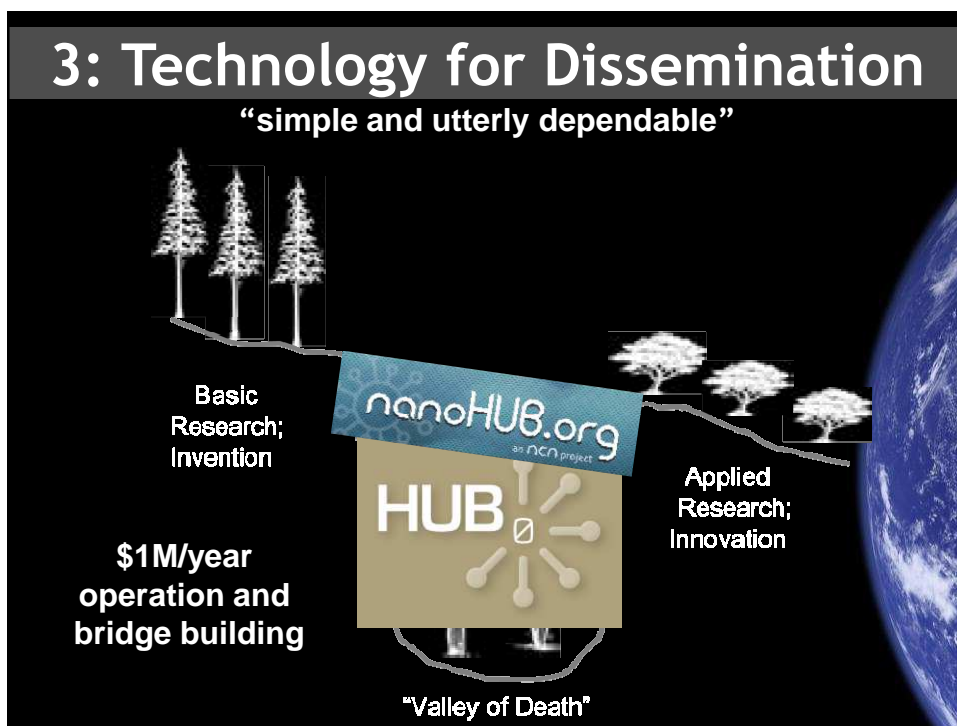
# Typical Dissemination Paths



# nanoHUB Technical Solution







Hub Technology Group  
Rosen Center for Advanced Computing

## Hubs 'R Us

- Feb 2007: 1 hub
- Feb 2008: 5 hubs
- Feb 2009: 8 hubs
- Feb 2010: 21 hubs

Each hub has its own funding stream

Outside institutions: A, NYSTAR, Rice

**HUBzero Consortium**

## 4: Tech Transfer Processes

“dedicated technical site leads”

**Content Creation and Support  
\$2.2M**

“Valley of Death”

## Knowledge Transfer Research

“educational research team”

**Purdue Cost Share \$100k  
CAREER Leverage**

“Valley of Death”

## 5: Open Assessment / Incentives

"gather, understand, disseminate stats"

Access, Use, Impact

Basic Research; Invention

Applied Research; Innovation

"Valley of Death"

## World-Wide Learning Community

**116,000 users worldwide**

As much traffic as [www.purdue.edu](http://www.purdue.edu)  
 Users at all Top 50 US Engr Schools  
 19% of all .edu domains  
 116 classes at 76 institutions in 2009  
 8,200 users ran 345,000 simulations

