



Rensselaer

Invited Presentation

Computing Research Association

Conference @ Snowbird, Utah

June 25-27, 2006



Engineering & Computer Science Higher Education-

*Its Global Divestiture &
Challenges for
International Graduate Students*

Dr. Lester A. Gerhardt

Rensselaer Polytechnic Institute

Troy, New York

gerhal@rpi.edu

Why Couple Engineering and CS?

- **I'm a Professor of ECSE as Well as CS**
- **USNWR Mandates that Engrg Include CS**
- **Many Times CS is in the SoE**
- **I Had More Data on Engineering**
- **Why Not?**
 - More Seriously**
- **Both Fields are Strongly Related & Highly Interdisciplinary**
- **Both Fields Experience Similar Fluctuations**
- **Both Fields are Encountering Similar Issues of International Competition**

Universities warn against denying research jobs
to the world's best and brightest minds.

Plan shuts labs to foreigners

BY ERIC ANDERSON
DEPUTY BUSINESS EDITOR

It's no secret that the United States has grown more dependent on foreign researchers. At Rensselaer Polytechnic Institute, for example, 577 foreign undergraduate and graduate students are enrolled, and many are engaged in original research.

The Research Foundation of the State University of New York, meanwhile, says it has 18,006 non-citizens, including researchers, employees and students, on its campuses across the state.

And institutions from General Motors' Global Research Center in Warren, Mich., to the Ordway Research Center in Albany have recruited heavily the foreign-born.

Now, proposals by the U.S. Departments of Commerce and Defense to restrict access by many of the researchers to various sensitive technologies have academic and industry groups warning that the move could hurt the nation's technological edge.

"Graduate education plays a really vital role in moving science along," said Kermit L. Hall, president of the University at Albany. "The regulations are too sweeping (and) not as focused as they

Please see FOREIGN ED



Times Union
12/4/05

Challenges Facing International Students

- Some Agency Grants Limit Support to U.S. Students
- Difficulties With & Lengthening of Visa Application Process
 - Emphasis on Those From Middle East, Former Soviet Union, and China
- Delays in Re-Entry Process
 - For International Students As Well As Faculty
 - Puts Those Attending International Conferences or Visiting Family in Home Country At Risk

Challenges Facing International Students

- Need to Maintain Full time Status and Funding
 - UG-12 Credits/Semester; Grad.-9 Credits/Semester
 - Need to Maintain Support; Employment Limitations
 - Arrest, Deportation, Re-Entry Barred, Are All Possible
- SEVIS Tracking System Reporting Requirements
- Federal Export Control Regulations
 - International Students Considered 'Deemed Export'
 - Students, Faculty, University Possibly Subject to Severe Criminal and Civil Penalties
 - Fundamental Research Excluded But Ill-Defined

Regulation Changes

- Defense Department Published Proposed Changes in the Federal Register in July, 2005
- Commerce Department Released Proposed Changes to the Public also in 2005
- Comments Were Requested; Numerous Responses
- Final Decision Pending
- Commerce Department Formed 12 Member Advisory Committee to Study Approaches and Impact Further-May 9, 2006
Appeared in Federal Register-May 22, 2006
- Proposed Changes Highlight Access to 'Sensitive Technologies'

Detailed Effects of Tightening Export Controls

- Provision Requires Universities to Obtain Licenses for Foreigners Working with Equipment Subject to Export Controls, Even if Underlying Research is Exempt from Licensing
- Calls for Foreign Born Researchers to be Segregated From Labs Containing Sensitive Equipment or Other Technologies
- Issue Badges of Identification
- Classification of Foreign Student and Scholar Researchers 'By Country of Birth', Rather than by 'Country of Citizenship or Permanent Residency'

Fundamental Research

- Fundamental Research is Exempt From Licensing Requirements

BUT

- Thus Far Fundamental Research Fails to be Properly Addressed or Mentioned

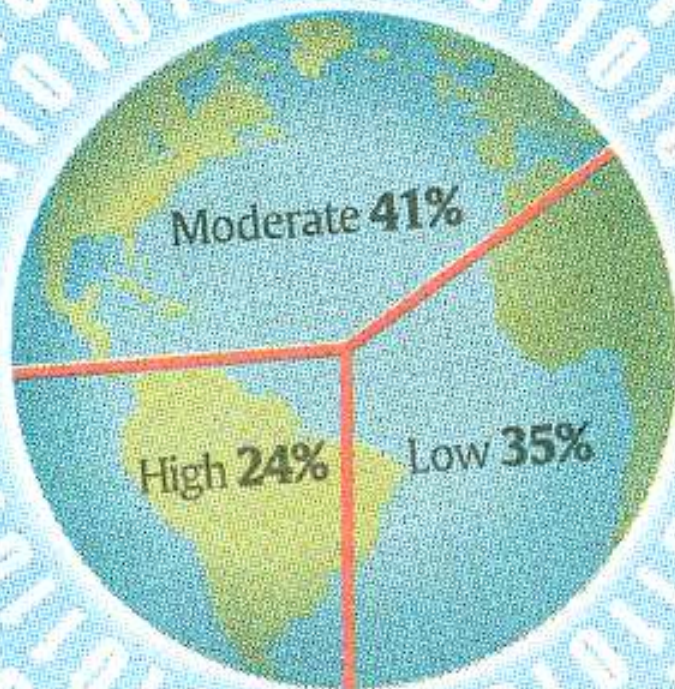
Potential Adverse Effects

- Reduction of International Researchers
- Shift of Domestic Research Elsewhere
- Hinders an Intellectually Open University
- Global Outreach/Impact & Trade Balance Could Be Severely Impeded
- We Have Been the 'Land of Opportunity' with Core Strengths of Diversity, Freedom, and Democracy Through Education
(Opportunity=Favorable/Advantageous Circumstance; Chance for Progress and Advancement; Opening)
- Let's Not Become the 'Land of Restrictions' with Core Weaknesses of Discrimination and Fear

USA TODAY Snapshots®

Most not concerned about globalization

How would you rate the risks related with globalization?



Source: Managing Business Risk in 2006 and Beyond by FM Global and Harris Interactive (www.protectingvalue.com) survey of 602 financial executives around the world. Margin of error: ± 4 percentage points.

By Jae Yang and Karl Gelles, USA TODAY

USA Today
2/8/06

Barrier Erosion Promotes Global Education

- **Technology**
 - Travel
 - Distance Learning
- **Language**
- **Diversity of Culture**
- **Uniformity of Process**
- **Best in Class**
- **Multi-National Corporations & EWP**
- **Standardization Among Competitors**

The Reality

- **A Technologically Borderless Planet**
- **A Globally Interactive Economy**
- **A Distributed Educational System**
- **A Global Engineer is Needed**
- **Balancing Cooperation and Competitive Position**

What's Happening in...

China

- More Students in Colleges & Universities (20 million) than US, India, Russia, Japan
- Doubled Number of S & E PhDs From 1996-2001 to Greater Than 8,000
- Beijing Geely University, one of 1,300 Private Universities – 20,000 Students @ \$1,000/yr
- Tsinghua University – the MIT of China – Most Faculty Studied Abroad, English Popular
- Applications to US Down 60% in Last Two Years

Ballooning of China's Higher Education System

- **The Number of Public Institutions Grew From 1,080 in 1994 to 1,980 in 2004 (83%)**
- **The number of Private Universities Grew From 43 in 2000 to 475 in 2004 (1004%)**
- **Students Enrolled (Public & Private) Grew From 3.4 Million in 1998 to 16 Million in 2006 (371%)**

What's Happening in...

India

- More Stay in India for Higher Education Than Ever Before
- 12,000 Seats in 54 Engineering Institutions
- Berkeley, UCSD, CMU, Cornell, SUNY@Buffalo & Case Western
 - 3 Year MOU with India (AMRITA Univ.) for Satellite Learning
 - Network Funded by QUALCOMM, Microsoft, Cadence
- Applications to US Down More Than 40% in Last Two Years

What's Happening in...

Malaysia

- Private Universities Developed by Industry
- Teaching in English

Germany

- BS, MS, PhD Degree Structure
- Teaching in English
- ECTS

Everywhere

Scoping US Higher Education

- **13 Million Americans in Higher Education**
- **1.5 Million Graduate Students in the US**
- **1.1 Million of These are Masters Students and Leads Growth With Women @ 60%**
- **Growth in Doctoral Sector is Smaller and Led by International Students**
- **Only About 50% of PhD Students Complete Degrees**

The Rise of Competition in Graduate Education: Some Indicators

- Europe produced *more* PhDs than US in 2003
- Asia produced *more* PhDs than US in 2003
- Application for Graduate Study in US is Down
- Bachelors (3 Yr. Becoming Standard in EU), Masters, PhD Format Adopted in Europe & Asia
- Cost
- Cooperation within EU & within Asia
- All seeking *diverse* student population
- Increased Teaching in English

For The US – A Changing Scene

- From a 'Virtual Monopoly' in Higher Education to Formidable International Competition
- The 'ATT Divestiture Equivalent for Higher Education'
- Single Digit Percentages of UG International Students
- High Double Digit Percentages of Graduate International Students

A Contradiction?

Engineering Has Held a Supremacy Role in the United States and in its Development

BUT

The US Now Graduates 15,000 Fewer Engineers Annually Than It Did 20 Years Ago

AND

Europe and Asia Produce 3-5 Times As Many Engineers As The US Which Are Available at 20%-30% the Cost of a US Engineer

AND

Many International Schools have Substantial Equivalency and Are Seeking Full Accreditation

Engineering Degrees-2005

- China-500,000
 - India-200,000
 - North America-70,000
-
- One U.S. Engineer's Salary is Equivalent to
 - Five Chinese Chemist's Salaries
 - Eleven Indian Engineer's Salaries

Engineering Degrees- The Other Side of the Coin

- Per Capita Engineering Graduates*
 - United States-758 Degrees/Million Citizens
 - China-497 Degrees/Million Citizens
 - India-199 Degrees/Million Citizens
 - Dramatic Increases in China & India in Recent Years
- Many Degrees in China and India are in Fact Subbaccalaureate, BUT Conversely Many Engineering Degrees in the US are Associate Degrees or Bachelor of Technology Degrees

* Framing the Engineering Outsourcing Debate-Placing the US on a Level Playing Field with China and India-Duke University, December, 2005

Engineering Degrees

NO MATTER WHICH POSITION IS CHOSEN,

INTERNATIONAL COMPETITION

IS HERE TODAY

OR

IS SURE TO CHALLENGE US TOMORROW

Asia Productivity of Engineers

- China Will Produce 6 Times the Number of Engineers Next Year, as the US Will Graduate
- Japan, With One Half Our Population, Produced Twice as Many Engineers as the US in Recent Years
- If Present Trends Continue, 90% of the World's Scientists and Engineers Will be living in Asia by 2010 (Richard Smalley-Nobel Laureate)

U.S. Trade Balance-High Technology Goods

- 1990-\$33 Billion in the ***BLACK***
- 2004-\$24 Billion in the ***RED***

Impact of Scientists and Engineers

US Scientists and Engineers Make Up Less Than 5% of Our Population, But Create Up To 50% Of Our GDP

High School Seniors

Less Than 6% Of Our High School Seniors Plan
to Pursue Engineering Degrees, Down From
36% From a Decade Ago

International Applications

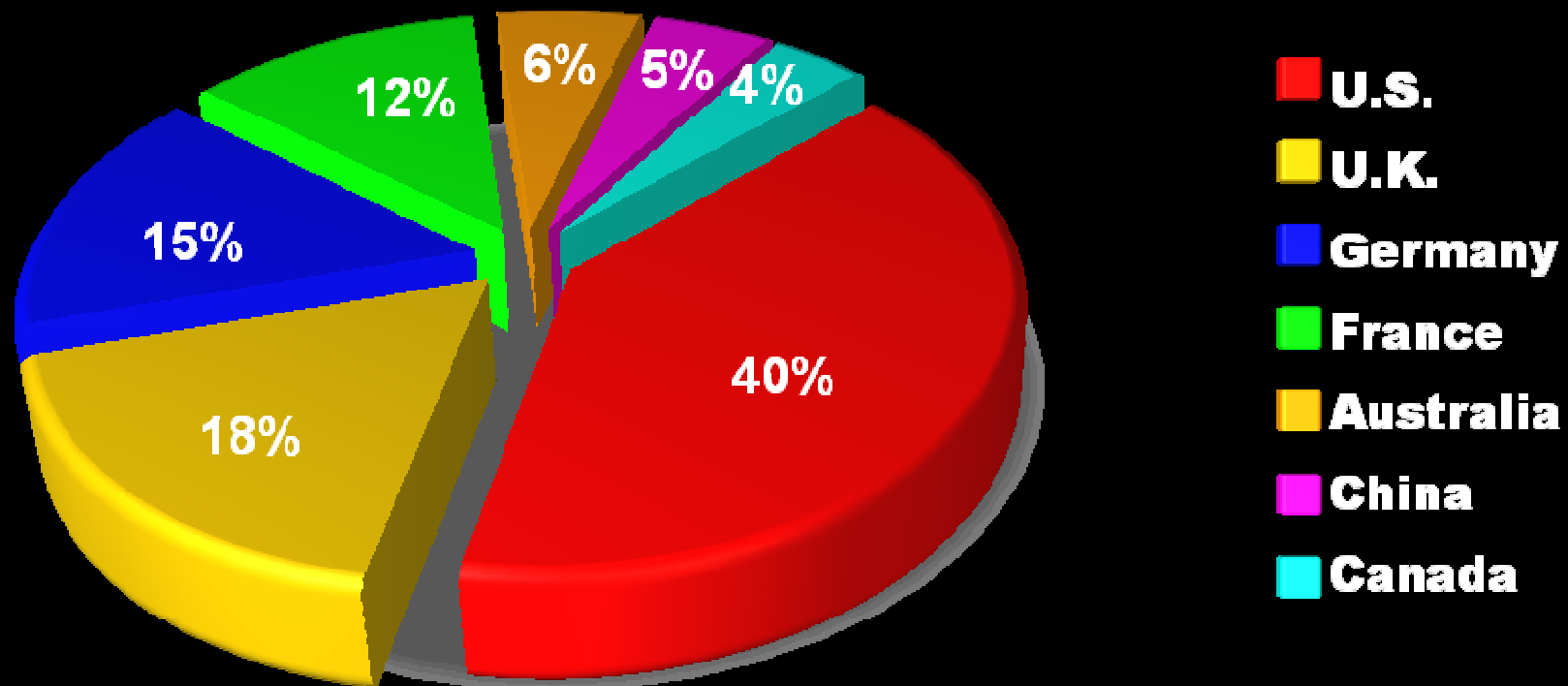
Country	Application Change '03-'04	Application Change '04-'05
China	Down 45%	Down 13%
India	Down 28%	Down 9%
South Korea	Down 14%	Down 0%

11% Increase of '05-'06 Intern. Student Appl. Overall*

2005 CGS International Graduate Admissions Survey III

- **Increase in First Time Enrollment**
 - **China-3%, India-3%, Korea-5%, Middle East-11%**
- **First Time International Enrollment by Field**
 - **Engineering- up 3%**
 - **Physical Sciences- up 1%**

International Students Global Market Share – Host Countries



The Future

- Homogeneity of the Process
 - A Trend to Uniformity
- Heterogeneity of the Students
 - A Trend to Diversity
- Safety
 - Go Anywhere, Do Anything
 - Insulating Bubble

Homogeneity of the Process: Common Practices

- English Becoming More Prevalent in Universities
 - DTU, Budapest University, Tohoku University, Nanyang University, etc.
 - Master Degree in Information Technology at TU Munich in English
- Global Adoption of the Bachelors, Masters, and Doctoral Format
- Every Country Seeking Highly Diversified Student Body

Homogeneity of the Process: Common Practices

- Erasmus Program
 - Large Scale Partnerships Between European Universities
 - Joint Degree Programs
- European Credit Transfer System – ECTS
 - Common Standards and Practices within Europe
- European Universities Beginning to Charge Tuition
 - DTU Will Start Charging 100,000 Dkr/year

Homogeneity of the Process: Common Practices

- ABET 2000
 - Outcome Assessment Based
 - US and European Adoption
- Bologna Declaration
 - More Unified Higher Education Approach
 - Two-Cycle Bachelor's and Master's Across Europe
 - Credit Accumulation System
 - Quality Assurance and Accreditation Systems

Heterogeneity of the Students

- Large Number of International Graduate Students in the U.S.
 - 572,509 in '03/'04 overall
 - 274,310 (of 1,893,736 US graduate students-14.5%)
- U.S. and Asian Students Sought in European Universities
- University Consortia – Global Draw
- Virtual Universities
 - Country Independent

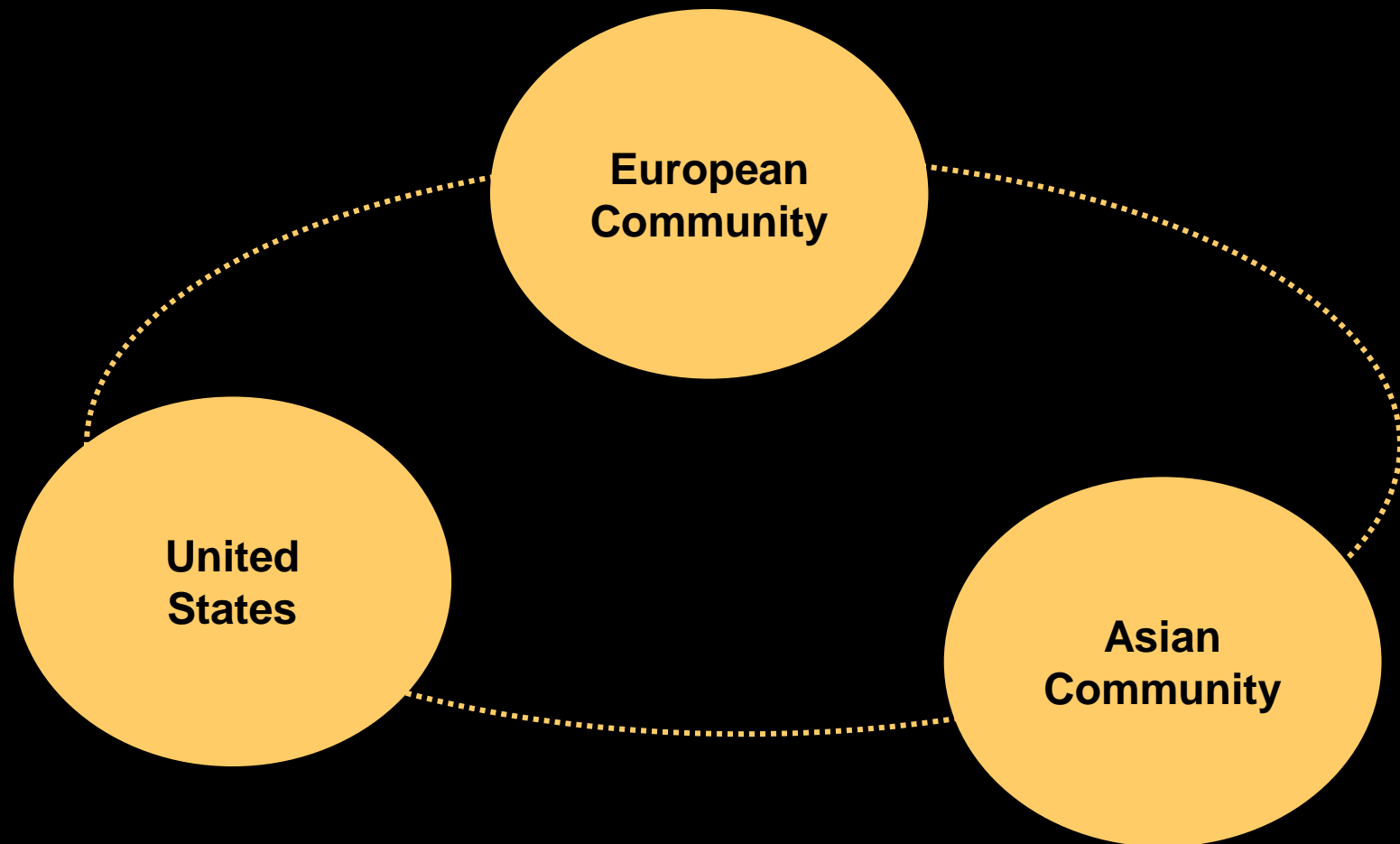
The Future

- Changing Face of Competition
 - Traditional Campus Based University
 - Distance Learning Virtual University
 - Industry Based University
- International Competition Increasing
 - A Global Virtual University
- Degree Credit Requirements

US Need for International Exchange

- **96%**
of Humanity Lives Outside the U.S. Borders
- **13 Million**
Americans in Higher Education
- **175,000 (1.35%)**
of Those Have an International Education
Experience Annually
- **5,000 (0.04%)**
of Those are Engineering Students

The Future



The Future



The World is Flat

But is the Playing Field Level?

