Second Monterrey International Conference on K-12 Science Education

Preparing Students for Science and Technology Careers: Challenges in the 21st Century

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California Council on Science and Technology

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CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

- Established in 1988 at request of State Government
- Not-for-profit corporation sustained by major post secondary education institutions
- Project funding from multiple sources
- Comprised of 30 members from industry and academia
- Governed by 13 board members
- Additional membership 107 Fellows
- Total of 150 science and technology leaders
- Includes 6 Nobel Laureates, 12 National Medal of Science/Technology, 84 members of the National Academies

RECENT CCST ACTIVITIES

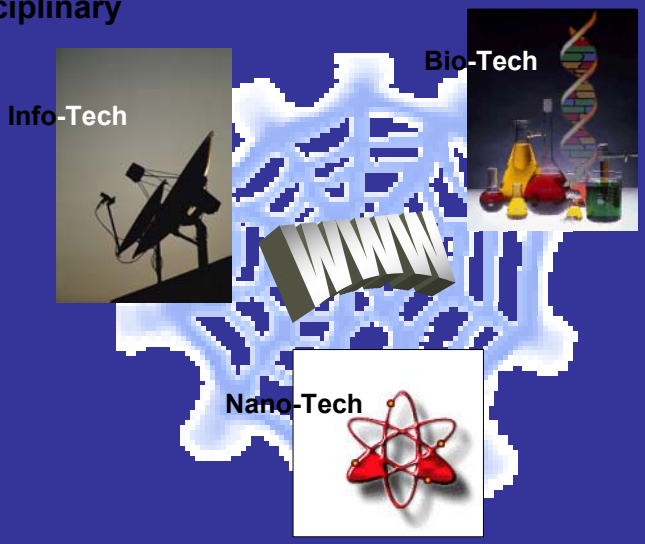
- Nanoscience and Nanotechnology
- Risk Analysis of Food Biotechnology
- Retrospective Report on California's Electricity Crisis
- Public Interest Energy Research Program Review & Policy Recommendations
- Technologies for Counter-Terrorism
- Public Affairs Forums on Innovations at Risk
- Climate Modeling and Water Resources
- California Report on the Environment for Science & Technology
- Critical Path Analysis of California's S&T Education System
- Critical Path Analysis of Science and Math Teacher Production and Retention

HIGH-TECH KEY FOR CALIFORNIA

- High-tech industry is a crucial and growing component of the California economy and will be for the foreseeable future.
- Although growth of tech employment has slowed sharply, California still added more high-tech jobs in 2002 (over 12,000) than any other state.
- California leads the nation in high-tech employment.
- High-tech future depends on:
  - Production of ideas
  - Production of people

THE DRIVERS

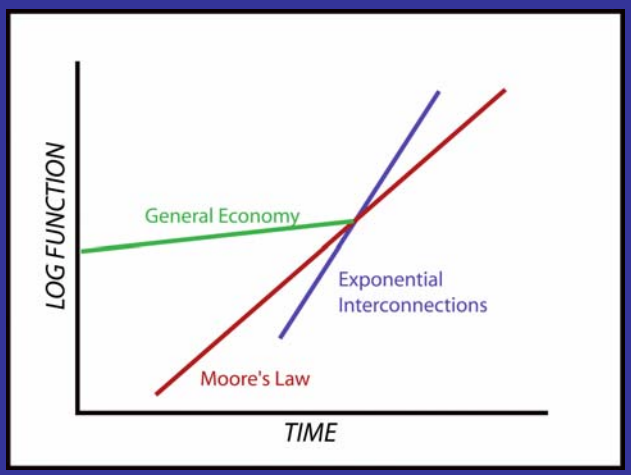
Many of the most important opportunities are interdisciplinary



SRI International

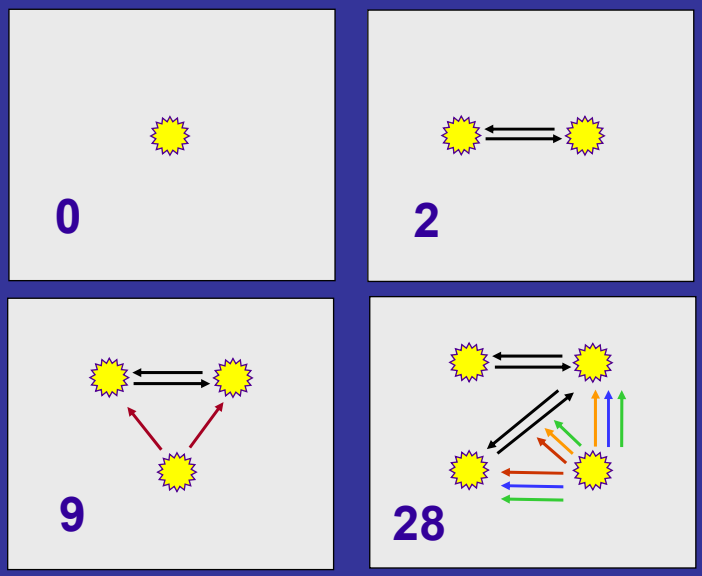
EXPONENTIAL ECONOMY

An increasing attribute of our knowledge age



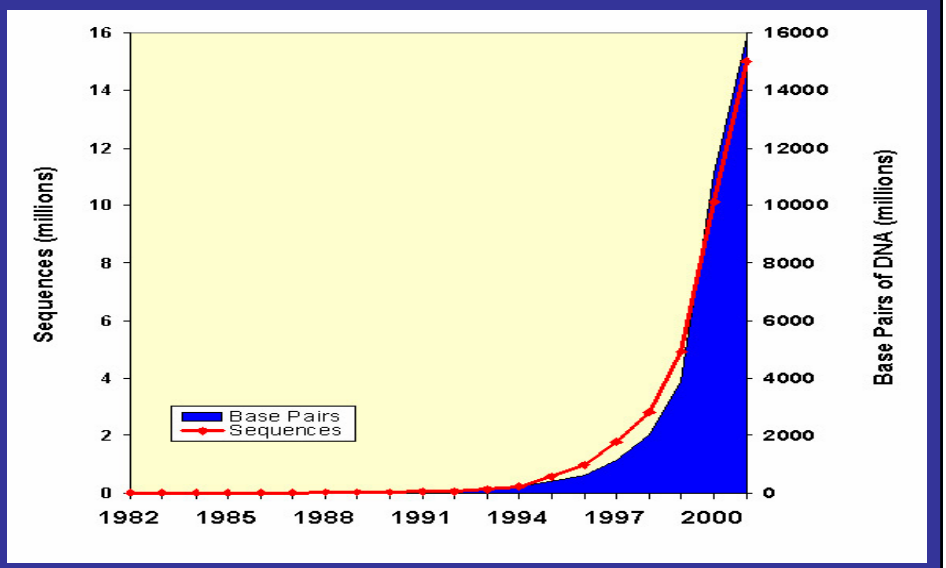
EXPONENTIAL VALUE OF INTERCONNECTIONS

Possibility for creating $N(2^{(N-1)}-1)$ value



GENBANK DATABASE TRENDS

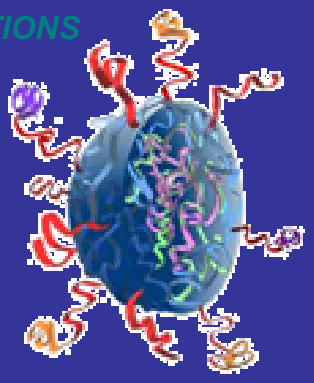
Exponential growth: >2x every 18 months



BIOTECHNOLOGY

POTENTIAL APPLICATIONS

- **Tailor-made proteases**
- **Nanomachines used as biosensors**
- **Biomimetic materials (e.g. constructing replacement blood vessels /tissue)**



Schematic of synthetic polymers being used for gene therapy
(S. Park, Healy Biomaterials Group, UC Berkeley)

- **Modifying living systems *in vitro* for beneficial purposes**
- **Synthetic intracellular molecular machines**

NANOTECHNOLOGY

- **Understanding, at a molecular scale of resolution, the structure and dynamics of nanosystems**
- **From the:**
  - **protein to the organ**
  - **molecule to the logic circuit**
  - **genome to the bio-algorithm**
  - **molecular error to the disease cure**
  - **polymer to the optical switching**
  - **atom to the quantum computer**

NANOTECHNOLOGY
TEXTILE APPLICATIONS TODAY

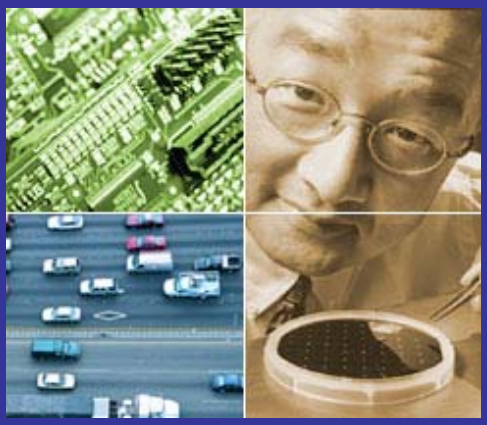
- Stain repellent clothing (e.g. Docker's Stain Defender, Eddie Bauer Nano Care shirts and pants)
- German researchers at forefront of marketing "healing textiles" -
  - Shirts which release UV protection on sunny days
  - Stockings that feed vitamins A, B, and C into legs
  - Textiles that kill bacteria in sweaty clothes
  - Analgesics for rheumatism sufferers
- Depending on the product, remain effective for 30 to 100 washes

NANOTECHNOLOGY
CONCERNS IN THE PRESS

- Serious ethical study lags far behind the science
- Distant, controversial applications (e.g. "gray goo") discussed/editorialized, but discourse on relevant, specific near-future applications lacking
- U. Toronto study (Joint Center for Bioethics, Feb. 2003): Nanotech research could be derailed if study of ethical, social, legal implications doesn't catch up with scientific development
- Similar concerns for other developing technologies

INFORMATION TECHNOLOGY

Highly-distributed, reliable, and secure information systems that can evolve and adapt to radical changes



Societal-Scale Information Systems that can configure, install, diagnose, maintain, and improve themselves

www.citris.berkeley.edu

INFORMATION TECHNOLOGY

POTENTIAL APPLICATIONS

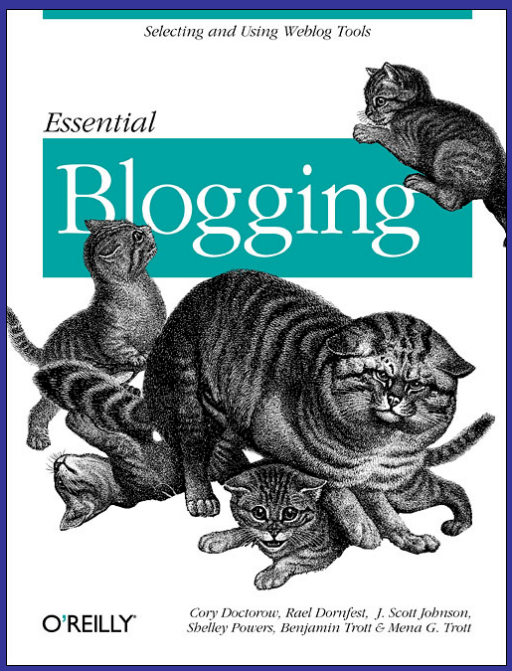
- **Energy efficiency, via networks of embedded sensors in buildings (potential savings of $8 billion/year in California alone)**
- **Transportation management/optimizing traffic (potential savings of over $15 billion/year in CA)**
- **Emergency response: reliable, personalized information in minutes to emergency teams**
- **Health care monitoring via ubiquitous sensors**

INFORMATION TECHNOLOGY
MEDICAL TELEPRESENCE AT WORK

InTouch Health Inc. has begun field trials of *Companion* mobile robot - real-time two-way broadband communication

BLOGGING

- **A blog is a web page made up of short, frequently updated posts - like an online journal**
- **Blogging is instant: can be done from anywhere, even your phone**
- **Virtual Community**



O'Reilly & Associates, www.oreilly.com

BLOGGING AND SMART MOBS

AP Photo/John D. McHugh

- "Smart mobs" - people who are able to act in concert even if they don't know each other. They can connect via blogs with laptops, cell phones, PDAs
- Tools enable new forms of social power: this is how anti-war and anti-globalization protests are being organized worldwide today, instantly, minute by minute
- Last week Baghdad blogger returns to the web www.dear_raed.blogspot.com

Important caveat: there is no filter on blog information

STRONGEST COMPETITIVE TRAITS

AS RANKED BY THE WORLD COMPETITIVENESS YEARBOOK 2001
OUT OF 49 COUNTRIES TOTAL

USA

- **Basic Research** #1
  Enhances long-term economic and technological development
- **Venture Capital** #1
  Easily available for business development
- **University Education** #5
  Meets the needs of a competitive economy
- **Computer Power per Capita** #1
  MIPS per 1000/Source: Computer Industry Almanac
- **Brain Drain** #1
  Well-educated people do not emigrate abroad

MEXICO

- **Personal Income Tax Rate** #4
  Percentage of GDP per capita
- **Working Hours** #7
  Average number of working hours per year
- **Electricity Costs** #15
  For industrial clients
- **Air Transportation** #15
  Number of passengers carried by main companies
- **Computers in Use** #16
  Worldwide share

WEAKEST COMPETITIVE TRAITS

AS RANKED BY THE WORLD COMPETITIVENESS YEARBOOK 2001
OUT OF 49 COUNTRIES TOTAL

USA

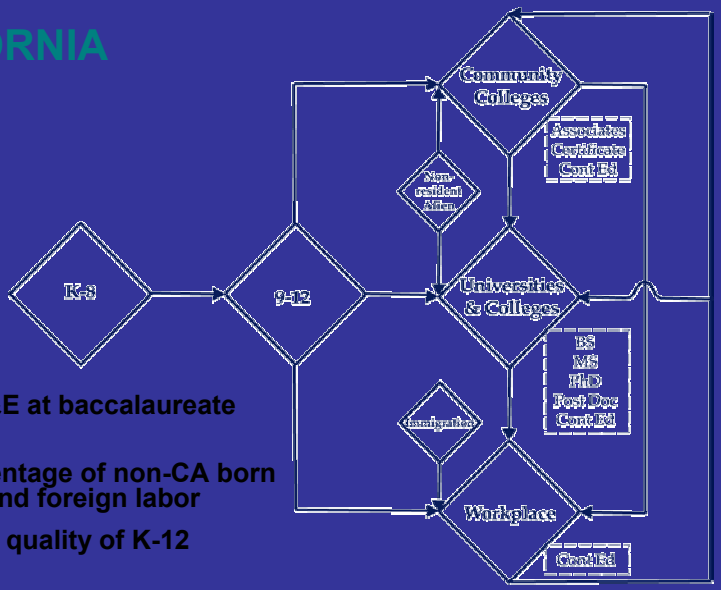
- **Science & Education** #32
  Science is not adequately taught in compulsory schools
- **Qualified Engineers** #29
  Are not available in labor market
- **Working Hours** #24
  Average # of working hours per year
- **Alcohol & Drug Abuse** #46
  Pose a serious problem at the workplace
- **Youth Unemployment** #32
  Unemployment (under 24 years as a percentage of total unemployment)

MEXICO

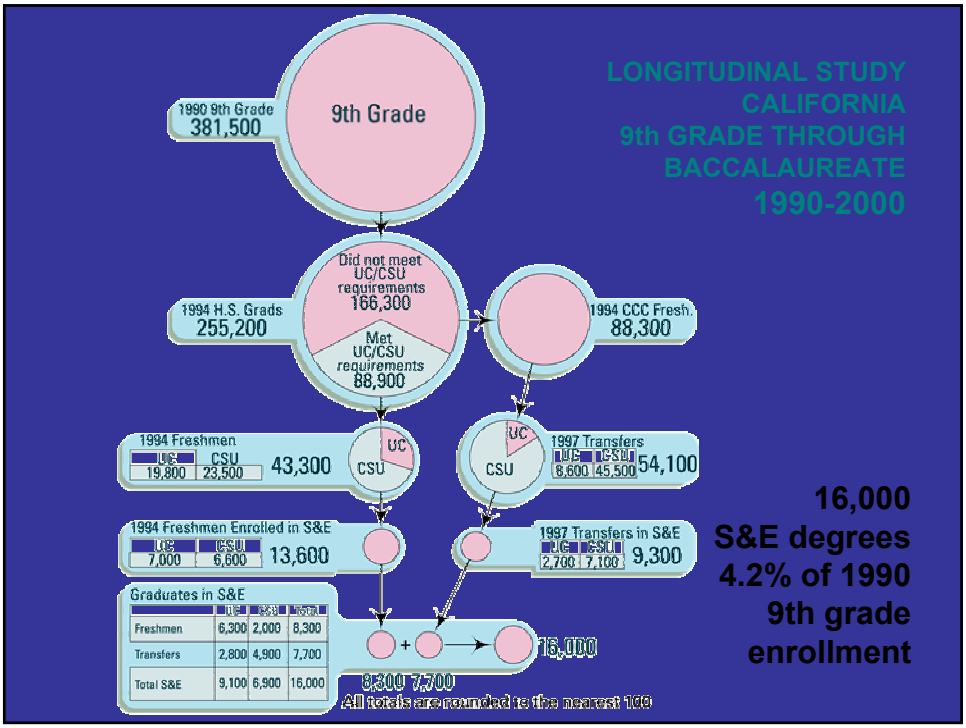
- **Science & Education** #47
  Science is not adequately taught in compulsory schools
- **Science & Technology** #43
  Does not interest youth
- **Basic Research** #46
  Does not enhance long-term economic and technological development
- **Company-University Cooperation** #47
  Tech transfer insufficient
- **Venture Capital** #47
  Not easily available for business development

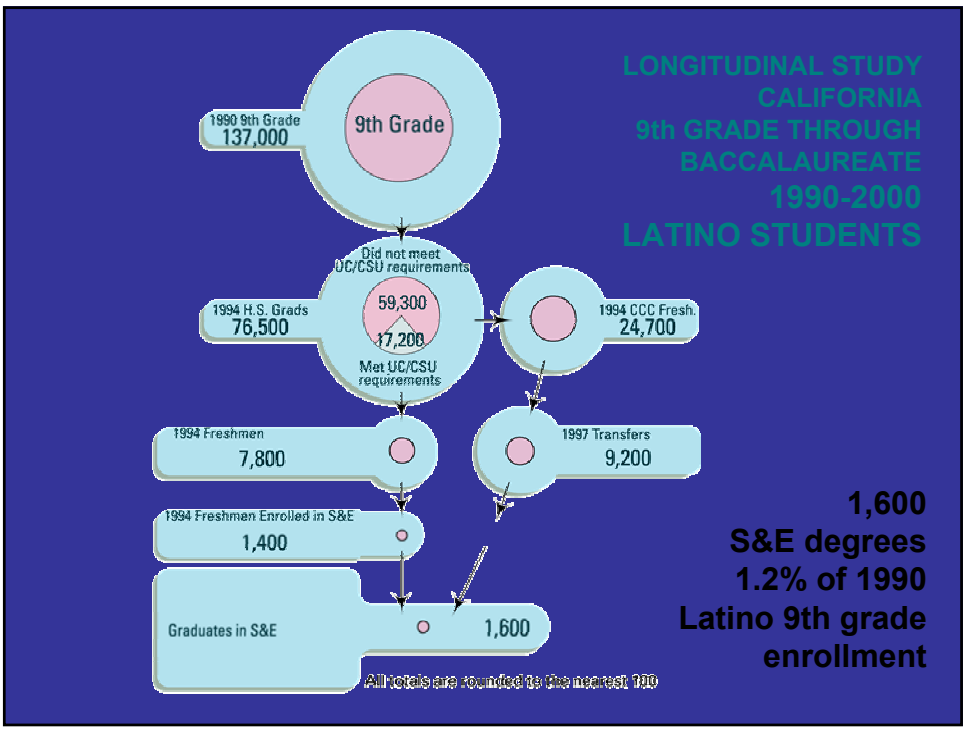
HIGH-TECH WORKFORCE PRODUCTION

CALIFORNIA

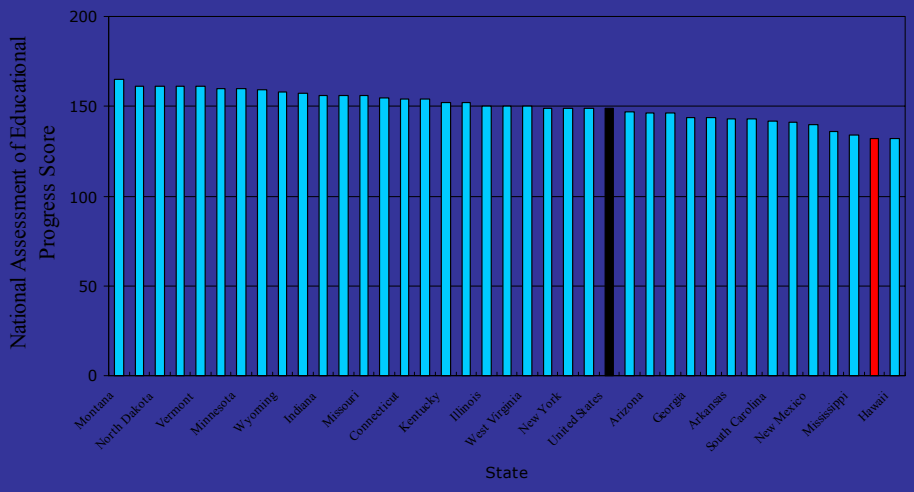


- Loss in S&E at baccalaureate level
- High percentage of non-CA born students and foreign labor
- Quantity & quality of K-12 teachers


LONGITUDINAL STUDY
CALIFORNIA
9th GRADE THROUGH
BACCALAUREATE
1990-2000
1990 9th Grade
381,500
9th Grade
Did not meet UC/CSU requirements
166,300
Met UC/CSU requirements
88,900
1994 H.S. Grads
255,200
1994 CCC Fresh.
88,300
1994 Freshmen
UC 19,800
CSU 23,500
43,300
UC
CSU
1997 Transfers
UC 8,600
CSU 45,500
54,100
1994 Freshmen Enrolled in S&E
UC 7,000
CSU 6,600
13,600
1997 Transfers in S&E
UC 2,700
CSU 7,100
9,300
Graduates in S&E
UC CSU Total
Freshmen 6,300 2,000 8,300
Transfers 2,800 4,900 7,700
Total S&E 9,100 6,900 16,000
16,000
9,300 7,700
All totals are rounded to the nearest 100
16,000
S&E degrees
4.2% of 1990
9th grade
enrollment


LONGITUDINAL STUDY
CALIFORNIA
9th GRADE THROUGH
BACCALAUREATE
1990-2000
LATINO STUDENTS
1990 9th Grade
137,000
9th Grade
Did not meet UC/CSU requirements
59,300
Met UC/CSU requirements
17,200
1994 H.S. Grads
76,500
1994 CCC Fresh.
24,700
1994 Freshmen
7,800
1997 Transfers
9,200
1994 Freshmen Enrolled in S&E
1,400
Graduates in S&E
1,600
All totals are rounded to the nearest 100
1,600
S&E degrees
1.2% of 1990
Latino 9th grade
enrollment

Eighth Grade Science Performance: 2000 (37 states)



WHY ARE WE FAILING IN K-12 SCIENCE AND MATH EDUCATION?

- **Complex educational bureaucracy impedes change; size of system is a significant obstacle (over 6 million students)**
- **Historically low per-pupil spending**
- **>40,000 underqualified teachers in California; math & science teachers 50% more likely to be underqualified**
- **Disconnect between college requirements and minimum high school requirements**
- **Science not yet part of standardized testing - schools teach to the tests**

WHAT CAN WE DO ABOUT IT?

- **Work to improve quality of science & math teaching**
  - New teacher training and professional development
  - The poorest schools have the largest numbers of unqualified teachers
- **Develop strategies to motivate students to fulfill the basic requirements necessary to pursue science, math, and technology degrees**
- **Increase student access to effective academic and career counseling**

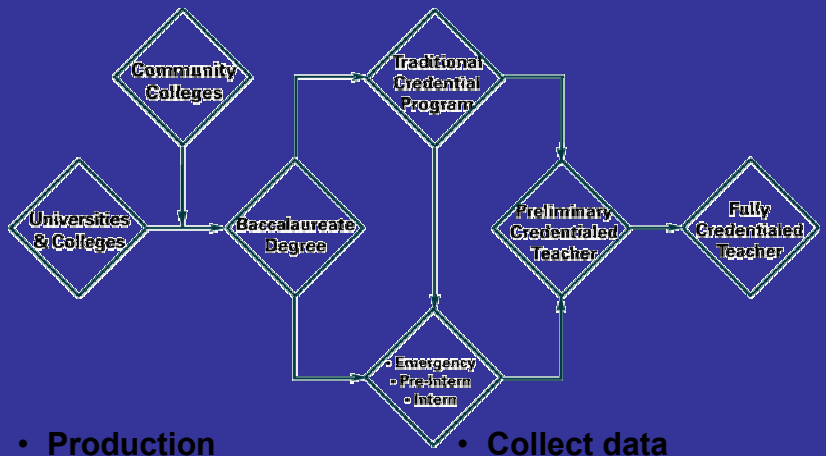
QUESTION OF SCALE

Many successful pilot programs exist, helping thousands of students and teachers. However, no program is large enough to address the problem.

California's K-12 school system has:

6,000,000 students
300,000 teachers
8,900 K-12 schools
1,056 school districts

CALIFORNIA'S MATH AND SCIENCE TEACHER SHORTAGE: A CRITICAL PATH ANALYSIS



- Production
- Retention
- Support

- Collect data
- Examine performances
- Evaluate models

CALIFORNIA-MEXICO COMMISSION ON SCIENCE, TECHNOLOGY, AND EDUCATION

CCST collaborating on 2 studies:

- **Developing a Framework for California/Mexico High-Tech Research Collaboration**
  Jump-start clusters of innovation in high-tech areas in Mexico that will drive economic growth by developing peer-to-peer connections with California institutions

- **Professional Development of In-Service Teachers**
  Increase the effectiveness and retention of teachers by providing technology-based professional development capabilities in both California and Mexico

"Without the proper education to enter the S&T industry, Californians can't compete for the high-paying high-tech fields."

-George Scalise
President, Semiconductor Industry Association