The Impact of Globalization on R&D at Texas Instruments

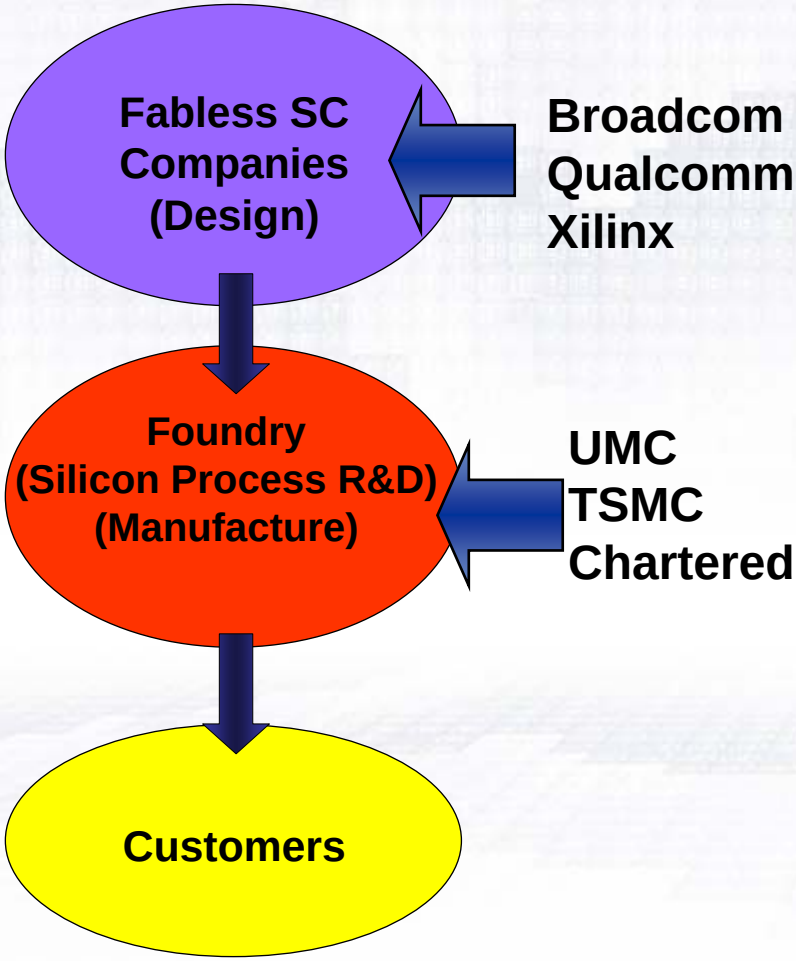
Dr. Hans Stork
Senior VP and CTO Texas Instruments
Director Silicon Technology Development

Outline

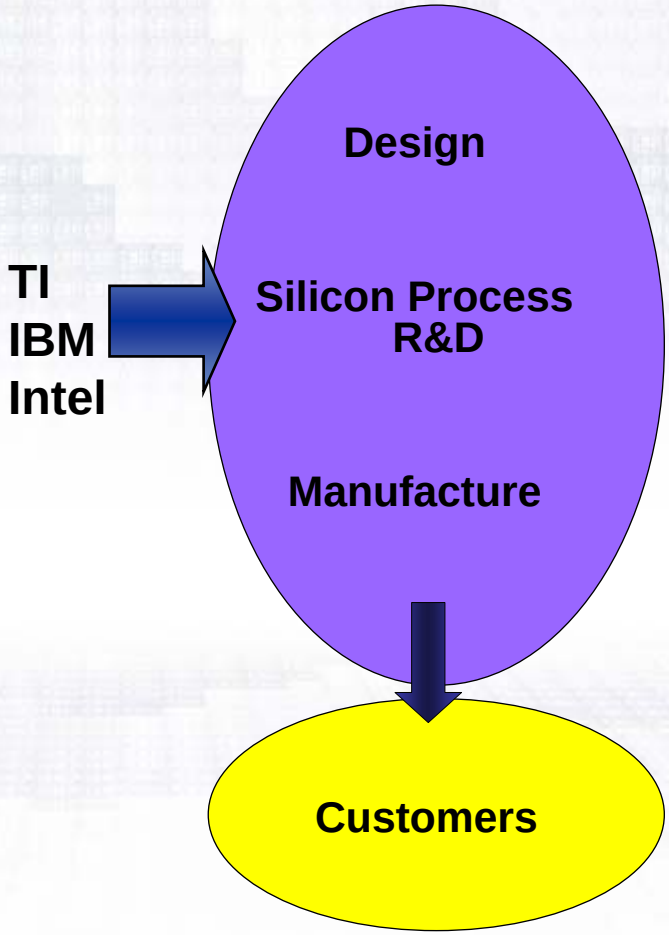
- Global Semiconductor Manufacturing
- Process R&D
  - Project Emmitt
- Product Engineering
  - TI India Bangalore
- Summary

Semiconductor Business Models

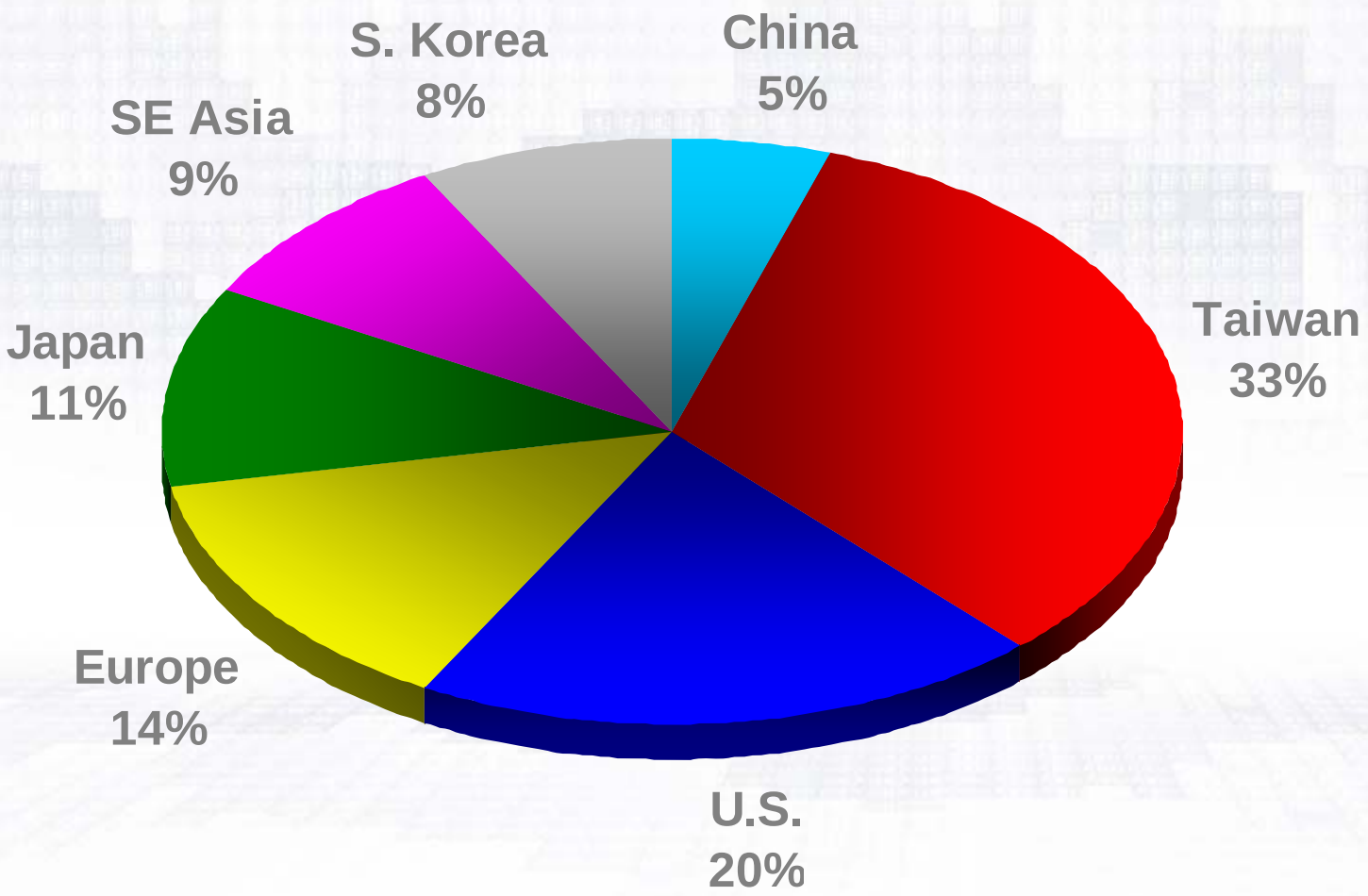
Foundry Model



IDM Model



Two thirds of new 300mm Fabs under construction, equipping, or in production are in Asia



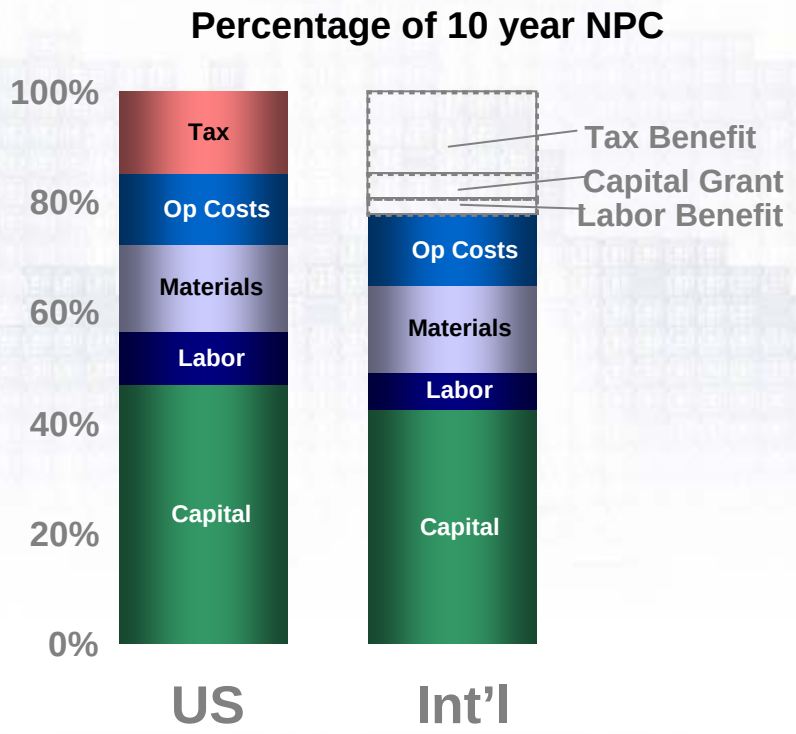
Source: Strategic Marketing Associates, May 2004

Global Manufacturing Trends

- Over time, a greater percentage of global SC manufacturing will occur in foundries
- Foundry capacity (and R&D) migrating to Asia/China due to cost advantages and rising technological competence
- Those locating first-generation 300 mm plants in US want proximity to existing R&D and installed manufacturing base
- Strategic issue: extent to which US will continue to compete and win on cost and R&D excellence

Wafer FAB Cost Model: Key Assumptions & Drivers

- **Cost model compares alternatives based on 10 year NPC**
  - Production starting in year 3
    - Ramp with “current generation” technology products and transition to next gen products after 5 years
- **What factors drive analysis ?**
  - Cost differences driven by tax treatment, capital grants, local factors
    - Other local factors: utilities, labor, logistics



	Concept 300mm FAB 10yr NPC
Int’l	$5.6B-$6.1B
US	$6.7B-$6.8B

Comparative Taxes/Incentives

U.S.	▪ 35% corporate tax rate ▪ Various state-level incentives
ISRAEL	▪ Up to 20% capital grant ▪ 10% tax rate – 2-year tax holiday
CHINA	▪ 5-year tax holiday ▪ After holiday, ½ normal rate for next 5 years
MALAYSIA	10-year tax holiday
IRELAND	12.5% corporate tax rate

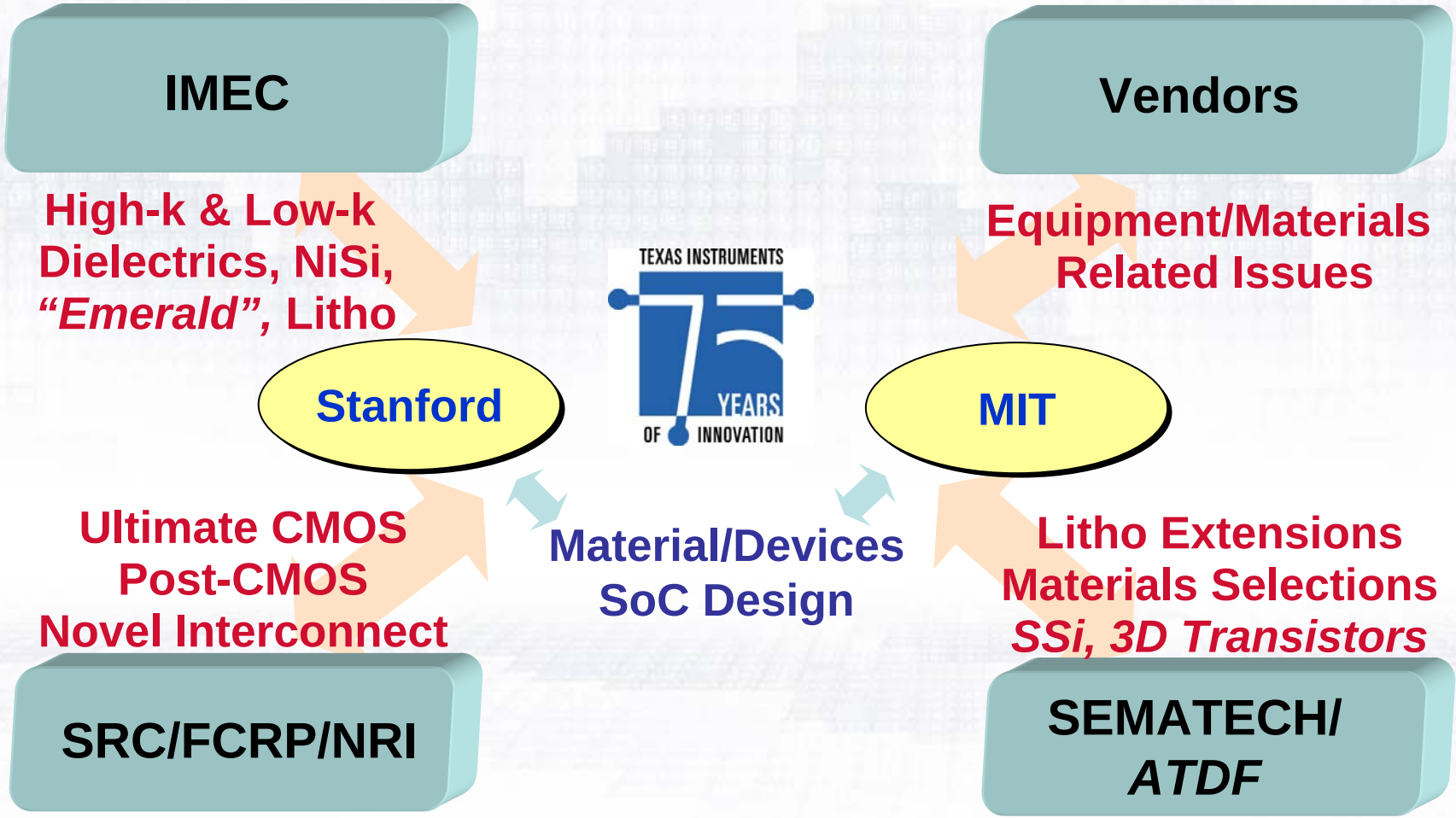
R&D and Manufacturing Linkage

- Today (yesterday?) U.S. chip companies have (had) most of their facilities and employment in the U.S.
  - 77% of U.S.-owned capacity is in the U.S.
  - 55% of U.S. industry's worldwide employment is in the U.S. (and 75% of the compensation).
- However, leading edge (300-mm) capacity is decreasing in the U.S. to a projected 20% by 2005; moving off-shore is driven by incentives offered outside the U.S.
- Co-location of R&D with leading-edge manufacturing has become imperative.
  - Cost: R&D must address yield etc requiring tooling and scale identical to that found in manufacturing.
  - Time to market/money: Process transfer times between R&D and manufacturing must be shortened/eliminated.
  - Optimized use of intellectual capital: Close collaboration of R&D&M at all levels is required for continuous improvement.

Consequences of Off-Shore Migration of R&D and Manufacturing

- R&D in a broad spectrum of semiconductor-related fields will exit the U.S., following leading-edge manufacturing.
  - Device R&D
  - Process tooling and associated process development
  - Design-related R&D
    - Small design houses will follow leading-edge manufacturing to be co-resident with their suppliers in regions of low-cost
  - Materials R&D (crucial for future scaling)
- Educational/research university infrastructure enabling the present U.S. technology superiority will be lost (this trend is already underway).

External R&D Collaborations



Partnering Strategy

	Research	Pre-Competitive Development	Development	Production
Partners	Universities/IMEC	IMEC/ISMT/ vendors	TI customers/ vendors	TI customers
Communication	Publications	Internal reports/ publications	Process Delivery Kit	Customer commits
Applicability	Generic to all technologies	Multiple silicon technologies	Mobile and high-performance technologies	Specific products

Partner extensively with other IC manufacturers

Partner extensively with customers

Product Design and Engineering

- **Proximity to the customer**
  - Really understanding the application and use
  - High frequency and face-to-face interaction
  - Upfront negotiation; support afterwards
- **Cost is not the (first) issue**
  - Establishing skill centers with critical mass
  - Local management with core company culture
  - For small design teams, cost never an issue
- **Cycle time and cost**
  - Around-the-clock continuity for large teams
  - “Slicing” the work load to obtain maximum efficiencies

TI India in Presidents Visit

"Americans also benefit when U.S. companies establish research centers to tap into India's educated workforce. This investment makes American companies more competitive globally. It lowers the cost for American consumers. Texas Instruments is a good example. Today Texas Instruments employs 16,000 workers in America. It gets more than 80 percent of its revenues from sales overseas. More than 20 years ago, Texas Instruments opened a center in Bangalore, which is India's Silicon Valley. They did so to assist in analog chip design, and digital chip design, and related software development. The company says that their research centers in countries like India allow them to run their design efforts around the clock.
They bring additional brainpower to help solve problems, and provide executives in the United States with critical information about the needs of their consumers and customers overseas.

These research centers help Texas Instruments to get their products to market faster. It helps Texas Instruments become more competitive in a competitive world. It makes sense. The research centers are good for India, and they're good for workers here in the United States."

Brief TI India History and Status

- **Initiated in Aug 1985 for strategic presence in Asia/Pacific**
  - **Support proprietary EDA software**
  - Followed by Mixed Signal design center 3 years later
  - Followed by DSP design center in 1998
- **Complete product designs started in late nineties**
  - Programmable resolution A-D converter
  - TMS320C2800 core
  - Digital Video Interface standard support
- **Wireless and customers**
  - Cellular (3G) chipsets started in 2001, followed by WLAN, and later OMAP platform support
  - Over 1200 engineers employed in software, vlsi design, and tools development
  - Supporting over 50 Indian companies

Summary of Observations

- **Quality of skills not an issue (anymore)**
  - Equally strong, more and eager candidates
  - Process and design, software and hardware, research and engineering
- **Proximity different issue for process versus product**
  - Large capital investments drive co-localization of R&D and manufacturing skills
  - Strong customer interaction favors product design teams to be located in user community
- **Cost considered a short term benefit**
  - Long term skill base
  - Strategic job slicing
  - Cycle time imperative


TEXAS INSTRUMENTS
75
YEARS
OF INNOVATION