

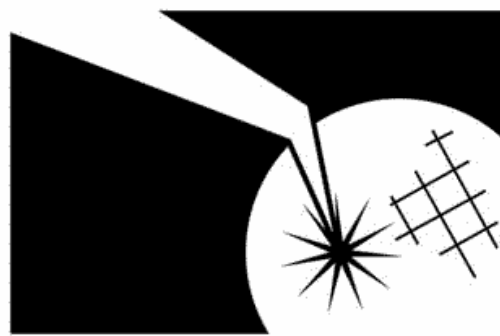
# Impact of Globalization and the Development of the Test Tooling Industry

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**Director**

**Assembly Test Capital Equipment Development**

**Chandler, Arizona**



**SOUTHWEST TEST WORKSHOP**

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# Has Tooling Improved in the last 2 years?

## 2002 Messages:

- Increasing costs have driven changes in Capital Equipment for Test
- A revolution is happening in Test Equipment to respond to these costs
- The Tooling Supply industry has not changed to meet customer needs
  - comprehensive solutions, cost, leadtime or capability
- It's time for a Revolution in Test Tooling

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## Testers: The revolution continues

- Two successive generations of test equipment has achieved higher performance at lower cost and footprint
- The CMT and Tester Open Architecture initiative are real
  - CMT is in production with great success
  - Expect OA content to increase

## Tooling: No revolution in cost, capability or technology has happened

- Improvements have been evolutionary not revolutionary
- Costs are flat (at best) or (mostly) up
- Fewer technology options exist
- Tooling suppliers still operate in isolation, without supply chain collaboration

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The message has not changed

The tooling industry needs to enable future capabilities at lower costs

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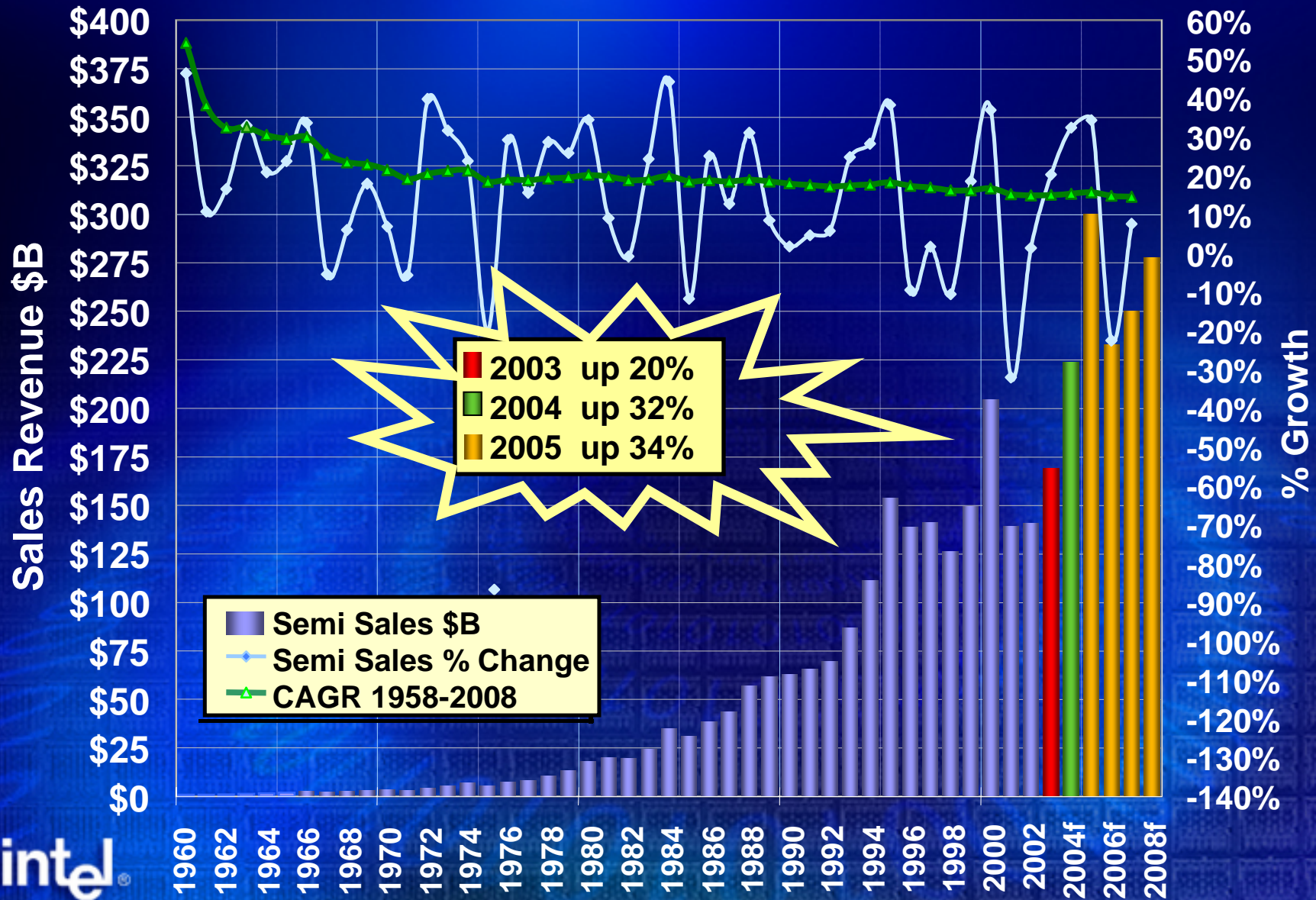
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# These are the good times!

Source: VLSI Research



# These are the good times!

Source: VLSI Research Semi Equipment Sales Forecast

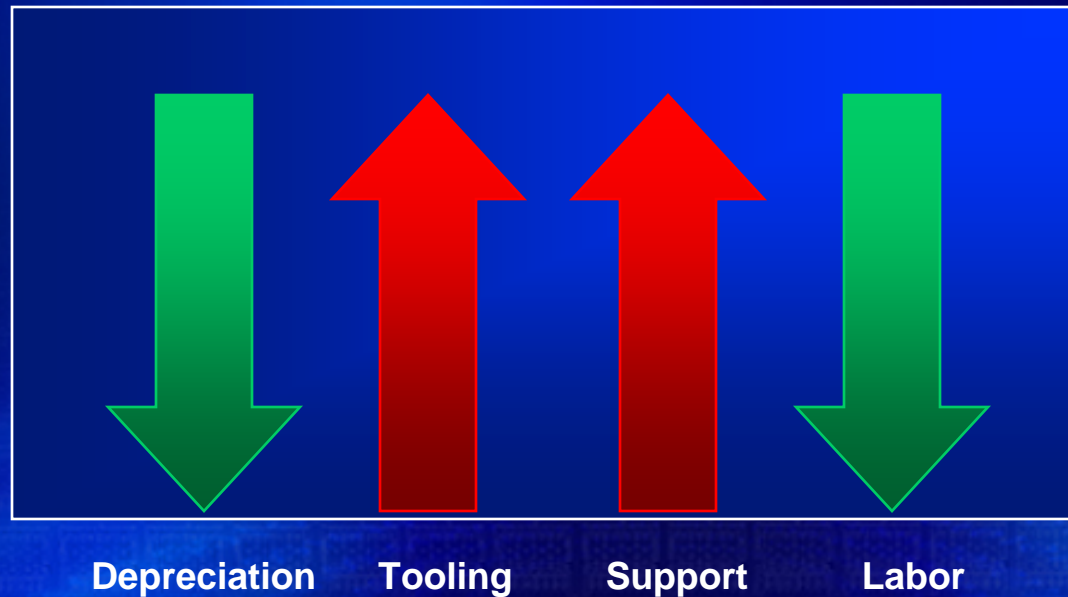


Wafer Fabrication Equip  
Test & Related Equipment

Chip Assembly Equipment  
Annual Growth Rate



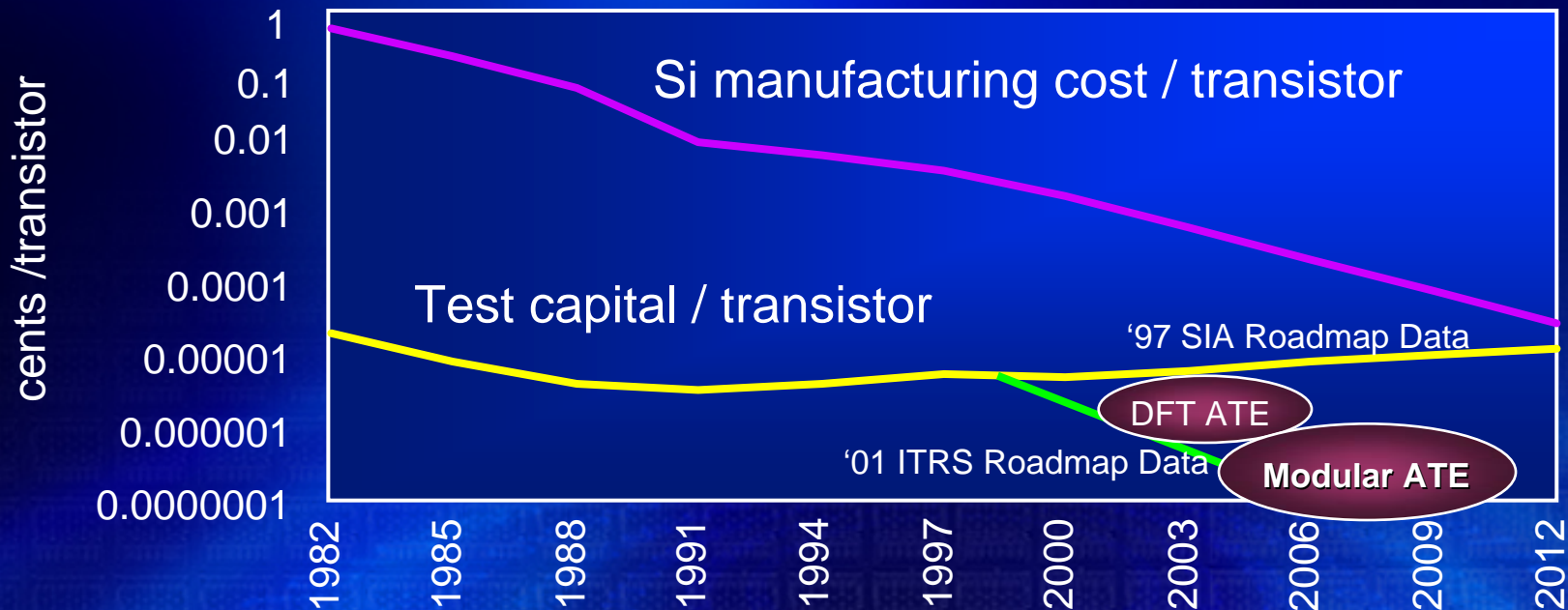
# Manufacturing Test Cost Trends



- Capital cost reduction efforts are beginning to pay off
- Tooling and Service costs are increasing as an overall percentage of test cost

# What did the Tester Guy's Do?

## Cost Reduction Roadmap: Functional → DFT → Modular



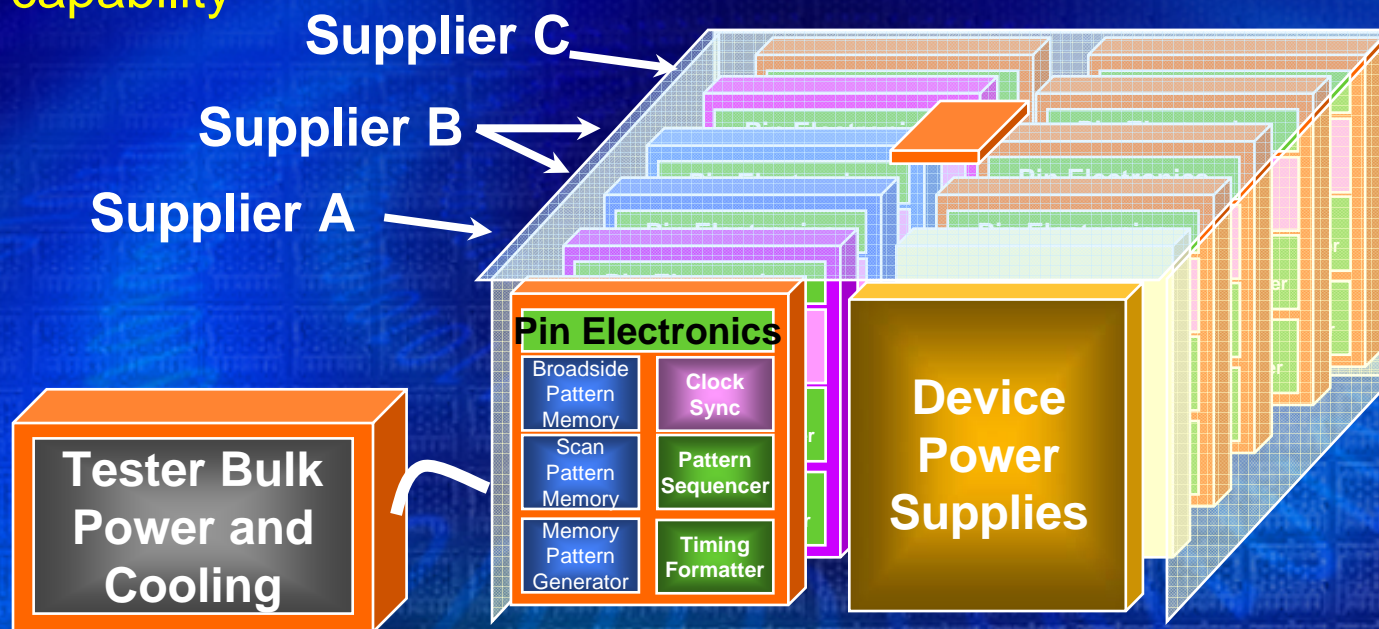
- DFT & Structural Test reduce equipment cost & complexity
  - Lower I/O data rate and accuracy requirements
  - Lower tester channel count
  - Lower timing and resource flexibility requirements



# What did the Tester Guy's Do?

## Innovation of Modular Open Architecture for ATE

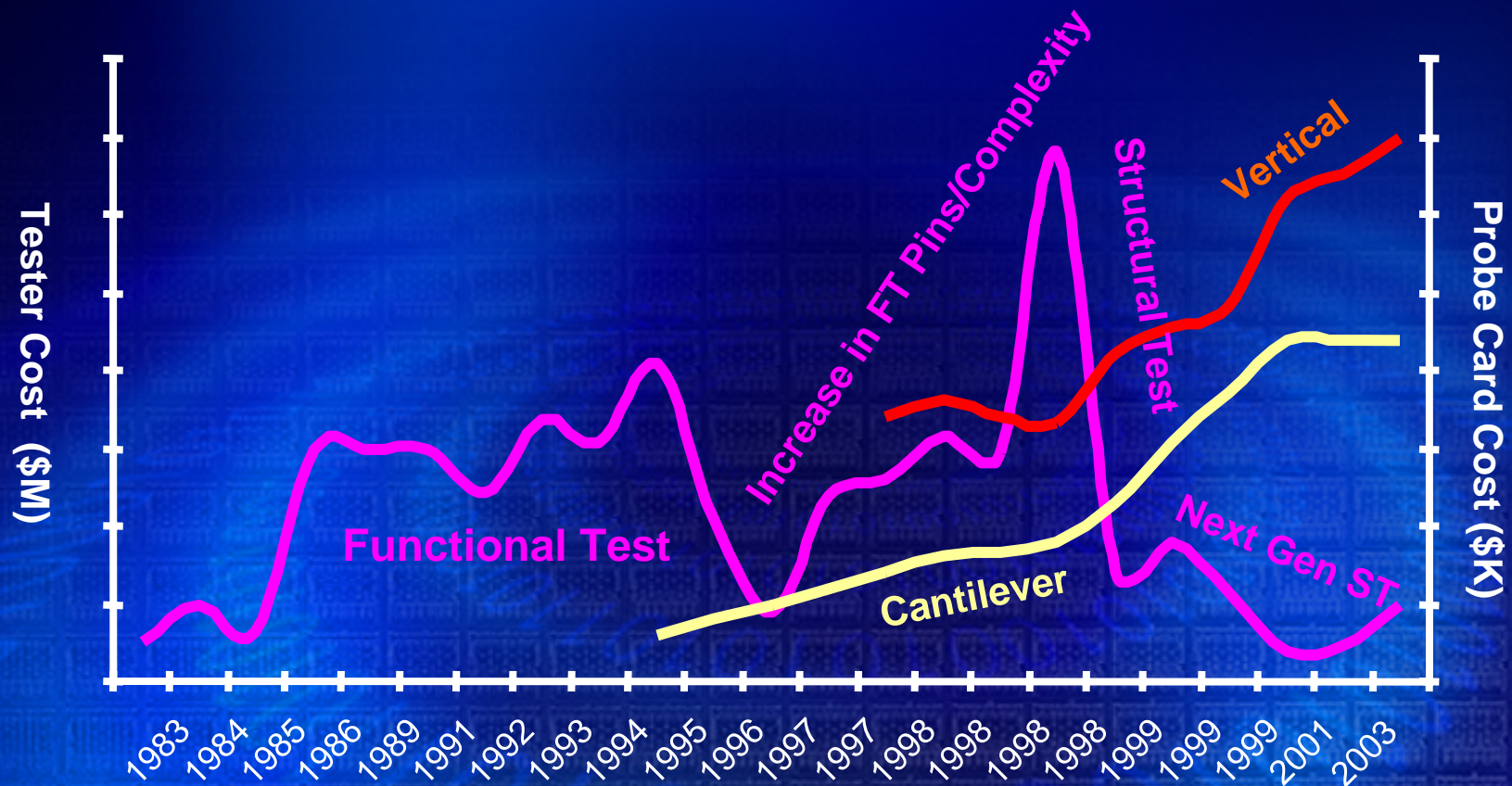
- Multiple suppliers using industry standards
- Scales across price, performance, pin counts, applications
- Reusable platforms enable new capabilities with incremental modules
- Standard operating system and equipment interface software
- Addresses high mix, low volume business need for “configure on the fly” capability





# Tooling Grand Challenge # 1: Cost

## Logic Tester vs. Probe Card Tool Cost

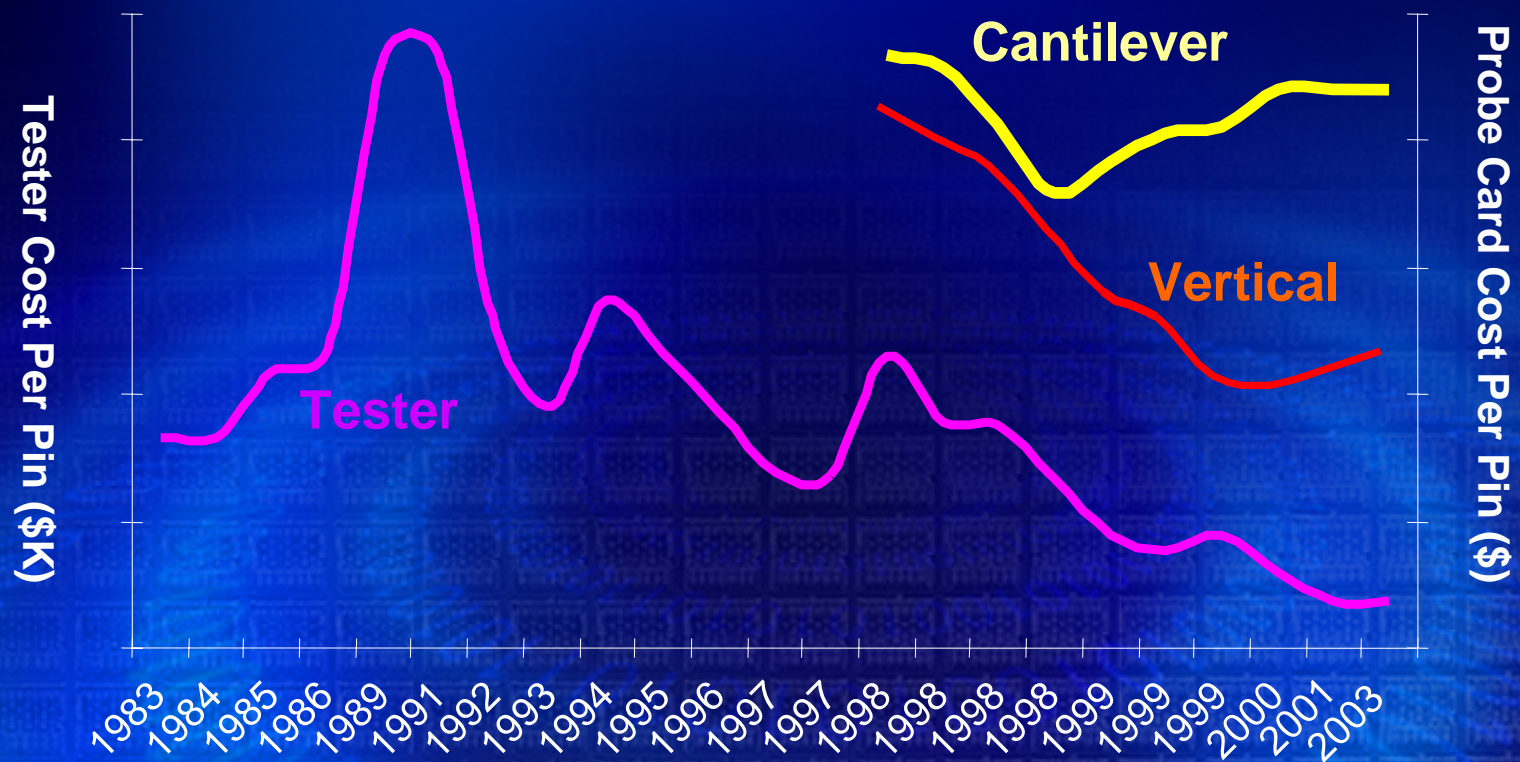


Source: Intel and Dataquest



# Tooling Grand Challenge # 1: Cost

## Logic Tester vs. Probe Card Cost Per Pin



Source: Intel



# Tooling Grand Challenge # 1: Cost

## Memory Tester vs. Probe Card Tool Cost



Source: Intel



# Tooling Grand Challenge # 2: Enabling Next Generation Technology

Supplier	Current Market Presence	Future Core Competency	Probes	PCB	Interconnect	Design
A	None	Potential future generation Memory SIU supplier. Base technology related to a flexible space transformation.	No	No	Yes	No
B	None	Mems Probe Manufacturing	Yes	No	No	No
C	Capital Equipment / Memory	Mems Probe Manufacturing	Yes	No	No	Yes
D	Capital Equipment	Chemical Etched Probes	Yes	No	No	Yes
E	None	Chemical Etched Probes	Yes	No	Yes	No
F	Logic and Memory	Older generation Memory SIU supplier. Stamped Probes. Researching chemically formed solutions	Yes	No	No	No
G	Logic and Memory	Plated / Etched Probes	Yes	No	No	Yes
intel H	Logic and Memory	Chemical Etched Probes	Yes	No	No	No



# Tooling Grand Challenge # 2: Enabling Next Generation Technology

VLSI Research Executive Advisory: The  
Probe Card Market forecast in May 2001:

- Cantilever Probe Card Technology TAM ~ \$400M by 2005
- Advanced card TAM ~ \$423M by 2005
  - 23.9% CAGR vs 9.9% for older technology

Strauss's math: Advanced Probe Card Technology TAM<sup>1</sup> in 2003 was ~ \$400M

## How many individual suppliers afford the R&D?

### Advanced Probe Card R&D

TAM<sup>1</sup> = \$400M

R&D = 15%

R&D for Product Development<sup>3</sup> = 50%

Industry Available R&D = \$30M / year

### R&D Required

Cost to develop Advanced Probe Card  
Capability

= \$20 - 25M (scratch, 3-4 yrs)

= \$15M - 20M (derivative 1-2 yrs)

### Product R&D Generated by Top 5 Suppliers

Supplier A <sup>2</sup>	Supplier B <sup>2</sup>	Supplier C <sup>2</sup>	Supplier D <sup>2</sup>	Supplier E <sup>2</sup>
\$8M	7M	2M	2M	1M



Note 1. Top 10 Suppliers

Note 2. Profitable R&D Estimated from published and extrapolated market data from 2001 VLSI data and 15% R&D

Note 3. R&D for Product Development also called "Product R&D"

## Tooling Grand Challenge # 2: Enabling Next Generation Technology

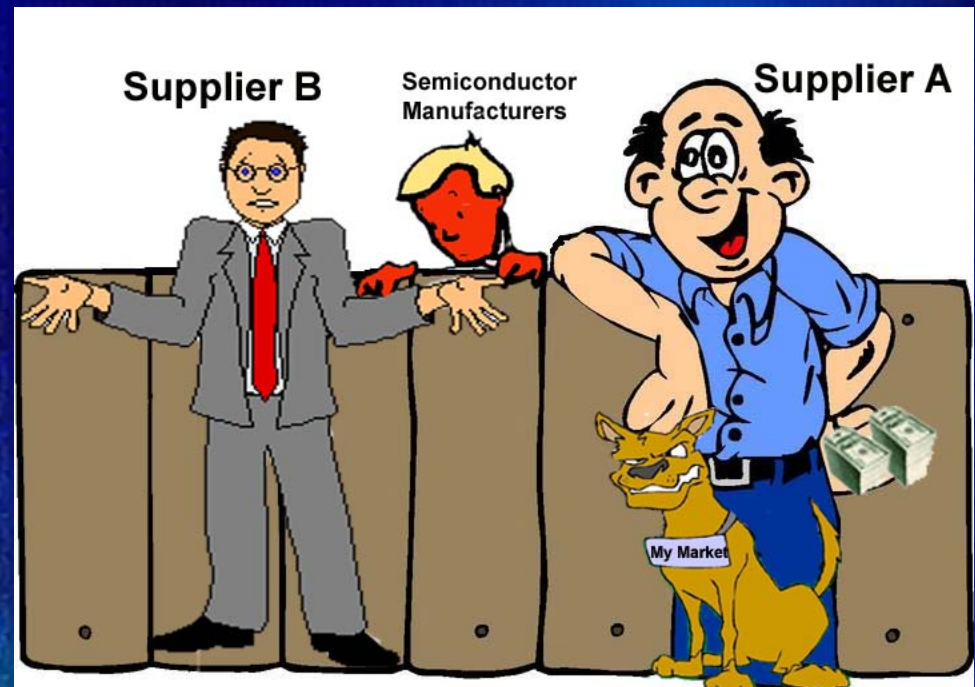
### The tooling industry needs suppliers to collaborate

- Tooling suppliers need to make significant investments in R&D and capital to enable timely availability of technology
- If you don't move to the next generation...someone will and you will be left behind
- If you can't beat 'em, join 'em!

Wall Street Journal April 20, 2004...GM and Ford join forces to build 6-speed automatic transmission. Ford and General Motors will spend U.S.\$720 million...Each company will be responsible for integrating the transmission into its own vehicles...

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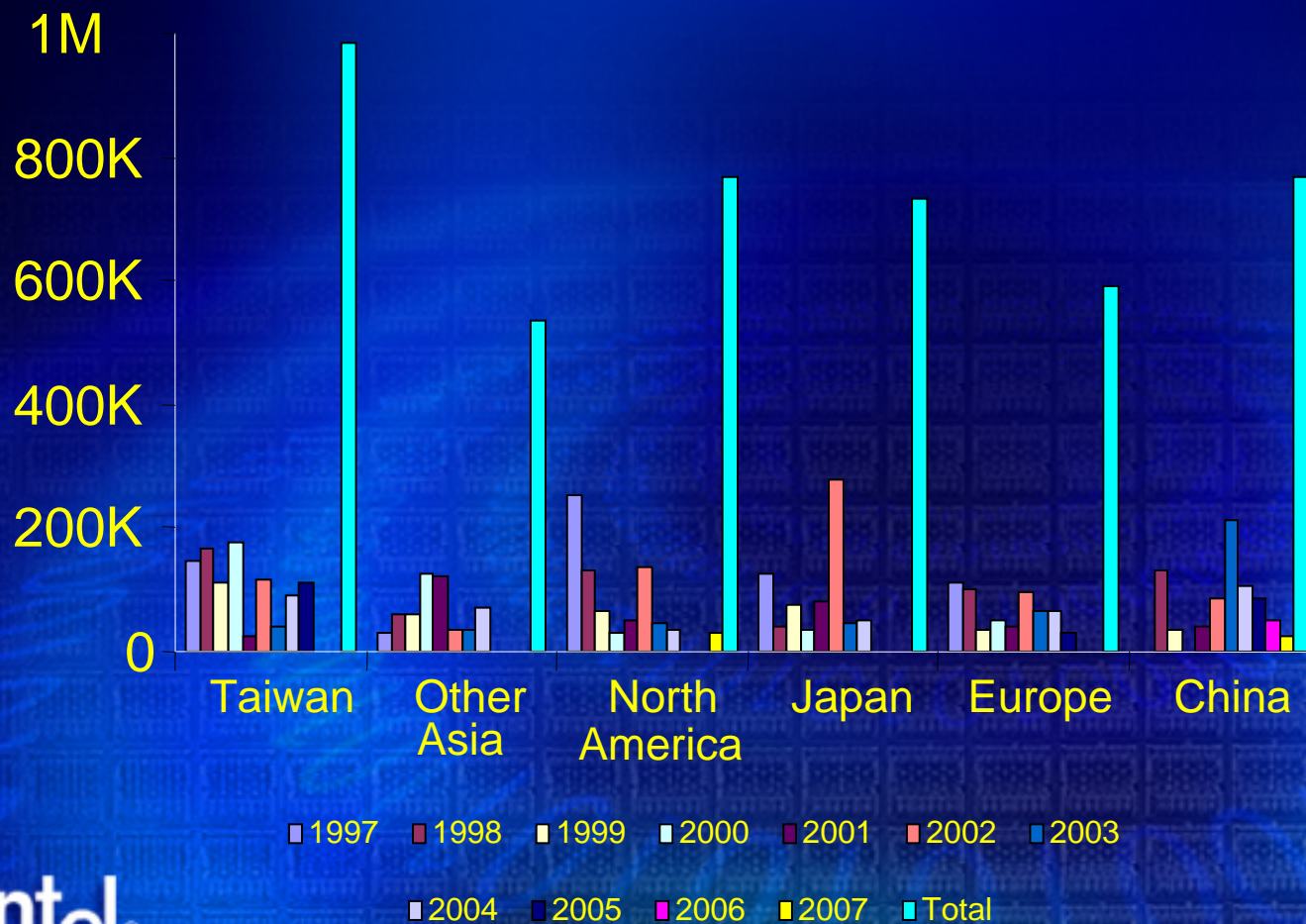
### Today's Model





# Tooling Grand Challenge # 3: Globalization

China set to flood the world with chips -- Asia Times – 4/04 “China is sitting on a mountain of wafers.... Chinese fabs hold about 9 percent of the foundry market's capacity today, and they are expected to produce 15 percent of the industry's chips by the end of the year, and well over 20 percent in 2005....”

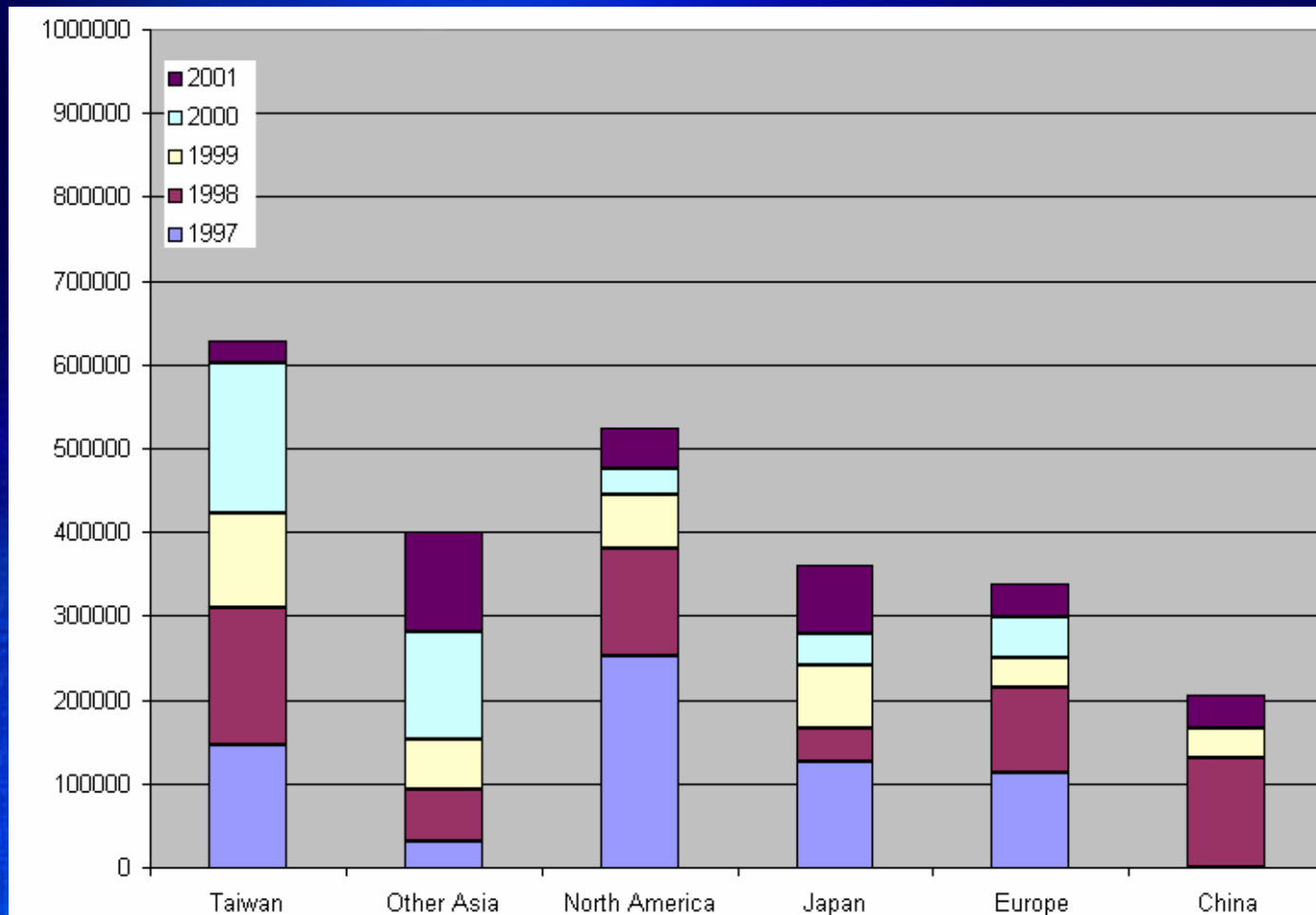


**Fab**  
as well as  
**Assembly**  
and **Test**  
is growing  
fast in  
**Taiwan and**  
**China**



# Tooling Grand Challenge # 3: Globalization

## Where is the world is the Fab Capacity ?



**Wafer Starts Per Month**  
(not normalized to diameter)

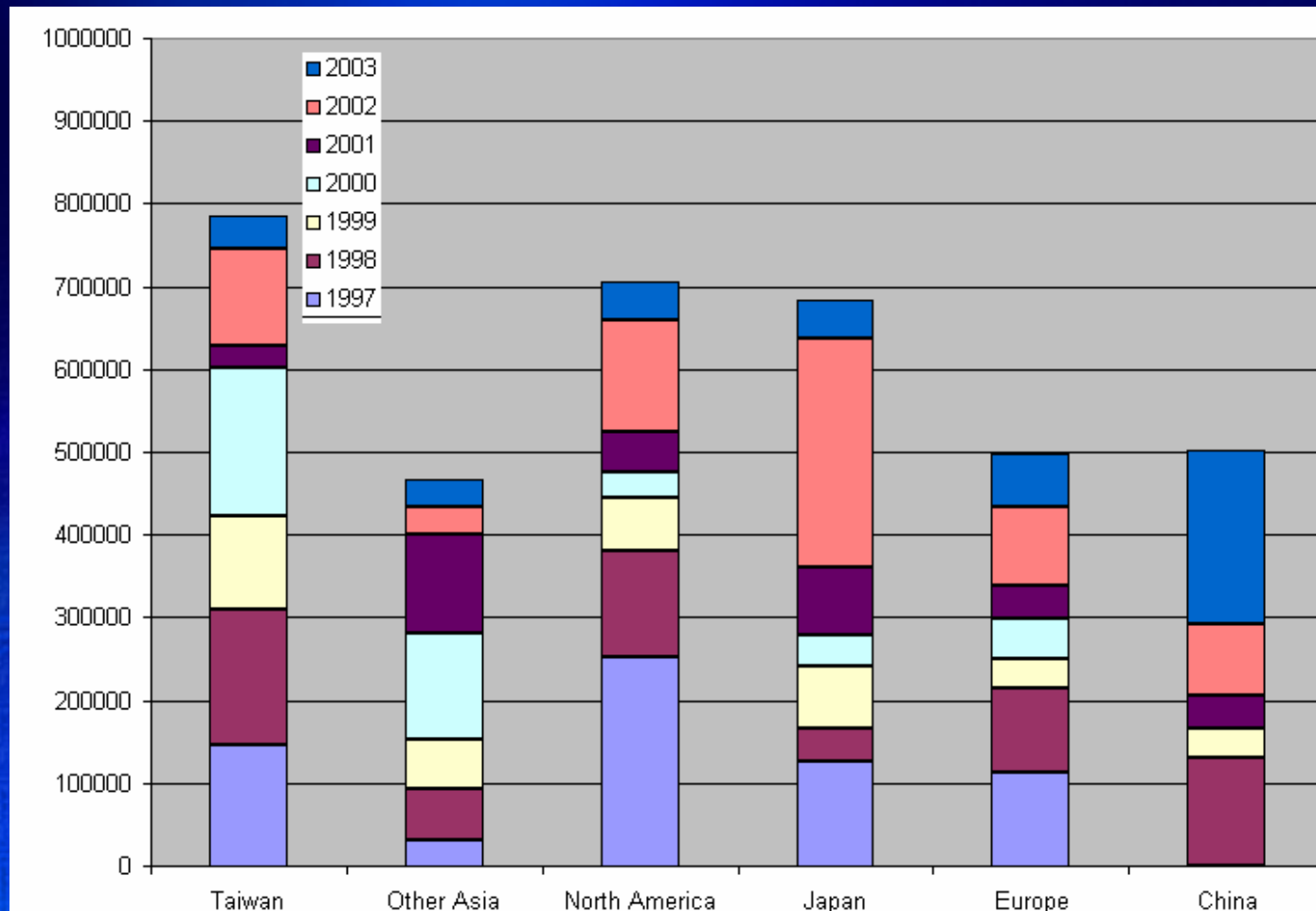


Source: Gartner



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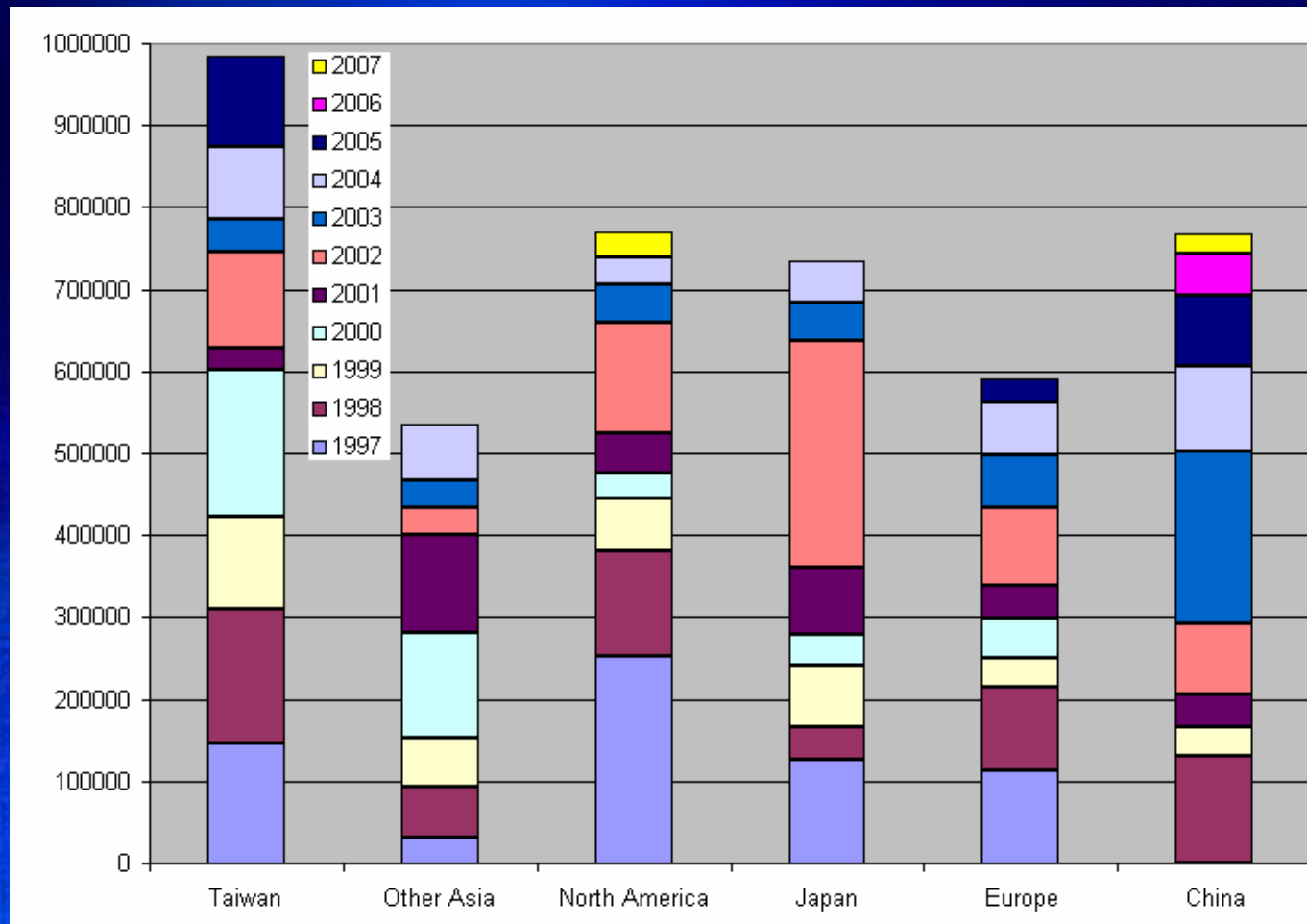
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# Tooling Grand Challenge # 3: Globalization

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# Tooling Grand Challenge # 3: Globalization

“Globalization means two things to me: putting resources in place to serve our customers around the world and making use of the best, most productive talent wherever it resides.” – Craig Barrett

## Three major parts of the Capital Equipment / Tooling Life cycle

# 3. Deployment to a worldwide virtual factory base

# 2. Maintain / Sustain in this world wide environment

1990's  
Methods

Continuously need to move our worldwide engineering resources to higher value tasks



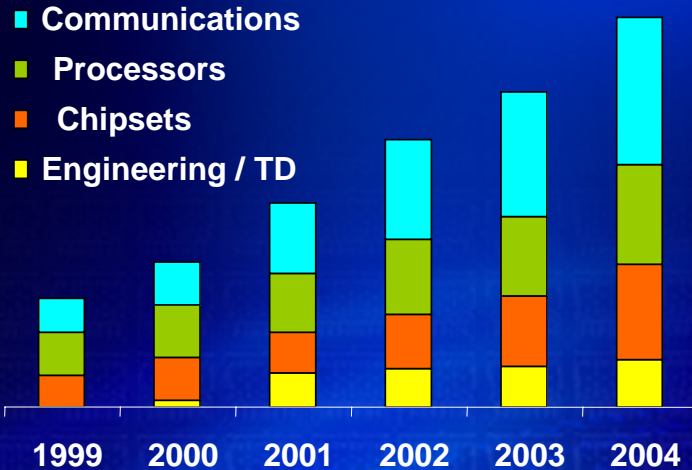
# 1. Enable Design and Development with Global Engineering Teams

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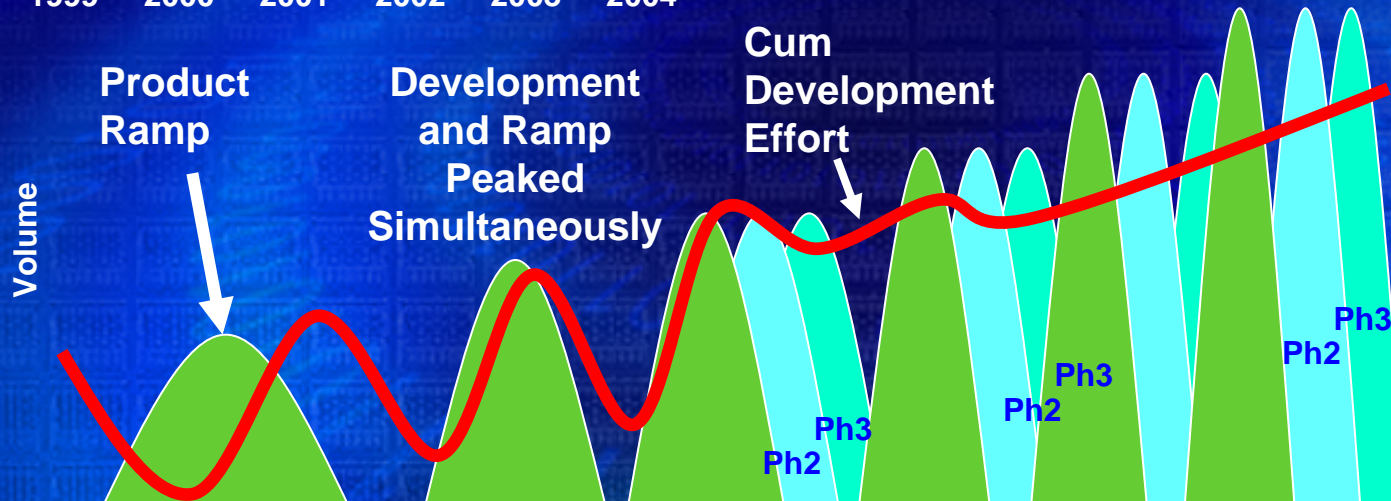
# Tooling Grand Challenge # 3: Globalization

## Why do Global Equipment Development ?

### Intel's Test Tooling Demand



- Multiple collaborative development teams are required to do the work
- It makes sense to leverage **global resources** in setting up these teams

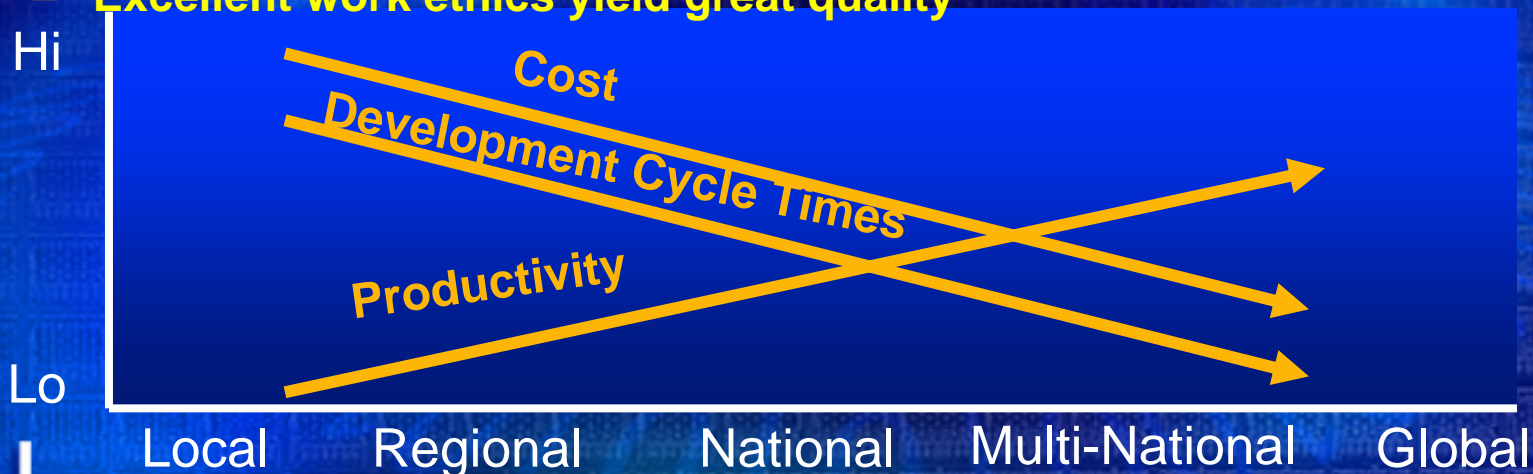




# Tooling Grand Challenge # 3: Globalization

## Why do Global Equipment Development ?

- **Customers**
  - Customers pull us into non US markets as they expand or shift to emerging markets
  - Time zone synergy with customers
- **Cost**
  - Lower cost geographical sourcing of engineering talent
  - Economies of scale and lower operating cost
- **Capability**
  - Good engineering and business expertise and a 24 hour development day
  - Excellent work ethics yield great quality



# Tooling Grand Challenge # 3: Globalization

## Need to rethink team dynamics

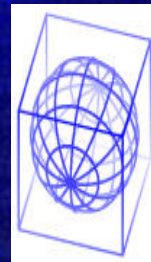
- **Management methods to comprehend continuously collaborative worldwide teams**
  - **Teams must be empowered with decentralized decision making**
- **Must develop technical skills at new levels of capability**

**Leadership and Management**  
Global reporting structure  
Cultural influences  
Communication Methods  
Work Hours  
Escalation policies paths



The traditional, at your desk from 8 to 5

+



Complex Landscape

=



Unhappy Employees

## **Project Planning and Work Execution**

Project planning  
Tools/Processes  
Data Repositories  
Scheduling  
Calendaring  
Logistics  
Meetings (time, FtF, phone, e-mail, video conferencing)  
Program roll-out



# Take Away

- **These are the good times!**
  - **The Semiconductor Business is in an upswing**
- **The Test Equipment Industry has made huge improvement in Cost and Capability**
- **The Test Tooling Industry has not seen significant improvement**

## Tooling Grand Challenges

1. **Costs are going the wrong direction**
2. **Tooling Industry lacks collaboration and is not enabling the technology of the future**
3. **The industry is going global, are you ready?**

# Summary

**“There is at least one point in the history of any company when you have to change dramatically to rise to the next level of performance. Miss that moment - and you start to decline”**

**-- Andy Grove**



# Q&A