The need for a Revolution in Test Tooling

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Take Away:

• 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
Semiconductor Industry Cycles

Source: VLSI Research
The Last Cycle

The curve shows the growth and time of the Internet, highlighting phases of irrational exuberance and rational growth. The timeline includes:

- Internet Enabling Technologies
- .com Irrational Exuberance
- Internet Bubble?
- Rational Growth

The graph illustrates the evolution and potential peak of the Internet bubble, moving from initial growth to a more rational phase.
Optimism for 2H’02 – ’03

- Consumer confidence is up
- US economy predicted to grow 3.2% in 2002
- China, South Korea, and Eastern Europe are leading
- IT dependent countries (Singapore, Taiwan) will follow by latter half
- Some economies are stuck in reverse (Argentina, Japan)
  - will they follow in 2003?

Will supplier improvement and responsiveness continue in the upturn?

Source: Merrill Lynch/IMF
Technology Trends

Transistors doubling every 2 years toward a billion transistors

~2B Transistors

Q4’01 estimates for Q4’02 CPU top frequency was 2.5Ghz, reality will be 3Ghz +

~2004: 5GHz, 80W
Technology Trends

Device I/O

- System performance coming from new I/O architectures
- Penetration of high speed interfaces into new designs is increasing dramatically
The Process Lifecycle

130nm – 4 quarters from development to HVM
No time for Mistakes – HVM and Prototypes are one and the same
The Real Product Cycle

June           July        Aug   Sep       Oct       Nov      Dec     Jan         Feb        Mar April      May

Q3’02                            Q4’02 Q1’03                               Q2’03

Pentium 4 Product Roadmap

Product Changes
Speed Improvements, Yield Improvements, Packaging and other changes yield an effective product cycle of 3 to 6 months

Overlapping ramp up, peak, ramp down

No time for Mistakes – HVM and Prototypes are one and the same
We are buying less and less Test Capital Suppliers.

And...Tooling is becoming a bigger and bigger % of product cost.
Tooling

Probe Cards, Sockets, Test Boards, BIB’s...
The tooling challenge

Provides a temporary Thermal Mechanical and/or Electrical interface to the DUT

Is custom to products

Customized to: Packaging form factors, Electrical and Thermal requirements and Device Function

Demand driven by product ramp cycles

Complex supplier and supply chain logistics

And is a technology, development and HVM enabler!
Tooling Suppliers are not fully enabling their customers
NPI numbers increasing

2001- All SIU’s designed in-house

Probe Card Design Growth:
- 22% 2000 to 2001, 38% 2001 to 2002

Strategy changed in 2001 to enable outsourced designs
- >1/3 outsourced designs planned in 2002

Intel had to enable suppliers to be able to do these designs

These same suppliers could not provide total solutions – only designs
Example: Lead time reduction
Only marginal improvement in 2 years

- Complex Assemblies
  - Goal < 2 weeks
  - Goal < 4 weeks

- Sub Components
  - Goal < 2 weeks
What does a revolution look like?

A Tester Example
Example Problem: SOC

- Highly integrated device containing any combination or permutation of the following:
  - Processor Core
  - DSP Core
  - Memory Interface
  - Embedded Memory (SRAM, Flash)
  - Analog (ADCs, DACs, baseband, RF)
  - High Speed Serial
  - Peripheral Interfaces
Problem:
Need to change the slope of the test curve

Evolution: Distributed Test
Revolution: Modular ATE

Source: ‘01 ITRS Roadmap Data
Distributed Test
Partition the test content by socket:

- The ATE industry has enabled this capability!
  - Implemented advanced DFT to manage test complexity
  - Reduce capability treadmill
  - Enable parallel test in complex designs

- Move a significant percentage of test content to less expensive DFT based structural testers
  - Enables capital cost reduction
  - Deliver state-of-the-art capabilities
  - Simplified tester hardware designs
  - Optimized content and flow

Source: Intel STTD
Modular ATE: Current Tester Architecture

- Closed architecture
- Custom infrastructure
- Difficult to support
- Improvements are ‘generational’ and difficult to incorporate
- Single supplier

Source: Intel TCED Navid Shahriari
Modular ATE:
A small step forward

integration enables modularity

Positives:
- Modules = “Tester on a board”
- Flexible configurations

But….Still has negatives
- Single supplier
- Closed architecture

Source: Intel TCED  Navid Shahriari
Revolutionary Solution:
Open Architecture VLSI ATE

- Multiple suppliers, industry specifications
- Scales across price, performance, pin counts, applications
- Reusable platforms & incremental CIP
- Standard operating system and equipment interface software
- Addresses high mix, low volume business need for “configure on the fly” capability

Source: Intel TCED Navid Shahriari
Turn Key Tooling?

- Are there any “turn key” tooling suppliers?
  The tooling industry is fragmented

- The Capital Analogy:
  - Buy capital equipment – One stop shopping
    - You don’t buy the pieces from 2-3 suppliers!

- Let’s buy a Vertical Probe Card
  - 1 supplier for Design
  - 1 supplier for PCB / Space transformer manufacturing
  - 1 supplier for Probes / Integration

- Who stands by the final product? The Customer?

The Tooling Supply Chain Needs to provide Solutions, not components
Today’s Tooling Supply Chain

- Tooling suppliers fall into 2 categories
  - Component manufacturers
  - Integrators or Assemblers

- A typical tooling supply chain contains 2-4 poorly synchronized suppliers
  - Design
  - Custom component design and manufacturing
  - Assembly or Integration
  - HVM support

- This industry infrastructure will not achieve the requirements of the future products and processes
The Next Generation Tooling Supply Chain

- Is proactively on the “treadmill”
  - Technically
  - Economically
  - Logistically
- Enables fungible designs that last multiple product generations
- Is synchronized with the specific technologies of the customers
- Provides complete turn key solutions
- Has 2 - 4 weak lead times, and finds innovative ways to continue to drive it down
- Is low, low cost and continues to drive costs down
What it takes is Revolution

- Evolution will not yield these goals!
- The scaling treadmill that the industry has relied upon needs to be replaced by disruptive technologies
- If you want to survive you must:
  - invest in disruptive technologies
  - cannibalize your current ones
  - acknowledge that your business model will be completely different in 2 years.

Can you do this? If not you won’t survive!

Strauss’s Prediction:
About ½ of you will be around in 2 years
Will you be one of them?
“The definition of insanity as doing the same thing the same way over and over again, hoping for a different result. If you want to achieve different results -- *better results* -- you have to do things differently. Success is not accidental. It happens because people plan carefully and they lay the necessary groundwork to get the right result in the end.”

-- Craig Barrett  
*President and CEO, Intel Corporation*  
*December 29, 2000*