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PACKAGE TEST – DELIVERING MORE THAN A TECHNOLOGY

by

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ABSTRACT

Moore's law continues to set the pace for the Microprocessor industry driving transistor density, performance and rich capabilities even as ASPs drift down. Test capital has stretched to keep up through improved parallelism, advanced architectures and in-field configurability while test tooling quality, lead time and cost are starting to fall behind. New technology needs will continue to challenge test tooling but are more evolutionary in nature while the business drivers have grown to be critical.

We are seeing an inflection in the test tooling industry's future where traditional test strategies will evolve. Quality, lead time and cost will dominate tooling choices and be the future engine to enable quicker time to market, a more nimble business and improved cost competitiveness. Test tooling has moved from a commodity to an integral business enabler. Tight collaboration between supplier and customer will be paramount. We will share key tooling business trends, challenges and what can be done to enable future opportunity and growth in this industry.

Package Test: Delivering More Than a Technology

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Burn-in & Test Strategies Workshop

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(intel)

Today's presentation contains forward-looking statements. All statements made that are not historical facts are subject to a number of risks and uncertainties, and actual results may differ materially. Please refer to our most recent Earnings Release and our most recent Form 10-Q or 10-K filing for more information on the risk factors that could cause actual results to differ.

Agenda

Tooling Trends

Velocity Challenge

Quality Challenge

Cost Challenge

Key Messages

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Key Messages

• Moore's Law is alive and well. Driving ever increasing tooling complexity

• New business driving an explosion of many new packages and much more tooling

• Tooling quality, lead time and cost are falling behind

• Test tooling Industry business inflection is on the horizon
   – We must work together to meet future challenges

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Our Story – in a nut shell

- Moore's law continues and business expands
- Tooling complexity and technical challenges increase each day.
- Lead time is flat against faster business needs
- Quality isn't keeping up with reduced margin for error
- Tooling cost scaling higher with complexity
- All this with an ever decreasing ASP

- Change is on the horizon…

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Intel's Product Trends

Phone   Tablet   Netbook   Ultrabook   Laptop   Desktop   Server   DC / HPC

Ultra-thin
High integration
Lowest Pitch
Highest complexity
Shortest lead time
…Yet, lowest ASP

New SOC Business
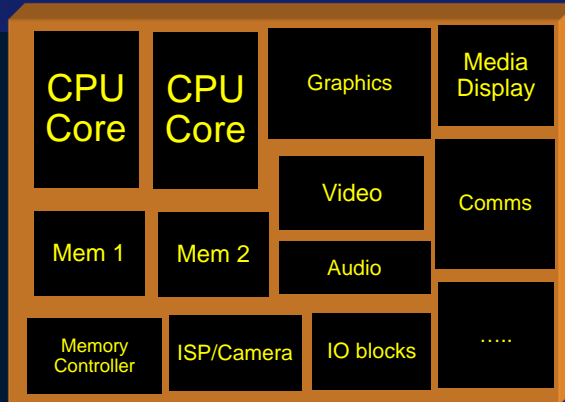*A very different Business Model*

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Growing Complexity In Design

- Advanced CPU
- Multiple cores
- Complex subsystems (e.g., Graphics)
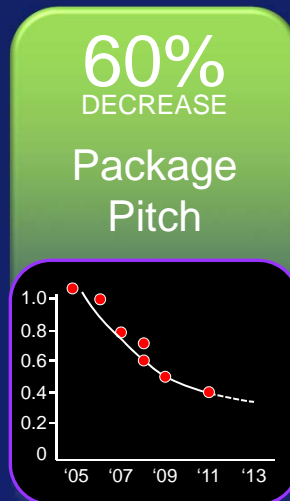- High bandwidth/ throughput IOs
- Multiple comms

CPU Core	CPU Core	Graphics	Media Display
		Video	Comms
Mem 1	Mem 2	Audio	
Memory Controller	ISP/Camera	IO blocks	.....

New levels of HW integration and complexity

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Tooling Complexity Trends
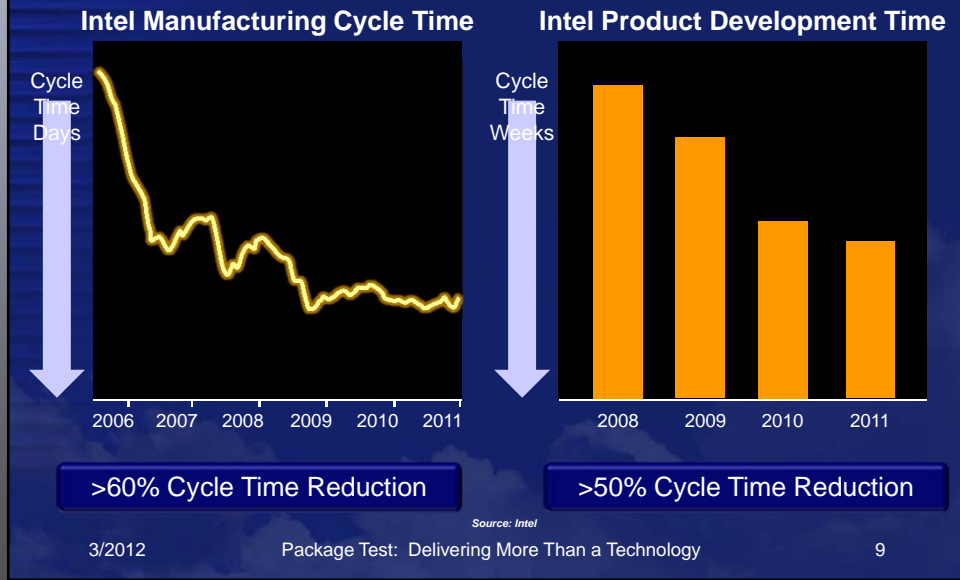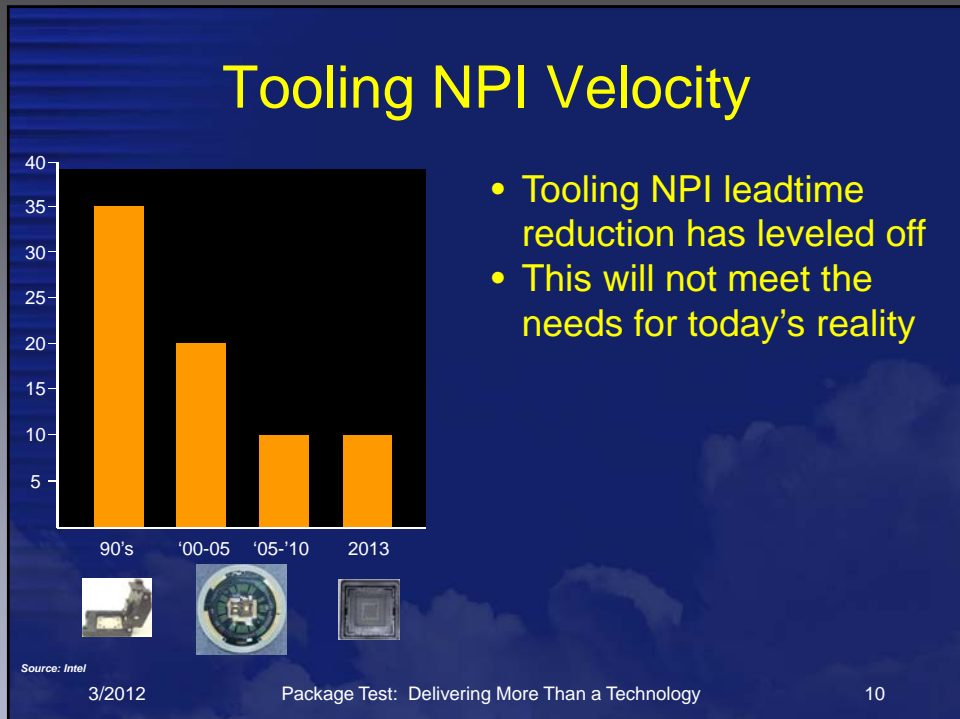
6X INCREASE
PC Board Features

60% DECREASE
Package Pitch

60% DECREASE
Package Thickness

'08 '09 '10 '11 '12

1.0
0.8
0.6
0.4
0.2
0
'05 '07 '09 '11 '13

'05 '07 '09 '11 '13

Source: Intel

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Velocity Trends

Intel Manufacturing Cycle Time

Cycle Time Days

2006   2007   2008   2009   2010   2011

>60% Cycle Time Reduction

Intel Product Development Time

Cycle Time Weeks

2008   2009   2010   2011

>50% Cycle Time Reduction

Source: Intel

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Tooling NPI Velocity

40
35
30
25
20
15
10
5

90's   '00-05   '05-'10   2013

- Tooling NPI leadtime reduction has leveled off
- This will not meet the needs for today's reality

Source: Intel

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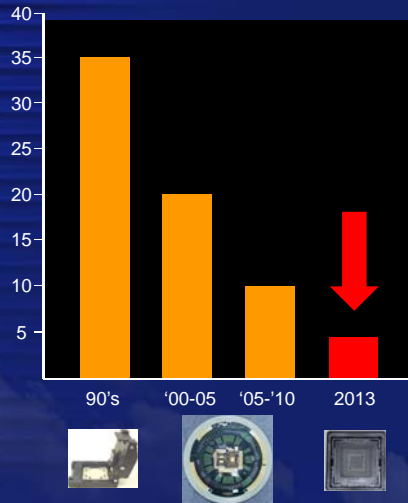
Tooling NPI Velocity

- Tooling NPI leadtime reduction has leveled off
- This will not meet the needs for today's reality

- Need a 4 week NPI cycle to keep pace or …
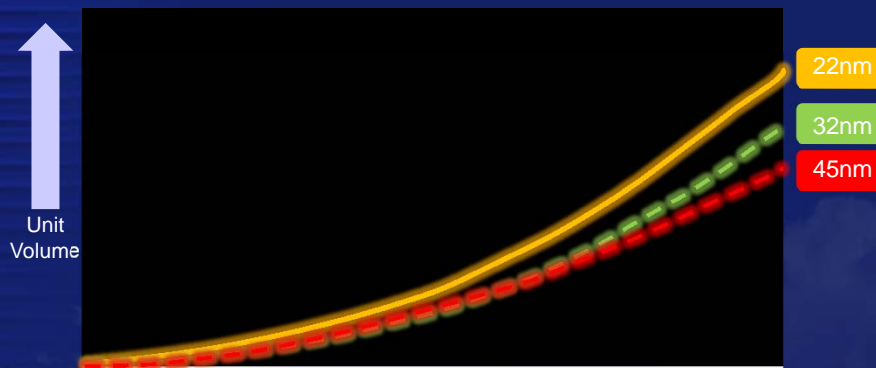
- Tooling will limit *Time-to-Market*

Source: Intel

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Faster Ramps With Each Generation

22nm

32nm

45nm

Unit Volume

Faster Ramps result in no margin for error.
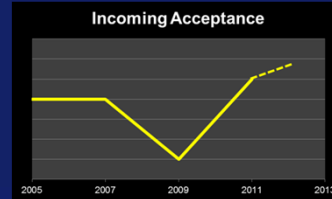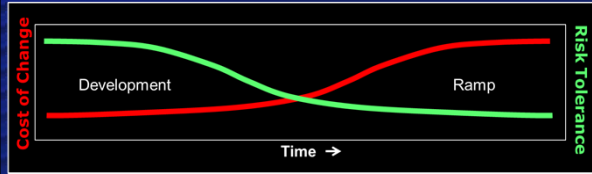Quality must be designed in from the start.

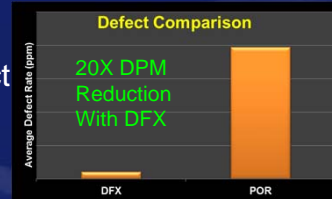3/2012   Package Test: Delivering More Than a Technology   12

Quality & Reliability
Critical that Tooling works flawlessly in ramp

Incoming Acceptance

Key Points:

- Tooling issues in HVM drive high impact
- We need to trust Tooling to work
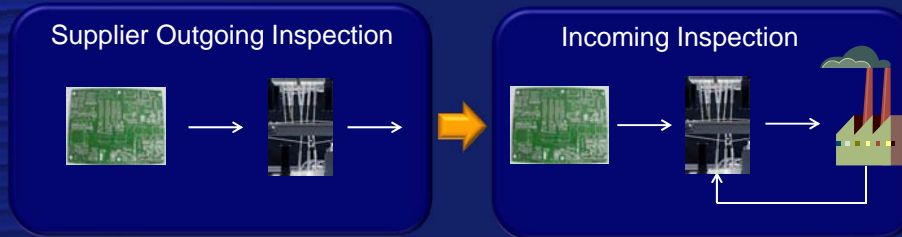- Need to invest in DFX upfront
- Who owns this?

Defect Comparison

20X DPM Reduction With DFX

Source: Intel

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Investing in Quality

Supplier Outgoing Inspection

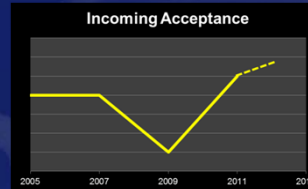Incoming Inspection

Introduced Incoming Inspection and Test

- A Known good TIU delivered to the Tester
- Incoming testing measures Supplier quality
- Testing and repair to ensure floor health
- Database of all Tooling events

Incoming Acceptance

Source: Intel

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Cost Pressures Increase

Mobile Internet Device **Low-cost PC**

Consumer Electronics

|	2010 Avg. Wholesale Price	2014 Avg. Wholesale Price
Desktop PC	$528	$450
Mobile PC	$612	$542
Tablets	$630	$530
Net Books	$329	$219
Mobile Internet Device	$235	$115

Source IDC & ABI Research

Constant declining ASP Pressure

Future growth markets require lower cost structure

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Tooling TIU Cost

1975 1980 1985 1990 1995 2000 2005 2010 2015
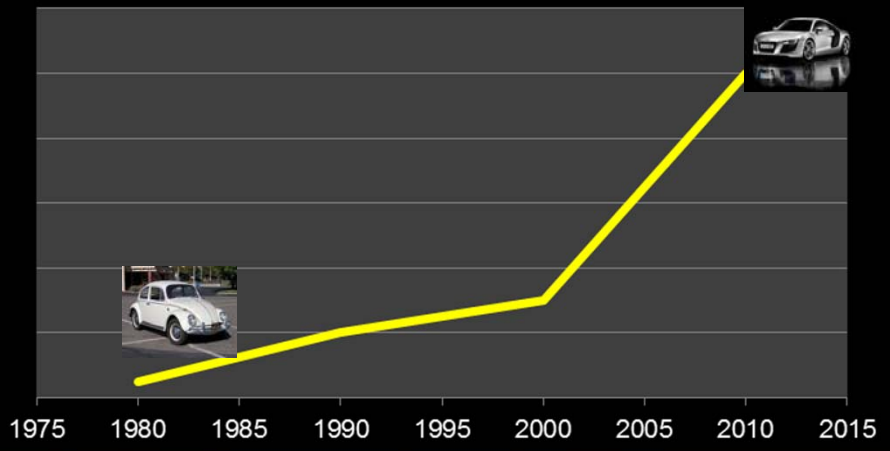
Source: Intel

Tooling cost scaling up with complexity.

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Tooling cost > Tester Cost ?

Tester vs. Tooling Cost ($)

Per Unit Cost

1990 2000 2010 2020 2030
Year

— Tooling Unit
— Tester Unit

Source: Intel
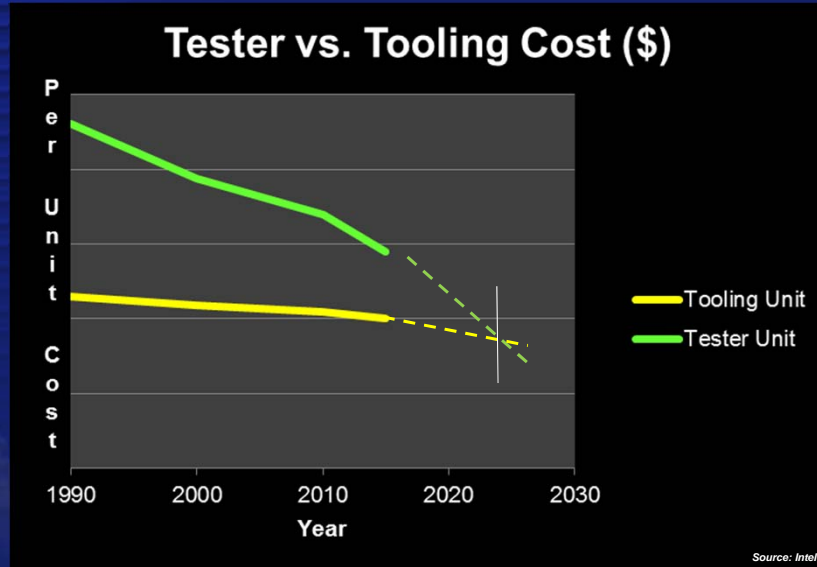
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Summary & Key Messages

- Tooling has not kept pace with the Semiconductor industry
  – Quality, Reliability, Lead Time or Cost
- Tooling is on our radar. It is a key business driver
- Collaboration is an imperative

Design Mfg. Inspection Usage ➡ Design Manufacturing Inspection Usage
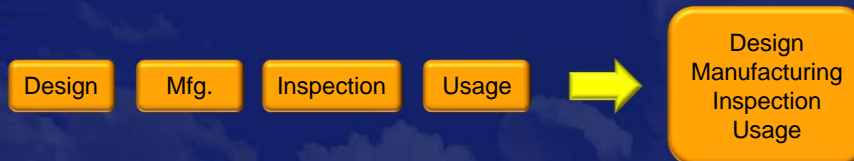
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Thank you

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