Test Coverage Consultant:
A coverage tool to explore the question
“What does it mean when the board test passes?”

Mike Farrell
Michael_farrell@agilent.com
Agenda

• How can Test improve Product Quality?
• How do we measure Test Coverage?
• Does it make sense to target 100% test coverage?
• What is needed to generate an accurate test strategy?
• A case study …
How can Test improve Product Quality?
… by striving to detect or prevent all faults on the product so that only good products are shipped.

- How do I know what is tested and what is not?
- How do I know how good the test is?
- How do I know if my tester is good enough to meet the test requirements?
- How do I define the optimum test strategy?
- How do I produce a complete test specification?
- How do I manage quality and non-quality?
Do you …

1) spend more than a week to generate a test coverage report?
2) have to generate the report manually?
3) get lots of stress to generate the test coverage report in a day?
4) wonder if the test coverage report will include features that your existing tester can cover?
5) wonder if the test coverage for the developed board test is as predicted?
6) Have problems justifying ICT to your customers and Boss?
Currently …

<table>
<thead>
<tr>
<th></th>
<th>Testability Report</th>
<th>Test Coverage Report</th>
<th>Coverage Analyst</th>
<th>Testplan Analyser</th>
</tr>
</thead>
<tbody>
<tr>
<td>board file compiled</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Full test developed</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Text only</td>
<td>√</td>
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<td></td>
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<tr>
<td>HTML only</td>
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<td>√</td>
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<tr>
<td>Spreadsheet only</td>
<td></td>
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<td>√</td>
</tr>
<tr>
<td>Test Prediction</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Coverage Comparison</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

* Only if comparing Predicted vs Actual test coverage

Observations:
• Test development is required to generate the above reports. At minimum, for the Testability Report, the board and board_xy files need to be compiled successfully.
• Reports generated are text based or HTML based or spreadsheet based, but not all at once.
• Level of detail is different
• Type of detail is different
• The purpose for each tool is different

No intention to remove existing tools.
What is ATCC?

Agilent Test Coverage Consultant (ATCC)

A push-button test coverage analysis tool that automatically generates coverage prediction and measurement reports.

Through automation, the ATCC tool reduces the generation time from 4 days to 5 hours, saving on engineering time and ultimately reducing time to market. The automation also provides a consistent report that both new and expert engineers can produce.
How do we measure test coverage?

First, we need to identify the faults that can occur

Then, we divide the faults into categories, to understand what types of faults can be captured by what type of tester
How do we measure test coverage?  
~ Test coverage by defect category

Each test technique brings a certain ability to detect the defects defined within ‘defect universe’

Pre-reflow A01
AXI
ICT

No single solution is capable of detecting all the defects.  
Good coverage = combination of tests.
Does it make sense to target 100% test coverage?

The total costs of testing depend on two factors: the actual test costs and the costs of non-quality.

Is it easy to design a test strategy?

Do I have enough information?
Do I know how the coverage is affected by different testers?
How do I find what are the overlapping tests?
How do I find what are the gaps?
How do I decide on the optimum test strategy?
What is needed to generate an accurate test strategy?

Generate a predictive test coverage report in PCOLA-SOQ format (CAD/Sch/BOM)

Generate an actual test coverage report in PCOLA-SOQ format

Compare the actual and predicted test coverage to determine gaps

Decide on the best test strategy by selecting the combination of test platforms that provide the best test coverage

Do the same comparison with different test platforms, like optical or x-ray or boundary scan
Case Study

6 Easy steps:
1) Input the board data
2) Modelize the components
3) Place the probes
4) Select the test strategies
5) Generate the test coverage report
6) Comparison of reports

Case study of a sample board ➔ Cherry_BC1 board
Step 1: Input the board data

**CAD, BOM, schematics files** are required to understand the board.

The CAD/CAM data includes
- component information (class, value, tolerance, height, centroid, test model, …)
- probe locations so that the node access is taken into account during the analysis.

The CAD layout information can be in two forms:
- The CAD data from layout or schematic format.
- The output of an existing CAD format translator like CAMCAD, Fabmaster or TestSight assuming probe locations are selected.
Step 2: Modelize the components

For more accurate test coverage prediction, the following information is required ...

1) Component type, value, tolerances, part number, etc (obtained from BOM)
2) BSDL file
3) Pin assignment, internal component structure
4) Component test libraries/models (if any)
Step 3: Probe placement (optional)

Probe locations are required to determine pin coverage more accurately during ICT coverage estimation.

Probes should be placed with consideration to
- Mechanical constraints
- DFT rules

If not enough probes are assigned, consider placing Agilent Bead Probes on traces.

An Accessibility report is created to list out the nodes without access.
Step 4: Selection of test strategy

As there are many different types of testers and inspection machines in the industry, the tool should be able to generate a report for each machine so that the test strategy can be generated.

- Coverage estimation
- Real coverage
- Selected strategies
Step 4: Early coverage estimation

In order to provide better accuracy in the predicted report, any test features that are available on the specific testers should be incorporated into the analysis. This brings the analysis closer to the actual test coverage.

Early estimation can be used by …

• OEMs and ODMs to check on the coverage of the Layout by R&D.
• CEMs can use this tool to determine the test strategy to test this board or to assist in quick quotation generation to their customers.
Step 4: Real coverage

The real test coverage is determined after the test has been developed.

Using PCOLA-SOQ,

- the same measures for predictive coverage analysis and actual coverage analysis → what are the gaps?

- test coverage of a combination of testers and inspection machines can be measured → complementary coverage

When determining test strategy, it is important to be able to consider all test platforms on the production line such as AOI, AXI, BST and FPT.

For example:
Acculogic (BS, Scorpion, SPRINT), Agilent (i1000, i3070), ASSET, CORELIS, GOEPEL (CASCON, OPTICON), JTAG Technologies, Mirtec, MYDATA, OMRON, Orbotech, SAKI, SEICA, SPEA (4040), TAKAYA (APT8000, APT9000), TRI (TR7500), VISCOM, ViTechnology, XJTAG, YESTech.

Functional test should also be supported!
Step 5: Generate the coverage reports

Comprehensive HTML and Excel reports detailing:
- Board level overview
- Explicit coverage information on selected items
- Excel format for easy sorting and further report generation

Fully interactive cross-probing between HTML reports and schematic/layout views.

Coverage visualization categorized using easy-to-interpret traffic light colors.
Step 6: Comparison of Predicted vs Actual Coverage Reports

The test coverage tool compares the early estimation (defined in Statement Of Work/Test specification) with the real implemented tests.

- Test program development quality management,
- Opportunity to benefit from new test techniques by increasing the overall coverage.
Step 6: Comparison of Summary Reports

Executive summary by strategy or for the complete test line.

Quick overview of the coverage
Step 6: Comparison of Component level reports
Step 6: Detailed component coverage report

U2 digital IC report
→ zoom down to the pin details
Step 6: Navigate the layout, schematics and netlist

To better understand the circuit surrounding the component.
Step 6: Comparison ~ Excel comparison report

Using the Excel format comparison report

→ Easy to sort the information

Find the differences

Edit the test!
Applications

A quality tool management that serves from design to production:

<table>
<thead>
<tr>
<th>Application</th>
<th>OEM</th>
<th>ODM</th>
<th>CMS</th>
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</thead>
<tbody>
<tr>
<td>Check the test coverage of the board based on CAD from R&amp;D</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Plan the test strategy of the manufacturing line</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Compare the predicted test coverage against actual</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Quickly estimate the test coverage of the board for quotation purposes</td>
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<td></td>
<td>✔</td>
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</table>
# ATCC Highlights

<table>
<thead>
<tr>
<th>Highlights</th>
<th>How?</th>
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<tbody>
<tr>
<td><strong>Quick</strong></td>
<td>Generate test coverage reports <em>within minutes instead of days</em>. A report for 2,000 node board CAD file can be completed in 5 hours compared to a 4 day manual effort to produce a similar report.</td>
</tr>
<tr>
<td><strong>Easy</strong></td>
<td>At the <em>push of the button</em>, a consistent test coverage report is produced regardless of engineer’s experience and expertise.</td>
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<tr>
<td><strong>Complete Coverage Measurement</strong></td>
<td><em>PCOLA-SOQ</em> covers the span of manufacturing test defects and the user can quantify the effectiveness of the test(s) deployed.</td>
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<tr>
<td><strong>Agilent Specific Features</strong></td>
<td>Precise test coverage analysis for Agilent ICT by selecting optional features matching the configuration of the target test system. You can generate reports with and without an Agilent test feature to assess its value.</td>
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</table>
| **Multi-purpose**              | A single tool for test coverage and test strategy analysis for both NPI and manufacturing. The resulting test coverage report can be used for:  
1. Test coverage documentation  
2. Understanding gain/loss of test coverage by adding/losing a test feature  
3. Comparing test coverage by tester type  
4. Manufacturing test strategy analysis using a combination of ICT and Imaging testers |
Software Demo

Please contact Jack France for a demo of the software