300mm Implementation Status

(ISMT Software Test Project)

e-Manufacturing Workshop

December 3, 2002

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Presentation Objective

In this presentation we will seek to share some of the results from the International SEMATECH 300mm Equipment Integration and Automation Software Standards Test Project, that reflect the current state of the industry in this space. Further, an overview of some of the obstacles, experience, and what we believe are the lessons learned that can be applied to future endeavors such as the e-Manufacturing initiatives.

Project Objectives

Accelerate: THE MATURITY AND AVAILABILITY OF EQUIPMENT INTEGRATION AND AUTOMATION SOFTWARE

Assess: THE CURRENT STATE OF THE INDUSTRY FOR 300 MM STANDARDS CONFORMANCE

Assist: THE SUPPLIER IN STANDARDS IMPLEMENTATION AND PROBLEM RESOLUTION THROUGH INTERACTIVE DISCUSSION AND EXPERT GUIDANCE

Conformance Defined

For the purpose of this project, conformance is defined as ***"the ability and extent to which the software is able to support the functions needed to operate in a production fab, as defined by the operational modes of the IC manufacturers".***

- "Compliance" to standards is not well defined or agreed upon
- Even if software were compliant to standards, that does not insure that the standards will work together properly
- The operational modes defined by the members require a mix of functions that the standards classify as fundamental, additional, or optional. Those classifications are not meaningful in terms of an integrated operational mode of the end user.

- **Bottom Line: they need to work the way we want them to in a fab**

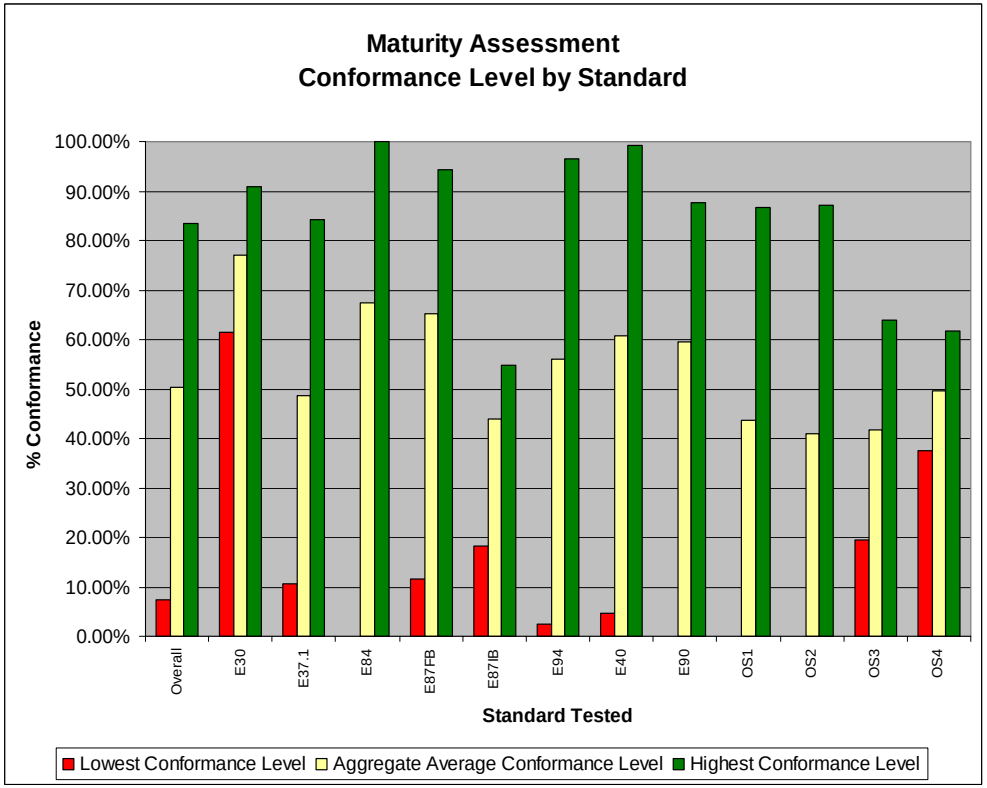
Metrics

- To what extent we were able to test the requirements (defined in the ISMT Standardized Test)
  - Coverage % = Cases Tested / Standardized Requirements
- How good was the performance of the cases tested
  - Test Result % = # Pass / # Tested
- To what extent does the equipment meet the requirements of the consensus requirements (defined in the ISMT Standardized Test)
  - Overall Conformance % = Coverage x Test Result
- What rate is improvement being made during the SWIPE activity
  - SWIPE Issue Closure Rate = # issues closed at each review meeting. Review meetings are held every three to four weeks

Warning: The results that we will look at are from Maturity Assessments, and constitute a snapshot of the current state before improvements

Aggregate Results

- Conformance Level is the combination of Coverage and Test Result %
- The Conformance Level measures the extent to which the tool met the requirements
- The average results can be considered a snapshot of the state of the industry
- Test Coverage had a more significant impact on the Conformance Level than Test Result %



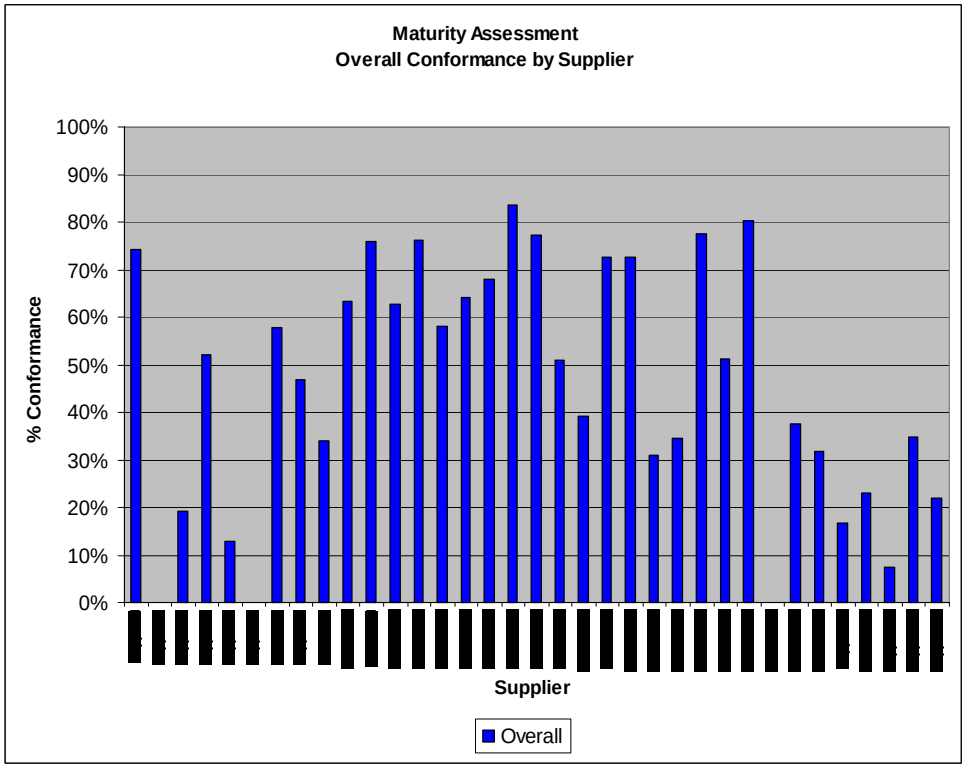
Overall Conformance Levels

This chart shows the Overall Conformance Level by tool for our most recent tests in 2002

Approximately half of these tools have Conformance Levels well below 50%

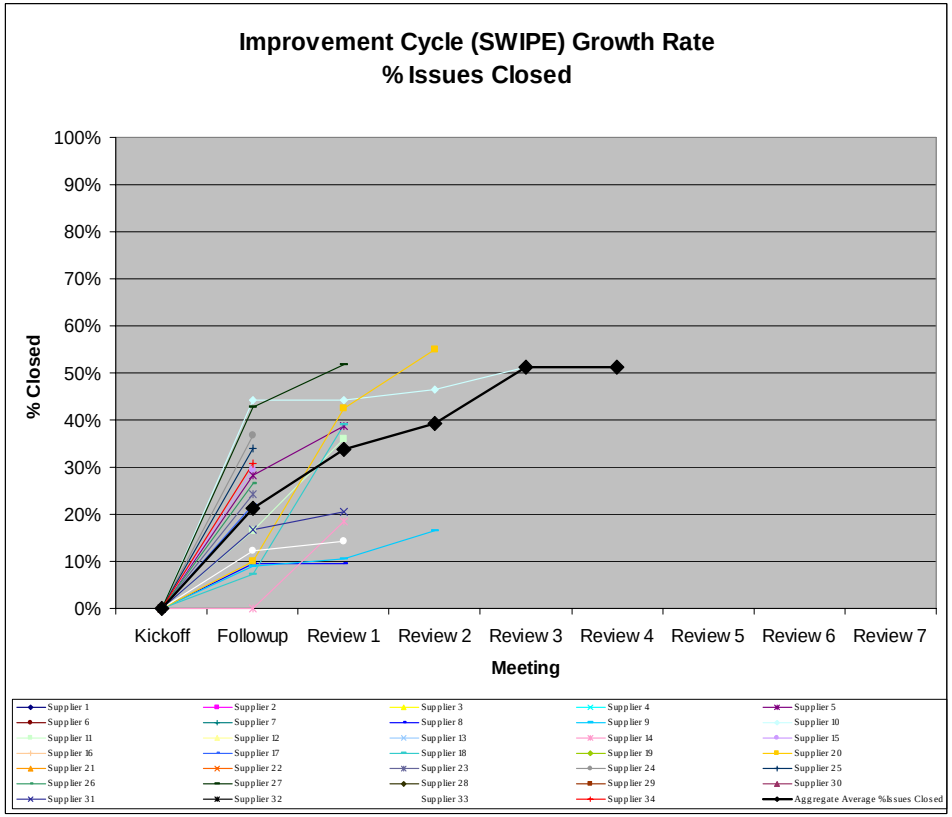
Tools with Conformance Levels >85% are more easily integrated into fab environments

Meeting these fundamental requirements, even low volume operations, is no guarantee of good performance in High Volume Production usage

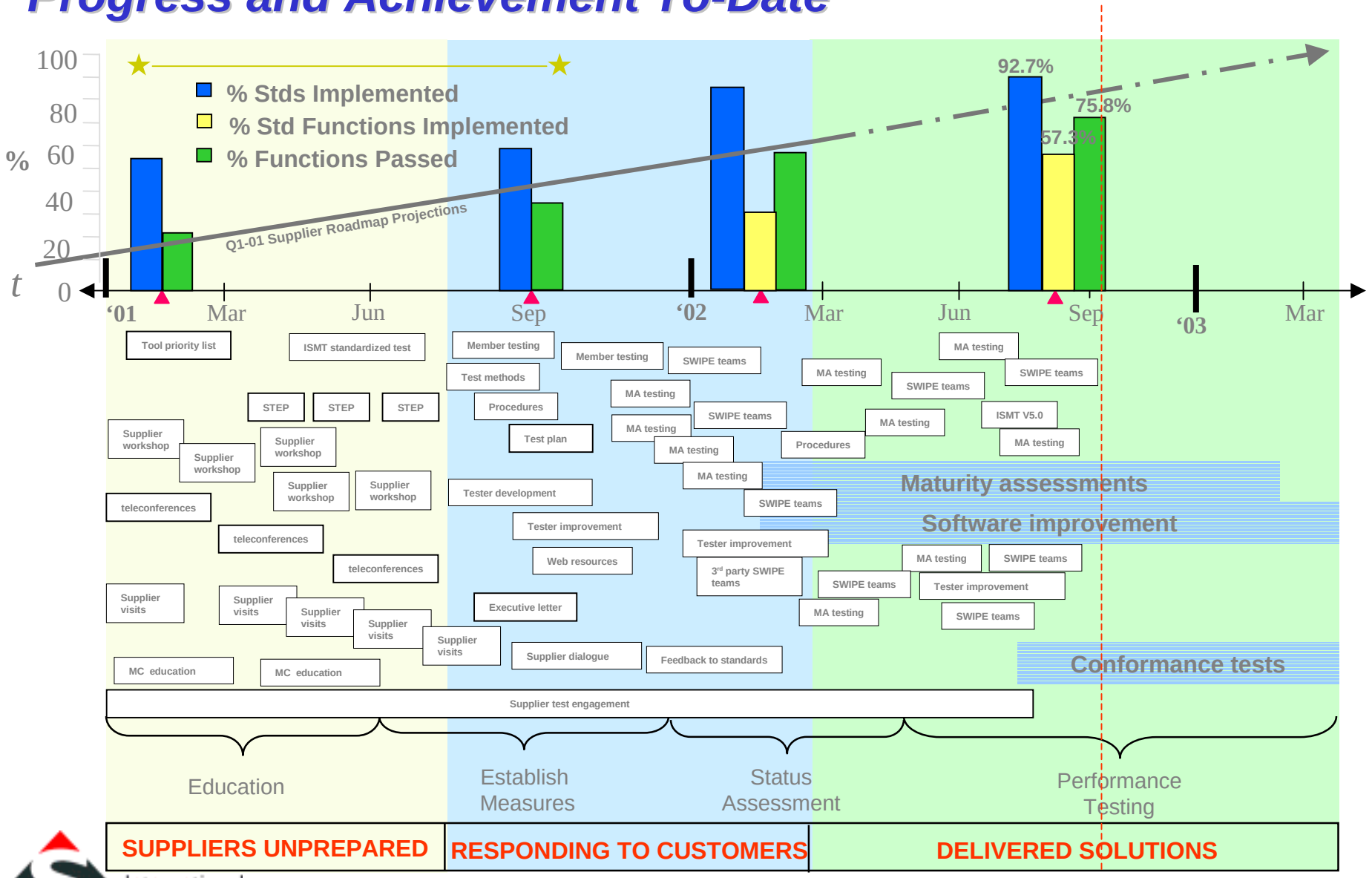


Improvement Cycle Results

- Issue Closure Rate represents the rate of correction or growth of the software
- Approximately 25% of issues identified were easily corrected in under 1 month (low hanging fruit)
- The focus in the Improvement Cycle is on issues that are most important to Member Company end users



Progress and Achievement To-Date



The Implementation Experience!
or
(What actually happened in the Fab)

The Implementation Experience

As Fabs started receiving, installing, accepting and integrating 300mm equipment, they found that in addition to the delivery of standards software support being late, they experienced a significant number of obstacles and issues. We would like to share some of those issues and experiences, many of which are still ongoing. These issues were collected from a variety of member companies and people, are presented in no particular order or priority, and are not intended to represent a complete and exhaustive listing.

There remain significant 'interpretation' issues with the standards, but in a production fab it is what happens that is important

Issues & Experience – page 1

- **Standards not implemented**
  - Supplier disagrees with the need for a particular standard
  - Supplier disagrees with the content of a standard
  - Tool OS or application software/hardware cannot support the function
- **Documentation**
  - The documentation does not match the delivered software
  - The documentation does not support the many versions, interim releases and software patches in the field
  - The documentation has many errors in critical data such as CEID's, SVID's, Alarms, and Events
  - Documentation errors between tools/models by the same Supplier
- **Revision/Release Control**
  - Multiple levels of released software in the field, e.g. Beta, Beta 2, Final, etc.
  - Software patches are not revision controlled
  - Multiple iterations of software version during installation and prior to acceptance
  - Core software is not revised to reflect the application of interim solutions or patches (I.e. two tools will show the same release number when one of them has had patches applied – no other indicators)
  - Confusion in the field and FE community on valid revisions, current revision, etc
  - Release notes not available

Issues & Experience – page 2

- **Data Inconsistencies**
  - Data length variations between tools, such as the Object ID requirement to support a maximum length of 80 characters (some suppliers interpret this as unclear in the standard)
  - Concurrent processing (multiple load ports processing multiple carriers, CJs and PJs) attach event reports and data to the wrong material
  - Data collection formats vary between equipment
  - Many suppliers have implemented formats based on equipment capabilities, not standards
  - Cascade processing has been found to interfere with data integrity, sometimes good data is returned, sometimes stale or wrong data
  - Equipment retains completed or cancelled/deleted CJs and PJs, then applies them to other material randomly
- **Equipment OS Instabilities**
  - Many error conditions require re-initialization of the equipment
  - Communication drop outs, cannot reconnect
  - Cumulative sync errors
  - Anomalous behaviors that can or cannot be cleared, with no known cause, ability to replicate, or ability to research to root cause

Issues & Experience – page 3

- **Network Connections**
  - Difficulty establishing initial connection or reconnecting
  - Tools that will not stay connected to the factory network longer than 6 hours
  - Inconsistent equipment end connection configuration
  - Domain incompatibilities and competition
- **Exception Handling (various examples)**
  - Clearing equipment of Carriers, CJs, PJs, is difficult or impossible
  - Removal of a carrier manually while in auto mode causes unexpected failures and interactions
  - Events happening out of the specific order the equipment expects cause unpredictable and sometimes radical variations in behavior
  - Queue handling 'loses' CJs and PJs, will not release them when completed, applies CJ ID of the in process job to queued jobs
  - In carrier management, during alarm conditions no action is allowed so the condition cannot be cleared
  - Clearing equipment internal databases is a challenge
  - Equipment Log files are cryptic, incomplete, or hard to interpret
  - Canceling carriers, jobs, or actions not supported or causes anomalous behavior
  - Lack of atomic level commands and GUI local mode access complicates recovery

Issues & Experience – page 4

- **Custom Requirements**
  - Some suppliers have added additional requirements outside the scope of the standard defined function in order for their equipment to operate
  - E30 Recipe upload and download may require additional data to work
- **General**
  - Equipment and software reliability is low
  - Frequent resetting, initialization and rebooting of the equipment is required on some equipment
  - Multiple layers of legacy software, 3rd party software, network software on one equipment. Delays and compatibility issues between layers.
  - There is rarely one point of contact within a supplier for FA software or issues
  - Equipment software experts are often required to resolve issues, and their availability and accessibility is poor
  - The equipment support infrastructure in the field is not knowledgeable, equipped, or educated on the requirements and support of the FA software

Conclusions

There is still significant improvement required across the industry for the FA standards software. The cost of these delays and functional impairments is staggering. With production ramps moving into the High Volume Manufacturing (HVM) range, these problems are causing wafer scrap. More importantly, the OEE productivity improvement required is not being realized. This cost will certainly get the attention of the IC maker management.

Lessons Learned

- As we have moved through the Software Test project we have identified a number of high level areas where the experience and learning can be applied to future efforts.

Test Project Learning

- Many suppliers did not believe that the requirements were real, and development did not begin until after orders were placed in many cases
- The expertise and understanding required to implement the standards did not exist in most supplier engineering ranks. This learning curve was a significant delay.
- The requirements and functions in a standard *must* be interpreted from the perspective of the end user – otherwise costly delays and reprogramming are needed
- Most suppliers do not have sufficient understanding of the factory environment to provide context for their implementation, or what it takes to be a good behaving member of a factory tool set
- The size of the company, long term relationships, or maturity of the product did not significantly contribute to the ability or success of implementing the FA standards

Test Project Learning - continued

- The quality and stability of the test tool and method is critical to success
- Suppliers that actively participate in the Standards process are more successful in implementation
- The overall quality and stability of software has degraded from 200mm
- Early development and implementation activities, especially the development of in house knowledge and expertise has high leverage
- Partnering or close cooperation with an IC maker or group such as ISMT Test Project significantly improves likelihood of first pass success and accelerates development and delivery
- Error and exception handling *must* be considered in development
- Establishing an objective test criteria, like the ISMT Standardized Test enables accelerated maturation

Summary

- The availability of robust integration and automation implementations has been late and slow improving
- There remains a great deal of work to be done, that can best be accomplished by the IC makers and Suppliers working together openly and aggressively
- We must use this experience to ensure that emerging standards address implementation and intended use modes, interaction between standards, and testability