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Inside

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Hi-Tech Equipment Reliability A Practical Guide for Engineers and the Engineering Manager

By Dr. Vallabh H. Dhudshia
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High-Tech Equipment Reliability Series

WWK recently received permission to reprint sections from Dr. Vallabh H. Dhudshia's book, *Hi-Tech Equipment Reliability: A Practical Guide for Engineers and Managers*. This book, first published in 1995, is now *back in print:*

http://www.amazon.com/exec/obidos/ASIN/0595458289/wrighwillikelly

Dr. Dhudshia has been an equipment reliability specialist with Texas Instruments and with Xerox Corporation. He served as a Texas Instruments assignee at SEMATECH for three years. Dr. Dhudshia received a Ph.D. in IE/OR from New York University. He is an ASQ fellow and a senior member of ASME. He has developed and taught courses in equipment reliability overview and design practices. He is an affiliate of WWK, specializing in reliability consulting.

In this issue of Applied Cost Modeling we are reprinting Chapter 14. We hope that you find the information in this series useful.

[Continued on Page 3]

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Calendar of Events

January 2011

9-12 **Industry Strategy Symposium (ISS)**
Ritz-Carlton
Half Moon Bay, CA

17-20 **World Future Energy Summit**
Abu Dhabi National Exhibition Centre
Abu Dhabi, UAE

February 2011

27-1 **Industry Strategy Symposium Europe**
World Trade Center
Grenoble, France

March 2011

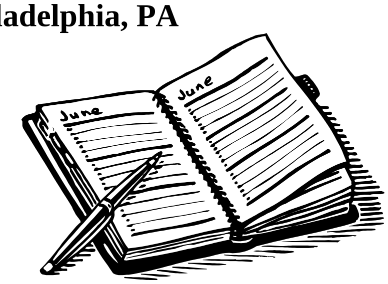
15-17 **SEMICON China**
New International Expo Center
Shanghai, China

20-22 **PV Fab Managers Forum Europe**
Hotel Concorde Berlin
Kurfuerstendamm, Germany

28-31 **NA Standards Spring Meetings**
SEMI Headquarters
San Jose, CA

April 2011

15-17 **PV America**
Pennsylvania Convention Center
Philadelphia, PA



Chapter 14
Reliability Improvement Program: Implementation and Assessment

Today's highly competitive and global market environment requires an optimum level of reliability in every product that manufacturers make. To achieve this level, most manufacturing organizations should implement a well thought-out reliability improvement program. In this chapter, we will learn more about such a program, including how to implement and assess it.

14.1 Reliability Improvement Program Implementation

We learned most of the key elements of an effective reliability improvement program in the previous chapters. We also learned about the people who drive the program. The reliability level of equipment in actual operations depends upon how these elements and people are applied in an organization. This application creates a long list of factors, summarized in Appendix A, that could affect the reliability level in actual operation. An effective RIP should address most of the applicable factors. Once the reliability improvement program is prepared, the next challenge is to implement it. The following two sections contain the implementation steps for equipment suppliers (manufacturers) and users (customers).

Equipment Suppliers

The following is a chronological sequence of steps to effectively implement equipment reliability improvement programs at a supplier's operation.

1. Appoint an executive champion.
2. Establish an empowered equipment reliability group.
3. Educate equipment design, manufacturing, and service engineers, parts buyers, and program managers in equipment reliability and relevant SEMI specifications.
4. Develop a corporate level reliability improvement policy.
5. Include reliability improvement activities in the business project plans.
6. Understand customers' reliability requirement specifications.
7. Include reliability requirement specifications in the part buying process.
8. Engage with the key customers and suppliers at an early stage of the equipment design.
9. Invite key customers and suppliers into equipment design reviews.
10. Let customers perform alpha or beta (early validation) tests on the new equipment designs.
11. Conduct joint equipment improvement programs with the customers.
12. Implement equipment performance tracking systems to get equipment performance data from the customers.
13. Work with the customers to develop and implement the needed corrective actions.
14. Perform an assessment (described in the next section) of your organization's reliability improvement program. Identify opportunities for improvement and implement corrective actions.

Equipment Users/Customers

The following is a chronological sequence of steps designed to effectively implement an equipment reliability improvement program at a user's operation.

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1. Appoint an executive champion.
2. Create an empowered equipment reliability group.
3. Educate equipment users, EEs, PEs, buyers, and managers in equipment reliability and relevant SEMI specifications.
4. Prepare reliability requirement specifications.
5. Include reliability requirement specifications in the buying process (for equipment and spares).
6. Engage with the supplier at an early stage of the equipment design.
7. Participate in the suppliers' equipment design reviews.
8. Conduct joint equipment improvement programs with the suppliers.
9. Implement a system for tracking equipment performance data.
10. Supply equipment and spare parts performance data to the suppliers.
11. Work with suppliers to develop and implement any needed corrective actions.
12. Participate in the supplier's goodness assessment (described in the next section) of their reliability improvement program.

14.2 Goodness Assessment

Once an equipment supplier implements a reliability improvement program, he should assess his reliability improvement program. If you are a user/customer, you would like to assess your key suppliers' reliability improvement programs. In this section, we will learn a simple methodology to assess the goodness (effectiveness) of a supplier's reliability improvement programs.

<u>Assessment Methodology</u>

The assessment methodology consists of assessing a set of organization's one hundred traits related to the following eight categories, listed in Appendix B.

1. Company culture, see table B1
2. Reliability group, see table B2
3. Reliability goals/objectives, see table B3
4. Design assurance, see table B4
5. Reliability testing, see table B5
6. Manufacturing quality assurance, see table B6
7. Reliability growth management (continuous improvement), see table B7
8. Software development and testing, see table B8

Each trait in each category has maximum of ten points. Assign a score between zero and ten, depending upon the presence of the trait in the organization being assessed. Use the following guideline.

- Assign a zero if you disagree completely with the trait statement
- Assign a five if you neither agree nor disagree with the trait statement
- Assign a ten if you completely agree with the trait statement
- Assign in between scores as the situation warrants

<u>Assessment Process Steps</u>

1. Select a group of people who have knowledge of the reliability discipline and reliability improvement program activities and are familiar with the organization whose reliability improvement program is being assessed.
2. Have the selected individuals assign assessment scores for each trait in each category. Their scores should be between zero and ten for each trait as explained in the previous section.

3. Tally the results and calculate the average score for each trait, each category, and overall.
4. Use your overall score and table 14.1 to find out where the organization stands with respect to an average organization and a benchmark organization. This scale is very generic. You can develop your own scale based on your assessments of many organizations.

	Range of the Overall Assessment Score				
	Below 350	**350 - 500**	**500 - 700**	**700 - 850**	**Above 850**
Standing of Reliability Improvement Program	**Below Average**	**Average**	**Above Average**	**Excellent**	**Bench Mark Level**

Table 14.1 Reliability Improvement Program Assessment Guide

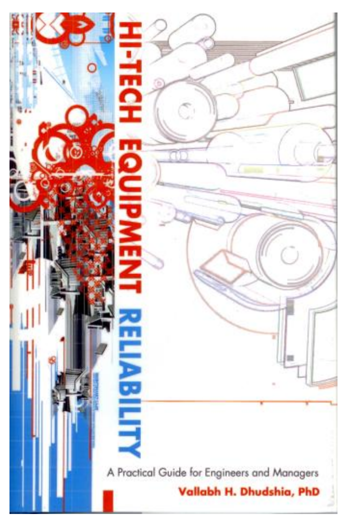
EXAMPLES:

- If your average overall score is 375, your reliability improvement program is average—similar to that of an average organization.
- If your average overall score is 860, your reliability improvement program is a benchmark program.

Uses of the Assessment Score

Once the goodness assessment score is known, suppliers and/or users can use the score to:

- Satisfy curiosity
- Compare with a competitor or a benchmark company
- Identify weak areas in the program that may require some changes
- Gauge gradual improvement in the effectiveness of the reliability improvement programs
- Get management attention and funding for the needed changes in the reliability improvement program, if the assessment score is low
- Market the equipment, using the high assessment score as an advantage
- Select equipment for acquisition (equipment buyers) based on the assessment score, which foretells equipment performance once it is purchased and installed



Factory Commander® Paper in Photovoltaics International

Photovoltaics International's 10th edition contains a paper written by Spire Corporation and Wright Williams & Kelly, Inc. The journal can be obtained at http://www.pv-tech.org. This paper, the fourth in a series covering cost modeling studies for photovoltaics (PV), examines a new approach to module assembly based on the concept of "Supersized" 1-kW PV modules. Utilizing supersized modules (5-ft x 12-ft) and integrated micro-inverters, this new approach is estimated to save utility solar installations up to $0.55/watt. The paper will conclude with a detailed cost and resource case study comparing two 40-MW module lines, one employing breeder technology and the other producing conventional sized modules.

The fifth paper will appear in the 11th edition to be published in the spring 2011 time frame. This paper will examine the cost structure of thin film PV manufacturing. WWK is currently looking for partners for this paper. Any interested parties can contact WWK at info@wwk.com.

Factory Explorer® Paper Presented at the Winter Simulation Conference

At the recently completed Winter Simulation Conference track on Modeling and Analysis of Semiconductor Manufacturing, Zhugen Zhou from the Technical University of Dresden presented a paper utilizing WWK's Factory Explorer® discrete-event simulation software. The title of the paper is "A PULL/PUSH CONCEPT FOR TOOLGROUP WORKLOAD BALANCE IN WAFER FAB." A copy of the paper can be obtained from the author at zhugen.zhou@tu-dresden.de.

In this paper, a pull/push concept is proposed in order to balance toolgroup workload in a wafer fab. This is accomplished by using a so-called WIP Control Table. Each upstream toolgroup maintains a WIP Control Table that contains current WIP information of downstream toolgroups such as target WIP, actual WIP and WIP difference. In case of lot move in/out and tool status change, the WIP Control Table is updated. Therefore, the upstream toolgroup is able to detect WIP distribution and pull request of downstream toolgroups dynamically, then push optimal lots with consideration of lot status and local tool constraint to the downstream toolgroup that runs short of WIP. The simulation results demonstrate that the proposed pull/push concept is superior over First-in-First-out (FIFO) and Operation Due Date (ODD) with regard to average cycle time and on time delivery.

TECHNISCHE UNIVERSITÄT DRESDEN

WWK's David Jimenez Appointed to Valley Community Bank Advisory Board

It was announced that WWK's president and co-founder, David Jimenez, has been appointed to a one year term to the advisory board for Valley Community Bank starting January 2011. Valley Community Bank, which was founded in Pleasanton, California, celebrated its twelfth anniversary in 2010. The bank remains committed to its original objective of providing banking services to professionals and local businesses in the Tri-Valley and San Jose areas.

Valley Community Bank is a publicly traded corporation (stock symbol VCBC). The Bank reached the $100-million-in-assets five years after opening and ended 2009 with assets over $221-million. The Bank's directors, all with strong local interests and contacts, are committed to community banking with expert local staffing and personalized service.

Update on Planned Revisions to SEMI COO Standards E35 and E140

Meeting twice so far, the Equipment COO Task Force (TF) has completed an initial review and editing of the drafts for the planned revisions to E35 (Equipment/Process COO), E140 (Gas Delivery System COO), and the E140 Excel spreadsheet example. Some open technical issues (e.g., use of uptime vs. utilization, how rework is included, updating old default values, changes related to making E35 easier for related industries to implement) still remain to be resolved. Unfortunately, participation has been lower than expected so far, especially from related industries such as photovoltaic [PV]. The next online TF meeting is tentatively scheduled for Friday, February 4, from 8:00 – 11:00 AM Pacific Time.

If you are interested in actively participating on the TF, please contact the co-chairs so they can add you to the TF membership and e-mail distribution lists (e.g., to receive copies of proposed revision drafts, meeting announcements, and minutes). The co-chairs are Daren Dance (Wright, Williams & Kelly, Inc. [WWK]; 435-730-7643; d.dance@wwk.com) and David L. Bouldin (Fab Consulting, 972-727-3591, david.bouldin@sbcglobal.net). The SEMI Standards Regulations now require that all TF meeting participants be registered as SEMI Standards Program Members, which is free. To register, please see the SEMI Standards Web site at http://dom.semi.org/standards/stdsmbr.nsf/Mapp!openform.

Take advantage of this opportunity to contribute to improvements in these SEMI Standards and network with other COO industry experts!

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Observations in 3-D (no glasses required)

Gene Goebel
Vice President, Business Development
Dynaloy LLC

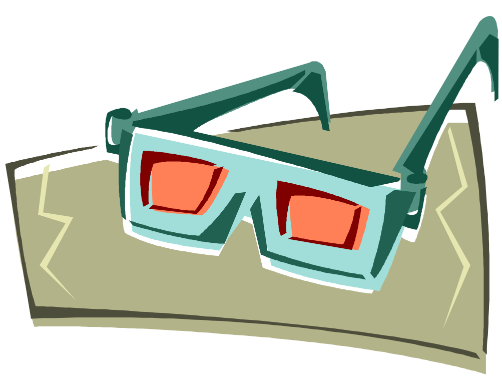
Last week at the 3-D Architectures for Semiconductor Integration and Packaging Conference I asked a speaker how it was possible to integrate 3-D for a cost of $150 per wafer. The answer was quite simple as the speaker said that the cost of the 3-D integration depended on which implementation was used, pointing out that the cost was a target and that some schemes could run well over $1,000 per wafer. What I did not expect was the firestorm of comments from speakers that followed about the cost of a 3-D or 2 ½ D implementation.

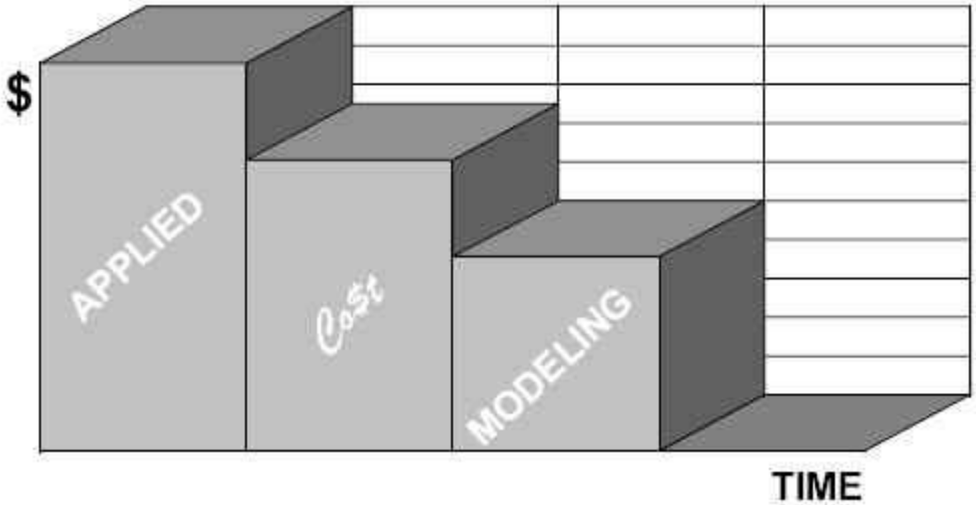
At lunch, I had the good fortune of sitting with an expert from well recognized and respected market research firm. The expert was kind enough to note that the $150 per wafer was only the cost of forming and filling the via. So, I took a look at a process flow for one metal level for a semiconductor backend of line (BEOL) in my WWK Factory Commander® cost and resource modeling software and, behold, depending on the cost of litho, RIE, barrier layers, seed, cleans, surface prep, electroplating, CMP, post-CMP surface cleans, and passivation deposition the cost of a 3-D structure can be >$1,000 per wafer.

However, if one were to look at the benefits, such as the increased device density or performance improvement, the added expense can be justified. As an example, a CMOS image sensor (IS) with a full 3-D implementation can be back lighted, thereby increasing the IS density between two and four fold. In addition, this implementation provides improved white balance, pixel count, and, most importantly, significantly reduces digital noise.

I don't see 3-D taking over and replacing the current 2-D technology immediately; what my analysis tells me is that 3-D will add value far greater than its cost when it is implemented appropriately. All one needs is the knowledge of the process flows and the tools with which to model cost combined with a marketing and business organization capable of understanding and extracting the value as demonstrated by the smart phone and pad device producers.

Mr. Goebel can be reached at genegoebel@dynaloy.com.





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