Information Exchange For Your Application & Use of Cost Modeling

APPLIED Co$t MODELING

Volume 15. Issue 3

Inside

Spring 2009

ISSN 1094-9739

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

By Dr. Vallabh H. Dhudshia
Reprinted by Permission of the Author[1]

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.iuniverse.com/bookstore/book_detail.asp?isbn=978-0-595-69727-4

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 the second half of Chapter 8. We hope that you find the information in this series useful.

[Continued on Page 3]

Editorial Board

Publisher

Published quarterly by:

Wright Williams & Kelly, Inc.
6200 Stoneridge Mall Road
3rd Floor
Pleasanton, CA 94588

Phone 925-399-6246
Fax 925-396-6174
E-mail support@wwk.com

Available at:
http://www.wwk.com
Select "Newsletter"

Calendar of Events

June 2009

24-26 **PV Japan 2009**
Makuhari Messe
Chiba, Japan

July 2009

14-16 **SEMICON West/Intersolar North America**
Moscone Hall
San Francisco, CA

16 **Understanding & Using Cost of Ownership**
Marriott Hotel
San Francisco, CA

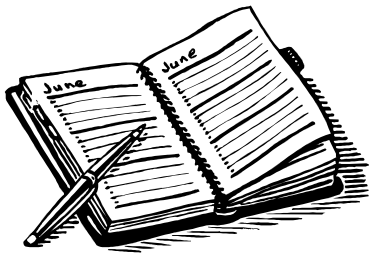
Register at:

http://www.semiconwest.org/ProgramsandEvents/ctr_028975?parent=yes&parentId=5

October 2009

26 **Understanding & Using Cost of Ownership & Factory Productivity**
Solar Power International
Anaheim Convention Center
Anaheim, CA

27-29 **Solar Power International**
Anaheim Convention Center
Anaheim, CA



8.4 Build-in Reliability

Building in reliability is a process that assures that parts, subsystems, and modules are made and assembled according to engineering drawings and specifications without degrading the designed reliability or introducing new failure modes. Important steps of this process are:

Assembly instructions
Prepare detailed instructions for each assembly step. These instructions should include proper parts, materials, step-by-step assembly procedures, tools, limitations, inspection procedures, etc.

Training
To minimize the assembly errors, it is essential that every assembly operator be trained in basic assembly methods and in all the assembly operations assigned to him or her.

Burned-in
All parts and the system itself should be properly and adequately burned-in, debugged, or stress-screened before shipment.

Product Reliability Acceptance Test (PRAT)
Conduct a PRAT on randomly selected units before shipping to assure the reliability level of the product line as it is being shipped.

Packaging and shipping
The equipment must be packed properly for the intended shipping mode. Select the shipping mode so shipping does not impart any undue stress on the equipment.

8.5 Manage Reliability Growth

Effectively managing reliability growth opportunities is a Continuous Improvement Process (CIP). Equipment manufacturers learn from actual in-house tests or field experience. All observed problems are documented and brought back to a central body for further analysis and disposition. If required, corrective actions are developed and implemented.

Failure Reporting and Corrective Action System (FRACAS)
A popular system named Failure Reporting and Corrective Action System (FRACAS) is used to manage this process. As shown in figure 8.3, FRACAS is a closed-loop feedback communication channel in which the customer works with the equipment supplier to collect, record, and analyze equipment failures, both hardware and software. The customer captures predetermined types of data about problems observed with a particular equipment line and submits the data to that supplier. A Failure Review Board (FRB) at the supplier's site analyzes the failures. The resulting analysis identifies corrective actions that should be developed, verified, and implemented to prevent failures from recurring.

Now let's look at three key elements of FRACAS in more detail.

Failure data reporting: All the failures, including those observed either during in-house testing or at a customer's site, must be recorded so all relevant and necessary data is captured in a systematic manner. A simple, easy-to-use form that is tailored to the respective equipment line should be used to record and report failure data. (Figure 8.4 depicts a typical failure reporting form.) If the data volume justifies the cost of administering FRACAS, the data form can be computerized to communicate failure data. Internet and e-mail are the most recent ways to report failure data.

Failure Review Board: The FRB is a multifunctional, self-managed team that

reviews, facilitates, and administers failure analysis. It also participates in assigning, developing, verifying, and implementing the resulting corrective actions. To do this job effectively, all the functional departments involved in the product line must participate on the FRB. Also FRB members must be empowered to assume responsibility, investigate failure cause, develop corrective actions, and ensure implementation of corrective actions.

Corrective Action: Any systematic action taken to eliminate or reduce the frequency of equipment failure (hardware or software) is a corrective action. Such actions may include parts design or materials changes, part supplier changes, assembly procedure changes, maintenance procedure changes, operational changes, training changes, or software changes.

When the cause of a failure has been determined, a corrective action plan is developed, documented, and implemented. The plan should identify the following three Ws:

- What actions are to be taken?
- Who is responsible for each action?
- When will each action be completed?

All the corrective action plans and their verification and implementation should be reviewed by the FRB on a regular basis. The FRB should also maintain a log of the corrective action status including open and closed corrective actions.

8.6 Applying the Reliability Improvement Process

Optimal benefit from using the RIP occurs when the process is applied to equipment during the concept and feasibility phase of the life cycle and then continuously thereafter. Benefits are also realized when the improvement process is applied to equipment that is in some advanced phase of its life cycle. Either way, it is important to address equipment reliability throughout the life cycle.

For example, reliability improvements may be necessary:

- Following the prototype phase because of design deficiencies or parts problems uncovered during prototype testing
- At the beginning of the pilot production phase because of reliability-related issues resulting from manufacturing a new equipment line
- During the production and operation phase because feedback from field personnel and customers indicates reliability problems caused by unanticipated failure mechanisms

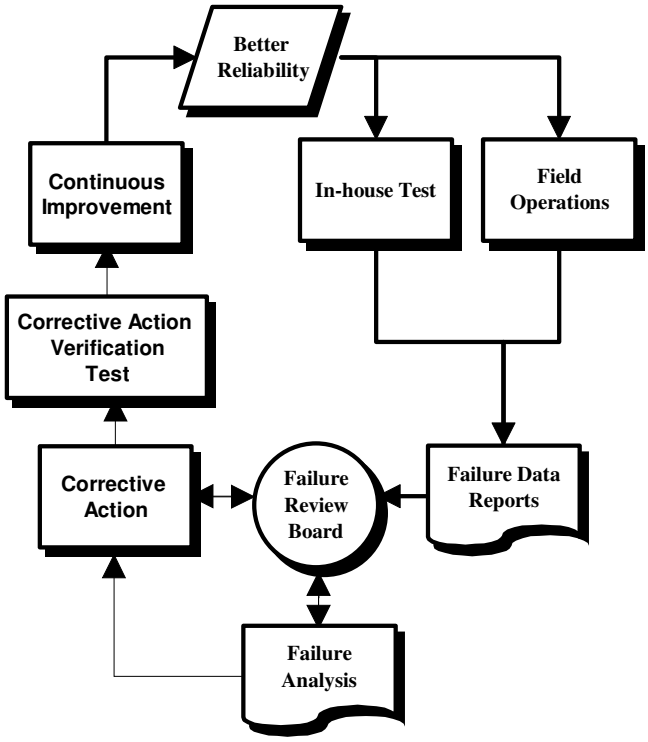


Figure 8.3 FRACAS Process Flow

SERVICE REPORT NO. _____

Customer	Customer System ID	Module	Received By:	
Reported By	Equipment Serial No.	Module Serial No.	Ref. Report NO.	
Phone No.	Contact		Date	Time

Service Category:

☐ Install ☐ Courtesy ☐ Warranty ☐ PM ☐ Development
☐ Training ☐ Telephone Fix ☐ Update ☐ UM ☐ Others

Problem/Symptoms/Reason for Service Call

Repair & Maintenance Action(s)

Problem Cause

Part Name	Part Number	Replaced	Cleaned	Comments

Status of Equipment Upon Leaving	Start Date	Time
	Complete Date	Time
Customer Remarks	Service Engineer's Signature	
	Customer's Signature	

Figure 8.4 A Typical Failure Report Form

8.7 Activities Associated with the Reliability Improvement Process

To achieve equipment reliability goals/requirements, equipment manufacturers and users must include equipment RIP in their overall business process. The activities associated with the process can be categorized into two categories: (i) equipment suppliers' activities, and (ii) equipment users' activities.

Equipment Suppliers' Activities

Equipment suppliers must include equipment reliability improvement throughout the various equipment life cycle phases as shown in table 8.5. Beside these activities, equipment suppliers must insists that their reliability-sensitive component suppliers use equipment reliability improvement activities in their business processes. If a customer does not specify reliability requirements clearly (see section 8.2), the supplier must let the customer know that specific reliability requirements are lacking in the PO and must be clarified.

Equipment Users' Activities

Table 8.6 summarizes users' reliability improvement activities at different stages of equipment acquisition, installation, evaluation, and operations.

If a supplier does not understand the reliability requirements clearly, users must help the supplier to understand the requirements and obligations.

8.8 Reasons to Use Reliability Improvement Process

Part Selection Knowledge of the equipment life cycle and the RIP is important because it provides a basis for understanding how and where reliability improvement activities should enter into the process of designing, manufacturing, and operating the equipment. This cycle and process provides a framework for equipment suppliers to track reliability and to guide when and where to apply resources. The RIP provides a means for systematically improving reliability throughout the equipment life cycle. It drives design improvements, manufacturing operations and maintenance procedure improvements, data collection, and statistical analysis.

	Equipment Life Cycle Phases					
	Concept and Feasibility	**Design**	**Prototype**	**Pilot Production**	**Production**	**Phase Out**
Reliability Improvement Activities	Goal Setting	Design-in Reliability	System Tests	FRACAS	FRACAS	FRACAS
	Apportionment	Modeling/Design Assessments	Reliability Level Assessments	System Tests	PRAT	Transfer Reliability Knowledge
	Reliability Plans	FMEA/FTA	Design Reviews	Life Tests	Reliability Level Assessments	
	Preliminary Modeling	Part Life Tests	FRACAS	Accelerated Tests	Build Reliability Data base	
		Design Reviews	Update COO Calculations	Reliability Level Assessments	Validate Modeling	
		COO Calculations		Design Reviews	Update COO Calculations	

Table 8.5 Equipment Suppliers' Reliability Improvement Activities throughout Equipment Life Cycle Phases

	Equipment Users Activity				
	Pre-Acquisition	**Acquisition**	**Installation**	**Evaluation**	**Operations**
Reliability Improvement Activities	Reliability Requirement Specification	POs with Reliability Specifications	Track Installation Problems	Track Reliability Performance and associated Problems	Participate in FRACAS
	COO Calculations	Review Supplied Reliability Data	Feed Back Problems to supplier	Reliability Level Assessments	Track Reliability Performance and associated Problems
	RFQs with Reliability Specification	Help Supplier to Understand Reliability Requirements	Initiate Reliability Tracking System	Finalize Reliability Tracking System	Reliability Level Assessments
					Update COO Calculations

Table 8.6 Equipment Users' Reliability Improvement Activities

Many semiconductor manufacturing equipment suppliers experience significantly improved reliability over the life cycle phases using the basic structure of the RIP.

8.9 Reliability Improvement Plans

The equipment supplier should develop two-tier formal reliability improvement plans based on the RIP, a general company-level plan covering all product lines, and a specific product-level plan, one for each equipment product line.

General Company Level Reliability Improvement Plan

This is an overall reliability improvement plan tailored to the company. It takes into account the company's size, product lines, and available resources. The plan must address, at minimum, the following issues:

- The company's reliability policy
- A description of organizational activities (see chapter 13)
- Identification of reliability champions
- Overall long-term strategy
- Acquisition and development of reliability skills within the company

Product Level Reliability Improvement Plans

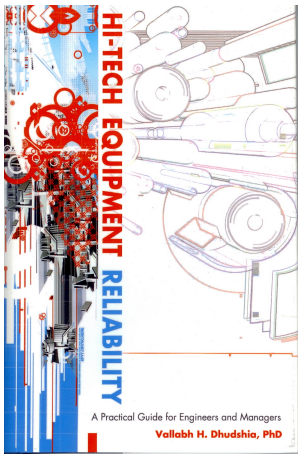
Each equipment line should have a reliability improvement plan based on the RIP activities summarized in table 8.5. The plan should identify the product line's specific reliability activities, responsibilities, schedules, and resource requirements. This plan should be coordinated with the overall company-level reliability improvement plan and the product development program plan.

REFERENCES

1. ARNIC Research Corp., Reliability Engineering (Englewood Cliffs, NJ: Prentice Hall, 1964).

2. SEMATECH, Design Practices For Higher Equipment Reliability - Guidebook, Technology Transfer #93041608A-GEN (Austin, TX: SEMATECH, Inc. 1993).

3. MIL-STD-1574A, Electronic Parts, Material, and Processes for Space Launch Vehicles, USAF. 1987.



Wright Williams & Kelly, Inc. Releases Factory Explorer® v2.10

June 8, 2009 (Pleasanton, CA) – Wright Williams & Kelly, Inc. (WWK), the global leader in cost and productivity management software and consulting services, announced today the latest release of its ultra-fast discrete-event simulation software, Factory Explorer®. WWK has a long history of providing fast simulators to industrial clients. WWK's Factory Explorer® is based on the "event-graph" paradigm. Factory Explorer® has been benchmarked with industry standard data sets to be more than ten times faster than other job driven simulators. Additionally, simulation speeds in excess of 3.5 million lot moves/minute are achieved with modest laptop computers (1.8 GHz, 2Gb DRAM) running standard Windows operating systems. This latest release includes the following enhancements:

1. A new "Merge Model Login" screen was added to log into the SQL Server database containing the data to merge. This screen is separate from the old Merge Product flow data screen. After login, a new screen allows selection of a specific factory to merge and specific types of data to merge from the factory selected; Merge product data and merge lot data.
2. Added new user functions for tracking scheduled events; User_PrintEventDescriptions, User_ProcessTracedEvents, Event_GetDescriptions, Event_SetTraceOn, Event_GetName, Event_LookupName, and Misc_FXAboutShow.
3. Added the following output charts with their associated output data worksheets:
    a. Bottleneck Simulation Resource Chart (Columns and Bars)
    b. Tool Group Bottleneck Capacity Chart (Columns and Bars)
    c. Tool Group Bottleneck Capacity Chart w/ Product Capacity Data
    d. Tool Group Bottleneck Simulation Chart (Columns and Bars)
    e. Operator Group Bottleneck Capacity Chart (Columns and Bars).
    f. Operator Group Bottleneck Capacity Chart w/ Product Capacity Data
    g. Operator Group Bottleneck Simulation Chart (Columns and Bars)
4. Excel 2007 compatibility.

WWK Hosts Cost of Ownership Seminar at SEMICON West/Intersolar

WWK and SEMI Co-Sponsor Event for the 17th Consecutive Year

June 9, 2009 (Pleasanton, CA) – Wright Williams & Kelly, Inc. (WWK), the world's preeminent cost of ownership software and consulting services company, announced today that it will be presenting its highly acclaimed seminar, "Understanding & Using Cost of Ownership," during SEMICON West/Intersolar North America. "Understanding & Using Cost of Ownership" will be held at the San Francisco Marriott on Thursday, July 16 from 9am to 5pm. This seminar covers all aspects of Cost of Ownership (COO) and Overall Equipment Efficiency (OEE) from fundamentals to hands-on applications and has been enhanced to meet the needs of the photovoltaics (PV) industry. Registration for this seminar can be done directly on the Semiconductor Equipment and Materials International (SEMI) web site at www.semi.org or by calling WWK directly.

There is limited seating available for this seminar, so please contact SEMI or WWK today to guarantee your place in this once-a-year event. It is expected that registration will close out shortly for this program. As an added benefit, WWK's software maintenance clients qualify for a 20% discount off the list price of the seminar if they book directly with WWK.

With more than 3,000 users worldwide, Wright Williams & Kelly, Inc. is the largest privately held operational cost management software and consulting company serving technology-dependent and technology-driven organizations. WWK maintains long-term relationships with prominent industry resources including SEMATECH, SELETE, Semiconductor Equipment and Materials International (SEMI), and national labs and universities. Its client base includes nearly all of the top 20 semiconductor manufacturers and equipment and materials suppliers as well as leaders in nanotechnology, micro-electro-mechanical systems (MEMS), thin film record heads, magnetic media, flat panel displays (FPD), and photovoltaics (PV).

WWK's product line includes TWO COOL® for detailed process step level cost of ownership (COO) and overall equipment efficiency (OEE), PRO COOL® for process flow and test cell costing, Factory Commander® for full factory capacity analysis and activity based costing, and Factory Explorer® for cycle time reduction and WIP planning. Additionally, WWK offers a highly flexible product management software package that helps sales forces eliminate errors in product configuration and quotation processes.

http://www.semiconwest.org/ProgramsandEvents/ctr_028975?parent=yes&parentId=5

ISSN 1094-9739

Wright Williams & Kelly, Inc. Adds Dual Citizenship (EU/US) Resumes to Staff

Includes Worldwide Spanish Language Support

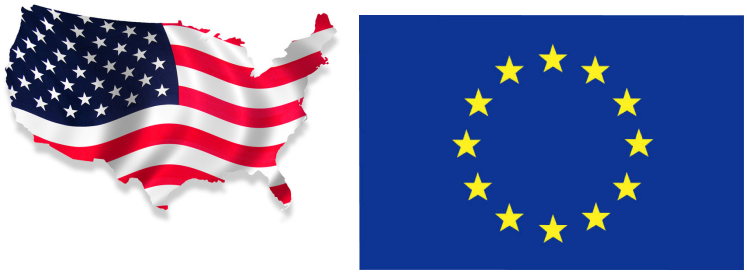
June 3, 2009 (Pleasanton, CA) – Wright Williams & Kelly, Inc. (WWK), the global leader in cost and productivity management software and consulting services, announced today the addition of European Union (EU) and United States (US) dual citizenships to its staffing resume. Additionally, WWK is set to address the needs of the Spanish speaking market, which has expanded dramatically in response to photovoltaic (PV) projects in Spain.

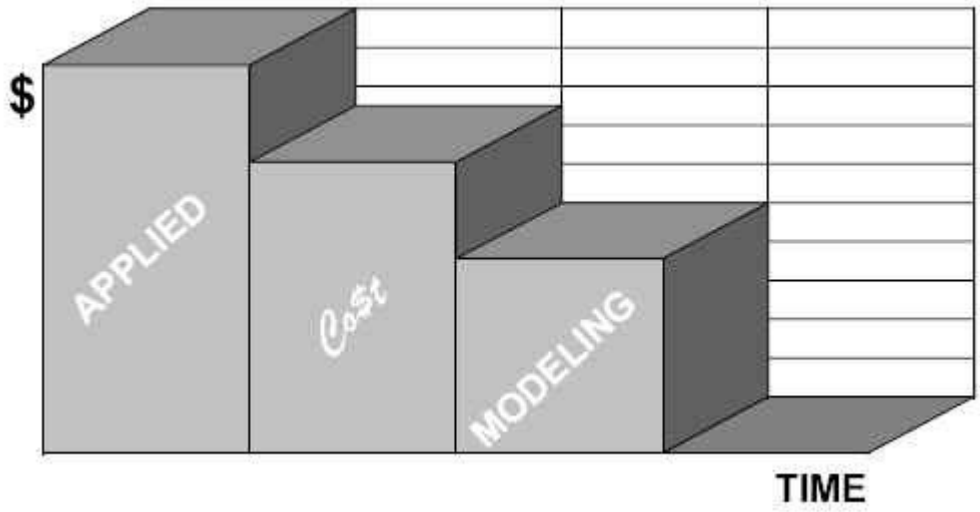
"Dual citizenship status by WWK's staff opens up multi-national projects without the need for work or residency visas," stated David Jimenez, WWK's President. "Our staff is now ready to support US and European clients in a borderless fashion. The dominance of EU PV projects and the new focus on US renewable energy creates an environment that is ideal for our new capabilities. When added to existing staff with citizenship in Asia-Pacific Economic Cooperation (APEC) countries, including China, WWK has become a truly global organization."

Additionally, WWK has added Spanish language support in recognition of the business opportunities represented by 500 million Spanish speakers worldwide today. While PV feed-in tariffs in Spain have been reduced, it is clear that a rebound in the world economy will see a return to more aggressive growth in that market segment as well as in Mexico and Central and South America.

With more than 3,000 users worldwide, Wright Williams & Kelly, Inc. is the largest privately held operational cost management software and consulting company serving technology-dependent and technology-driven organizations. WWK maintains long-term relationships with prominent industry resources including SEMATECH, SELETE, Semiconductor Equipment and Materials International (SEMI), and national labs and universities. Its client base includes nearly all of the top 20 semiconductor manufacturers and equipment and materials suppliers as well as leaders in nanotechnology, micro-electro-mechanical systems (MEMS), thin film record heads, magnetic media, flat panel displays (FPD), and photovoltaics (PV).

WWK's product line includes TWO COOL® for detailed process step level cost of ownership (COO) and overall equipment efficiency (OEE), PRO COOL® for process flow and test cell costing, Factory Commander® for full factory capacity analysis and activity based costing, and Factory Explorer® for cycle time reduction and WIP planning. Additionally, WWK offers a highly flexible product management software package that helps sales forces eliminate errors in product configuration and quotation processes.





ISSN 1094-9739