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Equipment Performance Metrics, Their Relationship and Hierarchy

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Introduction

The semiconductor manufacturing equipment industry has developed a variety of equipment performance metrics to satisfy equipment suppliers' and users' requirements (see Reference 1). Most of these performance metrics are simple to understand. However, their relationship with each other and their hierarchy are not clear. The purpose of this paper is to describe the make-up of the following six most widely used equipment performance metrics, to define their relationship with each other, and to show their hierarchy.

1. Reliability
2. Maintainability
3. Availability
4. Overall Equipment Efficiency (OEE)
5. Life Cycle Cost (LCC)
6. Cost of Ownership (COO)

Definition of the Performance Metrics

A. Reliability

Reliability is one of the basic equipment performance characteristics that has been in use since the 1940's. It is a life longevity measure of the failure-free operation period of any equipment. Formally, it is the probability of equipment performing its intended functions for a specified time under the stated operational conditions. One of the

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Calendar of Events

March

17-19 SEMICON China
Shanghai, China

22-23 1st International Workshop in Nano Bio-Packaging
Atlanta, GA

24-26 9th International Symposium & Exhibition on Advanced Packaging Materials
Atlanta, GA

April

20-22 SEMICON Europa, hall B2 - booth #662
Exhibiting with veonis Technologies
Munich, Germany

May

4-6 ASMC
Boston, MA

June

1-4 IEEE 54th Electronic Components & Technology Conference
Las Vegas, NV

9-12 SEMI FPD Expo Taiwan
Taipei, Taiwan

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Dresden, Germany

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14 Understanding and Using Cost of Ownership – SEMICON West

12-14 SEMICON West, North Hall – booth #5658
San Francisco, CA

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most popular metrics of reliability, used in the semiconductor manufacturing industry, is Mean Time Between Failures (MTBF), which is given by

MTBF = (total operational hours)/(number of failures during the same operational period)

B. Maintainability

There is no direct relationship between reliability and maintainability. Reliability deals with the operational life longevity and failures of equipment, while maintainability deals with restoring the equipment operation and the time it takes to restore it. However, both disciplines are complementary and they support high-level equipment performance metrics described in the following sections.

Formally, maintainability is the probability that the equipment will be restored to a specific operational condition (able to perform all of its intended functions) within a specified period of time, when the maintenance is performed by personnel having specified skill levels and using prescribed procedures, resources, and tools. Maintenance can be either unscheduled or scheduled. One of the most popular measures of maintainability is Mean Time To Repair (MTTR), given by:

MTTR = (total repair time)/(number of repair events)

Repair time includes diagnosis, corrective actions, and verification tests, but not maintenance delays.

C. Availability

Availability is a joint measure of reliability and maintainability. It is defined as the probability that equipment will be in a condition to perform its intended functions when required. Percentage uptime is one of most widely used metrics for availability in semiconductor manufacturing. Since equipment downtime can be attributed to equipment, equipment supplier, or equipment users, the uptime calculations vary accordingly. The following three kinds of uptime calculation are used in semiconductor manufacturing: (i) equipment dependent; (ii) supplier dependent; and (iii) operational.

Equipment dependent uptime includes the effect of downtime caused by scheduled and unscheduled maintenance inherent with the equipment (design) and it is given by:

Equipment Dependent Uptime, % = (equipment uptime x 100)/(equipment uptime + DTE)

Where:

DTE = Equipment Dependent Downtimes = (unscheduled repair time + unscheduled and scheduled time to change consumables and chemicals + product test time + preventive maintenance time)

Equipment uptime includes productive, engineering, and standby times. It does not include non-scheduled time such as holidays, shutdowns, nonworking shifts, etc.

Supplier dependent uptime includes effects of all equipment dependent downtimes (DTE) and maintenance delays caused by the equipment supplier. It is given by:

Supplier Dependent Uptime, % = (equipment uptime x 100)/(equipment uptime + DTE + supplier caused maintenance delays)

Operational uptime includes effects of all downtime caused by scheduled and unscheduled maintenance inherent with the equipment, maintenance delays caused by the equipment supplier and user, and any other downtime caused by the equipment user (such as facility-related downtime). It is given by:

Operational Uptime, % = (equipment uptime x 100)/(equipment uptime + equipment downtime)

D. Overall Equipment Efficiency (OEE)

OEE is the most recent high-level equipment performance metric. It was developed as an equipment effectiveness metric in Japan to measure the effectiveness of a manufacturing technique called Total Productive Maintenance (TPM). Originally, it was called Overall Equipment Effectiveness. The Semiconductor Equipment and Materials International (SEMI) Metrics Committee changed it to Overall Equipment Efficiency. SEMI and the American Institute of Total Productive Maintenance (AITPM) are currently the major sponsors of the OEE metric in the USA.

OEE is an all-inclusive metric of equipment productivity, i.e., it is based on reliability (MTBF), maintainability (MTTR), utilization (availability), throughput, and yield. All the above factors are grouped into the following three sub-metrics of equipment efficiency.

1. Availability
2. Performance efficiency
3. Rate of quality

The three sub-metrics and OEE are mathematically related as follows:

OEE, % = Availability x Performance Efficiency x Rate of Quality x 100

Now let us look at each OEE sub-metric in more detail.

1. Availability

We have already defined availability in the previous section. We can use any uptime metric in this equation depending upon which OEE we are calculating. For example, equipment dependent OEE calculations use equipment dependent uptime and so forth.

2. Performance Efficiency

The performance efficiency is based on losses incurred from idling, minor stops, and equipment speed losses. It is given by:

Performance Efficiency = (theoretical CT)/(actual CT) = (actual PPH)/(theoretical PPH)

Where:

CT = Process Time
PPH = Throughput Rate in Parts (Units) Per Hour

3. Quality Rate

The quality rate is a measure of output quality and is given by:

Quality Rate = (total part produced – number of rejects)/(total parts produced)

Where:

Rejects are defined as any produced part that does not meet the production criteria.

4. Simple OEE

There is a simple and quick way to calculate OEE without going into elaborate calculations of the above three sub-metrics.

Simple OEE, % = [(number of good units produced in ‘t’ calendar hours)/ (t x theoretical PPH)] x 100

Note that this value gives only rough estimate for the OEE. It does not give any indication of improvement activities direction. There are many other ways to calculate OEE depending upon the use of the measured values. See Reference 3 for some of the most popular ways to calculate OEE for semiconductor industry.

This metric is best applied to bottleneck tools since it penalizes standby time.

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Wright Williams & Kelly Names Yarbrough Southwest Sales Agent

Next Step in Global Expansion of Sales and Service

December 17, 2003 (Pleasanton, CA) –Wright Williams & Kelly (WWK), a cost & productivity management software and consulting services company, announced today the naming of Yarbrough Southwest as its sales agent covering the Southwestern US. This appointment represents the next step in WWK's strategic vision to provide increased sales and service support in close proximity to all of its customers, world-wide.

"Yarbrough was selected to support our critical installed base in the Southwest based on their unparalleled credentials," states David W. Jimenez, WWK's President. "They combine a unique understanding of the region's high-tech industries and the application of our software products and services to drive manufacturing optimization. Their dedication to both sales and service sets them apart from other organizations."

"We are pleased to begin representing WWK and its product line," says Mike Dailey, President of Yarbrough Southwest. "We see a large demand for software tools and consulting services designed to help optimize manufacturing costs and productivity. WWK will help keep our clients at the forefront of cost competitive operations."

Yarbrough Southwest was founded in 1973 to serve the emerging Semiconductor and electronic defense manufacturing industries in the Southwest. Unlike other representatives, the company has been focused on service and sales, employing a field service staff in addition to a growing sales staff.

By balancing the needs of the customer and the supplier Yarbrough Southwest has maintained a steady presence in the Southwest as the market has evolved into a center for semiconductor device manufacturers, equipment manufacturers, BioMed/Pharmaceutical and Nanotechnology.

With more than 2,800 users worldwide, Wright Williams & Kelly, Inc. is the largest privately held operational cost management company serving technology-dependent and technology-driven companies. WWK maintains long-term relationships with prominent industry resources including International SEMATECH, SELETE, Semiconductor Equipment and Materials International (SEMI), and national labs and universities. Its client base includes most of the top 10 semiconductor manufacturers and equipment and materials suppliers as well as leaders in thin film record heads, magnetic media, flat panel displays, and solar panels.

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.

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E. Life Cycle Cost (LCC)
LCC is an older metric than OEE and is based on equipment cost factors. It has been in use for many years to determine the optimal level of reliability that generates minimum LCC. It has also been used to perform trade-off between acquisition and operational costs.

LCC is the total cost of acquiring and operating equipment over its entire life span. It includes all supplier and customer costs incurred from the point at which the decision is made to acquire the equipment, through operational life, to eventual disposal of the equipment.

Two main elements of the LCC are: (1) acquisition cost and (2) operational cost. Supplier costs plus the supplier's gross profit is referred to as acquisition costs. These are passed to the customer in the purchase price of the equipment costs.

Since all elements of LCC do not occur in the same year, we need to consider one more factor named "time value of money" in the LCC calculations. This factor converts all costs incurred after the first year to an equivalent present value (worth) in the first year. A variety of LCC models are available. Reference 4 contains the most commonly used LCC models.

F. Cost of Ownership (COO)
LCC is one of the most widely used equipment performance metrics, but it has the following shortcomings. It does not include:

- Effect of the production volume
- Product scrap loss because of poor quality output
- Consumable cost
- Waste disposal cost
- Taxes, insurance, and interest expenses

To overcome these deficiencies, SEMATECH developed a cost of ownership (COO) model which calculated the true cost of ownership per good unit produced in a given time period, usually a calendar year (see Reference 5). SEMATECH worked with Wright Williams & Kelly (WWK) in a joint development to commercialize COO. The commercial COO model has been released by WWK as TWO COOL® COO simulation software.

COO depends upon the production throughput rate, equipment acquisition cost, equipment reliability, throughput yield, and equipment utilization. The basic COO is given by the following equation.

$$\text{COO per unit} = (F_C + V_C + Y_C)/(L \times THP \times Y \times U)$$

Where:

F_C =	Fixed costs (amortized for the period under consideration)
V_C =	Operating costs
Y_C =	Yield loss costs
L =	Life of equipment
THP =	Throughput rate
Y =	Composite yield
U =	Utilization

Hierarchy of Equipment Performance Metrics

When discussing manufacturing equipment performance, we have to deal with its metrics as described above. Since there are many metrics, to most professionals working with the equipment performance, the metrics appear disjointed. However, nothing could be further from the truth. They all fit into a hierarchical tree structure shown in Figure 1.

As shown in the figure, when we add time dimension to quality and safety, it becomes reliability. Reliability and maintainability jointly make up availability. When production speed efficiency and production defect rate are combined with availability, it becomes productivity. A metric for productivity is Overall Equipment Efficiency (OEE). Acquisition and operational cost comprise Life Cycle Cost (LCC). And when scrap, waste, consumables, tax, and insurance cost are added to LCC and the total is normalized by the production volume, the resulting metric is Cost of Ownership (COO). Reference 1 describes this hierarchy in detail.

To use these metrics uniformly, the industry needs standard definitions, terms and equations. Fortunately, the SEMI Standards Program has provided the industry with the infrastructure and resources to do so. Noted in Figure 1 are the three main industry specifications associated with equipment performance metrics: (1) SEMI E10 for reliability, availability and maintainability metrics (Reference 2), (2) SEMI E79 for productivity (OEE) metrics (Reference 3), and SEMI E35 (Reference 6) for cost of ownership (COO) metric.◄

References:

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5. SEMATECH, Cost of Ownership Model, Technology Transfer #91020473B-GEN SEMATECH, Inc., Austin, TX, 1992
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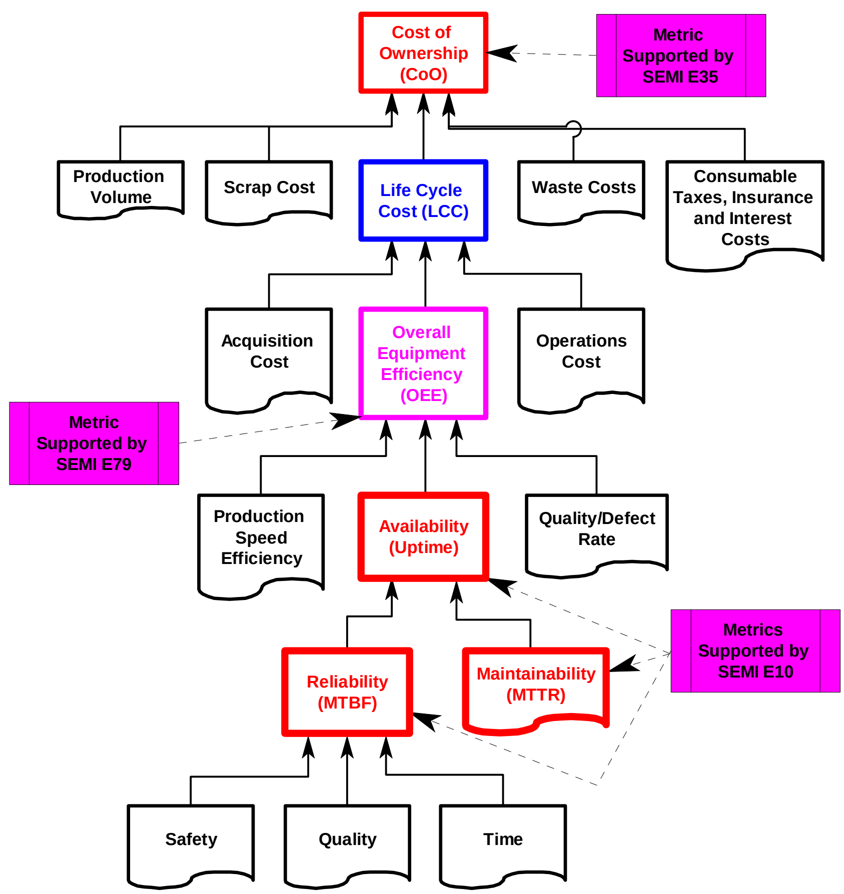

Figure 1: Equipment Performance Metrics and Their Hierarchy

Cost of Ownership: A Tool for ESH Improvements

Daren L. Dance and David W. Jimenez
Wright Williams & Kelly, Inc.

Introduction

The semiconductor industry's main use of cost of ownership (COO) is as a metric for purchasing processing equipment. However, COO can also be used as a tool for evaluating environmental, safety, and health (ESH) impacts of process equipment. Using COO to evaluate ESH issues has significant benefits for the end user. It is neither complex nor hard to do. With a few significant details about purchase conditions, operation, utilization, and technical performance, users can determine the life-cycle cost of owning a semiconductor tool. COO was developed for wafer fabrication tools but has been easily extended to other applications, including ESH. COO applications now provide a metric for ESH improvement in the semiconductor industry.

With equipment costs increasing and concerned about cost per wafer, SEMATECH began developing a COO model in 1990. Since then, COO standards have been published by Semiconductor Equipment and Materials International (SEMI).[1] A commercial COO model, based on these standards, has been introduced through a joint development project between SEMATECH and Wright Williams & Kelly (WWK). SEMATECH has built on this foundation with research into ESH cost modeling with WWK and Oregon State University.

A standardized COO model has several benefits for the manufacturer and supplier communities. First, the model can provide a clear estimate of the COO of the process tool. The model can also be used to evaluate the ESH impacts of different process and tool design alternatives. COO provides an objective analysis method for evaluating decisions and provides a systematic focus on issues that might otherwise be overlooked. Finally, the COO model provides communication between equipment suppliers and users. Both suppliers and manufacturers can work from hard data to support a purchase or product/process improvement plan. They can speak the same language, comparing similar data and costs using standard software algorithms and equations.

Basic COO Algorithm

Estimating a tool's COO is neither complex nor hard. With a few significant details, users can determine the life-cycle cost of owning a semiconductor tool. The basic COO algorithm is described by:

$$C_W = \frac{C_F + C_V + C_Y}{L \times TPT \times Y_C \times U}$$

where:

C_W =	Cost per wafer
C_F =	Fixed cost
C_V =	Variable cost
C_Y =	Cost due to yield loss
L =	Life time of process
TPT =	Throughput
Y_C =	Composite Yield
U =	Utilization

Fixed costs include purchase, installation, and facility costs that are normally amortized over the life of the equipment. Variable costs such as material, labor, repair, utility and overhead expenses are costs incurred during equipment operation. Throughput is based on the time to meet a process requirement such as depositing or etching a nominal film thickness. Composite yield is the operational yield of the tool and may include breakage, misprocessing, and defects. Utilization is the ratio of production time compared to total available time.

Yield loss cost is a measure of the value of wafers lost through operational losses and defects. Yield models are used in COO models for estimating the relationship between particle and yield loss or scrap. These models relate integrated circuit yield to circuit and process parameters such as device geometry and particle density.

ESH at the Process Tool

Different ESH operating practices affect equipment cost, operating cost, yield costs, downtime, and repair times. The impact of ESH on COO can be estimated by comparing the impact of ESH alternatives for significant cost drivers. An end-of-pipe solution is one approach to improved ESH performance. This involves adding pollution and hazard control equipment to standard tools. Another approach is based on a systematic analysis of the tool. Components and methods are optimized, based on this analysis, for ESH benefit.

Equipment cost includes all fixed costs such as equipment purchase, installation, ESH permits, and facility support costs that are normally amortized over the life of the equipment. ESH-related fixed costs include safety and hazard monitoring systems, containment hardware, and emission abatement systems. These costs also include waste consolidation, recycling, and treatment systems.

Annual operating cost includes all of the recurring costs such as material, labor, repair, waste disposal, utility and overhead expenses due to equipment operation. The costs of maintaining and operating ESH support systems are part of operating costs. Other ESH-related operating costs include calibration of monitoring equipment, periodic safety inspection, and worker health monitoring programs.

Process scrap yield or equipment yield is the operational yield of the tool. Die scrap yield is the defect-limited yield that is recognized at wafer test or probe. Yield loss increases ESH impact due to unproductive use of chemicals, equipment, and materials.

Downtime is the non-production time lost due to scheduled maintenance, engineering usage, standby, and repair. Repair time is estimated from mean time between failures (MTBF) and mean time to repair (MTTR). The reliability of ESH support systems is also part of downtime and utilization. An unreliable hazard monitoring system can cause significant production interruptions if the system fails or initiates a false alarm.

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The ESH impacts on these cost factors are illustrated by an analysis of point-of-use chemical generation (POUCG) for wet chemical processes. [2] The comparison of ESH impacts between POUCG and conventional wet chemicals is summarized in Table I.

The ESH cost impact is different for each alternative. Cost analysis of these alternatives should include estimates for each of the ESH cost impacts. The ESH costs are in addition to a standard COO analysis.

Table I
ESH Cost Impact Comparison

Factor	POUCG	Bottled Chemicals	ESH Cost Impact
Equipment Costs			
Chemical Generator	Required	Not Required	Hazardous gas monitor
Distribution System	Required	May be required	Double containment and leak detection
Bottled Chemical Handling	May be required	Required	Safety showers and spill control
Operating Costs			
Chemicals and Gases	Required	Required	Waste disposal
Bottle Handling	May be Required	Required	Includes rinse and disposal
Personal Protective Equipment	May be Required	Required	Equipment and training
Exhaust Air	Required	Required	Air scrubbing costs
Down time			
Hazardous Gas Monitor	Required	May be Required	Failure may interrupt production
Waste Disposal System	Required	Required	Failure may interrupt production
Air Scrubber	Required	Required	Failure may interrupt production

<u>ESH for the Factory</u>
Different ESH operating practices also impact the factory. ESH systems may be installed at point-of-use or for factory-wide operation. For example, the ESH equipment mentioned in the previous section includes a hazardous gas monitor, a waste disposal system, and an air scrubber. These might be small units servicing one wet bench or large units servicing the factory. Each alternative has different ESH cost impacts. At the factory level, ESH cost impacts may also be considered on equipment, operation, and downtime costs.

ESH equipment cost impacts include purchase and installation costs. Factory-wide systems may provide economies of scale, but require more extensive installation costs. These larger systems are often installed in utility or other low cost spaces. Smaller units may cost more for a given capacity and may occupy clean-room space but may be phased in as production volumes ramp to full capacity.

ESH operations costs at the factory level depend more on level of automation than on equipment size. Highly automated systems minimize labor cost but increase equipment cost. Automated waste disposal systems minimize exposure of workers to hazardous materials. ESH supervision, training, and inspection costs are other operation costs that need to be considered in evaluating various alternatives.

Reliability of ESH equipment must be considered at the factory level. Downtime for a factory is very expensive. The reliability requirements of a factory-wide ESH system are much greater than for individual processing tools. Multiple ESH systems provide for redundancy. Single tool point-of-use scrubbers may require a central backup system to achieve suitable reliability. Methods must be provided for scheduled system maintenance that do not impact production.

ESH Benefits of Yield Improvement

Yield improvement projects may have significant ESH benefits at both the tool and factory levels. Yield losses increase ESH impact due to unproductive use of chemicals, equipment, and materials on products that are never shipped. A previously published SEMATECH equipment improvement project resulted in significant yield improvement. [3] Further analysis of this project shows the ESH benefits as well. Operation improvements resulting from this project significantly reduced moisture and particle levels in the tool. These improvements reduced cleaning frequency and improved die yield, both of which have ESH impacts.

In the SEMATECH example, the average number of days between cleans was increased from 11.7 to 18.8 days. Over the course of a year, this change reduces the amount of cleaning chemicals released and the amount of worker exposure to these chemicals by 60%. In addition, the number of particles per wafer pass was reduced by about 73%. Since metal deposition occurs in the later part of semiconductor processing, yield improvement at metal deposition is an effective yield improvement at each prior process step. This is illustrated in Figure 1. Thus, the same number of good die can be shipped by processing fewer wafers; using less chemicals and hazardous materials. These productivity improvements are also ESH improvements.

Summary

The semiconductor industry, which leads the use of COO, can also use COO as a tool for evaluating environmental, safety, and health (ESH) impacts of processing equipment. While COO was developed for wafer fabrication tools, it can easily be extended to ESH applications. Different ESH operating practices affect equipment cost, operating cost, yield costs, downtime and repair times. The impact of ESH on COO can be estimated by comparing the impact of ESH alternatives for significant cost drivers for process tools. At the factory level, ESH cost impacts may also be considered on equipment, operation, and downtime costs. Yield improvement projects may have significant ESH benefits at both the tool and factory levels. Yield losses increase ESH impact due to unproductive use of chemicals, equipment, and materials on products that are never shipped.

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1. E35-0701, Cost of Ownership For Semiconductor Manufacturing Equipment Metrics, SEMI International Standard, http://www.semi.org.

2. Laura Peters, “Point-of-use Generation: The Ultimate Solution for Chemical Purity, “ Semiconductor International, Jan. 1994, pp 62-66.

3. R. W. Burghard, D. L. Dance, R. J. Markle, and T. A. Silvestri, “Reducing Tungsten-etch Equipment Cost of Ownership Through In Situ Contamination Prevention and Reduction, “ Microcontamination, Jun. 1992, pp 33-36.

Case 1: Point-of-Use Chemical Generation

Point-of-use chemical generation replaces the distribution of hazardous chemicals to processing equipment in semiconductor fabrication with distribution of chemical precursors to a point-of-use chemical generator near the processing equipment. The chemical generator may serve a cluster of similar tools or it may be incorporated in the processing tool.

One purpose of POUCG is to improve process chemical purity, but another benefit may be improved safety and environmental impacts. The ESH cost impacts of the two methods will be compared in the following case. The required cost elements from Table I have been replaced with contrived costs in Table II. These costs are realistic, but do not reflect any specific case. This case has been slightly modified to work with TWO COOL® packaging and assembly software. Thus, we consider a packaged unit clean rather than a wafer clean and describe the unit of activity as a packaged unit.

Table II
ESH Cost Impact Comparison

Factor	POUCG	Bottled Chemicals	Comments
Equipment Costs			
Chemical Generator	$100,000	$0	
Distribution System	$50,000	$0	
Hazardous Gas Monitor	$20,000	$40,000	Note 1
Bottled Chemical Handling	$10,000	$20,000	Note 2
Operating Costs			Annual Cost
Chemicals & Gases	$150,000	$250,000	
Bottle Handling	$0	$65,000	Includes bottle rinse and disposal
Personal Protective Equipment	$0	$3,000	Equipment and training
Waste Disposal	$150,000	$150,000	Assume equal to chemical cost
Exhaust Air	$2,000	$1,000	Air scrubbing costs
Down time			
Hazardous Gas Monitor	0.1%	0.2%	Two systems
Waste Disposal System	0.1%	0.1%	
Air Scrubber	0.1%	0.1%	
Total Down Time	0.3%	0.4%	

Note 1: POUCG requires 1 monitor at the point-of-use. Bottle chemicals require 1 monitor at the point-of-use and 1 in the chemical warehouse area.

Note 2: POUCG requires 1 safety shower at the point-of-use. Bottle chemicals require 1 safety shower at the point-of-use and 1 in the chemical warehouse area.

Note 3: Set default adhesives costs to $0.00.

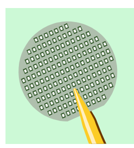
Case 2: Tungsten Etch Cost of Ownership

The tungsten etch COO example demonstrates the ESH and cost benefits of improved operating methods that reduce particle contamination and reduce cleaning frequency. This case has also been modified to work with TWO COOL® packaging and assembly software. All yield improvements will be included in equipment yield. Table III outlines the basic cost parameters.

Table III
ESH Cost Impact Comparison

Parameter	Base Case	Improvement	Comments
Scheduled Maintenance	35	12	Hours/week
Throughput	18	16	UPH
Equipment Cost	$1,000,000	$1,000,000	
Equipment Yield	96.5%	98.3%	Includes Defects
Specialty Chemicals	$31,000	$20,000	Cleaning Chemicals
Scheduled Maintenance Technicians	2	2	Buddy System for Safety

Note 1: Set default adhesives costs to $0.00.



Wright Williams & Kelly Re-Opens Texas Offices

Wright Williams & Kelly (WWK), a software and consulting services company based in Pleasanton, California, announced today it has re-entered the Texas market with new offices in the Austin and Dallas areas. These offices will directly support WWK's existing client base as well as be critical assets in expanding its consulting practice.

"New business opportunities, the efficiencies of the Internet, and a company reorganization have allowed WWK to reopen offices closed by previous management," said Daren Dance, WWK's Vice President of Technology. "We are excited about the signs of growth and the opportunities that we see in Texas and the surrounding region. These offices will allow us to strengthen our long-term relationships with International SEMATECH and electronics companies in the area."

"I am very pleased to be able to offer our clients in the Southwest more direct access to our expert resources," stated David Jimenez, WWK co-founder and President. "This is just the first step in meeting our customers' needs for out-sourced services in manufacturing, assembly, and business cost optimization. We will have another major announcement in that area in the next week."

New Fellow Category Targets Nominations from Industry

BY KATHY KOWALENKO

IEEE members working at activities besides research and development now have a Fellow category created specifically for them. "Application Engineer/Practitioner" will apply to nominees for IEEE Fellow who work in such areas as process or production engineering, quality control, and systems integration.

The IEEE Board of Directors approved this and other changes last June, based on suggestions made by a task force appointed by 2003 President Michael Adler. The task force recommended the category be added as a way to increase Fellow nominations from industry. The new category recognizes the vast number of members who are involved in engineering practice, as opposed to R&D.

"The Board has been concerned for several years about how few engineers from industry have been elected to Fellow grade," says 1985 Past President Bud Eldon, who chaired the task force. "The percentage of members working in industry is higher than those in academia, but the number of nominations for Fellows from industry is significantly lower."

Nominations of members working in R&D–whether in industry, government, or academia–that previously fell under the "Engineer/Scientist" category now will be classified as "Research Engineer/Scientist." The two remaining categories, "Technical Leader" and "Educator," are unchanged.

Nominees for the new category, like nominees for the other three, will be evaluated primarily on the basis of achievements in "bringing the realization of significant value to society." This is one of three criteria for elevation to Fellow grade, along with being an IEEE senior member and having paid-up dues.

S.Y. Technology Engineering and Construction Co. Licenses WWK Software Suite

Creates Technology Partnership in PRC

February 2, 2004 (Pleasanton, CA) –Wright Williams & Kelly, Inc. (WWK), a cost & productivity management software and consulting services company, announced today that it has licensed its full software suite to S.Y. Technology Engineering and Construction Co., a subsidiary of the China Electronics Engineering Design Institute (CEEDI). The software suite covers cost of ownership (COO), overall equipment effectiveness (OEE), capacity analysis, product costing, profitability and return on investment (ROI) analysis, and full factory simulation for inventory and cycle time optimization.

“This is a major step for both S.Y. Technology and WWK,” states David W. Jimenez, WWK's President. “The licenses for TWO COOL®, Factory Commander®, and Factory Explorer® provide S.Y. Technology with the most advanced operational modeling tools available anywhere in the world. They will be in a position to assist their clients in designing the most innovative factories and then optimize their operations for lowest cost and highest productivity. The benefit to WWK is having such an important client in mainland China who has agreed to help us expand our marketing efforts in what is clearly the fastest growing manufacturing region in the world.”

"After a careful comparison of the available solutions, we decided that the software tools from Wright Williams & Kelly would be the best approach to support our clients and grow our engineering practice," says Dr. Sean Du, Vice President of S.Y. Technology and Construction Company. "The need to keep costs low, quality high, and product flowing is essential to maintaining the impressive growth of Chinese manufacturing. We look forward to introducing WWK's products to our broad and diverse client base."

S.Y. Technology and Construction Company has completed a large number of international projects for prestigious companies such as Intel, Grace Semiconductor, AMD, Dupont, Hana Microelectronics, and STMicroelectronics. Established in 1953, China Electronics Engineering Design Institute (CEEDI) is a sizeable and comprehensive engineering construction enterprise registered with the State Administration of Industry and Commerce and one of the 10 key companies of survey and design directly under the State Council. CEEDI has more than 1100 employees located in 10 offices throughout China.

Being guided by the philosophy of scientific and technological innovation, based on a people-oriented design concept in conformity with international practices and the flexible utilization of new techniques, CEEDI has been well received among clients both domestic and overseas. Its services for a large number of national key projects have well established the CEEDI brand name and won high recognition. CEEDI is well on its way towards becoming a top ranked international engineering firm and noted in the world's engineering circle.