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Inside

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The Bottom-Line Benefits of Cycle Time Management

Dr. Frank Chance
FabTime, Inc.

Dr. Jennifer Robinson
FabTime, Inc.

Introduction

Over the past three years, we've had a number of discussions with people throughout our industry on the topic of cycle time management and its financial return. In general, we've found that people believe shorter cycle times are a Good Thing. However, the link between shorter cycle times and improved financials remains murky. In this discussion, we'll present our thoughts on how this murkiness can be quantified. The end-result is an Excel spreadsheet that estimates the dollar-impact of shorter cycle times.

Consumer Protection Warning

We'll be using averages and estimates for the inputs in our model. This is just a starting point. Every fab is unique, so the spreadsheet won't apply to your fab unless you modify the inputs. Also, you will need to consider the assumptions underlying each potential benefit. For example, if the benefit is increased production of a product you can't currently sell, then you won't be improving your profits one bit!

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Editorial Board

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6200 Stoneridge Mall Road
3rd Floor
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Phone 925-399-6246
Fax 925-396-6174
E-mail support@wwk.com

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Calendar of Events

September

13-15 **SEMICON Taiwan**
Taipei, Taiwan

27-29 **IEEE International Symposium on Semiconductor Manufacturing (ISSM)**

October

3-6 **International Trade Partners**
Hawaii, HI

November

14-17 **SEMI NanoForum**
Austin, TX

December

1-3 **SEMICON Japan**
Tokyo, Japan

January 2005

9-12 **Industry Strategic Symposium**
Half Moon Bay, CA

February

2-4 **SEMICON Korea**
Seoul, South Korea

March

2-4 **SEMICON China**
Shanghai, China

April

12-14 **SEMICON Europa**
Munich, Germany

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From Cycle Time to Dollars

The first step in our quantification process is to lay out the paths by which an improvement in cycle time may be reflected on the bottom line. To be useful, these paths must ultimately lead to increased revenues or decreased expenses, so we'll group paths into these two high-level categories. If you'll recall, back in issue 2.6 of this newsletter we discussed several of these paths, with the focus on one in particular - reduced inventory write-offs during a downturn. This month, we'll include that path plus a number of others in one consolidated spreadsheet.

Expense-Related Paths

E1) Raw Materials Savings - Yield Improvements:
Shorter production cycle times → Improved yield → Fewer starts required for same throughput → Decreased raw material costs → Decreased expense.

E2) ECN (Engineering Change Notice) Savings - Decreased WIP:
Shorter production cycle times → Decreased production WIP → Fewer lots requiring ECN rework → Decreased expenses.

E3) Finished Goods Write-Off Savings - Decreased Safety Stock Required:
Shorter production cycle times → Decreased safety stock required for finished goods inventory → Decreased risk of inventory obsolescence → Decreased write-offs of inventory → Decreased expense.

E4) WIP Carrying Cost Savings
Shorter production cycle times → Decreased WIP → Decreased WIP investment → Decreased WIP carrying costs → Decreased expense.

Revenue-Related Paths

R1) Design Wins - Increased Cycles of Learning:
Shorter R&D cycle times → More cycles of learning during product development → More time for experimentation and product refinement → More competitive products → Increased design wins → Increased revenue.

R2) Design Wins - First to Market:
Shorter R&D cycle times → Faster product development → First to market → Increased design wins → Increased revenue.

R3) Pricing Premium - First to Market:
Shorter R&D cycle times → More cycles of learning during product development → Faster product development → First to market → New product pricing premium → Increased revenue.

Quantification and Inputs

We have quantified these paths in a spreadsheet that can be found on our website at http://www.FabTime.com/bottomline.htm. (Note that this spreadsheet replaces the earlier cycle time benefits calculator that was available from FabTime's website.) The first worksheet, Calculator, contains a summary of inputs and benefits. The second worksheet, Details, contains the detailed calculation behind each benefit. The third worksheet, Notes, contains notes and references.

Several of the benefit calculations use inputs for which you may not know an exact value. For example, benefit R1 (Design Wins due to Increased Cycles of Learning) has these inputs:

(Current R&D Cycle Time)
(Target R&D Cycle Time Improvement)
(Weekly Wafer Outs)
(Workweeks per Year)
(Good Devices per Wafer Out)

(Revenue per Device)
(Current Design Wins per Year)
(New Product Pct) = "Percent of shipments that are new products (design wins from prior 12 months)"
(Design Win Factor1) = "Percent increase in design wins per additional R&D learning cycle"

And these calculations:

R1.1) (New Product Volume) = (Weekly Wafer Outs) * (New Product Pct) / (Current Design Wins per Year) * (Workweeks per Year)

R1.2) (Current Learning Cycles) = 365 / (Current R&D Cycle Time)

R1.3) (Improved Learning Cycles) = 365 / (Improved R&D Cycle Time)

R1.4) (Additional Learning Cycles) = (Improved Learning Cycles)-(Baseline Learning Cycles)

R1.5) (Additional Design Wins) = (Additional Learning Cycles) * (Design Win Factor1) * (Current Design Wins per Year)

R1.6) (Additional Wafers) = (Additional Design Wins) * (New Product Volume)

R1.7) (Additional Devices) = (Additional Wafers) * (Good Devices per Wafer Out)

R1.8) (Additional Revenue) = (Additional Devices) * (Revenue per Device)

The only input that is likely not estimable from existing fab data is

(Design Win Factor1) = "Percent increase in design wins per additional R&D learning cycle"

But it should be possible to provide a reasonable range of values. One additional R&D learning cycle per year could increase design wins by 1% to 5%, but it probably won't increase design wins by 25%.

Example

The spreadsheet on our website contains sample inputs for a fab with these characteristics:

500 wafer outs per week
50 day production cycle time
25 day R&D cycle time
90% line yield

The cycle time management targets are:

5% improvement in production cycle time
5% improvement in R&D cycle time

For the remaining inputs, we have entered values based on past experience, or for factors such as (Design Win Factor1), estimates that strike us as reasonable and conservative.

The resulting bottom-line benefits are:

$76,313	E1: Raw Material Savings
$24,802	E2: ECN Savings
$34,105	E3: Finished Goods Write-Off Savings
$62,500	E4: WIP Carrying Cost Savings
$100,855	R1: Design Wins - Increased cycles of learning
$164,063	R2: Design Wins - First to market
$82,031	R3: Pricing Premium - First to market
$544,668	Total Annual Benefit of Cycle Time Management

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WWK Adds Metrology Analysis Module to its TWO COOL® Cost of Ownership Software

June 28, 2004 (Pleasanton, CA) –Wright Williams & Kelly, Inc. (WWK), a cost & productivity management software and consulting services company, announced today that it will unveil the next generation of its Cost of Ownership (COO) and Overall Equipment Efficiency (OEE) software, TWO COOL® v3.1, at SEMICON West San Francisco (Moscone Hall North booth #5658).

TWO COOL® is the de facto standard for COO and OEE analysis software used by industry and academia. Originally developed at the request of SEMATECH, TWO COOL® is used in the semiconductor and other industries to manage procurement and optimization of multi-billion dollar capital asset portfolios.

TWO COOL® version 3.1 incorporates not only the traditional metrics for process equipment but now includes critical features to measure the performance of metrology systems and sampling plans. Version 3.1 provides the ability to measure the cost impact of incorrect metrology results (alpha and beta errors). The inclusion of sampling plans allows metrology costs to be more accurately assigned to the total production being supported by the metrology tools. "Metrology COO analysis allows our customers to better understand the costs and benefits of measurement and control when implementing leading edge technologies," said Daren Dance, WWK's vice president of technology

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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Notice how the revenue-based benefits are larger than the expense-based benefits. This is a pattern we have seen in the past. In general, it matches our intuition that improvements in cycle time are quite valuable on the customer side of the equation (revenue). If you experiment with the spreadsheet, you will find that improvements in R&D cycle time generally have a bigger impact than improvements in production cycle time. This behavior is due to benefit paths R1, R2, and R3, which are all premised on an improvement in R&D cycle time. It is certainly possible that other benefit paths exist for improvements in production cycle time. Again, however, this behavior matches our intuition - cycle time is quite valuable when you are pushing to bring a new product to market, to get it into customers' hands for the very first time.

Even without the revenue-based benefits, however, the expense savings are significant.

Summary

Quantifying the benefits of cycle time management is a useful exercise. It puts the focus on areas where the potential return is greatest, thus clarifying our priorities. It also serves as a benchmark for post-improvement analysis: if the cycle time improvement targets have been achieved, were the predicted benefits obtained?

Acknowledgements

We would like to thank Ken Beller, of the FabTime advisory board, for his contributions during the brainstorming phase of this project, particularly in the identification of the various benefit paths. Thanks are also due to a newsletter subscriber who pointed out the double-counting of yield benefits in an earlier version of this spreadsheet - if there is an improvement in yield, you can either sell the additional wafers (thereby realizing a increase in revenue), or start fewer wafers (thereby realizing a decrease in raw wafer expenses), but not both. In the current model we resolve this issue by accounting for yield benefits entirely as a reduction in raw wafer expenses.

Further Reading

For a discussion on the cost of delays in new product introductions, see D. Kinkead, J. Mastrobuono, K. Dean and W. Trybula's "The Cost of Imperfect Wafer Environmental Control," Semiconductor International, June 2001, p. 135. This paper suggests that each day of delay in ramping a new DRAM product to volume production costs $2.5M over the lifetime of the product. This paper is available through the archives on the Semiconductor International website. Since it is more than 6 months old, you will need to register.

Originally published in the FabTime Cycle Time Management Newsletter, Volume 3, Number 5, 2002. Reprinted with permission.
http://www.fabtime.com

Tighter Equipment Tracking for Efficient Fabs

Laura Peters, Senior Editor
Semiconductor International

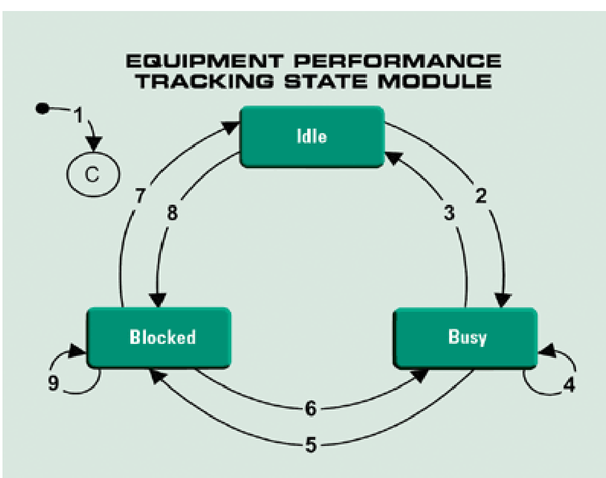
As semiconductor fabs ramp to higher utilization rates, there is ever increasing emphasis on productivity — at the factory, line, tool and module levels. Achieving higher yields by adding more metrology steps can run counter to higher productivity and shorter cycle times. Especially for 300 mm fabs, there is a need to better track tool activity in an automated fashion to optimize output rates while maintaining highest levels of quality and yield.

SEMI recently published several updated standards that apply to equipment automation, software, facilities and materials. There is a provisional specification for equipment performance tracking (SEMI E116-0304), which enables a host computer to track basic equipment performance automatically without operator or host input. A second specification (SEMI E79-0304) defines different means of measuring productivity in individual tools and modules so that specific areas for improvement can be targeted.

The equipment performance tracking (EPT) spec provides automatic reporting of equipment state changes to a host computer of equipment status, time at state, and reasons why a piece of equipment might be blocked from performing a given task. The host computer can compute equipment run rates for the tool suppliers or fab engineers to identify areas for improvement. Industrial engineers can combine EPT data with MES (manufacturing execution system) data to calculate SEMI E10 states and SEMI E79 metrics at the equipment and module levels.

Due to restrictions placed on this reprint by the author, please find the rest of the article at:

http://www.reed-electronics.com/semiconductor/article/CA411460



Production Tool Time Allocation

E10 States	E79 Productivity losses and improvement domains	
Non-scheduled time Scheduled downtime Unscheduled downtime	Availability efficiency losses (supplier and user domain)	
Engineering Standby	Operational efficiency losses (user domain)	Performance efficiency losses (supplier and user domain)
Production time	Rate efficiency losses (supplier and user domain)	
	Assignable quality efficiency losses (supplier and user domain)	Theoretical production time for actual units
	Theoretical production time for effective units	

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WWK Delivers Advanced Cost Modeling Software to the Universidad Politecnica de Madrid

June 16, 2004 (Pleasanton, CA) –Wright Williams & Kelly, Inc. (WWK), a cost & productivity management software and consulting services company, announced today that it has shipped its latest version of TWO COOL® Cost of Ownership (COO) and Overall Equipment Efficiency (OEE) software to the Universidad Politecnica de Madrid's Instituto de Energia Solar. The software will be used as part of their advanced teaching and research in photovoltaics and solar energy.

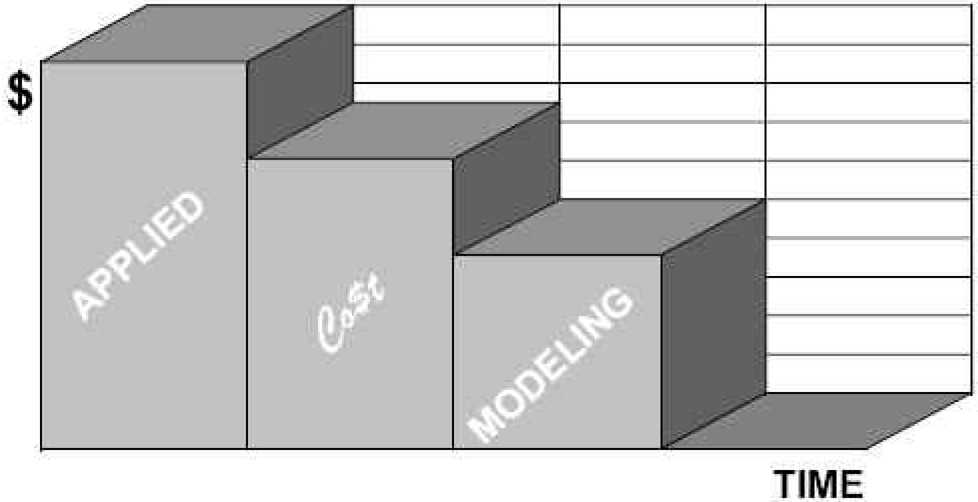
TWO COOL® is a feature rich software tool with a state-of-the-art graphical user interface, automated report, chart, and sensitivity analysis generation, built-in database, and multiple analysis modes. Since comparative COO analysis is such a powerful technique, TWO COOL® incorporates both single and multi-column formats, allowing direct side-by-side evaluations. This all adds up to TWO COOL® setting the standard for efficient and accurate operational cost modeling and decision analysis.

The Institute of Solar Energy (IES) of the Polytechnic University of Madrid was established in 1979 as part of the Semiconductor Laboratory. The objective of the IES is to investigate all aspects associated with the development of photovoltaic solar electricity.

WWK Delivers Advanced Manufacturing Simulation Software to Boise State University

August 11, 2004 (Pleasanton, CA) –Wright Williams & Kelly, Inc. (WWK), a cost & productivity management software and consulting services company, announced today that it has shipped twenty-six seats of its latest version of Factory Explorer® capacity analysis and discrete-event simulation software to Boise State University.

Factory Explorer® will be used by students majoring in Operations Management in the College of Business and Economics. The Operations Management program is one of the most comprehensive undergraduate programs of its kind in the west with core courses in Lean Manufacturing Systems, Supply Chain Management, Operations Modeling, Project Management, Quality Implementation, and Manufacturing Strategy. The program is supported by faculty members who hold advanced degrees from schools such as the University of Kansas, Louisiana State University, University of Missouri, University of Oregon, and the University of Utah.



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