FabTime Cycle Time Management Newsletter

Volume 3, No. 7 August 2002

Information

Mission: To discuss issues relating to proactive wafer fab cycle time management.

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Editor: Jennifer Robinson

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Contributors: Scott Mason (University of Arkansas); Sanjay Rajguru (National Semiconductor); Guy Gandenberger (Micrel Semiconductor); V.A. Ames (Applied Materials)

Welcome

Welcome to Volume 3, Number 7 of the FabTime Cycle Time Management Newsletter. Frank and I were able to meet several newsletter subscribers for the first time at SEMICON West last month. We always enjoy being able to put a face with a name, and we hope to meet more of you in the future.

In this issue, we have an announcement from Scott Mason about a survey that his lab is conducting related to capacity and simulation modeling for wafer fabs. For subscriber discussion, we have a response from Sanjay Rajguru concerning the operator cross-training issue raised last month by Douwe van Engen, a response from Guy Gandenberger to our cycle time management styles article, and responses from V.A. Ames to subscriber questions about mean time between assists and recipe management.

In this month's main article, we have chosen to briefly review the topics described in the FabTime newsletter issues to date (both the main articles and the subscriber discussion topics). The primary reason for this is that we have many new subscribers, who may not be aware of the topics already covered. Even for long-time subscribers, job descriptions and market conditions change regularly. A topic that wasn't of interest to you when it first came out may be more relevant now. In this month's Recommendations and Resources section, we review the many resources available on FabTime's website (papers, tutorials, book reviews, software demos, etc).

Thanks for reading! -- Jennifer

FabTime

325M Sharon Park Dr. #219
Menlo Park CA 94025
Tel: 408 549 9932
Fax: 408 549 9941
www.FabTime.com

Community News/Announcements

Capacity and Simulation Modeling Survey

The Razorback Electronics Manufacturing Laboratory at the University of Arkansas (www.uark.edu/~remlab) is currently engaged in various semiconductor manufacturing-related projects, including factory planning and scheduling. Both static and dynamic capacity modeling are typically an integral part of factory planning efforts. The REM Lab is currently fielding a "State of the Art Static and Dynamic Modeling Survey." All survey responses will be kept confidential. Our intention is to tabulate the survey results, then report back to all survey respondents via a high level, summary document. Please contact Scott Mason (mason@uark.edu) to learn more about participating in this survey.

FabTime welcomes the opportunity to publish community news and announcements. Simply send them to Jennifer.-Robinson@FabTime.com.

Subscriber Discussion Forum

Operator Dedication

In response to Douwe van Engen's question last month about how people are handling operator dedication/training, Sanjay Rajguru, Manufacturing Manager at National-Arlington, wrote the following: "At National, Texas, our plan is to get the operators involved not only in performing routine PM's but also dispositioning lots (minor engineering duties). Our rationale is that this will reduce variability since the lack of technician availability causes more variability."

Cycle Time Management Styles

In response to last month's main article, Guy Gandenberger, VP of Wafer Fab Operations at Micrel Semiconductor, wrote the following, "Interesting reading regarding "styles" of running a fab. I must confess my fabs are self proclaimed combinations of a Traffic Cop and Shepherds. I think you missed another aspect or style of running a fab which includes FIFO vs. critical ratio or static dispatching and the ability to "pull" lots to make a schedule date. I.e. forcing the line to focus on a back-end lot because it is 1 day late vs. a lot at the front-end being one day late. I know you would consider this activity part of "shepherding" but I think the distinction is an important one, and at this point I think we all realize a balance between all three is a must if you want to rate as a world class fab."

FabTime Response:

I think that you have an excellent point that our discussion of cycle time management styles didn't take into account

scheduled due dates (except for super-hot lots, as managed by the Relay Coach). I do think that it's different from the Shepherd style, as we defined the Shepherd style, because the Shepherd focuses on lots that have been at their current operation for too long, without reference to differences in the individual lot due dates. As you say, a balance is needed here, because if you focus wholly on the due dates and the lots in the back of the line, you end up with too much variability (it's too hard for the lots at the front of the line to get through, which causes problems later).

Calculating Mean Time Between Assists (Response to Prior Question)

V.A. Ames from Applied Materials sent in the following response to Issue 3.05's question about calculating mean time between assists for die bonders: "I noticed that there were no replies to the question about Calculating Mean Time Between Assists (MTBA) on the die bonder in the May Newsletter. If they are still interested in a response here are my thoughts on the subject.

It doesn't matter whether it is a die bonder or a litho tool, the purpose of measuring MTBA is to identify any interruptions during production so the impact to productivity can be measured. Since the goal should be to reduce assists to zero, all factors should be considered.

I think it is very important to include the "fudicial not found" errors in the MTBA calculation, not only because some of the errors may be caused by the die bonder (camera out of focus, improper setup and alignment, not enough light, etc), but it also gives you the best chance of getting the quality of the substrates improved.

If the impact to throughput on the die bonder by waiting an extra 10-12 seconds can be proven to cost more than improving the condition of the substrates then you have a good argument for spending money. For one week's time take the number of assists times 10 seconds and then divide by the time it takes one substrate to be completed. This is the extra substrates that could be produced in that week. If it's a bottleneck tool you may have a big impact, but if it has lots of idle time due to no product then you probably don't need to worry about it and can live with the poor quality substrates.

My experience tells me that the substrate quality issue has been raised in the past, but shot down because of money needed or that someone says the substrates are as good as they get. Good data can usually change that type thinking quickly if the impact to the bottom line (number of die out the door) is completely understood."

Recipe Management (Response to Prior Question)

V.A. Ames also sent in a response to last month's question about how companies handle recipe management. "A five-step systemic process based on 5S/CANDO is the only process that I have seen work at sites without a host recipe management system. It sounds very simple, but takes dedication and the completion of all five steps to be effective. Here is a summary of each activity.

Ground Rules:

- Perform the process on one tool at a time. The first tool is the most critical. Take your time to do it right. The other tools will not take near as long if you create a good model.

- You can start with a model tool to create the process (preferred) or do multiple tools in parallel (different areas of the fab).

- Do not go the next step until the

current step you are on is complete (should be a management review of the results after each step to determine readiness to proceed).

- Everyone (operator, equipment tech, process tech, engrs, mgmt, etc) participates.

- You need an "owner" from each job classification listed above and each area of the fab.

- Try not to relent to the pressure for a "quick fix." You will just end up back where you are now in about six months (you've probably done that before)

Step 1: Clear out all unused recipes (leave questionable ones for step 3) - Everyone agree on list.

Step 2: Arrange the recipes that are left. Rename them if you have to. From reading your note they can be classified by Product, Tool, Lot, R&D, etc. Then divide them into Primary and Secondary. Use a rule to define which group to put them in. Ex: Primary are recipes used within the past three months, Secondary recipes are the ones left. Decide what fits your situation best.

Step 3: Neaten up the final list. Scrutinize the list and eliminate the ones you could not decide on in Step 1. Try to add a date or some other identifier to put the recipes in logical order. Use the alphabet to see immediately of a recipe is missing. Use your imagination through brainstorming with the users to see if an innovative method can be created to make a missing recipe name obvious to ANYONE.

Step 4: Disciple the users by creating recipe auditing list. Assign scheduled audits to be performed on a regular basis. Primary recipes need to be audited much more frequently than secondary recipes. Everyone should be performing audits. Operators audit production and lot recipes, equipment techs audit tool recipes, engineering techs audit R&D recipes, and managers perform spot audits on a quarterly basis.

Step 5: Ongoing review of the process. Keep the audit list updated with recipes that are added and deleted (Owner). Perform root cause analysis on problems that still exist and implement improvements. You will find that if you did a thorough job in steps 1-4, this is a rare event (believe it or not). Use an external auditor (from another area of the fab) once a quarter to have a "different set of eyes" look at the process and suggest improvements. This can also be very helpful in steps 2 and 3.

This sounds like pretty basic stuff, but is very hard to complete because everyone would rather just continue to do business as usual. If you put in the effort, though, everyone is much happier after using the system for a while. It will take about 6 months of using the system to get everyone on board, although a few people will say immediately "Why didn't we do this a long time ago." Look hard for them and use them to help drive the process."

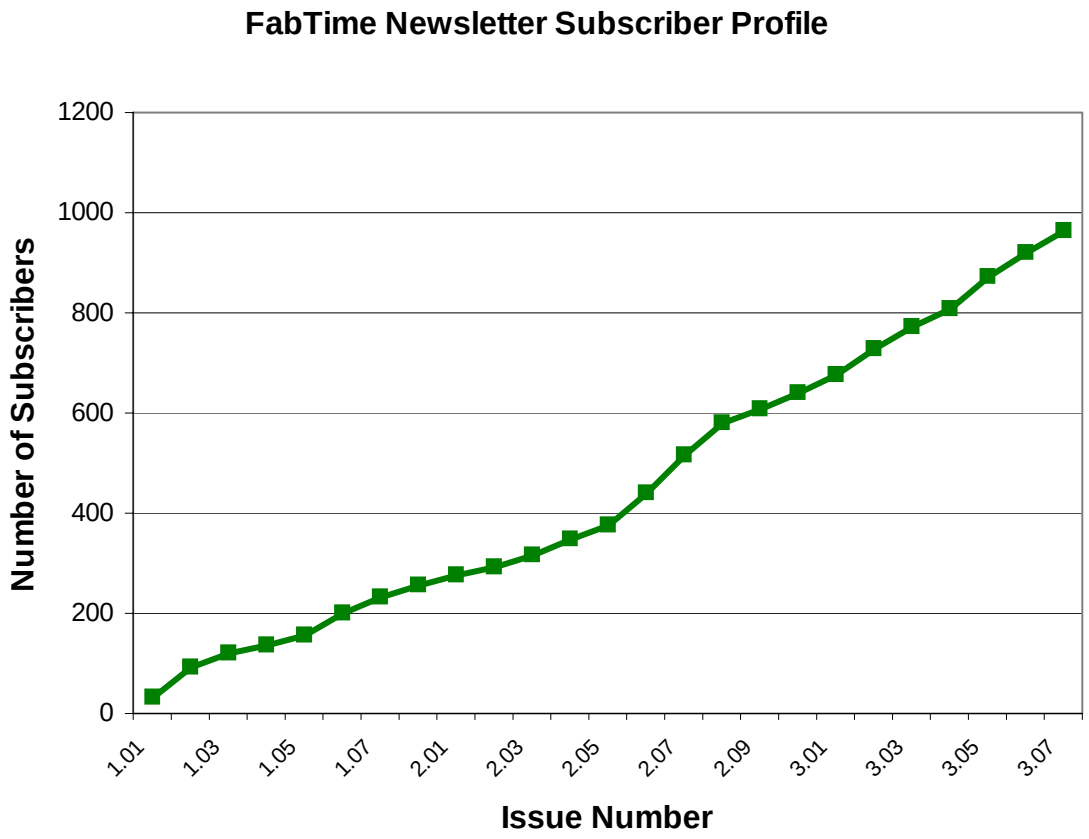
FabTime Newsletter Retrospective

Introduction

The first issue of the FabTime Cycle Time Management Newsletter was sent on Friday, April 14th, 2000, to thirty-three brave new subscribers. The newsletter was just an idea that we had, to promote cycle time management as a valid category within fab operations management. We also wanted to build a community of people interested in this sort of work. Two years later, this twenty-fifth issue goes out to nearly 1000 subscribers, plus some unknown set of people who receive the newsletter through forwarding each month. We no longer have any doubt that people are interested in wafer fab cycle time management. And we think that we're building a real community. People send us questions and discussion topics, and other subscribers take time to address each other's issues. When we meet newsletters subscribers at conferences and trade shows and site visits, we feel like we're continuing a dialog with people we already know, rather than meeting people for the first time. We hope that this will continue and grow (see the graph showing growth below).

Special thanks are due to the thirty-three original subscribers (thirty-two of whom still subscribe), who believed in us enough to give the newsletter a try, and passed the newsletter along to their colleagues, so that the community could grow. Thanks!

If you would like copies of any or all of the past issues described below, simply email your request to Jennifer.Robinson. The past issues will be sent as formatted PDF files, as many people have told us that they find the PDF version easier to read and save when reviewing the past issues. If you would like to change your regular subscription so that you receive the PDF attachment version, just email Jenni-



fer, or use the form at www.FabTime.com/newsletter.htm. Be sure to tell specify whether or not you still wish to receive the text email version.

Volume 1, Number 1

Number of Subscribers: 33
Main Topic: The Hawthorne Effect. The Hawthorne Effect proposes that productivity increases as a result of attention received by the workers.

Discussion Topics: Knowledge-sharing regarding lot release, dispatch, and scheduling techniques for cycle-time management.

Volume 1, Number 2

Number of Subscribers: 93
Main Topic: The P-K Formula. The Pollaczek-Khintchine (called P-K, for obvious reasons) formula gives the expected average WIP at a single-tool workstation where arrivals to the workstation are highly variable, and process times are somewhat less variable. The P-K formula is the mathematical justification for variability reduction efforts in a wafer fab.

Discussion Topics: Contributors to wafer fab variability.

Volume 1, Number 3

Number of Subscribers: 119
Main Topic: Little's Law - The relationship between cycle time, WIP, and throughput.J. D. C. Little first documented the relationship between cycle time and WIP in 1961. Little's Law states that at a given throughput level, the ratio of WIP to cycle time equals throughput, as shown in these formulas: Throughput = WIP / Cycle Time, or equivalently, WIP = Throughput * Cycle Time.

Discussion Topics: Reducing variability in observed process times.

Volume 1, Number 4

Number of Subscribers: 137
Main Topic: A Short Introduction To The Theory of Constraints. The Theory of Constraints is now in its fourth decade of development. FabTime's write-up on the subject concludes with some implications of TOC for wafer fabs.

Volume 1, Number 5

Number of Subscribers: 157
Main Topic: Theory of Constraints and Just-in-Time Manufacturing. This article is concerned with an apparent conflict between an implication of the Theory of Constraints (TOC) as applied to wafer fabs and the application of just-in-time manufacturing (JIT). We conclude that if you are going to adopt a just-in-time manufacturing mindset, or a goal manufacturing mindset, you should set aside sufficient time to apply the entire process.

Volume 1, Number 6

Number of Subscribers: 200
Main Topic: Performance Measures Typically Used in Wafer Fabs. This article proposes some wafer fab performance definitions to apply within the niche of cycle time management. The terms defined in this article include starts, utilization, OEE, turns, throughput, line yield, cycle time, cycle time/raw process time, and cycle time per layer. We discuss each of these in detail.

Volume 1, Number 7

Number of Subscribers: 233
Main Topic: Improving Factory Cycle Time Through Changes at Non-Bottleneck Tools. This article describes FabTime's believe that you can reduce overall cycle time by reducing cycle time at any tool group in the factory, not just at the bottleneck. If you focus your efforts strictly on bottleneck tools, then, you miss out on many opportunities for improvement.

Discussion Topics: A question about tool performance vs. rate of return.

Volume 1, Number 8

Number of Subscribers: 258
Main Topic: Understanding the Impact of Single-Path Tools. Single-path tools are a common feature in wafer fabs. Our results suggest that if you have a legitimate choice between cross-qualification and tool-dedication, you should consider the cycle time benefits of cross-qualification when making your decision.

Discussion Topics: A proposal for cycle time reduction through tool integration; and a suggestion about using PEE.

Volume 2, Number 1

Number of Subscribers: 277
Main Topic: Impact of Batch Size Decision Rules on Cycle Time. This article discusses policies for deciding when to form a partial batch at large batch tools, using simple numerical examples and simulation results. We conclude that for batch tools that are not highly loaded, forcing full or near-full batches can significantly increase local cycle times, as well as overall fab cycle times.

Volume 2, Number 2

Number of Subscribers: 293
Main Topic: Should You Reduce Lot Sizes to Reduce Cycle Times? This article concerns possible changes to production lot sizes for cycle time improvement. We suggest that you consider lot size reduction to reduce cycle times, but that you consider it very carefully, and we outline several specific issues to consider.

Discussion Topics: Observations about time constraints and batch size decisions, and sequence dependent setups and batch size decisions; and a question about defining utilization at batch tools.

Volume 2, Number 3

Number of Subscribers: 317
Main Topic: Improving Cycle Time During a Downturn. Downturns are a fact of life in the cyclic semiconductor industry. We suggest using this time to focus on low cost cycle time improvement efforts, including setup/dedication policy investigation, process analysis, layout analysis, bottleneck analysis, OEE/TPM analysis, simulation model validation, system upgrades, and education.

Discussion Topics: A success story on cycle time reduction through batch size decision rule changes; and a clarification of the units in the P-K formula.

Volume 2, Number 4

Number of Subscribers: 347
Main Topic: In-Depth Guide to OEE Resources. In this article, we review the formulas for calculating OEE (both the full formula and a short-cut version), as well as some of the reasons for low OEE in wafer fabs. We also include a series of links to OEE resources on the Internet (including primary resources from SEMI and SEMATECH), as well as some additional published OEE references.

Volume 2, Number 5

Number of Subscribers: 377
Main Topic: One-Year Anniversary Issue. This issue contains full-length abstracts to the main topics in all previous issues.

Discussion Topics: The SEMI E-10 Standard reference; a question about defining ideal process time in OEE calculations.

Volume 2, Number 6

Number of Subscribers: 439
Main Topic: What is One Day of Cycle Time Reduction Worth? This article represents FabTime's first formal attempt at quantifying the financial benefit of cycle

time improvement, through looking at the reduction in inventory write-off costs that stems from cycle time improvement.

Discussion Topics: The SEMI E-79 Standard definition of ideal process time; and a clarification of the OEE calculations for quality rate.

Volume 2, Number 7

Number of Subscribers: 518
Main Topic: Cycle Time Characteristic Curve Generator. The characteristic curve generator is an Excel-based tool for generating characteristic curves of single tools with failures. It is available from FabTime's website. This spreadsheet tool allows you to get a quick visual impression of the impact of both downtime and variability attributes. You can download the spreadsheet from http://www.fabtime.com/charcurve.htm.

Discussion Topics: The method for ordering the SEMI E-79 Standard document; a description of where to find abstracts to INFORMS articles; a request for fab cycle time benchmark data; and a request for tool cycle time benchmarks.

Volume 2, Number 8

Number of Subscribers: 581
Main Topic: Setting Goals for Fab Performance. This article discusses the proliferation of goals in a wafer fab - from aggregated goals down to detailed per-operation goals - as well as the implicit assumptions behind long-term goals, and how to mix long-term goals with appropriate short-term targets.

Discussion Topics: A question about generating operating curves for the wafer test area; a description of experiences in measuring process time variability; and a request for the logic behind the variability parameters in the FabTime characteristic curve generator.

Volume 2, Number 9

Number of Subscribers: 608
Main Topic: Implicitly Including Cycle Time in Capacity Planning. In this article, we discuss methods that we have observed companies using to implicitly include cycle time considerations when planning fab capacity.

Discussion Topics: A question about the standard for 300mm lot size; a question about quantifying cost savings from cycle time reduction; an inquiry about the availability of published productivity report indices for fabs; a request for references on literature regarding new product introductions; and a practical best-case X-factor for cycle time goals taking human performance into account. (A paper by Hermann Gold on the last topic can be requested from Jennifer.Robinson.)

Volume 2, Number 10

Number of Subscribers: 642
Main Topic: Explicitly Including Cycle Time in Capacity Planning. In this follow-up to Volume 2, Number 9, we discuss a method for explicitly including cycle time goals in the capacity planning process, through the use of simulation models.

Discussion Topics: Several responses to the 300mm lot size question; a proposal for calculating the cost of cycle time; a statement of the continued need for moves as a daily fab performance metric; a modification to the cycle time calculations in the characteristic curve generator; a case study comparing actual performance to short-term goals; and questions about the implications of 300mm factory size, relating OEE to cost per wafer, modeling operator impact, modeling cycle time and WIP during a volume ramp, the industry definition of "loading", calculation of product and factory line yield values, and benchmarking cycle time for wafer production.

Volume 3, Number 1

Number of Subscribers: 675
Main Topic: OEE and Cycle Time. Striving for high traditional OEE values tends to lead to high cycle times. In this issue we discuss a revised form of OEE called Production Equipment Effectiveness (PEE) that takes this issue into account.

Discussion Topics: A request for information on measuring shift performance; a question about performance measures regarding human resource to activity relationships; and a question about model accuracy relative to actual performance.

Volume 3, Number 2

Number of Subscribers: 730
Main Topic: Cycle Time and Hot Lots. In this article, we present a formula for estimating the average cycle time of lots through a tool that processes lots with different priorities (regular lots and hot lots). We provide a numerical example that shows how the cycle time of the regular lots increases as the percentage of hot lots is increased, and discuss implications for managing hot lots in a wafer fab.

Discussion Topics: A response to the question about performance measures regarding human resource to activity relationships; a request for cycle time reduction case studies; and an observation on production equipment efficiency (PEE) as a measure of tool variability.

Volume 3, Number 3

Number of Subscribers: 771
Main Topic: How Much Does Tool Dedication Inflate Cycle Time? This month's article concerns quantifying the impact of tool dedication on cycle time. We present a formula for queue time as a function of traffic intensity, process time, and number of tools in the tool group, and show why, according to this formula, queue time tends to improve as tool dedication is lessened (for the same overall traffic intensity).

Discussion Topics: A question about segregating downtime and idle time into "good" and "bad" for PEE calculations; a request for opinions on how to model single wafer lots; a question about the details of generating characteristic curves; a request for foundry performance data benchmarks; and several detailed responses to the Volume 3, Number 3 hot lot article. (A SEMATECH paper by Kristin Rust and a Ph.D. dissertation by Stuart Carr that each concern hot lots can be requested from Jennifer.Robinson.)

Volume 3, Number 4

Number of Subscribers: 810
Main Topic: Cycle Time and the Core Conflict. This guest article by Dan Siems (Philips) represents Dan's thoughts on a core conflict that often exists in managing wafer fabs - trying to get lots out quickly, but having to frequently stop the lots for quality checks. Dan proposes the elements that he believes must exist to weaken this conflict, and maintain good cycle times over the long term.

Discussion Topics: Several detailed responses to tool dedication article; a recommendation for finding fab benchmark data; a request for information concerning automated material handling vs. lot dispatching; and a request for case studies concerning lot size change.

Volume 3, Number 5

Number of Subscribers: 872
Main Topic: The Bottom-Line Benefits of Cycle Time Management. In this new article, we provide a more comprehensive framework for linking cycle time management to financial returns. An Excel spreadsheet tool for what-if analysis is provided on FabTime's website at

www.FabTime.com/bottomline.htm. Under the assumptions in our default example, the total annual benefit of cycle time improvement could be more than half a million dollars.

Discussion Topics: A request for information on wafer start methodologies; a request for research on staffing models; a request for literature on ramp models; a question about how companies treat cost of scrap; and a question about calculating mean time between assists.

Volume 3, Number 6

Number of Subscribers: 921
Main Topic: Cycle Time Management Styles. In this month's main article, we propose three distinct cycle time management styles, and describe how each can be used to improve cycle time. We have named these three styles: The Traffic Cop; The Shepherd; and The Relay Coach. These are management styles we have observed in real fabs, although the names and descriptions are our own.

Discussion Topics: Responses on wafer starts methodologies, treating scrap in product costing, and ramp planning; a reference to a conference presentation about operator modeling (the presentation, by H-N Chen and R. Dabbas can be requested from Jennifer.Robinson@FabTime.com); a question about how much is too much in reference to operator cross-training; a question about how people handle recipe management; and a request for benchmarks for gallium arsenside fab cycle times.

FabTime Recommendations

Introduction

In keeping with this month's summary theme, this section highlights several resources available from FabTime's website. Most of these resources can be found either under Tech Info or under Library on FabTime's website (www.FabTime.com).

Cycle Time Management Course

FabTime's Cycle Time Management Course is a two-day course designed to provide production personnel with a more in-depth understanding of the issues that cause cycle time problems in a fab, and to suggest several possible approaches for improving cycle times. The material in the course is drawn from, and expands upon, ideas described in the FabTime Cycle Time Management Newsletter and on FabTime's website. The course was developed for managers and supervisors. (A separate course for industrial engineers, focusing more on the technical details, may be available in the future.) Course topics include:

- Cycle time management styles
- Cycle time intuition
- Metrics and goals

Hands-on exercises are used throughout the course. Please use the form at http://www.fabtime.com/ctmcourse.htm to

request information about delivery of this course at your site. (The course itself is not available online - only a description of the course, and a form for requesting more information.)

Internet Demos of FabTime's Cycle Time Management Software

FabTime's primary goal is to provide wafer fab cycle time management software. Our FabTime software is designed to give wafer fab management personnel the information that they need, in real-time, to run their fabs effectively. FabTime extracts lot move and equipment state transaction data from the fab manufacturing execution system (MES) in near-real time (about every five minutes), and processes this data into a database. Users then access the data via a web browser from anywhere within the corporate Intranet. The software includes a pre-defined set of fab performance charts that we have found to be useful in managing and improving cycle times. Most of the charts display performance relative to factory-specified goals. The software also includes a system for defining real-time alerts based on current fab conditions. To request an Internet demo of the software, please visit www.FabTime.com/software.htm.

Cycle Time Tutorial

Cycle time in a factory is directly related to the amount of product in the factory (WIP), the number of hours of production time available on each machine (capacity), and the amount of variability in the factory. These relationships can be proven mathematically, and generally agree with the intuition of factory managers. Understanding how the relationships work is the first step to reducing cycle times. This tutorial includes definitions, followed by sections on:

- Cycle Time and WIP
- Cycle Time and Capacity
- Cycle Time and Variability
- Cycle Time and Batching
- The P-K Formula

The FabTime wafer fab cycle time tutorial can be found at http://www.fabtime.com/tutorial.htm.

Cycle Time Estimation Formulas

For manufacturing systems, queueing formulas can be used to estimate system performance measures such as average cycle time and throughput. For a full-scale wafer fab, these formulas usually become prohibitively complex. Accurate closed form solutions are not readily available -- at least not solutions that contain sufficient detail to match actual cycle times in the fab. As a result, most practitioners turn to simulation for estimating cycle times.

Queueing models can be very useful, however, for validating the behavior of individual workstations and workcells. For our customers' convenience, we have collected a series of relevant queueing formulas. Most of these formulas have also been published in Chance (1999). For more information, we recommend any good queueing textbook. Examples include Gross and Harris' Fundamentals of Queueing Theory or Asmussen's Applied Probability and Queues, both published by John Wiley & Sons. FabTime's Cycle Time Estimation formula repository can be found at www.fabtime.com/formula.htm.

FabTime Papers

FabTime's website includes a bibliography of twenty-six FabTime-related papers. Most of these papers were co-written by FabTime's founders - a few describe studies in which we were directly involved, without being authors. Twenty of the papers can currently be requested from FabTime's website in PDF format, using the form at www.fabtime.com/request.htm

Cycle Time Bibliography

In this cycle time bibliography (www.fabtime.com/CTBiblio.htm), we have collected a list of nearly 100 articles related to wafer fab cycle time. Some are application papers, while others are more theoretical, but they all include cycle time as a performance metric. We welcome suggestions for additional papers that fit with this focus. Please note that we are not able to provide copies of most of these papers (only those included on FabTime's paper request form, described above). You can download recent papers from the Winter Simulation Conference at no charge from the INFORMS College of Simulation website (www.informs-cs.org/wscpapers.html). If you are an INFORMS member, you may be able to download papers from INFORMS PubsOnline (www.informs.org/Pubs/). Alternatively, a great variety of papers can be downloaded for a fee from Infotrieve (www4.infotrieve.com).

Industry Conference Directory

There are many semiconductor industry conferences and trade shows every year. We believe that the conferences listed in FabTime's conference directory will be of particular interest to people working on manufacturing productivity for wafer fabs. This list is not intended to include all conferences available to the industry. Instead, it represents a summary of the conferences that we have found particularly relevant to manufacturing, with dates and meeting locations for 2002. The list is organized by date. The conference directory is located at www.fabtime.com/confs.htm.

FabTime Book Reviews

FabTime's website includes reviews of twenty books that we believe our customers will find useful and/or interesting. You can find a listing of the books reviewed at http://www.fabtime.com/books.htm.

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eSilicon Corporation (1)
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FabOptima GmbH (1)
FabTime (3)
Fairchild Imaging (1)
Fairchild Semiconductor (3)
Fort Wayne Wire Die (1)
Fraunhofer (2)
Front Line Performance (1)
Gebze Institute of Technology (1)
Genmark Automation (1)
Georgia Tech (1)
Gintic Institute of Mfg. Technology (1)
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Intersil (3)
Interstar Technology (1)
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SAMES (1)
Samsung (14)
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Unlisted Companies (9)

Consultants:
Carrie Beam
Vinay Binjrajka (PWC)
Tom Blount
Javier Bonal
Steven Brown
Stuart Carr
Alison Cohen
Paul Czarnocki
Scott Erjavic
Greg Fernandez
Ted Forsman
Navi Grewal
Cory Hanosh
Norbie Lavigne
Bill Parr
Nagaraja Jagannadha Rao
Michael Ray
Lyle Rusanowski
Mark Spearman (Factory Physics, Inc.)
Dan Theodore
Craig Volonoski
Henry Watts (CAMDesigns)

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