FabTime Cycle Time Management Newsletter

Volume 7, No. 9 November 2006

Information

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

Publisher: FabTime Inc. FabTime sells cycle time management software for wafer fab managers. New features in the software this month include tool qualification charts, hold time charts, and improved data archiving functionality.

Editor: Jennifer Robinson

Contributors: Douwe van Engen (NXP Semiconductors)

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Welcome

Welcome to Volume 7, Number 9 of the FabTime Cycle Time Management Newsletter! It's starting to feel like fall here in Northern California, and I know that some of you have already experienced major snowstorms (hello, Colorado Springs!). It's a good time to curl up and read the FabTime newsletter.

In this issue we have a FabTime-related announcement, complete with a glowing endorsement from one of our newer customers. We also have one last conference announcement for the year. Our software user tip of the month concerns hiding chart legends on your FabTime home page. We have one subscriber response to last month's article about lot release policies. We're hoping that subscriber discussion levels will ramp back up in the future.

In our main article this month was discuss seven things that we believe people need to understand in order to improve wafer fab cycle times. We focus on high-level items, areas through which fab management can have a significant influence. These include utilization, tool redundancy, equipment downtime, product mix, staffing levels, access to performance data, and selection of metrics. There are many other factors that influence cycle time in wafer fabs, too, of course (batching, setups, hot lots, and holds, just to name a few). But we think that the areas highlighted in this article are worthy of your time and attention. We welcome your feedback.

Thanks for reading!—Jennifer

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Community News/Announcements

FabTime Receives Purchase Order from 11th Software Site, Completes Installation at FlipChip International

San Jose, CA – November 6, 2006 – FabTime is pleased to announce that over the past year we have increased the number of our software customer sites from six to eleven. We are currently supporting wafer fabs in the US, the UK, Japan, and Australia. Not all of the fabs have yet given us permission to list them publicly. However, we are pleased to be working with Headway Technologies (Milpitas, CA), Spansion (Austin, TX), TDK (Nagano, Japan), International Rectifier (Wales, UK), FlipChip International (Phoenix, AZ), and several others. We have also recently completed our software installation at FlipChip.

"We're very happy about our decision to work with FabTime," said Sheila Mosher, VP of Information Technology for FlipChip International. "The installation went smoothly and quickly. We are especially pleased with FabTime's high level of responsiveness to our needs as a customer, which helps us to better support our own customers. We have found the FabTime team to be extremely professional, courteous and skilled. They have been very effective in not only installing and maintaining the software, but in applying their software to address our particular business needs. Their expertise in the field has obviously been instrumental in creating a very useful and well-constructed product."

"We've found FlipChip, as well as our other new customers, to be a joy to work with," said Jennifer Robinson, FabTime's Chief Operating Officer. "FlipChip's specific business needs have helped us to make the software more flexible. We are also grateful to our longer-time customers, whose many excellent suggestions have helped us to make the software what it is today. We look forward to learning what innovations the new customers will inspire."

For more information about FabTime's software, or to request a demonstration, see www.FabTime.com/software.shtml.

About FabTime: FabTime Inc. is the first company to focus solely on the challenging problem of cycle time management for semiconductor wafer fabrication facilities. We believe that the cycle time problems faced by wafer fabs are uniquely difficult and that our customers will be well-served by a company that declares its focus and sticks to it. To that end, we offer cycle time management software and training, as well as a free email newsletter dedicated to discussing best practices for fab cycle time improvement. FabTime's website is located at www.FabTime.com.

Semiconductor Manufacturing Track at Upcoming Winter Simulation Conference

The 2006 Winter Simulation Conference (WSC) will be held December 3rd to 6th in Monterey, California. While FabTime will unfortunately not be attending this conference, we wanted to bring it to your attention, because there is a semiconductor manufacturing focused track with thirteen industry-focused papers. Sessions include:

- Factory Simulation
- Performance Analysis in Semiconductor Manufacturing
- Dispatching and Scheduling Approaches
- Planning Approaches in Semiconductor Manufacturing
- Modeling Approaches for Wafer Fabs

For more information, visit www.wintersim.org/.

FabTime welcomes the opportunity to publish community announcements. Send them to newsletter@FabTime.com.

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FabTime User Tip of the Month

Hide Legends on Home Page Charts

If you keep relatively small-sized charts on your home page tabs, you may have noticed that the chart legends (the key to colors, etc) take up quite a bit of valuable home page space. You probably don't need to see these chart legends anyway, for charts on your home page, because once you have looked at a chart more than once or twice, you usually know what the colors mean anyway. By making one settings change on your home page, you can turn off the display of the legends for all of your home page tabs. Simply find the drop down list in the lower left corner of your screen labeled "Legends:" and select "Hide" from the drop-down list. Then (as button below where you are on the page. FabTime will re-build all of your home page charts, but will not display the chart legends. If you haven't tried this before, you'll be amazed at how much this increases the amount of data that you can see on page. You may be able to make your charts smaller (using the "Width" and "Height" controls, and to increase the number of columns per row. This change was made at the request of a long-time FabTime user.

If you have any questions about this feature (or any other software-related issues), just use the Feedback form in the software.

Subscriber Discussion Forum

Issue 7.08: Lot Release Policy

Douwe van Engen (NXP Semiconductors) wrote in response to last month's subscriber discussion question about how often fabs release lots. He said: "In our 4 inch fab we now start all of our lots (on average fifteen 50 wafer lots) at once. The reason is that if we do it this way the steppers have enough load to perform well. Should they over-perform we have the possibility of starting extra lots at the end of the week. In practice we experience during the first days of the week an (expected) overload on some dry etch tools (this is the process step immediately following the stepper). However, we don't worry about this, because those lots are processed in a steady stream. In the past we started lots daily, but the current system offers us more flexibility. We believe that it has increased our capacity a little bit. Of course you are right, but it seems in our case a little better to do it another way (perhaps because our real bottleneck in more at the end of the process route).

FabTime response: We agree with Douwe that there are specific cases in which spreading out lot releases is not helpful for a particular fab. As we cannot address our articles to every possible fab situation, our conclusions are necessarily a bit broad. We appreciate Douwe taking the time to share his specific case.

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7 Things You Should Know About Wafer Fab CT

Over the fourteen years that Frank and I have each been working in the semiconductor industry, we've talked with people from many different types of fabs - large and small, low-mix and high-mix, foundry and captive, etc. For years we have been asking the people we talk with what their biggest cycle time-related challenges are. We want to know what they would change if they could. What makes their jobs particularly difficult. What they consider inevitable vs. what they think could be improved. Certain themes have resounded through the years, while others seem to be ramping up in importance more recently. We've written about many of these topics in past newsletter issues.

What we've noticed is that often when we talk with people, they say something like "I wish my management understood x better" or "I wish that other people in my fab would (or would not) do y so frequently." In this article, we highlight seven critical things that people who work in fabs need to know, in order to improve cycle time. Our focus is on things that are driven by fundamental factory behavior. Some of them are obvious, others may be less well-known. Without further ado, here are seven things that you (and your management) need to know about fab cycle time. Each is discussed in more detail below.

1) You can't achieve great cycle time if you are near 100% utilization on most of your tools.

2) Sometimes it's worth buying an extra tool (not needed for capacity) to reduce cycle time.

3) You should think about evaluating equipment vendors based on the duration of time from when a tool goes down until it is back up and working, rather than purely on mean time between failures

4) The greater the process mix, the harder it is to get low, predictable cycle times.

5) Not having enough operators may be causing your fab to lose capacity on bottleneck tools.

6) Accurate and easily accessible performance data is necessary for identifying improvement opportunities.

7) You need to measure more than moves to bring down fab cycle times.

You can't achieve great cycle time if you are near 100% utilization on most of your tools

In order to achieve low, predictable cycle times, your tools must have some buffer capacity that keeps you from running close to 100% utilization. This buffer capacity protects you from variability, giving, for example, some catch-up capacity in the event of WIP bubbles. The closer you try to operate to 100% utilization on your tools, the higher the average cycle time will be. It will be especially difficult to get good on-time delivery numbers if you have high utilization on most of the tools. This is because in addition too being higher; the cycle times will be more variable. This is discussed in more detail in FabTime Newsletters 6.05 and 7.06.

Sometimes it's worth buying an extra tool (not needed for capacity) to reduce cycle time

Number of tools per tool group is a major driver of cycle time. Tool groups with only one or two tools have much higher average cycle times per visit than larger tool groups. This is because one or two of a kind toolsets are extremely vulnerable to variability (e.g. from long downtime events). Adding redundancy is a high impact way to improve cycle time, especially for tool types that are less reliable. Adding redundancy at batch tools can also be very helpful for cycle time improvement, by allowing the tools to be run with smaller average batch sizes. An example of a project to add tools for cycle

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time reduction is described in Grewal et. al., 1998 (reference below). The general issue of number of tools per tool group is discussed in FabTime Newsletter 6.05. Batch tools are discussed in Issues 2.01 and 3.08.

Corollary: Buying similar, but non-identical, tools from multiple vendors may be increasing your cycle time.

This point is closely tied to the number of tools per tool group. Buying non-identical tools from different vendors often leads to smaller toolgroups, which can drive up cycle time significantly. Tool dedication is discussed in Issue 3.03.

You should think about evaluating equipment vendors based on the duration of time from when a tool goes down until it is back up and working, rather than purely on mean time between failures

When we ask people about the biggest cycle time problem in fabs, the most common answer that we hear is downtime (or availability, or availability variability, or downtime on one-of-a-kind tools). Pretty much everyone in the industry would like to see ever-improving equipment uptime values. What is not always obvious to people, however, is how much worse lengthy downtime occurrences are than shorter events. Long downtime events, as when the fab must wait for the vendor to bring in a part from out of state, allow WIP bubbles to build up. Such WIP bubbles have a huge impact on overall fab cycle times. This suggests that fabs should be measuring equipment vendors based on the duration of downtime, in addition to the more common practice of using mean time between failures. This phenomenon also has implications for spare parts management systems, and maintenance scheduling. Equipment downtime is discussed in Issues 4.04 and 5.07, and is discussed extensively in FabTime's cycle time management class.

The greater the process mix, the harder it is to get low, predictable cycle times

Product or process mix is one of the top reasons that people give for cycle time problems in their fabs. Being high mix in terms of number of process flows leads to problems with: process time variability, setups, decisions about batch formation, other dispatching decisions, and reticle management. Being high mix in terms of having short product life cycles leads to problems with: unbalanced tool utilizations, learning curves (especially variability from yield problems), increased holds, and setting goals for new, low volume products. There are things that fabs can do to help mitigate the impact of these mix-related issues (discussed in Issue 6.01). One that holds particular promise for cycle time reduction is process simplification (whereby different products use the same recipes for similar operations).

Not having enough operators may be causing your fab to lose capacity on bottleneck tools

Any fab that is not fully automated is subject to the fact that people cannot be in more than one place at one time. This means that capacity is lost at tools every day, due to an operator not being present to load or unload a particular tool (because the operator is busy elsewhere). This is not a huge problem on non-bottleneck tools (though it may increase wait time for individual lots). However, when this occurs on bottleneck tools, the resulting capacity loss can push the tool closer to 100% utilization, and lead to significant cycle time increases. It can be shown (see Kotcher and Chance, 1999, for example) that "overstaffing" (adding more operators at key tools) may improve overall fab cycle times. The idea is to ensure that critical tools never wait for an operator. See Issues 4.06 or 7.02 for further discussion of the impact of operators on cycle time.

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Accurate and easily accessible performance data is necessary for identifying improvement opportunities

If your supervisors can't get accurate performance data about where lots are spending their time, and how tools are performing, it's very difficult to know where to make improvements. Data that can be especially illuminating for cycle time includes:

- Percentage of time that your key tools spend idle with WIP waiting (the tool is up and could be running, but no one is there to load the tool)
- Percentage of time that your key tools spend waiting to unload (the lot is finished, but no one is there to move it to the next operation)
- Average cycle time per visit (Pareto by operation or toolgroup)
- Coefficient of variation of the arrival process to key tools
- Average and variation in tool unavailable times
- OEE for bottleneck tools, in particular the reasons for capacity losses

Naturally, all of the above data is available in our software, but you can certainly obtain it directly from your own systems. The important thing is to give your managers better access to these often-hidden sources of information.

You need to measure more than moves to bring down fab cycle times

In our experience, fabs that wish to improve cycle time have moved away from just measuring moves or starts to favor metrics that encompass WIP and cycle time in some way. There are a number of choices: WIP turns, lot inventory age, per-visit cycle times through key tools, and dynamic x-factor. All of these have been discussed in past newsletter issues. The central point is that your metrics must include WIP in some way, in order to manage and improve cycle time.

Conclusions

In this article, we have discussed seven things that we believe people need to understand in order to improve wafer fab cycle times. We have kept our focus on high-level items, areas through which fab management can have a significant influence. We have focused on utilization, tool redundancy, equipment downtime, product mix, staffing levels, access to performance data, and selection of metrics. There is a great deal of synergy between these items. Downtime has a greater impact on tool groups with little redundancy, and on tools that are relatively highly utilized. Product mix changes directly affect tool utilization. Metrics are strongly influenced by the availability of accurate performance data. A fab is a complex environment, and it's important to keep the interplay between these various factors in mind. There are many other factors that influence cycle time in wafer fabs, too, of course (batching, setups, hot lots, and holds, just to name a few). But we think that the areas highlighted in this article are worthy of your time and attention.

Closing Questions for FabTime Subscribers

Do you think that the above statements are true? What would you add to the above list? (We will keep your response anonymous if you prefer.)

Further Reading

- N. S. Grewal, A. C. Bruska, T. M. Wulf, and J. K. Robinson, "Integrating Targeted Cycle-Time Reduction Into The Capital Planning Process," *Proceedings of the 1998 Winter Simulation Conference*, Washington, DC, 1005-1010, 1998. (Available for download from http://www.fabtime.com/abs_Sea98.shtml.)
- R. Kotcher and F. Chance, "Capacity Planning in the Face of Product-Mix Uncertainty," *1999 IEEE International*

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Symposium on Semiconductor Manufacturing Conference Proceedings, Santa Clara, CA, 73-76, October 11-13, 1999. (Available for download from http://www.fabtime.com/abs_ISSM99.shtml.)

- J. Robinson and F. Chance, "Cycle Time Effects of Equipment Downtime," *FabTime Newsletter*, Vol. 4, No. 4, 2003.
- J. Robinson and F. Chance, "How Much Does Tool Dedication Inflate Cycle Time," *FabTime Newsletter*, Vol. 3, No. 3, 2002.
- J. Robinson and F. Chance, "In-Depth Guide to Operators and Cycle Time," *FabTime Newsletter*, Vol. 4, No. 6, 2003
- J. Robinson and F. Chance, "Operator Variability and Cycle Time," *FabTime Newsletter*, Vol. 7, No. 2, 2006.
- J. Robinson and F. Chance, "Product Mix and Cycle Time," *FabTime Newsletter*, Vol. 6, No. 1, 2005.
- J. Robinson and F. Chance, "Quantifying the Effect of Tool Downtime," *FabTime Newsletter*, Vol. 5, No. 7, 2004.
- J. Robinson and F. Chance, "Resolving the Cycle Time vs. Utilization Conflict," *FabTime Newsletter*, Vol. 7, No. 6, 2006.
- J. Robinson and F. Chance, "The Three Fundamental Drivers of Fab Cycle Time," *FabTime Newsletter*, Vol. 6, No. 5, 2005.

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Subscriber List

Total number of subscribers: 2305, from 459 companies and universities. 22 consultants.

Top 10 subscribing companies:

- Intel Corporation (150)
- Analog Devices (75)
- Atmel (74)
- Micron Technology (71)
- Infineon Technologies (63)
- Cypress Semiconductor (60)
- STMicroelectronics (59)
- Freescale Semiconductor (58)
- Texas Instruments (53)
- Philips (50)

Top 3 subscribing universities:

- Virginia Tech (11)
- Arizona State University (7)
- Ben Gurion Univ. of the Negev (7)

New companies and universities this month:

- Madras Semiconductor
- NXP Semiconductors (Philips)
- VIASYS Healthcare Inc.

Note: Inclusion in the subscriber profile for this newsletter indicates an interest, on the part of individual subscribers, in cycle time management. It does not imply any endorsement of FabTime or its products by any individual or his or her company.

There is no charge to subscribe and receive the current issue of the newsletter each month. Past issues of the newsletter are currently only available to customers of FabTime's web-based digital dashboard software or cycle time management course.

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FabTime® Cycle Time Management Training

"It was helpful to see best-in-class methods for wafer fab cycle time management. Discussing these matters in-depth with you was quite valuable, as we could ask questions specific to our fab and processes."

Shinya Morishita
Manager, Wafer Engineering
TDK Corporation

Course Code: FT105

This course provides production personnel with the tools needed to manage cycle times. It covers:

- Cycle time relationships
- Metrics and goals
- Cycle time intuition

Price

$5950 plus travel expenses. On-site delivery for up to 15 participants, each additional participant $295. Discounts available for multiple sessions.

Interested?

Contact FabTime for a quote.

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Web: www.FabTime.com

Do you make the best possible decisions?

- Do your supervisors possess good cycle time intuition?
- Are you using metrics that identify cycle time problems early?
- Can you make operational changes to improve cycle time?

FabTime's Cycle Time Management Training is a one-day course designed to provide production personnel with an in-depth understanding of the issues that cause cycle time problems in a fab, and to suggest approaches for improving cycle times. A two-day version is also available upon request.

Prerequisites

Basic Excel skills for samples and exercises.

Who Can Benefit

This course is designed for production personnel such as production managers, module managers, shift supervisors, hot lot coordinators, and production control.

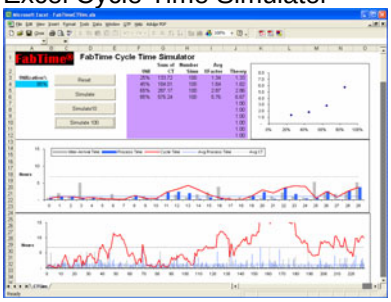
Skills Gained

Upon completion of this course, you will be able to:

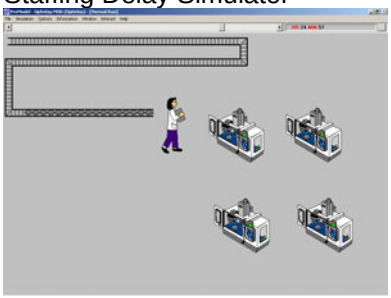
- Identify appropriate cycle time management styles.
- Teach others about utilization and cycle time relationships.
- Define and calculate relevant metrics for cycle time.
- Teach others about Little's law and variability.
- Quantify the impact of single-path tools and hot lots.
- Apply cycle time intuition to operational decisions.

Sample Course Tools

Excel Cycle Time Simulator



Staffing Delay Simulator



Additional Half-Day Modules

- Executive Management Session.
- Site-Specific Metrics Review.
- Capacity Planning Review and Benchmark.

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