FabTime Cycle Time Management Newsletter

Volume 8, No. 1 January 2007

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 this version include a shipments early/late histogram chart, as well as on time delivery performance information on other existing shipments charts.

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Welcome

Welcome to Volume 8, Number 1 of the FabTime Cycle Time Management Newsletter! We hope that you all had a joyful holiday season, and we wish you a happy and productive 2007. Things are off to a busy start for FabTime. We ended 2006 with a series of four cycle time classes at various companies in mid-December, and greeted the first week of 2007 with a purchase order from our 12th software site. One of our goals for this year is to significantly increase the number of subscribers to this newsletter. If you enjoy this publication, please consider forwarding it to any colleagues who you think would find it useful. Thanks!

We have a short, but action-packed newsletter for you this month. Our software tip of the month is about how to cross-slice move and WIP data in a single chart data table (to look at, for example, WIP by priority within each area on the same page). We have several subscriber discussion topics. Anonymous subscribers wrote in with new questions concerning justifying additional capacity to management, and identifying and analyzing your own fab's top three cycle time problems. We also have a response from David Jimenez of WWK to a question posed last month about labor modeling for fabs.

In our main article this month we address a problem that we've heard mentioned at several companies. The issue is that new, low volume products often incur long cycle times, because the traditional performance measures in fabs allow them to slip through the cracks. We present a series of recommendations for mitigating this effect. We welcome your feedback.

Thanks for reading!—Jennifer

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Community News/Announcements

FabTime Receives Purchase Order from 12th Customer Site

FabTime is pleased to announce the receipt of a purchase order from the 12th customer site for our web-based cycle time management software. The software helps fabs to reduce cycle times, and also saves fab management considerable time in data collection and reporting. Current customers include Headway Technologies (Milpitas, CA), Spansion (Austin, TX), TDK (Nagano, Japan), International Rectifier (Newport, Wales), FlipChip International (Phoenix, AZ), Cypress Semiconductor (Minneapolis, MN), and several others. Our first customer, Headway, has been using the software for more than six years. Several of our customers are also using (or installing) FabTime's optional lot dispatching and capacity planning modules. All of our customers have contributed suggestions that keep the software ever-improving, and we are very grateful to be working with them. We look forward to another great year! For information about our software, see www.FabTime.com/newsletter.shtml, or email sales@FabTime.com.

We also completed 10 sessions of our cycle time management course, of varying lengths and focus levels, in 2006. This course is designed to provide semiconductor wafer fab production personnel with essential skills and techniques needed to manage cycle times. The course material is similar in content to the material in these newsletters, with the addition of spreadsheet-based and pen-and-pencil-based exercises and interactive quizzes, and is independent of our software. If you would like more information about scheduling a FabTime course at your site, please visit www.FabTime.com/ctmcourse.shtml.

FabTime welcomes the opportunity to publish community announcements. Send them to Jennifer.Robinson-@FabTime.com.

FabTime User Tip of the Month

Cross-Slice Moves and WIP Data on the New Line Summary Chart

Have you ever wanted to look at moves and WIP data sliced by more than one variable on the same data table? For example, to look at the moves by operation, and then look at the WIP by product within each of the operations? Or to look at the WIP by priority within each area? You can, of course, do this for a single area by drilling down to a second chart. However, you can now do this on one page using the cross-slice functionality on the new Line Summary chart.

The Line Summary chart (available as a separate chart group, located just below the Moves charts), is similar to the Moves Pareto chart, except that the data table is expanded to include week-to-date and month-to-date moves. The data table also

contains a secondary slice (called a "cross") of WIP within each slice-by object. The Line Summary chart defaults to show Moves by area, crossed by area (yes, it is redundant, but area is the default drop-down for both slice-by and cross-by variables). To change the table to see the moves by area and within each area, WIP sliced by priority, for example, scroll down to the bottom of the big set of filters to the left of the chart, and select the "Cross" drop-down. Select "PriorityClass" from the list, and then press the "Go" button immediately beneath the Cross dropdown. Your change will be reflected in the right-hand columns of the data table (one column for each priority class in your fab).

You'll also notice in the Line Summary chart data table a colored bar set within the cells of the table, displaying performance to goal for each primary slice-by object (e.g. for each area in the above example). If you like this visual component of the data table, please let us know. The Line Summary chart is available in patch84, now available from FabTime. Your local system administrator can tell you if this patch has been applied yet for your site.

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

Justifying Additional Capacity to Management

An anonymous subscriber wrote: "I am working in a semiconductor backend assembly house (packaging). My management sets goals for cycle time like four days assembly cycle at 95th percentile. This means the cycle time cannot exceed four days for 95 percent of the assembly lot population. Our assembly capacity is calculated based on bottleneck equipment capacity. The capacity calculation for the equipment is the equipment uph x the operating hours per week. The disconnect here is that the capacity calculation does not have any time element factor to achieve a desired assembly cycle time goal. It is difficult to justify any additional capacity, and to know how much additional capacity we need to achieve the cycle time required. How do you approach this issue?

The issue here is how do I work out my capacity such that there is a relationship between the cycle time required and the capacity that needs to be installed? We have management here that has no fundamental understanding about factory physics and setting goal like five days assembly cycle time at 99th percentile. This means the factory needs to run perfectly to achieve the target. The goal has changed over the years, but apart from that nothing has changed because the fundamental underlying problem has not been addressed. We never meet the goal that

management sets except when business is slow."

FabTime Response: The best way that we know of to address this issue is to educate management about the relationship between cycle time and utilization (as we have discussed many times in the newsletter, e.g. issue 6.05). This is a mathematical relationship, and the higher the utilization, the higher the cycle time will be. Some sites use simulation models of the factory to make this point, others use queueing models like the one available for download here www.fabtime.com/bottomline.shtml to look at individual toolsets. The only way to improve cycle time at an already high utilization is to reduce variability.

We are opening up this topic to other subscribers, to see if anyone else has wisdom to share.

Staffing Models

David Jimenez wrote in response to last month's question about staffing models to tell us about a new WWK project focused on detailed operator modeling in WWK's Factory Explorer capacity analysis and simulation product. The new operator model is currently in beta at three WWK customer sites. FabTime's Frank Chance was the original developer of Factory Explorer, now owned by WWK, and so we have a particular interest in how WWK is handling this more detailed modeling of operator behavior. This text is extracted from a document written for WWK by Professor Scott Mason of the University of Arkansas.

"People are not homogenous. They differ in skills, motivation, and training. In order to model this reality, we propose the concept of each operator/operator group having some capability. Capability describes both 1) which tools/toolgroups each operator/operator group can/is trained to work on and 2) their respective degrees of skill/proficiency in working with each tool/toolgroup. We propose to add a worksheet in FX called Operator Capability. For each operator group, this sheet will specify which toolgroups the associated operator group is capable of working on.

Users will also specify a "skill factor" field to input the skill factor for a given operator group on a given toolgroup. The baseline "skill factor" for an operator group is 0. A 0 indicates that the operator group works at the mean productivity level for the toolgroup. The skill factor works intuitively based on a "higher is better" performance metric, and is expressed on a percentage basis. For example, a skill factor greater (less) than 0 indicates the operator group can perform tasks (e.g., load and unload) on the corresponding toolgroup at a rate higher (lower) than the average. The skill factor provides a means of specifying an intuitive percentage speed increase or decrease for the operator group. The operator model will also include detailed specification of schedules for operators, as well as the ability to model overtime for operators."

Issue 7.10: In-Depth Guide to Cycle Time Management Resources

In response to last month's main article, in which we discussed resources for fab cycle time improvement, an anonymous subscriber suggested a topic for future newsletter consideration. "In response to "Closing Questions for FabTime Subscribers: What topics would you like to see in future issues of the newsletter? What industry resources for understanding and improving cycle time have we missed that you think should be included? We will include a follow-up in next month's subscriber discussion forum." I would like to seek advice or hear more from others about the topic of "How to analyze and identify your own fab's top 3 cycle time problems". I would also like to know more about how to quantify the cycle time improvement that can be expected if the problem is solved.

As you may know, the first step of problem solving is to identify the problem. Everybody knows how to solve the problem once the root cause is identified. However, the root cause of cycle time problems is probably a complicated fish bone diagram. For example, 100% tool utilization, lack of operators, long hold times, long downtime events, too many out of control processes, slow escalation, too many product mix changes, etc., etc.

But "what are the major or top 3 problems that we can focus on immediately? Once we have solved them, can we see a significant cycle time improvement immediately?" is a common question among the engineers who need FOCUS. "We did a lot of improvement on the items that you mentioned. Why have we seen no cycle time improvement yet? How can we quantify the cycle time improvement? Are we improving the wrong items?" are another set of frequent questions among engineers who need "RESULTS". Thank you for your sharing in advance."

FabTime Response: We think that this is an excellent topic for discussion. We would like to put this question to you, our subscribers, to see what your experience and insight is in this area. We'll compile results and draw conclusions accordingly. Thanks for your help!

Highlighting Cycle Time Problems for New Products

We live in an era of product proliferation, and short product life cycles. We often work with customers who are introducing new products, often radically different new products, within an existing fab. These new products typically start out in low volumes, and may or may not ramp up over time. In some cases, the new products represent the future of a factory (for example, a fab switching over from producing microprocessors to producing flash memory). These new, low volume products, however important in the long term, can sometimes get lost in the "noise" of the fab. We wrote about product mix back in Issue 6.01, and it has been climbing ever since on our list of top cycle time problems in wafer fabs. We would like to explore the specific issue of cycle time problems for new products here.

Background

When new, low volume products require a longer process time than existing products at key toolgroups, they will often get moved to the side. This is particularly true for fabs that focus on wafer moves as a primary metric. Human behavior says that

if the new products take longer, and the old products allow for a higher UPH rate, the old products will be the ones run first. This can lead to long queue times for the new, low volume products, even though the fab as a whole appears to be running smoothly. New product or customer qualification lots may also, due to their low volume, require extra process checks and paperwork, to minimize the chance of a wafer being scrapped – again this means more time required to run fewer wafers, and thus an incentive to put these lots aside.

This type of behavior is also often seen at batch tools, where there is a disincentive to run a smaller batch of the low volume product. Given a full batch of a high volume product A, and a partial batch of low volume product B, the clear incentive lies with product A, regardless of how long the lots of product B have been waiting. Methods for forcing the running of the B lots at some point may be necessary. Tools requiring significant setups experience similar issues.

If the fab is tracking total moves, the lack of moves on the new products certainly won't impact total moves. In fact, putting the new lots aside will likely help increase total moves, as it allows the fab to keep running the fastest UPH wafers. In terms of total WIP, the volume of new product wafers is likely to be quite small, and thus will not appear as a significant element of overall fab WIP until much time has passed.

Recommendations

Here are some recommendations for highlighting new, low volume products, and keeping them moving smoothly through the fab.

- Track moves and WIP and WIP turns separately for new products, with separate goals. Due to the low volumes for new products, look across the entire fab, not in specific areas, where the low-volume product WIP is likely to be extremely variable. This is particularly true for WIP turns, which are unlikely to be useful except at the fab level. Here WIP turns are defined as moves divided by WIP at the start of the shift.

- Use Dynamic X-Factor for the new products to highlight the impact of the above behavior on the lots' cycle time. Dynamic X-Factor is total WIP in the fab, divided by WIP currently running on tools (as discussed in Issues 4.08 and 5.03). Dynamic X-Factor for a single product is simply the total WIP in the fab of that product type, divided by the WIP currently running on tools for the product type. Dynamic X-Factor is an early indicator of overall cycle time X-Factor. So, for example, if you calculate Dynamic X-Factor for a product, and the result is 10, this means that for every 10 lots of this product type in the fab, only one is in process at the moment. If the Dynamic X-Factor for the product is consistently observed to be 10, lots of this product type can be expected to have overall cycle times of roughly 10 times the theoretical cycle time. In practice, the Dynamic X-Factor for low volume products will likely be quite variable from hour to hour, and may require some statistical smoothly to draw conclusions about expected cycle time. However, even without such analysis, you'll be able to quickly observe cases where most of the lots of the low volume product are sitting in queue.

- Track inventory age at key tools across all products. Inventory age is the time that each lot has been at its current operation (usually measured as the time since move out from the previous operation). Inventory age can be summed or averaged across all of the WIP in queue at a toolgroup. Measurement of inventory age across all products at each toolgroup should show increased inventory age at tools where the new products are de-prioritized. Inventory age will increase even when WIP is not growing. If

operators are consistently moving the higher volume products, but leaving the new product lots sitting to the side, WIP will be relatively constant but inventory age will creep up over time.

- Report static lots and/or "worst wait time" lots. Related to tracking inventory age, many fabs have a maximum acceptable inventory age (fab-wide or toolgroup-specific), and flag any lot which has a time in queue exceeding the cutoff time. For fabs that operate on a mainly first-in-first-out basis, this is a nice way to ensure that critical lots don't slip through the cracks. Another fab that we once worked with pioneered the notion of reporting "worst wait time." This is reported by toolgroup at the start of each shift, and is the inventory age of the lot that has been in queue for the toolgroup the longest. Because there is a distribution of queue times at any toolgroup, working to reduce the "worst wait time" will tend to pull in the entire distribution. In general, flagging individual lots that have been in queue for a long time will tend to keep lots from slipping through the cracks, whether they are low volume or high volume lots. The cutoff for "waiting too long" might also vary with the type of tool. For example, lots may be allowed to wait longer at batch tools, or tools with setups. However, it's especially important at these types of tools to have some sort of threshold that says when enough waiting is enough and forces a batch or setup.

- Set up lot alerts. Another variation to using lot inventory age, but more proactive, is to establish a specific cut-off time for the low volume lots, either across the fab as a whole, or just at specific tools. You can then set up alerts so that someone is notified (by email, page, etc) any time a low volume lot has been waiting for longer than the cut-off time.

- Change lot priorities. Another possibility for ensuring that critical low volume lots are not lost in the noise of the fab is to give them a higher priority than the other lots. As long as your dispatch rules place emphasis on lot priority, this should certainly keep the low volume lots moving. Of course there are trade-offs here. This type of approach must be considered carefully, because we don't want to have too many hot lots in the fab, either. Making the lots a higher priority could result in too many small batches, or too many setups. This option only makes sense when the low volume lots truly are critical.

Conclusions

As the end user markets continue to drive new products, the presence of new, low volume products within production wafer fabs is going to be inescapable. Often these new, low volume products are particularly important to get out quickly, for market share reasons. The problem is that the standard metrics in use in many fabs tend to disincentivize people from running new and difficult low volume lots. In this article, we have made a series of recommendations for mitigating this effect. We hope that some of them are applicable and helpful in your fab. We welcome your feedback.

Closing Questions for FabTime Subscribers

How do you keep your low volume products from getting lost in the "noise" of the fab?

Subscriber List

Total number of subscribers: 2363, from 460 companies and universities. 22 consultants.

Top 20 subscribing companies:

- Intel Corporation (154)
- Micron Technology, Inc. (79)
- Analog Devices (75)
- ATMEL (73)
- Infineon Technologies (63)
- Cypress Semiconductor (59)
- Freescale Semiconductor (59)
- STMicroelectronics (57)
- Texas Instruments (55)
- NXP Semiconductors (50)
- Chartered Semiconductor Mfg (48)
- ON Semiconductor (47)
- TECH Semiconductor Singapore (47)
- X-FAB Inc. (46)
- IBM (34)
- Seagate Technology (33)
- Maxim Semiconductor (32)
- BAE Systems (31)
- Honeywell (29)
- FlipChip International (28)
- Spansion (28)

Top 5 subscribing universities:

- Virginia Tech (11)
- Arizona State University (7)
- Ben Gurion Univ. of the Negev (7)
- Nanyang Technological University (5)
- University of Texas (5)

New companies and universities this month:

- Telefilter GmbH
- University of Pennsylvania
- Vectron Frequency Devices Swiss
- Volvo

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 Software

"Instead of spending time preparing reports, shift facilitators can get the data they need quickly from FabTime, and then spend their time making real improvements."
Mike Hillis
Cycle Time and Line Yield Improvement Manager
AMD Fab 25

FabTime Installation

One fixed price includes

- Site license, unlimited users.
- Implementation & training.
- Software maintenance.

Pilot Project – Analyze your data with FabTime

For $7500, FabTime will

- Identify key contributors.
- Benchmark common metrics.
- Review results at your site.

Interested?

Contact FabTime for technical details or a pilot project quote.

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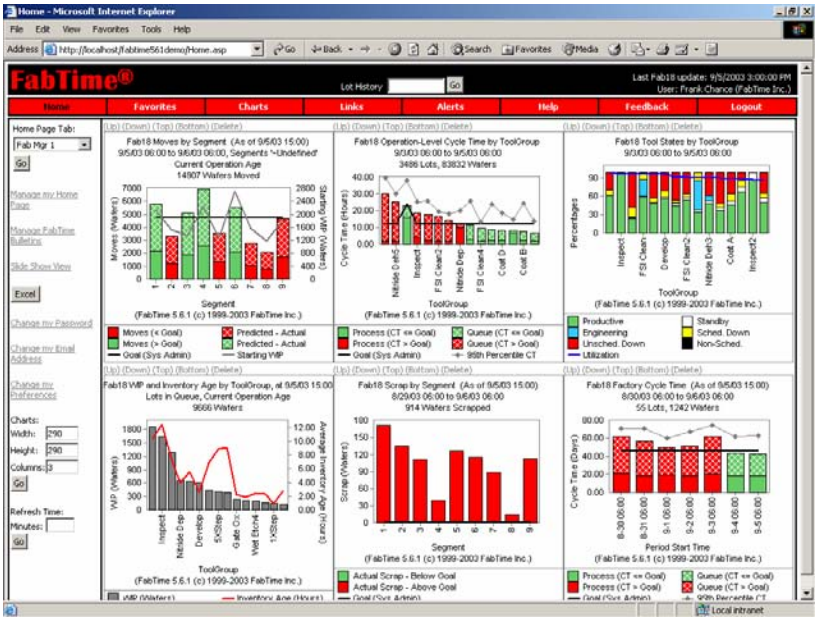
Do you have the best possible information?

- Are your supervisors swamped with daily reports, but lacking real-time information?
- Is it difficult to link equipment performance to cycle time?
- Does each new cycle time analysis require IT resources?

FabTime is a digital dashboard for your fab. In real-time, it provides a comprehensive view of fab performance data – everything you need for proactive management of cycle time. FabTime is designed for hands-on use by managers and supervisors, unlike traditional reporting tools, which were designed for programmers. FabTime also now includes **lot dispatching** (via dispatch rules) and static **capacity planning**.

A Web-Based Digital Dashboard

"I use FabTime every day, and so do the supervisors who report to me. The data that I need is right on my home page where I need it when I come in every morning."
Jim Wright
Production Manager
Headway Technologies



FabTime Benefits

- Cut production cycle times by 10%, hot lot cycle times by 20%.
- Focus improvement efforts on the tools that inflate cycle time.
- Improve supervisor productivity – cut reporting time by 50%.