FabTime Cycle Time Management Newsletter

Volume 10, No. 8 November 2009

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 ability to export hidden columns and rows of data tables to Excel.

Editor: Jennifer Robinson

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Welcome

Welcome to Volume 10, Number 8 of the FabTime Cycle Time Management Newsletter! In this issue, we have only one brief community announcement, about FabTime's sponsorship of the coming Fab Owners Association golf tournament. Our software user tip of the month is about our new custom chart feature. We have subscriber discussion concerning dispatch execution / dispatch compliance, and target percentages of hot lots in the fab.

In our main article this month, we revisit and refresh our very first newsletter topic. The Hawthorne Effect, based on studies that took place at the Western Electric plant in Hawthorne, Illinois, suggests that worker productivity improves as a result of workers having their performance monitored, and then working harder. Although the Hawthorne Effect was formulated in the early 1920's, it remains of interest today. There continues to be debate over whether or not the Hawthorne Effect is "true". That is, people question whether in fact the productivity improvements recorded could be rightly attributed to the study at all. FabTime's feeling is that the general conclusion, that people will work harder if management pays attention to their outcomes, is intuitive and valid. For those who believe this, too, we've included some recommendations for leveraging the Hawthorne Effect in wafer fabs. We welcome your feedback.

Thanks for reading!—Jennifer

FabTime

Tel: (408) 549-9932
Fax: (408) 549-9941
www.FabTime.com
Sales@FabTime.com

Community News/Announcements

FabTime Sponsoring FOA Golf Tournament in Austin, TX

We're pleased to announce that FabTime will be one of the corporate sponsors for the Fab Owners Association Golf Tournament, to be held in conjunction with the FOA meeting later this month in Austin, Texas. The FOA meeting will be held at SVTC in Austin on November 12th. The tournament will be on November 11 at the Jimmy Clay golf course. More details are available at the FOA website: http://www.waferfabs.org.

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

FabTime User Tip of the Month

Create Customized Versions of FabTime Charts

A new capability in FabTime is the ability for end users to create customized versions of FabTime charts. For example, you could:

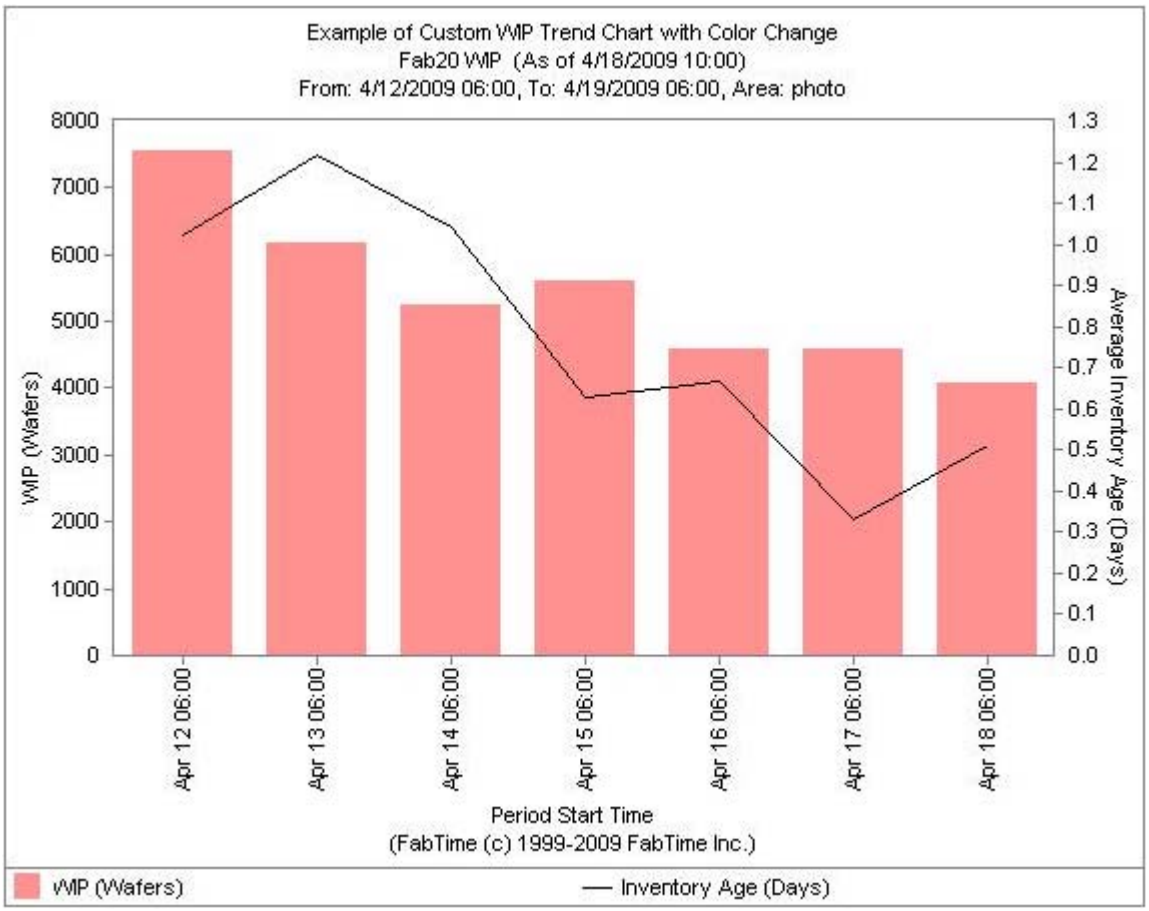
- Remove the utilization lines from the Tool State Trend and Pareto charts.
- Change the color of the bars on the WIP Lot List charts (example shown on the next page).
- Create a Hold % Trend chart that shows, at the start of each period, the ratio of lots on hold to total WIP.
- Calculate a customized yield loss metric, based on a sub-set of the scrap data in FabTime.
- etc.

Custom charts are generally created by copying an existing chart, and then modifying it using a special user interface. Access to the custom chart interface is a user-level permission, granted by your site administrator. For example, you could copy the Tool State Trend chart, and then modify column colors, or which columns are displayed in the chart and/or data table, using a form interface. When you finish a new chart, you have the option to show it so that all FabTime users may use it. Custom charts are available via a special chart category, located at the bottom of the Charts page. To see if anyone at your site has finished any custom charts, simply scroll to the bottom of the Charts page, and click "Show" next to "Custom Charts". If you do not see the "Custom Charts" category, it means that there are no finished custom charts for your site.

It's also possible to use the custom chart interface to create charts that are combinations of existing charts (as in the Hold % Trend example, which takes the ratio of two versions of the WIP Trend chart). Although you may need to ask FabTime for help with more complex chart manipulations (e.g. when we need to call more than one FabTime procedure

from the chart), the advantage of the custom chart method is that you don't need to wait until your chart is developed, tested, and added to the standard version of FabTime. Instead, FabTime can quickly create the custom chart, share it, and let you test it out, and start using it, immediately. We hope that you'll find this capability useful.

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

Dispatch Execution

A subscriber recently emailed to ask if FabTime had any advice about what constitutes good results for dispatch execution. We talked in the subscriber discussion forum in issues 10.3 to 10.5 about a particular metric for dispatch compliance that we call dispatch precision [Dispatch Precision% for a Lot = 100% * (1.0 - ((Lot's order on dispatch list) - 1)*(1/(#lots on list)))]. We also mentioned, back in Issue 10.2 that in FabTime we report, for each tool, the average location on the dispatch list of all of the lots that

were processed. For example, a result of 3 for a tool means that, on average (over the time period displayed on the chart), the operators ran the third lot from the dispatch list (instead of the top lot from the dispatch list). This data can be aggregated across toolgroups and areas, and can also be displayed for individual employees.

Although we've worked with individual customers on dispatching, we haven't seen published results on what is considered "good" dispatch performance. So we thought that we would again open up the question of dispatch execution to our subscriber base. Do you have any other metrics that you use for tracking dispatch execution? Do you look for a particular target value across the fab, in terms of compliance, or does it vary by tool? We welcome your feedback.

Hot Lot Percentage

The same subscriber asked about what is considered a reasonable percentage of hot lots in a fab. We said: "FabTime's view is that the most important thing is to keep the number of super bullet lots (where you hold tools, break setups, etc.) to a minimum. We recommend trying to keep that number to 1 or 2 in the fab at one time. Certainly no more than 5. The more of those lots you have, a) the less people will treat them as highly critical and b) the more they will interfere with each other.

With other types of priority lots, where you prioritize them ahead of other lots in your dispatch system, but don't break setups, or hold tools, etc., the situation isn't as critical. In theory, if you don't lose any capacity for these lots, all you are doing is shifting queue time away from the higher priority lots, and adding it to the queue time of the lower priority lots. Your overall average queue time doesn't change. We know of fabs that have 30%-40% "high priority lots", because they always prioritize make to order lots ahead of make to stock lots, and they accept a longer queue time for the make to stock lots.

That said, our experience in talking with people in fabs is that, regardless of the number of categories of hot lots, many fabs try to keep the total below 5%. [We used to hear 10% as a value, but in recent years, people seem to have tightened up on the number of hot lots they allow, and so they try for 5%.] But again, if you have broad classes of lots, it can be ok to have higher percentages. The important thing is not to make decisions that restrict your capacity based on these priorities (e.g. in regards to setups or batch tools)."

We talked extensively about hot lots in the newsletter several years ago (for example, see Issue 6.08), but have not revisited this topic recently. So we thought, again, that it would be worth opening up to you. What targets have you set in your fab for hand-carry lots vs. regular hot lots? Has this changed in light of the industry downturn?

If you have any input on either of these topics, or any other fab manufacturing performance topics that you would like to see addressed, please email Jennifer.Robinson@FabTime.com. Any questions or responses can be attributed to you, or can be treated as anonymous inputs.

The Hawthorne Effect Revisited

Introduction

In honor of FabTime's 10-year anniversary (and the upcoming 10-year anniversary of the launch of the newsletter), we're going to be taking a retrospective look at some of our early articles and providing updated information where it's available. In our very first newsletter issue (published in April of 2000), we included a brief "definition" section. The term that we defined was The Hawthorne Effect. We said:

"The Hawthorne Effect is named after a series of studies conducted at the Western Electric Hawthorne plant in the early 20th century. The initial aim of the studies was to understand the impact of lighting levels on worker productivity. As expected, the first studies found that as lighting levels increased, so did productivity. However, researchers did a parallel experiment in which lighting levels were decreased, and found that productivity went up as the light decreased, even when lighting was very low. After conducting a number of other related studies, the researchers concluded that productivity increases as a result of attention received by the workers. This phenomenon is believed to be due at least in part to the fact that work is a group activity, and employees strive for a sense of belonging (Hopp and Spearman, Factory Physics, 1996).

It should be noted that some questions have been raised as to the statistical validity of the original experiments. There was a New York Times article to that effect entitled "Scientific Myths that are too good to die" (12/6/98). It seems to us that the reason the Hawthorne Effect remains well-known is that it makes sense to people. If you pay attention to what workers are doing, they will work better than if they are toiling away in obscurity."

Updates and Questions

Now, nearly 10 years later, the Hawthorne Effect is still quite well-known, and still under fire. In the age of Google and Wikipedia, it's easier than ever to find information about it, though hard facts remain a bit elusive.

Stephen W. Draper, senior lecturer in the Department of Psychology at the University of Glasgow maintains a detailed notes page on the Hawthorne Effect and related phenomena (link below). Draper explains: "This began as a note on the Hawthorne effect: often mentioned, not so easy to find a simple account of it. It also now has a significant revision with reviews of related effects on experiments from expectation and the experimenters: Pygmalion, placebo, and other effects. What they have in common is that performance or other significant objective effects come from (non-objective) causes of humans simply expecting something."

There is a Hawthorne Effect Wikipedia page (link below), complete with extensive references. One of the links is to a June 2009 Economist article "Questioning the Hawthorne effect". We also found a related June 2009 New York Times blog post (link below) by Steven Levitt, author of Freakonomics, asking "Was There Really a Hawthorne Effect in the Original Hawthorne Studies?". Levitt says that he and economist John List "find that there actually wasn't a Hawthorne Effect in the original data, at least not of the sort that you read about in virtually every introductory psychology textbook, where it is claimed that the workers' output went up every time the lighting was changed, whether the change was to make the lights brighter or dimmer."

So, the Hawthorne Effect, as originally reported, may not exist. That is, the productivity measurements may not have been accurate enough to really say that productivity improved with the changes in lighting levels. And if the productivity didn't improve, it's impossible to say whether or not paying attention to people had any impact at all. However, we can still draw some conclusions from these results.

Implications of the Hawthorne Effect Controversy

It seems to us that two conclusions can be drawn from this information:

1. The continuing controversy, some 85 years after the original experiments, illustrates how difficult it is to tie productivity improvements directly to a specific change.

In any reasonably complex manufacturing environment, many factors have an impact on productivity. It's extremely difficult to say "operating practice X caused Y outcome to change by Z percent", because while X was changing, 10 or 100 other things were also changing. To tie this back to wafer fabs, we've always hesitated to predict what improvement a fab will see in cycle time from installing FabTime's software. We've heard some general "10-20%" numbers from our customers, perhaps more for hand-carry lots. But the fab environment is so complex that it's nearly impossible to say what change caused what outcome. Suppose your fab installed FabTime right before an industry downturn hit, and your start rate dropped by 50% over the course of the 3 month installation. If your cycle time decreased by 40%, how much of that was due to FabTime, and how much was due to the reduced utilization on your bottleneck tools? Suppose you now idle some tools, bringing the utilization back up, and your cycle time rises. Does that mean that FabTime didn't work? Does that mean that your manufacturing personnel have been doing something wrong? Of course not.

This point is closely tied to last month's article, about how tricky it is to use short-term indicators to make long-term performance improvements. It's something that we'll be talking more about going forward. (For example, what do you review to see if past solutions have had the intended effect, e.g. did the change taken in response to a signal result in improvement of the long-term measure?)

2. Even though there have been serious questions raised about the reported results, the Hawthorne Effect still appeals to people.

The Hawthorne Effect is still out there, talked about in psychology classes and wafer fab cycle time management classes, because it makes sense to us. The idea that people respond to having attention paid to them, that they will work a bit harder when they feel that someone is noticing what they're doing, seems reasonable. How could it NOT be true, in at least a general sense? Sure, there are probably people out there who are motivated purely by the love of their work. People who don't care at all about external recognition. But most people don't like slaving away in obscurity. They like to know that what they do makes a difference for their company, that people notice, and that, ideally, their local actions have some sort of larger impact.

Implications for Wafer Fabs

Whether or not we believe in the exact data that led to the formulation of The Hawthorne Effect, if we believe that the effect itself exists, then there are several implications for reporting in wafer fabs.

1. Display performance metrics in a highly visible way. Make sure people can see when things are improving (and when they are not). Make sure people know that management actually looks at, and makes decisions based on, the metrics.

2. Find a balance between new and old metrics. If you never add new metrics, people will tend to stop noticing the ones

that are out there. The Hawthorne Effect can be temporary. On the other head, if you give people whiplash by introducing new metrics every week, they probably won't take any of them seriously. Still, if you're going to launch a new initiative for improving a particular outcome (cycle time, yield, TPM, etc), it's a good idea to highlight a new metric or two to go along with it. And, as above, let people see that management is paying attention to those new metrics.

3. Communicate with people about fab performance. The heart of the Hawthorne Effect is the idea that people respond well when they feel that attention is being paid to their efforts. It seems to us that establishing two-way communications with people about what's going well and what needs improvement is a great way to move the fab in the right direction.

Whatever you believe about the origins of the Hawthorne Effect, it's hard to see how these activities could possibly hurt.

Conclusions

We hope that you have enjoyed this visit down memory lane to the very first topic discussed in the FabTime newsletter. The Hawthorne Effect, based on studies that took place at the Western Electric plant in Hawthorne, Illinois, suggests that worker productivity improves as a result of workers having their performance monitored, and then working harder. Although the Hawthorne Effect was formulated in the early 1920's, it remains of interest today. There continues to be debate over whether or not the Hawthorne Effect is "true". That is, whether in fact the productivity improvements recorded could be attributed to the study at all. However, our feeling is that the general conclusion, that people will work harder if management pays attention to their outcomes, is intuitive and valid. For those who believe this, too, we've included some recommendations for leveraging the Hawthorne Effect in wafer fabs. We welcome your feedback.

Closing Questions for FabTime Subscribers

Do you think that the conclusions from the Hawthorne Effect study are valid (that people strive to do better when they sense that their performance is being monitored and noticed)? If so, have you ever tried to tap into this effect in your fab? Have you had success?

Further Reading

- "The Hawthorne Effect", Wikipedia, http://en.wikipedia.org/wiki/Hawthorne_effect.
- "Light work", *The Economist*, June 6th 2009, p. 80, http://www.economist.-com/finance/displaystory.cfm?story_id=13788427.
- Stephen W. Draper, "The Hawthorne, Pygmalion, Placebo and other effects of expectation: some notes", *Psychology Department*, University of Glasgow, http://www.psy.gla.ac.uk/~steve/hawth.html.
- W. Hopp and M. L. Spearman, Factory Physics, *McGraw-Hill*, 1996.
- Steven D. Levitt, "Was There Really a Hawthorne Effect in the Original Hawthorne Studies?", *Freakonomics Blog*, New York Times, June 9, 2009. http://freakonomics.blogs.nytimes.com/2009/06/09/was-there-really-a-hawthorne-effect-in-the-original-hawthorne-studies/

Subscriber List

Total number of subscribers: 2725, from 462 companies and universities.

Top 20 subscribing companies:

- Maxim Integrated Products (191)
- Intel Corporation (146)
- Chartered Semiconductor Mfg (87)
- Micron Technology, Inc. (81)
- Western Digital Corporation (76)
- X-FAB Inc. (69)
- Texas Instruments (62)
- ON Semiconductor (57)
- TECH Semiconductor Singapore (57)
- Analog Devices (55)
- Freescale Semiconductor (54)
- International Rectifier (50)
- NEC Electronics (50)
- IBM (47)
- STMicroelectronics (45)
- Infineon Technologies (43)
- Cypress Semiconductor (38)
- Seagate Technology (37)
- ATMEL (33)
- NXP Semiconductors (32)

Top 3 subscribing universities:

- Virginia Tech (11)
- Arizona State University (8)
- Ben Gurion Univ. of the Negev (8)

New companies and universities this month:

- Adcock Ingram
- Blue Coat
- HHNEC Shanghai
- Salvagnini

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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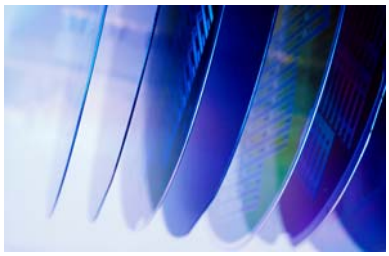
FabTime® Dispatching Module



Dispatch Configuration and Support

We offer our dispatching and planning modules together for a single, fixed monthly fee (on top of your regular FabTime subscription). This includes:

- Dispatch rule and factor configuration via user-friendly web-based interface.
- Training.
- Dispatch list feed to the MES (if applicable).
- Support and upgrades.

Dispatch Factors

- Batch code at the current tool.
- Lot priority.
- Downstream tool priority.
- Current tool FIFO.
- Current tool idle time.
- Downstream batch efficiency.
- Critical ratio.
- Earliest-due-date.
- Current step processing time.
- Remaining processing time.
- Current step qualified tool count
- WIP level or staging time at downstream tools.
- Up to 20 other site-specific factors.

Interested?

Contact FabTime for technical details.

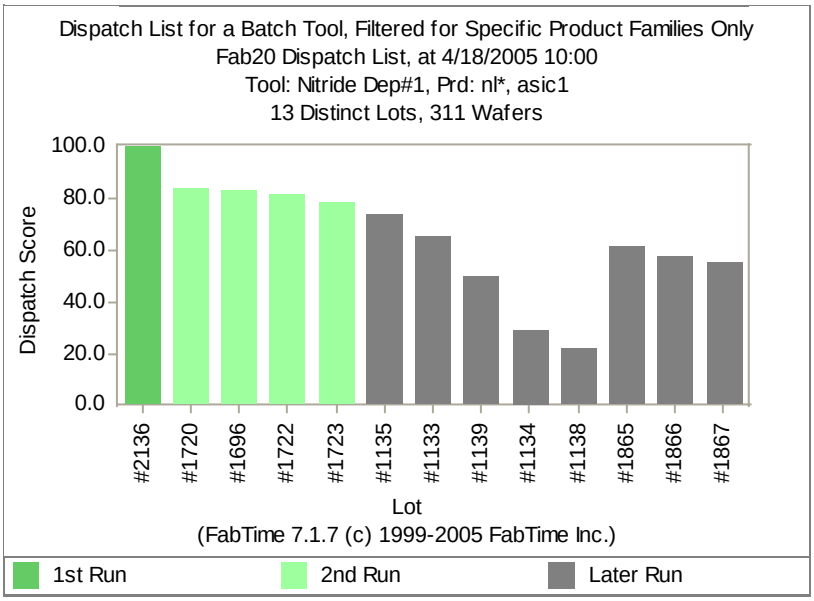
FabTime Inc.
Phone: +1 (408) 549-9932
Fax: +1 (408) 549-9941
Email: Sales@FabTime.com
Web: www.FabTime.com

Do your operators make the best possible dispatching decisions?

- Do you struggle to balance lot priorities and due dates with tool utilization and moves goals?
- Do your critical bottleneck tools ever starve?
- Do you use standard dispatch rules, but feel that your fab's situation is more complex, requiring custom blended rules?
- How well does your fab execute your dispatching strategy?

FabTime's dispatching module is an add-on to our **web-based digital dashboard software**. At any point, for any tool in your fab, FabTime will show you the list of all lots qualified to run on that tool. This list will be ordered by the dispatching logic that your site has selected for that tool. This logic can use standard dispatch rules such as Priority-FIFO and Critical Ratio. However, you can also create custom dispatching logic using any combination of dispatch factors (shown to the left).

You can display dispatch lists in FabTime, and/or export them back to your MES. FabTime also includes a dispatch reservation system to hold downstream tools when a lot is started on an upstream tool, as well as dispatch performance reporting.



FabTime Dispatching Module Benefits

- Ensure that wafers needed by management are in fact the wafers that are run, while requiring less manual intervention on the part of management.
- Improve delivery to schedule, and the display of performance to schedule.
- Document the dispatching logic used by the best operators and make this available to all shifts.