FabTime Cycle Time Management Newsletter

Volume 20, No. 1 **February 2019**

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 development right now include Tool State Stacked Trend and Pareto charts, drag and drop home page chart movement, and support for fiscal calendars.

Editor: Jennifer Robinson

Keywords: Tool Availability; Hot Lots; Dispatching; Metrics and Goals

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Welcome

Welcome to Volume 20, Number 1 of the FabTime Cycle Time Management Newsletter. It's hard to believe that this is the 20th year of publication for this newsletter. Many thanks to all who have joined us along the way. We welcome your feedback on topics that we should cover in the coming year.

We hope that everyone's 2019 is off to a great start. This issue's software tip is about enabling and using FabTime's Javascript charting engine. In our subscriber discussion forum, we seek your input regarding a new metric that we are implementing, Green to Green time. In our main article, we discuss metrics for make to stock vs. make to order production. Specifically, we question the use of the On-Time Delivery (OTD) metric for lots that are make to stock, and suggest other approaches.

Thanks for reading and Happy New Year! – Jennifer

FabTime

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

Community News/Announcements

FabTime welcomes the opportunity to publish community announcements, including conference notices and calls for papers. Send them to newsletter@FabTime.com. We have no announcements at this time.

FabTime User Tip of the Month

Enable Javascript Charts

A tips subscriber pointed out to us that the tip in the December issue (rotating a chart) only works for charts that have Javascript enabled. We apologize for that omission, and thought that it would make a good follow-up to discuss the Javascript chart capabilities in a bit more detail.

When we first developed FabTime we used a third party charting engine called ChartFX to generate the chart images. Several years ago, for more flexibility, we decided to build our own internal charting engine using Javascript. Newer FabTime sites generally use only our Javascript engine, while sites that have had FabTime for longer may have both as options.

To enable Javascript charts, look for the "Active" dropdown near the bottom of the "Format:" section on either a home page tab or on the individual chart page. Select "Javascript" and press the nearest "Go" button. You should also make sure to set "Javascript" as the default on your Charts page, so that future charts generated from the Chart list will default to the newer format. If you do not see Javascript as an option in the "Active" dropdown, or if you have trouble with the Javascript charts, please contact FabTime support. You may need a more recent version of FabTime.

The FabTime-generated charts look slightly different from the ChartFX charts, but have the same basic information. Here are a few things that you can do with Javascript charts that cannot be done with ChartFX charts:

- Rotate the X and Y axes by 90 degrees (newer versions of FabTime only) by clicking the small "R" in the lower right-hand corner of the chart.
- Drag-to-resize. Simply place your cursor over the two small diagonal lines in the lower right-hand corner of the chart and drag. Release at your target size. Note that you can also use the chart's "Width" and "Height" controls to set a specific size for either type of chart.
- View pop-up data values when you place your mouse over the chart.
- Change the legend placement by clicking the small "L>" in the lower left-hand corner of the chart. Clicking the small "L>" multiple times cycles through three options.
- Display data values within or above the bars on a chart by clicking the small "#" symbol in the lower left-hand corner of the chart. Again, keep clicking to cycle through the available options.

■ Automatically update when editing the chart. You can edit certain aspects of any chart by using the edit controls beneath the chart. Many of these updates will occur automatically when using the Javascript version. You will have to press the associated "Go" button to see the changes when using ChartFX charts.

■ Display trendlines when editing charts. Trendlines are only supported on Javascript charts.

There is one thing that is easier to do with ChartFX charts than with the Javascript charts, but we do have a workaround. Because the ChartFX charts are static images by the time they get displayed in FabTime, you can generally right-click to copy them as images. This is useful for sharing charts in other applications. Because the Javascript charts are active, you first need to render them static before copying. Simply click the small "D" in the lower left-hand corner of the chart to toggle between dynamic (the default) and static (the D will show a slash through it).

Some of these capabilities can be seen in the figure below. We hope that you find this tip useful.

If you have questions about this item, or any other FabTime software questions, just use the Feedback form inside FabTime's software. Subscribe to the separate Tip of the Month email list (with additional discussion for customers only). Thanks!

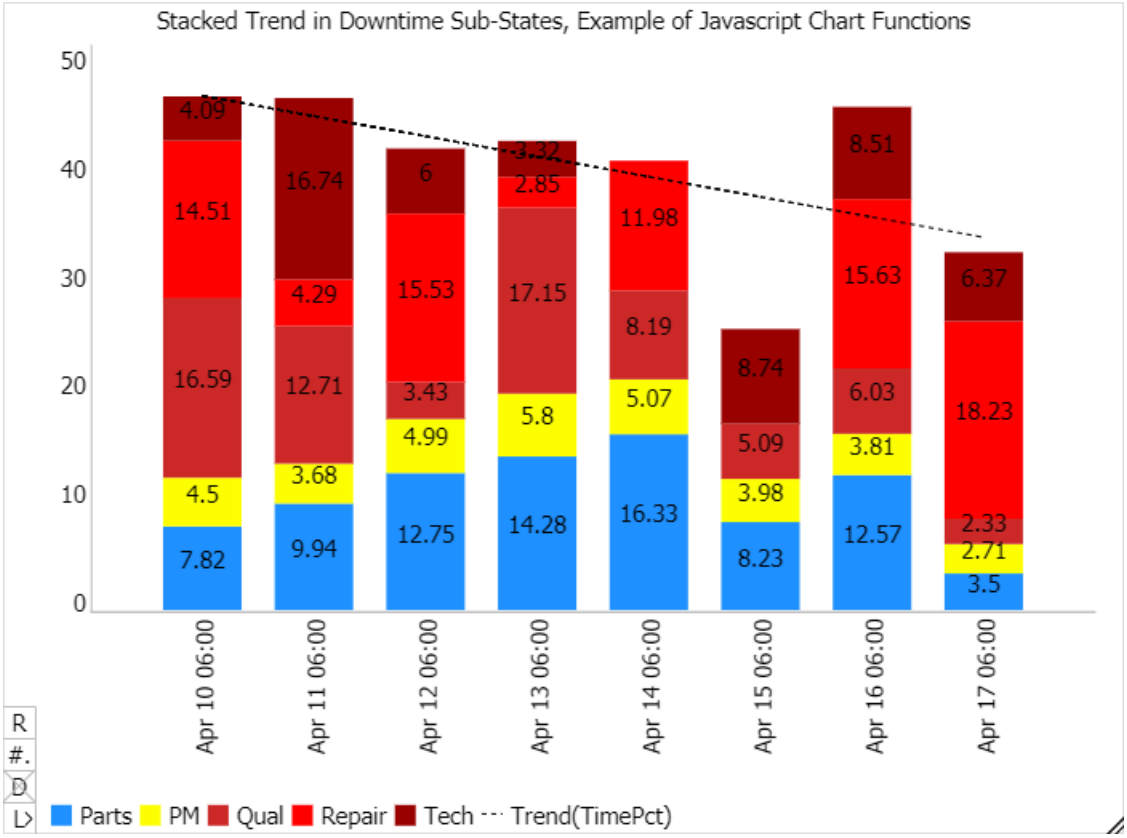

Figure 1. Example showing selected Javascript functions on a Stacked Downtime Trend chart

Subscriber Discussion Forum

Green to Green Reports

FabTime's technical team is working with our User Group to outline parameters for "Green to Green" charts. These charts measure periods of total downtime, whether scheduled or unscheduled, from when a tool becomes unavailable until it is available again (with an option to ignore very brief intervals of standby or productive time).

We have had very productive discussion with our team already. However, if anyone knows of any papers or standards that we should be considering, please let us know.

FabTime welcomes the opportunity to publish subscriber discussion questions and responses. Simply send your contributions to Jennifer.Robinson@FabTime.com.

Cycle Time Metrics for Make to Stock vs. Make to Order

Introduction

We recently had a conversation with colleagues in which we learned that it's apparently not uncommon for fabs that track on-time delivery (OTD) to do so even for lots that are make to stock. In such cases, a lot might even be made hot because it is behind its assigned schedule, even though it will sit in inventory when completed.

This doesn't seem like a good strategy in terms of its cycle time impact. Making something hot that is going to end up sitting in inventory puts it in queue ahead of other lots that will finish later because of this decision. Also, as we've discussed many times in this newsletter, hot lots add variability in wafer fabs and variability increases cycle time. By taking lots that are make to stock and making them hot, you are almost certainly increasing the cycle time of the other lots. If these other lots are make to order, this is a particularly bad idea.

Even if all of your lots are make to stock, it still doesn't make sense to make some of them hot because they are behind in terms of some artificial due date. Your average cycle time across all of the lots, if you have any hot lots, will likely be higher than otherwise.

We can see how this situation would arise. You decide that instead of tracking average cycle time, you're going to track OTD. This makes sense when you have customers with specific due dates, especially when you have a lot of cycle time variation. Having a great average cycle time doesn't help you if your 95th percentile cycle times are leading to customer complaints. The problem here lies in applying the OTD metric to ALL of the lots in the fab when only some of them are make to order. We could also see this arising in a fab that used to make everything to order but now makes some things to stock.

In the extreme case, maybe you don't make anything to order, but you used to. Or you have a manager who likes OTD and is used to using it from another company. Or you read somewhere that tracking OTD is better than tracking average cycle time. The problem here is that may well be adding unnecessary variability, resulting in a higher average cycle time than you would have otherwise.

Of course if all you're doing is looking at the OTD numbers as the lots ship, and not using due dates at all as part of your dispatching, then it probably doesn't matter. But tracking OTD without using the due dates for dispatching decisions along the way also doesn't seem like it would be very helpful.

What should you do instead? We have a few thoughts, but would welcome further feedback on this complex issue.

What If All of Your Lots Are Make to Stock?

If due dates are largely meaningless for your fab (does this ever happen?), we recommend that you not use them in your dispatching decisions. What you want in this case is to keep your average cycle time as low as is reasonable without ending up with dramatic cycle time variability. All else being equal you'd like a nice, consistent mean and distribution of the cycle time. The reasons for wanting reasonably low average cycle time in this case, even if you don't have specific customers waiting for them, include:

- The possible relationship between cycle time and yield. There is research that suggests that the longer lots are in the fab, the worse their yields are.
- The definite relationship between cycle time and WIP (Little's Law, see our tutorial). Longer cycle time means more WIP in the fab. More WIP means more things to manage and keep track of, and more opportunities for misprocessing.
- Marketing flexibility. If you have things ready to ship, you may win sales that you wouldn't otherwise.

The way you keep cycle times low is by using dispatch rules that minimize variability. You still might have a higher priority for lots that are newer products, so that you can get feedback about those sooner. This means using priority class first in your dispatching, then using first in first out. There are a couple of exceptions to first in first out, of course, including:

- Batch tools. Our recommendation for the best cycle time is to fill them if there's WIP there, but not to hold them until they fill up. Go ahead and run them using a "greedy" policy if there is anything there to run.
- Tools with significant setups. What you normally want here is a setup avoidance policy that says to choose a lot with the matching setup next, even if it's not the next lot in queue. Usually you need a cap on the setup avoidance policy so that if lots have been waiting more than a certain amount of time, you go ahead and change over. That cap can be pretty high for make to stock lots, but not infinite.

Then you work on reducing the other sources of variability in the fab: downtime, batch travel, lot release, and so on.

What if You Have a Mix of Make to Stock and Make to Order?

We wrote back in issue 11.04 about the problem of lots that are early. These lots take capacity away from other lots, which may then end up being late. In that issue as well as in Issue 7.04 we talked about reasons to tighten the distribution of cycle times and recommendations for doing so. In the case of a fab with both make to stock and make to order production, the distribution of cycle times might well end up being bimodal. And that's perfectly ok. An example is shown at the top of the next page.

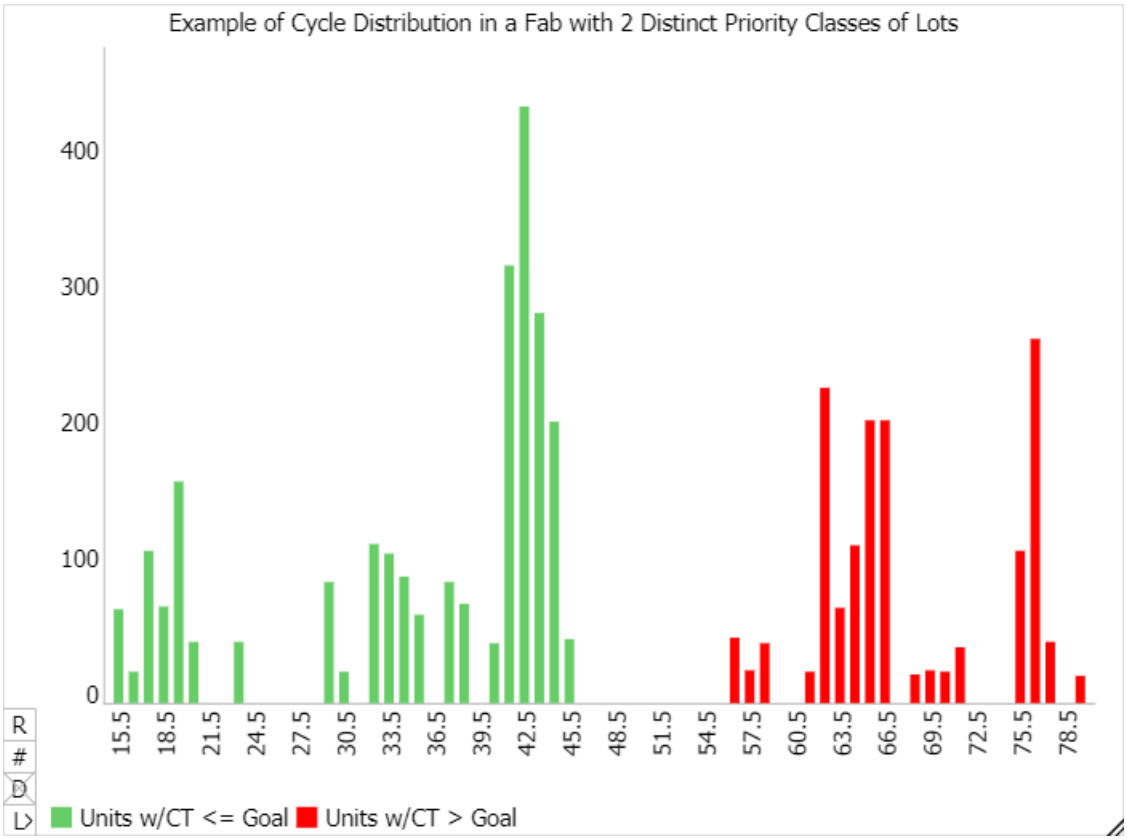

Figure 2. Example of a Fab with a Bimodal Distribution of Cycle Times

The simplest thing to do in this case is to assign a priority class to each lot depending on whether it's make to stock or make to order. You could also have sub-priorities within those. You might have priority 1, 2, and 3 for some of the make to order lots, and then have use priorities 100 and 200 for the make to stock lots. The trick is to make sure that however the priorities are used in your dispatch rules, the make to stock lots are nearly always behind the make to order lots. Here again batching and setup avoidance might be exceptions.

If you are using a critical ratio type dispatch rule that takes into account each lot's performance relative to due date, what you want is for the due dates of the make to stock lots to be far enough into the future that they don't skew your system by coming to the top of the list. If you have influence over setting the (inherently arbitrary) due dates for the make to stock lots, you want to set those relatively far into the future, based on some higher-than-expected x-factor. If not, then you should make sure that priority class is much more heavily weighted in the dispatching system than the critical ratio piece.

When it comes to looking at cycle time performance, by all means look at OTD, but make sure that you first filter by priority class. Look at OTD for the make to order lots only. For the make to stock lots, the average cycle time is probably more meaningful.

Other Situations

What if your "orders" are all internal? That is, you have some distant level management setting due dates, even though everyone knows that some of them are meaningless. We would say that it depends on whether your fab is being evaluated based on performance to those due dates. If it is, you act accordingly. But

you might pass on the message that that doing this is harming the cycle time of more genuinely pressing lots.

What if your fab replaces make to order with make to stock when demand goes down, and you want to stay in practice for when demand picks back up? Then go ahead and use OTD everywhere if that practice is important, but be aware that you may be increasing the cycle time for your most important (make to order) lots.

Conclusions

We wrote this article to sound a cautionary note for fabs that might be applying an on-time delivery (OTD) metric to make to stock lots. Making a lot hot because it is behind in terms of some arbitrary due date, or even just prioritizing it more heavily in your dispatch system, takes cycle time away from that lot and adds it to other lots. This decision also likely increases variability in the fab, adding to the cycle time of ALL lots. Changing this behavior could well improve the cycle time of more critical lots.

The choice of dispatch rules and cycle time performance metrics should be determined based on each fab's balance of make to stock and make to order lots. These choices may need to be re-assessed when situations change over time. We have attempted to make a few recommendations in this area, but we would, as always, welcome reader feedback.

Closing Questions for Newsletter Subscribers

Have you ever worked in a fab that used on time delivery as a metric for lots that were make to stock? Have you ever seen a make to stock lot made hot? What are we missing in this discussion?

Further Reading

- J. Robinson and F. Chance, "Cycle Time Variability," Vol. 7, No. 4, *FabTime Cycle Time Management Newsletter*, 2006.
- J. Robinson and F. Chance, "Early Delivery Times in Wafer Fabs," Vol. 11, No. 4, *FabTime Cycle Time Management Newsletter*, 2010.
- L. M. Wein, "On the Relationship between Yield and Cycle Time in Semiconductor Wafer Fabrication," *IEEE Transactions on Semiconductor Manufacturing*, Vol. 5, No. 2, 156-158, 1992.

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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

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- Cycle time relationships
- Metrics and goals
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- 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 and a half-day executive management version are also available upon request. The course is only available for delivery at sites within the United States, unless it is delivered in conjunction with software training for FabTime customers.

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.

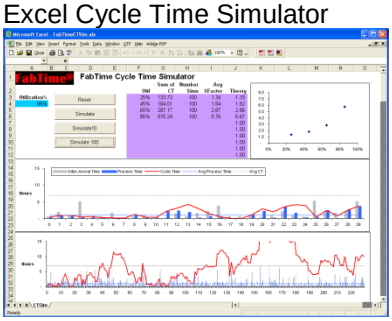
Skills Gained

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