FabTime Cycle Time Management Newsletter

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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 Gantt charts (and ability to view other charts in Gantt style) and new Operating Curve chart showing cycle time versus utilization.

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

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Welcome

Welcome to Volume 19, Number 1 of FabTime's Cycle Time Management Newsletter. We hope that everyone had a happy holiday season, and that you are all successfully fending off winter ailments. In this issue of the newsletter we have an announcement about a FabTime webinar that was held in January (and is available for viewing by FabTime customers). We have a subscriber discussion question about hot lots. Our FabTime software tip of the month is about adding a new chart series on the right-hand Y-axis when customizing charts.

In our main article this month, written with Hani Ofeck from Tower Semiconductor, we explore the setting of availability targets. While availability is an important and widely tracked metric in fabs, there is surprisingly little literature regarding the calculation and implementation of availability targets. In our article we share some general thoughts as well as implementation ideas. It is our hope that this will spur further discussion, such that we, the FabTime newsletter community, can improve our collective understanding in this area.

Thanks for reading – Jennifer

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Community News/Announcements

FabTime Hosts Customer Webinar on Tool State Analysis

For those FabTime users interested in learning more about tool state analysis, FabTime's Mike Krist recently held a specialized webinar on this topic. The webinar included supplemental training on tool charts in FabTime as well as real-world examples of answering common tool related questions in the fab, such as finding the number of tools at the start of each shift that are down for preventive maintenance. Topics included:

1. Learning about Tool State, Tool Hours, OEE, Availability, A20/A80, and Gantt charts.
2. Building a home-page alert to notify you any time a tool goes down.
3. Q&A and wrap up.

The webinar was held on January 30th. Any users from active FabTime customer sites are welcome to log in and view a saved version of the webinar at their own convenience. Please email newsletter@FabTime.com for the webinar link. Please note that you will need to click "register" in order to view the recording even if you have already attended the webinar training.

FabTime welcomes the opportunity to publish community announcements, including conference notices and calls for papers. Send them to newsletter@FabTime.com.

FabTime User Tip of the Month

Place New Series on Right-Hand Y-Axis when Editing Charts

FabTime's "Edit Chart" capability has for some time now allowed users to remove series from charts, or add additional (related) data. New in Patch108, you can now add new series and have them display against the right-hand Y-axis, instead of the default left-hand axis. This is a necessary condition for adding data that is at a significantly different scale.

For example, suppose you have a Tool State Trend chart for which, instead of showing a WIP line against the right-hand Y-axis, you would like to show the average duration of unscheduled downtime across the included tools. To do this:

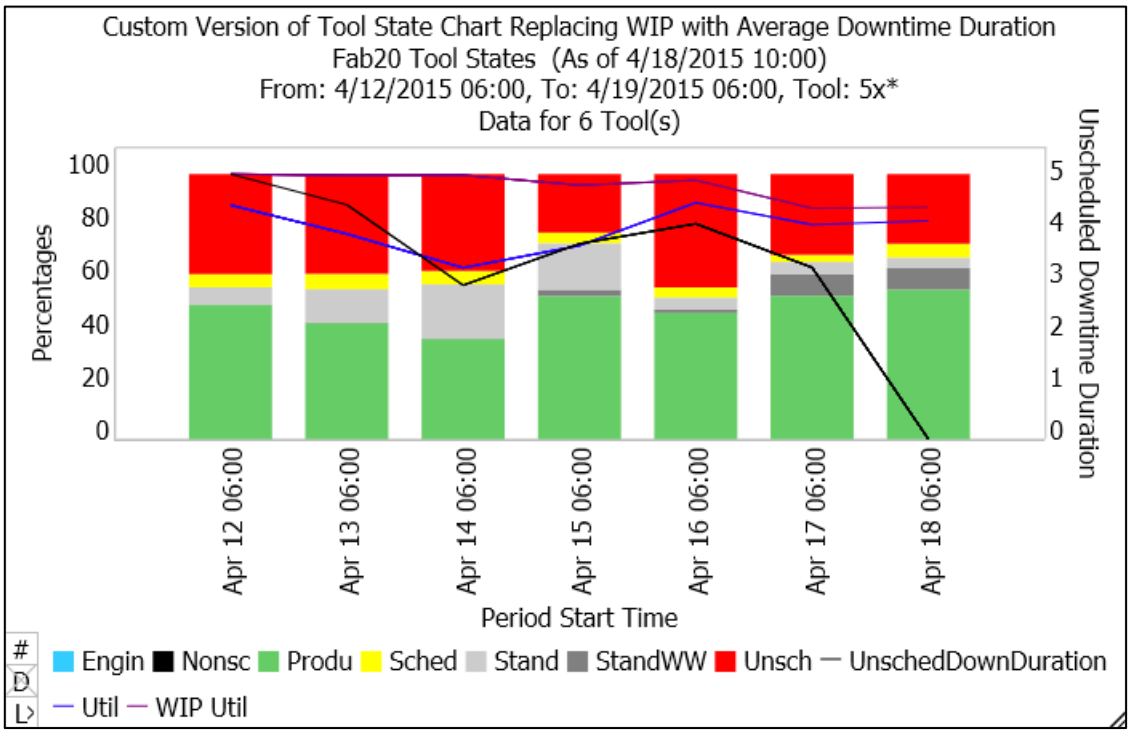
1. Generate the Tool State Trend chart, and set filters as needed.
2. Click the "Edit Chart" and "Show All Fields" boxes immediately below the chart image.
3. Find the row for "Avg WIP Units", and change the "On Chart" column from "Line" to "Unused". This removes the Average WIP line from the chart.
4. Scroll down to find the row for "Unsched Down Duration" and change the "On Chart" column from "unused" to "Line". In the same row, change the "Y Axis" column from "Left-Y" to "Right-Y". You can also change the line color if you like, using the "Settings" column.

5. Scroll back up to just below the chart and change the Y2 Axis Title to "Unscheduled Downtime Duration" and press the "Go" button immediately beneath the input box.

6. Add a custom title to your chart if desired. Save the chart by adding it to a home page tab. Your customizations will be saved with the chart.

An example of the customized Tool State Trend chart is shown below. You can use this method to add secondary Y-axis data to any chart, as long as the field (or fields) that you wish to add display in the table beneath the chart when "Show All Fields" is selected.

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!



Subscriber Discussion Forum

Hot Lot Targets

An anonymous subscriber wrote: "I wonder if you had in the past the topic of impact of priority lots on overall FAB performance / capacity / cycle time and what are recommended percent values of super rocket, rocket lots, etc. If nothing has been written in the past, maybe that could be a nice topic for a future one?"

FabTime Response: We have talked about hot lots in two past newsletter issues (Issues 3.02 and 6.08), but it's been a while. You may be right that we're due for a new look. Thanks for the suggestion. We'll consider this for a main article topic for 2018. If any other subscribers have hot lot related questions, please let us know, and we can include those in the discussion.

As to recommendations for percent hot lots, we've tightened that up over the years. For front of the line hot lots, we used to say 10%, but we've found that fabs that are doing well in terms of cycle time keep that down to more like 5% (unless you are in a situation where you just run two different classes of lots, like make to stock vs. make to order). For super-hot lots (where you hold tools, hand carry, etc.) we recommend no more than 1 to 2 lots in the fab at one time, total. More than that is too disruptive, and they start to interfere with one another.

Line Yield Metrics

A subscriber and FabTime customer is looking for input on what metrics other fabs are using to calculate line yield. The company is particularly interested in metrics that can be used to compare across fabs. They are considering using the LY20 metric outlined here.

FabTime Response: FabTime has discussed line yield metrics in issues 5.01, 5.02, and 9.06, and has implemented multiple metrics into our FabTime software. If any subscribers would like to share input on calculating line yield, particularly for sharing across fabs, we would be happy to share them in the next issue, possibly as a new article on the topic.

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

Determining Availability Targets

by Hani Ofeck, Frank Chance, and Jennifer Robinson

Hani Ofeck from TowerJazz Semiconductor, a long-time FabTime customer, asked Jennifer and Frank earlier this year whether we knew of any literature on setting equipment availability targets. We did not, and a literature search produced only a couple of articles that were not quite on point to the question.

We broached this topic with our FabTime User Group and found general interest, but no specific resources. The three of us subsequently spent time brainstorming via email. We came up with some general questions as well as a couple of implementation ideas. We share these below, in the interest of starting a more in-depth discussion.

We welcome your feedback.

Definition of Availability

Following the SEMI standard for E10 Tool States, FabTime defines Available Time as Productive Time + Standby Time. Or, more specifically, AvailablePct = 100 * ProductivePct + StandbyPct, where AvailablePct is equivalent to "ManufacturingTime / TotalTime" in the SEMI E10 standard.

In FabTime, the term "Available" means "available to manufacturing." FabTime includes Tool Available % Trend and

Pareto charts, and allows for the setting of a Tool Available % goal for each tool.

What we are looking at in this article is methods for determining that Tool Available % goal, which we will refer to as availability.

General Questions Re: Determining Availability Targets

Here are a few things that we might ask, in our quest to set availability targets:

1) I have historical availability data for my equipment. What is a good method for setting availability targets from this data? How can I detect and exclude outliers? Or should I include the outliers? How often should I be re-calculating this data?

2) Should I only use historical data for Implanter #1 when setting its availability targets? Or can I use historical data for Implanter #2 and #3 which are similar (but not identical) implanters?

3) Should my availability targets be influenced by what the equipment vendor has promised, or by what my IE team's capacity model says that we require? That is (relative to the above), should my availability targets be based on historical data, or should they be more aspirational?

4) Is there general goal-setting theory that I should be using (e.g. if actual performance for the past 2 quarters is 62%, will I get better engineering response if I set the target to 65%, or if I set a stretch goal of 85%?).

5) Over what time period should I measure availability performance? For example, if the availability goal is 80%, are we looking at 80% every day, or averaged over a week (or longer), getting 80% availability? For cycle time, we'd like to limit long downtimes, so we'd like to measure availability per day (or even shift), and have that consistently meet 80%. Is there an obvious answer to this question?

6) Do we have time limitations between two tools/operations such that availability of one will affect other and will cause WIP bubble? Might we have cases where we have different availability targets for the same type of tool, based on where the tools are in the process flow?

7) Could the gaps between availability performance and goals, and between WIP and WIP goals, be used to define dynamic bottlenecks?

8) Should bottleneck tools get more aggressive availability targets? Does cost have an impact in setting availability targets (for example, would a high cost of spare parts impact availability targets?

9) Do we have a clear method for setting cluster tool availability targets (for the mainframe and for individual chambers)?

Implementation Ideas

The above questions suggest a couple implementation ideas for generating and using availability targets.

1) We might calculate availability targets based on the combination of scheduled and unscheduled downtime losses, rather than simply setting a single number. Because of course another way of looking at availability is to consider all of the other sub-states besides productive and standby. We might calculate:

Available % = 100% - (Non-Scheduled Time + Unscheduled Downtime + Scheduled Downtime + Engineering Time)

In this case, the more detail we have about those sub-components of availability, the more accurate our availability targets could be.

2) Do we need to have availability targets that adjust based on the period displayed? For example, if looking at day-by-day availability, the goal is 75% available every day. If looking at availability for an entire week, the goal is 80%.The idea here is that availability is a major killer of fab performance, particularly the ability to

meet cycle time and on-time delivery targets. On a given day, due to scheduled downtime events or to unplanned events, we may have to accept a worse availability level. But over time, we need to meet a higher availability target on average, in order to make throughput goals. That higher target would be the one used in capacity planning models.

3) Do we need to add a percentage loss factor for bottleneck tools and/or tools with a high cost of spare parts? For example, photolithography tools that have high cost spare parts will get an additional percentage buffer allowance relative to their statistics results.

4) Should we consider in the availability targets the average MTTF (Mean Time to Failure) and average MTTR (Mean Time to Repair) as part of setting unscheduled downtime goals? Does preventive maintenance (Scheduled Downtime) have similar parameters that should be used, such as average MTTSE (Mean Time to Scheduled Event/PM) and average MTOSE (Mean Time of Scheduled Event/PM duration)?

Conclusions

FabTime has been asking people for 18 years to name the top cycle time contributors in their fabs. The number one response, consistently over the years, has been tool downtime. We know that tracking and improving availability performance is a major goal for all fabs. Availability as an absolute number contributes to the ability to meet throughput goals. Variability of availability contributes to cycle time and delivery performance problems. SEMI is quite clear on how to calculate actual availability, and our customers have requested the addition of many tool-performance tracking charts to FabTime.

And yet... the literature on setting availability targets is extremely sparse. In this article, we have shared some thoughts on ways to calculate and implement these targets. We welcome your feedback, and hope to present a follow-up article next time.

Further Reading

■ M. Bartholdt, B. Bertsche, and R. Schmidt, "Determining Availability Targets – A Value Managerial Approach," *Reliability and Maintainability Symposium (RAMS), 2016 Annual*. The authors are from University of Stuttgart and the European Center for Nuclear Research. Can be purchased from IEEE.

■ T. J. Massie, "Semiconductor Fab Maintenance Challenge and BKM in Downturn Economy," IEEE 2002 *Advanced Semiconductor Manufacturing Conference (ASMC '02)*, 228-230, 2002. The author is from Microelectron. Div., IBM Corp., Essex Junction, VT. Can be purchased from IEEE.

■ S. Wilson, "Talking Shop - Linking Training to Factory Indicators," *2001 IEEE International Symposium on Semiconductor Manufacturing (ISSM '01)*, 103-106, 2001. The authors are from Intel Corp., Rio Rancho, NM. Can be purchased from IEEE.

Closing Questions for Newsletter Subscribers

How do you set availability targets in your fab? Do you use historical averages? Do you use vendor targets, or something suggested by your capacity models? Have you ever used availability targets that vary according to the time period length?

Subscriber List

Total number of subscribers: 2732

Top 20 subscribing companies:

- ON Semiconductor (175)
- Infineon Technologies (145)
- Micron Technology, Inc. (140)
- Intel Corporation (115)
- GLOBALFOUNDRIES (102)
- Maxim Integrated Products, Inc. (99)
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- ABB (29)
- Silterra Malaysia Sdn. Bhd. (27)

Top 4 subscribing universities:

- Ecole des Mines de Saint-Etienne (EMSE) (15)
- Arizona State University (8)
- Virginia Tech (7)

New companies and universities this month:

- Deca Technologies
- Uni Karlsruhe

Sampler Set of Other Subscribing Companies and Universities:

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- Selantek (1)
- Semiconductor Equipment Corp. (1)
- Solar Valley GmbH (1)
- ST Assembly Test Services (1)
- Technical University of Munich (3)
- Testtronixcs (1)
- Texas State University (1)
- TowerJazz Semiconductor Ltd. (21)
- United Monolithic Semiconductors (2)

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FabTime® Software for Assembly and Test

"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
Spansion Fab 25

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FabTime's Web-Based Dashboard is Fully Applicable for Assembly & Test Facilities

- Do your customers (internal or external) want more visibility into your factory?
- Is it difficult to look at trends in equipment performance, or tie equipment performance to throughput and cycle time?
- Does your factory lack real-time reporting?

FabTime can help. FabTime saves your management team time daily by turning MES data into information, via a real-time web-based dashboard that includes lot dispatching. FabTime saves your IT staff time by breaking the cycle of custom-developed reports. Most importantly, FabTime can help your company to increase revenue by reducing cycle times up to 20% for regular lots, and even more for high-priority lots.

Although FabTime was originally designed for front-end manufacturing, you can use FabTime for your assembly or test facility. You simply need to have a transaction-based manufacturing execution system. FabTime can link to all commercial systems commonly used in the industry (e.g. WorkStream, Promis, Eyelit, Mesa, FactoryWorks) or can link to internally developed systems. FabTime can pull data from multiple databases if needed (e.g. WIP transactions from the MES, tool transactions from another system). FabTime is currently being implemented in two assembly and test facilities, with no major technical hurdles.

FabTime Applicability for Back-End Factories

- FabTime handles lot merging and splitting, with full tracking of overall cycle times.
- All chart quantities (moves, WIP, etc.) can be displayed as die, with data tables formatted for readability of large quantity values.
- Custom assembly and test parameters (applicable to WIP or tool state transactions) can be mapped.
- Custom site-specific reports for wire bond area have been developed for customers (die and component placements, etc.).
- Custom dispatch factors allow for incorporation of back-end-specific data used in dispatch decisions (e.g. availability of boards, and minimization of sequence-dependent setups).