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 the coming release of FabTime include OEE support for multi-path cluster tools, including support for parent/child relationships for tools.

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Keywords: WIP Turns; Metrics and Goals; Predicted Cycle Time

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Welcome

Welcome to Volume 16, Number 2 of the FabTime Cycle Time Management Newsletter! In this issue we are pleased to announce the 16 year anniversary of FabTime, which we are celebrating by kicking off our 40th software installation. We also have an announcement from the Fab Owners Association about a new Packaging and Test group within the FOA. Our software tip of the month is about re-setting the default sort order for a chart. We also have a new subscriber discussion topic about balancing competing priorities of cost vs. on-time delivery in fabs.

In our main article this month we discuss the use of WIP Turns to generate forward estimates of fab cycle time. We discuss the benefits of this information, as well as related computational issues. As always, we welcome your feedback!

Thanks for reading – Jennifer

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Community News/Announcements

FabTime's 16 Year Anniversary

FabTime launched in early March of 1999. LinkedIn reminded us recently that FabTime had been in business for 16 years. The time has flown by, and we would like to thank those of you who have been with us since the beginning, as well as the many friends and colleagues we have met along the way. We celebrated 16 years of FabTime as a company by starting our 40th software installation.

Fab Owners Association Expands to Packaging and Test

The Packaging and Test Group of the Fab Owners Association, (www.waferfabs.org, Cupertino, CA) held its first official meeting on February 4th. This was just one of the meetings held as part of the third annual FOA Collaborative Forum in Santa Clara, CA.

The fourteen inaugural FOA-PT members heard a presentation on the "Roadmap of Packaging Things" by Bill Bottoms, who represented ITRS, and an update on packaging and test standards from Paul Trio of SEMI. The PT members then joined with the "Device Maker" (DM) members, senior manufacturing managers from IDM companies, to hear a portion of the morning presentations during the DM Only portion of the Forum. We remained after lunch with the other AMs to enjoy the afternoon session's presentations.

One representative presentation of benefit to both the fab (frontend) and the packaging (backend) managers was a joint project by ON Semiconductor and Plasma-Therm reporting on the installation of stealth wafer dicing in some of the ON Semi facilities. They reported that stealth dicing enabled ON Semi to reduce the saw street widths thus enabling them to fabricate 20% more die per wafer, increasing overall fab capacity.

As is the FOA custom, an evening social event was held at the Faultline Brewery with over 100 DMs, PTs, and Associate Members (AMs) enjoying the opportunity to network.

The February 5th meeting day included all members who heard select supplier members (AMs) present their solutions and propose new collaborative projects for future presentation.

The FOA-PT Group membership is targeted towards companies with operating semiconductor packaging and test operations. This includes companies with captive operations (Pure-Play Fabs and IDMs) and packaging service companies (OSATs).

The inaugural PT Group agreed that it would be a significant member benefit to have access to an industry wide packaging and test cost benchmark. One of the FOA members, Max International Engineering Group, announced the launch of such a study with participation of several large IDMs, OSATs and FOA members. Following up on the FOA-PT Group request, FOA's Executive Director, L.T. Guttadauro, has been able to secure a deeply discounted participation fee for FOA members.

Other PT member requests for inclusion in future meetings include information on emerging packaging opportunities, especially 2.5D and 3D packaging and more "game-changing" technology disclosures, such as stealth dicing.

The next meeting of the FOA PT Group will be in May in San Jose. The location and date will be announced shortly.

For more information contact the FOA-PT VP, **Phil Marcoux** at phil@waferfabs.org or 650-274-7762.

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

Re-set Default Sort Order for a Chart

One of the ways that you can make a FabTime chart more relevant to your immediate needs is by changing the sort order for the chart columns. This can be especially useful for Pareto charts, where you might sometimes want to see things sorted in operation order (e.g. to look at the WIP profile in your fab), but other times you want to see things sorted by values (e.g. to bring the tools with the longest per-visit cycle time to the top). FabTime remembers the sort order that you have used for a particular chart and will use that order the next time you generate that chart from the chart list.

However, sometimes you're just experimenting, and you don't necessarily want to see a particular sort order again. Perhaps the order you've specified isn't a good fit for a stacked chart that you're looking at. Rather than having to figure out what a more logical setting might be for the sort settings for this chart, FabTime does offer a quick shortcut for returning a chart to its default sort order.

Simply set all three sort order options (to the left of the chart, below the big set of filters) to "N/A" and then hit the "Go" button right beneath the sort control. This will re-set the sort order to use FabTime's default for that chart, and get you back to business.

If you have other shortcuts, tips, or tricks that you feel other FabTime users might find helpful, please let us know.

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

Balancing OTD and Cost Pressures

At the last Fab Owners Association meeting, **Guy Gandenberger**, VP of World Wide Operations for **Micrel Semiconductor**, suggested a discussion topic for the newsletter. Guy asked (for factory manager): "How do you balance on-time delivery with cost pressure in practice in your fab? For example, running with fewer operators or pushing utilization higher can help with cost, but hurt delivery performance." Does anyone have thoughts on this to share with Guy, and with the newsletter community?

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

Using WIP Turns for Forward Cycle Time Estimation

Introduction

We've talked previously in the newsletter (Issue 10.06) about predicting completion dates for individual lots. But sometimes what you need is a more general estimate of what your cycle time is likely to be given the current conditions in your fab. It's possible to use WIP turns to perform this estimation. In this article we will discuss WIP turns as a metric in general, and also show how WIP turns can be used to generate a forward estimate of fab cycle time.

WIP Turns

WIP turns are a useful metric for tracking overall fab performance, as well as for monitoring performance by production area. WIP turns are defined as follows:

Turns (for a time period) = Moves (for that time period) / average WIP

WIP turns are a helpful metric to use for the fab as a whole because it tells you if you are maintaining a consistent pace in processing WIP. Turns reflect, on average, how many times per day you are moving each wafer.

For example, suppose you had 32,000 moves for a 12-hour shift, with average WIP of 8,000 wafers. The turns rate is 32,000/8,000 = 4/shift. This means that on average each wafer moved four times per shift. Assuming that this performance is typical, you can expect each wafer to move eight times per day, on average. If you see your overall turns rate declining, this may be a sign of problems (more on the impact of this on cycle time below).

WIP turns are also a useful metric at the area level, because they compensate for short-term WIP fluctuations. WIP turns allow you to avoid penalizing an area for not meeting a moves goal when the area was starved of WIP. WIP turns for an area are computed the same way they are for the fab as a whole, but include only the moves and WIP recorded in that area.

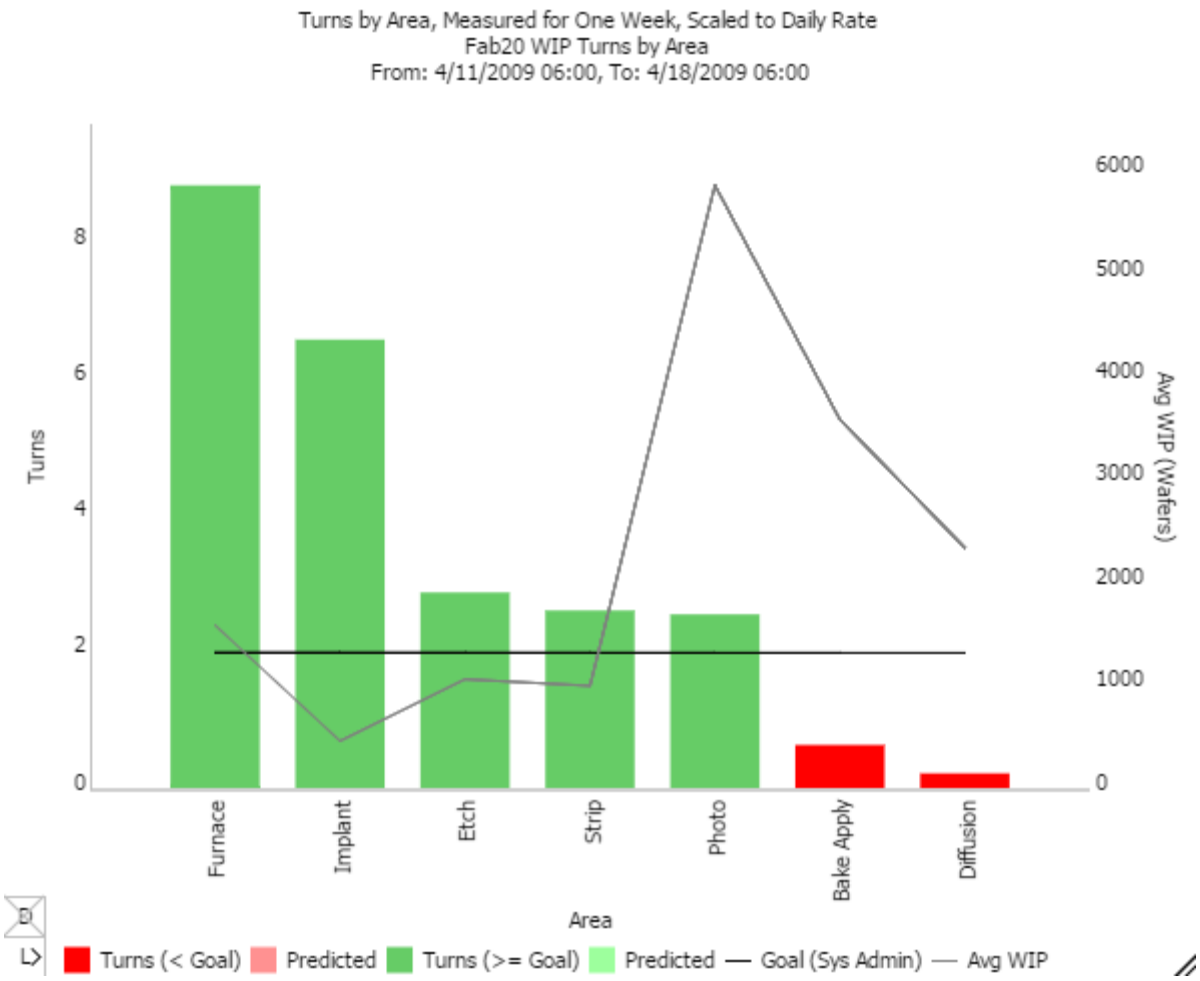
An example of a WIP Turns Pareto by Area is shown at the top of the next page. In this particular example, the goal for each area is set based on a fab-wide goal of approximately 2 turns/day. The Furnace and Implant areas demonstrate a higher turns rate, but this is because they are both relatively starved of WIP. The Photo area, despite having a high level of WIP, has been keeping up sufficient moves to meet the overall turns goal.

WIP turns can also be calculated for tools and tool groups. Because there is more shift-to-shift variability in both moves and WIP at this lower aggregation level, however, this may not be as useful in practice. At the tool level you also can get into issues in which the moves or WIP for a shift is zero, leading to calculation distortions.

Computational Notes Regarding WIP Turns

In our software we scale raw turns to a turns per day metric, with scaled turns = (raw turns) * 24 / (period length in hours). FabTime performs this scaling so that it is easier to compare turns performance when changing the period length, for example if you change the period length to 168 to display week-by-week turns (as in the example on the next page).

Average WIP is computed in FabTime by dividing each period into sub-periods, and computing the average starting WIP for each sub-period within the period. For example, suppose the first chart period is from 6am to 10am (4 hours) and the sub-period length is set to 1 (hour). Suppose the starting WIP at 6am is 10 wafers, at 7am is 25 wafers, at 8am is 30 wafers, and



at 9am is 50 wafers. The average WIP is (10+25+30+50)/4 = 115/4 = 28.75 wafers. If you wish to use starting WIP rather than average WIP, you can set the sub-period length equal to the period length -- this will result in average WIP being the starting WIP.

Using WIP Turns to Estimate Future Cycle Time

In addition to being a general indicator of whether or not your fab is continuing to operate at the same pace, WIP turns can also be used to predict future cycle times. As discussed above, WIP turns tell you, on average, how many times per day your fab is moving each wafer. If you also know the average number of steps that each wafer goes through, then you can predict the average cycle time for your current WIP.

Continuing the example described in the text above, if you move each wafer 8 times per day on average, and each wafer requires 400 steps to complete processing, on average, then your cycle time will be 400 steps / 8 steps/day = 50 days. Of course the number of steps used for this calculation must be consistent with the level at which you are tracking moves. If this is the case, and if you maintain a consistent turns rate, then you can expect average cycle times in the future to be about 50 days.

If, on the other hand, your turns rate starts to decrease, and you don't do anything about it, then you can expect your cycle times to increase in the future. Increasing your turns rate (either by increasing moves or by decreasing WIP) will drive your cycle time down.

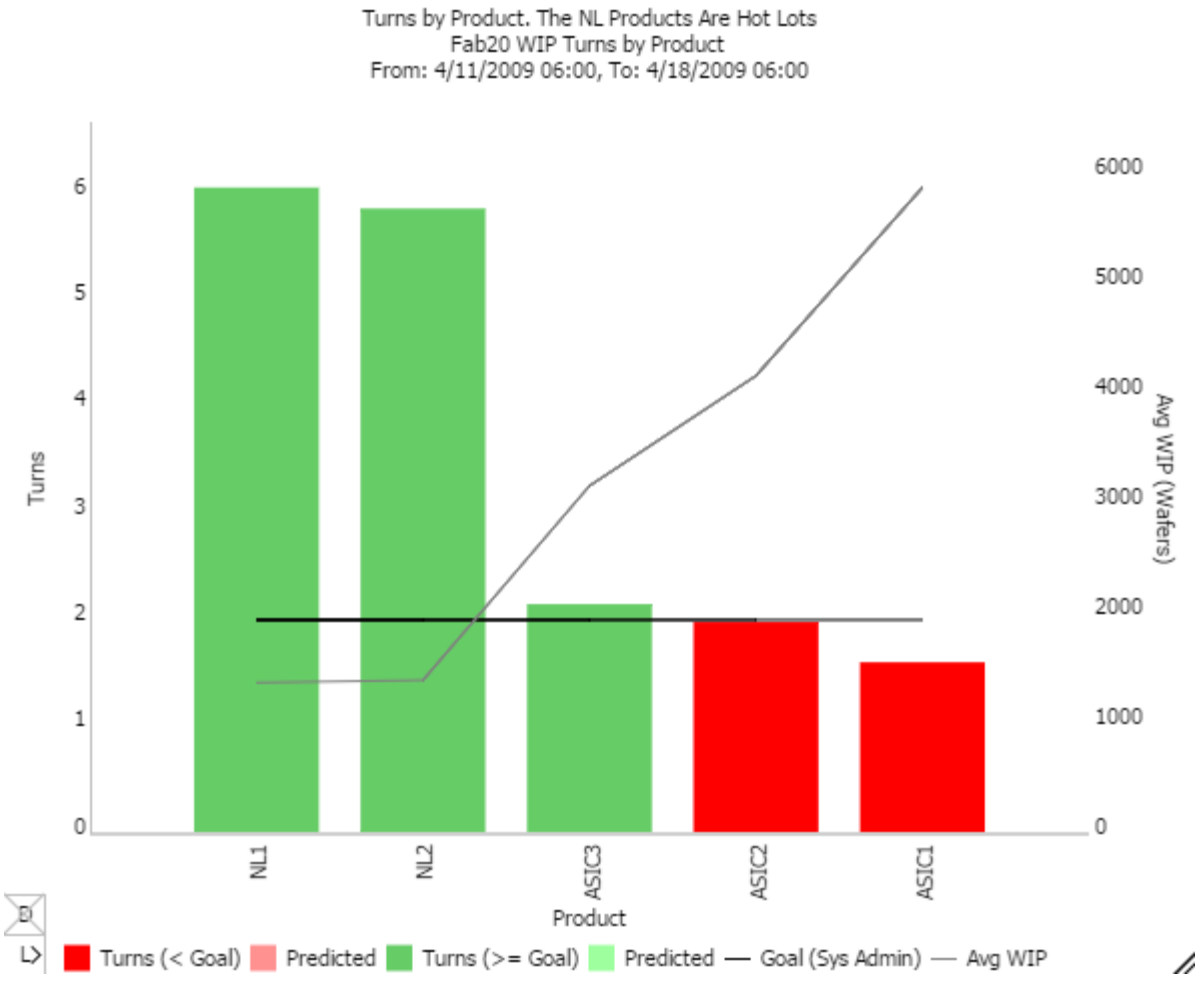
The above example applies to the fab as a whole. It is more likely, however, that you will want to look at this information by route or family, and/or priority class. As with looking at turns by area, you simply calculate turns by using the moves and WIP for your route or family or interest, and then use the corresponding number of steps.

Intuitively, if your hot lots have a turns rate that is three times as high as the turns rate for production lots, you would expect that those hot lots would have a cycle time that is approximately one-third as long. The sample Turns Pareto by Product chart shown below illustrates this. The NL products are a higher priority, and are moved three times as often as the ASIC products.

Computational Notes Regarding Forward Cycle Time Estimation

The tricky part of using WIP turns to predict overall average fab cycle time lies in knowing the right number of steps to use in the calculation. What you need for the overall average is a weighted average number of steps, where the weighting is by relative proportion of WIP. Because product mix in a fab can change rapidly, the weighted average number of steps may change, too, particularly if you have process flows that vary in complexity.

Our advice is not to get hung up on keeping track of this on a daily basis as your mix changes, but to perhaps keep a spreadsheet in which you track the number of steps per major flow. You can then quickly calculate the weighted average



number of steps at any point by entering the proportion of the WIP belonging to each major flow. (In FabTime, use the WIP Pareto by Family, and divide the WIP for each family by the total WIP shown in the chart title.) And, of course, if you simply estimate the cycle time by major route in the first place, then you don't need to worry about a weighted average number of steps per route.

This forward look at cycle time from WIP turns is just an estimate. Things change so frequently in the fab that it is not reasonable to expect that the cycle time for some particular lot will be exactly 50 days, or whatever the calculations show. Rather, using WIP turns will give you a general idea of what your average cycle time is likely to be, if things stay reasonably consistent. And certainly if you then increase your turns rate, you can reliably expect that cycle time will get better (and vice versa).

Conclusions

Fabs that are concerned about cycle time generally track overall WIP turns, in addition to tracking moves. Turns for the fab are straightforward to calculate, and give you an idea of whether or not your fab is on pace. The intuitive explanation for turns is that turns tell you, on average, how many times per day (or per shift) you are moving each wafer. With this information, as well as an understanding of how many steps you have in your process flows, it is possible to use WIP turns to derive a forward estimate of fab cycle time.

While this estimate will not be an exact predictor of cycle time to the day, given the rate at which things change in a fab, it is still most likely a better predictor of future cycle times than the cycle time for lots that have already shipped. And it will certainly be useful to look at the direction in which this estimate is trending over time for your fab. The forward estimate of cycle time from WIP turns can give you a valuable early warning of cycle times that are trending in the wrong direction.

Closing Question for FabTime Subscribers

Do you use WIP turns to predict cycle times in your fab? If so, have you found these estimates to be accurate?

Further Reading

J. Robinson and F. Chance, "Forecasting Lot Completion Dates," *FabTime Newsletter,* Volume 10, No. 6, 2009.

Acknowledgement

An email exchange with **Don Myers from JDSU** inspired this article.

Subscriber List

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