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 more granular information about cycle time sub-categories on all relevant charts and a new WIP Hours metric.

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Welcome

Welcome to Volume 20, Number 3 of the FabTime Cycle Time Management Newsletter. In this issue we have an announcement about availability of new papers from the Winter Simulation Conference. Our software tip of the month is about saving data table configurations. We have no subscriber discussion this month, but we are seeking feedback about a metric defined in our main article: WIP hours. WIP hours is a metric used to compute the hours of WIP waiting at each tool, normalized by the number of tools that are qualified to run each wafer. We believe the WIP hours could be useful in identifying short-term bottlenecks and tool groups that could particularly benefit from additional cross-qualification. As always, we welcome your feedback.

Thanks for reading – Jennifer

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Community News/Announcements

Full Papers from the 2018 Winter Simulation Conference Are Now Available Online

One of our favorite resources for papers about planning and productivity improvement for wafer fabs is the MASM Track from the annual Winter Simulation Conference. WinterSim 2018 was held December 9-12 in Gothenburg, Sweden. The MASM (Modeling and Analysis for Semiconductor Manufacturing) track was coordinated by John Fowler (Arizona State University), Cathal Heavey (University of Limerick), and Jei-Zheng Wu (Soochow University, Taiwan, School of Extension Education). You can view abstracts as well as full papers for all of the conference presentations in the WSC Archive (which has papers going back to 1968). Although it's a simulation-themed conference, topics in this session also include scheduling, dispatching, quality management, supply chain management, optimization, variability reduction, and lots more.

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

Save Data Table Column Configuration

FabTime's data tables often contain more detailed information than can be displayed on the chart. For example, the WIP Lot List table includes things like the lot owner, the list of qualified tools that could be processing the lot, the lot's due date and expected ship date, and many other pieces of data. The Lot Progress Chart contains information about which operator entered each transaction, what tool the lot was processed on at each step, and so on. This information is often useful.

However, sometimes there is TOO much information in a particular data table. For example, if you are looking at a list of lots that are in process, you may not be interested in the list of qualified tools that each of the lots could have otherwise been processed on.

Any time you have a data table displayed in FabTime, each column has a "(Hide)" link at the top. Simply click "(Hide)" to remove that column from the display. Currently FabTime reloads the page when you do this, but we will have a new patch soon that allows you to click multiple "(Hide)" links without reloading the page. (Power users know that this will be a nice time-saver.)

Once you have the data table set up the way you want it, you can add the chart to one of your home page tabs. FabTime will save the column configuration for that saved chart and use it next time you drill down to the chart page. If you would like to use that column configuration for other future charts of this type, click the link in "Save current columns as default" above the data table. Note that this option will only be available if you have hidden at least

one column. Once you save the configuration, whenever you generate this type of chart from the chart list in the future, FabTime will use your saved column configuration. Charts that you have previously added to your home page will not be affected.

You can at any time click the link in "Show all hidden columns" to see the hidden columns. You can also use the "Excel (all data)" link to export the full set of chart data, including any hidden columns (or rows).

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!

Subscriber Discussion Forum

FabTime welcomes the opportunity to publish subscriber discussion questions and responses. Simply send your contributions to Jennifer.Robinson@FabTime.com. We have no subscriber discussion at this time but hope that this month's main topic will generate some.

Defining a Metric for WIP Hours

With input from our User Group, we are working to add a new metric to FabTime's software: WIP hours. The idea behind WIP hours is to convert WIP waiting into hours of required processing at each tool. This information is useful in understanding in more detail whether individual tools are currently overloaded. WIP hours as a metric gives people running wafer fabs quick information about the WIP that they might see in queue in front of tools. For example, if you notice a large pile of WIP in front of a tool, but that WIP is labeled "4 hours", you don't have to worry about it too much. But if you come upon a pile of WIP that is labeled 85 hours, this is likely a short-term bottleneck.

In this article, we describe the challenges in defining and implementing WIP hours and the decisions we have made so far. We conclude with a list of unresolved questions that we are working to address. We believe that this metric, though complex to implement, will be of interest to the broader newsletter community. We welcome your feedback.

Background

We saw a mention of WIP Hours many years ago in the context of A20/A80 data. A80 is the availability that a tool can achieve 80% of the time. The general idea was that if you knew how many hours of WIP were waiting for each tool, and you had an idea of a reasonably likely uptime,

you could identify short term bottlenecks. You would use the A80 metric to estimate the number of hours available and then divide that into the number of hours required. You could then look for tools where this ratio was greater than the shift length. We mentioned this idea in our cycle time management course but did not implement WIP hours in our product at the time.

Since then, however, we have not seen WIP hours reported in practice, nor have we been able to find it mentioned in any publicly available documents. If we have missed anything, please do let us know.

Normalized WIP

More recently, one of our customers asked us to add the metric "normalized WIP" into our software. Normalized WIP is useful because WIP is often qualified to run on more than one tool in a tool group. When we present a metric that shows WIP sliced by tool, a given lot may be included in the WIP at more than one of the tools. This means that when we look at the graph, we get a skewed idea of what the total WIP is across the tools (though of course we can view that total in other ways).

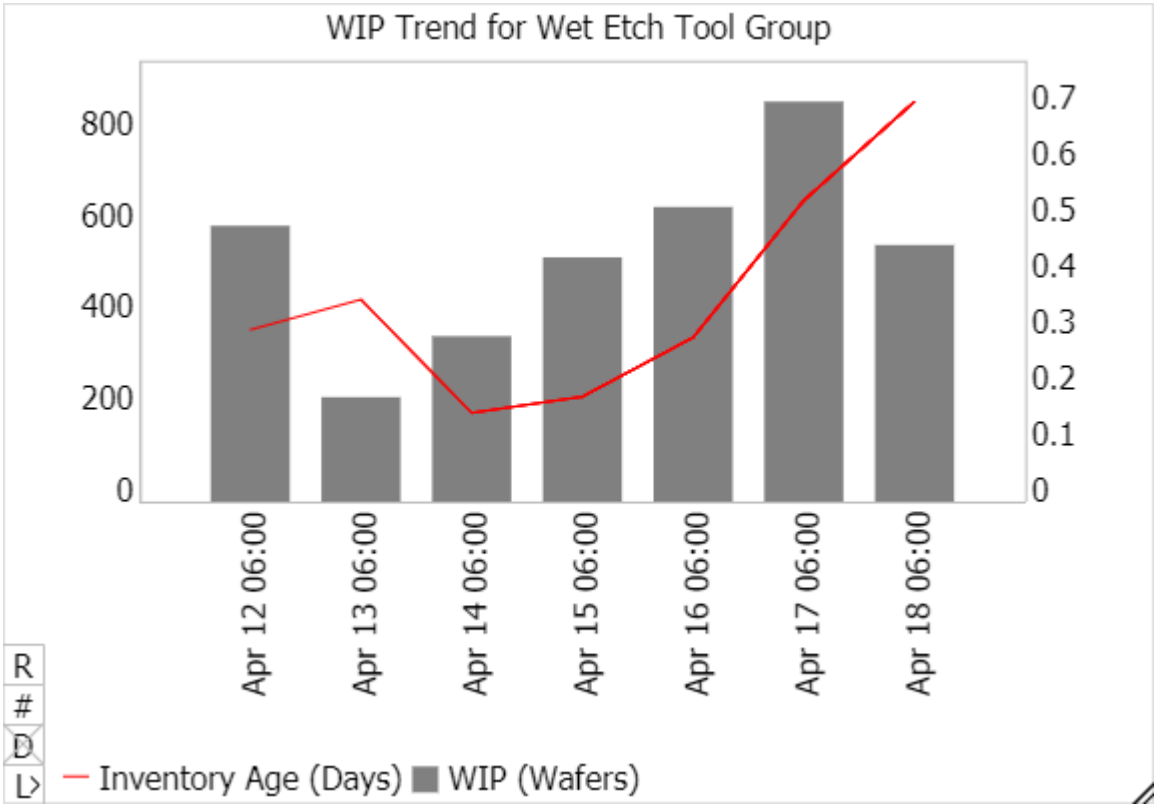
For example, suppose you have 100 wafers in queue, and Etch01 and Etch02 can both process these wafers. If you slice WIP by tool in FabTime, you see 100 wafers in queue for Etch01 and 100 wafers in queue Etch02, for a total of 200 wafers. But, of course, there are really only 100 wafers.

To better handle this issue in FabTime, we added normalized WIP. This is WIP normalized by the number of tools that can process it. When you slice WIP by tool in this example you now see:

Etch01
WIP = 100 wafers
Normalized WIP = 50 wafers

Etch02
WIP = 100 wafers
Normalized WIP = 50 wafers

Or, for an example from FabTime's software (using our demo data), a WIP Trend chart for a Wet Etch tool group with two similarly qualified tools is shown below.

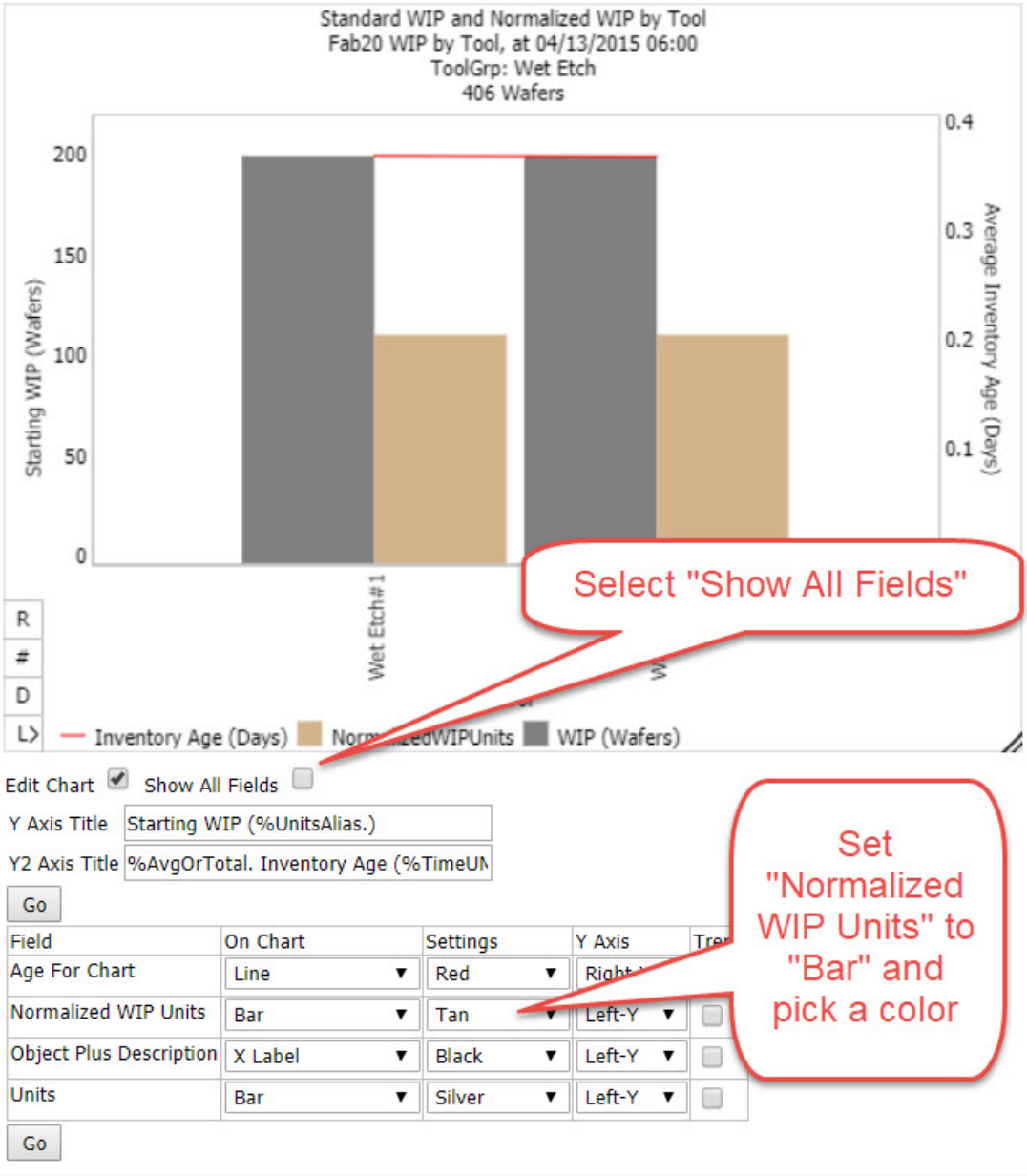


On April 13, this tool group had approximately 200 wafers in queue at the start of the shift. If we slice this bar by tool and use FabTime's "Edit Chart" capability to show the normalized in addition to the standard WIP, we get the chart shown below.

That is, we see the 200 wafers displayed (gray bars) for EACH tool and, also the normalized WIP (tan bars) of approximately 100 wafers for each tool.

WIP Hours

WIP hours takes the concept of normalizing WIP a step further and converts wafers into hours of processing. WIP hours starts off as a simple calculation. If, in the first example above, Etch01 can process wafers at 25 wafers per hour and Etch02 can process wafers at 25 wafers per hour, then on average we can process those 100 wafers at 25 wafers per hour. This means that there is 4 hours of work to do. We have two pieces of



equipment, so we have 2 hours of work for each piece of equipment.

Etch01:
Normalized WIP = 50 wafers
WIP Hours = 2 hours

Etch02:
Normalized WIP = 50 wafers
WIP Hours = 2 hours

However, as with most things involving fab data, it's not always that simple. Here are a few of the complexities that we have identified and addressed (at least provisionally) so far:

1. Does WIP that's already in process count toward WIP hours? We decided "no". We will only include WIP that is in queue. What about post-process WIP, where the tool has sent a signal that the tool is finished, but the lot has not yet been moved out? Should this WIP count toward its next step? We decided "no" here also.

2. Does WIP that's on hold count toward WIP hours? Here we decided "yes" unless the user excludes held WIP from the chart. The ability to exclude held WIP from any WIP-related chart is standard in FabTime already.

3. What if Etch02 is down? Do we still count it as an available tool, or do we shift its two WIP hours onto Etch01? There are arguments for both approaches here (since we don't know how long Etch02 will be down), so we decided to have two metrics:

- WIP Hours per tool (original metric).
- WIP Hours per effective tool (divide work only across the up tools, or if a percent effective is known, take that into account).

4. What if there's missing UPH data for a particular tool or overall? We decided to fall back to flow/step-level planned process times in this case. This means lot size won't be taken into account, but if there's no UPH data then there is no direct way to take lot size into account. Our algorithm uses UPH data and lot size if available, but substitutes the planned process time if needed for particular tools.

5. What if the UPH varies among the tools, e.g. 25 wafers per hour for Etch01 and 28 wafers per hour for Etch02? We decided to compute WIP hours at the tool level, sum these WIP hours, and then divide by the number of tools (to compute WIP hours at the tool level) or number of effective tools (to compute WIP hours per effective tool). In effect, we use a weighted average of the UPH rates.

6. What if WIP is queued at a clean step even though it's waiting for a furnace? We want WIP hours for the furnace to count the WIP that is queueing at the clean steps. We decided to support site-specific logic:

- Input: List of Flow/Step pairs where WIP is currently queued.
- Output: List of Flow/Step pairs and an indication (if any) of another step (or steps) where the WIP should be counted toward WIP hours.

In this case, a given lot is included in the WIP hours for both the clean step and the furnace step (since it does need to be processed at both).

7. What if WIP is queued at a step where there will be back-to-back (or back-to-back-to-back) processing? For example, suppose WIP is queued in front of an implanter and the implant takes 2 hours. But suppose the next two following steps are also implants on this same piece of equipment, so really this is 6 WIP hours for this implanter. We *think* we can use the same site-specific logic as will handle the clean/furnace situation to handle back-to-back processing. We are still working on the details.

Open Questions

Several other questions remain as we implement WIP hours.

- Will the calculations be able to look forward in time and include lots that are scheduled to arrive? Should they?
- How will we identify clean-furnace situations in the flow-step data? A process engineer looking at the flow data can quickly spot clean-furnace pairs based on step name, qualified tool data, or other clues. How will an algorithm identify these pairs, if they are not tagged in the MES flow/step data?
- How will we identify back-to-back processing in the flow-step data? This is the same situation as for clean-furnace pairs.
- How will effective WIP hours handle tools that are partially down? How will FabTime know this?
- What slice-by variables will we support? Would it be Tool and all tool groupings (ToolGroup, Area, etc.)? "Slice by" is FabTime's terminology for creating a pareto chart and slicing the data by a variable.

Conclusions

We believe that a metric reporting hours of WIP in queue for each tool (or each tool that is available) will be useful for people managing fabs. WIP hours could be used to identify short-term bottlenecks as well as tool groups that would benefit from additional cross-qualification (where WIP hours vary considerably from tool to tool). WIP hours is easy to explain as a high-level concept but gets trickier once one digs into the details. In this article, we have defined WIP hours and discussed implementation issues, both those that we have already resolved and those that we are working on. We hope to share a followup article in the future that includes success stories from those who have used WIP hours in practice.

Closing Questions for Newsletter Subscribers

Have you implemented a WIP hours metric at your site? How about normalized WIP? Do you see value in this metric? Do you have any thoughts that you would be willing to share regarding the open implementation issues?

Acknowledgements

We are grateful, as always, for our User Group for their suggestions and feedback regarding WIP hours. Special thanks to Jason Burk (Microchip Technology), Hani Ofeck (TowerJazz Semiconductor), and Nick Paxton (ON Semiconductor) for their contributions to the discussion.

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Jim Wright
Production Manager
Headway Technologies

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- Improve supervisor productivity – cut reporting time by 50%.
- Improve IT productivity – eliminate need for custom reports.