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FabTime® Newsletter

Volume 27, No. 3 **September 2026**

Information

Publisher: Acquired by INFICON in 2024, FabTime has been helping fabs with cycle time and performance improvement since 1999. FabTime's flexible reporting software, cycle time management course, and this newsletter are now part of the INFICON Intelligent Manufacturing Systems (IMS) group.

Editor: Jennifer Robinson, Cycle Time Evangelist for INFICON

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Keywords: Fab metrics; equipment maintenance; wafer fab management; fab health

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Welcome

Welcome to Vol. 27, No. 3 of the FabTime Cycle Time Newsletter. For our main topic, we describe ten metrics that, together, indicate a healthy wafer fab. We also share discussion with subscribers about recommended reading, maintenance metrics, and formatting home page tab annotations. We have announcements about FabTime version 2610, the recent Fab Owners Alliance meeting, and INFICON's plans for the upcoming SEMICON West convention.

Thanks for reading! – Jennifer

Community News/Announcements

In this month's announcements, we share release notes for FabTime software version 2610. We also have announcements about the recent Fab Owners Alliance meeting in Maryland and INFICON's participation in the upcoming SEMICON West event.

Q3 FOA Recap

Mario Faria, **Jennifer Robinson** and **Carlo Verdino** (shown left to right) represented INFICON at the Q3 Fab Owners Alliance meeting. The meeting was hosted by Northrop Grumman in Linthicum, Maryland. INFICON sponsored the Women of the FOA (WFOA) meeting, where Jennifer presented on INFICON's AI product strategy and co-led, with **Jeannie Jesson**, a group discussion about women and AI (photo credit **Raschell Hickmott**).

Jennifer also presented survey results at the supplier partner meeting, together with Supplier Partner Advisory Council (SPAC) co-members **Andrew Seward**, **Matt Ritchie**, and **Raschell Hickmott**. Highlights of the meeting for the INFICON team also included evening social events at the local Guinness factory and TopGolf.

INFICON at SEMICON West

INFICON will have a booth and extensive representation at SEMICON West next month. Highlights include:

- **John Behnke** presenting *From Always-On to Intelligent Control: Closing the Subfab Gap with Factory-Integrated Control* in the SCIS Forum on Tuesday, October 13th from 12:15-12:35 pm Pacific Time.
- **Igor Kuvychko** and **Holland Smith** presenting *Scaling Factory Scheduling for Modern Back-End Semiconductor Manufacturing* in the Smart Manufacturing Pavilion on Wednesday, October 14th from 11:35-11:55 am Pacific Time.
- **Chunhua Song** presenting a poster on *Advancing QCM Sensors: From Established Applications to AI-Driven Innovation* in the Test Vision Poster Session and Reception on Wednesday, October 14th from 3:10–5:00 pm Pacific Time.
- **Jennifer Robinson** participating in a panel discussion during the **Women's Lunch**, co-sponsored by the Women of the FOA, and the **Women's Walk**, both scheduled for Wednesday, October 14th.

Stop by and see us at **Booth #5268** in the North Hall, conveniently located across from the **Smart Manufacturing Pavilion.**

FabTime software version 2610 is available for customer testing

The latest version of the FabTime flexible reporting software is currently available for customer testing and is installed on several customer test servers. Contact your FabTime support engineer for information about getting a preview of this update installed at your fab. Highlights of 2610 include:

Major Updates

- Home page chart annotations: user-defined text boxes that can be added above each chart, with markdown formatting available
- Trending multiple date ranges on a single chart: users can now enter multiple date ranges. For example, you might include scrap by quarter for the prior year on the left as a reference, followed by scrap by day for the current week or month to the right.
- AskJen 3.0: integrated access to FabTime software tips and help and past cycle time newsletters, with ability to create individual charts or full, annotated home page tabs
- Alert run-time budgets: daily limits on run time for individual alerts, to improve overall system performance
- Analyze 3-level and 4-level pivot tables with first-class support for Ag-Grid pivot charts.

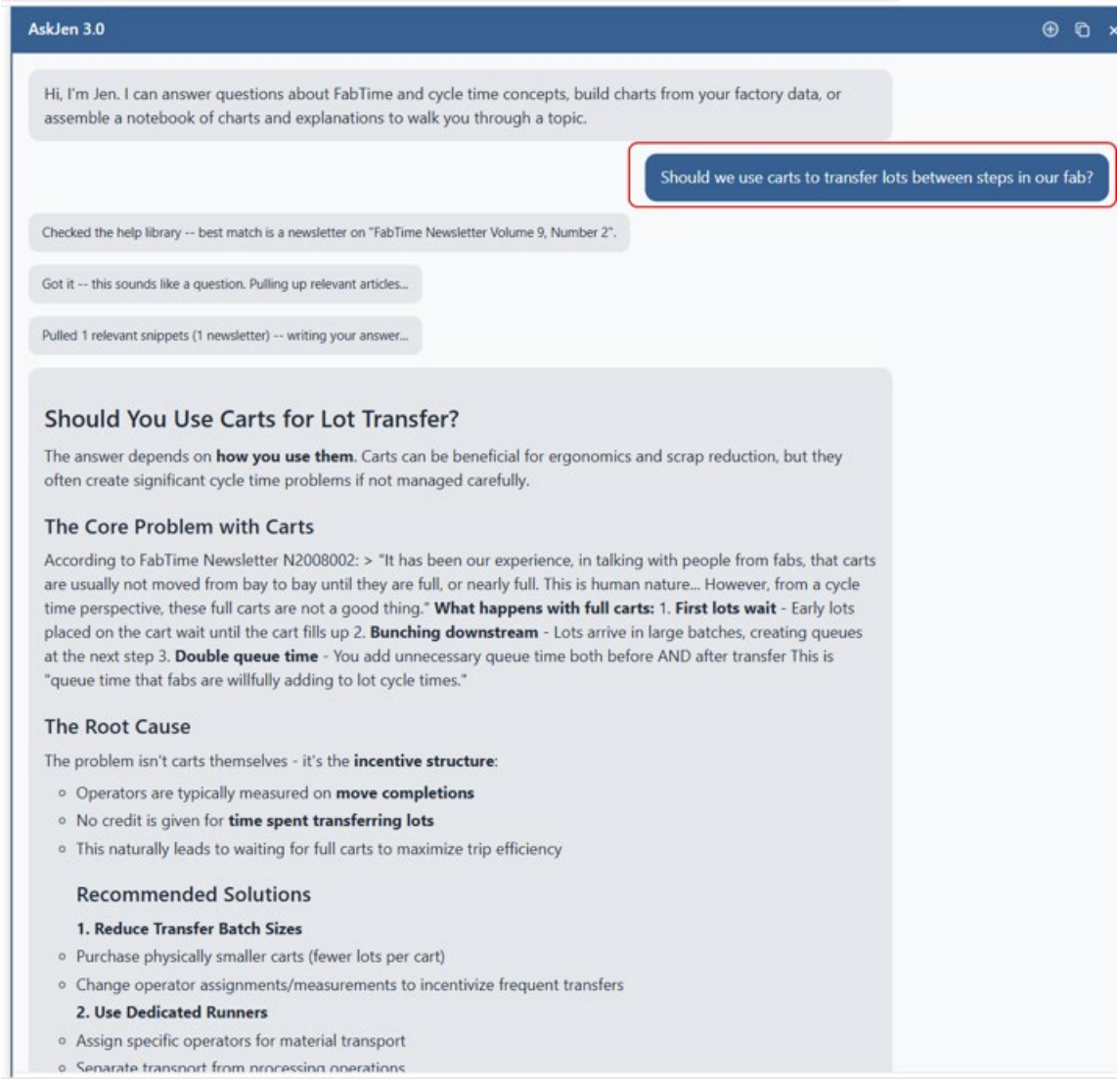
Minor Updates

- M-Ratio and PM-Ratio: metrics that distinguish between planned maintenance and more disruptive unplanned downtime
- Display QR codes in grids for operator use, e.g. to scan a lot number.
- Chart hover (i) info icon to give users the information that they need to re-create shared charts on their own
- Improved placement and configurability of AG Grid custom charts

AskJen 3.0 Example:

In addition to asking software and chart questions, you can use AskJen 3.0 to ask factory performance questions. AskJen will search the past FabTime newsletters and generate a mini-

article in response to your question. The article will link directly to source material within the FabTime help system (help articles, FabTime newsletters, and FabTime software tips). In the example below, we ask “Should we use carts to transfer lots between steps in our fab?” This was covered back in Volume 9, Number 2 (2008!). The first part of the response is shown below.



Interesting Reads

Semiconductor Insights and Productivity Tips

Recent articles shared on Jennifer’s LinkedIn include:

- A link to a white paper about how INFICON is applying modern scheduling techniques to **improve back-end manufacturing performance**. This solution is in production in a large back-end factory in Asia today.
- A link to another white paper about how INFICON has been working with STMicroelectronics to develop **Impact Manager**, “a smart factory supervision and control

room application built on digital twin technology from INFICON. Impact Manager continuously monitors factory KPIs and operational conditions, automatically identifying current and emerging anomalies such as tool downtime, bottlenecks, lot holds, queue time risks, and AMHS disruptions."

- A New York Times story in Jennifer's local newspaper about **Intel's recent turnaround progress**.
- A news release from NVDIA about the Wistron assembly and test factory that opened in Fort Worth in July, "a 324,000-square-foot greenfield plant producing superchips at the heart of some of the world's most capable AI systems."
- I've been following in general efforts to bring more semiconductor manufacturing to the US. I thought this was an interesting story from CNBC about the **impact of Micron Technology's Boise expansion on the local economy**.

For more industry news, connect with Jennifer on LinkedIn.

Subscriber Discussion Forum

We have subscriber discussion about our recommended texts for understanding fab operations, a follow-up to Q2's discussion of maintenance metrics, and formatting home page tab annotations in FabTime. If there is a topic you've been wondering about, please reach out to Jennifer on LinkedIn.

Software Tip: Learn to use home page annotations and format them with markdown script

This topic comes from a discussion in our June FabTime User Group meeting. A new feature in FabTime 2610 is home page chart annotations. These are user-configurable text boxes that can be inserted above any home page chart and formatted for increased visibility. To add an annotation to any chart:

1. Mouse over the upper left-hand corner of the chart. A small toolbar appears. Click the "+" in the toolbar. This adds a text box above the chart.
2. New text boxes contain sample text that describes how to use markdown script to format your text.
    a. Adding a hashtag prior to a line of text displays that line in top header format. Adding multiple hashtags creates lower-level sub-headers (up to six).
    b. Using a dash prior to each row of text displays the text as a bulleted list.
    c. Using a number followed by a period and a space for each row displays that text as a numbered list (the numbers you use don't have to be sequential – they will still display in numerical order).
    d. Using ** before and after a word or phrase displays that text in bold. Single * displays in italics. Triple *** displays in bold and italics.
3. After adding your text, press "Save" to exit the text editor and display the annotation.

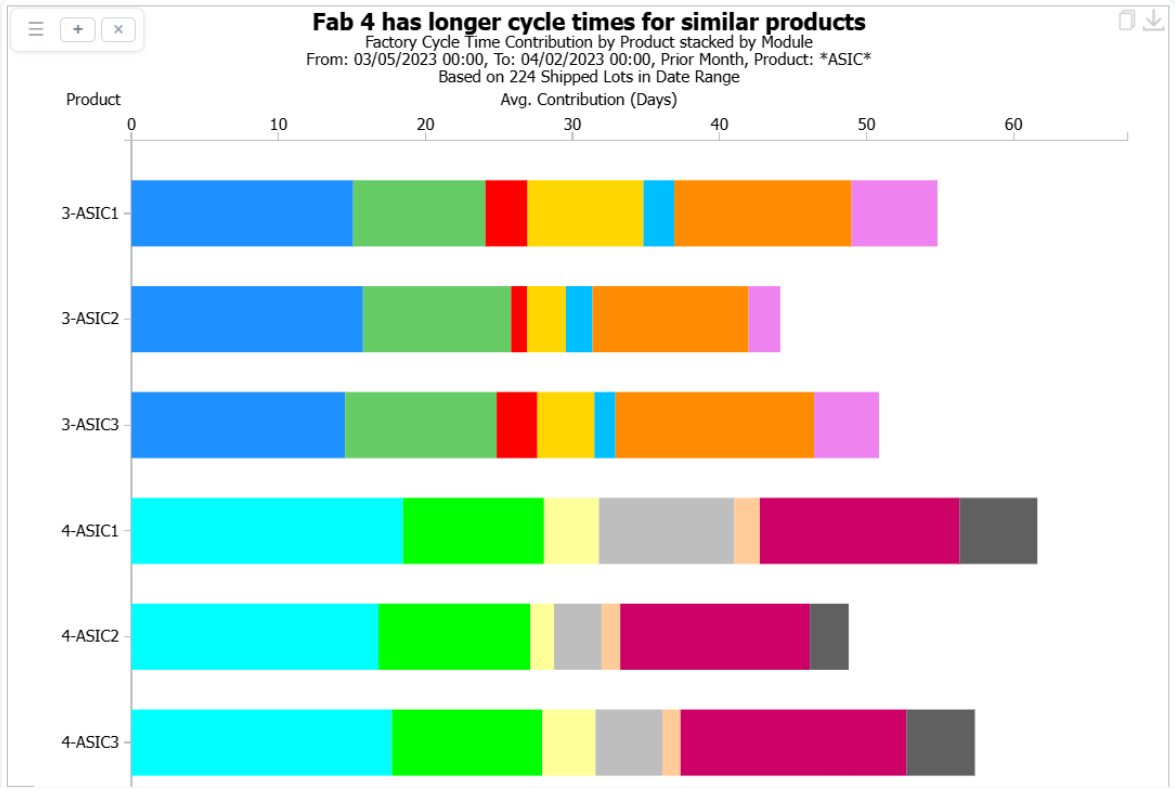
4. Mousing over the left-hand corner of the annotation reveals the same small toolbar. Use the three horizontal lines to drag the comment elsewhere on the home page tab or use the “X” to delete it.

If you would like to keep a history of the annotations in FabTime, there are currently two options (additional functionality will be available in future software versions).

1. Copy your entire home page tab. Rename and save the annotated version. For example: Morning Meeting – Work Week 27.
2. Add more than one annotation above each chart and include the date for each one. An example showing quarterly cycle time by product for two factories is shown below:

> Q1 cycle time notes (graph not shown)
>
> Cycle times for the two fabs were similar for similar products.

> Q2 cycle time notes (shown)
>
> CT was longer for Fab 4 than for Fab 3 for similar products, due to critical downtime of a one-of-a-kind tool in Fab 4.



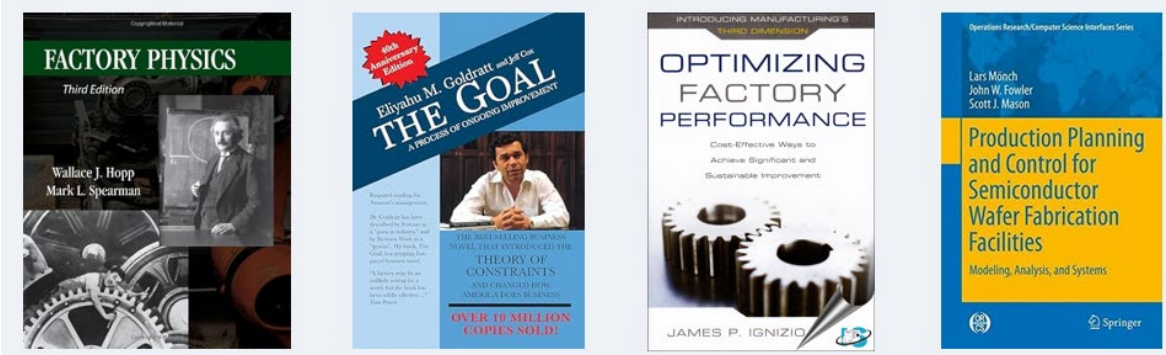
Software Tip: Add site-specific content to AskJen 3.0

As described in this month’s community announcements, you can use the new AskJen 3.0 chat engine in FabTime to ask factory productivity or cycle time improvement questions. The results normally draw on past FabTime newsletters, software tips, and help files. However, a member of

our User Group asked an excellent question about including site-specific content in the responses. This is possible today, by adding site-specific help content to FabTime. AskJen 3.0 gives preference to focused tips (checklists), so we recommend these as a starting point. To add content, work with your FabTime support engineer.

Recommended reading for understanding wafer fab operational performance

What we're sharing here is not a question that was asked by any individual subscriber, but rather, a resource that we think that subscribers to this newsletter may find useful. There are four books that we reference and recommend that can help those looking to better understand and improve wafer fab performance. For the first two, we (Jennifer Robinson and Frank Chance) wrote reviews back in the early days of FabTime. The other two we have not formally reviewed but do recommend. To see other books that we read and recommended during our FabTime days, download this PDF: Business Book Reviews.



Factory Physics, Third Edition by Wallace J. Hopp and Mark L. Spearman, Waveland Press, 2011.

Factory Physics is the kind of textbook that people refer to while doing jobs out in the real world. It places a mathematical framework around the behavior of factories, describing the underlying relationships with clear, easy-to-read examples and summing them up into straightforward Factory Physics Laws.

The book is targeted toward factory operations. The first section is a review of the traditional production management curriculum, including inventory models, MRP and JIT. The second section contains what we find the most useful material in the book, with chapters on basic factory dynamics, variability, and pull production systems. The third section puts the principles from the second section to use, and includes chapters on total quality management, production planning, shop floor control, scheduling, capacity planning and inventory management.

This book is filled with simple numeric examples and charts but does not shrink from including queueing formulas where they are necessary. The Factory Physics Laws are easy to remember, but also important. For example, Law 11 states:

> "Pay me now or pay me later: If you cannot pay for variability reduction, you will pay in one or more of the following ways:
>
> 1. Long cycle times and high WIP levels.
> 2. Wasted capacity (low utilization of resources)
> 3. Lost throughput "

We recommend this book for those who have some engineering background but want to better understand factory operations and planning systems. It's the text that we would use if we were teaching a course on the subject.

The Goal: 40th Anniversary Edition by Eliyahu Goldratt and Jeff Cox, North River Press, 2012. Also now available as a 2024 graphic novel illustrated by Dean Motter.

This book has been widely read by semiconductor manufacturing personnel since it was first published in 1984. It accurately describes the behavior of manufacturing facilities, including such fundamental concepts as bottlenecks, constraints, and the impact of variability. One reason why it has been so broadly read is that it frames these concepts in the guise of a novel. This makes the ideas easy to read and digest.

The premise is that Alex, a factory manager, is given an ultimatum -- dramatically improve the performance of his factory in three months, or the facility will be shut down. Believing that traditional improvement strategies will never make enough difference in such a short time, Alex must resort to more desperate measures. He tracks down an old professor, now working as a consultant, and begs for advice. The advice of this consultant, Jonah, sets Alex and his team on a journey. Instead of just giving them the answers, Jonah asks them questions, and refuses to give more help until each question has been answered. As Alex learns through this process, so does the reader.

Some of the lessons of the book include the following.

- When you are productive you accomplish something in terms of your goals. Every action that brings a company closer to its goal is productive. The goal of a manufacturing organization is to make money.
- Because of variability, a factory cannot be run at 100% of capacity. Or, as Jonah says, "the closer you come to a balanced plant, the closer you come to bankruptcy."
- One of the biggest problems in improving your factory is collecting the right data. Alex eventually concludes that "we're going to have to accept the fact that we're not going to have perfect data to work with."
- "An hour lost at the bottleneck is an hour lost for the entire system … The actual cost of a bottleneck is the total expense of the system, divided by the number of hours the bottleneck produces." This suggests managing bottlenecks very closely. This idea has spawned numerous consulting and software firms since the book was published.
- Non-bottlenecks do not need to be regulated so closely and should not be operated to maximize utilization. Jonah says that "activating a non-bottleneck to its maximum is an act of maximum stupidity." [Side note: this is why striving for maximum OEE for non-bottleneck tools is unhelpful.]

We think that everyone who works in a manufacturing facility should read this book at least once. We re-read it at regular intervals and always find it insightful. Though we haven't read it, there is now a graphic novel version available.

Optimizing Factory Performance: Cost-Effective Ways to Achieve Significant and Sustainable Improvement by James P. Ignizio, McGraw Hill, 2009.

While we have not formally reviewed this book, we did reference it recently when writing about The Waddington Effect (see Issue 25.06). Here is the most relevant part of the book's description on Amazon:

> "Focusing on the three primary enemies of factory performance—complexity, variability, and lackluster leadership—*Optimizing Factory Performance* cuts to the heart of the problem of less-than-world-class performance and demonstrates how those enemies manifest themselves in companies across manufacturing sectors. Ignizio also explores the insidious effect company politics and flagging commitment to manufacturing performance have on competitiveness."

Note also that this book is an excellent resource for information about M-Ratio, which is discussed below.

Production Planning and Control for Semiconductor Wafer Fabrication Facilities by Lars Mönch, John W. Fowler and Scott J. Mason, Springer, 2013.

This text, published in 2013, bills itself as the first book to tackle the problem of production planning and control as applied to the complex environment of semiconductor wafer fabrication facilities. It covers the semiconductor manufacturing process, dispatching, scheduling, order release, capacity planning and production control (circa the early 2010s). The authors brought extensive academic and industry backgrounds to the project, and the book is full of useful illustrations and references. Recommended for industrial engineers and others looking to dive deep into these topics.

Following up on maintenance metrics: PM-Ratio and M-Ratio

In the subscriber discussion forum of the previous issue, we discussed two metrics for encouraging preventive maintenance over more disruptive unscheduled downtime. We reviewed M-Ratio (a long-time metric used by people in the industry) and introduced a new, similar metric requested by one of our customers.

This is just a quick follow-up to let readers know that we have named the new metric PM-Ratio. We have added both M-Ratio (**scheduled downtime % / unscheduled downtime %**) and PM-Ratio (**scheduled downtime % / (scheduled % + unscheduled downtime %)**) to the data table for FabTime Tool State charts.

We also received feedback on these metrics from regular newsletter contributor **Thomas Beeg**, who writes the ever-useful Factory Physics and Automation blog. Thomas said: "my vote is to keep to M-Ratio, which is known to some extent already. Some of my thoughts on the topic I have shared on my blog here and here." The second of these links includes the results of a poll on M-Ratio values achieved in the semiconductor industry (albeit one with a low number of responses), as well as proposed M-Ratio classes for wafer fabs.

While we take Thomas' point that M-Ratio is already better known, we do think that there is value in making PM-Ratio also available. One nice thing about PM-Ratio is that it is reported on a scale of zero to one, whereas for M-Ratio there is theoretically no upper bound. To implement M-Ratio in FabTime, we had to select a maximum value for display, which we set to 10. Thomas' survey results suggest that in the real world, M-Ratio values are highly unlikely to exceed 10, and in fact rarely exceed five. We also set M-Ratio to 10 when the denominator (unscheduled downtime %) is zero. We set PM-Ratio to 1 when the denominator is zero.

Why Track These Metrics?

- These metrics help distinguish planned maintenance (predictable, manageable) from reactive unscheduled downtime (disruptive, costly)
- On tool-state trend charts, these metrics reveal whether rising downtime reflects planned work or growing equipment problems
- On Pareto charts, tools with low M-Ratio or PM-Ratio are the highest priority for maintenance discipline improvement
- These metrics complement utilization metrics by revealing downtime quality, not just quantity
- Note: M-Ratio and PM-Ratio appear as data table columns only — they are not plotted on the tool state charts by default

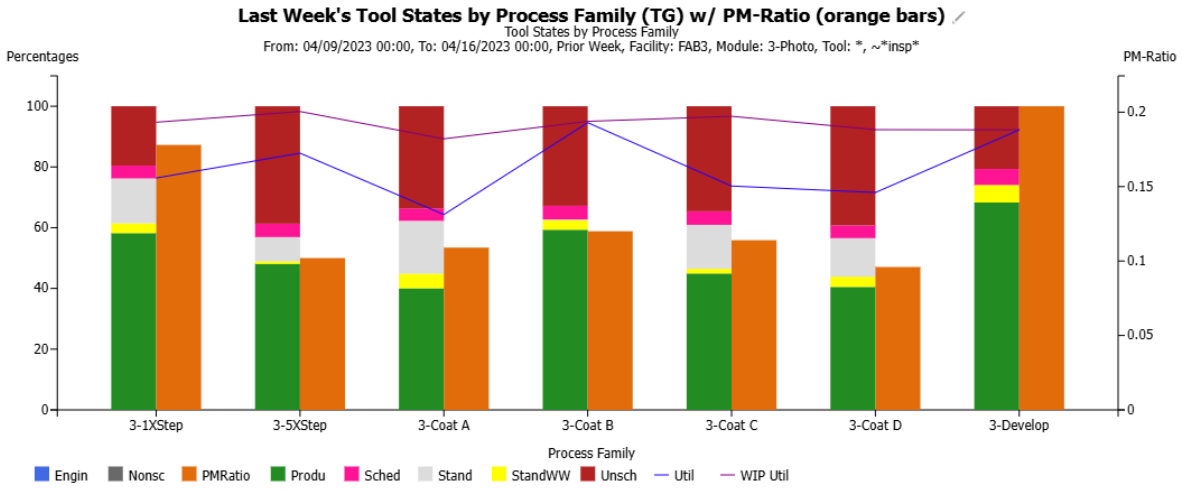
Why Keep Both?

- Some sites use one…
- And some may prefer the other!

How do I display M-Ratio in FabTime?

To display M-Ratio or PM-Ratio by tool group in FabTime, use the "Edit Chart" functionality, as follows (the instructions are similar for display on a trend chart):

1. Create a Tool State Pareto chart. Slice by Process Family/Tool Group, set the date range to be at least a week, and filter to include your tool groups of interest (e.g. filter by module).
2. Click "Edit Chart" below the chart and/or data table.
3. Set the "On Chart" column for the "Avg WIP (wafers)" row to "Unused". This is so that you can use the right-hand axis to display M-Ratio or PM-Ratio.
4. Click the box next to "Show All Fields."
5. Find the row for either M-Ratio or PM-Ratio and change the "On Chart" column to "Bar" or "Line" as you prefer. Select a color in the next column. Change the value in the "Y Axis" column to "Right-Y".
6. Change "Y2 Axis Title" to "M-Ratio" or "PM-Ratio" instead of WIP (Wafers).
7. Scroll up to just below the chart and click the box next to "Activate these edit-chart settings?"
8. Add the chart to a home page tab to save. An example of the resulting chart for PM-Ratio is below.
9. Because the scale of M-Ratio is ten times the scale of PM-Ratio, we recommend adding one or the other, but not both. If you would like to include both, one option is to remove all the other data from the chart (except for the "Process Family (description)" row, which is needed for x-axis labels), and put M-Ratio on one Y-axis and PM-Ratio on the other.



Main Article: Ten Metrics for Fab Health

By Jennifer Robinson

Ten years ago, in Issue 17.03, we published a newsletter about why fabs require multiple metrics. We said:

> Wouldn't it be great if there was a single metric that you could use to monitor the health of your fab? You could track performance to this metric in a highly visible way and ensure that everyone in the fab was on board with improving it. This is something we've had people ask us about, or seen people try to implement in their fabs.
>
> Unfortunately, however, running a fab is not that simple. Fabs are complex, dynamic entities. Actions that drive improvements in one metric are often harmful in some other way. Fabs must strike a careful balance between driving up utilization, driving down cycle time, and maintaining high yields. [See recent newsletter articles about trade-offs between cycle time and cost and cycle time and yield.] Fabs must balance keeping things moving (for throughput) and dampening variability (for cycle time). What's really needed is a cohesive framework of metrics that work together to drive the overall goals of the fab in the right direction.

In that prior issue, we reviewed several candidates for "the" fab metric and proposed a framework for managing the fab by looking at different metrics at the strategic, tactical and operational levels.

Since publishing that article, our thinking about this has evolved. We now think that what would be more useful is a **daily fab health scorecard**: a set of key metrics that, if all kept in line, will drive the fab in the right direction. This idea is like the recent trend towards personal health dashboards, where there's no single health score. In both cases, a lag in *any* indicator could inspire action.

This, of course, has long been the approach with INFICON's Factory Dashboard product (formerly FPS Dashboard). Factory Dashboard provides a user-friendly and concise overview of the factory's real time status and priorities, including real-time bottleneck identification. The Dashboard format is relatively fixed, however. There's benefit to a more flexible, adaptable framework of fab health metrics that can be customized to different types of factories, market conditions, or roles within the factory.

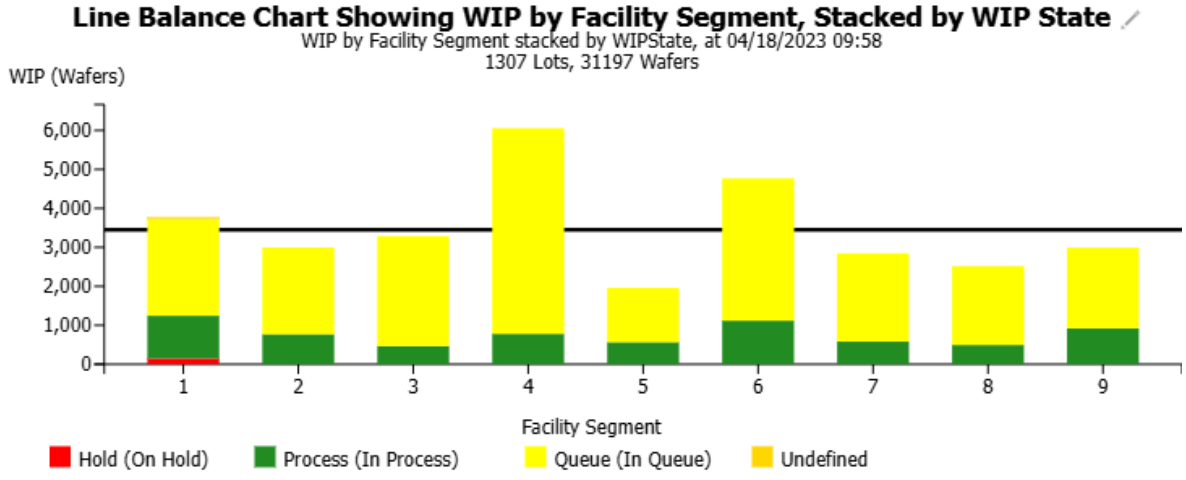
In this article, we discuss ten fab indicators that, if all on target, indicate that your fab is healthy and running smoothly. Depending on the situation in your fab today, you can decide which of these deserve immediate emphasis.

1. Your WIP is balanced

There are two things we can mean when we think about WIP being "balanced" in a factory. We can mean balanced across tool groups or balanced along process flows. The latter is the one people usually mean when they refer to line balance in a wafer fab. But let's first look at balance across tools.

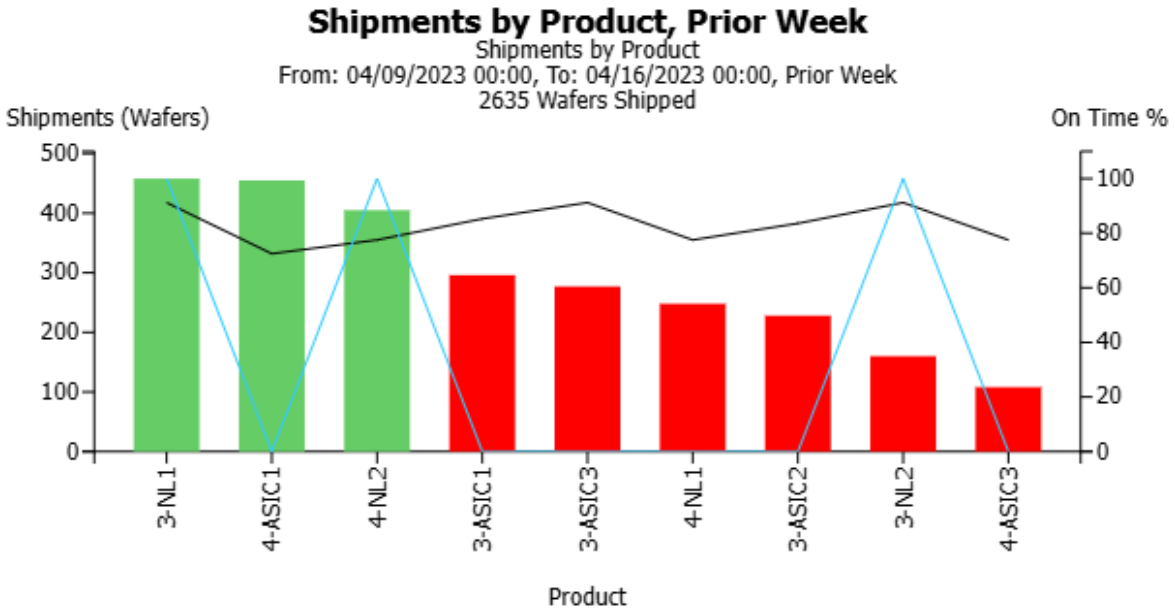
Balance across tool groups: Some factories can be run, as advocated in Eli Goldratt's *The Goal,* by subordinating everything else to the bottleneck (the tool group with the highest planned utilization). However, this approach is insufficient for a high mix, reentrant wafer fab with unreliable tools. While we can and should keep a close eye on the fab's planned capacity bottleneck, equipment loading can vary due to changes in product mix and/or availability. Short-term, downtime- or variability- driven bottlenecks can arise at any time. This makes it risky to starve near-bottlenecks at the expense of "the" bottleneck. While it makes sense to maintain higher WIP levels at higher utilization tools, to avoid the chance of those tools being starved, we need some balance of WIP across those more highly loaded tool groups. We don't want to see 99% of the WIP sitting in front of the DUV stepper, and everything else sitting idle.

Balance along process flows: Long wafer fab process flows make it necessary to maintain WIP at different stages of completion, to maintain a smooth flow of departures from the fab. For this reason, it makes sense to have WIP distributed relatively evenly across the line. Most fabs accomplish this by generating a line balance chart, as shown below. Each process flow is divided into segments. Typically, each segment represents approximately one week of cycle time. It is also possible to use smaller sub-segments, or even operations, to make the chart more detailed. The line balance chart shows the current WIP in each segment and is reviewed daily. The goal is to minimize differences between the segments. (This can also be achieved by looking at cumulative WIP vs. remaining planned cycle time.) When the line is balanced, we know that we can achieve regular shipments and absorb regular new lot releases. In the example below, segment five is relatively starved, while segments four and six have excess WIP. The balance in this fab could be improved. (See the Subscriber Discussion Forum for Vol. 27, No. 2 for instructions for generating a line balance chart in FabTime.)



2. You're meeting shipment and on-time delivery targets

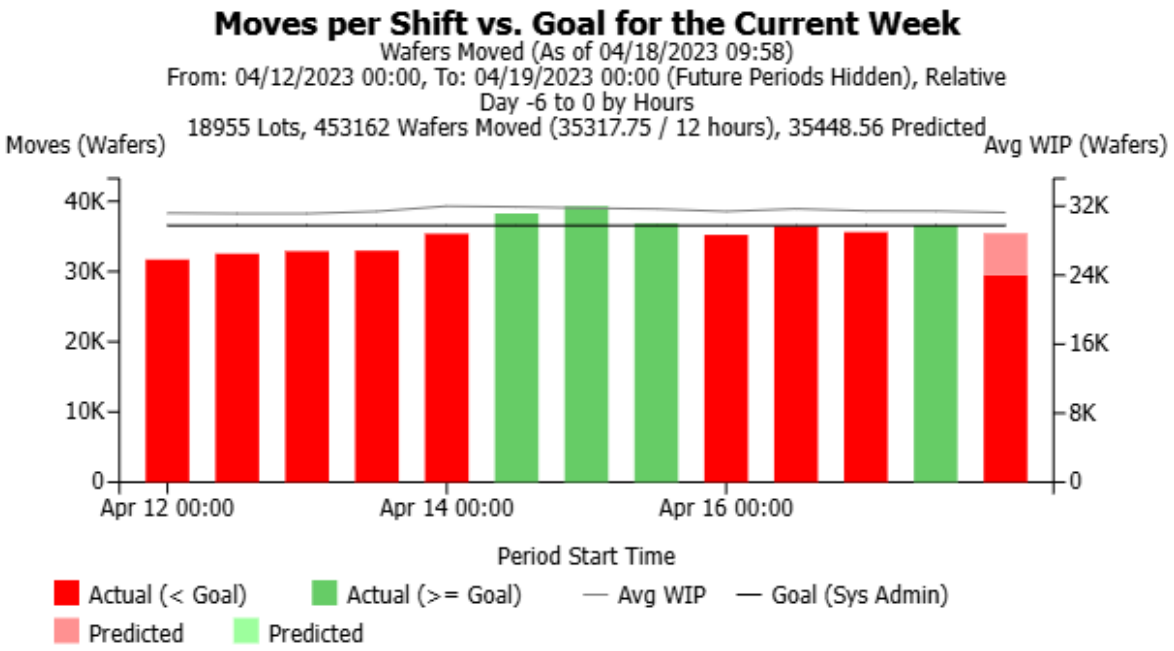
If your line is balanced, your weekly shipment levels should also be relatively balanced. But it's also important to be shipping the right products and shipping them on time. A healthy fab can meet weekly shipment targets by product. In the example below, the fab is only meeting shipment targets for three of the nine major products (indicated by the green bars, which are above the black goal line). On-time delivery performance (the blue line) is extremely poor, only at 100% for two of the products (and at zero % for several products).



3. Your current pace is sufficient to prevent future shipment problems

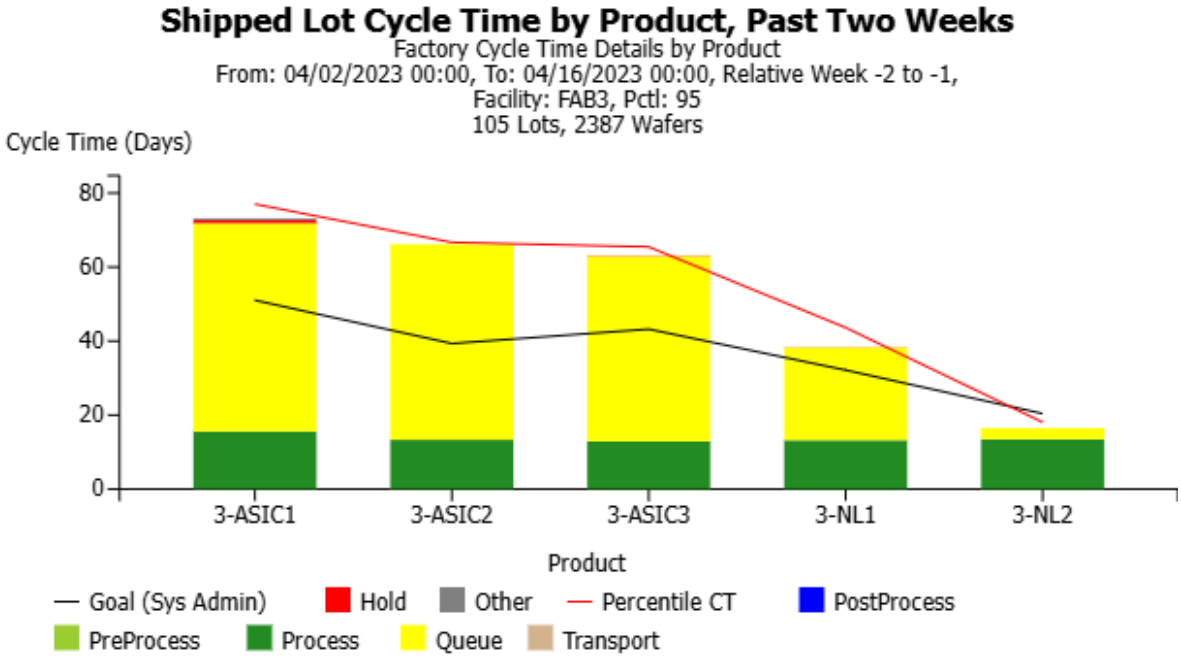
The most common fab health metric is total moves per shift. If your fab is not meeting moves targets, you will not be able to meet future shipment targets. It is of course possible to meet moves targets without moving the right WIP (only doing the easiest moves, avoiding setups and leaving low volume lots to sit forever, etc.). This is why overall moves can't be your only fab health metric. But it is certainly true that if your fab is NOT meeting moves targets, there is a problem that needs to be addressed.

In the example below, the fab has consistently struggled to meet the goal for moves by shift for the prior week. For the current (right-most) shift, the light red portion of the column indicates risk of missing the move target at the current pace. An hourly moves chart for the current day or shift is also recommended. Some fabs also look, by major route, at moves by operation for the current day or shift vs. a dynamic goal, to identify any gaps. Such granularity in tracking performance to move targets by operation is most suited to fabs that use a scheduler (such as the INFICON Factory Scheduler) to generate daily or weekly move targets by route-operation.



4. You're meeting cycle time targets

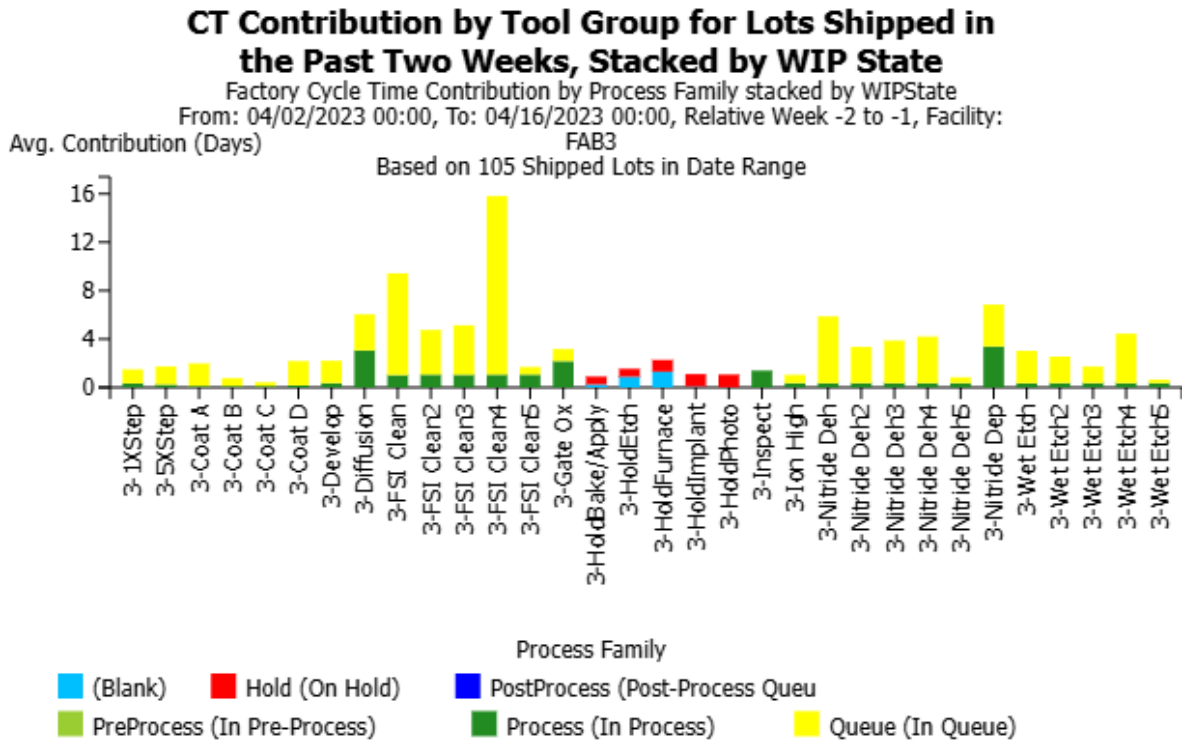
Shipped lot cycle time is a trailing metric. It doesn't tell you much about how to improve future cycle time. However, consistently failing to meet shipped lot cycle time targets and customer due dates is a likely indicator of operational problems. Shipped lot cycle time can also be useful in setting due dates for future lots, and in benchmarking improvement opportunities. In the example below, only the NL2 product had cycle time below the goal (black line).



If your shipped lot cycle time is increasing, or is higher than you expect/prefer, a useful next step is to look at the contribution of different tool groups to overall cycle time. Because of the reentrant

nature of semiconductor processing, queue time accumulates across all visits to a tool group. Looking at the cumulative contribution of each type of tool to cycle time by product can identify improvement opportunities.

For example, in the chart below, we see that on average, the FSI-Clean4 tool group contributed 16 days of cycle time to each lot that used it (about half of the total WIP). Of those 16 days, 14.8 days (the yellow) was queue time. Improvements at FSI-Clean4 could reduce overall cycle time for some products by more than two weeks.

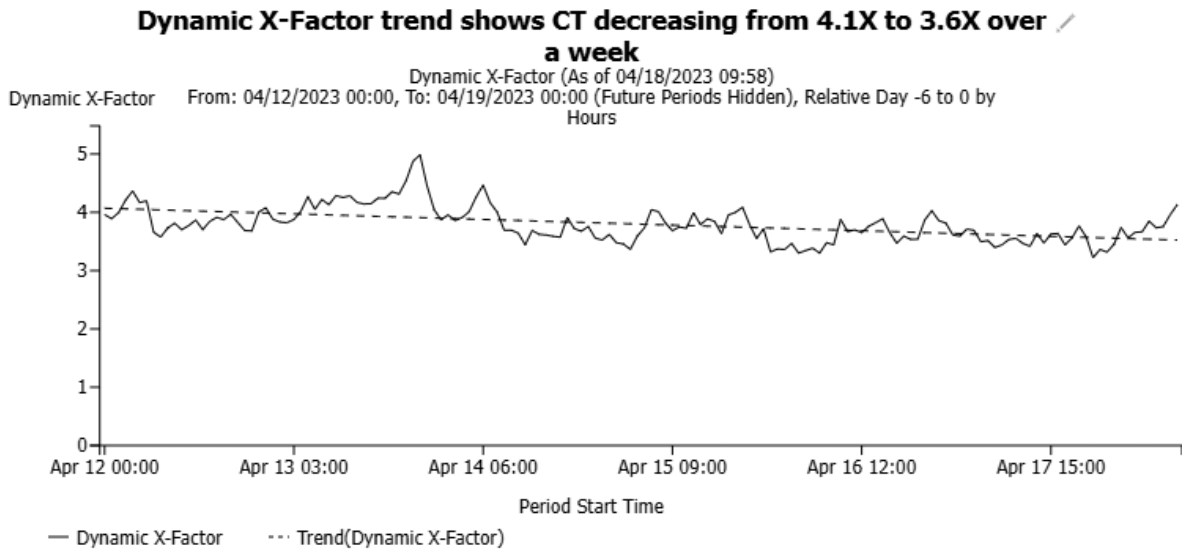


Of course, this chart is based on shipped lot cycle times, and the current situation in the fab could be quite different. FabTime also has a version of this chart based on elapsed cycle time contribution between two operations. This chart can give more current results, as can other forward-looking cycle time metrics, as discussed below.

5. Your forward cycle time isn't trending up

There are several forward-looking cycle time metrics (WIP Turns, Dynamic Cycle Time, Dynamic X-Factor). See Issue 24.03 for details. The important thing is to keep an eye on at least one of them, to ensure that future cycle time isn't creeping up. Even if your current shipped lot cycle time is stable, it's possible for increases in start rate or variability to drive future cycle time increases. The earlier you become aware of problems, the better your chance of keeping things from getting out of control.

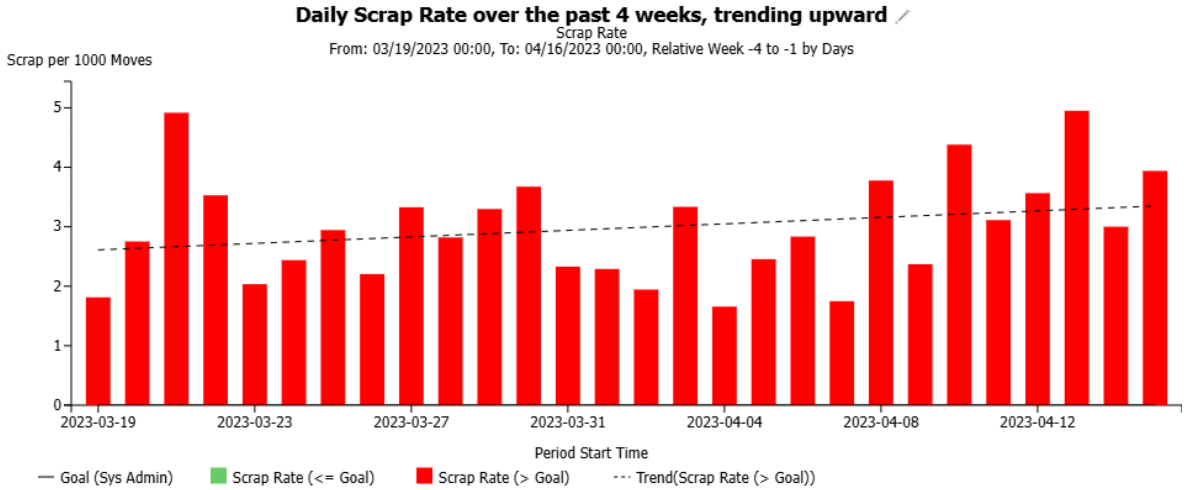
In the example below, dynamic x-factor (DXF) is trending slightly downward, an indication that the fab is not expecting near-term future cycle time increases. DXF is a point estimate in which we track total fab WIP divided by non-rework WIP currently running on tools. Adding a trend line smooths out hourly fluctuations and gives insight into expected future performance.



6. Your scrap and rework rates are low and trending down (or at least not trending up)

Low scrap rates are, of course, essential to fab profitability. Wafers that are later scrapped waste capacity, and scrapping more wafers than expected threatens shipment targets. This is a particular challenge for high mix, low volume fabs. Rework similarly wastes capacity and increases the risk of not meeting lot due dates. Hold times inflate lot cycle time and thus also threaten due date performance. Holds in general add variability to the fab.

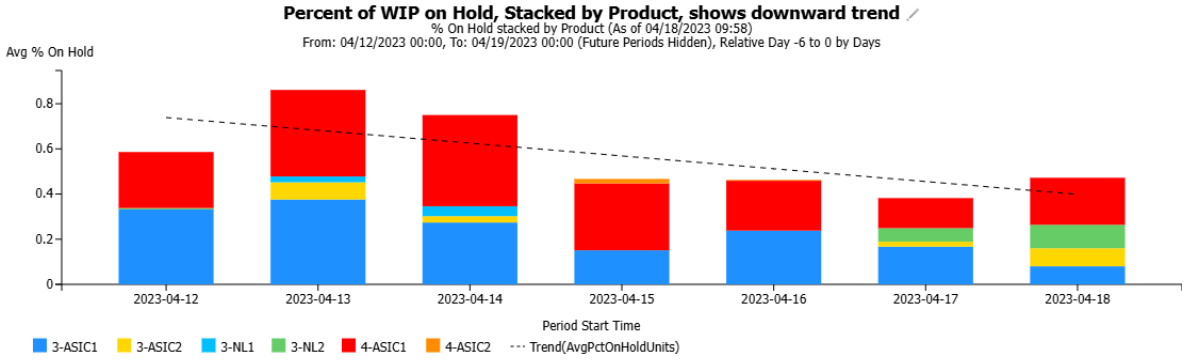
For scrap, you can track absolute wafers scrapped per day or per week or look at the scrap rate over time. The example below shows scrap per 1000 moves by day over the prior four weeks. The dashed trend line indicates that scrap rates are increasing for this fab and warrant attention.



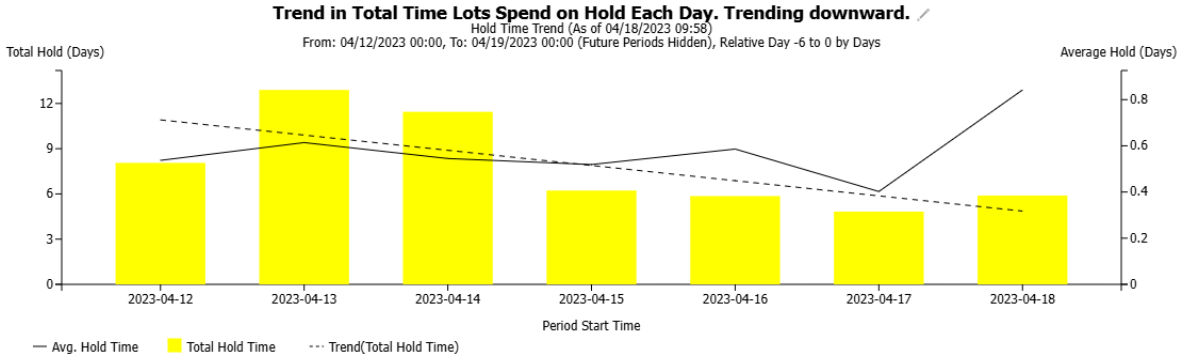
Similar charts can be generated in FabTime to show daily rework moves, or (as a custom chart) percent of daily moves that are rework.

7. Your percentage of lots on hold, and time lots spend on hold, are decreasing

For holds, we might look at the percentage of WIP on hold, stacked by product, over time. This is a standard chart in FabTime.



Alternatively, we could look at the total amount of time that lots spend on hold each day (the yellow bars in the chart below) and the average hold time length (the solid black line). The goal for these metrics is to see them declining over time.



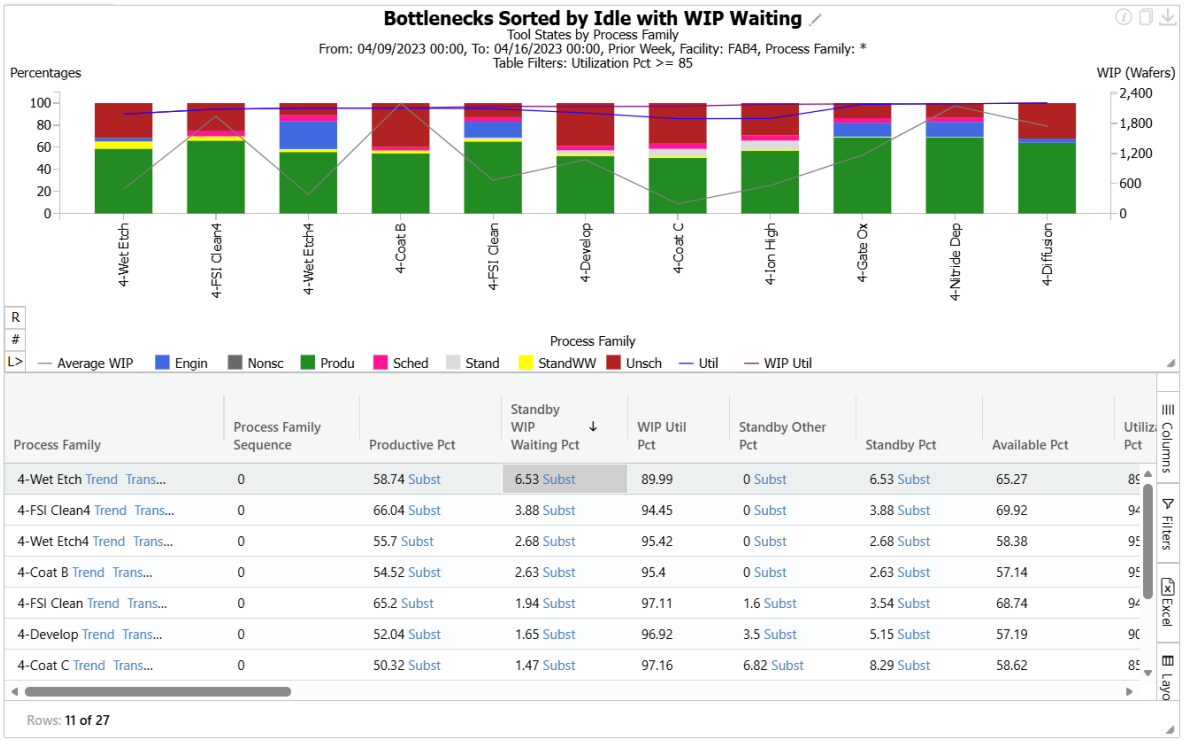
8. You don’t have any bottlenecks that are spending significant time idle with wait waiting (IWW)

In a healthy fab, bottleneck capacity is not wasted. A useful indicator of squandered bottleneck capacity is the tool state “idle with WIP waiting” (or “standby with WIP”). This is an enhanced tool state relative to the SEMI E10 states in which idle time is broken down according to whether WIP is waiting. Whenever any tool is idle with WIP waiting, lots in queue accumulate unnecessary cycle time. When this happens on bottleneck tools, capacity can be lost forever, threatening throughput goals.

Of course, to identify bottlenecks in this state, we must first identify the bottleneck tools. As discussed above, there can be a difference between the long-term planned capacity bottleneck and the tool groups with the highest utilization in the short-term. What probably makes sense is to look, on a short-term basis, at all tools with a utilization greater than 80 or 85% that incurred more than, say, 5% idle with WIP waiting.

In the example below, the chart is first filtered to only include tools with 85% or higher utilization, then sorted by idle with WIP waiting (the yellow). The data table below the chart shows that the

tool group 4-Wet Etch spent 6.5% of time idle with WIP waiting. This tool is a top candidate for improvement efforts.



Process Family	Process Family Sequence	Productive Pct	Standby WIP Waiting Pct	WIP Util Pct	Standby Other Pct	Standby Pct	Available Pct	Utiliz Pct
4-Wet Etch Trend Trans...	0	58.74 Subst	6.53 Subst	89.99	0 Subst	6.53 Subst	65.27	89
4-FSI Clean4 Trend Trans...	0	66.04 Subst	3.88 Subst	94.45	0 Subst	3.88 Subst	69.92	94
4-Wet Etch4 Trend Trans...	0	55.7 Subst	2.68 Subst	95.42	0 Subst	2.68 Subst	58.38	95
4-Coat B Trend Trans...	0	54.52 Subst	2.63 Subst	95.4	0 Subst	2.63 Subst	57.14	95
4-FSI Clean Trend Trans...	0	65.2 Subst	1.94 Subst	97.11	1.6 Subst	3.54 Subst	68.74	94
4-Develop Trend Trans...	0	52.04 Subst	1.65 Subst	96.92	3.5 Subst	5.15 Subst	57.19	90
4-Coat C Trend Trans...	0	50.32 Subst	1.47 Subst	97.16	6.82 Subst	8.29 Subst	58.62	85

Rows: 11 of 27

9. No key tools have been down for more than 12 hours

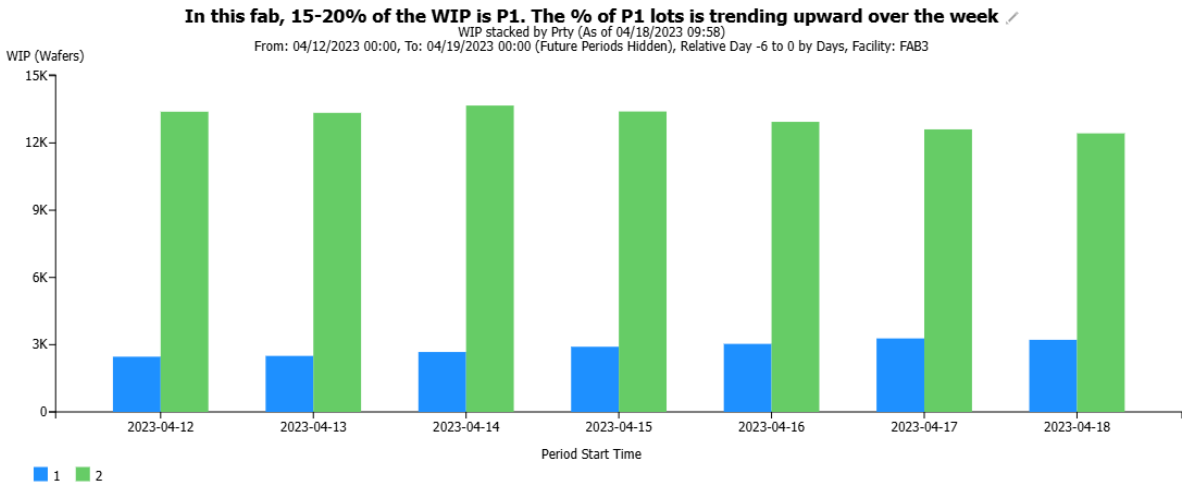
Downtime is a major detriment to fab health. There are many downtime-related metrics. See Issue 25.04 for a comprehensive discussion of downtime-related metrics for cycle time improvement. A simple metric that can help with both increasing fab capacity and reducing variability is a list of tools that have been down for more than 12 hours (whether for scheduled or unscheduled downtime). In the best case, this chart will be empty. In some cases, downtime may be such a problem that this chart will need to be modified to only include tools down for 24 hours or more. Alternatively, this chart might be better tracked by area instead of for the fab as a whole. While the configuration details may vary, the general idea is that tools that are down for a long time:

- Are not contributing to throughput goals; and
- Are adding to fab variability (and hence, cycle time)

A healthy fab tracks these long downtime tools and works to minimize them.

10. Hot lots make up no more than 5% of your WIP, and are not increasing

Fabs that are struggling frequently exhibit ever-increasing numbers of hot lots. If you keep the percentage of WIP that is high priority below 5%, you can achieve excellent cycle time for the hot lots, without paying a significant penalty in regular lot cycle time. Some fabs, of course, run with tiers of lots, in which case the highest priority product might be a higher percentage. For example, a fab might prioritize all make to order WIP ahead of all make to stock WIP. Generally, however, it's worth keeping the percentage of high priority lots as low as possible. It's also important to track this percentage over time, to keep it from creeping up in response to delivery challenges.



Take it to the next level

If all ten of the preceding indicators are in good shape, there are always other indicators you can target. For example:

- Nothing is in danger of missing a time link.
- You're seeing no missed cascades.
- No PMs are behind schedule.
- Tools aren't being left idle during shift change.
- The M-Ratio for the fab is greater than 4 (much more preventive maintenance than unscheduled downtime).
- And more…

Conclusions

Fabs are complex environments with many moving parts. It would be nice to have a single metric to track to say "yes, this means that everything is going well." But this is not, alas, the world we live in. Keeping a fab running smoothly requires monitoring line balance, moves, shipments, scrap rates, down tools, and much more.

In this article, we've suggested ten metrics that, if kept on target, will drive towards healthy overall performance. Naturally, these metrics are available in our FabTime and/or Dashboard products. Today, you can quickly build a custom home page tab that filters these metrics to your needs. As our AI capabilities evolve, the software will do more trend monitoring and anomaly detection for you automatically, based on these same core principles. Contact us for more information.

Closing Questions for Subscribers

What do you think about these fab health metrics? Which ones are realistic? Which ones are too easy? What would you add? We welcome your feedback.

Acknowledgements

Thank you to Frank Chance, Holland Smith and Lothar Mergili for taking the time to review a draft of this article and provide feedback. Lothar's experience as a long-time driver of fab improvement projects was especially informative.

Further Resources

For more about trade-offs between fab goals, see our recent articles about cycle time vs. cost, cycle time vs. yield, and cycle time vs. the status quo.

For a shorter article that outlines a starter set of FabTime charts for a new manufacturing supervisor, see the subscriber discussion section in Issue 21.01 in our FabTime Newsletter Archive. Our prior article about why fabs need multiple metrics is in Issue 17.03 is also available from our FabTime Newsletter Archive.

All past FabTime newsletters are available in PDF format from the FabTime Newsletter Archive. Please look for the link in the most recent email issue of the newsletter, or reach out to Jennifer on LinkedIn. You can download individual issues or download a zip file containing all past issues. Some articles have been re-published on the INFICON website. Those are linked above where mentioned.

For a more in-depth discussion of how these choices apply to your site, consider hosting a session of our four-hour web-based cycle time management course.