FabTime Cycle Time Management Newsletter

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 current release of FabTime include Y axis gridline support and X axis label increment control, for both JavaScript and ChartFX charts.

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Contributors: Elizabeth Nunn-Gage (Western Digital), Ken Kozlik (Fairchild Semiconductor) and Robin Tovey (International Rectifier Corporation, an Infineon Technologies Company)

Keywords: Fab Management; Metrics and Goals; Variability; Delivery Performance

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Welcome

Welcome to Volume 16, Number 1 of the FabTime Cycle Time Management Newsletter! We hope that 2015 is treating all of you well so far. Here at FabTime we remain busy with several software installations and dispatch configuration projects. But busy is how we like it! Our one announcement this issue is about the conversion of the text email newsletter to an html format. Our FabTime software tip of the month concerns setting default filters for FabTime charts.

We have two subscriber responses to a topic raised in the last issue: setting goals for fab cycle time and on-time delivery improvement. We thought that these responses were so useful that we have shared them and expanded upon them as our main article. We derive a brief framework for setting fab management goals at the strategic, tactical, and operational levels, with special attention to the "Prisoner's Dilemma" that can arise between shifts. As always, we welcome your feedback. We would be more than happy to continue this topic going forward, as we believe it has relevance to a large portion of our subscribers. If you agree, let us hear from you.

Thanks for reading – Jennifer

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Community News/Announcements

Conversion of Text Newsletter to HTML Format

In the interest of being able to include relevant figures for all subscribers, the text version of the FabTime newsletter will in the future be sent as an html email. We mentioned previously that we were considering this, and have heard no objections, so we will be going ahead with this change, effective immediately. If you have any difficulties with the html format, you are more than welcome to subscribe instead (or in addition) to the formatted PDF attachment version. Simply send your preference to newsletter@FabTime.com.

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

Set Default Filters for FabTime Charts

When you drill down in FabTime from a home page chart, or from one chart to another, FabTime takes along whatever filters you have set for that chart. However, when you create a new chart from the FabTime Charts page, FabTime uses your default set of filters. You can configure what is stored in your filter defaults right on the Charts page. When you bring up the page, you'll see a set of input boxes and drop-down controls on the left-hand side of the screen.

Simply enter your desired default filters here. For example, enter "Mfg" in the "Own:" field if you usually filter charts to look at data with owner code "Mfg", or enter "Photo" in the "Area:" field if you are primarily concerned with data from the Photo area. If you are in any of the input boxes (vs. the drop-down lists), you can simply hit the "Enter" key to save your changes. Or, you can press the "Set Defaults" button at the bottom of the list. You'll then be taken to a new page and receive this message:

> The FabTime server has generated the following message:
>
> Defaults have been updated.
>
> Continue

Press "Continue" to return to the Charts page. From now on, any chart that you generate from the Charts list will be pre-populated with the filters you have set. A few important points:

■ You can change the filter defaults any time by editing the values in the input boxes and saving your changes.

■ Even if you have filters that you usually use, you can always remove them from any chart after you have generated it, by cleaning the data in the relevant fields.

■ If you find that your charts are frequently displaying filters that you didn't mean to set, you may have inadvertently set default filters. You can go to the Charts page to clear them.

■ The input boxes in the default list do have auto-fill, so that when you start typing something, relevant values will appear in a pop-up list. Use the "Tab" or "PgDn" keys to select the value you need, and press "Enter". You can also click on the underlined name next to each input box to see a full list of applicable data for that field.

■ It's fine for defaults to include wildcards, exclusion filters, and/or comma-separated list, just as you use these options on the chart pages.

■ You can also set your default chart type preference between JavaScript and ChartFX, if your site includes both of these options.

One final point: if you type values into one or more of the input fields and DO NOT press "Enter" or "Set Defaults", but instead immediately press "Go" next to the name of a chart, FabTime will populate the chart with those values as a one-time only action. That is, your defaults will not be changed, but you can pre-set the filters for a particular chart. This is especially useful when bringing up Tool-related charts, for which some filter is always required.

When we are helping to troubleshoot validation issues with charts (why do we get this value instead of this value), an unintentionally set filter default is one of the first things we check for. We hope that you find this tip useful.

FabTime would like to thank **Elizabeth Nunn-Gage of Western Digital** for suggesting this tip. We welcome tip suggestions from other customers.

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

We have folded this month's subscriber contributions into our main article below. Goals for Fab Leadership to Drive Cycle Time Improvement

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

Goals for Fab Leadership to Drive Cycle Time Improvement

Introduction

In the last newsletter, a subscriber asked "what goals for fab leadership have worked the best to drive improvement in cycle time and on time delivery?" We shared some of our thoughts on this topic in that issue. In particular, we highlighted the importance of using WIP turns (vs. just using moves), using Dynamic X-Factor, and paying attention to metrics that capture fab variability. We also shared some details regarding the Earned Plan Hours metric, which we developed in conjunction with Cypress Semiconductor.

Following the publication of Issue 15.06, we received some excellent feedback from experienced managers working at two wafer fabs. We decided to share and expand upon their feedback as this month's main article. We believe that this topic of goal-setting will be of general interest to many FabTime subscribers.

Subscriber Feedback on Fab Goals for Cycle Time

Ken Kozlik, Senior Director and Salt Lake Plant Manager at **Fairchild Semi-conductor**, was kind enough to write in and share his thoughts on fab leadership goals, saying:

"From a tactical level, I think it's important to apply daily CT targets such as Moves, Moves/WIP, Dynamic X-Factor/days per layer, which are vital for the production staff to measure and focus on each day. At a more strategic level it's just as important to apply a metric that focuses on reducing lot to lot variation, such as "95% of our lots will be +/- 5 days" to original planned shipment. By utilizing both "speed" and "variability" metrics, an organization will drive a good balance of quick CTs and predictable deliveries."

Robin Tovey, Continuous Improvement Program Manager at **International Rectifier Corporation, an Infineon Technologies Company**, also shared a thoughtful and detailed response to this question, which is included here:

"In response to your article in Vol. 15 No 6; Goals for Fab Leadership to Drive CT Improvement and your statement regarding the behaviour of operators in response to an activity based target: ("When tracking moves (or major-step moves), there is an incentive to finish short production runs towards the end of a shift…". I would say that this potentially is a natural response to using targets to promote one shift against another.

In that situation the operators are behaving logically i.e. they are trying to maximise their own performance to hit an incentive. What can also be worse is that they will move fast WIP and then load up slow WIP for the start of the next shift in an attempt to ensure better performance than their counterparts. As you correctly stated this is a powerful source of variability and, over iterations of this cycle, a fab can become grossly unbalanced and severe degradation of performance can occur at great consequence to all parties.

In this scenario the error does not lie with the shop floor, rather it belongs to a Shift Vs. Shift targeting dilemma sometimes created for the operational teams. This is similar to the problem known as the Prisoner's Dilemma that is analysed with Game Theory. I shall try and illustrate below:

The shift has two choices:

1. Co-operate and run a balanced mix with potentially lower activity/turns etc. and risk being overridden by the other shift.

Or

2. Override and run a fast but unbalanced mix for higher activity/turns but leave the other shift with a poor setup.

	Shift A	
Shift B	Override	Co-operate
Override	- -	- +
Co-operate	+ -	+ +

A shift wants a plus i.e. to hit an incentive, and it can get a plus if it co-operates and the other shift co-operates or if it overrides and the other co-operates. It gets a negative whenever the other shift overrides, and if both shifts override performance is at its worst and everyone loses. Once a cycle of overriding has started it is very difficult to break and continued application of inappropriate targets could worsen the situation further as both shifts strive to gain a marginal advantage, e.g. pushing out PM activities into the other shift, corner cutting on quality control etc. In this scenario if the management want to hit ++ (peak performance) then they must be very careful to create a target that promotes co-operation. How many of us have targets that do this?

Variability is a natural characteristic of the wafer fab manufacturing environment and a fab will never achieve the clock work precision of a "traditional" manufacturing line and we should consider that within the metrics for the fab and how we interpret the data we generate with these measures. Are we reacting to an out of control situation or are we reacting to noise? Making pro-active decisions or chasing our tails? If one shift outperforms another from one day to the next, unless there are some well understood detractors, this is not necessarily an indication of tardiness but rather is more probably the response to the 10x sources of variability that exist within a Fab.

We should focus our improvement efforts on limiting those sources of variability and ensuring we have a fab with appropriate flexibility & capacity to deal with variability. Our metrics should seek to promote co-operation amongst teams and

we should look to introduce measures that assess line balance and ensure that all WIP moves towards its commitment date at the correct speed, neither too fast nor too slow, if that is occurring then we should take activity as it comes. As far as specific goals and targets are concerned then that is up to each management team to decide upon, but time should be taken to consider the unintentional consequences of such application."

A Framework for Setting Fab Goals to Drive Cycle Time Improvement

We think that both Ken and Robin make excellent points. Taking insights from each of their responses, plus FabTime's initial response to this question, and some ideas from our Cycle Time Management class, we can start to assemble a framework for the setting of fab goals for driving cycle time improvement. This is not meant to be a comprehensive list covering all aspects of running a fab. It is, instead, a simple framework that takes into account key issues in setting goals. The ultimate goal is to drive improvements in fab cycle time and on-time delivery.

At the Strategic Level:

1. Ensure that the fab has adequate capacity and flexibility. Plan tool utilizations so that they include a standby time buffer to allow tools to recover from the impact of variability. Minimize the presence of one-of-a-kind tools and dedicated tools as much as budgets allow. Without these things, achieving good cycle times will be extremely difficult.

2. Understand actual performance relative to theoretical performance in fab cycle times (so that you know what is the best that could be achieved). Use this knowledge in setting fab-level cycle time goals.

3. Create a culture that comprehends and cares about top-level variability metrics. Consider metrics that focus on reducing lot to lot variation, such as "95% of our
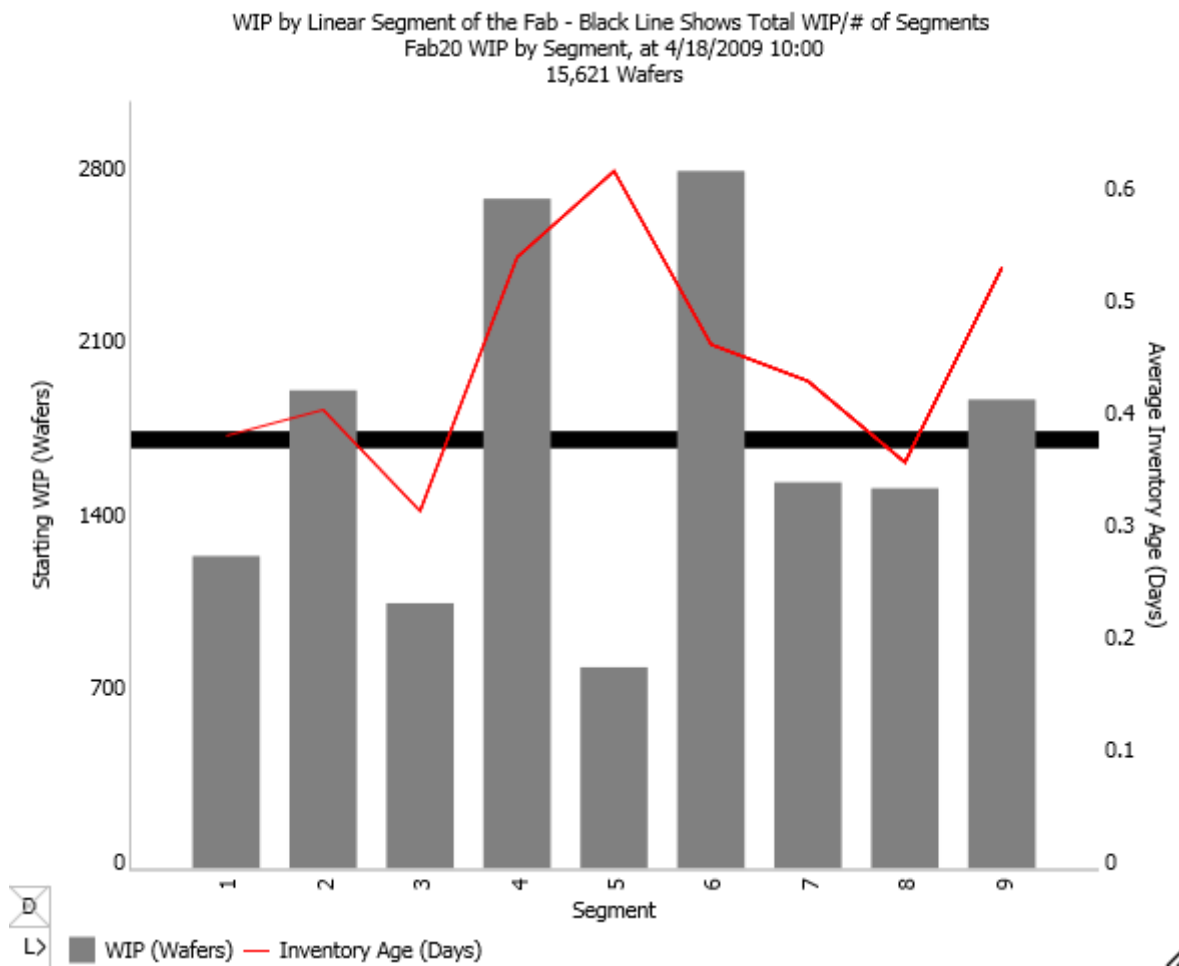
lots will be +/- 5 days to original planned shipment date" or that otherwise ensure that WIP is moving towards commitment date at the correct speed.

At the Tactical Level:

1. Monitor and (where possible) limit the sources of variability in the fab. Fab variability sources include product mix, long downtime events, batch lot releases into the fab, batch transfers between process steps, process restrictions, batch loading policies, hot lots, scrap and rework, and setup avoidance dispatch policies. Many of these topics have been discussed in previous FabTime newsletters.

2. Assess line balance. On a daily basis, look at WIP by segment of the line or by operation, and attempt to fill holes and smooth out bubbles. Consider line balance-focused dispatch rules, and/or

short-term adjustment of goals by area to take into account areas with too much, or too little, WIP. An example of a chart showing WIP by Segment is shown below. The black line shows where WIP would be balanced across segments.

3. Set goals for daily targets such as Moves, Moves/WIP (Turns), and Dynamic X-Factor, which are necessary for the production staff to measure and focus on each day. The exact set of goals to use will depend upon your fab's situation.

4. In setting goals by shift, look at ways to avoid the Prisoner's Dilemma outlined above. Consider using the Earned Plan Hours metric as an alternative to Moves - this metric was designed to adjust incentives, and reduce undesirable end of shift behavior. (See sample chart at the top of the next page.)

WIP by Linear Segment of the Fab - Black Line Shows Total WIP/# of Segments
Fab20 WIP by Segment, at 4/18/2009 10:00
15,621 Wafers

Earned Plan Hours Per Wafer, Displayed by Shift. Implied Target = 12 EPH/Wafer/Shift
Fab20 Earned Plan Hours/Unit
From: 4/11/2009 06:00, To: 4/18/2009 06:00
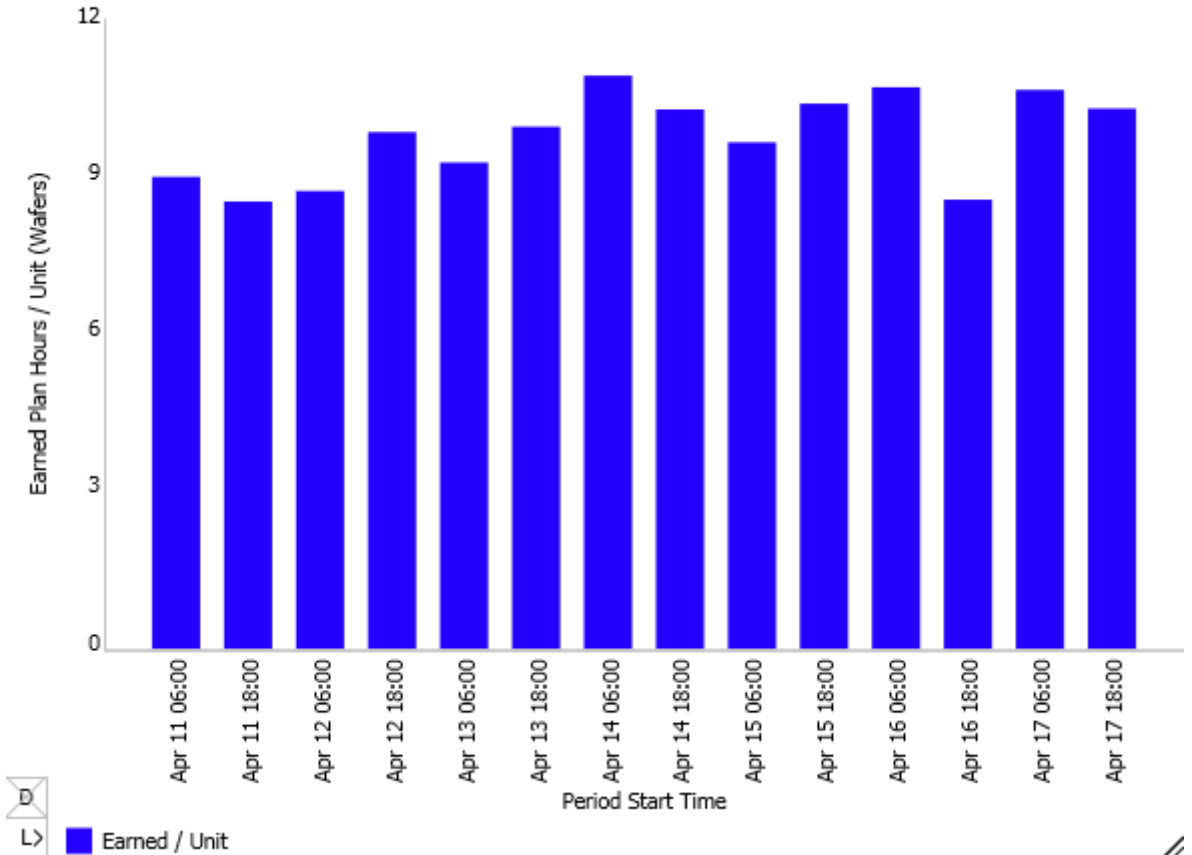
[The chart above shows Earned Plan Hours per Wafer by 12 hour shift. The earned plan hours metric attempts to counteract undesirable shift-change behavior by giving credit both when lots are tracked into tools, and as processing occurs on tools. When a lot is tracked into a tool, credit is given for the planned queue time of the lot at its current flow/step. As a lot is processed, credit is given for elapsed processing time, up to the end of the planned process time or shift change, whichever comes first. In this way, operators are incentivized to start a lot running on a tool, even if there are just a few minutes left in the shift, because they will immediately receive credit for the lot's planned queue time. And they receive credit for any portion of the planned process time up to shift-change, even if the lot doesn't move out of the tool until the next shift. If lots are being moved according to plan, then on average each wafer should accumulate 12 earned plan hours during each shift.]

At the Operational Level:

1. Monitor the above-discussed goals, in a highly visible way, so that people are motivated to follow them.

2. Look at queue delay by tool or tool group to identify short-term problems in cycle time.

3. If possible, use the dispatch system to adjust individual lots that are getting ahead of or behind schedule. Otherwise, look each day at a list sorted by absolute delta between expected shipment date and commitment date, and re-prioritize lots manually if necessary.

4. Look for places where WIP is being held up due to extended unavailable time (scheduled, unscheduled, or engineering), and focus on fixing those problems.

Conclusions

There is no shortage of metrics that can be applied in wafer fabs. Nor is there any shortage of ideas for improving fab performance (our Cycle Time Management course includes many more details on this topic). What we have attempted to construct here, using inputs from two experienced members of fab management teams along with our own understanding, is a brief framework for setting goals to drive improvements in cycle time and on time delivery for fabs.

The first trick, as indicated by both Ken Kozlik and Robin Tovey, is to find a balance between goals to keep things moving (Moves, WIP Turns, etc.) and goals to dampen variability (line balance and performance to commitment dates). The other trick, as described in detail by Robin, is to ensure that the goals that you use at the shift level don't incorporate operator incentives that lead to poor overall behavior. The use of dispatch systems can help with this latter problem (by taking some of the decisions about which lots should be processed next out of the operator's hands). But we believe that using metrics such as the Earned Plan Hours metric can help, too.

We welcome your feedback on this important topic, and look forward to expanding upon this framework in the future.

Closing Questions for FabTime Subscribers

What do you think is missing from this framework? How does your fab handle the Prisoner's Dilemma that can occur between shifts?

Further Reading

■ J. Robinson and F. Chance, "Overcoming Productivity Losses during Shift Change," *FabTime Newsletter*, Volume 14, No. 1, 2013. This issue introduces the Earned Plan Hours metric mentioned above, and may be requested by current subscribers from newsletter@fabtime.com between now and the publication of the next newsletter.

■ You can find more about the Prisoner's Dilemma mentioned by Robin Tovey at this Wikipedia page.

Subscriber List

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Note: Inclusion in the subscriber profile for this newsletter indicates an interest, on the part of individual subscribers, in cycle time management. It does not imply any endorsement of FabTime or its products by any individual or his or her company.

There is no charge to subscribe and receive the current issue of the newsletter each month. Past issues of the newsletter are currently only available to customers of FabTime's web-based digital dashboard software or cycle time management course.

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FabTime® Dispatching Module

Dispatch Configuration and Support

We offer our dispatching module for a single, fixed monthly fee (on top of your regular FabTime subscription). This includes:

- Dispatch rule configuration via user-friendly web-based interface for standard factors
- Training.
- Dispatch list feed to the MES (if applicable).
- Support and upgrades.

Custom dispatch rules and consulting from our dispatching expert available for additional fee

Dispatch Factors

- Batch code at the current tool.
- Lot priority.
- Downstream tool priority.
- Current tool FIFO.
- Current tool idle time.
- Downstream batch efficiency.
- Critical ratio.
- Earliest-due-date.
- Current step processing time.
- Remaining processing time.
- Current step qualified tool count
- WIP level or staging time at downstream tools.

Interested?

Contact FabTime for details.

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Do your operators make the best possible dispatching decisions?

- Do you struggle to balance lot priorities and due dates with tool utilization and moves goals?
- Do your critical bottleneck tools ever starve?
- Do you use standard dispatch rules, but feel that your fab's situation is more complex, requiring custom blended rules?
- Do you know how well your fab executes your dispatch strategy?

FabTime's dispatching module is an add-on to our **web-based digital dashboard software**. At any point, for any tool in your fab, FabTime will show you the list of all lots qualified to run on that tool. This list will be ordered by the dispatching logic that your site has selected for that tool. This logic can use standard dispatch rules such as Priority-FIFO and Critical Ratio. However, you can also create custom dispatching logic using any combination of dispatch factors (shown to the left).

You can display dispatch lists in FabTime, and/or export them back to your MES. FabTime also includes a dispatch reservation system to hold downstream tools when a lot is started on an upstream tool, as well as dispatch performance reporting.

Dispatch List for a Batch Tool, Filtered for Specific Product Families Only
Fab20 Dispatch List, at 4/18/2005 10:00
Tool: Nitride Dep#1, Prd: nl*, asic1
13 Distinct Lots, 311 Wafers

(FabTime 7.1.7 (c) 1999-2005 FabTime Inc.)

■ 1st Run   ■ 2nd Run   ■ Later Run
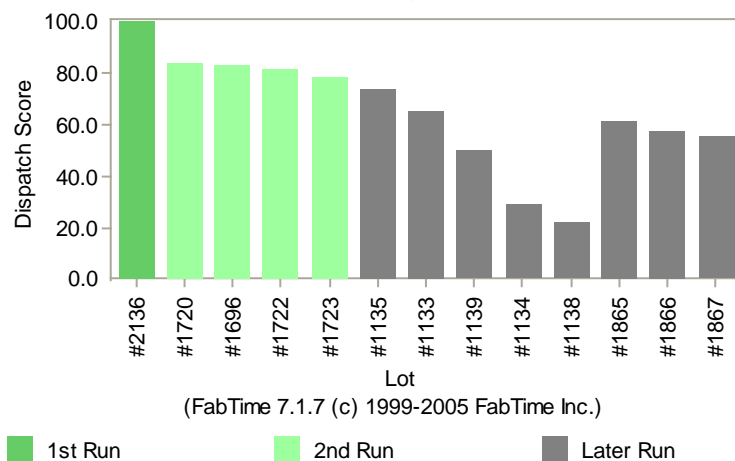
FabTime Dispatching Module Benefits

- Ensure that wafers needed by management are in fact the wafers that are run, while requiring less manual intervention on the part of management.
- Improve delivery to schedule, and the display of performance to schedule.
- Document the dispatching logic used by the best operators and make this available to all shifts.