FabTime Cycle Time Management Newsletter

Volume 18, No. 1 February 2017

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 version about to be released by FabTime include site-specific metrics dashboards, the ability for sites to specify their own colors for stacked object charts, and shipped lot x-factor charts.

Editor: Jennifer Robinson

Keywords: Reporting; Learning

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Welcome

Welcome to Volume 18, Number 1 of the FabTime Cycle Time Management Newsletter! We hope that you are all off to a productive start for the New Year. Here at FabTime, we are pleased to announce the imminent release of software Patch 108, containing lots of great new functionality. We also have an announcement about the upcoming Fab Owners Association Collaborative Forum. Our software user tip of the month is about generating a list of tools that have been down for more than some time period (e.g. 12 hours), using the new E10Age filter. We have no subscriber discussion in this issue, though we do welcome your questions and feedback.

In our main article this month we share highlights from *Make It Stic*k, a book about the science behind successful learning. Because making significant improvements often involves learning new things, and because all of us face opportunities for learning and growth in our personal lives, we felt that this topic would be of interest to the newsletter community. We welcome your responses.

Thanks for reading, and Happy New Year! – Jennifer

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Community News/Announcements

FabTime Completes Software Patch 108

January 25, 2017 -- FabTime is pleased to announce the final build of Patch 108 of our web-based dashboard software for cycle time management. New features in this version, about to be released, include:

- Support for metrics dashboards
- Ability to sort stacked charts by totals
- Ability to set stacked object colors by site
- Ability to place a new series on the right-hand Y axis when editing a chart
- Addition of new E10Age filter, to allow filtering by the duration of downtime
- Display of within-chart data values for bar charts (Javascript charts)
- Automatic uploads of Excel maintenance data
- New shipped lot x-factor charts
- Unified definitions and display for average WIP
- Automatic formatting for y-axis labels (Javascript charts)

If you would like to know when this new version will be available at your site, or have questions about the new features, please contact your FabTime system administrator.

FOA 2017 Collaborative Forum To Be Held In San Jose

From the Fab Owners Association: "Perhaps the premier FOA annual event is the Collaborative Forum. The 5th edition will be held at the San Jose Marriott Downtown in San Jose, CA on Feb.22-23. Again this year, the theme is "Manufacturing Challenges Supply Chain Solutions". It's been another record year for case study proposals and we'll have some very interesting analyst speakers as well, including perennial favorite Bill McClean of IC Insights. The forum will include SEMI presentations that will provide FOA members insight into some of the synergies we see between the two organizations. We're looking forward to a great event! We thank all those who are helping to make it happen.

This year's Wed. night social will be held at the San Jose Museum of Art, a short walk from the hotel. This will be a great opportunity to meet new acquaintances and re-connect with old ones! For more information about the Collaborative Forum and the latest agenda, visit the FOA online calendar."

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

Generate a List of Tools that have been Down for a Certain Time

A common use of the Tool WIP and State List chart is to generate a list of all tools that are down for scheduled and/or unscheduled maintenance (setting filter "E10St:" to "Sched, Unsch"). However, the more pressing need is often to see just the list of tools that have been down for more than some period of time (12 hours,

say, or 24 hours). There were "Age>=" and "Age<=" filters on the chart. However, these referred to the WIP line on the chart (only show WIP that has been waiting for more or less than some threshold), and not to the time that a tool had been in a particular state (the E10 Age shown on the left-hand chart axis). It was only possible to filter by E10 Age in earlier versions of FabTime by using the SQL filter, which was a bit cumbersome.

In Patch 108 we introduce the new "E10Age>=" and "E10Age<=" filters. The previous "Age>=" and "Age<=" filters have been renamed "WipAge>=" and "WipAge<=". Once you have Patch 108 installed at your site, you will be able to use the "E10Age" filters to show only tools that have been in their current state for more than, or less than, some particular time value. For example, to see the list of tools that have been down for scheduled or unscheduled maintenance for more than 12 hours, set "E10St:" to "Sched, Unsch" and set "E10Age>=" to .5 days. Set "Tool" to "*" to include all down tools. An example is shown below.

Note that the units to use should match the display on the "Time" drop-down. If Time is set to "Days" then enter .5 to indicate a 12 hour window. If Time is set to "Hours" then enter 12.

The "Age>=" and "Age<=" fields have been renamed "WipAge>=" and "WipAge<=" where they appear on other charts, for consistency. We welcome your questions and feedback.

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!

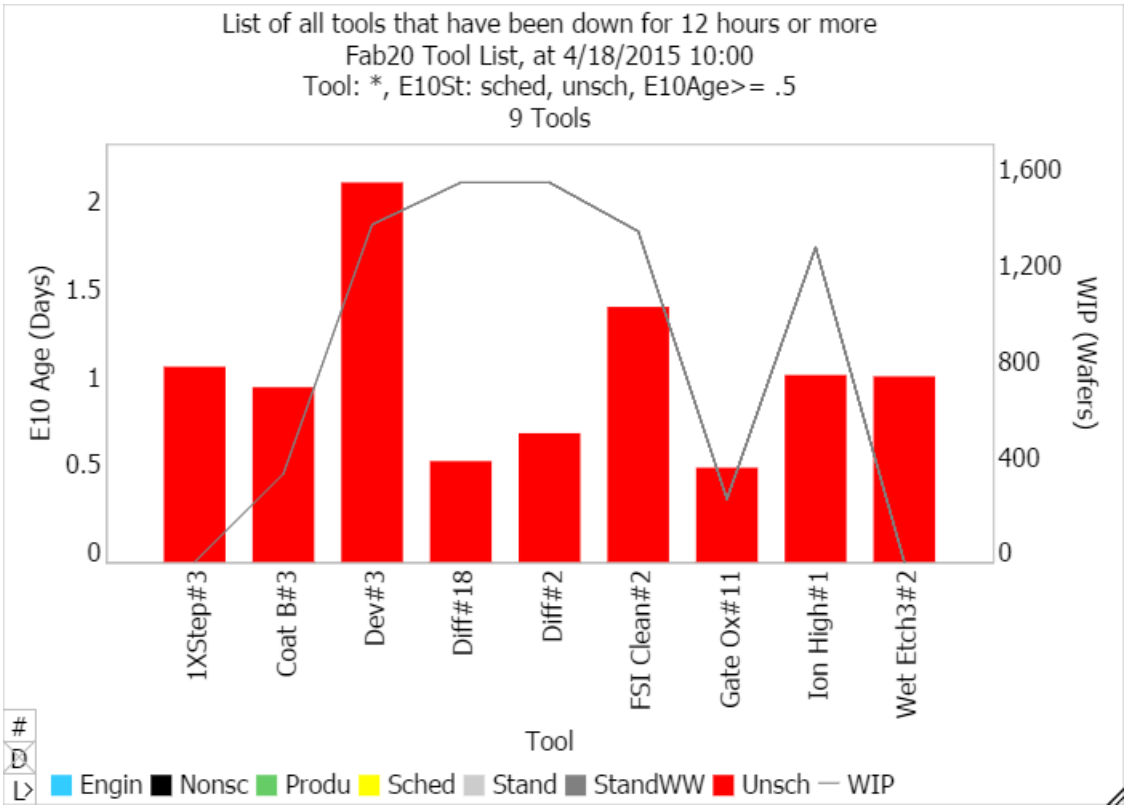


Figure 1. Example of Down Tools List Filtered by E10Age

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.

Learning New Things and Making Them Stick

Introduction

If you are reading this newsletter, you probably have some interest in improving how semiconductor and related factories operate. Making improvements often involves learning new things, and teaching those new things to others. Therefore, we thought that our audience here might be interested in a question that we have been wrestling with here at FabTime: how do you make those new things "stick"?

In seeking to answer this question, FabTime's Frank Chance recently read the book *Make It Stick: The Science of Successful Learning*, by Peter C. Brown, Henry L. Roediger III, and Mark A. McDaniel (Harvard University Press, http://amzn.to/2kpmEog). In this article we share some highlights that Frank captured from the book, as well as some examples we've observed of these concepts in practice. We also briefly discuss implications of this material for FabTime going forward, and for anyone interested in learning and retaining new information.

Make It Stick Summary

Here is a brief summary from the book's website:

"Grappling with the impediments that make learning challenging leads both to more complex mastery and better retention of what was learned. Many common study habits and practice routines turn out to be counterproductive. Underlining and highlighting, rereading, cramming, and single-minded repetition of new skills create the illusion of mastery, but gains fade quickly. More complex and durable learning comes from testing oneself, introducing certain difficulties in practice, waiting to re-study new material until a little forgetting has set in, and interleaving the practice of one skill or topic with another. In other words, the most productive practices are ones that feel slow and unrewarding and are seldom adopted by learners."

Concepts for Improving Learning from *Make It Stick*

For teachers, the authors of *Make It Stick* recommend assessing teaching practices with an eye to these eight concepts.

1) To give students an idea of why you, the teacher, are using a different approach, it's helpful to first explain how learning works.

2) Some difficulty during the learning process helps to make learning stronger, with better recall.

3) When learning is easy, it's often superficial / soon forgotten.

4) When learning is hard, it helps you to make new connections.

5) Students (of all ages) learn better when time is spent wrestling with new problems before seeing the solution.

6) To achieve excellence, learners must strive to surpass current levels.

7) Striving results in setbacks, which are often needed to provide feedback on what has yet to be learned.

8) Learning is cumulative – and assessment should be too.

For learners of any age the number one recommendation of the book is to engage in more hands-on practice. Here are five concepts to guide this practice.

1) Retrieval – self-quizzing is essential to store information in your brain such that it can be retrieved readily later.

a. Practice (self-quizzing) should be spaced out over time. Instead of testing yourself immediately after hearing a new concept, wait and see if you really can recall what you think you know over a longer term.

b. When practicing, it helps to interleave problem types. Don't practice repeatedly on the same type. More on this below.

2) Elaboration – relate the new concept to what you already know. Develop metaphors for new concepts. We try to do this in FabTime (in our newsletter and our cycle time management course) by keeping examples of any concepts strongly tied to realistic fab experiences.

3) Generation – solve problems before seeing the answers. Spending time thinking about how to solve a problem, before being told how to solve that type of problem, makes it easier to learn and retain problem-solving techniques.

4) Reflection – think over what you have just learned. Give your brain a chance to hold on to the information, and connect it to other ideas in your head.

5) Calibration – find out what you don't know. Test yourself realistically and understand where you need to improve.

The Importance of Variability in Self-Testing

One concept from *Make It Stick* that particularly struck Frank was the idea that if you are learning in a range of areas, testing yourself across that range is better than testing narrowly within each subject area (interleave problem types). An example cited in the book illustrates this. [Here is the link to the original study.]

Researchers studied the impact of extra batting practice on baseball players at Cal Poly. In addition to looking at whether or not extra practice time helped, they also looked at whether that practice should be administered in a blocked way (15 fastballs in a row, followed by 15 curveballs, then 15 change-ups) or randomly (15 of each pitch, but pitches received in random order by type). There were three groups: a control group that didn't get any extra practice session, and two groups that each received two additional practice sessions a week for six weeks, one group blocked and one group random. Here is a conclusion from the article:

"Pretest analysis showed no significant differences among groups. On both the random and blocked transfer tests, however, the random group performed with reliably higher scores than the blocked group, who performed better than the control group. When comparing the pretest to the random transfer test, the random group improved 56.7%, the blocked group 24.8%, and the control group only 6.2."

This makes sense, doesn't it? The batters who received random pitches during their extra sessions had to be able to react regardless of the type of pitch. This most accurately reflects the actual experience of being in a baseball game. The batters receiving blocks of similar pitches got more practice than the control group, but did not get as much practice at recognizing what type of pitch is coming and responding to that.

Other Real-World Examples of Interleaving Problems

Much as the above example makes sense when we think about it, it's quite common for assessment questions to be "blocked" or grouped according to type. A textbook might have questions at the end of each section that are about that section, without even having questions from across the whole chapter. During the school week, our students do problems topic by topic. Yet, when their standardized tests come along, those questions are mixed by topic. It seems likely that students who are pre-tested in an interleaved way will perform better than students who always practice one topic at a time.

Frank noticed some other examples along these lines:

1) DuoLingo (an online platform for learning languages at www.duolingo.com) has an option to "strengthen my skills." When Frank first used the app, it would pick questions randomly from all the topic areas. This was difficult and frustrating. Eventually DuoLingo got rid of this behavior… and now "strengthen my skills" picks only from a single topic area. This makes it much easier, because after a few questions you recognize the topic and this is a clue on how to answer other questions (e.g. "I know all these questions are about future tense… so the answer to this question must be in future tense…"). But we wonder if the original "strengthen my skills" was more effective at building proficiency.

2) FabTime has purchased online video classes from a company specializing in SQL Server, to strengthen our programmers' SQL skills. Only a few of the video classes that we purchased have quizzes. We wish they had more, and that we could get quiz questions from randomly-chosen topic areas, instead of from one topic for an entire quiz. In the meantime, Frank has found that creating his own examples after watching each video helps him to solidify what he has learned.

3) Frank is returning to flying, after a 25 year hiatus. As part of this effort, he purchased an online course that combines short videos, quiz questions, and FAA exam review. The FAA exam review is nice because it mimics the private pilot exam, with questions from all topic areas. It's tougher when the questions are mixed, but based on *Make It Stick*, this is likely better for long-term retention.

Implications of "*Make It Stick*" for FabTime

We are working to incorporate some of the *Make It Stick* ideas about learning into how we help our employees to learn new concepts. We particularly focus on self-quizzing, and relating new concepts to information that people already know. We encourage our employees to write up short summaries of tips and new ideas, and to share these via email and our support website. If it's a SQL tip, we include an exercise that can be carried out in SQL Server to demonstrate the concept, and include comments on what we found surprising or helpful.

We also spend a considerable amount of time thinking about how we can help our customers to learn to use FabTime's software well. We have always favored live training sessions, in which each user is on a computer, trying things out as we go. We find that this makes the "how to" lessons stick much better than, say, a presentation.

We also ensure that the training takes place only when a stable version of the software exists that contains the customer's actual data. It is much easier to learn how to navigate a product when one can recognize the names of tools, products, etc. that are displayed.

In our cycle time management course, we have long had quiz questions at the end of each section. What we have not done is randomize these questions in any significant way. This is something for us to consider in the future. Perhaps we could have fewer topic-specific questions at the end of each section, and a longer, more mixed set near the end of the course.

Implications for Anyone / Conclusions

Studies have shown that continuing to learn can help to slow mental decline. See, for example, this *New Scientist* article about the impact of having learned a second language on brain function in old age. Maintaining and enhancing our skills can obviously help with job advancement, too. Those of us who have children have an interest in helping them to learn effectively, and most of us have co-workers or mentees whom we would like to help learn new things. Therefore, we all have an interest in improving our understanding of the learning process.

Make It Stick offers one perspective on learning, with an emphasis on building durable, long-lasting learning. We feel that the practices described here, particularly self-quizzing with interleaved questions, can help with any type of learning, from understanding the impact of variability on cycle time to learning a new language.

Further Reading

- Peter C. Brown, Henry L. Roediger III, and Mark A. McDaniel, *Make It Stick: The Science of Successful Learning*. Belknap Press: An Imprint of Harvard University Press. 2014. Available from http://amzn.to/2kpmEog.
- Angela Duckworth, *Grit: The Power of Passion and Perseverance*. Scribner. 2016. Available from http://amzn.to/2jbPKlG.
- Carol Dweck, *Mindset: The New Psychology of Success*. Ballantine Books. 2007. Available from http://amzn.to/2kpsfuJ.

Closing Questions for FabTime Subscribers

Have you been to any recent training sessions, either internal or provided by a vendor? Did these training sessions incorporate any of the concepts discussed here, for example quizzes with interleaved questions, or solving problems before seeing the answers? Were the training sessions effective at helping you to master the material? Do you find that a particular vendor (or a particular company trainer) is consistently more effective?

Subscriber List

Total number of subscribers: 2753

Top 20 subscribing companies:

- ON Semiconductor (includes Fairchild) (170)
- Infineon Technologies (includes Intl Rectifier) (143)
- Micron Technology, Inc. (134)
- Intel Corporation (118)
- Maxim Integrated Products, Inc. (104)
- GLOBALFOUNDRIES (97)
- Carsem M Sdn Bhd (71)
- STMicroelectronics (63)
- Texas Instruments (63)
- X-FAB Inc. (55)
- Seagate Technology (53)
- Skyworks Solutions, Inc. (52)
- Freescale Semiconductor (50)
- Western Digital Corporation (49)
- Microchip Technology (47)
- Analog Devices (45)
- TDK (42)
- Atmel Corporation (37)
- NXP Semiconductors (35)
- ABB (32)

Top 3 subscribing universities:

- Ecole des Mines de Saint-Etienne (EMSE) (17)
- Arizona State University (8)
- Virginia Tech (7)

New companies and universities this month:

- Duet Microelectronics
- Foxconn Hon Hai Logistics Texas LLC
- ZHAW

Sampler Set of Other Subscribing Companies and Universities:

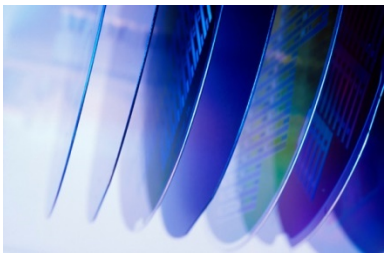
- Apple (2)
- Asia Management Group (1)
- Bruker BNS (1)
- CIMETECH International Inc. (1)
- Cornell University (1)
- Cree, Inc. (26)
- DEE - Politecnico di Bari (1)
- Dow Chemical (1)
- Elmos Semiconductors AG (6)
- Enovix Corp. (1)
- Globitech (1)
- Google (1)
- Hamburg University of Applied Sciences (1)
- Hitachi HHTC (1)
- INSEAD (1)
- Kun Shan University (1)
- M/A-COM / Tyco Electronics (8)
- Smoltek AB (1)
- Tara Technologies (1)
- Tiger Venture Analysis (1)

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.

To subscribe to the newsletter, send email to newsletter@FabTime.com, or use the form at www.FabTime.com/newsletter.htm. To unsubscribe, send email to newsletter@FabTime.com with "Unsubscribe" in the subject. FabTime will not, under any circumstances, give your email address or other contact information to anyone outside of FabTime without your permission.

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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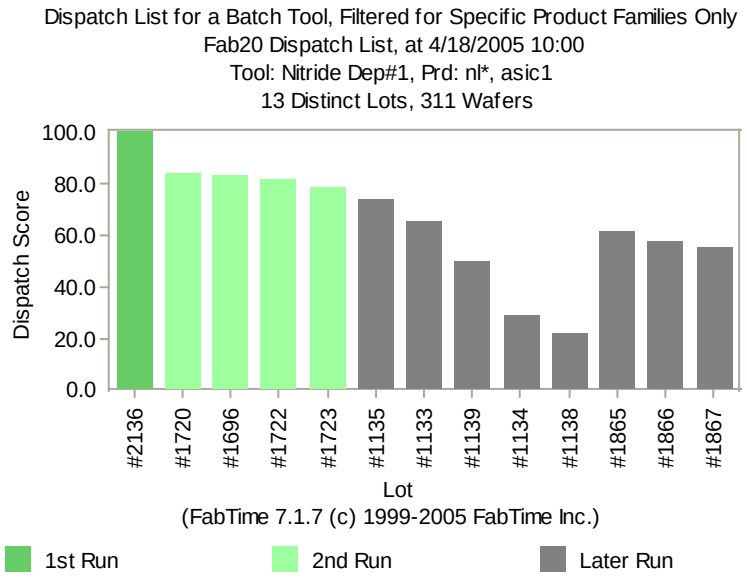
Do your operators make the best possible dispatching decisions?

- 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. FabTime now (as of 2016) also includes an optional **short-interval scheduler**.



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.