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FabTime Newsletter

Volume 25, No. 2 **March 2024**

Information

Publisher: Recently acquired by INFICON, 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

Date: Tuesday, March 19, 2024 – Vol. 25, No. 2

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Keywords: Operating Curves; Industry Cycles; Factory Physics

Table of Contents

Welcome

Welcome to Volume 25, Number 2 of the FabTime Cycle Time Management Newsletter. This is the first full newsletter issue since FabTime was acquired by INFICON (though I did send a Cycle Time Tip e-mail last month). Thanks for being here with us on this new stage in the FabTime journey. I'm happy to report that the FabTime team is doing well and has been made welcome by the team at INFICON. You can read a bit more about the merger in the announcement below.

This issue also includes an announcement about the upcoming Advanced Semiconductor Manufacturing Conference, as well as the usual highlights from my LinkedIn. Our software tip of the month is about creating a question for display in the FabTime charts menu from a chart. This month's subscriber discussion forum has feedback from subscribers about box plots, standby-WIP-waiting time and test wafer ratios, as well as a question from me about cycle time challenges in assembly and test factories. I'm looking for input in the hope of writing about back-end factories in a future issue.

In our main article this month, we discuss the benefits of educating people on your team about the fundamentals of cycle time management. We share some history about how our cycle time class came to be, as well as an overview of the topics that we have chosen to include, and why. We close with some of our favorite things to teach, and a few success stories. We welcome your feedback.

Thanks for reading! – Jennifer

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Community News/Announcements

FabTime Announces Merger with INFICON

(In case you missed our special announcement from late January) FabTime co-founders Frank Chance and Jennifer Robinson are delighted to announce that, after nearly 25 years of owning FabTime, we have sold FabTime to INFICON Inc. (owner of the FPS advanced industrial engineering software suite, among many other products).

We chose INFICON because we believe that INFICON will be a strong successor to our business and continue to provide good service and products to our customers. The entire FabTime team has joined INFICON, so that we can continue to support our software customers, cycle time class customers, and newsletter subscribers. We fully expect that INFICON will serve as a trusted partner to you all.

If you are a FabTime software user, rest assured that we will continue to provide you with the level of support and personal attention that you have come to expect from FabTime. Software support and upgrades will continue, and you will continue to have a dedicated FabTime support engineer.

If you are an INFICON FPS software user and a FabTime software user, you can expect the option for tighter integration between these products in the future, with FabTime serving as a flexible reporting engine within the FPS suite.

If you're an FPS customer and you don't have FabTime's reporting engine yet, we would be more than happy to speak with you about getting the FabTime module added to your system. Just reply to the newsletter email and we can put you in touch with the right person from INFICON.

As a FabTime cycle time newsletter subscriber, you will continue to receive your newsletters on their regular schedule. Those messages will be sent from Jennifer.Robinson@inficon.com for now, though changes to the mailing system are expected in the future. We have every intention of maintaining and increasing the quality level of the content provided.

If you have questions about any of this, please feel free to reach out to any of your previous FabTime contacts. We welcome your feedback and hope you'll join us in celebrating this exciting step in the evolution of FabTime!

ASMC

The Advanced Semiconductor Manufacturing Conference (ASMC) will take place in Albany, NY May 13-16. ASMC brings together manufacturers, equipment and materials suppliers, and academia to solve manufacturing challenges with innovative strategies and methodologies. We especially recommend for newsletter subscribers:

Session 8: Smart Manufacturing + Industrial Engineering 1 and **Session 16**: Smart Manufacturing + Industrial Engineering 2

Session Chairs: Shiladitya Chakravorty, Dave Gross, and Misty Thompson

"The availability of vast amounts of data is now being met with increasing computing capabilities and algorithmic approaches to predict properties of final products, equipment health and metrology results, and influence WIP flow decisions."

Highlights from Jennifer's LinkedIn

Jennifer continues to share articles about business management, the semiconductor industry, and productivity improvement on her LinkedIn feed. Recent links have included:

- A Reuters article, via Semiconductor Engineering, reporting that after talking about this for many years, it seems that India may finally see the construction of two wafer fabs and a packaging facility. Tata Group, CG Power and Industrial Solutions Limited, Renesas Electronics, Powerchip and Stars

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Microelectronics (Thailand) are all involved. “Indian Electronics Minister Ashwini Vaishnaw said construction will begin on the plants within the next 100 days.” Time will tell! [LinkedIn Post.]

- An announcement via the BBC that the UK government has approved Vishay’s takeover of the former Newport Wafer Fab in Wales. This is great news for the Newport team after years of uncertainty. From the article: “Vishay says it wants to expand the site, with an emphasis on research and development in compound semiconductors. It is promising to bring more high-skilled, well-paid manufacturing jobs to Newport.” [LinkedIn Post.]
- A re-share of a link from Robert Quinn about University of Arizona and Northern Arizona University joining forces to boost Arizona’s semiconductor industry. This seems like a smart move for Arizona and for the AZ universities in particular. Hopefully it will help with the future labor shortage in the semiconductor industry. [LinkedIn Post.]
- An announcement (via the WSJ and a re-shared Dispatch story from Avi Gur) about a pushback of the construction dates of two new Intel fabs in Ohio. The WSJ said: “Construction on (the) factories now slated to be finished in late 2026 as company also waits for government incentives... (An Intel) spokesman declined to give a new target for chip production at the facilities, but said the company remained fully committed to the project.” [LinkedIn Post.]
- A WSJ article about Sam Altman’s plan for “raising trillions of dollars to reshape the global semiconductor industry... The fundraising plans, which face significant obstacles, are aimed at solving constraints to OpenAI’s growth, including the scarcity of” AI chips. Jennifer noted that “significant obstacles” was a significant understatement, and was pleased to see a follow-up piece that delved more deeply into the problems with this idea (labor shortage, increasing industry boom/bust cycles, etc.). [Original LinkedIn Post. Second LinkedIn Post.]
- A Semiconductor Engineering deep-dive into industry apprenticeship programs from organizations like SEMI Foundation and National Institute of Standards and Technology (NIST). Here’s a snippet:
    - “There’s going to be a million different paths to working in the industry,” said SEMI’s Shari Liss. “It’s not a simple answer. There are going to be apprenticeship programs where we pull kids directly from high school, and we also pull veterans directly out of the military as they’re transitioning to civilian careers. We provide training upfront that gets folks on the fab floors, without any needed degrees. That’s one pathway. Other pathways may include students getting an AA degree first and then exploring apprenticeship opportunities. Then, of course, are the four-year engineering degrees.” [LinkedIn Post.]
- And finally, a re-share of the INFICON announcement of the FabTime acquisition, which generated many lovely comments. [LinkedIn Post.] See also Jennifer’s first-ever job change notice on LinkedIn (the start of FabTime having pre-dated the launch of LinkedIn).

For more industry news, connect with Jennifer on LinkedIn.

FabTime welcomes the opportunity to publish community announcements, including calls for papers. Send them to Jennifer.Robinson@inficon.com.

FabTime® Software Tip of the Month

Create a Question from a Chart

If you are using a relatively recent version of FabTime, core patch 114 or later, you have probably used the feature that lets you “Find a chart based on my question” from the Charts page. Examples of questions included on our demo server, many suggested by people from our User Group, are shown below.

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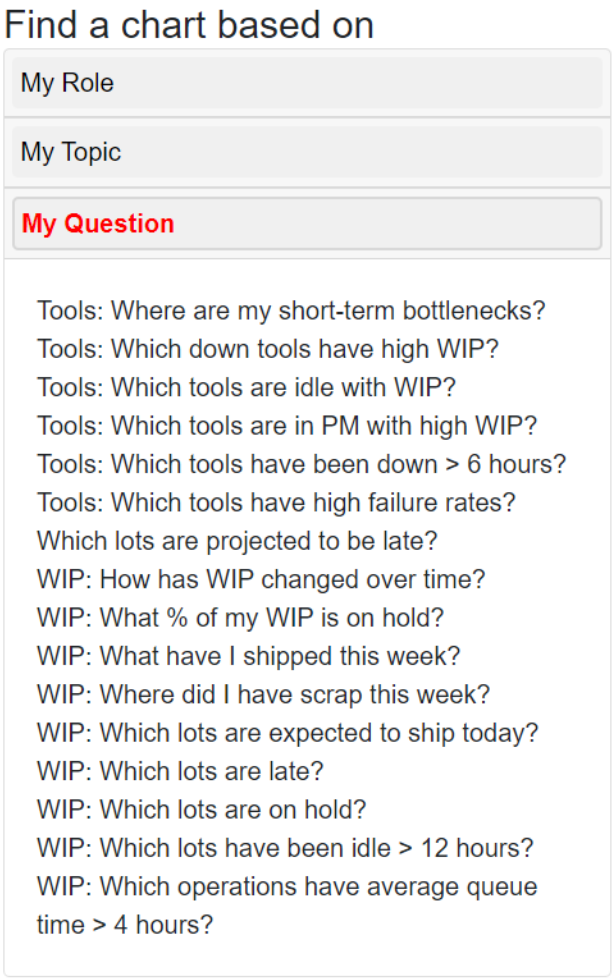

But did you know that (if you have permission from your internal system administrator) you can add new questions to this list? To do this:

1. Create a chart that answers a question that you or your team regularly asks. This could be a variation of the default questions, like “Which tools have been down > 12 hours?” or “Which lots of Product Family B are late?” Or it could be something completely new, like “Which operations have one or fewer qualified tools?”
2. Click the “Create question from chart” button to the left of the chart, enter the text you would like to display for the question, and click “Save.” Note: if you don’t see “Create question from chart,” ask your internal system administrator to give you permission to customize charts.
3. Return to the chart page to confirm that your question was added to the list. Click on the question, and then click on the thumbnail that is displayed, to verify that the chart correctly answers your question.
4. If you need to delete or edit a question, from the Admin menu in the toolbar, select “Customize Charts Menu” and then click “Question” in the tab at the top of the screen.

We hope you find this tip useful.

FabTime software module customers can subscribe to the separate Software Tip of the Month email list (with additional discussion for customers only) by emailing Jennifer.Robinson@inficon.com with your request. Thanks!

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Subscriber Discussion Forum

Response to Prior Software Tip about Box Plots

Albert Davis from onsemi wrote: "I love the boxplots…really good stuff. I am working on different scenarios that I can show the engineers how to use FabTime as an investigative tool, not just reporting, and boxplots will help a lot 😊 Great work by your team… I had another idea that could help (possibly a future enhancement at one point). At my prior company we called it a "Commons" report. You would supply a list of good lots and a list of bad lots and then the output would show if there was any piece or pieces of equipment through the process that were used on the good lots versus the bad lots and vice versa. It wasn't a difficult statical analysis, but when you were not quite sure where to start looking at the overall process to solve lot issues, this was one of the first things you would try."

FabTime Response: We are so glad that you will find the box plots useful! Thank you for letting us know. And thank you for sharing this idea. We will put this on the enhancement list. We're also sharing it here, as other subscribers may find it useful, too!

Quantity of Standby-WIP-Waiting Time in a Manual 200mm Fab

In a discussion at the January Fab Owners Alliance meeting, **Jose Garcia from Analog Devices** asked Jennifer and Frank a question. He wanted to know if we had any data on how much time bottleneck tools in a 200mm fab with manual lot transfer spend idle with WIP available (what's reported as Standby-WIP-Waiting in FabTime). His thinking was that if automated material handling could eliminate this Standby-WIP-Waiting time on bottlenecks, there would be a corresponding potential increase in fab throughput. Even for non-bottleneck tools, converting Standby-WIP-Waiting time into true standby time should improve cycle time. What do you all think? How much time is spent at key tool groups in Standby-WIP-Waiting? 3%? 5%? More? We welcome your feedback.

Test Wafer Ratios

John Clancy, a longtime subscriber, asked recently: "I'm curious whether FabTime has studied what the industry standards are in test wafer vs. revenue wafer ratios? I know it varies depending on process mix and node size but I'm trying to understand where we should be aiming in our fab."

Response: Unfortunately, that is not something that we have studied to date. We are including this question in the newsletter to see if any other subscribers have data they might be able to share on this topic. Now that FabTime is part of INFICON, we are thinking about ways to gather information like this from our combined customer base and share it within that community, but those discussions are in early stages. Subscribers?

Also, just as we went to press we noted a new post on Thomas Beeg's Factory Physics and Automation blog about test wafers which includes a poll on test wafer ratios. Perhaps if subscribers respond to that, you'll find useful results in a follow-up post.

What Makes an Effective Daily Status Meeting in the Fab?

Longtime subscriber and contributor **Hani Ofeck from Tower Semiconductor** wrote recently: "I am reaching out to gather some insights on the contents covered in daily status meetings. I would appreciate any guidance or advice you can provide based on your experiences." We referred Hani to Issue 8.02, which addressed this topic, and suggested a focus on problems that need immediate attention and action. We'd like to write an updated article on this topic, though, and are seeking input from subscribers.

Request for Input: Cycle Time Improvement for Back-End Factories

After writing last time about 300mm fabs, it occurred to us that we haven't ever focused on cycle time improvement recommendations for post-fab: packaging, assembly, and test factories. Are there any subscribers who work in these factories, or did work in one, who would be willing to share some insights about the specific

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problems that drive up cycle time? The first step to recommending improvements is of course to better understand the problems. You could share via email, or I (Jennifer) would be more than happy to schedule a call with you to discuss. Thanks in advance for any input you can provide. You can reach me at the email address below.

We welcome the opportunity to publish subscriber discussion questions and responses. Simply send your contributions to Jennifer.Robinson@inficon.com.

Main Article: On the Benefits of Cycle Time Education

Introduction

Even as some semiconductor manufacturing segments have recently experienced a moderate downturn, skilled labor in the industry remains, and is expected to remain, in short supply. This shortage extends beyond operators and maintenance technicians into the realms of industrial engineers and fab management. Many skilled, knowledgeable people who have worked in the industry for decades are retiring and are difficult, if not impossible, to replace.

One implication of this is that fabs are bringing in people who are less experienced. These fabs are providing training themselves and in some areas working with local universities. The SEMI Foundation is working on the training issue, as are the National Institute for Innovation and Technology (NIIT) and state governments like Arizona (working with NXP). [For an in-depth look at industry apprenticeship programs, see this piece by Liz Allan at Semiconductor Engineering.]

At INFICON, we believe that it is especially important for fabs to provide training for people who work in manufacturing on the fundamental drivers of cycle time, particularly utilization and variability. This training needs to comprehend and address the unique complexities of fabs that make running them so challenging, particularly the ones that have counter-intuitive implications. It also needs to teach participants to take advantage of data to identify real-time improvement opportunities.

Training on cycle time and factory behavior becomes even more necessary as background knowledge as software in the smart factory becomes more complicated. For example, configuring advanced scheduler features like automatic line balancing requires an understanding of cycle time fundamentals. Without such understanding, users may not recognize when advanced features are not working or are incorrectly configured.

The most forward-thinking fabs right now are taking advantage of the relative demand slump to prepare for the next upturn. A great way to do that is by training staff on how to combine the right intuitions with the right data so that they can drive better future performance.

In this article, we share a brief history of FabTime's cycle time improvement class and explain what we cover and why. We highlight a few of our favorite concepts to teach, and close with some success stories.

FabTime Cycle Time Management Course History

Long before being acquired by INFICON, FabTime offered a course on cycle time improvement. The course was an off-shoot of this newsletter, in fact, so let's start there. We sent out the first FabTime Cycle Time Management Newsletter in April of 2000. The welcome message for that issue said:

> "The purpose of this newsletter is to build a community of people who are interested in cycle time management and give these people a way to communicate with each other and share new ideas. We're also trying to better define cycle time management as a category within manufacturing management, because we think that it's an important area. Newsletter topics will include definitions (Little's Law, Hawthorne Effect, etc.), cycle time management ideas, success stories, discussion topics (where we aggregate feedback) and announcements/industry news."

We've kept to that purpose and format rather well over the years.

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In 2002, a fab manager who was an early subscriber to the newsletter called Jennifer to ask if we could provide some training that he was seeking. He wanted something that would convey cycle time/factory management to production personnel all the way down to technicians, or at least supervisors. He asked for something fab-focused, but comprehensive. The idea was to show how fabs could use data from tools like FabTime to improve things, starting by building intuition around core fundamentals such as how cycle time relates to utilization.

Jennifer and Frank, who both studied Industrial Engineering in graduate school, worked with this fab manager on the outline for the course, drawing from material that we had already included in the newsletter and on FabTime's website. We created spreadsheet companion tools, quizzes, and pencil and paper exercises, to make the course as interactive as possible. We even used dice to simulate possible batch sizes for one exercise. We delivered the first session of the course in August of 2002.

We subsequently delivered the class in person as a one-day or two-day course to many fabs over the next 18 years. Memorable experiences included a trip to Ireland for multiple sessions, and an extremely cold trip to Minneapolis one February. The class helped us to stay in business during industry downturns, particularly 2009, when several companies hosted multiple sessions of the class.

We focused mainly on doing sessions for individual companies, except for one multi-company session held in the Bay Area. The logistics for charging individuals made multi-company sessions challenging, and we also felt that it was better to have an audience from a single company, so that people could speak openly about their specific challenges.

With the advent of Covid in 2020, we converted the class to a four-hour online course delivered via Teams. The new format worked well. It forced us to condense the material down to what was most important and enabled us to deliver the class to people from more different time zones. Travel time had previously made doing international sessions of the course impractical.

Now that we're with INFICON, we anticipate that the course may change further. Perhaps future versions will integrate more content focused on managing Smart Manufacturing tools, addressing topics like automated line balancing with a factory scheduler or enhanced cycle time models. Perhaps we will add a recorded, self-paced version, instead of the current instructor-led Teams version. But for this article, we'll focus on the course as it is currently offered.

What's Included in Our Course and Why

We encourage companies hosting our course to invite people from different parts of the organization, including manufacturing, process engineering, equipment engineering, industrial engineering, and production control. We do this because people in each of these positions affect the cycle time of the fab in different ways. Having everyone be part of a single discussion can help with the implementation of changes.

We have found that it can be particularly helpful to include process engineers in cycle time training. Process restrictions and holds have a much bigger cycle time impact than is commonly realized. Including senior management in cycle time training can also be useful in setting expectations for how much cycle time can be improved in a given environment.

We've also learned over the years that a key success factor for our courses is having at least one participant who is willing to speak up and answer questions about the site. Often this person is someone senior in the manufacturing organization. Alternatively, this may be an industrial engineer who is already familiar with the general concepts taught in the class. Without someone willing to speak up in the audience, it can be difficult to get audience participation, and thus to tailor the discussion to the specific needs of the site. For Teams-based classes, having engagement with the audience is important to keep people from tuning out (or tuning back in to their email instead of to the material).

Our current course is usually delivered in two two-hour sub-sessions on different days. Breaking up the material gives people a chance to process the content and makes scheduling easier for disparate time zones.

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Here is the current agenda:

Part 1: Fundamentals

- Introduction
- The fundamental drivers of cycle time
  - Utilization
  - Variability
  - Number of qualified tools
- Little's Law

Part 2: Implications for Metrics + Operating Practices

- WIP-related metrics to drive cycle time improvements
- Cycle time and equipment downtime
- Other operational recommendations
  - Quick tips on holds, mix, hot lots, dispatching, staffing, and batching
- Conclusions

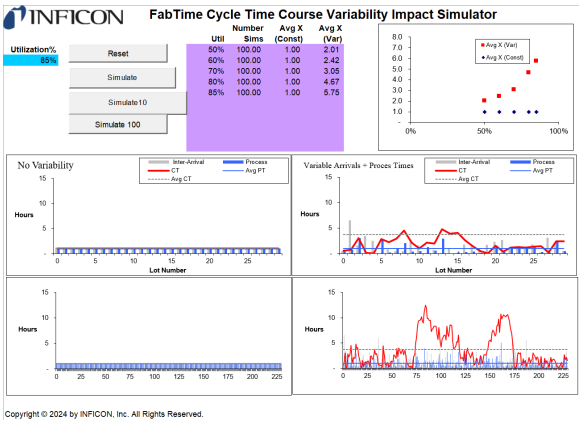
Part 1: Fundamentals

The first part of the course focuses primarily on **the three fundamental drivers of cycle time** at the tool group level: utilization, variability, and number of qualified tools. We start with definitions, so that everyone is on the same page when they talk about each of these attributes. We encourage discussion and questions, because **the most important thing about this course** is that participants internalize these core concepts.

Why are the three fundamental drivers important? Because everything else that impacts cycle time in a wafer fab does so because of the impact that it has on one or more of these fundamentals. Downtime, for example, increases cycle time because it takes away standby time, driving up effective tool utilization. Downtime also increases variability and decreases the number of available qualified tools. Lot release affects arrival variability. Hand carry lots cause forced idle time (driving up utilization) and increase arrival variability. And so on.

Why does the class focus on these drivers at the tool group level? Because the delays incurred at the tool / operation level are what accumulate, lot by lot, step by step, driving up total cycle time. And it's at the tool level where the things we do make a difference, even when we are changing something global in the fab. For example, the scheduler drives which lots get processed in which order on each tool. Equipment technicians do maintenance tool by tool. Process engineers focus on the process time of every step that a lot goes through. We must understand what's happening at the tool/operation level to make improvements. More specifically, we must understand how the things we do affect utilization, variability and number of qualified tools at that tool level, before we can think about making fab-wide changes.

A narrative introduction to the Fundamental Drivers of Fab Cycle Time can be found in Issue 22.04. What the course brings in addition to that narrative is: moderated discussions ("What do you think makes cycle time higher than you would like to see in your fab?"; quizzes ("Which of the following choices to you think is a reasonable approximation for the shape of the utilization vs. cycle time curve?); shared anecdotes by the instructor from prior experience; and three spreadsheet tools:



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- **Cycle Time / Variability Impact Simulator:** This spreadsheet uses Excel's random number generator to explore the relationship between cycle time and

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utilization, with and without variability. By performing replications at different utilization levels, participants build an operating curve.

- **Cycle Time Operating Curve Generator:** This spreadsheet uses queueing models to let participants explore the impact of different variables (arrival variation, process time variation, percentage of hot lots, number of qualified tools, etc.) on the shape of the operating curve.
- **Course Exercise Spreadsheet:** This spreadsheet asks participants to fill in numbers and formulas for examples, as shown to the right. It's easy to nod your head to say "yes, I understand," but much better for memory and understanding to have to fill in the right numbers yourself.

Cycle Time and Downtime

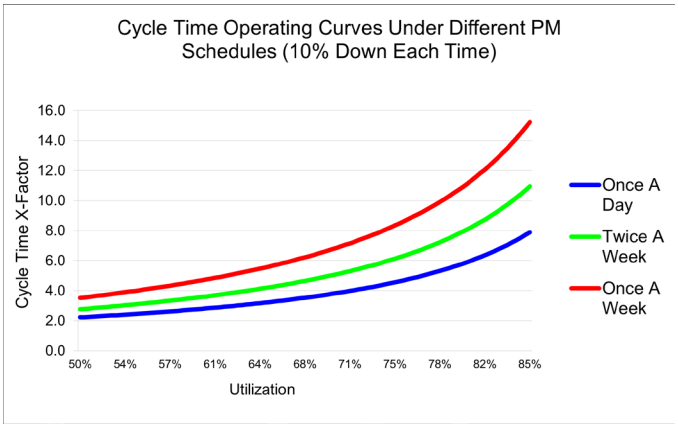
Example A			Example B	
Tool State	Hours in State (hr/day)		Tool State	Hours in State (hr/day)
Non-Scheduled Time	0		Non-Scheduled Time	0
Scheduled Downtime	28		Scheduled Downtime	28
Unscheduled Downtime	7		Unscheduled Downtime	27
Engineering Time	24.5		Engineering Time	34.5
Standby Time	35		Standby Time	5
Productive Time	73.5		Productive Time	73.5
Total Time	168		Total Time	168
Productive Time (hours)	73.5		Productive Time (hours)	
Standby Time (hours)	35		Standby Time (hours)	
Utilization (Pct)	68%		Utilization (Pct)	
CT Estimate [1/(1-Util)]	3.1		CT Estimate [1/(1-Util)]	

Part 1 closes with one more fundamental of fab behavior: Little's Law (see Issue 21.06). Little's Law is about the relationship between cycle time, WIP and start rate (or throughput rate). It applies to all types of factories, not just fabs. The primary implication of Little's Law in the context of the course is that if the fab start rate remains relatively constant, WIP and cycle time move together, meaning that WIP can be used as a proxy for cycle time in metrics selection (addressed in Part 2).

Part 2: Implications for Metrics and Operating Practices

In Part 2, we move from fundamentals to more tactical/operational recommendations. We start, following on the Little's Law discussion, by highlighting a few metrics that drive future cycle time improvement. We note that many of the metrics used in fabs day-to-day are more focused on increasing throughput than on decreasing cycle time, and argue to improve cycle time, a fab must also have metrics that focus on cycle time and/or WIP.

We then do a deep dive into the impact of equipment downtime on cycle time. We discuss, using the Operating Curve Generator to look at examples, the impact of downtime on utilization and variability. We offer several recommendations for mitigating the impact of downtime on fab cycle time and suggest cycle time-focused metrics related to downtime.



We next take a quick tour through several aspects of the typical fab that drive up cycle time: product mix, holds, hot lots, dispatching, staffing, and batch processing. When this was a two-day class, we delved into each of these topics in considerable detail. In shortening the class for online delivery, however, we pruned this content down to primarily focus on concrete recommendations (with continuing discussion about site-specific habits, and quizzes to build and test intuition). In most cases, we point participants to past newsletter issues, where they can find more details.

We close Part 2 by returning to the three fundamental drivers and highlighting specific recommendations related to each one. For example, in summarizing the impact of utilization, we share several recommendations for reducing forced idle time on tools. This reflects the overall goal of the class: to build people's intuition about how their actions affect cycle time, and then give them concrete recommendations to implement.

Our Favorite Things When Teaching the Course

Some things that we talk about in the course match the intuitions of most participants (at least to those who have experience in the fab). Losing capacity on the bottleneck because you're waiting for a hand carry lot is bad for throughput and cycle time. If a future hold is triggered when the engineer who placed the hold is on

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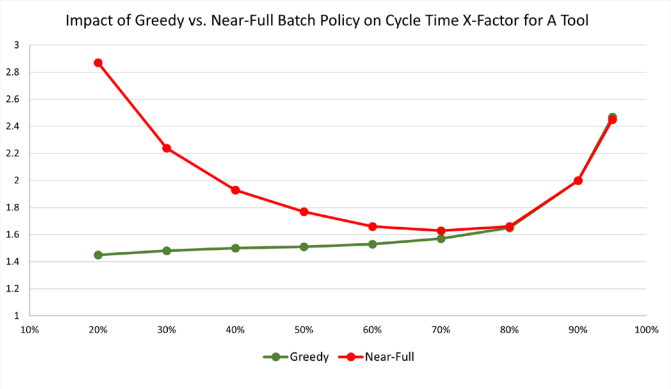
vacation, there is likely to be extra delay for the lot in question. Long downtimes on one-of-a-kind tools are a problem pretty much everywhere that they occur.

The things that are the most fun to teach are the ones that are counter-intuitive for many participants. Chief among these are, in our experience:

1. Why it's (much) better for cycle time to break up PMs instead of grouping them together. (See Newsletter 22.01.)
2. Why you shouldn't have a blanket policy requiring you to wait for full batches on furnaces. (See Newsletter 9.03. The picture to the right shows what happens to the operating curve under a full batch policy.)



We like it in general when we can broaden someone's perspective about something important. A key example here would be a manager who expects the manufacturing team to increase utilization and decrease cycle time at the same time. We can use the operating curve to show why these two goals are in conflict in general, but then show how reducing variability can help resolve the conflict.

But our favorite part of teaching the course is the discussions with each audience. We always open by asking "What are the causes of cycle time in your fab?" Many of the answers to this question are the same from fab to fab, of course (downtime, product mix, etc.). But every time we do the class, some other quirky response comes up, too. Then later, when we talk about hot lots, we hear different names for hand carry lots. (Pizza lots is a relatively new one that we heard last year. We thought this was meant to evoke the pizza delivery person, rushing to get the lot delivered in time. But it turned out, successful completion of a pizza lot led to pizzas being ordered for the team. Who knew?)

Fabs are such fascinating places. Even after 30 years of working with them, every time we sit down with a different team (even if it's a different team from the same company we did a class for last month), we learn something new. And we try to integrate the new knowledge into the class material, so that it can grow, too.

Success Stories

In the previous section, we shared some of our favorite aspects of teaching the course. But what you probably want to know as a reader is: what parts of the course do people who take it find useful? Below, we share feedback from managers at three sites that recently hosted the course.

Headway Technologies: A few months after we did a pair of training sessions for Headway Technologies in Milpitas, CA, **Jeff Meador**, Production Manager, told us that the sessions helped Headway to kick off new cycle time improvement initiatives. He said the "class was educational and helpful especially for new Supervisors… One example of cycle time improvement was a Readiness of Test product or First Articles for our Monitor Program. This was an area that was overlooked prior to class. This helped them set up Hourly, Daily and weekly goals also allowing them visibility of process flow for a proactive approach to reducing cycle time." He also said that the class increased overall understanding about operating curves and how utilization, variability and number of qualified tools drive tool-level cycle time, noting that "of course, the more you understand, the better decisions are made." Asked which specific recommendations from the class had been implemented afterwards, he highlighted three:

1. Reduce the number of hot lots in the fab, especially hand-carry lots that cause setup changes / force idle capacity.

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2. Make sure lots aren't sitting on hold when they could be in process.
3. Look for single-path operations and try to qualify a second path.

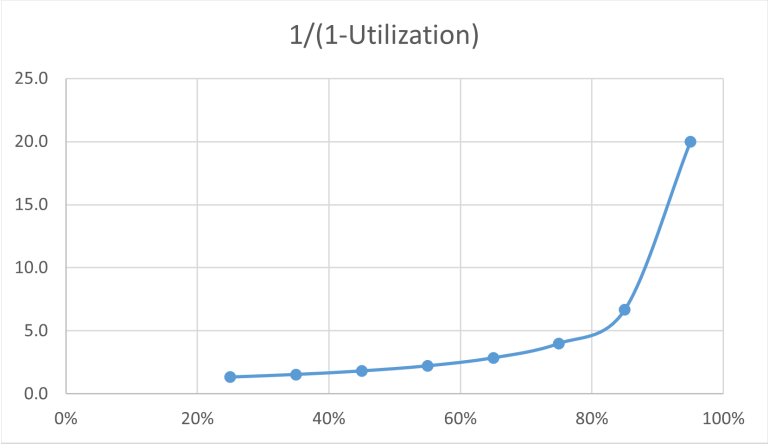
Analog Devices: Daniel Burlingame, General Manager of the Analog Devices fab in Beaverton, wrote a few months after a session for his fab: "The cycle time class opened the team's eyes to the importance of limitations, restrictions, and dedication. Specifically, the cycle time curve generator showing the X-theoretical impact left a lasting impression on the team. Since the time of your class, we've given our new tool releases extreme focus, with maniacal tracking of the layer releases. When releasing new tools, the date to first release is often tracked. With a new understanding of path importance, we're now tracking various tools to 100% layer releases and adding more rigor around lockouts, making sure to address them in a timely fashion. That allows us to decrease CT and provides some relief for the equipment teams responding to the previously frequent "no path" scenario."

Anonymous US Wafer Fab: The Manufacturing Director for another fab that hosted a session of the class shared this feedback: "I think the class was a good learning experience for the participants, particularly those who have never been exposed to fab cycle time impacts. The Process Engineering team has a better understanding of how capacity limitations impact fab cycle time, and they review the restrictions at their morning passdown. We also include the critical restrictions on our morning meeting passdown, so they have to present their plan to remove the restrictions. The Supervisors were learning about bottleneck management at the same time as this class was given as we had a book club approach to *The Goal*. They have a much better understanding of how bottlenecks limit fab production and how to properly manage them. They have improved knowledge thanks to your class, and we are very appreciative of the time you spent with us!"

Conclusions

Fabs are complex environments. There are strong financial reasons for improving fab cycle time, but doing so isn't easy. One can theoretically improve cycle time by throwing money at the problem, by adding tools, hiring more people, paying for service contracts, etc. But this isn't always practical. And even where there is some money to spend to improve cycle time, we want to make sure to use that money wisely, spending where the improvement will be greatest.

The good news is that a lot can be done to improve fab cycle time without spending large amounts of money, by focusing on the fundamentals. Focusing on availability and avoiding forced idle time improves utilization. Making operational decisions to reduce arrival and process time variability flattens the operating curve and improves cycle time. Having a "maniacal focus" on path importance throughout the fab drives step by step cycle time improvements.



People don't always know instinctively what changes to make to improve cycle time. They need training to build their intuition about the fundamentals of factory behavior (such as the shape of the operating curve, shown to the right). Because fabs are so complicated, this training needs to be tailored to a fab-specific audience. (Time constraints between process steps are not a thing in other types of manufacturing. Nor is reentrant flow.)

Ideally, the training should also be paired with efforts to increase data availability. Because that's the next step. Once you build people's intuition about what to do, you need to give them data to know where to start. We'll talk more about that in future articles.

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We'll conclude here by noting, again, that if things are a bit slower at your fab right now than they have been for the past few years, this is a good time to think about training your team. Then they'll be ready to hold variability down and stay laser-focused on utilization and process restrictions, during the next upturn. We welcome your feedback.

Closing Questions for Newsletter Subscribers

Have you done any cycle time improvement training for your fab (ours or someone else's)? What do you think is most important to include? What lessons have you learned that you would like to share with others? Do you have any memories from the FabTime cycle time management class that you'd like to share with the newsletter community?

Acknowledgements

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Further Reading

Liz Allan, "Chip Ecosystem Apprenticeships Help Close The Talent Gap," *Semiconductor Engineering*, February 12, 2024.

J. Robinson and F. Chance, "Batch Loading Policies for Wafer Fabs," *FabTime Newsletter*, Volume 9, No. 3, 2008. [Also shared as Cycle Time Tip of the Month #004.]

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J. Robinson and F. Chance, "Little's Law and Metrics Selection," *FabTime Newsletter*, Volume 21, No. 6, 2020.

J. Robinson and F. Chance, "On Breaking Up PMs and Other Unavailable Periods," *FabTime Newsletter*, Volume 22, No. 1, 2021. [Also shared as Cycle Time Tip of the Month #002.]

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