FabTime Cycle Time Management Newsletter

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Information

Mission: To discuss issues relating to proactive wafer fab cycle time management

Publisher: FabTime Inc. FabTime sells cycle time management software for wafer fab managers. New features in development right now include integration of a more user-friendly engine for managing data tables and new charts displaying percentage of WIP.

Editor: Jennifer Robinson

Contributors: Luca Casati from Vishay

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Welcome

Welcome to Volume 20, Number 5 of the FabTime Cycle Time Management Newsletter. In this issue we have an announcement about the upcoming meeting of the Fab Owners Alliance and another about connecting with FabTime on LinkedIn. Our FabTime software tip of the month is about how FabTime calculates standby-WIP-waiting time, and why that is useful information.

We are trying something new with the subscriber discussion forum this month. We are seeking feedback in advance of the planned main article for the next issue of the newsletter: dispatch compliance. Any responses will thus be included in the same issue, and easier to refer to in the future. We also have a question from a subscriber about cycle time benchmarking. We would welcome responses from readers on that topic also.

In our main article for this issue, we discuss the impact of tool qualification on cycle time. While the impact of one-of-a-kind tools on fab cycle time is well known, the price of tool qualifications that lead to single-path operations is more significant than is sometimes realized. We illustrate this via FabTime's Operating Curve Spreadsheet tool, which we are making available to newsletter subscribers for the first time. We hope you find the spreadsheet, and the discussion, useful.

Thanks for reading – Jennifer

FabTime

Tel: (408) 549-9932
Fax: (408) 549-9941
www.FabTime.com
Sales@FabTime.com

Community News/Announcements

Fab Owners Alliance Meeting to be Held in Colorado Springs Oct. 16-17

The next full membership meeting of the Fab Owners Alliance (formerly Fab Owners Association) will be held October 16-17 at the Microchip facility in Colorado Springs, CO. The FOA, now a SEMI Strategic Association Partner, is "an international, group of semiconductor & MEMS fab owners and industry suppliers who meet regularly to discuss and act on common manufacturing issues, combining strengths and resources to maintain and increase their global competitiveness." FabTime has been an associate member of the FOA for many years and recommends it to any IDM or supplier considering membership. More information about the FOA can be found at the SEMI website.

FabTime's Jennifer Robinson will be attending the October meeting (Wednesday evening social and Thursday afternoon session) and hopes to see you there.

Connect with Us on LinkedIn

Jennifer continues to share articles about business management, the semiconductor industry, and productivity improvement on her LinkedIn feed. Recent news has included Cree's new wafer fab announcement, prospects for industry growth in 2020, and an interesting new use of data analytics: finding doctors who are over-prescribing opioids. We are also actively working to connect with more newsletter subscribers so that we can keep up with people if they change companies. You can connect with Jennifer here: http://www.linkedin.com/in/jenniferrobinsonfabtime

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

Understand How FabTime Calculates Standby-WIP-Waiting Time

A FabTime user recently asked us for clarification about how FabTime calculates Standby-WIP-Waiting Time on the Tool State-related charts. We thought that the answer might be of interest to other users.

FabTime's Tool State charts (Tool State Trend, Tool State Transaction List, etc.) measure and display the times that each tool spends in the SEMI E10 tool states. These include Scheduled Down, Unscheduled Down, Engineering, Nonscheduled, Productive, and Standby. Where the data is available to do so, FabTime breaks Standby time into Standby-WIP-Waiting and Standby-Other.

FabTime's auto-standby and auto-WIP-Waiting procedures are used for this. These procedures use WIP transactions to generate automatic Standby/Productive and Standby/Standby-WIP-Waiting transactions. Arrival transactions with information about tool qualification data are required so that FabTime can link each lot to its qualified tools.

Standby-WIP-Waiting is time that the tool is available to manufacturing, has WIP in queue, but is not running. Standby-Other is Standby time in which there is no WIP waiting. Every time a tool is logged into a Standby state, FabTime checks to see if there is WIP that is in queue and qualified to run on that tool. If so, FabTime sets the tool state to Standby-WIP-Waiting. Otherwise, the state is set to Standby-Other. FabTime recomputes WIP in queue at every point in time when a new WIP transaction is recorded and uses that info to change the state back to Standby-Other if the WIP gets tracked in elsewhere.

Standby-WIP-Waiting can be useful in understanding unexpected cycle time problems. We know from theory that a fundamental factor driving cycle time at the tool level is utilization, defined as Productive Time / Manufacturing Time, where Manufacturing Time = [Productive Time + Standby Time]. The smaller the Standby Time is relative to the Productive Time, the higher the cycle time. The trick here is that Standby-WIP-Waiting time isn't true Standby Time. If there is WIP waiting, and the tool is not being run, chances are that what you are really looking at is Operator Unavailable Time. Tools are rarely logged to an "Operator Unavailable" state, of course. Hence, we use Standby-WIP-Waiting as something of a proxy. This is more of a capacity loss than a true Standby state.

Please note that if you are holding WIP at one tool to avoid sending it to another tool too early (e.g. staging WIP at a clean step prior to a furnace), Standby-WIP-Waiting time at the staging step will not be as meaningful. But if you see any Standby-WIP-Waiting time on a bottleneck tool, further investigation is warranted. You can also set alerts for Standby-WIP-Waiting time on your key tools to be notified proactively.

We hope that you find this tip useful.

If you have questions about this item, or any other FabTime software questions, just use the Feedback form inside FabTime's software. Subscribe to the separate Tip of the Month email list (with additional discussion for customers only). Thanks!

Subscriber Discussion Forum

Dispatch Compliance

A subscriber asked us recently to consider writing an article about dispatch compliance for the newsletter. We thought that this was a good idea, and we are working on that for Issue 20.06. There is some research in this area, but there doesn't appear to be an industry consensus on how to measure and report dispatch compliance. We know what we do in FabTime, of course, and are working our way through some of the literature.

Meanwhile, we thought that we would try something new and open this topic to our newsletter community before sharing our article. That way we can incorporate your contributions into the same issue, making them easier to find in the future.

So, here are a few questions:

- Does your site use a formal metric for dispatch compliance?
- If so, and you can share any details about the calculation of this metric, we would be interested to hear it.
- If not, is it because a) you don't use a formal dispatch system; b) you don't have a good metric to use; or c) your operators don't have discretion to process anything except the top lot on the list?
- Have you written or do you know of publicly available papers on this topic?

If you do respond, please let us know if you would like your name and company name included with the response or would prefer to remain anonymous. Please don't send anything proprietary.

Cycle Time Benchmarking

Luca Casati from Vishay wrote recently: "The reason for this email is to ask for your inputs about benchmarking cycle time between different fabs using a standardized metrics.

I have come across different ones:

- X-time the theoretical cycle time. I used to say that 2.5xCT (theoretical) is a 'good level performance' and a useful benchmarking metrics;
- X-days/mask layer: 1.5day/layer considered as an excellent level of performance.

Have you got any inputs on these or others, or any numerical references?"

FabTime Response: In our experience, X-Factor (x-times theoretical) and days per mask layer (DPML) are the two primary metrics used in the industry. At FabTime, we like X-Factor, because it tells you how you are doing relative to how you could be doing. In simple cases you can use queueing models to predict the impact of changes on X-Factor, as discussed in the main article below.

What we say about X-Factor as a benchmark in our Cycle Time Management Course is that 2X is world class performance, but is most realistic for a large, low-mix fab with plenty of tool redundancy. For smaller fabs, 3X is usually considered reasonably good, and 4X to 5X are not uncommon for fabs that have a high mix and/or a lot of one-of-a-kind tools. We've been citing these numbers for years, and we think it is reasonable to think that the definition of "good" may have pushed back to more like 2.5X. [Other subscribers? Any comments on that?]

It's also a matter of choosing where you are comfortable running in terms of utilization. One way to go from 3X to 2.5X is to run at a lower utilization on your bottleneck tools. However, that costs more. We still think that the most likely way to get to 2X is in any cost-effective manner is to have a big enough fab and a low enough mix such that you have relatively large tool groups (both in name and in practice – that is, you can't have a lot of process restrictions that effectively shrink your tool groups. This is also discussed in the main article below.).

We have observed that much of benchmarking in practice is done in terms of days per mask layer instead of X-Factor. We've seen numbers for world class that run a little lower than what you cited, more like 1.3-1.4, but that again would be for large, low-mix fabs. Our understanding is that people like using DPML because if you have an idea of the type of technology, it's easier to have a sense of what that means for overall cycle time. To convert X-Factor to cycle time you need to know the total theoretical process time, which may be more variable (and harder to calculate) across products.

Unfortunately, we don't have any numerical references on this. SEMATECH used to publish some data on what they considered "World Class", but that tended to be for quite leading-edge fabs. In general, benchmarking data is usually held as confidential, so we don't see many publications about it.

The Fab Owners Alliance, mentioned above, does benchmarking across participating members in terms of cycle time (as well as other metrics). We believe that the benchmarking survey is one of the primary reasons that companies join the FOA. Customers that use our software for multiple fabs can also do this type of benchmarking internally with FabTime, but of course we can't share that data.

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

The Impact of Tool Qualification on Cycle Time

Introduction

Something that we've been discussing with our User Group (and with a company site that FabTime's founders visited recently) is the impact of single-path operations on cycle time. While it's well known across the industry that single-path operations (whether from one-of-a-kind tools or from process restrictions) increase cycle time, the magnitude of that impact is not always well understood. Although fabs may not have much day-to-day control over the number of true one-of-a-kind tools, tool qualification changes can yield immediate, significant benefits. In this article, we discuss the reasons for this impact, illustrate its magnitude using our Operating Curve Spreadsheet tool, and make several concrete suggestions for mitigating the problem.

Background

First, a few definitions, to make sure we are all on the same page:

One-of-a-Kind Tool: A tool group that contains only one tool. Also sometimes called a "single tool."

Tool Qualification: The process by which a tool is "qualified" to run a recipe or operation. Often one tool is initially qualified to run a new operation. Additional tools are qualified over time to run that operation, if available.

Tool Dedication: Restriction of an individual recipe or operation to a certain tool, or small set of tools, rather than allowing the recipe to run on any of the tools in a tool group. Also called "process restriction." Dedicated tools are a consequence of tool qualification practices. They can also arise over time if process restrictions are added or as a result of layout or operations choices (e.g. attempts to minimize setups).

Single-Path Operation: A recipe or operation that can only be processed on one specific tool. This can occur because the tool is a one-of-a-kind tool, or because of tool dedication or qualification policies.

Tool qualification is a necessary practice in wafer fabs, where technology changes rapidly. It is important for yield management to ensure that new recipes can be run safely on individual tools. Process restrictions are sometimes put in place later, too, in response to yield issues. In some cases, the tools in a tool group are not identical. Newer tools may be able to process recipes that are a problem on the older tools. There are, in short, valid reasons that lead to tool dedication.

The problem is that tool dedication results in smaller tool groups, sometimes with less balanced utilizations. In the presence of variability (which is inevitable in fabs), smaller tool groups result in higher cycle times. This is because lots that are passing through a single tool are at the mercy of all the variability of the lots ahead of them. This is the same dynamic we all see on the highway. On a single lane road, even if overall traffic is light, if we end up behind a slow truck, we will be stuck there for a while. In light traffic on a two-lane road, we can almost always get by the truck quickly.

Queueing Approximations: FabTime Operating Curve Generator

Queueing models, where available, allow us to predict long-run average behavior of systems. Because they don't require simulation, they can be coded into spreadsheets as formulas. Our last full newsletter issue on tool dedication was back in Issue 3.03 (available upon request to current subscribers). In that issue, we outlined an approximation for average queue time through a tool group as a function of the number of tools.

We later coded a more detailed approximation into a spreadsheet tool that we developed for our cycle time management course. Results are for a tool group with a general – possibly batch – arrival process, general distribution of the process times, multiple tools, and one failure distribution. This approximation came from a formula that was originally given to us by Ottmar Gihr of IBM Germany, when we worked with him on the SEMATECH Measurement and Improvement of Manufacturing Capacity (MIMAC) project back in the mid-1990s. We later modified the calculation of coefficient of variation used in the approximation slightly, to follow a formula listed in the text *Factory Physics* (equation 8.28 in the Second Edition), by W. J. Hopp and M. L. Spearman.

The idea behind this spreadsheet tool was to use queueing models to demonstrate the impact of changes in various factors on the operating curve for a tool group. Participants use the tool extensively during our one-day cycle time management class. A simpler version of the tool has been available from our website for several years. However, that version only applies to one-of-a-kind tools.

Up until now, the full version (with multiple tools) was only available to our software customers and course participants. However, we have decided to make the full version available to newsletter subscribers. If you would like the full version, just send an email or a LinkedIn message to Jennifer to request it.

The full version allows you enter data for up to three scenarios. You can look at:

- Impact of utilization on cycle time
- Impact of variability (in process time, time between arrivals, arriving batch size, and repair time) on cycle time
- Impact of front-of-the-line hot lots on the cycle time of regular lots
- Impact of preventive maintenance strategies on cycle time (short/frequent PMs vs. longer/less frequent PMs)
- Impact of batch arrivals on cycle time
- Impact of tool dedication / qualification decisions on cycle time

There are a few limitations to the tool:

- The spreadsheet has no capability to look at the operating curve of batch processing tools.
- The models use a Priority-FIFO dispatch rule.
- Each operating curve generated is for a tool group in isolation (except for allowing you to look at the variability of the arrivals to the tool group. You can't use it to look at the fab as a whole.

Inputs for the spreadsheet are shown below as Figure 1. We have found this tool to be quite useful for building intuition about operating practices (and the magnitude of the impacts of variability and utilization) on cycle time.

FabTime Cycle Time Operating Curve Generator

Calculates regular lot (non-hot-lot) cycle time for multiple-tool machine groups with general arrival and service processes.
Each tool has a single failure process, indicated by MTBF and percentage downtime.

Source	Description	3 Tools	2 Tools	1 Tool	Notes
Operations	Average process time (hours)	1	1	1	
Operations	Hot lot percentage	0%	0%	0%	Percent of WIP with priority over regular lots.
Operations	Number of tools	3	2	1	
Operations	Process time variability	1	1	1	Coefficient of variation of process times
Operations	Inter-batch arrival variability	1	1	1	Coefficient of variation of arrival process
Operations	Average arriving batch size (lots)	1	1	1	If lots tend to arrive in batches
Operations	Arriving batch size variability	0	0	0	Coefficient of variation of arriving batch size
Operations	Repair time variability	1	1	1	Coefficient of variation of repair process
Operations	Mean time between failures (hours)	24	24	24	MTBF
Operations	Percentage downtime	10%	10%	10%	

Figure 1

Using the Operating Curve Generator to Explore Qualification Decisions

Back to today's topic, let's use the operating curve generator to look at the impact of tool qualification on cycle time for a tool group.

Here the input that we are going to vary (shown circled in red in the image above) is number of tools. Apart from that we will include a moderate level of variability – exponentially distributed arrivals and process times, and 10% downtime, with the repair time also exponentially distributed and a 24 hour mean time between failures. We have not included any hot lots or batch arrivals in this scenario.

The resulting operating curve looks like the image below (Figure 2). It's important to note that we are looking at tool qualification here and not at purchasing additional tools. What we're comparing is having a single tool qualified to run a set of lots (the red curve), vs. having two qualified tools and twice the number of lots run on them (the green curve), vs. having three qualified tools and three times the number of lots. We can then compare the curves at the same utilization value. If we wanted to look at adding a second tool to a one-of-a-kind tool, we would expect a reduction in the utilization and thus an even greater impact on cycle time.

What we think is most significant about this chart is the magnitude of the reduction as we go from the red curve to the green curve (and to a lesser extent to the blue curve). It's clear visually that the cycle time x-factor through the tool group is cut roughly in half as we go from single-path to having a second qualified tool. The reduction as we go to three qualified tools is less, but still significant at higher utilizations.

This relative reduction is robust to changes in the other variables. The reason for that is the way that the number of tools appears in a portion of the queueing formulas. Other factors are multiplied by this factor, shown in Figure 3.

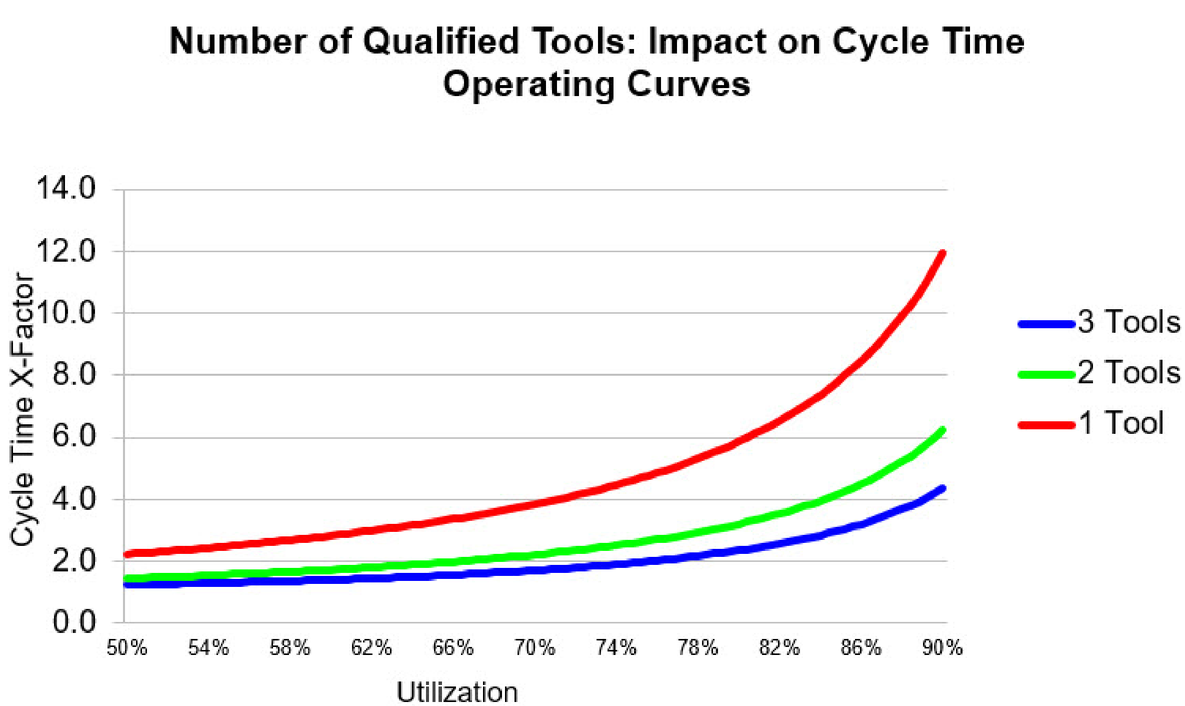

Figure 2

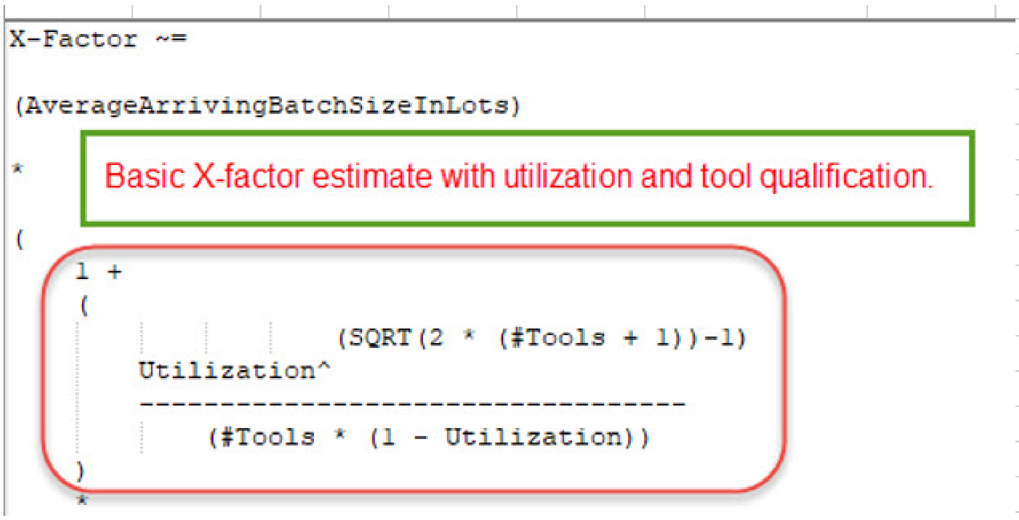

Figure 3. Portion of the Queueing Formula Showing Impact of Number of Tools

A new page on the spreadsheet tool called Impact of Tool Qual allows you to explore this in more detail. Coding just that part of the equation into the spreadsheet and varying the utilization gives the results shown below in Figure 4.

We've done a similar analysis to display the impact of qualifying from one tool up to ten tools at 90% utilization, as shown in Figure 5 on the next page.

Here we again see about a 50% decrease in cycle time as we go from single-path to dual-path, a smaller but still significant reduction as we go to three tools, and smaller and smaller decreases as additional tools are qualified.

An Intuitive Explanation

In the example above, the decrease in queue time is quite dramatic as the number of tools increases. Once there are 10 tools in the tool group, the queue time is small, even though the tools are all loaded to 90% of capacity. Think about it this way. When you have a group with 10 tools, each loaded to 90% of capacity, each tool is going to be idle 10% of the time (neglecting downtime). If arrival times and process times are highly random, then

Tools	1	2	3	CT Reduction of single-path to dual-path	CT Reduction of single-path to 3 tools
Util	Basic XF	Basic XF	Basic XF		
50%	2.00	1.37	1.19	32%	41%
55%	2.22	1.47	1.25	34%	44%
60%	2.50	1.60	1.33	36%	47%
65%	2.86	1.77	1.43	38%	50%
70%	3.33	1.99	1.58	40%	53%
75%	4.00	2.32	1.79	42%	55%
80%	5.00	2.81	2.11	44%	58%
85%	6.67	3.63	2.65	45%	60%
90%	10.00	5.29	3.75	47%	63%

X-factor impact of dual-path is smaller at lower utilization, but rises to approximately 50% reduction at 90% utilization.

Figure 4. X-Factor Impact of Varying the Number of Tools at Different Utilizations

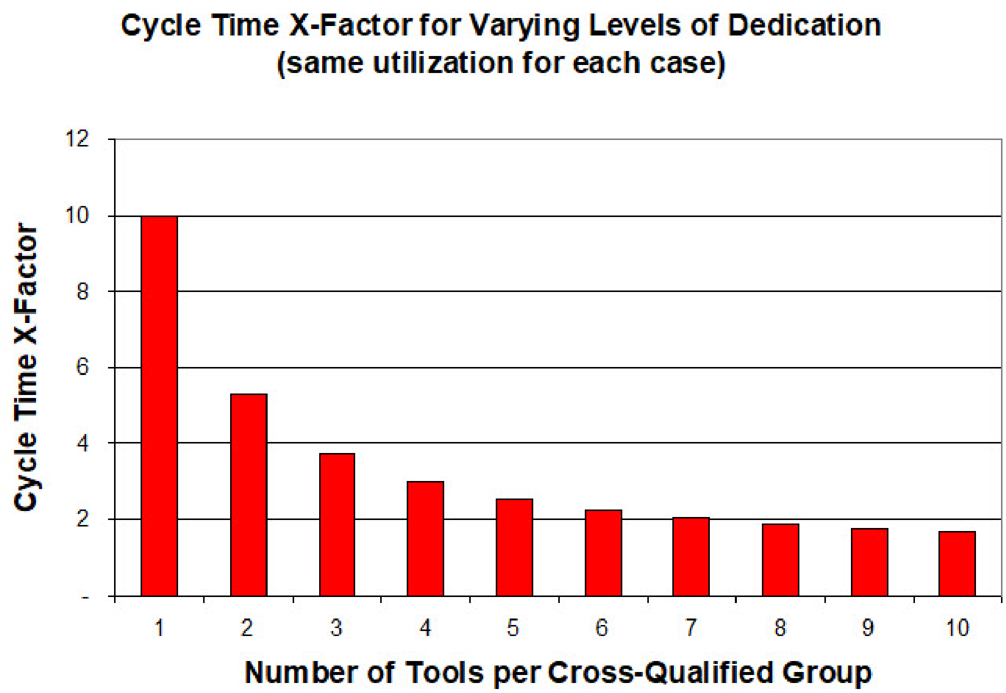

Figure 5

much of the time, when a lot arrives, at least one tool will be idle and ready to process that lot. By contrast, if you only have one tool in a group, and lots can arrive any time, 90% of the time, when a lot arrives, the tool will be busy, and the lot will have to wait.

Examples in Everyday Life

The obvious example that comes to mind here is the grocery store. If instead of having 10 separate checkout lines your grocery store was configured to have a single line for all 10 cash registers, your average waiting time would decrease dramatically. This is because you would never be waiting in line for one cash register, while another one down the line became free. You would never be stuck immediately behind the person who requires a price check, or has never used a credit card before, because you would get the next available register. However, the day of having a single line at the grocery store is not likely to come any time soon. Grocery stores probably use separate lines because of space constraints (the carts are very large).

On the other hand, TSA boarding pass agents at the airport usually share a single waiting line. Each agent is cross-qualified to handle anyone who comes through. Airports will often provide a dedicated line for hot lots – TSA pre-check and CLEAR customers – but in our experience there are usually still multiple servers (agents) provided. This is to prevent holding up the entire line when there is a problem.

A Rule of Thumb

All of this leads to our rule of thumb for tool qualification: any time you can get a second tool qualified, to go from single-path to dual-path, for a relatively heavily loaded tool, you can expect a cycle time reduction of about 50%. Getting to three tools will reduce cycle time even further (more than 60% total from the original single-path).

This is not to say that there aren't yield benefits to single-path. But we believe strongly that those benefits should be considered in light of the impact on cycle time, which is sometimes underestimated.

Soft Constraints

One other point about tool dedication is that "soft constraints" can also arise. Soft constraints are places where tools are dedicated in practice, even if there is such official restriction. This can happen due to layout issues (where a tool group is broken up across the fab), setup minimization policies, or operator preferences for tools. Such soft dedication may make sense in many cases, but when it leads to single-path operations, it can be a hidden source of cycle time in the fab. One way to identify these types of tool preferences is to graph moves and availability by tool on the same chart and look for places where moves are low, despite high availability.

Recommendations

Here are a few recommendations for mitigating the impact of single-path operations in practice:

- Educate process engineers about the magnitude of the cycle time benefits from cross-qualification. Promote standards for getting to at least dual-path.
- Develop reports that generate lists of operations that have only one qualified tool (or no qualified tools, as can also happen). FabTime has a standard chart like this, but it is only as good as the tool qualification data that is entered into the MES.
- Provide automatic warnings when a new process restriction is going to result in single-path.
- Provide warnings when a long PM is going to lead to single-path (or no path). Consider breaking up PMs on key tools that lack redundancy. Similar rules may apply to times when engineers take over tools to run experiments.
- Check periodically for soft constraints.

Conclusions

One of the three fundamental drivers of cycle time in a factory is the level of tool redundancy. At the tool group level, number of tools has a significant impact on cycle time. This impact accumulates across the fab. It is the primary reason why smaller fabs that have many one-of-a-kind tools tend to have higher average cycle time than larger fabs.

The number of one-of-a-kind tools is not something that fabs can easily change on a day-to-day basis. However, something that fabs can change is their tool qualification policies. When tool qualification policies result in single-path operations, they drive up cycle times significantly. Often the cycle time through a single-path operation is twice what it would be if a second path was provided.

In this article, we share a spreadsheet tool that allows companies to use queueing approximations to explore tradeoffs in tool qualification policies. We hope that this tool will be of use in conveying to team members the importance of providing and maintaining backup tools.

Closing Questions for Newsletter Subscribers

Does your fab have policies regarding single-path operations? Do you consider operating decisions that will lead to temporary single-path (e.g. deferring a PM if one of three like tools is already down)? Do you have regular reports that identify single-path operations?

Further Reading

- J. Robinson and F. Chance, "How Much Does Tool Dedication Inflate Cycle Time?" *FabTime Newsletter*, Vol. 3, No. 3, 2002.
- J. Robinson and F. Chance, "The FabTime Cycle Time Characteristic Curve Generator," *FabTime Newsletter*, Vol. 2, No. 7, 2001.
- W. J. Hopp and M. L. Spearman, *Factory Physics: Third Edition*, Waveland Press, 2011. Reviewed (Second Edition) here.

Acknowledgements

FabTime would like to thank Ottmar Gihr of IBM Germany for the core approximation used in our Operating Curve Spreadsheet. We are indebted to Mark Spearman for the reference to the modified formula for calculating CV in the spreadsheet.

We are also grateful to our user group, and to the company that Frank and Jennifer visited in September, for recent discussions around the topic of tool qualification and cycle time.

Subscriber List

Total number of subscribers: 2698

Top 20 subscribing companies:

- ON Semiconductor (211)
- Infineon Technologies (145)
- Micron Technology, Inc. (122)
- Intel Corporation (112)
- GlobalFoundries (93)
- Maxim Integrated Products, Inc. (88)
- NXP Semiconductors (76)
- Microchip Technology (70)
- Carsem M Sdn Bhd (69)
- Skyworks Solutions, Inc. (65)
- STMicroelectronics (62)
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- Texas Instruments (54)
- Seagate Technology (52)
- X-FAB Inc. (49)
- TDK (47)
- Analog Devices (41)
- Zymergen (34)
- Cree, Inc. (33)
- Honeywell (30)

Top 5 subscribing universities:

- Arizona State University (8)
- Virginia Tech (7)
- Ben-Gurion University of the Negev (6)
- Ecole des Mines de Saint-Etienne (EMSE) (6)
- Nanyang Technological University (6)

New companies and universities this month:

- Corning Inc.
- Edwards Vacuum
- EUV Litho Inc.
- Fluor Corporation
- i3 Electronics
- Inficon
- Jabil Circuits
- JTJR Solutions
- Matthews Industrial Automation
- Micro Systems Engineering
- MicroLink Devies
- Retirement Clearinghouse LLC
- SiCamore Semi
- Walmart

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.

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FabTime® Cycle Time Management Training

"It was helpful to see best-in-class methods for wafer fab cycle time management. Discussing these matters in-depth with you was quite valuable, as we could ask questions specific to our fab and processes."

Shinya Morishita
Manager, Wafer Engineering
TDK Corporation

Course Code: FT105

This course provides production personnel with the tools needed to manage cycle times. It covers:

- Cycle time relationships
- Metrics and goals
- Cycle time intuition

Price

$7500 plus travel expenses for delivery at your site for up to 20 participants, each additional participant $500. Discounts are available for multiple sessions. Pricing to increase on 1/1/2020.

Interested?

Contact FabTime for a quote.

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Web: www.FabTime.com

Do you make the best possible decisions?

- Do your supervisors possess good cycle time intuition?
- Are you using metrics that identify cycle time problems early?
- Can you make operational changes to improve cycle time?

FabTime's Cycle Time Management Training is a one-day course designed to provide production personnel with an in-depth understanding of the issues that cause cycle time problems in a fab, and to suggest approaches for improving cycle times. A half-day executive management version is also available upon request. The course is only available for delivery at sites within the United States, unless it is delivered in conjunction with software training for FabTime customers, or unless multiple sessions are requested on the same visit.

Prerequisites

Basic Excel skills for samples and exercises.

Who Can Benefit

This course is designed for production personnel such as production managers, module managers, shift supervisors, hot lot coordinators, and production control.

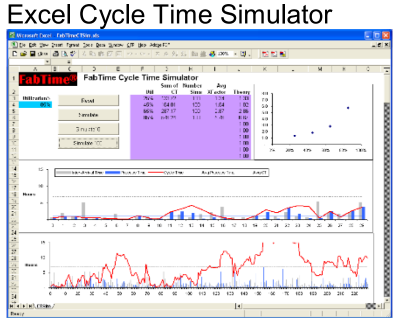
Skills Gained

Upon completion of this course, you will be able to:

- Identify appropriate cycle time management styles.
- Teach others about utilization and cycle time relationships.
- Define and calculate relevant metrics for cycle time.
- Teach others about Little's law and variability.
- Quantify the impact of single-path tools and hot lots.
- Apply cycle time intuition to operational decisions.

Sample Course Tools

Excel Cycle Time Simulator



Staffing Delay Simulator