FabTime Cycle Time Management Newsletter

Volume 12, No. 2 March/April 2011

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 software this month include better drill-down from shared home page tabs, and the ability to save a default home page tab for landing on login.

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Contributors: James Ignizio (University of Texas - Pan American); Bob Kotcher (Philips Lumileds)

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Welcome

Welcome to Volume 12, Number 2 of the FabTime Cycle Time Management Newsletter. We'd like to extend our deepest sympathy to our friends in Japan. While many of the high-tech manufacturing facilities haven't been directly affected by the natural disasters, it seems that everyone is dealing with power outages, not to mention fears regarding nuclear crises. Our hearts go out to everyone in Japan. We're reminded by this crisis just how connected we are, as a world economy and a world population.

In the spirit of our connectedness as a population, we've chosen to use our main article this month as a forum for re-introducing a number of previously raised subscriber discussion topics. Our hope is that some of you will find that you have something to say on one or more of these topics, so that we can all learn from one another as a community. We welcome your feedback

In this issue we also have two calls for papers for conferences. Our FabTime user tip of the month is about ways to export full chart datasets to Excel. In our subscriber discussion forum we have two responses to last month's question about managing in the presence of multiple constraints, and a follow-up from Bob Kotcher to last month's main article about confidence intervals vs. prediction intervals.

Thanks for reading – Jennifer and Frank

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Community News/Announcements

Call for Papers: e-Manufacturing & Design Collaboration Symposium 2011/ISSM 2011

In collaboration with ISSM, this joint Symposium attends to recent technological advancements to align the needs of designers, manufacturers, equipment suppliers, software vendors, solution providers and researchers. It offers a public arena for the exchange of up-to-date experiences among manufacturers for adoption of technological developments. With green notions of supply / engineering / value chains, coverage of the joint symposium includes (this is a sub-set of the full list):

- Benefits and Justification (ROI, CoO, OEE ...)
- Engineering/Supply/Value Chains
- Fab Management / Scheduling / Dispatching
- Factory Integration/Operations
- Factory Physics & Queueing Operations
- Manufacturing Control and Execution Systems
- Manufacturing Strategy and Operation Management
- Ultra High Productivity in High-Volume Manufacturing
- Yield Enhancement and WIP Management

Online abstract submission starts on April 1, 2011 and the submission due date is June 1, 2011. The symposium will be held September 5-6 in Hsinchu Taiwan. The full list of topics, and submission details, can be found here: http://www.digicraft.com.tw/tsia2011/callforpaper.html

Call for Papers: 6th International Conference on Queueing Theory and Network Applications (QTNA2011)

The 6th International Conference on Queueing Theory and Network Applications (QTNA2011) will be held in Seoul, Korea on Aug. 23-26, 2011. The conference is a continuation of the series of successful conferences - QTNA2006 (Korea), QTNA2007 (Japan), QTNA2008 (Taiwan), QTNA2009 (Singapore), and QTNA2010 (China). QTNA2011 is a conference for the dissemination of state-of-the-art research on queueing theory and its applications in networks and related issues. The aim of the conference is to bring together researchers, scientists and practitioners from the world to identify important and challenging problems and issues in the area of queueing theory and network applications and work together to discover feasible solutions for these problems. The conference will cover all the key topics in queueing theory, communication networks and other related areas. It will provide an in-depth representation of theory and practice in these areas. Each submission should promote queueing theory or related techniques, and demonstrate a relationship between theory and its application; any topic that satisfies these requirements would be of interest.

Papers must be submitted through the conference website: http://math.korea.ac.kr/~qtna2011. Abstract and title registration are due by April 20th, with full papers due May 1st.

FabTime welcomes the opportunity to publish community announcements. Send them to newsletter@FabTime.com.

FabTime User Tip of the Month

Export Full Datasets to Excel*

The Excel button on FabTime's chart pages (located just above the data table) opens up the data table as shown on the page in a separate instance of Excel (changing your security settings may be necessary for this to work - see the help page that pops up if you have trouble). This means that if you are not displaying all of the rows of the data table, or you have hidden some columns, the data that is not shown will not be included in the Excel button export.

However, you can now use the "Excel (all rows)" and "Excel (all data)" links to export chart data, even if it is not displayed on the web page. The "all rows" link will export all available rows of data, regardless of the setting used in the "Rows" field, but will not include any data in columns that you have hidden. The "all data" link includes all rows and all columns, whether hidden or not. The "Excel (as shown)" link exports the data table as shown (as you would expect).

The Excel links work slightly differently from the Excel button, in how they access Excel. The button opens a separate instance of Excel, and saves the associated file in your c:/temp directory. The Excel links (all three of them) access Excel from within the browser. A window pops up that asks: "Do you want to open or save this file?", and prompts you for where to save the file. If you open the file, depending on your system configuration, Excel may open from within your browser, requiring you to use your browser's Back button to return to the chart page.

Excel export capabilities require you to have Excel installed on the computer that you are using. The Excel button only works in Internet Explorer, and not in Firefox, because it uses an ActiveX control. All of the Excel links work in Firefox (which is why the "Excel (as shown)" link exists, even though the button also exports the data table as shown). Other system configuration and security issues may affect how the Excel export works on your computer. Please contact your internal FabTime administrator for help with these issues.

If you have any questions about this feature (or any other software-related issues), just use the Feedback form in the software.

Subscriber Discussion Forum

Managing in a Multi-Constraint Environment

Professor James Ignizio (University of Texas – Pan American) wrote in response to the subscriber discussion topic introduced by **Shmulik Perez** in the last issue. James said: "Shmulik Perez's concerns, with regard to the management of a factory within a multi-constraint environment, sound quite familiar. As a consultant to various semiconductor firms, and as a previous employee at one, the fabs I've been exposed to (five in the U.S. and two elsewhere) have **all** had multiple, migrating constraints. The number of constraint tool sets have ranged, again in those fabs I've seen, from around six to a dozen (and, depending on the maintenance

schedule, factory starts clustering, and headcount allocation, dispatch rules, even more).

The approach I would recommend is to remove or at least mitigate the "Three Obstacles to Performance." These are: (1) *Unnecessary Complexity*, (2) *Excessive Variability*, and (3) *"Lack of Vision."* The third obstacle is the most difficult to deal with as it requires that fab managers and engineers take on a rather different perspective of fab strategies and tactics.

Examples of this approach are provided in my book: *Optimizing Factory Performance* (McGraw-Hill, 2009) and there are illustrative factory simulations available through the McGraw-Hill website (www.mhprofessional.com/ignizio) that allow one to compare various tactics (e.g., balanced lines, Theory of Constraints, and the minimization of variability and complexity).

At any rate, I personally feel confident that it should be possible to run the Micron/ Israel fab with a Load Adjusted Cycle Time Efficiency (LACTE) of at least 40 percent, even with its large number of constraint/near-constraint tool sets."

Another longtime subscriber also responded anonymously (if anyone would like to be put in touch with him, let us know offline):

"What a great topic! A couple comments off the top of my head:

1) Is there such a thing as a number of optimum near constraint tools? As an inveterate operations guy given unlimited funds and the choice, I would have only one constraint in the fab and would be modeled on Goldratt's image. However, given the economy, competition and need for ever increasing margins, that kind of capital is not going to show up to the game. I am confident there are many companies in this situation. Specifically, that there are a relatively large number of near constraint tools (as Shmulik defines it, which I think is a good definition) managing a significant proportion of the process flow operations. I know I live there! My point is that this is a real problem that needs to be managed and he is not alone.

2) He comments on PM activities. First of all, that is a critical component of the management approach. The idea being that one anticipates and controls the planned downtime to avoid the unplanned down time. Especially with an aging tool set, it is critical these PM's are well designed and executed as expected. We are on a steep learning curve in this regard ourselves at my company. We must get very good at this.

a. We are generating new metrics (time to completion vs. some standard, first pass success) to measure our progress. Make use of post mortem analysis when things don't go well to shape improvements. I recommend this also.

b. Scheduling is key. It is unavoidable that WIP will build at the constrained tool set during planned maintenance. The best thing to do, which I am also aggressively pursuing, is to have sufficient flexibility to keep at least some minimum level of throughput going. We are also developing tools that are allowing us to anticipate better and be smarter about what we do when. I think this is very important.

3) Regarding how to manage the WIP in general terms, I have to agree that applying a drum type approach is critical especially where a tool set has what I call a "nested re-entrant" condition. In other words, a tool set or two that feeds itself at multiple layers. This can get pretty complicated and can result in some very weird results. I have observed material getting into odd oscillations where material would go back and forth "inside" the nest and only come out in a trickle. This can be a problem particularly when they feed additional

downstream constraints/near constraints. My sense is the best methodology is to drive a drum across the scope of the tool set. This is not always well appreciated by the Planning folks. I am speaking from a strictly linear approach to WIP management and there may be other considerations driving the lot selection process.

In short the things I think Shmulik should consider are:

- A sophisticated preventive maintenance program with performance metrics to drive improvement
- Drive to maximize tool flexibility to help overcome availability issues
- Intelligent dispatching to manage local optimization and reduce the risk of unintended consequences downstream.

Prediction Intervals vs. Confidence Intervals

Bob Kotcher from Philips Lumileds, whose question inspired last week's main article about prediction intervals vs. confidence intervals, wrote:

You asked, "Do you use prediction intervals in any of your fab planning (cycle times, WIP levels, throughputs)? If so, what methods do you use for calculation?" Your readers might be interested in what I did using Frank and Beth's help:

We have a reasonably long supply chain. We want to maintain sufficient starts to get the outs that we need at the end of the line. In Excel, we can calculate expected outs each week from each process node based on our capacity models and have a nice synched low-WIP line. But in reality, of course, variability will cause outs each week from each node to be different than planned, causing us not to meet some of our outs targets. How do we account for this variability so that we can adjust our starts plan accordingly?

At this point I contacted my old friend and **Brilliant Statistics Guy Frank Chance** for advice on how to estimate variability in a parameter (not the parameter's mean value) based on Monte Carlo modeling. Upon counsel with his apparently even **Brainier Statistics Gal Beth Chance**, he got back with me about "prediction intervals" and how running a Monte Carlo model many times and calculating the percentage of results that lie within a range is the only way to do it.

Dang, I was hoping it would be simpler than that. I've built a detailed Monte-Carlo simulation model of our entire worldwide operation using WWK's Factory Explorer software (which was authored many years ago by none other than Frank Chance), but it would take a while for the many repetitions and subsequent data crunching needed to generate reasonably accurate prediction intervals for everything. So for this need, I took the existing static WIP-predicting Excel spreadsheet that started it all and added random variation to the output of each node each week. What I did was, using Excel's internal random-number generator function (RAND[]) and an Excel lookup table, I could allow each node's output to vary each week in accordance with its historical variation. The spreadsheet would then allow that process node to process that quantity that week (unless WIP was lower than that, in which case the throughput would be equal to the WIP value).

So the spreadsheet now showed one Monte Carlo "trial," showing, for the coming several months, what starts we planned, what WIP and throughput would be at each node each week, and what the outs would be at the end of the line. Pressing the F9 key caused Excel to generate a new set of random numbers, generating a new result. But how could I generate thousands of trials so that I could calculate prediction intervals? What I did was copy values from the table into a row

below, then drag-copy that row 10,000 rows below, creating 10,000 "trials".

Above this lower table I created formulas that counted, across the 10,000 trials, what quantity were within a certain range, then divided that by 10,000 to get the percentage. This would give me the probability of any throughput or WIP level being within a certain range for any process in any week. Pressing F9 created a new set of random numbers, but with this many trials, the probabilities above stayed the same, which gave me confidence that I had enough trials for high confidence in my estimate of the effects of variability (actually, probably a thousand trials would have been fine).

I thus could estimate what the probability was of our supply chain's output being at least X in week Y. I could also estimate the probability of any node running dry of WIP in any week—stuff like that. This Monte Carlo spreadsheet is not as accurate as the detailed worldwide Monte Carlo simulation model that I built using Factory Explorer software, but it's more accurate than the original static Excel spreadsheet and is accessible to everyone in the company. Now anyone can change assumptions and get reasonably good answers instantly.

FabTime Response: Sounds like an excellent use of spreadsheet-based simulation to us!

FabTime welcomes the opportunity to publish subscriber discussion questions and responses. Send them to: Jennifer.Robinson@FabTime.com.

Ten Fab Management Discussion Topics

Introduction

Since we have such extensive and useful subscriber discussion this month, we've decided to go with a very short main article. We noticed that quite a few interesting subscriber discussion topics that have been raised could benefit from another look. We thought we would review some of these, and open them up for new discussion.

Here are 10 topics, pulled from past newsletter issues and other offline discussions, and edited by FabTime.

1. Queueing Models: Has anyone had success in applying queueing models to the fab as a whole? How accurate have you found exponential models in practice? Do you try to measure utilization and variability for the fab as a whole, or look at this by tool or step? [Note: FabTime has quite a bit that we can say on this topic – we're wondering how wide the interest level is among the newsletter community.]

2. Short-Term Simulation Models: Does anyone use simulation models for short-term analysis? By that we mean plugging in the current WIP and tool status of the fab and simulating to see when and where WIP bubbles are likely to form in the coming days and weeks.

3. Lean Manufacturing: Has anyone implemented formal lean techniques (Six Sigma, Kaizen, Pull System, etc.)? If so, are there any success/failure stories that you can share?

4. Running Development and Production Wafers: How do fabs that run both development and production wafers maintain learning with fewer moves devoted to R&D lots?

5. Ramping: How quickly can we ramp a mature fab back up after it has been running at a much lower utilization rate?

6. Multi-Constraint Environments: What are good methods for WIP management and maintenance scheduling in the presence of multiple, nested constraints?

7. Supply Chain Planning: Should we maintain some stock points in the line, to help us respond to order or design changes? If so, where should those be, and how should we manage them?

8. Hot Lots: What is considered a reasonable percentage of hot lots in a fab? What is a reasonable number of hand-carry lots? [We have discussed hot lots in Issues 3.02 and 6.08, but we feel that benchmark numbers may have evolved over the years since then.]

9. Staffing Productivity: What are reasonable operator productivity numbers for 200mm and 300mm fabs? How do people define operator productivity? Is there a defined proportion between 300mm productivity and 200m operator productivity? Does anyone have models that they use for measuring engineering staff productivity?

10. Dispatch Performance: What constitutes good results for dispatch execution? What are good performance measures for dispatch compliance?

If any of these questions inspire you to respond, please send your thoughts to Jennifer.Robinson@FabTime.com. Your response can be attributed to you, or kept anonymous, as you prefer. And if these questions made you think of some other question, send that along too. We'll respond in the next issue with our thoughts on these topics, and any subscriber responses that we've received.

Conclusions

The newsletter community includes people from a wide range of fabs and other high-tech manufacturing facilities. One of the things that we've always tried to do with the newsletter has been to provide a forum by which members of the community can benefit from one another's experiences and insights. Although FabTime's team members talk with people from fabs every day, we're not right there working in the fab, day in and day out. When questions come up, we often have something to say, either from our discussions with fabs, or from our graduate studies of manufacturing behavior. But other times, many of you are better equipped to answer one another's questions than we are. And those of you who take the time to do so strengthen the knowledge base of the whole community. For that matter, those of you who take the time to ask questions add to the collective knowledge base. Because we'll bet that for every person who asks a question like the ones above, at least 10 other people (or perhaps 50 other people?) are struggling with the same issue.

In looking back through the many subscriber discussion topics that have been raised over the years, we identified ten that we thought could benefit from further examination by the subscriber community right now. We welcome your feedback! Thanks for participating!

Subscriber List

Total number of subscribers: 2756, from 453 companies and universities.

Top 20 subscribing companies:

- Maxim Integrated Products, Inc. (174)
- Intel Corporation (146)
- Micron Technology, Inc. (105)
- GLOBALFOUNDRIES (95)
- Western Digital Corporation (69)
- Carsem M Sdn Bhd (67)
- X-FAB Inc. (67)
- Texas Instruments (66)
- International Rectifier (63)
- TECH Semiconductor Singapore (61)
- ON Semiconductor (58)
- STMicroelectronics (56)
- Analog Devices (53)
- Freescale Semiconductor (53)
- IBM (48)
- NEC Electronics (46)
- Infineon Technologies (40)
- Cypress Semiconductor (38)
- Skyworks Solutions, Inc. (36)
- Seagate Technology (35)

Top 5 subscribing universities:

- Ecole des Mines de Saint-Etienne (12)
- Arizona State University (8)
- Ben Gurion Univ. of the Negev (8)
- Nanyang Technological University (8)
- Virginia Tech (7)

New companies and universities this month:

- GM Components Holdings (GMCH LLC)
- Dynacraft Industries Sdn Bhd
- AMCKaizen (Advanced Manufacturing Consultancy)
- Littlefuse
- Nanophotonics Technology Center Valencia (NTC)

Sampler Set of Other Subscribing Companies and Universities:

- Acer (1)
- Adcock Ingram (1)
- Alfalight (2)
- Avago Technologies (15)
- Cyberfab (1)
- DotChain Consultant, Inc. (1)
- Edwards Ltd. (1)
- Enterprise Systems Partners (1)
- Global Integrated Ventures (1)
- IDC (2)
- Kun Shan University (1)
- Nimble Consulting Services (1)
- Shanghai Grace Semiconductor Mfg. (GSMC) (6)
- Telefunken Semiconductors (4)
- TESCO HSC (1)
- THAT Corporation (1)
- University of California - Berkeley (4)
- University of Malaysia (1)
- University of Teesside - UK (1)
- Wuhan Xinxin Semiconductor Manufacturing Co. (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® 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 U.S. site for up to 20 participants, each additional participant $300. Discounts are available for multiple sessions.

Interested?

Contact FabTime for a quote.

FabTime Inc.
Phone: +1 (408) 549-9932
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Email: Sales@FabTime.com
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 two-day version and a half-day executive management version are also available upon request. As of January 1, 2011, the course is only available for delivery at customer sites within the United States.

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.

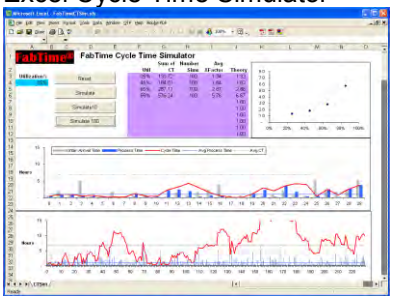
Skills Gained

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