FabTime Cycle Time Management Newsletter

Volume 2, No 3, March 2001

Information

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

Publisher: FabTime Inc.

Editor: Jennifer Robinson

Contributors: Brent Bogue (Amkor) and Jerzy Tomasik (Texas Instruments)

Table of Contents

Welcome

Welcome to Volume 2, Issue 3 of the FabTime Cycle Time Management Newsletter. By now, in this current industry slowdown, many of you have discovered the number one way of reducing fab cycle times - just reduce your start rate significantly. Not really the method that we at FabTime would prefer to see in use, but what can we do? On the bright side, maybe this slowdown will leave a little more time for thinking about other cycle time improvement efforts, and putting things in place to help when start rates increase again. Because of course they will increase eventually. This month's issue is dedicated to ideas for improving cycle time during a downturn.

In this issue, we also have some feedback from Brent Bogue regarding the batch size decision issue (2.1), from Jerzy Tomasik regarding one of the earlier issues on the P-K formula, and an additional reference on the lot size question from issue 2.2. Also, a few people have asked lately for back issues of the newsletter. I have a self-extracting archive that contains all of the past issues as individual text files. If you would like a copy, just let me know. You can also request the issues as individual text files, or in a zipped format.

Thanks for reading! We're now at 322 subscribers, and counting! -- Jennifer

FabTime

325M Sharon Park Dr. #219
Menlo Park CA 94025
Tel: 408 549 9932
Fax: 408 549 9941
www.FabTime.com

Responses to Prior Newsletter Topics

Issue #2.2 (Should You Reduce Lot Sizes to Reduce Fab Cycle Time?)

This is not a response exactly, but we came across an article in Semiconductor Magazine on how reducing lot size may increase cycle time for 300mm fabs. The article is at www.semi.org/web/wmagazine.nsf/url/maghomet. The article explores the idea that in 300mm fabs lot size may be reduced below 25 wafers. The author (Rafi Maslaton of Tefen) mentions increased load on operators (leading to larger headcount), the effect on capacity, increased setups, degraded batch efficiency, etc., and concludes that the reduction in theoretical cycle time from smaller lot sizes will not compensate for increases due to these other factors.

Issue #2.1 (Impact of Batch Size Decision Rules on Cycle Time)

Brent Bogue (Amkor) sent in the following comments: "I recently returned from the Far East and read your last two newsletters. What you described in the batching process for Diffusion is something I did back with Motorola at our MOS10 facility in 1996-1998. We had great success reducing not only Diffusion stage cycle times, but we also had a favorable impact on the reduction of overall fab cycle times. The strength of your newsletter is that you provide mathematical models and trend charts to prove the common sense. I wish I had those charts you put together to show some old nay-sayers when I started out reducing batch sizes. The old guard gave me the evil eye, but they came around once they saw fab cycle times reduced."

Issue #1.3 (P-K Formula)

Jerzy Tomasik (TI) recently sent in the following message: "Thank you so much for the past issues. In reading through them, I found the P-K formula discussion in one of the first issues very interesting. It provides theoretical basis for what we have actually seen in practice. However, I did run into some problems trying to plug real numbers into the equation. In particular, the third term of the equation has different units then the first two terms, unless sigma is in units reciprocal to lambda. Your examples use 0 for no variability and 1 for high variability. Is it per chance scaled to the average service time? Without scaling it this way I'm getting results which defy intuition. For example, lambda=7, mu=10 and lambda=70, mu=100 give drastically different WIP levels."

Here is my response to Jerzy: "Yes, the units of variance are units reciprocal to lambda squared. For an exponential service distribution, for example, sigma^2 is (1/mu)^2. For a constant service time distribution, sigma^2 is zero. Usually in my examples I use exponential to represent a high variability distribution. If I said that the variance ranged from zero to one, that was incorrect. The coefficient of variation does range from zero to one, where the coefficient of variation is the square root of the variance divided by the mean. So, in the exponential case, you have (1/mu)/(1/mu) = 1.0. I was probably sloppy about that somewhere (referring to the variance where I should have referred to the coefficient of variation). The coefficient of variation is basically a scaled, dimensionless version of the variance, and is a general representation of how variable a distribution is (ranging from zero to one). So, for both the exponential case and the constant service distribution case, I think that you do get the same results for lambda=7, mu=10 and lambda=70, mu=100 (because for the exponential case, sigma^2 = (1/mu)^2). Because your intuition is of course correct that the scale shouldn't matter (we should get the same result whether we express the times in

minutes or hours, for example, as long as we're consistent about it)." And my thanks go out to Jerzy for being thorough enough to catch me on two issues that were definitely unclear as initially presented.

Improving Cycle Time During a Downturn

Background

Downturns are a fact of life in the cyclic semiconductor industry. Various factors contribute to their existence - capacity buildup (and the long lead-time required in capacity purchases), decline in selling prices, inventory build-up, and the general state of the economy. This one seems to have been triggered mainly by the last two factors. This is a simplification, but basically a decline in consumer confidence and spending led to a glut of consumer end-product inventories, and a subsequent sharp decline in orders across most sectors of the chip industry. Industry analysts think that this decline bears many similarities to the downturn in 1984 and 1985. (See the February 27th story on Semiconductor Business News at www.siliconstrategies.com/story/OEG20010227S0041 for details.)

The bad news is that this type of downturn can strike very quickly (as I'm sure you noticed), and revenues can drop quickly and painfully. The good news is that this downturn is likely not to be as long as capacity utilization and selling price-driven downturns such as the 1996-1998 downturn. Most analysts are predicting improvement before the end of the calendar year. IC Insights, for example, recently predicted increasing sequential revenues by Q3 of this year, based on data from the last five downturns. (See the story at www.icinsights.com/news/releases/press20010301.html.) Of course the situation can change quickly, but there seems to be room for optimism.

The quickest way to reduce cycle time in a wafer fab is to significantly decrease start rates. This moves your factory to the left on the cycle time vs. factory loading curve, to a region of lower cycle times. You can see a sample graph on our website, at www.fabtime.com/ctcapac.htm#ctcap. It's kind of ironic, really. Just when customers aren't clamoring for product, your fab can delivery product with record cycle time and on-time-delivery performance. The thing is, however, that it's very easy under these conditions to get a bit sloppy, and to take the lower cycle times for granted. But then when start rates begin to increase, when customers are paying attention again, your cycle times will degrade rapidly. If you don't have great cycle times now, you certainly won't have great cycle times when start rates go back up. Therefore, we suggest using this time to focus on low cost cycle time improvement efforts.

Some Suggestions for Cycle Time Improvement During a Downturn

Setup/Dedication: During a downturn, it's more important than ever to get custom/qualification lots out quickly, so that you don't lose any orders. This may mean doing more setups, even if the setup is only done to get a couple of lots through. If you have spare capacity, you can afford to spend this time on setups, and the additional setups will help to get things out quickly. Therefore, our first suggestion is to revisit setup and dedication schemes in light of changes in start rate.

Process Analysis: You can also spend time during a downturn finding out what the real raw process time is for your products. For example, you could have someone hand-carry a lot through its process

flow, recording only the time spent actually processing the lot. Having accurate information about the raw process time by operation can be very helpful in setting goals for operation cycle times (and, by implication, overall cycle time). By comparing the theoretical cycle time by operation to the actual observed cycle time for completed lots, you can identify operations that are disproportionately increasing cycle time. Once you identify them, you can work on improvement.

Layout Analysis: Another thing that you can do by hand-carrying a lot through its process flow is map the process flow, and looking for savings. Could you change the layout and significantly reduce travel distances? Are lots sitting waiting to be grouped for transport somewhere? Could you reduce the transport lot size, and reduce this waiting significantly?

Bottleneck Analysis: A downturn could be a good time to work with a local university, and have some grad students in to do an analysis of your bottleneck or near-bottleneck areas. There are probably either operational or process changes that could be made that would improve cycle time, and maybe even throughput, on your bottleneck tools. But manufacturing doesn't generally have spare time to investigate these changes, let alone having spare time to answer questions from students. So have them in during a downturn, when there is some capacity to spare on the bottlenecks, and when the fab manager might even have time to think about the results of the analysis. You can often get grad students to do this type of work for free, because they are looking for real-world problems. As a side benefit, the students might be finished with their degrees by the time the downturn ends, and you'll be in a good position to hire them. FabTime can put you in touch with Industrial Engineering professors at most universities if you like - just send us an email (Frank.Chance@FabTime.com or Jennifer.Robinson@FabTime.com).

OEE/TPM Analysis: During a downturn, the traditional OEE of your tools will decrease, due to an increase in standby (idle) time. However, a downturn is a good time to focus on improvements to equipment availability, process speed, and other attributes of OEE and TPM analysis. Then when start rates begin to come back up, your tools will have better performance, and higher available capacity.

Simulation Model Validation: A simulation model is an excellent tool for doing what-if analysis. What would happen to the cycle time if we changed the lot size? What would happen to the cycle time if we broke up this tool group into smaller, dedicated groups? What would be the benefit of an improvement in the downtime on the bottleneck? The possibilities are limitless. To be of interest to manufacturing, however, these analyses need to be done using a model that bears some resemblance to the situation in the real fab. The model doesn't need to generate the exact same cycle times, down to the minute. However, the results of the model need to be close enough to reality for manufacturing to take them seriously as a reflection on the real fab. All too often, simulation models are not kept up to date with the latest process, product mix, and equipment changes. Then manufacturing doesn't take them seriously, and no matter what conclusions the simulation analysts come up with, the results are never implemented. There are a number of underlying causes for this problem, and it is not our intent to dissect them all now. We just want to point out that a downturn could be a good time to update and validate your simulation model, to get it closer to the real fab.

System Upgrades: Just as you can use a

downturn to find time to upgrade your simulation models, you can also take advantage of extra fab capacity to perform system software upgrades. This could include version upgrades of your manufacturing execution system (MES) or other manufacturing software, or operating system upgrades on the computers that run your MES and other fab software. You probably pay a maintenance contract for your MES, and have access to the upgrades at no additional dollar cost, but you put off doing the upgrade because it requires taking down the whole fab for several hours. Even during a downturn, this is clearly a major headache for manufacturing, but if you're ever going to do it, better now than later.

Education: When things are slower, it can be a good time to work on education for operators and supervisors. You can find classes on cycle time, factory physics, statistical process control, and theory of constraints, for example (including one from us on cycle time fundamentals). We've found that people who work in manufacturing generally have an intuitive understanding of many of these concepts, but can benefit from a more structured educational approach. We recommend that you find courses with plenty of graphs and concrete examples. Of course it's harder to find money to pay for courses like these during a downturn, but there are some lower-cost options. Try your internal industrial engineering department, or the IE department at a local university, or work with a consulting firm as a kind of beta-tester for their courses. And, of course, you can forward FabTime's free newsletters to people within your company - we're always happy to have more readers, and price is certainly right!

One-Sentence Summary

If you don't have great cycle times now, you certainly won't have great cycle times when start rates go back up, so you should focus on low-cost improvement efforts to achieve the best possible cycle times now.

Conclusions

A downturn is a tough time - stressful, hard on your stock portfolio, and filled with the specter of layoffs. But it does offer at least one potential benefit: time to think. Time to think about manufacturing issues like lot size and batch size policies. Time to think about tool dedication schemes, and layout changes. Time to get your fab in order, and drive your cycle times to a minimum, before the next upturn comes along.

Additional References

■ S. Brown, J. Domaschke, and F. Leibl, "No Cost Applications for Assembly Cycle Time Reduction," Proceedings of the 1999 International Conference on Semiconductor Manufacturing Operational Modeling and Simulation, 1999 Western MultiConference, January 17-20, 1999, San Francisco, CA. Edited by John W. Fowler, Jeffery K. Cochran, and Courtland M. Hilton. Though not about wafer fab, this paper is a nice example of identifying low cost areas for cycle time improvement. You can request this paper from www.fabtime.com/abs_NoCost.htm.

■ J. Bonal, M. Fernadez, O. Maire-Richar, S. Aparicio, R. Oliva, S. Garcia, B. Gonzalez, L. Rodriguez, M. Rosendo, J.C. Villacieros, and J.Becerro, "A Statistical Approach To Cycle Time Management," Proceedings of the 2001 Advanced Semiconductor Manufacturing Conference (ASMC 01), Munich, Germany, 2001. This paper describes a cycle time reduction method used by Agere System in Madrid.

■ N. S. Grewal, A. C. Bruska, T. M. Wulf, and J. K. Robinson, "Validating Simulation Model Cycle Times at Seagate Technology." In Proceedings of the 1999

Winter Simulation Conference, ed. P. A. Farrington, H. B. Nembhard, D. T. Sturrock, and G. W. Evans, 843-849. Institute of Electrical and Electronics Engineers, Piscataway, New Jersey, 1999. This paper specifically addresses the issue of validating a simulation model against a real fab. You can request this paper from www.fabtime.com/abs_Sea99.htm.

There are many more references on cycle time improvement projects. Some describe actual changes made in factories, while others describe simulation analyses. References to a number of these studies can be found at www.fabtime.com/CTBiblio.htm. We have abstracts to most of the papers, so let us know if you want more information.

Community News/Announcements

SMOMS Conference

The 2001 International Conference on Semiconductor Manufacturing Operational Modeling and Simulation (SMOMS '01) will be held April 22 - April 26, 2001, at the Renaissance Madison Hotel in Seattle. This conference is part of the 2001 Advanced Simulation Technology Conference (ASTC '01), sponsored by the Society for Computer Simulation. The organizers for SMOMS are basically the same people who organized the MASM (Modeling and Analysis for Semiconductor Manufacturing) conference in 2000, and this year's SMOMS looks like it will be another good conference. The preliminary program is available in PDF format from www.scs.org/confernc/coninfo.html#astc2001 (right-click on the preliminary program link and select SaveAs). There appear to be many interesting papers. This PDF file also contains conference registration forms. You can save $60 by registering before March 28th. You also might as well sign up for the Society for Computer Simulation, since the $85 membership fee is deducted from the conference registration fee for members.

FabTime welcomes the opportunity to publish announcements for individuals or companies. Simply send them to Jennifer.Robinson@FabTime.com.

FabTime Recommendations

■ **FindArticles:** www.findarticles.com - this is a searchable archive of articles from about 300 magazines and journals. Magazines are grouped by subject, so that you can search only within a specific area of interest. The computers and technology magazines include the standard PC magazines, as well as Hewlett-Packard Journal, Electronic News, and Electronic Business. The search +"cycle time" +semiconductor across all magazines finds about 500 articles, while the search "semiconductor" +downturn finds 880 articles. The blinking ads are a bit annoying, but you can find some useful information.

■ **Hot Lot Article:** www.glue.umd.edu/~cjpo/Hotlot.html - this is a link to a nice article on hot lots in wafer fabs, by Casey O'Connor and Liyu Yang. It's basically a summary of research by a number of people, rather than presenting much new

information, but you may find it useful to have all of these hot lot-related references in one place.

■ **AtomTime**: www.atomtime.com - Frank and I have both been using AtomTime since the beginning of the year. From AtomTime's website: "AtomTime98 is a 32-bit Windows Internet (Winsock) application which will connect to the Atomic Clock time server in Boulder, Colorado (USA) and fetch the current atomic clock time value. It compares this value to your PC time and displays the difference. You then have the option of updating your PC clock to match the atomic clock value. There are a number of options to automate the update process. AtomTime98 also features support for most proxy servers." We really like it. AtomTime costs $10 for a single license, and we've found it to be both stable and non-intrusive. And it's very nice to have at least one clock around that always displays the right time!

Subscriber List

Total Subscribers: 293

Advanced Energy Industries (1)
Advanced Micro Devices (11)
Agere Systems (5)
Agilent Technologies (4)
Alpha Industries (1)
Amkor (2)
Analog Devices (2)
Applied Materials Corporation (6)
Arizona State University (3)
Artest Corporation (1)
Atlantic Technologies Ltd. (1)
BP Solarex (3)
Canon USA (1)
Carsem M Sdn Bhd (1)
Chartered Semiconductor Mfg (6)
Clarkson University (1)
Cofer Corporation (1)
Compugraphics International Ltd. (1)
Conexant Systems, Inc. (3)
Corning Lasertron (1)
Cronos Integrated Microsystems (1)
Dallas Semiconductor (3)
Dick Williams and Associates (1)
DomainLogix Corporation (1)
Durham ATS Group (3)
E-Tek Dynamics (2)
e-METS Co, Ltd (1)
eSilicon (1)
Eskay Corporation (1)
FabTime (2)
Headway Technologies (5)
Hewlett-Packard Company (1)
Hyundai Semiconductor America (2)
IBM (4)
IDC (1)
Infineon Technologies (22)
Intarsia Corporation (1)
Integrated Device Technologies (1)
Integrated Technologies Company (2)
Intel Corporation (19)
International Rectifier (1)
IRIS Technologies (1)
James Nagel Associates (1)
Kansas State University (2)
Ken Rich Associates (1)
Lexmark International, Inc. (1)
Lockheed Martin Fairchild Systems (1)
LSI Logic (7)
Macronix International Co. (2)
Maxim Integrated Products, Inc (1)

Metrology Perspectives Group (1)
Micrel Semiconductor (1)
Micro Photonix Int. (1)
MicroVision-Engineering GmbH (1)
MIMOS Semiconductor (1)
Mitel Semiconductor (8)
Motorola Corporation (28)
MTE Associates (1)
Multimedia University (1)
Nanyang Technological University (2)
National Semiconductor (11)
NEC Electronics (9)
Nortel Networks (3)
Oklahoma State University (1)
ON Semiconductor (8)
Penn State University (1)
Philips (8)
Powerex, Inc. (4)
PRI Automation (1)
Productivity Partners Ltd (1)
Propsys Brightriver (1)
Raytheon (1)
Read-Rite Corporation (2)
RTRON Corporation (2)
SAMES (1)
Samsung Semiconductor (2)
Seagate Technology (9)
SEMATECH (10)
Semiconductor Research Corp. (SRC) (1)
SEZ America, Inc. (1)
SiGen Corporation (1)
Silicon Manufacturing Partners (2)
Solectron Corporation (1)
SSMC (1)
Standard MEMS, Inc. (1)
STMicroelectronics (9)
SVG (1)
Synergistic Applications, Inc. (1)
Synquest (3)
Takvorian Consulting (1)
TDK (1)
TECH Semiconductors (2)
Texas A&M University (1)
Texas Instruments (6)
TriQuint Semiconductor (1)
Tru-Si Technologies (1)
United Microelectronics Corp (1)
University of Arkansas (1)
University of California - Berkeley (2)
University of Maryland (1)
University of Miami (1)
University Porto (Portugal) (1)
University of Virginia (1)
University of Wuerzburg (Germany) (2)
Wacker Siltronic AG (2)
Unlisted Companies (3)

Independent Consultants:
Steven Brown
Stuart Carr
Alison Cohen
Ted Forsman
Dan Theodore
Craig Volonoski

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. To protect the privacy of our subscribers, email addresses are not printed in the newsletter. If you wish contact the subscribers from a particular company directly, simply email your request to the editor at Jennifer.Robinson@FabTime.com. To subscribe to the newsletter, send email to the same address. We will not, under any circumstances, give your personal information to anyone outside of FabTime.