FabTime Cycle Time Management Newsletter

Volume 9, No. 5 June 2008

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 Scrap Rate Trend and Pareto charts, and several enhancements to the dispatching module.

Editor: Jennifer Robinson

Contributors: Dan Siems (Operating Curve); Frans Brouwers (NXP Semiconductors); David Carmichael (Jazz Semiconductor); Otwin Mekul (Infineon Technologies)

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Welcome

Welcome to Volume 9, Number 5 of the FabTime Cycle Time Management Newsletter! We're having heat waves all over the US right now, and I hope that wherever you are you're staying cool, and finding some time to relax. In this issue we have a community announcement about the third issue of Fab Engineering & Operations Magazine (a publication that's not affiliated with ours, but that we think our readers will enjoy). Our FabTime user tip of the month is about using FabTime's software to generate a list of lots ahead of or behind schedule, according to planned cycle times at future operations.

We have one new subscriber discussion question in this issue, about the use of short-term simulation. We also received several detailed responses to last month's question about the transition between paper and electronic lot travelers. In fact, these responses are so thorough, and varied, that we've decided to convert them into this month's main issue. This is a slightly unusual approach to our main article, but one that we think will prove useful to anyone facing this paper to electronic traveler transition. The strength of these responses also shows what a valuable resource this subscriber community can be. We are very grateful to the subscribers who took time to respond to this topic and to all of you who have helped us with prior discussions. We welcome further feedback on paper vs. electronic lot travelers. We would also love to hear about other topics that you would like to see addressed in the newsletter (either by FabTime or by the subscriber community).

Thanks for reading!—Jennifer

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Community News/Announcements

Fab Engineering & Operations Magazine: Third Issue

The third issue of Fab Engineering & Operations (FEO) Magazine is now available for free download from http://www.feomag.com/welcome.asp. Several long-time FabTime newsletter subscribers (and customers) are on the editorial board of FEO Magazine. Their input, along with considerable editorial care by the FEO team, helps make it a publication sure to be of interest to readers of the Newsletter, and that's why we're bringing it to your attention.

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

FabTime User Tip of the Month

Use FabTime to Generate a List of Lots Ahead of vs. Behind Schedule

A customer asked the other day "How would you tell in FabTime which lots that are all on the same Flow/Product are ahead or behind the standard cycle time?" This information is available for individual lots, of course, using the Lot Progress chart. However, what this customer wanted to do was see this data in one place for all of the lots of a particular product flow. This information is now available in FabTime, in the data table of the WIP Lot List chart. To get a list of lots ahead of or behind schedule, relative to the due date and planned cycle time information from your MES:

1. Generate the WIP Lot List chart from the FabTime chart list.

2. Filter the chart for the flow or product or family of interest.

3. Sort the data table by the "Estimated Days Early or Late" column, by selecting it from the first sort drop-down above the data table. Leave the "Descending?" box un-checked, so that the table will be sorted in ascending order. Estimated Days Early or Late is calculated as Factory Due Date - Estimated Shipment Date. This means that lots that are on target to be early will have positive values, while lots that are expected to ship late will have negative values. Sorting the column in ascending order will bring the latest of the lots to the top of the list. Note that you may need to increase the number of rows displayed to see all of the late lots.

If FabTime does not have planned cycle time data for the future operations of a particular lot, you may see "N/A" in the Estimated Ship Date column, and "0" in the Estimated Days Early or Late column. This can happen for new flows, for which no planned cycle time data is available in your MES. If your fab does not have any planned cycle time data, then you will not be able to use this feature. (However, do

contact us, to see if we can help). Please also keep in mind that these estimated shipment dates will only be as accurate as your planned cycle time values - they are based on the planned values, not on any kind of short-term simulation. However, many of our sites find this estimated shipment performance data a useful indicator.

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

Short-Term Simulation of Fab Dynamics

An **anonymous subscriber** asked: "Do any of your subscribers use simulation models for short-term analysis? By that I 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. I've heard of two fabs that do this, but they are large and therefore presumably have fine tool granularity (that is, capacity at any particular operation is spread among a large number of tools, meaning capacity stays relatively stable as tools go up and down, meaning queue times are pretty consistent and therefore the timing of wafer arrival at machines is pretty predictable). Our fab, in contrast, is tiny, starting just 300-400 wafers a week, and our coarse tool granularity causes capacity to vary wildly as tools go up and down (toggling between zero and 100 percent in the case of a single-path tool, for example). This makes the formation of WIP bubbles unpredictable. In a model, I would take the average of multiple runs, but in the real fab a number of "low-probability" down events are going to occur every day, and I fear that our coarse tool granularity will cause reality to diverge from the model's "average" result quite quickly, making the model's predictions for WIP bubbles unlikely to be accurate in the short term.

I'm thinking, however, that even in a fab with coarse tool granularity like ours, a model may be somewhat accurate in predicting WIP bubbles formed by more macro factors. Specifically, I'm talking about the effects of an inconsistent start rate combined with the phasing in and out of various products, each of which loads tools to a different degree and at different times in its route.

My questions to your readers:

1. Do any of you do short-term simulation? What "bucket" do you use? Shift? Day? Week?

2. Does anyone with a fab as small as ours do it?

3. How helpful is it? Any tips on how to do it most successfully?

FabTime Response: We have looked a bit at doing short-term simulation in FabTime. Our take on this is that probabilistic modeling of downtime events in a very short-term model isn't practical,

because you really don't know what's going to happen tomorrow. We think it's more useful to project planned process times forward, tied to your dispatching logic, to get a sense of where things are going to go, and then look for problems. True probabilistic simulation like this is, we think, more appropriate for slightly longer term projections. But we are interested, too, to see what other fabs are doing in this area. We welcome subscriber feedback.

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

Paper vs. Electronic Lot Travelers

Introduction

Last month, we included the following subscriber discussion question in the newsletter:

"I'm looking for a way to eliminate our clean room paper travelers, and wondering if you could share some of your thoughts and ideas, knowing what we do here...Our hang-up is being so used to having people see from the traveler where to deliver the box to...and then to see from the traveler that the lot is ready to load, etc..... To eliminate the paper traveler, we are thinking to go with hand held devices, or something to allow people to "know" where in the process flow the wafer is, versus physically where the wafer is... We wondered if you had any thoughts on this, from all of your visits to different fabs."

We didn't have experience with this, but we posted it to the Newsletter community. Four different people took the time to send in responses to the question. They sent detailed, articulate responses that we think readers will find of interest. We've decided, therefore, in lieu of a regular newsletter article written by us, that we will include all four responses here. We hope that you find this topic of interest, and we welcome further feedback.

Grammatical note: some people use "traveler" and some people use "traveler". For consistency, we have edited the responses to all refer to "traveler".

Part 1 – Frans Brouwers from NXP Semiconductor

Frans said: "People on the shop floor need a reference on the lot. Taking a production batch in the hand, an operator wants to see where to go and what to do with the lot. This means some sort of information is required. You will notice this in any type of industry. In the semiconductor industry solutions have been available for quite some years. Electronic devices based on infrared, RF or bar codes are commercially available and can be attached to the lot. These devices can replace the paper system.

My experience with the subject: I have been working in wafer fabs with and

without paper lot travelers. Some 10 years ago, I actually was involved in making the switch from paper lot travelers to such electronic devices. I still can remember going into the fab with some colleagues and removing all the paper lot travelers. Like any change, the first year was difficult. People are just used to paper. It is easy to read and one can write comments on it. Also implementing electronic devices has its own problems: getting the system running 100% for 24 hours * 365 days was hard work. And it still requires some maintenance effort. Until now we did not succeed in eliminating all physical attachments to the lot. Still some indicators are attached to the boxes (like a special color for a Fast Batches). But it is getting less and less and less. Now even the most strong-headed development engineers are getting used to the idea that papers need to be abandoned.

Is it cost effective? I really don't know. I have never done the calculations.

Was it worth it? First of all we did not have so much choice. The factory was designed with an automated transport system which did not allow us to have loose paper work attached to the batch. We needed some kind of electronic identifier of the box. Now, after 10 years, I think it was worth the effort.

1. Housekeeping is far easier.

2. It enforces the use of the automation system: comments can only be done in the system, and not on the paper lot travelers.

3. Updates to the production process can be done electronically. You don't need to update all the paper lot travelers.

4. Electronic devices are always up to date. People make mistakes."

Part 2 – Dan Siems from Operating Curve

The second response was from Dan Siems, who practices Physics, Psychology and Process from Orange County, California and can be found at www.OperatingCurve.com.

"Dear Traveler,

Very few things beat paper for speed and ease of use. I once worked in a fab that aspired to "paper-less". Indeed, in the day, we aspired to "people-less" too! Automated guided vehicles, over-head transport units, recipe downloading, lot scheduling, lights-out – yes, we dreamed dreams. Welcome to our ranks.

Let me extol the virtues of the "clean room paper traveler"….

- You can write on it! Not only can you write letters and numbers, you can draw pictures, use arrows, circle, cross-out, highlight, star, initial. In short…you can communicate with it. Try that with your simple hand-held device.

- Paper travelers are expandable! Need to run an experiment? Attach a sheet of clean room paper to the traveler with your instructions. Oops! Need to do that step over again, no problem, print a new page and staple it on. Wait a minute – Got a process change you need to do? Remove some pages and add some pages! Tuck them in, or better – cut and paste – yes, with scissors and tape.

- Portable flawless memory! Need to compare where two lots went? Put the paper travelers side-by-side and do a paired comparison – try that with a computer! Want to check the machine recipe with the traveler? Pick up the traveler, hold it next to the machine's screen, and check it. You can't lug your shop floor controller monitor next to the machines screen – too heavy, and those cables! Ugh. No, you have to "remember" the parameters and do the comparison, don't you? Oh, wait, some of you write on your glove! Still, paper traveler beats glove!

- Really clever fabs put their whole process flow into one gigantic traveler. As the lot moves through the line, the traveler is folded into a scroll. You know where the

lot is in the process by how much of the scroll is to one-side or the other. Paper travelers are great visual aids to process positioning.

So, dear Traveler, I hope you see that taking away these little gems is going to be a real challenge. I also hope you see the challenge is not technical, it's social. Let me assure you – having been intrigued by shiny technical objects myself once – and been burned as well – there are two other "legs" to the stool. Let me explain….

The stool is made of three legs.

1. The first, as you noted, is Technical – in this case you want to substitute a cute handheld device for arcane paper.

2. The second leg is Process – this refers to all the "business processes" this little scrap of paper interacts with. A few process examples – the "engineering experiment" process, the "hot-lot" process, the "rework/re-do" process, the "recipe verification" process, the "data collection" process, the "moves counting" process – these are just a few of the processes the paper traveler is used in.

3. The third leg of our stool is People – specifically, how do people interact with those scribbles on the parchment? How will they do their job without them? Can we really give them something as fast – or faster – than Hertz? Why, even the old paper days at Hertz were faster than the handheld devices…remember those days? Here are my keys, I've noted the mileage and gas on the rental sleeve, see ya!

Even more troublesome with People – as you hinted – how will we get them to change their way of working?

Now, perhaps you sense some bitterness in me. It's not that. Really, it isn't. Let me tell you the story of what didn't work…

Not too many decades ago, we had the paperless dream. We knew the dirtiest thing in the fab was people, and the second dirtiest was paper (Ha! We were naïve – the dirtiest thing was our process, the second dirtiest was our equipment processing chambers!). Anyway, we had the dream.

So we embarked on a grand plan to automate – with bar codes – lot tracking, recipe downloading, data collection. It was a wonderful time. And it would have worked, except…

We couldn't get the barcode readers to read the wafers. So we read the cassettes. We trusted the wafer would be in the proper cassettes. But we needed a place to put the cassettes, so we labeled shelves, and equipment…the nomenclature was spectacular. But then we couldn't build the equipment interfaces fast enough to download the recipes. So we relied on the operator to plug that in. And – this is important – we didn't plan to have all these computer terminals on the tables, so we couldn't put many of them in – not enough space. Besides, they're dirty too.

So here is what the operator had to do because we took their paper travelers – and pens – pens are dirty – away…

- Go to the computer and look up what lot to process, remember the lot id
- Read what cassette it was in, remember that
- Read where the lot was – shelf id – remember that
- Look at what equipment it went on – remember the equipment id
- Note the process recipe id to use on the equipment – remember that too
- Go get the lot – check all that stuff – put the lot on the tool – enter the recipe name – hit go. Sometimes I think they said a little prayer before they hit go – because hitting go could be a career ending move.

Keep in mind, the lot id was something like: B451784.B2, the shelf id was WIP8-4, the equipment was STEP08, the cassette id was 4732, the recipe id could be anything

from 1 to 16ETCH_OX-25.02p!

More amazing – the "good" operators could grab two lots at a time!

At this point in my story, dear Traveler, I'd like to introduce you to Miss Process. She's an expense one to get to know!

Do I have an answer? No. Do I think you can do it? Yes. Is the answer Technology? Technology is necessary, but not sufficient. Your answer, dear Traveler, is found in your business processes and people – and how you will change those.

Success!"

Part 3 – David Carmichael from Jazz Semiconductor

David wrote: "I have quite a bit of experience of this as I led the first project to eliminate paper followers in the Scottish Fab of a major manufacturer, and later another Fab in California.

I have visited many Fabs in different stages of systems implementation and seen many approaches to the problems encountered.

First let me say that the advantages of lot follower elimination are huge, regardless of the Fab's level of sophistication. Most think immediately of the reduction in particulate achieved by removing mounds of dog-eared paper from a clean area, and while this may be true, it ranks dead last in my personal list of benefits.

I believe the number one benefit is flexibility. It becomes possible to change the routing of a lot on-the-fly, perform sample-based measurements, adaptive processing (changes in processing depending upon prior measurements) and essentially engineer your system to improve yields to previously unheard-of levels.

The second major benefit is tracking accuracy. You are much less likely to lose a lot or have its processing misreported in a paperless environment because everyone understands that the only record of the processing of the lot is what is in the MES. At the same time, every change to a lot's process spec is tracked because the only way to change it is by using the tracking system. No more hand-written notes to Operators in the margins of the lot follower. You know much more about how lots really move in your Fab because the MES must be pretty accurate 100% of the time and this improves the quality of any analysis you perform using that data.

The third major benefit is the ability to integrate tool automation much more tightly with lot tracking. You cannot get good results from tool automation unless the lot is tracked correctly and the process spec for the step is fully defined.

The problems I encountered during my forays into Lot Follower Elimination fell into several categories, one of which was mentioned by your anonymous subscriber.

1. Logical and physical lot movement
2. Data collection
3. Data communication
4. WIP information
5. Associated systems
6. Management resistance
7. User resistance

1. Logical and physical lot movement

This is a minor issue in some Fabs and a really major issue in others. If your Fab is cleanly laid out and WIP is stored in well defined locations, central or otherwise, then the only problem is one of ensuring lots are delivered to the correct locations after they have finished processing on each tool. If the tool Operator can deliver each lot (or batch of lots) to the correct location directly as soon as the lot had been unloaded from the tool, then there is no issue. Obviously if your Fab is lucky enough to have a (working) Material Transport System with well laid-out Stockers, then this would apply to you, but you are probably already paperless. If however, the Operator must store lots locally and have them moved by dedicated (human) lot movers, then you have to find

a way to tell the lot mover where to put the lot.

We solved this problem in one Fab by installing both tethered and wireless barcode guns which would display the source, current state and destination of any lot by reading the barcode label on the box. To make this work did involve significant modifications to our MES and the creation of fairly complex Material Movement logic. You may also want to redesign your MES tracking definitions in order to take full advantage of your new-found flexibility.

2. Data collection
Paper is very handy stuff. You can write notes on it and collect data and comments. Unfortunately it is hard to search, easy to lose and you can doodle on it too. In most older Fabs, Operators take tool readings and wafer measurements and write them down on the lot follower. Later those values are typed into computers or read by technicians. Without paper, your MES and/or automation systems must do all of this. It means a great deal of change, much training, and extra terminals/workstations. Most MES systems can handle it very well but you may have to do quite a bit of workspace re-engineering to solve all of the problems.

3. Data communication
As mentioned above, lot followers tell Operators and others about the history and future of a lot. You may need to modify your MES to do the same job. You have to provide significant training to ensure all MES users know how to see the recent past of the lot in a way that tells them what they need to know.

4. WIP information
A rack of lots with attached lot followers makes it easy for a Supervisor to pick any one and see at a glance what processing is required next. Without paper, the Supervisor still needs to be able to do this easily and quickly. It all comes back to providing simple access to MES functions. I have seen a situation where the MES did not provide the information needed in any of its displays and in this case it had to be modified to tell users what was going to happen to the lot in its immediate future.

5. Associated systems
The key thing here is your MES. Is it really as available as you think it is? You would be amazed how often I have been quoted 24 x 7 x 365 and on further interrogation discovered that this does not count the one-hour shutdown once a week for "essential maintenance". If you need the MES to be up all the time then it must be designed to be up all the time and many are not. If you need 24 x 7 x 365, aim for zero planned downtime and no more than 2 hours unplanned downtime per year. This can be done. We don't even have to shut down when the clocks go back. Can your MES and other systems handle the extra load of all those queries that were previously done by eye? This used to be a big issue but modern minicomputers and disk subsystems have pretty much solved the problem. This may not be the case if you run on Windows or if you wrote the MES yourself. What about all the extra steps you will need to know exactly where every lot is? You must be ready for the extra complexity you will want and need.

6. Management resistance
This can be a pretty big deal if the benefits are not fully understood. Actually it is always a pretty big deal when it comes to Fab Operators doing more typing. Tackle it head-on because you don't want to do all the work and find you still have lot followers in your Fab years later. Help your management to understand that the time the Operator spends typing is not going to be added onto the overall cycle-time for every lot. Teach them Little's Law.

7. User resistance
In my experience this is hardly ever an issue. Everyone gets it pretty much immediately. They are happy to receive the training and especially Engineers are happy

with their enhanced ability to make improvements to yield.

Part 4 – Otwin Mekul from Infineon

The fourth response was from Otwin Mekul of Infineon Technologies, who recommended the LotTrack system from Intellion (www.intellion.com), a "solution to actively control manual operated logistic flows in semiconductor fabs. Working like an "indoor GPS", the system delivers the position of each wafer-carrier in real time and assists the operator according to the next operation and destination information, using a large display on each carrier."

Conclusions

As with any change, there are pros and cons to transitioning from paper to electronic lot travelers (or lot followers, as they are sometimes called). Frans Brouwers, despite facing some challenges along the way, considers the transition to electronic travelers worthwhile, and cites his reasons why. Dan Siems is a bit more skeptical, and a bit more tongue in cheek, but raises some valid points about the advantages of paper in some situations. David Carmichael thinks that the benefits to going electronic outweigh the disadvantages, but offers some cautionary notes to consider during the process. Otwin Mekul suggests a specific product to help keep track of the lots, in the absence of paper travelers.

From FabTime's perspective, changes that increase the accuracy of the electronic data maintained in the MES are a good thing. That's because we pull all of our data from the MES, in near-real time, and our customers are using that data for things like evaluating fab performance and making dispatching decisions. We obviously have an interest in having the electronic data be as detailed and accurate as possible. We would hate to miss something important because it's on a piece of paper somewhere. That said, we also agree with David about the difficulty that many fabs have in adding to the operator's typing workload. This has to be done carefully, and in a way that doesn't lead to an increase in the number of lots sitting waiting to be loaded or unloaded for lack of an operator. But it's fairly clear from reading the above contributions that, difficult transition or not, electronic travelers are the way of the future. Fabs are under constant pressure to introduce new products more quickly, and change products on the fly, to react to changes in the end market. Electronic travelers make this process work a lot more smoothly than paper travelers can. This means that the pressure to move to electronic travelers is going to continue increasing each year. Hopefully the collective wisdom shared by Frans, Dan, David, and Otwin will help make this process run a bit more smoothly for those who still have the transition to undertake. Our profound thanks to those who took the time to share their experiences. We welcome further feedback on this topic.

Subscriber List

Total number of subscribers: 2819, from 477 companies and universities. 21 consultants.

Top 21 subscribing companies:

- Maxim Integrated Products, Inc. (240)
- Intel Corporation (158)
- Micron Technology, Inc. (81)
- Analog Devices (66)
- X-FAB Inc. (64)
- Infineon Technologies (63)
- Freescale Semiconductor (62)
- ON Semiconductor (60)
- Texas Instruments (59)
- NEC Electronics (58)
- Chartered Semiconductor Mfg (55)
- International Rectifier (55)
- Cypress Semiconductor (54)
- STMicroelectronics (54)
- TECH Semiconductor Singapore (54)
- NXP Semiconductors (48)
- IBM (43)
- Spansion (36)
- ATMEL (34)
- Seagate Technology (33)
- Western Digital Corporation (33)

Top 3 subscribing universities:

- Virginia Tech (11)
- Ben Gurion Univ. of the Negev (8)
- Nanyang Technological University (7)

New companies and universities this month:

- BinOptics
- Harris Stratex
- University of Central Florida
- Wuhan Xinxin Semiconductor Manufacturing Co.

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.

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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:

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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 is also available upon request.

Prerequisites

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Who Can Benefit

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

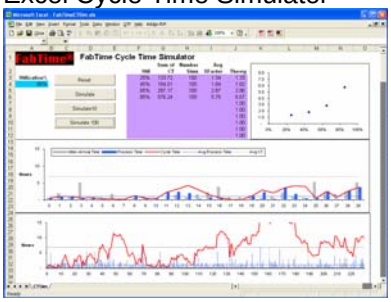
Skills Gained

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

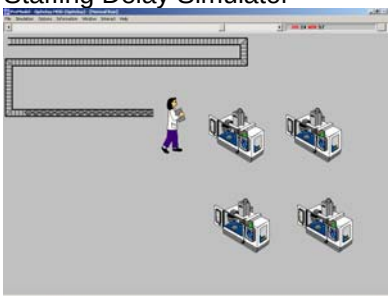
- Identify appropriate cycle time management styles.
- Teach others about utilization and cycle time relationships.
- Define and calculate relevant metrics for cycle time.
- Teach others about Little's law and variability.
- Quantify the impact of single-path tools and hot lots.
- Apply cycle time intuition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

Sample Course Tools

Excel Cycle Time Simulator



Staffing Delay Simulator



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