# 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 for FabTime include a configurable dispatch dashboard showing the upcoming schedule for a user-specified set of tools, along with the current status of these tools.

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**Contributors: Mike Hillis** (Cypress Semiconductor)

**Keywords**: WIP Management, Product Mix

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## Welcome

Welcome to Volume 17, Number 4 of the FabTime Cycle Time Management Newsletter! We hope that those of you in the northern hemisphere are enjoying pleasant summer weather and the free time to appreciate it. In this issue we have a brief announcement about two new FabTime interns. Our software user tip of the month describes two ways to move a chart to a different home page tab. We have no subscriber discussion this month, but we do have a main article that we hope will generate discussion for future issues.

This main article, co-written with Mike Hillis from Cypress Semiconductor, is about the rise of and challenges in managing high-mix, low-volume fabs. The increased market segmentation of high-tech products is likely to drive ever-increasing levels of product mix, with lower volumes of many individual products. This combination of high mix and low volumes exacerbates many of the management challenges already present in wafer fabs. It is in all of our interest to come up with better solutions for managing such facilities. We hope that this article launches a productive discussion.

Thanks for reading – Jennifer

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# Community News/Announcements

### FabTime Hires Two New Interns from Cal Poly

FabTime is pleased to announce the hiring of two student interns from Cal Poly San Luis Obispo to help with our programming efforts. Computer Science students **Andrew Adriance** and **Zin Mar Tun** will be reporting to Lara Nichols, FabTime's Director of Engineering. Please join us in welcoming Zin and Andrew to the FabTime team. They are already making positive contributions to FabTime.

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

### Move Charts to a Different Home Page Tab

We launched the FabTime User Tip of the Month feature back in mid-2003. It was recently pointed out that some of the tips may have been superseded by changes in functionality over the past 13 years. So we'll be reviewing the prior tips, and publishing updates where appropriate (interspersed with all-new tips).

In Issue 4.10 we wrote about moving home page charts to different tabs. We initially covered this topic because we had long-time users who might have a hundred charts on their default home page tab. We recommended using multiple home page tabs in order to better organize charts and improve performance. At that time, the only way to move charts between home page tabs was to use the Manage Tabs/Notes interface. Today, however, there is a second way to move a chart between tabs, one that users might find quicker and more intuitive.

1) Use the Manage Tabs/Notes interface

a) Click on the "Manage Tabs/Notes" link, visible from any home page tabs that currently contain charts or from the Charts page. The table displayed includes a row for each chart. The first column of the table is labeled "Home Page Tab".

b) To move a chart to a new home page tab, just enter the name of the new home page (e.g. Long-Term Trends) in the Home Page Tab box, as shown in Figure 1 on the next page, and press the Save button at the bottom of the page. FabTime will then build a separate home page tab for each unique home page name entered. Be careful here – if you enter two different tab names that are almost the same, like Move Charts and Moves Charts, you will get two separate home page tabs.

c) Enter any additional notes about this chart in the "Notes" field. These notes are displayed below the chart when you are in Slide Show View.

d) When you are finished moving charts to different home page tabs, just click on the "Return to Home Page" link. Make sure you press "Save" first to save any changes.

2) Use Add and Delete to move a chart to a different (existing) home page tab. If you would like to move a chart to a home page tab that already exists, the following is one shortcut to the do that:

a) Click on the chart from the home page to go down to the detailed chart page.

b) Select the target home page tab from the drop-down list in the upper left-hand corner of the screen, below the "Add" button, and then click the "Add" button. FabTime will add a copy of that home page chart to the target tab, and will also take you out to that target tab.

c) Use your browser's Back button twice to go back to the original home page tab, and find the first copy of the chart.

d) Click the "(Delete)" link above the chart.

If you have many home page charts, this second method may be quicker than using the Manage Tabs/Notes interface. If, however, you need to create a new home page tab, or would like to add notes to your home page chart definition, then you should use the first method above.

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!

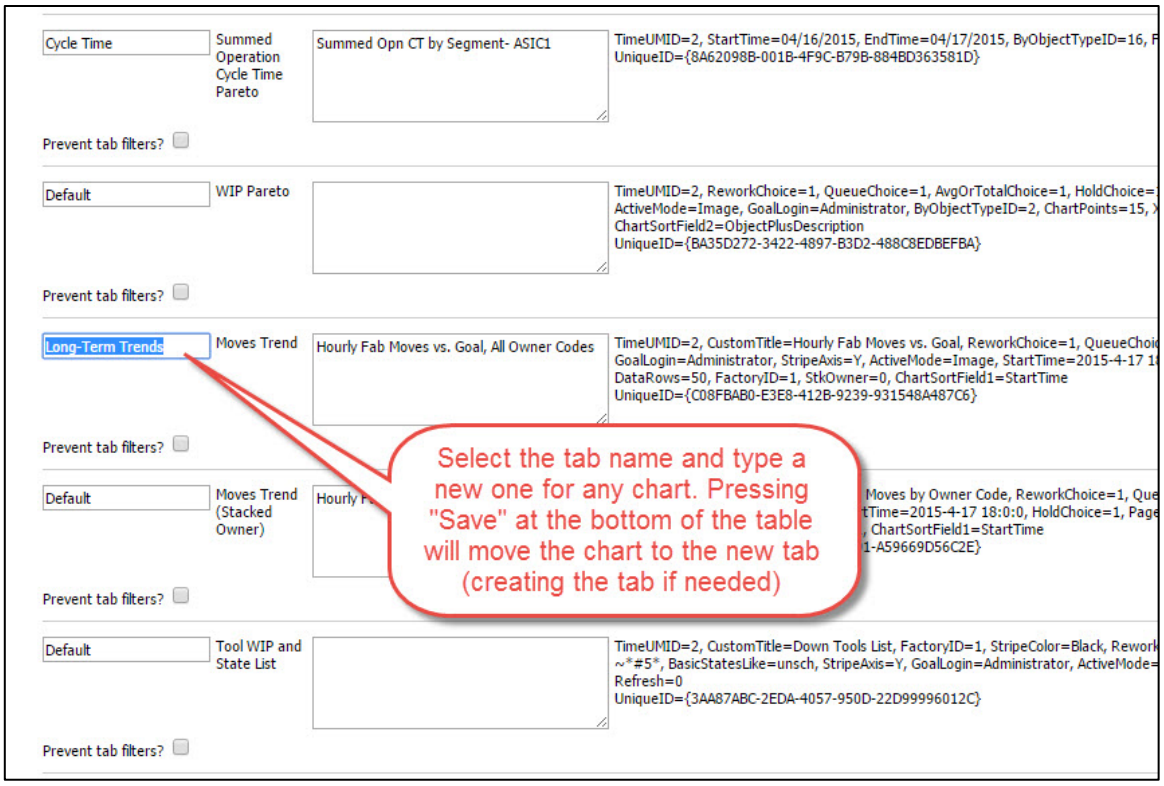


**Figure 1. Example of Manage Tabs/Notes Interface**

# Subscriber Discussion Forum

FabTime welcomes the opportunity to publish subscriber discussion questions and responses. Simply send your contributions to Jennifer.Robinson@FabTime.com. While we have no subscriber discussion topics in this issue, our main article stemmed from an email discussion with a long-time subscriber. We welcome discussions with other subscribers, too.

# Managing High-Mix Low-Volume Wafer Fabs

**By Jennifer Robinson (FabTime) and Mike Hillis (Cypress Semiconductor)**

An issue that we've been contemplating lately concerns the real-world management of high-mix, low-volume (HMLV) wafer fabs. With the increasing proliferation of high tech end products, higher mix fabs are inevitable. Semiconductor facilities are running ever-increasing numbers of technologies and devices, many of which are run at relatively low volumes. For high volume wafer fabs, running a large product mix is challenging but (more or less) manageable. However, for smaller, lower volume fabs, running a high product mix becomes extremely difficult. Even fabs that have moderate production volumes overall may find themselves running a high mix of products, each of which runs at a low volume.

## Aspects of the Problem

There are a number of reasons why HMLV fabs are challenging to operate. These include:

**Lack of Redundancy:** Fabs that run low volumes overall may find it difficult to justify spending money on tool redundancy. As has been extensively discussed in past newsletters, one-of-a-kind tools, particularly when these tools are bottlenecks, contribute to high cycle times. Even if a fab has redundancy at key tools, a high mix of new products tends to correlate with a prevalence of single-path operations. It takes time to qualify multiple tools for new operations, and until that qualification takes place, cycle times will be inflated. Just managing the ever-changing tool capability data is a challenge in this situation, potentially leading to misprocessing.

**Difficulties in Batch Formation**: Fabs with a wide range of low volume products may find it necessary to run very small batches in tools like furnaces. Weighted utilization numbers may not support additional capacity at such tools (e.g. "this tool is running at 20% loading, we don't need another"). However, due to long process times on such tools, queue times can be quite long, as lots with rare recipe IDs wait for processing even when the tool is not full. Deciding which batches to run when no full batches are available can be a significant operational challenge.

**Lost Capacity Due to Setups:** In areas such as implant where setups are required between different recipes, having a large mix of low volume recipes is also a

management challenge. When no lots are available to run that match the current setup on a tool, the operator must decide whether to perform a potentially lengthy setup to a new recipe or to wait for a matching lot to arrive. Higher volume fabs tend to have the capacity to dedicate tools to certain recipes, at least temporarily. But for HMLV fabs, managing setups is a critical issue.

**Difficulties in Reticle Management:** Managing reticles is an issue for any high mix fab. Lower production volumes mean that, as with setups, reticles need to be changed more frequently, leading to lost capacity.

**Insufficient Data for SPC:** When running many low volume operations, collecting enough data to do statistical process control (SPC) can be an issue. This can result in delayed identification of yield problems. Also, when there are yield issues in low volume product lines, it may be difficult to meet order commitments (because there are fewer like lots that could be sent instead of the scrapped lot).

**High Variability at Tools:** Cycle time at the tool level is driven by utilization, arrival variability, and process time variability. Even where tool utilization is low, due to low overall volumes, arrival and process time variability can drive up cycle times. Fabs with a high mix of low volume products will tend to have a high degree of variability in process times from lot to lot (depending on the type of tool). With lower mix or higher volumes, like lots can be grouped to run in sequence, damping this variability. But this is not the case in HMLV fabs. This process time variability will then move downstream as arrival variability, augmented by the disproportionate impact of tool downtimes on tools that lack redundancy. For fabs running higher volumes, this arrival variability is damped, at least at bottleneck tools (since lots usually arrive to the back of a queue).

**Lack of Sufficient Planning Data**: In a fab with a high mix of new products, particularly low volume products that may not have been run frequently, coming up with a planning cycle time can be challenging. This makes giving expected shipment dates to customers tricky.

## Potential Solutions

Comments that we've heard on managing HMLV fabs emphasize the importance of having sufficient capacity and manufacturing flexibility. An HMLV fab should be designed with a lower utilization threshold than either a high volume or a low mix fab, particularly for large batch tools and tools that require setups between recipes. You simply can't design an HMLV fab and plan to run your one-of-a-kind bottleneck at 95% utilization, unless you are willing to accept very high cycle times.

Traditional fab improvement efforts, particularly process simplification, reticle management, and setup time reduction are more important than ever in HMLV fabs, and should certainly be pursued. We would also think that changes in metrics will be needed as a fab transitions to HMLV. For example, while a fab might still use WIP turns as a metric, it might help to highlight the distribution of turns across different product types, with automatic highlighting of outliers. There are surely other potential modifications of standard metrics that would make them more relevant for HMLV fabs.

But even assuming that you have a reasonable degree of buffer capacity and are working to reduce lost capacity to setups and other issues, managing WIP in an HMLV fab is going to be an ongoing challenge. It is our impression that running such a fab with local dispatch rules alone will not be sufficient. We feel that running HMLV fabs successfully is going to require some degree of scheduling lots across multiple tools, at least in the photo and furnace areas. This scheduling will need to

include solid strategies for managing reticle and tool capability information.

## A Request for Help

We've reviewed the literature on this problem, and found some studies that address HMLV fabs via planning models and/or simulation. We have not found very much, however, in the way of case studies about how people manage HMLV fabs in practice. Our primary intent with this article is to reach out to the FabTime newsletter community to ask whether any of you have experiences or suggestions that you would like to share (either anonymously or with attribution) on this topic. We will share any responses in a follow-up article.

## Conclusions

The increasing proliferation of high-tech end products for consumers is leading to an explosion in product mix in the semiconductor industry. Increasing market segmentation means that the production volumes of many such products are trending downward. Meanwhile, building large-scale wafer fabs is increasingly, prohibitively expensive, particularly in the US. All of these factors together are resulting in an increase in fabs that run a high mix of low volume products (HMLV fabs).

HMLV fabs are challenging to operate due to an exacerbation of the impact of factors like batching, setups, tool qualification, and reticle management. These challenges can be mitigated somewhat by ensuring sufficient capacity buffers on tools, and by efforts such as process simplification and setup time reduction. However, these avenues may not be sufficient. It seems to us that better scheduling of lots across multiple tools may be needed. We are hopeful that other subscribers who have worked with HMLV factories may have other experiences to share, so that we can continue this conversation, and learn together. We welcome your feedback.

## Questions for Subscribers

Do you, or have you, run a high-mix, low-volume manufacturing facility (fab or post-fab)? Are there other challenges to running such facilities that we have missed in the discussion here? Are there tactics that you've found particularly helpful in coping with the variability and WIP management issues in HMLV fabs? Do you agree that the challenges of running such fabs point to the need for more robust scheduling across groups of tools?

## Further Reading


- A. Balakrishnan and F. Vanderbeck, "A Tactical Planning Model for Mixed-Model Electronics Assembly Operations," *Operations Research*, Vol. 47, No. 3, 395-409, 1999.

- Mike Gißrau and Oliver Rose, "Practical Assessment of a Combinated Dispatching Policy at a High-Mix Low-Volume ASIC Facility," *Proceedings of the 2013 Winter Simulation Conference*, 2013. PDF available here. Previous papers about the same project are available here and here. See also the first author's dissertation.

- Vida A. Killian, "The Impact of High-Mix, Low Volume Products in Semiconductor Manufacturing," Ph.D Dissertation, Massachusetts Institute of Technology, 2003.

- R. Michael Mahoney, *High-Mix Low-Volume Manufacturing*, Hewlett-Packard Professional Books, Prentice Hall PTR, 1997. Available from Amazon.

- John Sprovieri, "Managing High-Mix, Low-Volume Assembly," *Assembly Magazine*, March 5, 2004. Available here.

- Zhugen Zhou and Oliver Rose, "WIP Balance and Due Date Control in a Wafer Fab with Low and High Volume Products," *Proceedings of the 2012 Winter Simulation Conference*, 2012.

# Subscriber List

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- Lumentum
- Lumileds
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- Test Advantage (1)
- Titan Ind Limited (1)
- Universität der Bundeswehr München (1)
- Vectron Frequency Devices Swiss (1)
- Vishay (6)

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Mike Hillis
Cycle Time and Line Yield Improvement Manager
Spansion Fab 25

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- Unlimited users via your Intranet.
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Headway Technologies


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