FabTime Cycle Time Management Newsletter

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 this version (7.5) include the ability to add a user-defined title to any chart, and the ability to add a colored stripe to any chart (e.g. to add a colored band indicating the target WIP range).

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Welcome

Welcome to Volume 6, Number 10 of the FabTime Cycle Time Management Newsletter! We hope that you are all enjoying the holiday season. This month we have a job change announcement from Allan Ravitch and a press release regarding a new version of our software. Also, due to positive response from our subscribers, we are repeating our offer of a free one-hour talk on cycle time management for fabs in the U.S. Our FabTime software user tip of the month describes a short-cut for home page management. This month we have subscriber discussion about WIP States and cycle time estimation formulas.

In our main article this month, we have gathered a collection of operational recommendations and metrics for driving cycle time improvement efforts. We have heard from several fabs recently that they are planning cycle time reduction initiatives for the New Year, and we thought that this collection would be helpful. Because the article references a number of past newsletter issues in which we have discussed the various recommendations in more detail, and as a holiday gift to our subscribers, we are offering each subscriber the opportunity to request up to three past newsletter issues at no charge. This is described in more detail at the end of the article.

And finally, we do have a small request for you. If you think that this newsletter is useful, we ask that you take a moment to forward it to any colleagues who might appreciate it. And if you receive this newsletter only as a forwarded message each month, we ask that you take a moment to subscribe yourself. We would very much appreciate it!

We wish you all a joyful holiday season, and a productive New Year. Thanks for reading, and for participating in our newsletter community!—Jennifer

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Community News/Announcements

Job Change Announcement: Allan Ravitch

Allan Ravitch, formerly with Peregrine Semiconductor Australia, has joined Toyo Tanso, USA in Portland Oregon as their new Processing Manager. His new position will leverage his former 15 years of semiconductor manufacturing experience to lead TTU in managing a line of precision coated graphite parts for the silicon growing and semiconductor industry. Among others, Toyo Tanso supplies PECVD wafer carriers and Single Wafer Susceptors to key customers within the semiconductor industry.

FabTime Releases Version 7.5 of Web-Based Digital Dashboard Software for Cycle Time Management

San Jose, CA. December 6, 2005 – FabTime Inc. today announced the immediate release of Version 7.5 of their cycle time management software for semiconductor wafer fabs. New features in the version include:

- Dispatch performance reporting.

- Enhanced dispatch factors and dispatch scoring, including a reservation system to hold downstream tools when a lot is started on an upstream tool.

- Flexible charts capable of displaying any type of WIP transaction.

- Forecast outs charts.

- An XFactor parameter for lot progress charts, so that a multiple of theoretical cycle time may be used for estimated cycle times and required times, rather than planned cycle time.

- New chart formatting controls, to place a user-defined background stripe (horizontal or vertical) on any chart, and to add custom chart titles.

- Enhanced results-caching and speed optimization for many chart types.

- A new area-level arrivals alert (number of arrivals to an area during some time period).

FabTime Version 7.5 supports Microsoft SQL Server 2000 and Microsoft SQL Server 2005, as well as Windows Server 2003. All end-user access to FabTime is via Microsoft Internet Explorer (Versions 5 and higher).

FabTime is a web-based digital dashboard designed to give semiconductor wafer fab managers the information that they need, in real-time, to run their fabs effectively. FabTime extracts lot move and equipment state transaction data from the fab manufacturing execution system (MES) in near-real time, and processes this data into a database. Users then access the data via a web browser from anywhere within the corporate Intranet.

The FabTime system consists of a series of pre-optimized charts demonstrating critical fab performance measures such as cycle time, work-in-process, moves, turns and tool states. Users can filter data by lot owner, shift, production area, and other variables, and can drill-down for more detailed information. FabTime also includes a user-defined alert capability by which users can be notified by email or pager when some condition is met (such as some tool being down for more than one hour). The software includes optional modules for shift-level production planning, static capacity planning, and lot dispatching. FabTime is designed for hands-on use by managers and supervisors. It is currently in 24-hour use in six fabs around the world, with a seventh just beginning installation. More information about the software is available at www.fabtime.com/software.htm.

Free One-Hour Talk on Cycle Time Management at Your Fab

Are you kicking off a new cycle time improvement effort? Do you want to ensure that your production personnel are thinking about cycle time as they make

operational decisions? Do you use the best metrics for improving cycle time? FabTime is currently offering to have Jennifer Robinson visit your site to give a one-hour talk on the factors that influence cycle time in wafer fabs, and the best metrics for cycle time improvement. This talk is a sub-set of our one-to-two day cycle time management course, and is being offered at no charge to fabs in the United States. The talk will be paired with a one-hour demonstration of FabTime's web-based digital dashboard software, with emphasis on ways that the software supports cycle time improvement efforts. If you are interested in scheduling a visit, please contact Jennifer.Robinson@FabTime.com. We are currently scheduling visits for mid-January and later.

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

FabTime User Tip of the Month

Log in Directly to the Charts Page to Manage and Remove Home Page Charts

Does your FabTime homepage contain many charts? Do you wait longer than you would like for the home page to load when you log in? Do you have one or two very data intensive charts that slow down your overall performance? If any of these conditions apply to you, here are two suggestions for improving your home page refresh speed.

1. Move less-frequently used charts to another home page tab, rather than keeping them on your default home page, so that your default tab has no more than 30 charts on it.

2. Move particularly data intensive charts (e.g. operation cycle times by hour for the past 10 months) to another home page tab, one containing only a few charts.

These suggestions boil down to the same thing. Make your home page more agile by removing charts that you don't look at all the time, or charts that are particularly slow. The quickest way to do this, without having to wait for the entire home page tab to load, is to log in directly to the Charts page. On the FabTime login screen, the default choice is to log in to your home page. However, clicking on the "Login: Charts" button will take you directly to the Charts page. Once you are on the Charts page, click on the "Manage Tabs/Notes" link. This will take you to the home page chart management interface. From here you can delete charts (by clicking the delete link next to any chart) or move charts between home page tabs.

The home page chart management table has a row for each chart. To move a chart to a different home page tab, select the tab

name from the "Home Page Tab" column (the first column) for that row, and type in the new name that you would like to use. Repeat for whatever charts you would like to move, and then press the "Save" button in the lower right corner of your screen. Using the home page management interface is the quickest way to move charts between tabs, and also to delete multiple charts from your home page.

We have one other related suggestion. If you need to delete multiple charts from a home page tab, and you prefer to do this while looking at the charts rather than using the above interface, you may want to reduce your Timeout interval first. This

setting can be found by following the "Email/Passwords/Etc." link on the Home page or the Charts page. This will cause your overall home page to load much more quickly, because FabTime will temporarily give up on the data intensive charts. You will need to increase your timeout interval back to the default value afterwards, so that all of your charts have time to load.

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

Modification to WIP States Hierarchy Proposal

Last month we published a proposal for a WIP States hierarchy, suggested by **Ulrich Dierks**. We suggested a modification of this hierarchy to also include crib time (extended holds for marketing/sales purposes). Ulrich wrote back in response to our addition of crib time. He said "Concerning "crib time" I agree that there is an analogy to E10 NonScheduled (NST), so it may be regarded as a performance detractor which has come from outside of Operations or even from outside the Fab. It is o.k. to rank it between travel & queue (E10 blue = ENG), but I suggest ranking it last (color dark grey), like E10 non-scheduled time (NST).

E10: Total Time – NST = Operations Time, which is the basis for operational metrics such as operational uptime (up_time / operations_time) and operational utilization (productive_time/ operations_time). Those metrics report operational equipment performance while accounting for conditions that are solely created outside of operations.

WIP STATES: Total Time – Crib Time = Operational Cycle Time, with Overall WIP Effectiveness = ideal_process_time / total_time and Operational WIP Effectiveness = ideal_process_time / operational_cycle_time

So there are two metrics, one indicating total performance, and another just for

operational performance, where the delta is due to marketing decisions. As crib time is something that normally has nothing to do with operational or fab performance this analogy seems to be valid.

FabTime Response: We agree with Ulrich, and appreciate his well-thought-out contributions to this discussion.

Cycle Time Estimation Formulas and Cost

An anonymous subscriber wrote: "I confess that in my company, the main driver is cost. If you ask our management what is the most important between cost and cycle time, they will obviously reply both. However, they are clearly putting more energy on cost reduction than on cycle time reduction. Consequently, wafer fabs tend to saturate their bottlenecks to maximize fab output and decrease wafer cost. Of course, this has a negative impact on cycle time, as the formula says.

The fabs which have the best cycle times in the company are the ones that limit their maximum utilization rate to ~90% (based on rule of thumb). However, their costs tend to be higher than those of other fabs.

Obviously, the only way to reconcile these metrics is to reduce variability. We do that in most of our fabs (through the A80/A20 metrics). However, today we don't have any formal process to for correlating the variability reduction effort with a better fab commitment (either in cycle time or in outs). What I had in mind was to use the X-Factor formula in a standardized way to:

1. Make a clear correlation between cycle time and fab saturation: with our actual variability performance, if we want to get X days per mask layer of cycle time, we need to saturate our fab at y%. Then it will be a management choice to find the best compromise.

2. Correlate our variability reduction efforts with a better fab commitment: if we reduce the variability factor, we can either commit more output with the same cycle time performance (improve cost) or commit a better cycle time with same amount of output. That would be also a way to put even more energy on the variability reduction effort, which is still for many people a fuzzy concept where they don't see clear payback. From my understanding, this will imply:

■ Drill down from a global wafer fab cycle time objective to detailed X-Factor objectives by toolset.

■ Measure the actual variability factor Do you think this approach is feasible and have you seen something similar in other companies?"

FabTime Response: As to whether or not this approach is feasible, we would have to say that we think that it would be difficult. We have worked with sites that have tried to use queueing formulas to look at individual toolsets, and roll those up to look at overall fab cycle times. And while we think that this approach is very helpful for intuition-building, there are some issues that make it difficult to roll up to get overall fab cycle time estimates. The queueing formulas are not applicable for tools with batch processing. They also cannot account for operator delays. They become tricky when you have shared tools between tool groups. Even calculating the variability coefficient is not necessarily straightforward, particularly for process time variability, as has been discussed in past issues.

What we have focused on with our customers is a two-pronged approach where we first offer our cycle time management course to help build intuition among manufacturing personnel regarding the relationships between cycle time, utilization, and variability. We then use our software to report actual cycle time and variability data.

Operational Recommendations for Wafer Fab Cycle Time Improvement

Introduction

If you want to improve cycle time in your fab, one approach, theoretically, is to throw money at the problem. Generally speaking, if you add lots of tools and add lots of operators, cycle time will decrease. This is not, alas, the world in which most of us live. Rather, there is pressure to get as much throughput as possible out of any toolset, while still maintaining reasonable cycle times.

The good news is that fabs can improve cycle time by changing operating practices to reduce variability. This tends to be a relatively inexpensive way to improve cycle time. And because there are so many sources of variability in a fab, there is usually some area worth targeting. So what specifically should you to do improve cycle time? We explore this topic in great depth in our 1 to 2 day cycle time management class, but thought that our subscribers would benefit from a brief summary here. We will focus on operational recommendations for cycle time improvement - short-term changes that you can make in your operating practices to improve cycle time. We will also briefly review our recommended short-term metrics for monitoring and improving cycle time.

Operational Recommendations

The three fundamental drivers of fab cycle time, as discussed in Issue 6.05, are variability, utilization, and number of qualified tools. Therefore, anything that you can do to reduce variability in the fab will improve cycle time. Also, anything that you can do to avoid capacity losses on tools (and hence reduce utilization) will either allow you to improve cycle time or will allow you to increase throughput. Finally, anything that you can do to increase the number of qualified tools available to run each operation will reduce

cycle time. Some more specific recommendations follow:

Variability:

■ Reduce transfer batch sizes between steps. When you group lots onto carts before moving them to the next operation, you introduce variability in waiting for the cart to fill and also when the full carts are unloaded downstream. Smaller carts can help minimize this problem.

■ Run batch tools under a greedy policy. Whenever you have lots ready and waiting to be processed on a batch tool, you should generally go ahead and start the batch (unless there are other process restrictions). Forcing operators to wait until a batch is full before running the tool introduces considerable delay for the lots already at the tool, and adds variability when the batch finishes and moves downstream.

■ Smooth the flow of arrivals into the fab. Releasing lots into the fab in large batches (say, once a day) can introduce variability into the line (unless you are specifically feeding an early batch tool).

■ Separate maintenance events instead of grouping them, especially on one-of-a-kind tools. When a critical tool is unavailable the entire fab feels the pain. The magnitude of this pain is directly and non-linearly related to the duration of the unavailable time. This is true whether the unavailable time is unscheduled or scheduled. There is sometimes a tendency in fabs to group maintenance events. That is, if the tool is already down for a monthly PM, to also take care of the weekly PM. This is not beneficial for cycle time. For cycle time, it is much better to have several shorter unavailable periods, rather than one long period. This is often true even if the total unavailable time from the shorter periods adds up to a longer overall time

unavailable. Caveat: If you have an extremely sensitive tool, and getting it running again after maintenance is always touch-and-go, combining several maintenance tasks into one longer PM may still be the best choice.

Capacity Loss:

■ Minimize the number of distinct tools for which each operator is responsible, and stagger break schedules. Whenever an operator is responsible for more than one tool, there is the possibility that the operator will be needed by more than one tool at the same time. That is, one tool might be ready to load, while another is ready to unload. This leads to lost capacity on tools. By measuring this lost capacity, fabs can get an idea of where to modify staffing plans to reduce the effect.

■ Reduce the number of hot lots in the fab, especially hand-carry lots. Hot lots add variability to the fab, and should be minimized. We recommend that fabs keep the number of front-of-the-line hot lots below 10%. Hand-carry lots are even more detrimental because they lead to capacity losses when tools are held idle for an upcoming lot, or when a setup is broken. We recommend that fabs have no more than one or two hand-carry lots running at one time, to minimize the disruption and the capacity loss.

■ Check setup avoidance policies to make sure that low volume lots aren't waiting too long, especially on non-bottleneck tools. A setup avoidance policy states that the operator should keep processing lots of the same recipe, and only perform a setup to a new recipe if there are no matching lots in the queue. While setup avoidance policies do reduce the overall setup time on tools, they should be monitored to ensure that low volume lots don't wait indefinitely.

■ Make dispatching decisions to keep critical downstream tools from starving. Next-step dispatch rules can look downstream, to see if any bottlenecks are in danger of running out of WIP, and thus experiencing forced idle time.

Number of Qualified Tools:

■ Identify and eliminate single path operations. Cycle times are on average much higher for operations that only have one qualified tool. Often this is because the tool is a one-of-a-kind tool, and there is nothing that the fab can do. However, sometimes process restrictions lead to single-path operations. These should be reviewed at regular intervals, to see if any restrictions can be relaxed. Going from a single path operation to having a backup tool can reduce average per-visit cycle times by 50% or more.

■ Check for soft-dedication due to operator preferences (which can lead to single path operations). Sometimes operators tend to prefer a tool (due to location or other issues). Where this leads to single path operations, it can have a significant effect on cycle time.

Just which of these recommendations will lead to the most cycle time improvement for YOUR fab depends, of course, on where your fab's problems lie. However, our experience has shown the elimination of single path operations to be a potentially high-yield area for cycle time improvement. The notions of separating maintenance events on tools and running a greedy policy on batch tools are often counter-intuitive to people in fabs, and thus may yield unexpected benefits.

Metrics and Reporting

Here is a brief listing of metrics and data sources that we recommend for identifying short-term cycle time problems and driving improvement efforts.

■ Per-visit Cycle Time by Operation, relative to process time, can be reported as per-operation X-Factor for tool groups.

■ Tool Utilization tracks closely with per-visit cycle times, and can be an early indicator of problems.

■ Tool Availability and A20/A80 Availability Variability measure how consistent the availability is across tools and shifts

■ Tool State data should break out the time when a tool is not running but is available and has WIP waiting (standby-no-operator)

■ WIP Utilization % = Productive Time / (Productive Time + Standby WIP Waiting). This metric drives operators to always run the tool whenever WIP is waiting.

■ WIP Turns measure moves during a time period (like a shift) divided by starting WIP. Turns account for shortages and excesses in WIP, and give a forward estimate of cycle time.

■ Dynamic X-Factor is a point estimate measuring total WIP in the fab divided by WIP currently running on tools. It gives a forward estimate of cycle time, and can also identify short-term problems.

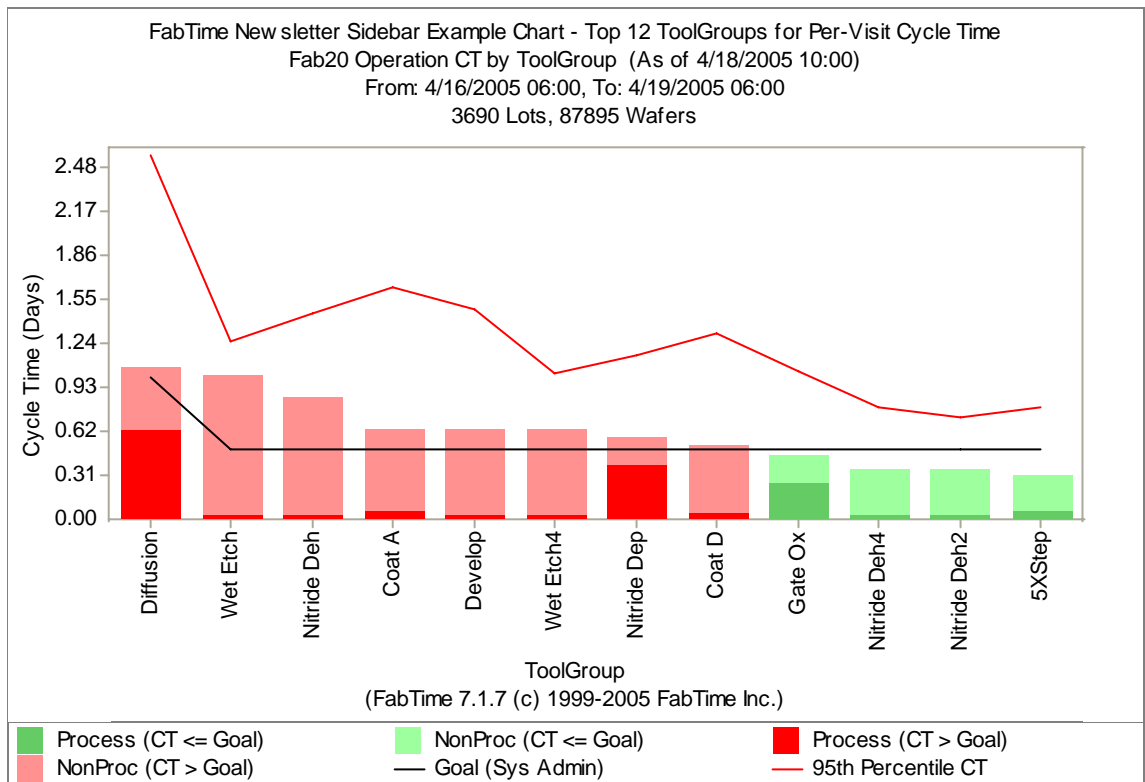■ Lot Inventory Age measures the time that each lot has been at its current operation. Many fabs set a cap on the maximum lot inventory age, and use this to keep lots moving through the fab.

■ Coefficient of Variation for process times, arrival times, and downtimes can help to pinpoint sources of variability in the fab, to drive improvement projects.

Sidebar: Exercise for FabTime Software Users

If you have FabTime's web-based digital dashboard software, you can generate any or all of the metrics listed above. All are part of the standard software package, available upon installation. To look at per-visit cycle times by operation:

1. From the Charts page, show "Operation Cycle Time" charts. Click "Go" to generate the "Operation Cycle Time Pareto" chart (example shown below).

2. Change the "From" date on the chart so that the chart covers 2 or 3 days, and change the "Slice" variable (available near the bottom of the big set of filters to the left of the chart) to ToolGroup, and press "Go".

FabTime New sletter Sidebar Example Chart - Top 12 ToolGroups for Per-Visit Cycle Time
Fab20 Operation CT by ToolGroup (As of 4/18/2005 10:00)
From: 4/16/2005 06:00, To: 4/19/2005 06:00
3690 Lots, 87895 Wafers

Legend:
- Process (CT <= Goal)
- NonProc (CT <= Goal)
- Process (CT > Goal)
- NonProc (CT > Goal)
- Goal (Sys Admin)
- 95th Percentile CT

(FabTime 7.1.7 (c) 1999-2005 FabTime Inc.)

3. (If necessary) change the "Sort" control immediately below the main set of filters to select "Actual Average Cycle Time", and check the box to the right to sort in descending order.

This will show you, for each tool group, the average time that lots spent there before being moved out, for all lots that moved out during the specified time period. The darker color is process time, and the lighter color is queue time. Look for tool groups that have a high value for the queue time. These are potential targets for improvement efforts.

Conclusions

In this article we have made a number of operational recommendations for cycle time improvement, and briefly reviewed metrics and data sources that can help to drive short-term cycle time improvement efforts. Most of these recommendations and metrics have been discussed in past newsletter issues (references below), and all of the metrics and data sources are available in our web-based digital dashboard software. However, we felt that there would be benefit for our readers and to our customers in having these lists collected in one place. We hope that you will find this a useful starting point for any upcoming cycle time improvement projects.

Closing Questions for FabTime Subscribers

Do you have any operational recommendations for cycle time improvement that we've missed? Have you had success with any of the techniques suggested? It would be great to start off the New Year with subscriber discussion centered on concrete cycle time improvement suggestions. We welcome your input.

Further Reading

In this section, we refer you to the FabTime newsletter issues in which each of these topics were originally discussed. All of these topics are also discussed in more detail in FabTime's cycle time management course. See www.FabTime.com/ctmcourse.shtml for more information.

■ Arrival variability (transfer batching and arrivals into the fab) – Issue 4.05

■ Availability and A20/A80 – Issue 4.02

■ Batch tools – Issues 2.01 and 3.08

■ Coefficient of Variation – Issues 4.01 and 4.02

■ Dispatching decisions – Issue 6.04

■ Dynamic X-Factor – Issues 4.08 and 5.03

■ Hot lots – Issues 3.02 and 6.08

■ Lot Inventory Age – Issue 4.07

■ Maintenance event scheduling – Issues 4.04 and 5.07

■ Operational X-Factors – Issue 4.07

■ Operators – Issue 4.06

■ Setup avoidance policies – Issue 6.07

■ Single path operations – Issues 1.08, 3.03, and 6.05

■ Standby with WIP Waiting and WIP Utilization % – Issue 5.05

■ Turns – Issue 1.06

■ Utilization – Issue 6.05

As our holiday gift to you, our loyal subscribers, you can each request up to three past issues at no charge, from now until publication of the next issue. Simply email your request, specifying the issue numbers that you would like, to Jennifer.Robinson@FabTime.com. You can find a complete listing of the past issues, with abstracts, at www.FabTime.com/newsletter.shtml. Please note that our response time for these requests may be slow during the holidays, but we will honor your requests. The complete text of all past issues is also available to all FabTime software customers from inside the software – simply go to the Help table of contents.

Subscriber List

Total number of subscribers: 1927, from 430 companies and universities. 22 consultants.

Top 10 subscribing companies:
- Intel Corporation (106)
- Analog Devices (78)
- Infineon Technologies (64)
- STMicroelectronics (61)
- Atmel Corporation (59)
- Freescale Semiconductor (58)
- Micron Technology (52)
- Philips (47)
- Texas Instruments (43)
- TECH Semiconductor (40)

Top 3 subscribing universities:
- Virginia Tech (10)
- Arizona State University (8)
- University of California – Berkeley (7)

New companies and universities this month:
- Pratt & Whitney Rocketdyne

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 Software

"Instead of spending time preparing reports, shift facilitators can get the data they need quickly from FabTime, and then spend their time making real improvements."
Mike Hillis
Cycle Time and Line Yield
Improvement Manager
AMD Fab 25

FabTime Installation

One fixed price includes
- Site license, unlimited users.
- Implementation & training.
- Software maintenance.

Pilot Project – Analyze your data with FabTime

For $4950, FabTime will
- Identify key contributors.
- Benchmark common metrics.
- Review results at your site.

Interested?

Contact FabTime for technical details or a pilot project quote.

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Phone: +1 (408) 549-9932
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Web: www.FabTime.com

## Do you have the best possible information?

- Are your supervisors swamped with daily reports, but lacking real-time information?
- Is it difficult to link equipment performance to cycle time?
- Does each new cycle time analysis require IT resources?

FabTime is a digital dashboard for your fab. In real-time, it provides a comprehensive view of fab performance data – everything you need for proactive management of cycle time. FabTime is designed for hands-on use by managers and supervisors, unlike traditional reporting tools, which were designed for programmers. FabTime also now includes **lot dispatching** (via dispatch rules) and static **capacity planning**.

A Web-Based Digital Dashboard

"I use FabTime every day, and so do the supervisors who report to me. The data that I need is right on my home page where I need it when I come in every morning."
Jim Wright
Production Manager
Headway Technologies
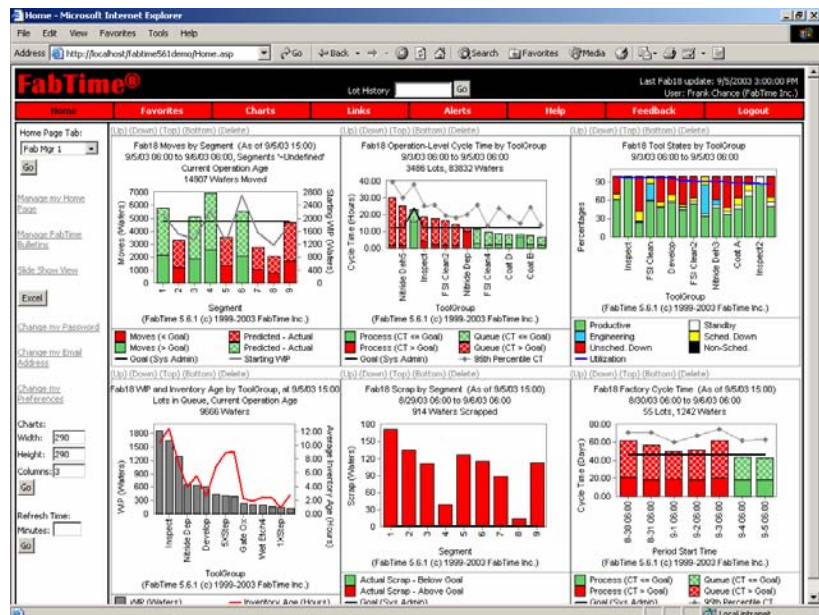
FabTime Benefits

- Cut production cycle times by 10%, hot lot cycle times by 20%.
- Focus improvement efforts on the tools that inflate cycle time.
- Improve supervisor productivity – cut reporting time by 50%.