FabTime Cycle Time Management Newsletter

Volume 5, No. 10 December 2004

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 current version (6.2) include tool OEE trend and pareto charts.

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Welcome

Welcome to Volume 5, Number 10 of the FabTime Cycle Time Management Newsletter! This issue marks the five-year anniversary of development for our FabTime web-based digital dashboard software. It's amazing how time flies! In this issue we have an announcement about the latest version of the software, as well as a short recap of a recent industry conference. Our software user tip of the month concerns methods for updating home page chart data. In the subscriber discussion forum we have several responses to last month's questions about paperless cleanrooms and the effect of linked tools on 300mm cycle times, as well as a new question about benchmarking for "single strand" toolsets.

Because we have extensive subscriber discuss this month, our main article is relatively short. We turned for inspiration to the responses to our cycle time issues survey (in which we have been asking people "What is the biggest cycle time problem in your fab?"). We noticed a number of responses pointing towards management behaviors that influence variability in the fab, at least from the perspective of people working in the fab. We've chosen to highlight these responses, and discuss their impact on our "Traffic Cop" cycle time management style recommendations.

We wish you all a safe holiday season, and a profitable and productive 2005. We'll be back in January.

Thanks for reading!—Jennifer

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Community News/Announcements

FabTime Releases Version 6.2 of Wafer Fab Cycle Time Management Software

San Jose, CA. November 18, 2004 – FabTime Inc. today announced the release of Version 6.2 of their cycle time management software for semiconductor wafer fabs. Version 6.2 is now installed and running 24 hours a day at all FabTime customer sites. Version 6.2 includes:

- Integrated capacity planning based on changes in product mix and line yield (and using actual process flow and tool uptime data).
- Color-coding of WIP lot list charts (to indicate on hold vs. in queue vs. in process).
- Reverse cumulative WIP data by process stage (to quickly locate shipment pull-points).
- The ability to mix FabTime slide show charts and external web content using a web-screen-saver.
- Automatic breakdown of standby time into "standby-WIP-waiting" and "standby-other".
- New WIP utilization outputs on tool state charts.
- Support for fractional hour periods on all trend charts.
- Dynamic x-factor trend and pareto charts.

FabTime is a web-based digital dashboard designed to give wafer fab managers the information that they need, in real-time, to help run their fabs effectively. FabTime extracts operations data (moves and tool state transactions) from the fab manufacturing execution system (MES) every five minutes, and makes the data available via web browser from anywhere within the corporate Intranet. The software includes a standard, pre-defined set of charts, reflecting performance measures that FabTime's founders have found to be useful in understanding and improving fab performance. FabTime is designed for hands-on use by managers and supervisors, unlike traditional reporting tools, which were designed for programmers. More information about FabTime's software is available at www.fabtime.com/software.htm.

ISMI Symposium on Manufacturing Effectiveness

In late October, I (Jennifer) attended the 1st International Sematech Manufacturing Initiative (ISMI) Symposium on Manufacturing Effectiveness. The symposium was held at the Downtown Omni hotel in Austin, TX. I thought that it was an excellent conference, with interesting papers and plenty of time to network. More than 200 people attended, from fabs and universities around the world, and they were mainly people interested in the manufacturing side of things. I had the opportunity to meet a number of newsletter subscribers in person for the first time (always something that I enjoy). I look forward to attending this conference again next year, and I think that it's an excellent fit for people interested in the types of topics that we discuss in the newsletter (manufacturing and performance improvement, etc.).

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

FabTime User Tip of the Month

Control Home Page Chart Updating

Your home page contains three settings to help you control when and how home page chart data is updated. This tip describes how to use these settings to ensure that your FabTime charts are always up-to-date.

Auto Slide Tab: Use this setting to tell FabTime to automatically slide all of the trend charts on a particular home page tab forward in time. Select "Daily" to slide them all forward once a day (the most common usage). Or, if you have a tab in which you look mainly at weekly performance, select "Weekly". Enter the time at which you would like FabTime to slide the charts forward (using the format hh:mm, e.g. 18:30 for 6:30 pm). For weekly auto slide, also select the day that you would like to use. Then, press the "Go" button under the "Last Slide" text box. FabTime will slide all of your charts forward in time by 24 hours (or 168 hours) the next time the clock reaches your specified slide time. If your charts are further back in time than one day, you can also bring them forward manually using the "Slide Tab (Hours)" control. All Auto Slide settings apply to the currently displayed tab only.

Refresh: Use this setting to tell your web browser to go and get updated data from FabTime. FabTime re-builds the charts whenever the home page is refreshed, adding data to trend charts, and moving list-based charts (like the WIP Lot List chart) forward to the latest time. To set this, enter a refresh interval (in minutes) into the text box labeled "Refresh" (the bottom control to the left of your home page). Hit enter, or press the "Go" button immediately below the text box. Note that the refresh setting is a global setting, and will apply to all of your home page tabs. To stop FabTime from refreshing, enter "0" in the Refresh box and press "Go".

Unpeg: Sometimes when you add a list chart (e.g. a WIP Lot List chart) to your home page, that chart will be "pegged" to a particular point in time. This can happen if you have looked at a list chart for a particular time in the past (e.g. by drilling down from another chart). If a value is entered into the date field for a list chart, and then you add that chart to your home page, the chart will be tied to that date. In this case, a link labeled "Unpeg" will appear above the chart. Clicking the "Unpeg" link tells FabTime to remove the tie to that date, so that the chart will from now on always display the latest data. If you don't see a link labeled "Unpeg" then the chart is not pegged to a set time, and will update when the home page is refreshed.

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

Paperless Cleanrooms

Last month **Della Killeen of STMicro-electronics** wrote: "I am trying to better understand how other wafer fabs handle the issue of paper inside cleanrooms. I think there is a human efficiency element to this issue, apart from the obvious defectivity side. Therefore, I'd like to ask your subscribers the following series of questions:

1. Do you have a 100% paperless cleanroom?

2. Do you allow printers only in chases, connected to Fab tools?

3. Do you allow printers inside the Fab?

4. What paperless solutions has your site deployed for taking notes and/or obtaining wafer maps?"

People from two fabs sent in detailed responses, which are included below. To preserve confidentiality, we have not included the names of these two subscribers (or their fabs), but we do thank them for their contributions.

Fab A:

1. Do you have a 100% paperless cleanroom? No – we have lots of clean room paper.

2. Do you allow printers only in chases, connected to Fab tools? No restrictions.

3. Do you allow printers inside the Fab? Yes.

4. What paperless solutions has your site deployed for taking notes and/or obtaining wafer maps? We have a paperless solution for wafer maps – and taking notes (internally developed – intranet based), but we still use paper for telling the operator what to do with the lot.

Fab B:

1. We still use paper travelers so we are a long way from 100% paperless.

2. We don't have printers connected to fab tools. We have 1 network printer that is located in the chase.

3. We do not allow printers in the fab. All of our traveler printing is done outside the fab in the office.

4. We have not deployed any solutions for taking notes or obtaining wafer maps. However, we have implemented electronic logs at tools.

Dan Estrada of Eyelit does not currently work for a fab, but contributed some thoughts regarding paperless fab solutions. "The key for going paperless is understanding what you need on a regular basis. Even more important is understanding what are the typical ad-hoc needs that drive the requirement for paper in some people's minds. An example would be new instructions to the operator or maintenance tech. Most regular needs should be provided for by the systems already on the shop floor.

Many paperless systems still don't have an easy solution for the ad-hoc issues that never seem to go away. Today's current generation applications could take advantage of instant messaging (yes the same IM that keeps our kids on the computer all night). Most modern systems are object-based systems. Objects or groups of objects can be set up as a group (buddy list type). An object could be a lot, batch, tool, workstation, order, etc. Suppose that you have a lot or product that has an urgent process change. Engineers don't always know the systems well enough to make the appropriate change or don't have the time to wait in the IT queue for the change. You could, for example, simply subscribe to the lot or product that is affected. In this case, when the operator moves in the lot an IM dialog box would pop up. Anyone subscribed would get the same dialog box, enabling two-way communication. All of this information (the conversation) would be captured in a log file and could be linked to the lot/product history. Of course email could still be sent, people paged, all of the things you can do with an open system. The IM dialog box could also be set to force the operator to send an acknowledgement before processing the lot. I'm curious to get feedback on this concept, as we have recently added this capability to our MES software to improve communication on the shop floor. We believe that a benefit of this will be reduced paper in the clean room."

Brett Brimhall of Maxim Integrated Products added these new questions on the same topic. He said: "Here are my own questions about going paperless. There is a lot of skepticism here about whether the benefits a paperless system will outweigh the cost of implementation. I would be interested in any feedback from you or from your newsletter group.

1. What studies have been done or what scientific evidence is there that paperless fabs give better yields than paper fabs? Has this been quantified?

2. What benefit, if any, would be derived from increased operator productivity in a paperless environment? It seems as if productivity will be less because operators now have to always go to computer terminals to find out what to do next with the lot rather than just simply looking on the traveler.

3. And lastly, what improvement, if any, can be derived from a paperless system over paper in terms of scrap? It seems that in a paperless system there is tighter integration of tools to the MES which means less chance of a wrong recipe, or mix-up of wafers, but I really don't know."

FabTime welcomes further discussions on this topic.

300mm Cycle Times

Last month **Bob Kotcher of MMC Technology** (disk drive manufacturing) sent in some detailed comments regarding linked tools as a potential contributor to higher-than-anticipated 300mm cycle times. Two subscribers (**Mike Hillis** and **Dan Estrada**) submitted responses to Bob's comments.

Mike Hillis's comments are integrated with some additional remarks from Bob Kotcher on the topic. Mike wrote: "I think that Bob Kotcher's comment regarding what I would call the "efficiency" of linked vs. non linked cells (generally in photo-lithography, although he doesn't refer to that directly) is very interesting. As an old fab hand and manufacturing guy, I had the same fears of linked tools as the technology progressed. His assessment is right on: lose a coat track on one cell and a stepper on another and the hit is 2X if you have dedicated links vs. freely interchangeable tools.

So, as we progressed even to 200mm it was with a lot of trepidation that I saw more systems thusly linked. To make matters even more complex, many layers were limited to just one or two cells, further reducing flexibility. Despite my personal misgivings on this issue, I've watched as we moved forward with the linked and dedicated cells.

The reason for needing this level of dedication is simple (although the details are numerous and pretty boring to talk about). The technology demands much tighter control over every input parameter. Linking tools reduced variation in delivery time from track to stepper. One can "tune" the lithocell to achieve optimum results.

While in our current environment cost control is big in the news, it has always been a major factor in our business, particularly in photolithography (where resists can be quite expensive). With that in mind, engineers tend to use the "best" chemicals on the most difficult layers and material with more modest capabilities on less rigorous layers. Thus the days of "all things being equal" have largely vanished. I can imagine, with our further travels into deep submicron design rules that this will become an even more intense necessity.

The bottom line is that linking and dedication have little to do with a choice with respect to productivity/cycle time or other "efficiency" (from a manufacturing person's point of view) but everything to do with capability and extending the usable life of installed equipment base. In other words: "effectiveness".

That being said, does that doom operations, planning and industrial

engineering to a life of gloom? I suggest that any derating of activities in a 300mm environment is more a function of a learning curve than an inherent handicap of the tool configuration. I believe that the key to high levels of productivity lies in creating a rational fallback strategy, along with a clever production planning and execution methodology. I'm sure there are dozens of ways of resolving these problems while still maintaining the process integrity that the engineers require.

I don't know what sorts of process/engineering constraints Bob must face in a disk factory and certainly some kind of simulation might help guide him in his decisions. My own prejudice would be to avoid linking tools if possible. It seems to me that if tool utilization is approaching what is required to meet his cycle time expectations, then he might lose some efficiency by linking. It may be more effective (and possibly cheaper) to evaluate looking at the manufacturing systems (i.e. MES or some kind of production planning methodology) to handle some of his other concerns such as misrouting."

Bob Kotcher's Response: On seeing an early preview of Mike's comments, Bob had the following to add. "Please thank Mike for his thoughtful reply. In that same vein, I remember at my previous company how when we had a number of identical machines, from a cycle-time and throughput perspective of course we wanted all machines qualified for all recipes--maximum flexibility. Process engineers, however, preferred that each recipe be set up on only one machine. This reduced their labor significantly and constituted tighter process control, which should produce higher yields. Another example is here at MMC, where process engineers want us to only run one type of substrate through each sputter machine for tighter process control, whereas Production wants to mix freely to maximize throughput. It's occurring to me that the throughput/cycle-time vs. process-control/yield tradeoff that Mike brings up may be pervasive in high-tech fabrication industries. It is difficult to resolve: a simulation model can estimate effects on cycle time and throughput of various policies, but estimating yield effects of increased or decreased machine flexibility is much more challenging."

Dan Estrada (Eyelit) wrote: "I did a similar project at a disk drive manufacturer in the 90's. We had the benefit of a simulation model, though I'm not sure it was as successful as we would have liked. The simulation model worked fine -- it was the arguments between the various groups on the model inputs that were our biggest issue. We also found that because the disk process cycle time changes so often, balancing the "linked operation" was always a challenge.

Things to consider, that we didn't realize the impact of at the time:

1. What generation of the technology platform are you on? As the platform matures you typically see less process/cycle time changes or at least they seem more predictable and therefore and can plan better for them.

2. The other issues that could affect disk processing cycle time in a big way are issues with end product quality. The three components are the recording head, channel and disk. With the head (wafer fab) having a typical total processing cycle time of 30-45 days it may be better (faster) to change the disk process to correct a problem in the end product. You can make a change in the disk line and see the results in a day or so (relative to at least four weeks in the fab). This is more common in a vertically integrated provider like IBM and Seagate, because you can keep the issue "internal".

On the next product we went back to a farm tool layout…….it gave us more flexibility as well as helping with the issues that Bob mentioned in the last newsletter. Our reasoning behind the project was

"lean" manufacturing (today's buzzword - although we had a different one at the time). We had a cell concept where the operators worked as a self-managed team, completely cross trained, to optimize space and travel time. With the farm layout we found that our product was moving 5x (distance) more that it really should have/needed to. Funny how things come back around and around."

FabTime Response: We think that Mike, Bob, and Dan all make some excellent points. We often look at these things from an industrial engineering perspective (what Mike calls "Efficiency"), and it's good to hear the capability/quality/"Effectiveness" side also. We welcome discussion from other subscribers on this topic.

Benchmark Cycle Time for Single Path Toolset

Another subscriber wrote to ask: "What would be a benchmark cycle time for a fab with a "single strand" (i.e. one of a kind) tool set? There has been a lot of discussion about effects of tool downs and tool utilizations in this scenario, but I have not seen the best results that anyone has been able to achieve. Some metric like days/mask level, or x-factor of RPT (with corresponding shift assumptions) would be quite interesting."

FabTime Response: We haven't seen anything formal on this. But from what we've seen 4-5X theoretical is a realistic target for fabs with many one-of-a-kind tools (that's assuming 7 by 24 production, and would need to be adjusted according to shift schedules). It depends on the utilization of the tools, of course. If you have a single tool, with a moderate amount of variability, you can roughly estimate cycle time x-factor as 1 / (1 - utilization). So, if you run at 80% utilization on a single path tool, with moderate variability, you can expect to be at about 5X (from 1 / 1 - .8) = 5). Because not all of your tools will be loaded to 80% or more, the overall average will probably be something less than 5X for the entire fab. We would welcome feedback from other subscribers on this question, especially with reference to days per mask layer.

Management Behavior and Fab Cycle Time

Introduction

When people subscribe to this newsletter, we ask them "What is the biggest cycle time problem in your fab?" To date we've collected more than 300 responses to this question. The top three most frequent responses are:

1. Downtime/availability
2. Bottlenecks/equipment utilization
3. One of a kind tools

These make sense to us as a top three, because they are all fundamental drivers of cycle time at the tool group level. We've talked about downtime several times in the newsletter, and certainly it influences cycle time in every fab. Most fabs, because of the high cost of equipment, also have high loadings on a number of tools. This contributes to high cycle times. Finally, although not all fabs have one of a kind tools, single tools cause a great deal of pain when present, especially in conjunction

with downtimes and high equipment utilization. To a certain extent, these are all inherent conditions in fabs, caused by the complexity, rapid product cycles, and high cost structure of our toolsets.

We have noticed, however, that there are quite a few individual responses that point a finger at more controllable inputs. We will not name names, of course, but we thought that you might find some of these individual responses interesting. A sub-set of actual responses is listed below.

- Management behavior surrounding controllable inputs – starts, surges, expedites.
- Rush jobs.
- Dealing with priority WIP and how it impacts the other WIP in the production line.
- Consistent WIP management (goal setting and tracking problem lots/consistent management of cycle time issues.
- Balancing the competing objectives within the fab, aligning cycle time objectives with line WIP objectives.
- Clients.
- Dynamic, unpredictable and non-linear loading from customer.
- Communication and workforce structure.
- No manufacturing strategy.
- My boss.

You get the idea. To summarize much of what we've seen and heard, people blame management when things that they feel should be controllable and predictable, aren't. This includes lot expediting (hot lots), variation in arrivals (e.g. due to customer orders), and frequent changes in product mix, goals and/or WIP management strategies. All of these contribute to fab variability. And, as we have discussed many times in this newsletter, variability has a large (and detrimental) influence on fab cycle times. What these survey responses show is that people do tend to naturally resist variability, especially when it is imposed upon them, and feels outside of their control.

The Traffic Cop

Back in Issue 3.6 (published in June of 2002) we introduced the concept of cycle time management styles. These were management styles that we had observed in real fabs, each suited to a particular cycle time focus. One of these, the one most relevant to management, was the Traffic Cop. The Traffic Cop's goal is to monitor and manage starts, to control equipment utilization. What the Traffic Cop does is:

1. Identify the fab bottleneck with a capacity model (usually spreadsheet, queueing, or simulation-based).

2. Control fab starts to keep the bottleneck utilization below 85%.

3. Monitor WIP turns in the fab to avoid unexpected utilization spikes.

This methodology requires that the Traffic Cop has access to an accurate capacity model, and has management authority for both starts plans and performance measurements.

Based on what we've observed in our cycle time issues survey, we would like to amend this description to add a fourth requirement for the Traffic Cop:

4. Manage controllable inputs to provide a buffer for employees against variability.

This includes minimizing the number of hot lots in the fab, and avoiding changes in mix, goals, and WIP management strategies when possible. We realize that "when possible" is a very vague description. The fact is that sometimes these inputs are not controllable. Important customers have to be satisfied in order for the company to stay in

business. Market conditions dictate changes in product mix, sometimes more rapid changes than employees would prefer. Or, the question of who can control them may be difficult to answer. Nevertheless, it seems to us a worthwhile goal for managers to try to shield the people who work for them from these types of variation.

Conclusions

No one that we talk with wants high cycle times or unhappy employees. And most people understand, at least in theory, that variability is bad for cycle time. Yet the fact remains that when asked anonymously what would help to improve cycle time in their fabs, a number of people point a finger at management behaviors. The question of what is or is not controllable in a fab is highly subjective, and certainly the question of what YOU can control depends on your job description, your corporate culture, etc. But what we think is that if you work in a fab, and you are managing other people who work in the fab, it's worth asking yourself this question:

Am I doing everything that I can to provide the people who work for me with a buffer against variability?

If your answer isn't yes, then there may be something that you can do to improve cycle times in your fab. It might not be an easy thing, but if you keep in mind the impact of better cycle times on your company's bottom line, you might consider it worthwhile.

Closing Questions for FabTime Subscribers

Do you feel that management decisions contribute to cycle time problems in your fab? As a flip question, if you're managing a fab (or a shift, or an area), what do you do to reduce "controllable" variability for the people who work for you? Note that FabTime will keep your responses anonymous, unless you tell us otherwise.

Subscriber List

Total number of subscribers: 1711, from 411 companies and universities. 25 consultants.

Top 10 subscribing companies:

- Intel Corporation (85)
- Analog Devices (79)
- Infineon Technologies (54)
- Freescale Semiconductor (52)
- STMicroelectronics (50)
- Philips (43)
- Micron Technology (42)
- Texas Instruments (38)
- Seagate Technology (37)
- AMD/Spansion (36)

Top 5 subscribing universities:

- Arizona State University (10)
- Virginia Tech (10)
- Georgia Tech (6)
- Nanyang Technological University (6)
- University of California – Berkeley (6)

New companies and universities this month:

- Emerson Network Power Ltd.
- Gartner, Inc.
- Maverick Institute, LLC
- Meadowlark Optics
- Ovotex NV
- Photronics Ltd.
- PTI Seminars Inc.
- Singapore Institute of Manufacturing Technology
- STATS ChipPAC
- Universite de Paris Sud
- Westcode Semiconductor

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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Email: Sales@FabTime.com
Web: www.FabTime.com

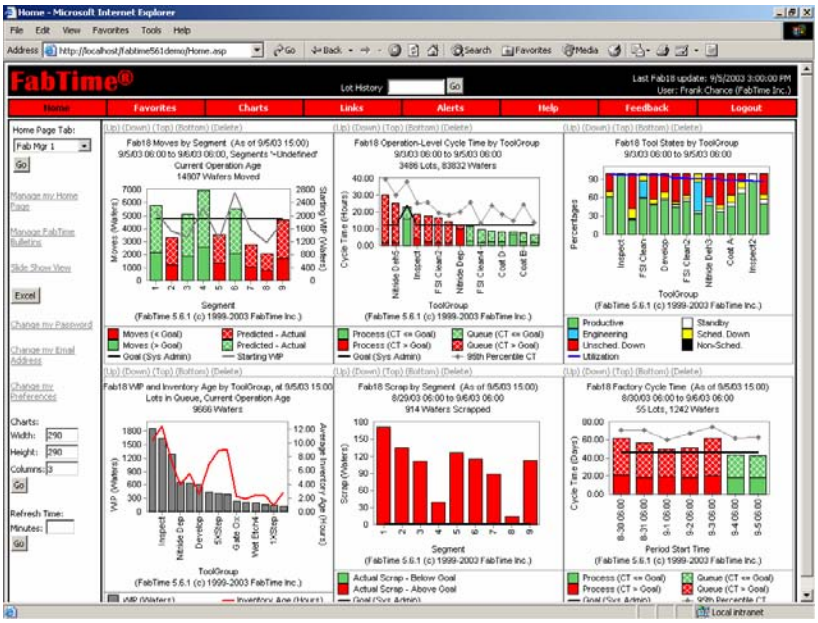
Do you have the best possible information?

- 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.

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%.