FabTime Cycle Time Management Newsletter

Volume 3, No. 10 December 2002

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.

Editor: Jennifer Robinson

Table of Contents

Contributors: David Chia (Chartered Semiconductor Manufacturing); Robin McAuslan (National Semiconductor); Mike Hanrahan (Eastman Kodak); Mike Hills (AMD)

Welcome

Welcome to Volume 3, Number 10 of the FabTime Cycle Time Management Newsletter. We have a couple of FabTime-related announcements this month. We have given our 2-day cycle time management course three times over the past few weeks, and seen it very well received. We hope that more of you will be interested in having the course at your sites, and we have included a brief course description below. Also, we have recently made 20 of our technical papers available for immediate download from our website, at www.FabTime.com/bibliogr.htm.

In this month's subscriber discussion forum we have many responses to last month's main article about the impact of staffing (particularly operator delays) on cycle time. Most of the respondents agreed that operator delays do have an impact on fab cycle times, at least some of the time. We hope that the high level of interest generated by staffing-related topics is an indicator that starts are increasing (and hence operators are becoming more of a constraint). We also have new topics raised by subscribers related to performing tool qualification on the bottleneck and estimating the impact of hand-carry lots on other lots.

Our main article this month is about a new performance metric we are proposing. After discussing what attributes we believe should be found in metrics for daily production meetings, we propose Quality Moves. Quality Moves measure, on a shift basis, the best performance that can be achieved given the fab's WIP profile and resource availability.

Thanks for reading! -- Jennifer

FabTime

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

Community News/Announcements

Cycle Time Management Course

We have given the 2-day FabTime Cycle Time Management course three times in the past six weeks. One of the course sessions was a multi-company session held in the Bay Area, while the other two were held at company sites (one in the US and one in Japan). The course has been very well received by participants. If you are interested in scheduling a session of the course for your site in 2003, please contact Jennifer.Robinson@FabTime.com, or use the information request form on our website. The course covers:

- Cycle time management styles
- Cycle time intuition
- Metrics and goals

On completion of the course, participants should be able to:

- Identify appropriate cycle time management styles relative to job descriptions.
- Teach others about basic cycle time relationships (utilization, capacity).
- Define common metrics and terms, and calculate metrics from raw data.
- Estimate suitable goals from basic models.
- Teach others about Little's law and variability.
- Understand the impact of hot lots, and recommend management strategies.
- Apply cycle time intuition to operational decisions.
- Estimate the bottom-line impact of cycle time improvements.

FabTime welcomes the opportunity to publish community news and announcements. Simply send them to Jennifer.-Robinson@FabTime.com.

Subscriber Discussion Forum

The Impact of Staffing on Cycle Time

At the end of last month's article on staffing and cycle time, we asked three questions:

1 Do you measure the percentage of time that your tools spend waiting for operators?
2 Do you include operators in your capacity and simulation models?
3 Do you think that operator loading levels are contributing to cycle time in your fab?

Apparently, these questions struck a chord with people, because we received several responses from newsletter subscribers, and have included them below (with or without attribution, as each person chose). Where there are new questions raised, or where we particularly have something to say, we've added FabTime responses, but mostly we've stepped back to let the subscribers talk about this issue.

A. An anonymous subscriber wrote:

"1. Do you measure the percentage of time that your tools spend waiting for operators? Currently, the only way of measuring operator performance in my fab is to calculate the turns (moves/wip) of a certain tool cluster and the fab as a whole. It sounds pretty sad, but we did experiment with measuring the amount of time a lot spends waiting at an idle machine. However, the following problems made this impractical and the data inaccurate:

(a) Many tools are registered within the MES to run a certain step. However, simultaneous resources, like reticles, have to be available too. E.g. 8 lots are waiting to run GP photo. Theoretically, more than one stepper can run these lots -- however, if there is only 1 reticle for GP, then 7 lots will need to wait while the first one gets processed. If we were to download data directly from the MES, it would appear that those 7 lots are idling away in front of idle steppers -- when in fact, they are not. To consider the availability of reticles takes additional resources.

(b) Tool dedication for certain steps.

(c) Queue time constraints between steps. e.g. between a cleaning step and furnace operation. This forces lots to wait in front of an over-capacity wetbench if the furnace (2 steps away) is busy.

I'll admit that with enough effort, the time tools spend waiting for operators can be studied. It is by no means a trivial exercise and appears prohibitive with the current resources we have. But it is in the works. Anyway, is there a simple approach how other fabs measure their operators' performance?

2. Do you include operators in your capacity and simulation models? No. However, we are looking into the impact of lot travel time (between tools) to CT. For your information, we do not use AGVs for lot transportation, but rely on manual operator movements. Therefore, operator efficiency is doubly critical. Any suggestions?

3. Do you think operator loading levels contribute to CT in your fab? Definitely."

FabTime Response:

Regarding how fabs measure operator performance, I don't think that there is one simple approach. It's a very complex topic. I think you made an excellent point about the availability of other resources such as reticles affecting this. I do know (see other responses below) that some MES systems can automatically log a tool into a "no operator" state, if there is WIP ready to be loaded, and the tool is available (but even then reticle availability might not be included).

As far as your other question, looking for suggestions related to operator modeling, what I've seen myself is that if operators are not included in simulation models, the models will tend to consistently underestimate cycle time. Even when operators are included, but not modeled in detail, cycle times will be closer to actuals due to the additional level of resource contention (if breaks are modeled, or the model includes operators being responsible for more than one tool at a time). I think that if you use your operators for manual transport, this will be especially true (because this is another point at which an operator is needed), and even more so if the operators can batch lots for transport (e.g. there's a cart that can hold six lots at a time).

B. Another anonymous subscriber wrote:

"Interesting dialog about operator availability. However, in a "state of the art" fab, the cost of direct labor is so small compared to the depreciation, no one ever skimps on direct labor, so the availability issue doesn't come up much."

C. Another anonymous subscriber wrote:

"1. We do measure idle time on the tools.
2. We currently have operators in our capacity model, and are shortly going to be adding operators to the simulation model,

though this is a long and arduous task... 3. Operator loading levels definitely contribute to cycle time in our fab, especially when the fab loading levels are high. This is the primary reason for adding operators to both static and dynamic models, so that we can understand the impact of cross-training, certification, and operator saturations for temporary WIP build-ups and long-term bottleneck tools. As a secondary driver for this effort, we also need to be able to justify maintaining operator levels in a slow period, increasing operator headcount in an upturn, etc. with accurate estimates of the metrics folks care about, like cycle time and outs, rather than stating an increase or decrease in "capacity"."

D. Robin McAuslan of National Semiconductor:

"We've not managed to measure accurately our real wait operator time, but we have started moving towards this. The problem is typically that usually this circumstance occurs because the operators are running other tools. On one tool set, which has recently been fitted with a customised Station Controller, we have programmed in the ability to log automatically to no operator if a batch has completed processing but Workstream has not been logged to "production-end" AND there is inventory waiting. This is a very hot topic for us at the moment.

I introduced operators into our ManSim model some 6 or 7 years ago; it was the first thing I did once I learned how to use the model and it paid instant dividends. It suggested a rebalancing of the fab headcount (from area to area and shift to shift), and where best to increase skills. Net result was a 30% improvement in cycle time achieved very quickly. We've kept our full complement of operators in the model now that we're using ASAP. We model each shift, breaktimes, absence and holidays, and personally I wouldn't be without it. As you stated, it is impossible to cover every aspect of the operators day, like telephone calls to engineers, impromptu training sessions etc, so to allow for that you need a max load rule on the operator. Typically I would aim for 70% as a guide. We interpret this data to create training plans for each shift/area, so the linkage between modelling and Training is key. If time ever allowed I would also model maintenance personnel, as this can be equally important from a planning point of view.

And yes, Operator loading levels undoubtedly contribute to cycle time in the fab!"

E. Another anonymous subscriber wrote:

"In regards to the question on operator staffing impact and whether or not we measure the percentage of time a tool is idle due to staffing issues. We do measure this time. Anytime a tool is unable to run because of the inability to staff it, it is logged down to a "No Operator" code. That time is rolled up into Standby Time since we feel we can impact and gain that time back. However, we wanted specific visibility to that element of Standby to use as leverage to address staffing shortfalls."

F. David Chia of Chartered Semiconductor Manufacturing

"Along the discussion on operator staff impacting capacity, I have a question on "what is the typical wafer moves per operator expected?" There is a measurement on how we staff operators verses number of equipment etc etc."

FabTime Response:

We believe that wafer moves per operator is a metric that some fabs use for determining the appropriate level of staffing, rather than doing detailed calculations for operator loading. If any subscribers care to share information on the typical wafer moves per operator that you use in your fab, FabTime will compile the results and publish them in the next issue. All results will be held confidential (no names or company names published) unless the person responding wishes otherwise.

Tool Qualification on the Bottleneck

A subscriber submitted the following question: "Lately, due to a sudden change in Mix, our Photo Lithography area became a major bottleneck. Generally, these days, it's a good sign but of course we're trying everything we can in order to utilize any hidden capacity. One area in which we see as an opportunity for improvement is Routine Qualification Tests performed periodically on each tool. These tests are performed in order to keep the tool qualified for production and the include tests such as Stability, Focus, others. These tests are usually performed by the Production people and Maintenance people are only called in case of a problem.

Actually, we calculated that these tests are reducing our available capacity by around 4%!

No need to mention how critical those 4% are for us today. Also, since the Down Time generated by these Tests is a highly variable figure, it's corrupting our Cycle Times significantly. The actual tool's downtime can be anywhere between 5 minutes if the tests goes through and 2 hours if there's a problem.

The following are a few questions on which I'll be glad to hear your/readers response regarding this issue:

1) Is the 4% a reasonable number?
2) What is the best way to consider this time in tool's capacity models?
3) Is this time reported in MES system under "Prod Test" event, and is it considered Downtime, Standby, or Productive time (or something else)?
4) Are there any theoretical/practical models for reducing the effect on Cycle Time?"

FabTime Response:

1) As you've already seen, the 4% is a reasonable number when the tool is not highly utilized. However, when working with the bottleneck in a fab, a 4% capacity loss can make a significant different. It sounds like you're in the steep part of the cycle time vs. equipment utilization curve, where any loss of standby time will rapidly drive up cycle times.

2) The standard way to capture this in the tool's capacity model is to explicitly include it as a loss factor, deducted from the available time per tool. This is straightforward if the qualification time is independent of the number of wafers processed (just use the 4% value as a loss factor in the capacity planning model). If the qualification time is dependent on the number of wafers processed, you will need to use a formula for the qualification time, as a function of wafers processed.

3) How this time is reported in the MES is probably fab-dependent. We consulted the SEMI E10 specification for tool states. While routine qualification tests are not explicitly mentioned in E10, it seems to us that they would be most likely be considered part of Scheduled Downtime.

4) The two important things for reducing the effect on cycle time are a) to maximize the total available standby time on the tools; and b) to minimize variability by keeping the length of time that the tools are unavailable due to each instance of these tests to a minimum. These are both things that we discuss and illustrate with exercises as part of our 2-day cycle time management course.

Perhaps some other subscribers will have more to say on this topic.

Measuring the Impact of Hand-Carry Lots on Regular Lots

Mike Hanrahan from Eastman Kodak asked us if we knew of any references describing the impact of hand-carry lots on the other lots in the fab. We did a search on this topic, and we found only one reference (in addition to our paper with Mike Hillis from AMD) that even looks at hand-carry lots. The reference and abstract are below.

K. Hsieh, A. Ling, S. Huang, R. Luoh, M. Lin, L. Lee, "Super-Hot-Runs Management System," *Proceedings of ISSM 2000*, 363-366, 2000. You can purchase and download a copy of this paper from www4.infotrieve.com/search/databases/detailsNew.asp?artID= 33025911.

Abstract: "Our project's purpose is to reduce the cycle time of "push lots". Some lots must be pushed at a faster speed than normal lots. We refer to these lots as super-hot-runs. For example: If the customer's special requirements includes, pilot lot or FAB potential-lot, our project's purpose is to reduce the cycle times of "push lots" (Super-hot-runs, pilot, hot-lots) to ensure maximum customer satisfaction. According to our historical data, the cycle times of push lots were 1.0 days/layer before we started this project. We made a project goal: by reducing the C/T from 1.0 days/layer to 0.8 days/layer. We set the goal by analyzing the percentage of run, queue, hold. Then tuned a reasonable queue time SPEC to meet C/T target. Hold time reduction is also being dealt with in this project."

If any of our subscribers know of other references concerning the impact of hand-carry lots on the other lots in the fab, please let us know.

Quality Moves: A Proposal for a New Performance Metric

Introduction - Do We Need Another Metric?

Most fabs are well supplied with metrics: moves, turns, yield, WIP, days per mask layer, OEE, on time%, utilization, etc. The list goes on and on. However, if you ask a fab manager, "What metrics do you focus on during your morning meeting?" you get a much shorter list. In our experience, most fab managers focus on three to five critical metrics (at various levels of responsibility) at these meetings. When we ask this question, we hear combinations such as:

- Moves, turns, and yield.
- Turns, yield, and OEE.
- Moves, inactives, and yield.
- Equipment availability, moves, and yield.

Clearly, there are recurring themes here. The first is yield. If yield is bad, that's bad news and everyone focuses on it. Yield isn't our area of expertise, so we'll acknowledge its importance and move on.

The second theme is moves and turns. More generally, some measurement of activity (lots completing operations), either reported in a raw form (moves) or normalized by WIP (turns).

The third theme, or lack thereof, is cycle time. Fabs want good shipped-lot cycle time. However, it's not easy to incorporate shipped lot cycle times directly into a morning-meeting-style metric. We'll discuss this in more detail below, but for now, think about the morning meetings you have attended, and see if shipped-lot cycle time has come up frequently as a driver for short-term, local performance evaluation.

Do you remember "The Goal" by Eli Goldratt? It's a rare fab that doesn't have at least one copy of this book on some manager's bookshelf. Do you remember the three factory performance measures from The Goal?

- Throughput (sales measured in $).
- Inventory (items that will become throughput, measured in $).
- Operating Expense ($ spent turning inventory into throughput).

Despite the popularity of the book (The Goal), we have yet to find a single wafer fab that focuses on these three performance measures during morning production meetings. [If you do, please contact us, we would be interested to hear how it works.]

We have pondered this disparity (everyone likes and agrees with The Goal, few if any use its performance measures in morning meetings). We believe the root cause is similar to the reason that shipped lot cycle time isn't a morning-meeting-style metric:

The longer the process flow, the harder it is to use factory-level metrics to drive local operating decisions.

Would you use factory-level metrics in morning meetings if you only had 10 operations? 100 operations? 500 operations? We're not sure of the cutoff point, but we believe that at some point, these factory-level metrics are not enough. You need additional metrics that can be used to drive local decision-making. And these metrics need to be in synch with factory-level metrics. We want to focus on metrics that, when improved, result in better factory-level performance. We certainly don't want local metrics that worsen factory-level performance. Finally, we would like metrics that we can use for goal-setting and performance evaluation. At the morning meeting, we'd like a useful yardstick of achievable performance for the day, and a fair evaluation of yesterday's performance.

To review, we want morning-meeting metrics that:

- Apply to local decisions.
- Drive improvements in factory-level metrics.
- Provide a useful yardstick for goal-setting and performance evaluation.

How do our current metrics stack up? First let's consider yield:

"Applies to local decisions?": Yes -- we can use experiments to quantify the yield impact of operating decisions, and use this information to drive toward operating practices that improve yield.

"Drives improvements in factory-level metrics?": Yes -- if yield is improved, good things happen at the factory level.

"Provides a useful yardstick for goal-setting and performance evaluation?": Yes -- everyone knows the ultimate target (100% yield), and yield is (to some extent) robust to changes in day-to-day WIP fluctuations.

Now let's look at moves and turns (turns = moves divided by initial WIP):

"Apply to local decisions?": Yes -- in either case (moves or turns), we can tailor our operating practices to move more wafers.

"Drives improvements in factory-level metrics?": Perhaps -- we know that if moves or turns fall drastically, then bad things will happen at the factory level. But the converse is not true -- we can move a lot of wafers (and drive up moves and turns), but that doesn't guarantee improvements at the factory level.

"Provides a useful yardstick for goal-setting and performance evaluation?": Partially -- moves goals are usually set weekly or monthly, based on long-term production targets. Daily fluctuations in WIP distribution and tool availability can make these long-term goals impossible to achieve. So it's hard to know at the beginning of each shift how many moves each module should be able to achieve, and it's equally hard to evaluate the previous day's performance -- meetings become an exercise in explaining why actual performance varied from the long-term goal. Turns goals are more robust, since they take initial WIP distribution into account, but can be hard to apply at a very granular level. For example, what happens when WIP at the start of the shift for an operation is zero? It's hard to evaluate performance at the operation level using turns in this case.

We started this section with the question "Do we need another metric?" After many discussions with fab managers, we believe the answer is yes, especially one that is applicable to morning production meetings. The discussion above presents our criteria for evaluating new metrics. The following section outlines our proposal for one such new metric.

Quality Moves

First, we must give credit where credit is due. Our colleague Mike Hillis at AMD Fab 25 suggested the concept and terminology "quality moves" many months ago. In the intervening time, we have argued back and forth over how to define this metric, and how it can be practically applied. This article represents a distillation of those discussions.

The goal for quality moves is as follows:

"Quality moves should measure, on a shift-by-shift basis, the best performance that can be achieved given the fab's WIP profile and resource availability."

Quantifying this a bit further, let's consider each phrase in turn:

"Quality moves should measure": Instead of counting all wafer moves, we are only counting a subset of these moves, according to specific criteria (our definition of "quality"). This should include only the wafer moves that are part of our current shift-level production plan.

"on a shift-by-shift basis": We want a goal that can be published at morning meetings for today's shift, and we want to compare prior shift performance against the appropriate goal for each shift.

"the best performance": Here we are measuring performance at the factory level. Factory-level goals will be specific to each fab, but given our knowledge of these goals for a particular fab, we must develop a shift-level production plan that points us toward these goals.

"that can be achieved": The shift-level production plan we are measuring against must be feasible.

"given the fab's WIP profile and resource availability": The shift-level production plan must take current WIP and resource availability into consideration.

Assessing Quality Moves

Do quality moves meet our criteria for a useful morning meeting metric?

"Applies to local decisions?": Yes -- given the shift-level production plan, we can tailor our operating decisions to increase quality moves.

"Drives improvements in factory-level metrics?": Yes -- if our shift-level production plan is constructed properly, then meeting it on a consistent basis will be good for the factory.

"Provides a useful yardstick for goal-setting and performance evaluation?": Yes -- the quality moves target recognizes short-term constraints and conditions.

Calculating Quality Moves - Goal and Actual

We have defined quality moves as the subset of moves that appear in our shift-level production plan. As yet, we have not defined how this shift-level production plan is to be generated (we will discuss that below). But we know we want quality moves to reflect the wafers we should be moving during the current shift. We don't want to give credit for moves made just for the sake of moving something - we want our operators to be moving the right wafers.

Calculating a quality moves goal is simple -- apply the same logic and rules used to calculate moves in the fab against the shift-level production plan. For example, if rework wafers are not counted as normal moves in the fab, they should not count toward the quality moves goal calculated from the shift-level plan.

For example, suppose that our production plan calls for us to run the following lots, and only the following lots, on Operation XYZ during this shift:

Lot Number	Lot Size (wafers)
100	25
110	10
120	25
130	25
140	10

Then the quality moves goal for Operation XYZ is 95 wafers during the shift.

To calculate actual quality moves, we define a quality move as a move that occurs in the fab within a given time window of its planned occurrence in the shift-level production plan. This time window may be as wide as one shift (typically twelve hours), or it may be shorter than one shift, e.g. 3 or 6 hours. Obviously, the smaller the time window, the harder it will be to generate quality moves in the fab, and the more difficult it will be to attain the quality moves goal. If our time window is the entire shift, and Operation XYZ completes these moves during the shift:

Lot Number	Lot Size (wafers)
100	25
120	25
130	25
150	25

Then the actual quality moves for Operation XYZ is 75 wafers (lots 100, 120, and 130).

Shift-Level Production Plans

The shift-level production plan is nothing more than a plan that specifies which wafers to run, and when to run them. Obviously the generation of such a plan is a non-trivial task. We need to consider:

- Initial conditions (e.g. WIP location, tool states, staffing).
- Planned within-shift events (e.g. scheduled PMs, scheduled starts, breaks).
- Processing data and constraints (e.g.

routes, process times, tool qualification, reticle availability).

- Operating decisions (e.g. dispatching, setups, batching).
- Factory-level goals (should drive operating decisions).

In general, we are seeking a shift-level production plan that is feasible and which drives us toward our factory-level goals. The process of finding such a plan is really a search through a variety of feasible plans.

Practically speaking, we have the following options:

- Use simulation to generate capacity-feasible plans. Tune the operating decision rules within the simulation to improve the plan with regard to our factory-level goals.
- Combine simulation with a search algorithm that seeks to improve the capacity-feasible plan generated by the simulation.
- Formulate as a mathematical programming (optimization) assignment problem.

Our Approach

At FabTime, we are pursuing both the simulation and the mathematical programming approaches. For math programming, we are working with Dr. Ted Ralphs of Lehigh University.

For simulation, we are building a module that reads directly from our FabTime data warehouse and automatically constructs a factory simulation model from this data and from associated factory data (the information necessary to simulate operating decisions, etc.) The outputs of this simulation become the shift-level production plan, and are fed back into FabTime. FabTime stores the simulated results in parallel with the actual fab data, so that users can explore the shift-level production plan using existing analysis charts. At the same time, the shift-level production plan will be used to generate quality moves goals, and to calculate quality moves from actual data.

Because the simulation reads from a common data model (the FabTime data warehouse), we seek to minimize the effort required to build such a simulation for each new fab. To maximize the fab's flexibility in modeling operating decision rules, the simulation module source code will be provided to the fab.

Summary

In this article, we started by examining the metrics commonly used for morning production meetings. We proposed three criteria for evaluating these metrics:

- Applies to local decisions?
- Drives improvements in factory-level metrics?
- Provides a useful yardstick for goal-setting and performance evaluation?

Based on these criteria, we argued that it makes sense to consider a new morning-meeting metric. We presented the concept of "quality moves", having this goal:

"Quality moves should measure, on a shift-by-shift basis, the best performance that can be achieved given the fab's WIP profile and resource availability."

We showed how this metric can be quantified and calculated, and highlighted the most technically challenging step (generating shift-level production plans). We closed with a discussion of our plans for implementing quality moves in our FabTime software.

Closing Questions for FabTime Subscribers

Does your fab have a system for automatically calculating achievable short-term goals, based on current WIP and tool-state information? If so, do you use simulation, or mathematical programming, or some other approach? Do you think that the approach that we've outlined here is feasible? We welcome your feedback on this topic!

Footnotes and References

We would like to mention one footnote. Although we have not seen the primary performance measures from "The Goal" used in wafer fabs, we wanted to point out that the philosophy from the Goal is frequently put into use in fabs. Some examples include focusing on the bottleneck, planning capacity around the bottleneck, and keeping the bottleneck running all the time.

There are many references on production planning and short-term scheduling in wafer fabs. You can find some of these references on Jennifer's personal website, at www.jkrconsult.com/capbib.htm. A selection of references that you might find interesting (by no means comprehensive) is included below. These papers are not available from FabTime. We would love to hear about your work in this area.

- H-N Chen, J. Cochran, and R. Dabbas, "Using Manufacturing Rules to Implement Daily Production Plans," *Proceedings of the 2002 MASM Conference*, Tempe, AZ, April 10-12, 2002, 175-181.

- K. Horiguchi, N. Raghavan, R. Uzsoy, and S. Venkateswaran, "Finite-Capacity Production Planning Algorithms for a Semiconductor Wafer Fabrication Facility," *International Journal of Production Research*, Vol. 39, No. 5, 825-842, 2001.

- R. C. Leachman, R. F. Benson, C. Liu, and D. J. Raar, "IMPRESS: An Automated Production-Planning and Delivery-Quotation System at Harris Corporation - Semiconductor Sector," *Interfaces*, Vol. 26, No. 1, 6-37, 1996.

- A. A. Ravitch and K. Ebbs, "Extracting the Most Out of your Simulation Model: A New System for Planning, Executing, and Problem-Solving," *Proceedings of the 2002 MASM Conference,* Tempe, AZ, April 10-12, 2002, 131-136.

FabTime Recommendations

Qlock World Clock

As I (Jennifer) write this, I'm working in Saku, Japan for the week. A handy little that utility I've been using every day is Qlock. Qlock is a World Clock for Windows. Once installed, it sits in your task tray, and whenever you click to maximize it, you see a series of clocks that you have chosen from more than 500 cities worldwide. I can leave my computer clock set for California time when I travel, but click on Qlock any time to see the local time in Tokyo (or change my computer clock, and use Qlock to see the time at home, of course). Qlock is freeware, available from http://www.qlock.com/ (they do ask for a $5 donation, but this is optional). I've been using the previous version for about two years, and have never had a problem with it, and just recently upgraded to version 1.44.

Subscriber List

Total Subscribers: 1121

1st Silicon (3)
3M Company (4)
ABB (5)
Abbie Gregg Inc. (6)
Adexa Corporation (1)
Advanced Micro Devices (34)
Advanced Sound Products (1)
Affymetrix (1)
Agere Systems (7)
Agilent Technologies (10)
Aisin Indonesia (1)
Alfalight Canada (1)
Allegro Microsystems (1)
Alpha-Sang (1)
ALTIS Semiconductor (1)
AMCC (1)
AMI Semiconductor (2)
Amkor (4)
AMR Research (1)
Anadigics (1)
Analog Devices (7)
Anam Semiconductor (1)
Andes University (1)
Angstrem Ltd. (1)
Applied Materials Corporation (13)
Aralight Corporation (2)
Arch Wireless (1)
Argi Institute of Manufacturing (1)
Arizona State University (9)
Arkansas Tech University (1)
ASE Test (1)
Asia Management Group (1)
ASM International NV (1)
ASML (4)
Asyst Connectivity Tech, Inc. (2)
ATMEL (4)
AU Optronics Corporation (1)
Australian National University (1)
Automatiseringsteknik (1)
Avon (1)
Axcelis Technologies (1)
Axsun Technologies (1)
Babson College (1)
BAE Systems (1)
BHEL (1)
Bond University (1)
Bookham Technology Plc (2)
Boston Scientific (1)
BP Solar (3)
Brooks-PRI (4)
C&D Aerospace (1)
Cabot Microelectronics Ltd. (1)
California Micro Devices (2)
California Polytechnic State University (2)
Cannon Precision (1)
Canon USA (1)
Carsem M Sdn Bhd (6)
Celerity (1)
Celestica (1)
Central Graphics (1)
Centurion Wireless (1)
Chartered Semiconductor Mfg (27)
CIMETECH International Inc. (1)
Clarion Manufacturing Corp Philippines (1)
CMC Electronics (1)
CNRI (1)
Coca-Cola (1)
Cognos (1)
Colliers International (1)
Communicant (2)
Compugraphics International Ltd. (1)
Conexant Systems, Inc. (4)
Continental Device India Ltd. (2)
Cornell University (1)
Corning (2)
C-Port Corporation (1)
Cree, Inc. (1)
Cronos Integrated Microsystems (1)
CSMC-HJ Co., Ltd. (1)
Cummins Inc. (2)
Cyberfab (1)
Cypress Semiconductor (4)
Dallas Semiconductor (3)
DALSA Semiconductor (2)
Dartmouth College (1)
Datacon Semiconductor Equipment (1)
DeHart Consulting, Inc. (1)
Delphi Automotive Systems (2)
Delta Design (1)
Dick Williams and Associates (1)
Digital Optics Corporation (2)
Dow Corning Corporation (1)
Durham ATS Group (4)

Eastman Kodak Company (18)
Electroglas, Inc. - Statware Division (2)
e-METS Co, Ltd (1)
ENSIACET (1)
EPCOS Pte Ltd (1)
EPFL Switzerland (1)
Ernst & Young (1)
eSilicon Corporation (1)
Eskay Corporation (1)
FabOptima GmbH (1)
FabTime (3)
Fairchild Imaging (1)
Fairchild Semiconductor (4)
Fort Wayne Wire Die (1)
Fraunhofer (3)
Front Line Performance (1)
Gebze Institute of Technology (1)
Genmark Automation (1)
Georgia Tech (2)
GestPro Ltda. (1)
Gintic Institute of Mfg. Technology (1)
Global Integrated Ventures (1)
HCL Technologies (1)
Headway Technologies (4)
HealthScribe Inc. (1)
Hewlett-Packard Company (6)
Hitachi, Ltd. (1)
Hitachi Nippon Steel Semiconductor (5)
HL Electronics & Engineering (1)
Honeywell (3)
HPL Japan (1)
Hynix Semiconductor Mfg America Inc. (1)
i2 Technologies (1)
Ibiden Philippines (1)
IBM (13)
ICF Consulting (1)
ICG / Semiconductor FabTech (2)
IDC (7)
I-FAB (1)
IMEC (3)
Indian Institute of Science (1)
Indian Sugar and General Eng. Corp. (1)
Infineon Technologies (38)
Infinite Graphics Inc. (1)
Infosim Networking Solutions (1)
INNOTECH Corporation (2)
INSEAD (2)
Institut National Polytech. de Grenoble (2)
Integrated Device Technologies (2)
Integrated Technologies Company (2)
Intel Corporation (50)
Intelligent Quality Systems (1)
International Rectifier / HEXAM (5)
Interpro Services (1)
Intersil (3)
Istanbul Technical University (1)
i-Stat (2)
ITI Limited (1)
IZET Innovationszentrum Itzehoe (1)
Jacobs Consultancy (1)
James Nagel Associates (1)
JDS Uniphase (3)
K&S Flip Chip Division (1)
Ken Rich Associates (1)
Kepner-Tregoe (1)
Keybowl, Inc. (1)
KLA-Tencor (1)
Kymata - Alcatel (1)
Laboratoire d'Automatique de Grenoble (LAG) (1)
Lexmark International, Inc. (1)
Linear Technology (1)
Litel Instruments (2)
London Business School (1)
LSI Logic (13)
Lynx Photonic Networks (1)
M+W Zander (2)
M2M Group (1)
Macronix International Co. (5)
Managed Outsourcing, Inc. (2)
MASA Group (1)
Maxim Integrated Products, Inc. (3)
Medtronic (16)
MEMS Optical (1)
Merck Sharp & Dohme (1)
Methode Electronics, Inc, (1)
Metrology Group, Inc. (1)
Metrology Perspectives Group (1)
Micrel Semiconductor (6)
Microchip Technology (2)
Micron Technology, Inc. (13)
MicroVision-Engineering GmbH (1)
Mitsubishi Semiconductor Europe (2)
MLI, Inc. (1)
MMC Technology (1)
Motorola Corporation (48)

MTE Associates (1)
Nanometrics (1)
Nanya Technology Corporation (2)
Nanyang Technological University (4)
National Chiao Tung University (1)
National Microelectronics Institute - UK (1)
National Semiconductor (18)
National Taiwan University (1)
National Univ. of Ireland - Galway (1)
National University of Singapore (2)
NEC Electronics (11)
Nortel Networks (6)
Ohio State University (1)
Oklahoma State University (2)
Old Adirondack Furniture (1)
ON Semiconductor (9)
Onix Microsystems (1)
OPTUM-IES (2)
Palmborg Associates, Inc. (2)
Penn State University (3)
Performance Consulting (1)
PerkinElmer (2)
Peter Wolters CMP Systeme (1)
Philips (40)
Piezo Technology Inc. (1)
Planar Systems (2)
PolarFab (3)
Politecnico of Milano (1)
Powerex, Inc. (3)
PRI Automation (2)
Productivity Partners Ltd (1)
Professional Control Corp - PCC (1)
ProMOS Tech. (1)
Propsys Brightriver (1)
PSI Technologies, Inc. (1)
Quanta Display Inc. (1)
Ramsey Associates (1)
Raytheon (5)
Read-Rite Corporation (2)
Redicon Metal (1)
Rexam (1)
Rockwell Automation (1)
RTRON Corporation (2)
SAE Magnetics (2)
Saint-Gobain Company (1)
SAMES (1)
Samsung (13)
Samtel Electron Devices GmbH (1)
Sandia National Labs (2)
San Diego State University (1)
SAP AG (1)
Sarcon Microsystems, Inc. (1)
Sarnoff Corporation (2)
SAS (1)
Seagate Technology (22)
SEMATECH (18)
Semiconductor Research Corp. (1)
SemiTorr NorthWest, Inc. (1)
Senzpak Pte Ltd. (1)
Serus Corporation (1)
Shanghai Grace Semiconductor Mfg. (2)
SiGen Corporation (1)
Silicon Integrated Systems Corp (1)
Silicon Manufacturing Partners (4)
Silicon Sensing Products UK (2)
Silterra Malaysia Sdn. Bhd. (6)
SIM-BCD (1)
Sipex Corporation (2)
Skyworks Solutions, Inc. (3)
SMIC (2)
Solectron (1)
Sony Semiconductor (11)
SoundView Technology (2)
Southern Wire Industries (1)
SSMC (8)
STMicroelectronics (40)
Stonelake Ltd. (1)
Storage Technology de Puerto Rico (1)
Sun Microsystems (2)
SUNY-Binghamton (1)
Superconductor Technologies, Inc. (1)
Süss MicroTec AG (1)
Synquest (2)
Systems Implementation Services (2)
Takvorian Consulting (1)
Tata Technologies (1)
TDK (4)
TECH Semiconductor Singapore (21)
Technical University of Eindhoven (2)
Technische Universitat Ilmenau (1)
Terosil, a.s. (1)
Texas A&M University (2)
Texas Instruments (28)
Tokyo Electron Deutschland (1)
Toppoly Optoelectronics (1)

Tower Semiconductor Ltd. (1)
Toyota CRDL (1)
Triniti Corporation (1)
TriQuint Semiconductor (8)
Tru-Si Technologies (1)
TRW (4)
TSMC (11)
UMC (6)
United Monolithic Semiconductors (2)
Unitopia Taiwan Corporation (1)
University of Aizu - Japan (1)
University of Arkansas (1)
University of California - Berkeley (6)
University of Cincinnati (1)
University of Federal de Santa Catarina (1)
University of Groningen - Netherlands (1)
University of Illinois (2)
University of Karlsruhe (1)
University of Notre Dame (1)
University of Southern California (2)
University of Texas at Austin (1)
University of Ulsan - S. Korea (1)
University of Virginia (2)
University of Wuerzburg - Germany (1)
Univ. Muhammadiyah Surakarta (1)
University Porto (1)
VIR, Incorporated (1)
Virginia Tech (10)
Vishay (1)
Voltas Limited (1)
Wacker Siltronic (2)
WaferTech (14)
Win Semiconductor (1)
Wright Williams & Kelly (4)
Xerox Brazil (1)
X-FAB Texas, Inc. (3)
Yonsei University (1)
Zetek PLC (1)
ZMC International Pte Ltd (2)
Unlisted Companies (13)

Consultants:
Carrie Beam
Ron Billings (FABQ)
Vinay Binjrajka (PWC)
Tom Blount
Javier Bonal
Steven Brown
Stuart Carr
Alison Cohen
Paul Czarnocki
Doreen Erickson
Scott Erjavic
Greg Fernandez
Ted Forsman
Navi Grewal
Cory Hanosh
Jani Jasadiredja
Norbie Lavigne
Bill Parr
Steve Perry (S. Perry Associates)
Peter Polgar (P Squared Enterprises)
Nagaraja Jagannadha Rao
Michael Ray
Lyle Rusanowski
Mark Spearman (Factory Physics, Inc.)
Dan Theodore
Craig Volonoski
Henry Watts (CAMDesigns)

Note: Inclusion in the subscriber profile for this newsletter indicates an interest, on the part of individual subscribers, in cycle time management. It does not imply any endorsement of FabTime or its products by any individual or his or her company. To subscribe to the newsletter, send email to the same address. You can also subscribe online at www.FabTime.com/newsletter.htm. FabTime will not, under any circumstances, give your email address or other contact information to anyone outside of FabTime without your explicit