

FabTime Cycle Time Management Newsletter

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Information

Mission: To discuss issues relating to proactive wafer fab cycle time management

Publisher: FabTime Inc. FabTime sells cycle time management software for wafer fab managers. New features about to be released by FabTime include site-specific metrics dashboards that display a variety of metrics in a compact format as well as enhanced ability to sort stacked charts by totals.

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Table of Contents

- Welcome
- Community News/Announcements
- FabTime User Tip of the Month – View Starts and Shipments Stacked by Product
- Subscriber Discussion Forum
- **Main Topic – Thinking Critically About Data**
- Current Subscribers

Welcome

Welcome to Volume 17, Number 6 of the FabTime Cycle Time Management Newsletter! We hope that you are all having a pleasant holiday season. In this issue we have a community announcement about the 25th anniversary of Wright Williams & Kelly. Our software tip of the month is about using the relatively new stacked starts and shipments charts. We have no subscriber discussion during this busy time of year.

We have a new type of main article this month. We share a detailed recap of a new nonfiction title including our own commentary on how the topic relates to the semiconductor industry. The book highlighted is *A Field Guide to Lies* by Daniel Levitin, about applying critical thinking to information presented in the form of data, words, and pictures. We also include a recent example of a statistic miscalculated by Facebook, as well as discussion, where applicable, of how Levitin's comments apply to FabTime and other reporting products. We would be especially interested to know whether you find this type of article useful.

Wishing you a joyful holiday season, and a productive 2017 – Jennifer and Frank

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Community News/Announcements

Congratulations to WWK on 25 Years

We are delighted to congratulate our friends at Wright Williams and Kelly on their recent milestone: 25 years in business. From their announcement:

“During the last 25 years, WWK has served more than 3,000 clients and users on five different continents from its roots in the semiconductor industry to numerous national labs and universities, industry leaders in photovoltaics, disk drives, defense, aerospace, nanotechnology, micro electro-mechanical systems (MEMS), flat panel displays (FPD), solid state lighting/light emitting diodes (SSL/LED), healthcare/medical devices, telecommunications, and engineering services.”

FabTime’s founders, Frank Chance and Jennifer Robinson, worked as consultants and partners to WWK prior to starting FabTime, and have maintained close ties with WWK ever since. Frank was in fact the original developer of WWK’s Factory Explorer product. We wish them all the best for the future. Learn more about WWK at <http://www.wwk.com>.

FabTime welcomes the opportunity to publish community announcements, including conference notices and calls for papers. Send them to newsletter@FabTime.com.

FabTime User Tip of the Month

View Starts and Shipments Stacked by Product

Two relatively new types of charts in FabTime are the Stacked Starts Trend and Pareto and the Stacked Shipments Trend and Pareto charts. These charts allow you to look at the variability of your starts and shipments by product (or route, or family, or priority class, or any of several other available variables).

To view a Starts Trend Stacked by Product, for example, simply generate the Starts Stacked Trend from the Chart list. On the detailed chart page, select “Product” from the “Cross” drop-down (at the bottom of the largest set of filters on the left-hand side of the screen). Press the “Go” button immediately below the

drop-down. You’ll be able to quickly see patterns in daily starts by product. An example showing daily starts over a two-week period, stacked by product, is shown at the top of the next page.

Set the period length (“Len”) to a longer time and set the “From” to further back in time to view longer-term starts data.

You can easily switch over to the Shipments Trend Stacked by Product by selecting “Shipments Stacked Trend” from the QuickJump drop-down. Putting these charts side by side on a home page tab will give you a quick visual idea of shifts in product mix over time for your fab.

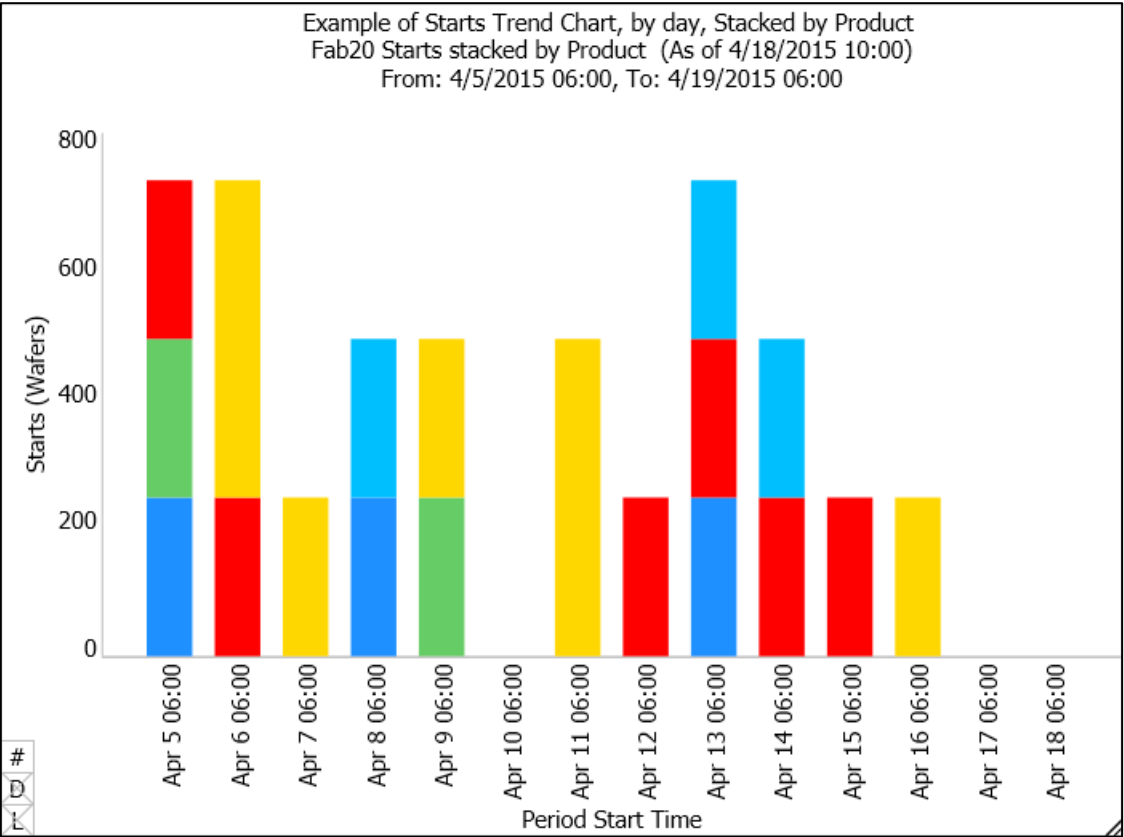
Pareto versions of the Stacked Starts and Shipments charts are also available. Note

that the “Slice” setting is used to specify the variable on the x-axis, while the “Cross” setting is for specifying the variable used to stack the chart. For example, you might look at starts sliced by product and then stacked (crossed) by priority.

Soon to be released enhancements to stacked charts in FabTime include the ability to sort by the total height of the stacked bar and the ability to set specific stacked object colors (at the site level).

These capabilities will be available in Patch 108, and should make all stacked charts (including the Stacked WIP and Moves charts) more useful.

If you have questions about this item, or any other FabTime software questions, just use the Feedback form inside FabTime’s software. Subscribe to the separate [Tip of the Month email list](#) (with additional discussion for customers only). Thanks!



Subscriber Discussion Forum

FabTime welcomes the opportunity to publish subscriber discussion questions and responses. Simply send your

contributions to Jennifer.Robinson@FabTime.com. We have no subscriber discussion at this time.

Thinking Critically About Data

Introduction

Jennifer recently read Daniel J. Levitin's new book *[A Field Guide to Lies: Critical Thinking in the Information Age](#)*, about the need for people to think when they evaluate data, rather than accepting shared information at face value. We felt that a recap of this title would be of value to our subscribers. We have added an example that we observed in recent media as well as some thoughts about how the conclusions apply to semiconductors and to FabTime's software. We would be interested to hear from our subscribers as to whether you find this type of article useful.

Evaluating Numbers

Daniel Levitin says in the book's introduction:

"We--each of us--need to think critically and carefully about the numbers and words we encounter if we want to be successful at work, at play, and in making the most of our lives. This means checking the numbers, the reasoning, and the sources for plausibility and rigor. It means examining them as best we can before we repeat them or use them to form an opinion."

The first section of the book, and the one most relevant to FabTime, is about evaluating numbers, beginning with the observation that one should always take the responsibility of checking reported numbers for plausibility. The author gives several examples of claims that sound good until one takes a look at the numbers and realizes that they cannot possibly be true. Levitin then notes that even when numbers pass basic plausibility checks:

"Three kinds of errors can lead you to believe things that aren't so: how the numbers were collected, how they were interpreted, and how they were presented graphically." (Page 3)

Touching on the topic of last month's newsletter issue (computational issues in reporting average WIP), Levitin devotes an entire chapter to the calculation of averages (including mean, mode, and median), and the ways that calling something "average" can misrepresent a situation. He gives examples of cases where the mean, because it is sensitive to outliers, gives unexpected results, and ways that "averages can be used to manipulate what you want others to see in your data." (Page 10)

Real-World Example: Facebook

A recent real-world example of this (not shared in the book, but noticed by Frank in the Wall Street Journal) concerns Facebook overestimating a key video metric. Our understanding of the situation was this. Facebook was telling advertisers:

"On average, users are watching video ads for X seconds"

But behind the scenes, they were computing X by throwing out all the data points where a user watched a video ad for 3 or fewer seconds.

So if you had this data:

- User 1: 1 second
- User 2: 1 second
- User 3: 1 second
- User 4: 2 seconds
- User 5: 3 seconds
- User 6: 30 seconds
- User 7: 2 seconds
- User 8: 40 seconds
- User 9: 1 second
- User 10: 2 seconds

They would report "on average, users watched video ads for 35 seconds" (using only the data from user #6 and user #8). Thirty-five seconds sounds a lot better than the average of all 10 users: 8.3 seconds.

We think that this is a nice example of why we should know what goes into a summary statistic, before we rely on it.

You can read more details here: [Facebook Overestimated Key Video Metric for Two Years](#) and also in this follow-up article: [Facebook Says It Found More Miscalculated Metrics](#).

Drawing Conclusions

Back to the book, Daniel Levitin also introduces two common pitfalls in drawing conclusions about individuals and groups based on averages.

“The ecological fallacy occurs when we make inferences about an individual based on aggregate data (such as a group mean), and the exception fallacy occurs when we make inferences about a group based on knowledge of a few exceptional individuals” (Page 18).

[This reminds us of another book that Jennifer read recently: [The End of Average: How We Succeed in a World That Values Sameness](#), by Todd Rose, also well worth a read.]

An example of the ecological fallacy in a wafer fab would be assuming that the cycle time of an individual lot is going to meet the average cycle time for that product type, and making a shipment commitment accordingly. An example of the exception fallacy would be looking at the cycle time of a rocket lot and assuming that this cycle time could be achieved by a larger population of lots. Other examples along these lines are limitless.

Shenanigans and Hijinks

The next chapter, Axis Shenanigans, is even more relevant to FabTime (since most of the data in FabTime is presented in the form of graphs). Levitin notes:

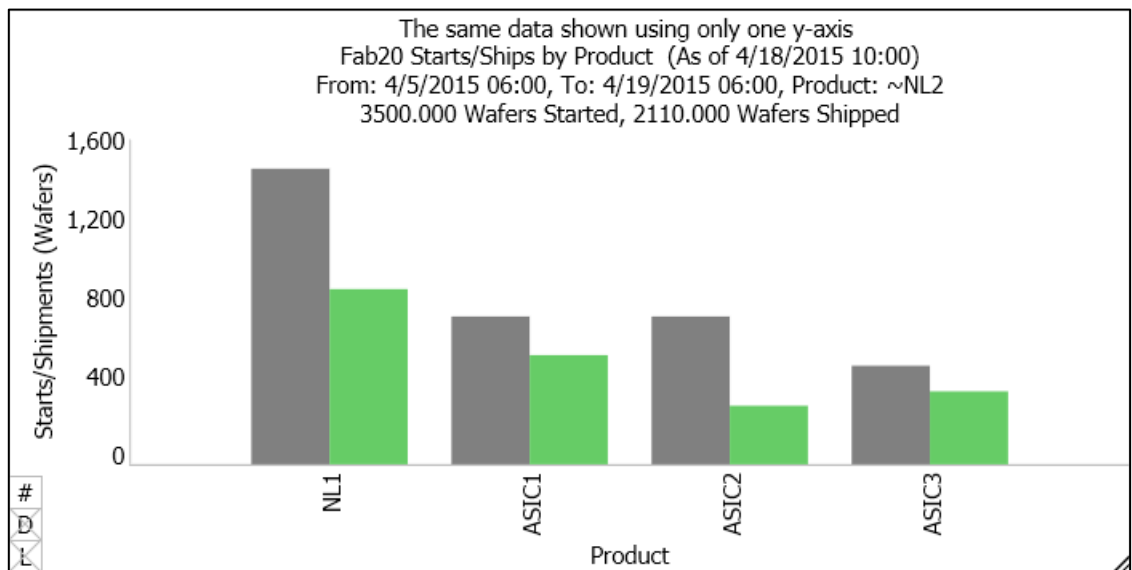
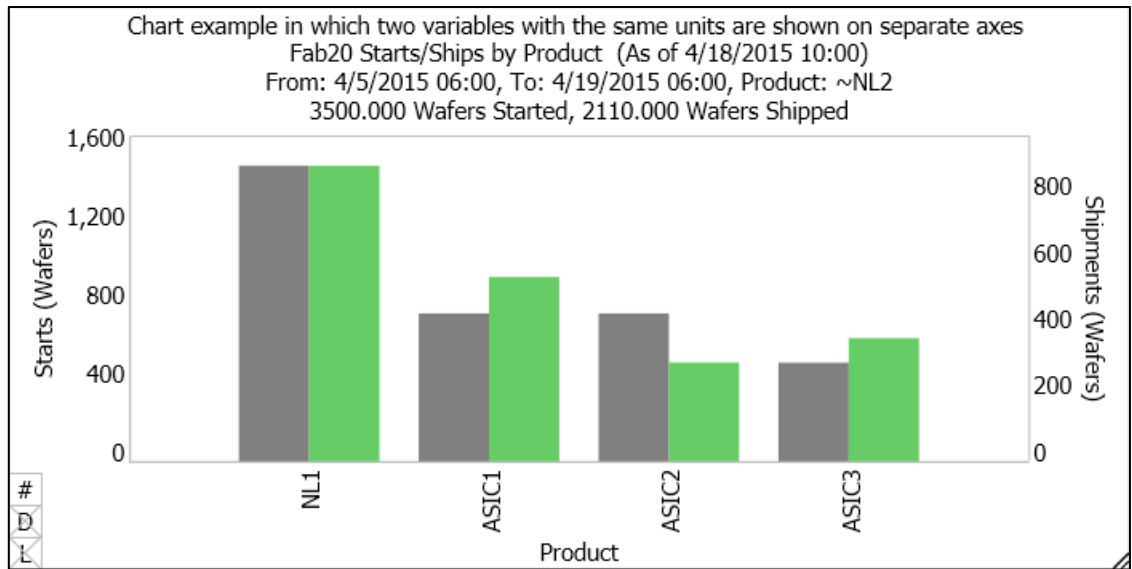
“The human brain did not evolve to process large amounts of numerical data presented as text; instead, our eyes look for patterns in data that are visually displayed. The most accurate but least interpretable

form of data presentation is to make a table showing every single value. But it is difficult or impossible for most people to detect patterns and trends in such data, and so we rely on graphs and charts.” (Page 26)

Levitin discusses several ways in which graphs can be used to misrepresent data, from unlabeled axes (in which we don't even know what we are looking at) to truncated vertical axes (which can magnify apparent effects) to the use of inappropriate double y axes (to make it appear that two things are related when they are not). Throughout this discussion he uses actual examples from popular publications, thus reinforcing the message that people need to view information skeptically.

In FabTime's software, as we're sure is the case in many reporting products, you can edit the scale of the y-axis on any chart. You can also, through FabTime's Edit Chart capability, put data onto two different Y axes. You can even edit the axis titles, if you want to. Fortunately, most people who are viewing charts in a reporting system have the ability to go in and directly look at the charts themselves (unlike when you view a suspect chart in the newspaper).

For example, at the top of the next page is a pair of charts that show total starts and shipments by product over a two-week period. On the first (top) chart, the starts and shipments are shown on different axes, with different scales (even though both use wafers as the unit of measure). The second chart is how the data is meant to be shown, using a common left-hand y axis. On a quick glance, the first version suggests that shipments are roughly equivalent to starts over the time period. This is not, however, the case. One could manipulate this impression further by stretching the scale of the left-hand axis to make the starts appear lower. Of course a close look at either chart does show the true data.



The next chapter, Hijinks with How Numbers Are Reported, covers such topics as

- Reporting irrelevant metrics.
- Plotting things that are unrelated (correlation vs. causation).
- Using deceptive illustrations.
- Making errors in interpreting and framing statistics.
- Reporting on differences that might be statistically significant but don't make any practical difference (for example, because the dataset studied was so large that even a tiny impact comes through as "significant").

■ Confusing precision (how close two measurements are to one another) and accuracy (how close a measured value is to a standard or known value). Your scale could be off by five pounds, but give you the same precise measurement of weight in two samples.

■ Comparing things that are not valid to compare (sampling from different populations, for example, and amalgamating the results).

■ Interpolating and (especially) extrapolating inappropriately.

The opportunities to mislead using data are endless!

We have seen cases where the underlying algorithms used to calculate metrics in some reporting systems are less than transparent. The onus falls on end users to be skeptical, and to seek an understanding of exactly how things are calculated. In FabTime, we outline the calculations used for each chart on that chart's help page, to try to be as clear as possible.

Regarding interpolation and extrapolation, Levitin says:

“Interpolation isn't a perfect technique, but if the two observations you're considering are very close together, interpolation usually provides a good estimate. Extrapolation, however, is riskier because you're making estimates outside the range of your observations.” (Page 58)

Here Levitin gives practical examples that show how ludicrous excessive extrapolation can be. He warns that when one does extrapolate it's important to have a large number of observations and to have some knowledge of the underlying process. The latter can help prevent obvious errors.

We are technically extrapolating in FabTime when we give an estimate of the predicted number of moves in the last bar of a Moves Trend chart (the current period). We are making an assumption that the rate of moves for the rest of the time period covered by the bar will be equal to the rate observed so far during the time period. This is accurate enough for most people's purposes for relatively short time periods. However, most FabTime users would expect that an estimate based on the first hour of moves with a period length of a week might not be useful.

In general, extrapolation in the highly variable environment of a wafer fab can be risky.

Lying with Statistics

The remaining chapters in the first section are about how numbers are collected and estimating probabilities. He reminds us

that “people gather statistics” and choose what to count. He warns:

“Biases, inaccuracies, and honest mistakes can enter at any stage. Part of evaluating claims includes asking the questions “Can we really know that?” and “How do they know that?”

He discusses the need for samples to be representative of the underlying population, avoid sampling and participation bias, and capture meaningful data. While not so relevant to the data in FabTime, where all of the data comes from the MES, this section has considerable relevance to polling numbers. These have been shown in several recent high-profile examples to sometimes be inaccurate. He introduces standard deviation, margins of error, and confidence intervals. He says:

“If you want to lie with statistics and cover your tracks, take the average height of people near the basketball court; ask about income by sampling near the unemployment office; estimate statewide incidence of lung cancer by sampling only near a smelting plant. If you don't disclose how you selected your sample, no one will ever know.” (Page 86)

On probabilities, Levitin warns that “a mistake that many non-critical thinkers make is in assuming that if there are two possibilities, they must be equally likely.” (Page 100). He devotes considerable time to explaining conditional probability and Bayesian statistics. He warns that “We also have a tendency to apply critical thinking only to things we disagree with” and that “bad statistics are produced by people--often sincere, well-meaning people--who aren't thinking critically about what they're saying.” (Page 119)

He concludes the section on numbers by noting that:

“People who are taken in by such (spurious) associations or coincidences usually have a poor understanding of probability, cause and effect, and the role

of randomness in the unfolding of events.”
(Page 120)

Extensions and Conclusions

Levitin moves on to discuss, in Part Two, “Evaluating Words” (verbal or written claims) and in Part Three to discuss “Evaluating the World” in general. He warns about how the human need to hear things in the form of stories can expose us to situations in which people share things that are untrue or irrelevant. He suggests that we choose the experts to whom we listen carefully, and discusses the different roles that reporters take on when presenting scientific vs. breaking news. He cautions that when evaluating a claim or argument, we should ask ourselves if there might be another reason, besides the one offered, that could account for the situation. He debunks certain coincidences using scientific reasoning, and warns about conclusions presented from studies that lack a control group. He warns against cherry-picking as well as selective winnowing, saying:

“But if you’re looking only for supporting evidence, you’re not doing proper research, because you’re ignoring the contradictory evidence--there might be a little of this or a lot, but you don’t know because you haven’t looked.” (Page 161)

In short, after reading *A Field Guide To Lies*, you will never be able to look at the graphs in USA Today or the latest political polls without a skeptical eye. You’ll find yourself wondering: “Yes, but where did they get that data? Did they ask this other question? Were there any outliers?” and many other useful critical questions.

Levitin’s conclusion:

“Critical thinking is not something you do once with an issue and then drop it. It’s an active and ongoing process. It requires that we all think like Bayesians, updating our knowledge as new information comes in.”
(Page 253)

FabTime’s conclusions:

Opportunities to manipulate data, particularly data in the form of charts, are limitless. In FabTime, for example, one can use exclusion filters to remove outliers, select start and end dates to highlight issues of interest, edit y-axis scales, and add or remove data series. And, of course, you can export any set of data you like to Excel, where you can do anything you like with it.

This is one of the reasons that any chart filters specified are displayed in the detailed chart titles in FabTime (though these can be hidden for home page charts). If you have a set of unusual exclusion filters, and you present a chart in the morning meeting, chances are someone will ask you about that. And because FabTime is generally used by a large number of people at a given site, it’s hard to get away with odd manipulations of chart axes and the like, because people will know how the chart usually looks. This latter point is true for any reporting system.

We all live in an increasingly data-filled world. Fabs are particularly data-rich environments, and people who work in fabs use data every day to make decisions and identify opportunities for improvement. Reading [*A Field Guide To Lies*](#) can help any of us to be more critical in how we view the data presented to us, at work and from the world at large. We highly recommend that you give this book a look.

Subscriber List

Total number of subscribers: 2754

Top 20 subscribing companies:

- Intel Corporation (148)

Top 4 subscribing universities:

- Ecole des Mines de Saint-Etienne (EMSE) (17)
- Arizona State University (8)
- Nanyang Technological University (7)
- Virginia Tech (7)

New companies and universities this month:

- KFS Group GmbH (consultants)
- Lockheed Martin
- Netgear
- Porex Technologies GmbH
- Saint-Gobain Abrasives
- Technical University of Dresden

Sampler Set of Other Subscribing Companies and Universities:

- 3M Company (2)
- ASML (16)
- DeHart Consulting, Inc. (1)
- Dongbu HiTek Co. (2)
- DotChain Consultant, Inc. (1)
- Era7 Information Technologies S.L. (1)
- Global Communication ■ Semiconductors (12)
- MIT (1)
- Molnlycke Health Care (1)
- Novati Technologies (8)
- Photonic Power Systems (1)
- San Diego State (1)
- Semitool (1)
- Semtech (1)
- Shanghai Jiatong University (1)
- SMIC (14)
- Soraa Inc. (1)
- Sygentics (1)
- Transform Inc. (1)
- Uppsala University (1)

Note: Inclusion in the subscriber profile for this newsletter indicates an interest, on the part of individual subscribers, in cycle time management. It does not imply any endorsement of FabTime or its products by any individual or his or her company.

There is no charge to subscribe and receive the current issue of the newsletter each month. Past issues of the newsletter are currently only available to customers of FabTime's web-based digital dashboard software or cycle time management course.

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FabTime® Cycle Time Management Training



"It was helpful to see best-in-class methods for wafer fab cycle time management. Discussing these matters in-depth with you was quite valuable, as we could ask questions specific to our fab and processes."

Shinya Morishita
Manager, Wafer Engineering
TDK Corporation

Course Code: FT105

This course provides production personnel with the tools needed to manage cycle times. It covers:

- Cycle time relationships
- Metrics and goals
- Cycle time intuition

Price

\$7500 plus travel expenses for delivery at your U.S. site for up to 20 participants, each additional participant \$300. Discounts are available for multiple sessions.

Interested?

Contact FabTime for a quote.

FabTime Inc.
Phone: +1 (408) 549-9932
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Email: Sales@FabTime.com
Web: www.FabTime.com

Do you make the best possible decisions?

- Do your supervisors possess good cycle time intuition?
- Are you using metrics that identify cycle time problems early?
- Can you make operational changes to improve cycle time?

FabTime's Cycle Time Management Training is a one-day course designed to provide production personnel with an in-depth understanding of the issues that cause cycle time problems in a fab, and to suggest approaches for improving cycle times. A two-day version and a half-day executive management version are also available upon request. The course is only available for delivery at sites within the United States, unless it is delivered in conjunction with software training for FabTime customers.

Prerequisites

Basic Excel skills for samples and exercises.

Who Can Benefit

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

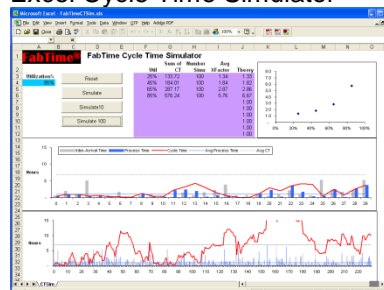
Skills Gained

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

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

Sample Course Tools

Excel Cycle Time Simulator



Staffing Delay Simulator

