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Metrics for the Order Fulfillment Process (Part 2)

Arthur M. Schneiderman

EXECUTIVE SUMMARY

- A complete set of results metrics for the order fulfillment process measures the following:
  1. How well commitments are met (lateness);
  2. How closely commitments match customer needs (excess lead time);
  3. The degree to which lateness hurts customers (severity); and
  4. Timeliness of order quoting (responsiveness).
- A set of results metrics must illuminate all significant undesirable tradeoffs (i.e., where one metric may improve but overall customer satisfaction declines).
- Process metrics assign responsibility for corrective action to individuals. The metrics must link up with internal data systems to facilitate root-cause analysis.
- How metrics are displayed and distributed has a significant influence on how useful they will be.
- Seamless integration into management planning and review systems assures the vitality of nonfinancial metrics.
- Focusing on rates of *improvement* (the half-life concept) rather than on performance levels contributes directly to organizational learning.

> *"DATA! DATA! DATA!" he cried impatiently, "I can't make bricks without clay."* Sherlock Holmes [Sir Arthur Conan Doyle, "The Adventure of the Copper Beaches," *The Complete Sherlock Holmes* (New York: Doubleday, 1953).]

Part 1 of this series of two articles described criteria for effective metrics in the context of the order fulfillment process at Analog Devices, Inc. (ADI).[1] These criteria fall into the broad categories of:

- Linkage to stakeholder satisfaction;
- Documentation; and
- Usefulness as part of an improvement process.

The creation of metrics should be viewed as a process itself—a process that must include refinement cycles. ADI's approach to metric creation attempted to balance top-down alignment with bottom-up ownership of the process.

This article describes the metrics ADI developed and the role they play in the day-to-day management of the company. The article tells how the metrics evolved, shows how they were integrated into ADI's management system, and explains their role in the company's quality improvement process. Finally, the article illustrates the use of customer-supplied performance data to validate internal metrics.

Results metrics

At ADI, results metrics for the order fulfillment process fell into the following categories:

- Lateness;
- Lead time;
- Severity; and
- Responsiveness.

As a set, these metrics called attention to potential tradeoffs that might lead to reduced customer satisfaction.

Lateness. The highest-level measure associated with the order fulfillment process is the degree to which order commitments are met. In other words, what percentage of the time is the shipment made in an acceptable window around the factory commit date (FCD)?

At ADI, that window was defined as one of the following, whichever was narrower:

- Two weeks early to zero days late; or
- The customer's window.

For example, Hewlett-Packard's window of three days early, zero days late was used for measuring delivery performance for Hewlett-Packard's orders.

There has been much debate over the relative significance of early versus late shipments. Traditionally, customers were willing to receive shipments early (i.e., "better early than late"). However, as customers have shifted toward just-in-time (JIT) manufacturing and have demanded broader process control from their suppliers, early shipments have become less acceptable. In fact, some ADI customers refused delivery of early shipments. For this reason, three categories of shipments were distinguished: early, on time, and late.

The primary metric at ADI was percentage of orders shipped late, because early shipments can be eliminated by a simple management policy—decision, namely, never ship early! The elimination of early shipments has a one-time revenue impact, and in some circumstances elimination of early shipments might reduce customer satisfaction. One approach is to phase out early shipments unless a customer has specifically authorized them.

To qualify as not late, 100 percent of the quantity ordered had to be shipped to the customer on or before the FCD. Each line on a purchase order (generally, a separate line is used for a different part or a different customer request date, or CRD) was treated as a separate "event." If a customer specified that an order with multiple lines (e.g., different parts) was to be shipped only when complete, then all the lines were counted as late if only one line was missing. In such cases, responsibility for all the late lines on the order was assigned to the offending factory (as discussed later).

The original FCD on a purchase order was maintained through all subsequent order changes and was used as the basis for metrics. If the customer pushed out the order (i.e., changed the CRD to a date after the original FCD), the order was still considered late, but responsibility was assigned to the customer. Should customer-controllable lateness become a major category of late shipments, this approach would highlight that situation and trigger joint improvement activities directed at helping customers improve the accuracy of their initial CRDs.

Lead times and "yes" commitments. A customer's lead time was originally defined as CRD minus order entry date (OED), and factory lead time was defined as FCD minus OED. However, it soon became apparent that these measures were weak proxies for customer satisfaction. The important thing to customers was getting the answer "yes." For example, a military customer needs a commitment to a series of shipments that may not start for a year and may spread over several years. At the other extreme, a consumer customer with a sudden upside opportunity might want a relatively small quantity of parts today. In each case a "yes" response was more desirable than a quote of a ten-week lead time, even if that was the best in the industry.

The creation of metrics should be viewed as a process itself— a process that must include refinement cycles.

Therefore, lead time metrics at ADI were redefined as percentage of CRDs not met and excess lead time, or FCD minus CRD for unmet requests (i.e., FCD ≠ CRD). "Percent CRDs not met" provided a measure of how often customers are disappointed, while "excess lead time" reflected the pain associated with that disappointment.

Severity. The results metrics defined above are determined on or before the FCD. If a late line on the purchase order were to be ignored by the metrics from this point forward, there would be an inadvertent incentive to give available product to a line due today rather than to go late on that line and send the product to an already past-due customer. Metrics must also address the degree of severity of the lateness.

The first severity metric at ADI was determined at the actual ship date and called

Exhibit 1. ***The Statistics of Lead limes***

Weeks to quoted availability	Percentage probability that product will be ready by the quoted date:
4	2
5	16
6	50
7	84
8	98
9	99.9

"shipped-late-how-late?" This was defined as the average days late of late shipments to customers. For early shipments, "shipped-early-how-early?" was tracked. However, this still leaves invisible the product in late backlog. For this, a severity metric called "still-late-how-late?" was defined as the average days late of lines currently in the late backlog.

Finally, a metric that represented the relative size of the late backlog was needed. For this purpose the late backlog "coverage" (which is analogous to inventory coverage) was defined as the late backlog divided by the average ship rate, both expressed in number of lines. This metric represents the number of months that it would take to ship the late backlog if all production were redirected toward reducing the backlog of late orders. These metrics are included as results metrics because they can be calculated by individual customers as well as for all customers as a group.

Responsiveness. The final set of results metrics associated with order fulfillment deals with responsiveness. One important responsiveness metric is the time required to schedule an order—i.e., the time between order entry and the communication of an FCD commitment to the customer. Like the lateness metrics, this one also has a secondary effect of discouraging "gaming of the metrics (i.e., when someone focuses on improvement of the metric rather than on customer satisfaction).

For example, if a product contains substantial purchased material, a decision-maker might be tempted to delay making a commitment until all the materials are in. This sort of gaming by waiting can reduce actual lead times and thus improve the chances of on-time shipment in line with the FCD. Meanwhile, however, the customer receives no response to his original request. This responsiveness metric makes the behavior visible and subject to constructive challenge about whether it advances customer satisfaction.

Tradeoffs

The above set of results metrics are *all* required if improved customer satisfaction in the order fulfillment process is to be assured. Consider the following scenario.

Division planners have the responsibility for establishing the inventory transfer plan on which product availability is initially determined. They also quote FCDs when the existing plan shows that no uncommitted product will be available on the CRD. In either case, they know from experience that their forecast of availability will be subject to variation.

Suppose that in a particular situation they expect that the product will be available in six weeks. Based on experience, however (or—better yet—historic data), they know that the standard deviation of errors in their previous estimates is one week. Exhibit 1 summarizes the probability (assuming a normal distribution) that the product will be available by the quoted date. On average, the above probabilities are identical to the expected delivery performance.

The planner's dilemma is clear. If the quote is based on the expected six-week availability, then (according to Exhibit 1) the probability is 50 percent that the product will not be ready on time. To go from 50 percent to a 98 percent probability of on-time delivery, a two-week "padding" is required. However, adding two weeks to promised delivery dates is likely to have the adverse effect of reducing the percentage of CRDs matched and increasing excess lead time by two weeks. Furthermore, most orders will be ready well before the FCD, thus putting pressure on the warehouse to ship early.

A complete system of metrics is necessary to make any undesirable tradeoffs visible. What has just been described actually occurred at one of ADl's major divisions. A first-line manager who was pressured to improve on-time delivery performance simply told his planners to add two weeks to all FCDs. although delivery performance improved, customer satisfaction in this division's order fulfillment process declined, and an unknown amount of business was lost. To make matters worse, when a customer requested delivery in six weeks, the division would respond that the best they could do was eight weeks—even though (about half the time) the division was able to ship the merchandise to the customer before the customer's original request date of six weeks. When this happened, it suggested to customers that the order fulfillment process at ADI was out of control.

Several months elapsed before the significant increase in excess lead times was detected. When it was brought to the attention of the division's general manager, the change in the quoting process was identified. Through work with manufacturing, sales, and marketing, an appropriate short-term balance was achieved between quoted lead times and expected delivery performance.

Lessons. Several important lessons were learned as a result of this episode:

- Well-meaning, conscientious managers can make poor business decisions when the measurement system encourages them to focus on the metric at the expense of customer satisfaction.
- In this case, the division's materials resource planning (MRP) system was updated to reflect the longer lead times. After a few manufacturing cycles, the system accommodated the longer lead times, work in progress (WIP) increased, and pressure grew to further extend lead times. In other words, a vicious cycle began that, if left unchecked, would have caused lead times to increase continually.
- The metrics directed attention to the true culprit—high process variability. The division refocused improvement activities on two root causes: low average yields and highly variable yields.

Technological limitations in every process

The existence of tradeoffs in complex processes must be reflected by an effective system of metrics. Every process has technological limitations that dictate the minimum possible variation for that process. For the order fulfillment process, there will always be tradeoffs between delivery performance and lead times as long as customers value shorter lead times and are unwilling to accept carrying large buffer stocks. JIT and "lot-size-of-one" trends test this tradeoff and require careful consideration and analysis on the part of both suppliers and customers.

Metrics directed attention to the true culprit—excessive process variability above and beyond the fluctuations inherent in the process.

This problem of tradeoffs has implications with respect to Motorola's concept of 6σ, as applied to the order fulfillment process. In addition to doubling quoted lead time in the above example, for many businesses, the 6σ standard of 3.4 late lines per million lines scheduled can literally require years of shipments without a single error. Thus, as long as this above tradeoff exists, it is unlikely that 6σ will ever be an appropriate objective for the order fulfillment process.

Process metrics

Useful metrics not only tell how well a process is doing, they also point out possible paths for improvement. To this end, responsibility for each late line should be assigned to the function that is closest to the root cause and its corrective action.

Assigning responsibility by subprocess. At ADI, four groups could contribute to shipping a line late:

1. *The divisions:* The divisions had responsibility for manufacturing the product and transferring production lots to a central warehouse by the to-be-assigned (TBA) date for subsequent shipment to customers. On occasion, they shipped directly to a customer from a limited inventory that they maintained on site. On average, each

transferred lot was divided between seven separate orders.
2. *The credit department:* Each order was reviewed by the credit department, which set a flag in the computer that allowed shipping documents to be printed. No order could be shipped without the credit department's having set this flag.
3. *The warehouse:* Once the credit approval flag was set, the ***warehouse*** picked the order and shipped it to the customer. On international orders, additional documentation was required before shipment.
4. *The customer:* Occasionally, a customer called and asked that a shipment be delayed past the FCD.

A complete system of metrics is necessary to make any undesirable tradeoffs visible.

Each day, the computer looked at all lines that had been shipped late the previous day and automatically assigned responsibility to one or more of the above groups. For example, if the transfer from the division was late *and* the order was on credit hold, both the division and credit were "dinged" (i.e., given responsibility) for the late shipment. Thus, the total number of "dings" could—and usually did—exceed the total number of late lines. Divisions were "dinged" for a late transfer even if the warehouse could accelerate its processing and ship the order on time.

Subprocess metrics

To aid analysis by the responsible groups, late shipments were further broken down into subprocess metrics. In every case, both the number and percentage of late lines were reported. Here is a listing of the four groups previously listed and the related subprocess metrics:

1. **Division-controllable delays:**
– *Missed transfer:* Adequate quantity was not on hand at the warehouse by the TBA date.
– *Shipped on time:* A missed transfer occurred, but the warehouse was able to ship on time.
– *Division warehouse error:* A direct-ship line from the division was not shipped by the FCD (this is an example of data not tracked by the central computer; the data were reported by each division for inclusion in the metrics).
– *Ship complete:* The customer has requested that an order with multiple items be shipped as one complete package. All lines on the late order are assigned to the offending division or divisions.
– *Zero price:* Although the order has been booked and is ready for shipment, a final price has not been set, so a shipping invoice cannot be printed. Division marketing is responsible for this subprocess.

2. **Credit-controllable delays:**
– *Credit referral:* The credit department has not completed its credit determination by the FCD.
– *Credit hold:* The customer has been put on credit hold; the customer must take action to increase his credit limit.

3. **Shipping-controllable delays:**
– *Warehouse error:* An error was made in the warehouse; the order was not shipped even though product was available and credit was approved.
– *Export papers:* Export papers were not complete by the FCD.
– *Letter of credit:* A letter of credit was not submitted by the customer by the FCD.

4. **Customer-controllable delays:**
– *Customer stop:* The customer has requested that the order not be shipped until after the original FCD.
– *Return to customer:* The order was a repair order and was returned to the customer without repair because no defect was found.
– *Vacation hold:* The customer will be shut down for vacation at the expected dock date and has requested a specific shipping delay.

Divisions retain overall responsibility

In some cases, responsibility was assigned to someone other than the subprocess owner. For example, the hierarchical process "owner" for the entire order fulfillment process was the CEO of the company. That is, the above three internal groups first came together on an organization chart at the CEO.

But, since it was unfeasible for the CEO to drive this process on a day-by-day basis, process ownership was assigned to the COO (and, subsequently, to the divisional general managers). Not only were they responsible for division-controllable lateness, but also for overall lateness as seen by the customer. In other words, the divisions represented the customers' interest in ADI. The logic for assigning overall responsibility to the divisions was twofold:

1. The divisions were responsible for the largest part of the problem; and
2. They had the biggest stake in improved customer satisfaction because they are managed as profit and loss (P/L) centers.

In addition, letters of credit and export papers, as subprocesses, are the responsibility of the customer. However, the warehouse department—as the ADI-customer interface for these documents— agreed to take on the responsibility of working with customers to help them create or improve their own subprocesses for timely production of these documents.

Analyzing and understanding responsibilities

Each of the responsible groups further broke down these metrics by the use of Pareto analysis. For example, improvement teams in the warehouse assigned causes for each warehouse error in categories such as the following:

- Equipment down;
- Absenteeism;
- Excessive workload (volume above capacity); and
- Human error.

Before the establishment of these metrics, if you asked representatives from any of the factory, credit, and warehouse departments who was responsible for most of the late shipments, they would assign most of the responsibility to the *other* two groups and accept little responsibility themselves.

Anecdotes abounded about someone else's role in causing a late shipment. Because no one felt that he owned late shipments, no one was willing to take responsibility for improvement efforts.[2] (The general thinking went like this: "*They're* the major problem; let *them* fix their part first, then I'll deal with my small part.")

When first introduced, the responsibility metrics were nicknamed the "finger pointing" metrics. Not surprisingly, early evaluations showed that responsibility for late shipments was split nearly evenly between manufacturing, credit, and shipping. The data were truly enlightening to all who were involved.

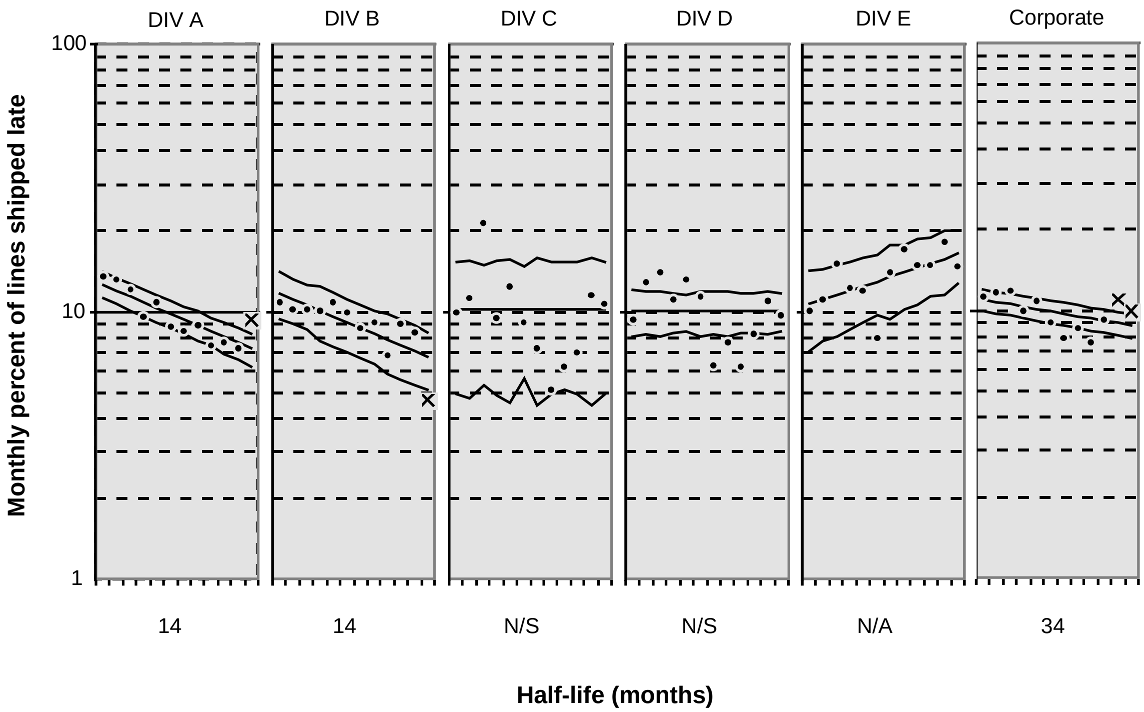
Well-meaning, conscientious managers can make poor business decisions when the measurement system encourages them to focus on the metric at the expense of customer satisfaction.

Other process metrics

In general, only results metrics were incorporated in the corporate or divisional scorecards (see Part 1 in this two-part series). The general approach to metrics at ADI was to focus corporate attention on results metrics and to assign ownership of process metrics to those identified as responsible for subprocess improvement. At the entity level, subprocess owners were identified and requested to develop their own scorecards and process metrics. The only requirement was that achievement of their scorecard goals would assure achievement of the relevant results metric, thus leading to accomplishment of the overall goal.

As part of ADI's divisional and functional annual plan reviews, subprocess owners presented their process metrics to ADI's senior management team. The spirit of this review was more a demonstration of the existence of underlying process metrics than a critique of the actual metrics used. In the spirit of *hoshin kanri*,[3] results metrics represent goals, and process metrics represent means for achieving these goals.

Exhibit 2. Late Shipments by Division



Using the metrics

Once metrics are defined, two things contribute significantly to their effectiveness as drivers for change:

1. *Format:* Although it may (on the surface) appear inconsequential, the format used in presenting results is important.[4]
2. *Incorporation into management review process:* The incorporation of metrics in the formal management review processes is also crucial.

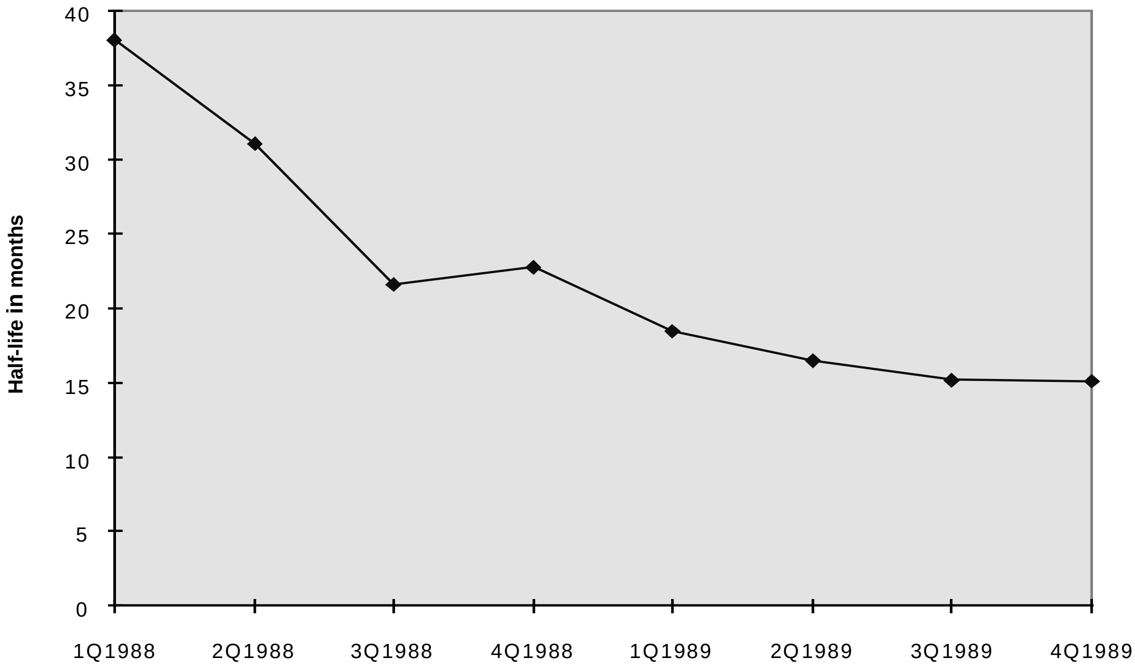
The paragraphs below discuss these issues in more depth.

Format. Exhibit 2 shows an actual representation of the metric “percent lines shipped late,” a typical order fulfillment process metric. Each column of data represents a different division's results or the corporate total. The vertical axis is the logarithm of the percentage of lines late, and the horizontal axis is time. (The logarithmic scale is used because a constant half-life produces a straight line in this format.) For each division, the most recent twelve months of monthly results are shown. Each month, a new point is added and the oldest data point is dropped.

The straight black line through the data is a statistical fit of an improvement model developed by the author called the *half-life model.*[5] It is based on the empirical observation that incremental process improvement appears to progress at a constant rate. In other words, each subsequent halving of the defect level takes the same amount of time. This constant time, or defect half-life, depends on the complexity of the process. For the order fulfillment process, an improvement half-life of nine months is normal.

The actual half-life for each division is shown at the bottom of each column of data. For rates of improvement slower than five years or negative half-lives (“unimprovement”), the model does not apply, so the symbol N/A is used. If the calculated half-life is not statistically significant

Exhibit 3. On-Time Delivery Half-Life



(r^2<.2), then no trend is assumed, and the symbol N/S is used.

The lines above the model line (which are colored red in the actual system) and below the model line (which are colored green in the actual system) are control limits (p-chart based on a monthly average taken from the half-life model line and the actual number of lines scheduled for shipment that month).

It is important to know when month-to-month variation is statistically significant, because this will determine the nature of the management review. When a new month's date falls above the upper control limit, the data point is changed to a red X. If it is below the lower control limit, it becomes a green X. After three months, each red or green X reverts to a normal data point. The distance of the control limits from the model line is inversely proportional to the square root of the number of lines scheduled for shipment in the month. For a small division (DIV C) the control limits are more widely spaced, while for a large division (DIV A) they are closer together. This reflects the greater variability expected with a smaller sample size even when the underlying process is the same.

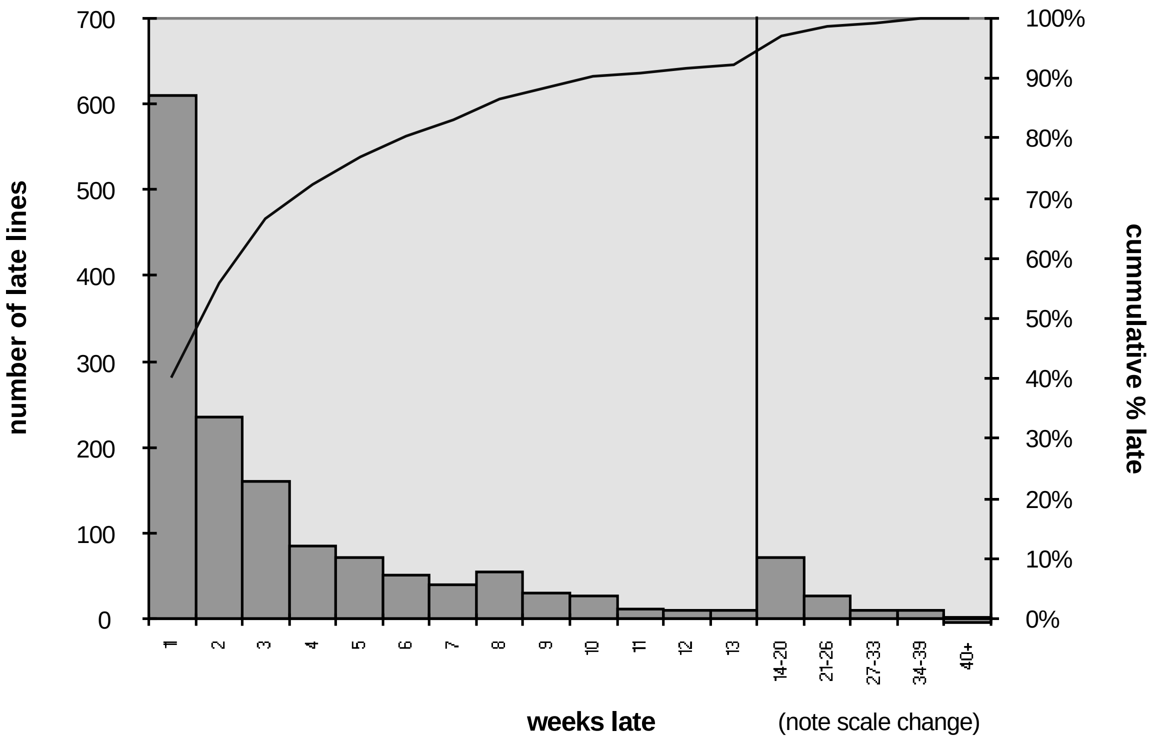
Although this format appears complex, managers at ADI adjust quickly to it and often found it easier to read than their tabular P/L reports. Among the advantages this format offers are as follows:

- It shows both the level and trend (half-life) of the metric;
- It distinguishes statistically significant variation from variation inherent in the metric;
- It uses colors to focus attention;
- It highlights both favorable and unfavorable special cause situations; and
- It shows a division's individual performance and its performance relative to other divisions, thus providing a vehicle for constructive competition (and subsequent learning) between divisions.

Use of executive information systems

The entire system of order fulfillment metrics was incorporated into an on-line executive information system used for

Exhibit 4. Shipped-Late-How-Late?



management of the scorecard. The access point in this case was the corporate scorecard entry for lateness. By pointing and clicking on this entry, the order fulfillment metrics appeared, now disaggregated by division, credit, warehouse, and customer. Clicking on any entity produced its order fulfillment metrics, with entries for all the previously described metrics. Clicking on any number displayed its time history. By clicking on a metric's name, its disaggregation appeared. The system allowed drilldown to the level of individual major customers (about 400).

A manager using the system could determine within minutes the levels and trends in performance by division or by major customer. The manager could also assess whether performance was being improved suboptimally—for example, by trading off delivery performance against lead time.

The most insightful display was generated by clicking on an entity's half-life. This produced a time history of the twelve-mop running average, as shown in Exhibit 3.

"Double-loop learning." The half-life display was the principal indicator of "double-loop learning" about the improvement process.[6] A decreasing half-life was a clear indication of the entity's increased mastery of the improvement process.

All of the metrics described above were represented in the format of Exhibit 2. In addition, the results metrics were also displayed as monthly histograms, an example of which is shown in Exhibit 4.

Over time, experience led to heuristic models of what represented a "normal" histogram. For example, histograms of late shipments were expected to be exponentially shaped. A statistical test for whether a particular "bin" in the histogram had the expected population was developed. A failure to meet this test for exponentiality led to detective work about the root cause. Often this detective work led to an out-of control situation with a particular product, which triggered the creation of a corrective action team to fix the problem. The resulting bulge in the histogram could be seen to move to the right from month to month until the problem was resolved.

Even in cases where the product problem was known and being addressed, the people working on the issue were impressed by the fact that their problem could be detected in the "macro" metrics. This gave them evidence that solving their apparently small problem could make a visible difference.

Metrics were conspicuously displayed at most divisions. Because of the standardized definitions, visitors from other divisions could make direct comparisons with the performance of their own divisions. Many opportunities for sharing are thus created through this use of metrics.

Management review

Metrics provided the basis for the annual goal-setting process at ADI and the quarterly management reviews of progress against plan. As part of the annual planning process, numerical quarterly goals were developed based on the current level and a half-life determined from the following:

- Previous rates of improvement;
- Achieved half-life in similar ADI divisions; or
- Targets based on benchmarks of improvement rates in processes of similar complexity.

In the spirit of the "PDCA" (i.e., the Shewhart/Deming Plan-Do-Check-Act) cycle, results are checked against plan using a process called "CAPDo," or Check-Act-Plan-Do. The CAPDo is a critical part of the Japanese practice of *hoshin kanri.*

At the post-quarter general managers meetings, the scorecard and the delivery performance metrics were presented by each general manager. Before each meeting, significant deviations from plan or out-of-control situations were highlighted on overheads (red for unfavorable, green for favorable).

At the meeting, each general manager was asked to discuss these situations. The objective was to move from anecdotal explanations to factual analysis of root causes and corrective action plans. A list of action items was maintained to assure that the corrective action plans were implemented. Favorable variances were viewed as an opportunity for sharing new solutions to generic problems and insights on increased rates of improvement. For example, one division with three consecutive months of green Xs attributed the resulting reduced half-life to the assignment of a full-time facilitator to assist the improvement teams. This approach was later adopted by several other divisions, with similar success.

Closing the loop—sharing metrics with customers

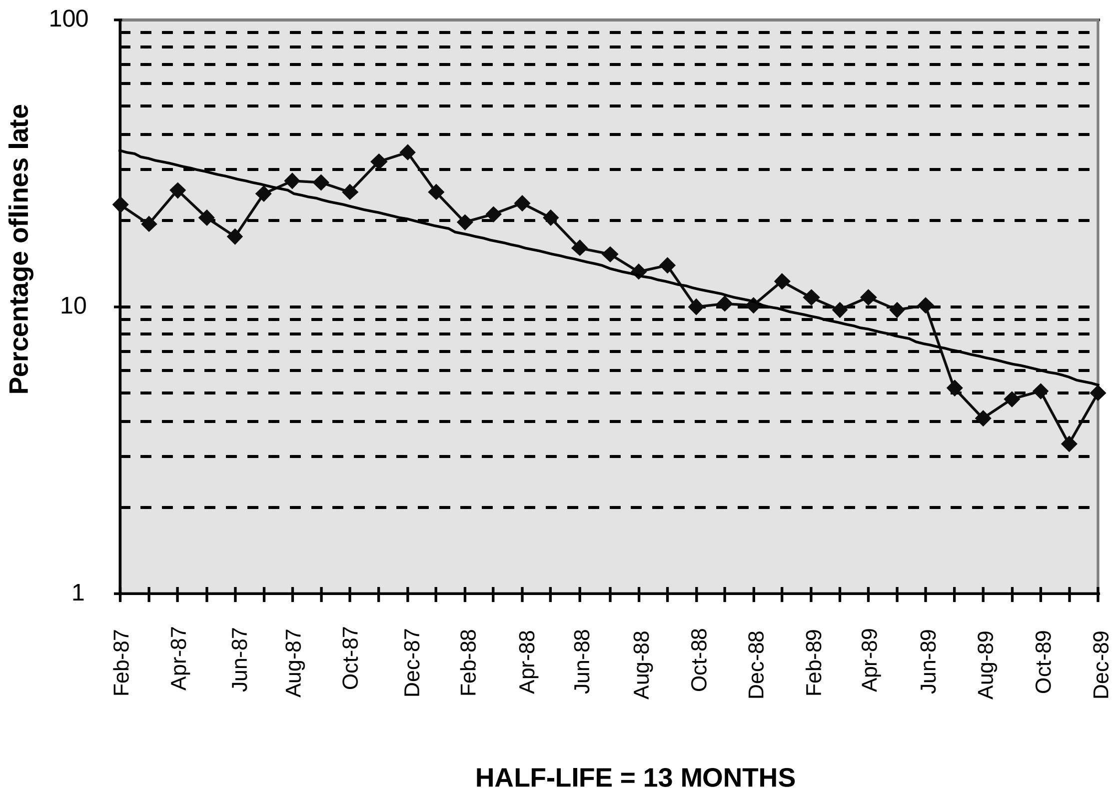
Another way to describe a metric is to say that it is a critical success factor, the improvement of which leads to significantly increased stakeholder satisfaction. This being true, it is likely that customers are measuring this same characteristic of their suppliers, whether objectively or subjectively. Therefore, results metrics for the order fulfillment process should correlate with customers' perceptions of the supplier's delivery performance.

The existence of real tradeoffs in complex processes must be captured in an effective system of metrics.

ADI maintains a database of customers' measures of its delivery performance that has grown to nearly 100 customers. Each quarter, the appropriate delivery data was averaged and published in the form shown in Exhibit 5. No adjustments are made for differences in definition (e.g., acceptance windows) or for contested deliveries. The average point in Exhibit 5 represents the mean of inputs from 22 companies.

The author (who was ADI's vice-president of quality and productivity improvement at the time) distributed the aggregated customer data to the sales force to demonstrate the value of collecting such information.

Exhibit 5. Delivery Performance as Measured by Customers



Many of the salespeople shared the results with their customers for two reasons:

1. To demonstrate ADI's improving performance levels and trends; and
2. To give customers data on how well their measures correlated with those of ADI's other customers.

Comparison of delivery performance as measured by customers (Exhibit 5) with delivery performance as measured by ADI (see Exhibit 1 from Part 1 of this article in the Summer 1996 issue of the *Journal of Cost Management*)[7] shows good correlation in both levels and trends (half-life). This gave ADI confidence that its metrics, as defined, were a good proxy for customer satisfaction.

Desaggregating results metrics

As described above, the results metrics can be disaggregated to the level of a specific major customer. By sharing these detailed metrics with that customer, many improvements have resulted. Here are some examples:

- According to a major customer in Texas, shipments from ADI arrived on-time only 17 percent of the time, while ADI's own metrics showed its on-time performance to be 93 percent of the time. A line-by-line comparison showed that the customer was using the confirmed FCD as the arrival date at the customer's shipping dock—i.e., the customer was allowing no time for transit from Boston to Texas. When ADI explained the FCD-plus-one-week transit time and adjusted the commit date accordingly, the customer's perception of ADI's performance changed dramatically. Furthermore, these new dates provided more realistic inputs into the customer's MRP system.
- One of ADI's most advanced customers (in terms of vendor rating systems) decided, after a joint annual meeting, to use ADI's metrics for delivery performance after being convinced that ADI's metrics more

accurately represented ADl's performance than the customer's own system did.

- For over a decade, ADI held quarterly meetings with a major Boston-based customer to review delivery and quality issues item by item. The tone of these meetings grew to be one of cooperation and learning. A highlight of every meeting was a review of the latest version of the graphs shown in Exhibit 2.

As these examples show, a good set of metrics can dramatically improve relationships between customers and suppliers.

Summary

This two-article series has attempted to bridge the gap between theory and practice by describing both the concepts of metrics and their application to the order fulfillment process at ADI. The articles define metrics as a dynamic subset of all possible measures of a process, then distinguish between results and process metrics.

Specifications for good metrics are as follows

- They provide a reliable proxy for stakeholder satisfaction;
- They have documented operational definitions;
- They are useful and timely; and
- They are complete in that they reveal undesirable tradeoffs.

Companies that are just starting to introduce metrics should consider the following steps:

1. Start with a well documented, stable process.
2. Carefully define a set of metrics with a heavy top-down emphasis.
3. Borrow initially from what has worked elsewhere and be prepared for constant **PDCA.** You *will* get *exactly* what you measure.
4. Build the monitoring of metrics into the management process.

Nonfinancial metrics invoke an organization's immune system—i.e., its resistance to change. This can only be overcome over time by persistence on the part of top management. ■

Arthur M. Schneiderman is an independent consultant in process management. He is located in Boxford, Massachusetts.
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Notes

[1] Arthur M. Schneiderman, "Metrics for the Order Fulfillment Process (Part 1)," Journal *of* Cost Management (Summer 1996): 30-42.

[2] Chris Argyris, "Good Communication That Blocks Learning," Harvard Business *Review (July-August* 1994): 77-85.

[3] Yoji Akao (ed.) Hoshin Kauri, *Policy Deployment for Successful* TOM (Cambridge, MA: Productivity Press, Inc., 1991).

[4] See, for example, Edward R.Tufte, The Visual Display *of* Quantitative Information (Cheshire, CT: Graphics Press, 1983) or idem, Envisioning Information (Cheshire, CT: Graphics Press, 1990).

[5] Arthur M. Schneiderman, "Setting Quality Goals," Quality *Progress (April* 1988): 51-57; Robert S. Kaplan, Ana*log* Devices: The HalJ-Life System (Boston, MA: Harvard Business School, 1989) Case #9-190-061.

[6] Chris Argyris and Donald A. Schon, Organizational Learning: A *Theory of* Action *Perspective (Reading,* MA: Addison-Wesley Publishing Company, 1978).

[7] Arthur M. Schneiderman, "Metrics for the Order Fulfillment Process (Part 1)," 31.