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Measurement for Manufacturing

Driving Operational Performance

Overview

This is part of MRSI's series on measurement for small and mid-size businesses, which includes white papers on various aspects of measurement in a variety of industries. This paper is focused on measurement of Operations in manufacturing companies.

Measurement is vital to drive performance and, as the saying goes, "what gets measured gets managed." Measures should be selected carefully and then connected to positions in the organization structure through formal reporting relationships and performance evaluation mechanisms.

Manufacturers need to select a variety of measures. For most small and mid-size firms, key among these will be measures of labor productivity. Labor and machine productivity can be broken down into several components in order to help target and identify where problems are while also driving up long-term productivity of those resources.

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Why Measure Anything?

Many managers in small and medium sized businesses mistakenly believe that measuring is expensive and therefore only for large companies. Others are self-taught and have never had the opportunity to find out what it is possible to measure. Both types of managers can benefit from awareness that knowing how one is doing is a fundamental human need. One reason people enjoy professional sports is that everyone knows the rules and everyone knows the score. Measures provide a scorecard that people can use to strive to improve against. Measures also allow management to set clear expectations. Consider the difference between “keep the equipment productive” and “Keep the equipment operating at 85% productivity or better.” Clear expectations have been repeatedly shown to improve performance.

*“Measure what is
measurable, and make
measurable what
is not so.”
- Galileo*

Measuring isn’t just about making people work harder. It is also about making people work smarter. With measures in place, people are also likely to get more creative and improve what they are doing. This works on two levels: First, expectations are set and people want to show that they can do better than the expectation, which usually requires working smarter as well as harder. Second, there is a reward for improvement; a significant improvement in process will show in the numbers that are posted and the individuals responsible will know that what they did is having an impact—there is also the belief that this impact will be recognized by others.

Measures also help management with diagnosing problems. For example, management may know that labor costs are up. But do they know that labor costs are up because a particular piece of equipment is down a lot, while the newly hired operator thinks a lot of downtime is normal on that machine because that is how it has always been in their experience? Management can target the problem and take action.

Are Financial Measures Enough?

In short, no. In the era of cheap small business accounting systems, most companies have a reasonable idea of monthly and annual profitability. However, these figures are very high level and are focused on the overall outcome rather than the specific processes that may have caused the result. It is much like a football coach that focuses on whether they won or lost the game – the information isn't always actionable enough. The football coach is also going to want to know about passing yardage, fumbles, quarterback sacks, first downs, kick-off return yardage, and so on. These figures help the coach focus energy where it can best be utilized. If the problem is quarterback sacks, the coach knows to focus energy on the quarterback throwing more quickly, getting receivers open, or tightening the offensive line. Time spent with the place-kicker would be largely wasted.

Team vs. Individual Measures

Generally speaking, individual measures are more effective in driving individual performance than team measures because the individual contribution is diluted in the numbers posted by the team. However, team measures are also effective in driving the performance of the individual.

From the earliest times, humans have gathered in groups. We all have a strong desire to please the other members of our team and to secure our social standing within the group. Peer pressure has a strong impact on performance.

It is also important to consider the dilutive effect as teams become larger. A team on a manufacturing line may be motivated to improve their productivity figures, but in a large factory, the effects of individual effort would be difficult to see in factory-wide productivity. Generally speaking the effect starts to become negligible once it is covered by about 100 people. Of course, if those people report into, say, a Production Manager, that manager can be held accountable as an individual.

In some instances, individual measures can lead people to perform less than optimally. If their performance requires a lot of group interaction and cooperation, it may be necessary to emphasize group measures or give them group measures exclusively. Most companies have experienced someone who focuses on getting their "real work" done, while ignoring their

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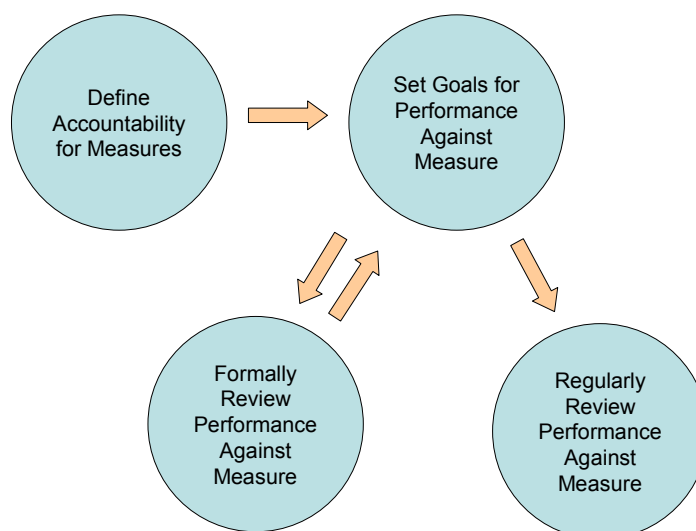
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paperwork, creating problems for the next person in the process. In some instances, including that next person in the team's key measures can help refocus people on the broader impact of their actions.

In summary, individual measures are best at driving individual performance if teamwork is not a major element of the position, but team measures can also be effective at driving individual performance.

Accountability and Measures

It is crucial to identify which measures are important, but if staff don't accept accountability for performance against those measures, they can simply become an academic exercise. All staff should know who is accountable for performance against which measure, which should be done through the organization chart. These measures should then be reviewed regularly with senior management to create ongoing accountability. Regular informal reviews should then be augmented by a formal performance evaluation process that includes setting goals for performance against measures. At each review or each time processes are changed significantly, the goals should be reviewed. An organization that does this comes to be perceived as fair and objective, while at the same time improving its performance.



People must have the authority to take the actions that they need to in order to perform against the measure.

Do People Need Total Control Over Results?

No, they don't. However, it helps if they can at least see that they can influence the measure. Most people accept that sales people should be measured on sales. But even sales people don't have full control; they are impacted by product availability, competitor activity, pricing policies, manufacturing and delivery issues, and so on. People just need to see that the number is not completely outside of their control. Similarly, people must have the authority to take the actions that they need to in order to perform against the measure.

Risks in Measurement

One problem setting measurable targets is that if they are not designed well, they can become too effective at driving performance against the measure to the exclusion of other things that are important. In 1937, a paleo-anthropologist with the regal-sounding name Gustav Heinrich Ralph von Koenigswald was searching for the bones of early hominids in Java, present-day Indonesia. Since the bones are exceedingly rare (even now, the entirety of the bones of early man that have been found would barely fill the bed of a pickup truck) and because it is difficult to know where to look, he hit upon the idea of using low-paid locals to aid in the search and make his team able to cover a larger area. He offered 10 cents for each piece of bone they could bring him. To his horror, he found his labor force was smashing priceless bones into fragments in order to increase their incomes. Perhaps he could have paid per pound, or paid more for larger segments, or paid by the hour. Regardless, Koenigswald discovered how painful the results of measuring the wrong things can be.

In manufacturing, symptoms of getting it wrong can often be seen. Customers are screaming for product while productivity numbers are up or customers are ecstatic but costs are spiraling out of control, or efficiency is up in manufacturing but inventory levels are rising and cash flow is tightening.

The Balanced Scorecard

The balanced scorecard is a concept developed by Robert Kaplan and David Norton of Harvard University. The main point of their research is that companies need to invest in intangible assets to ensure their future success and progress in these areas should be measured. Each company must select the key measures in each of the four areas that support its strategy. Most of the focus of this white paper is on measuring the key Internal Business Processes for manufacturers. Measurements in the other areas are vital to the long-term health of manufacturers as well.

Financial	Internal Business Processes
Customer	Learning & Growth

The right measures attempt to capture all of the appropriate things that result in success in a given company's unique context.

Does that mean you cannot move ahead with measures even if you do not yet have all of the measures you want? No! Start with the most valuable measures and make sure everyone is aware of any unintended consequences. Ensure that people know that, even though there may not be a measure yet for, say, quality, it is still something that they are going to be evaluated on and that management is paying attention to it.



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Major Area	Description
Throughput	How much is the factory putting out as a whole or as a department. Note that it could be possible to have low throughput but have very high labor productivity.
Labor Productivity	How much product is produced per unit of time?
Material Productivity	How much material is used in production versus wasted?
Machine Productivity	How much is produced per hour of available machine time?
Cash Flow / Inventory	Are inventories building up to high (or running down too low)? Are inventory locations accurate?
Customer Service	Is the customer getting what they ordered when they wanted it? How many backorders are there? How big is the backlog?
Scheduling	Are schedules being prepared in a timely fashion and coordinated with manufacturing and purchasing?
Quality	Is the product being made as promised? How is delivered quality? How many failures are experienced in process that result in rework?
Purchasing	Is purchasing keeping up to sales and meeting promised arrival dates?

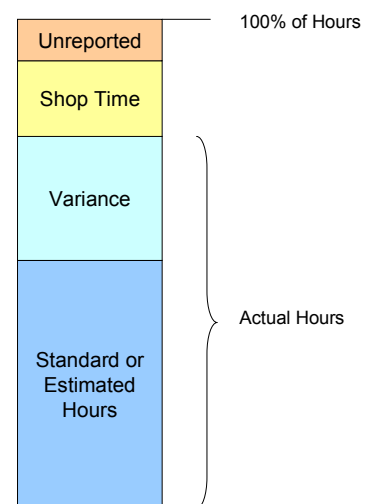
Major Categories of Measure for Manufacturing

There are numerous measures that can be implemented in a manufacturing environment. A selection is shown below. The importance of each individual measure will vary for a particular manufacturer. For example, if production is having a difficult time keeping up with demand in a growing industry, measures of throughput or the backlog are likely to be crucial, while in highly competitive environments with low margins, productivity measures are probably central. In high end, custom environments and electronics, measures of delivered quality will be vital. Most business should work toward having measures in all of these categories eventually, but they need to be prioritized to begin.

Using Standards to Drive Productivity

The era of factories that make only one product are largely behind us. It used to be possible to measure productivity simply by the number of units that were produced. Standard-setting was developed partly as a means of overcoming this problem.

A standard is the amount of time that management has determined is reasonable for a given activity. The standard can be determined through a timing study or by using historical averages. Generally speaking, the standard should be broken down as far as is feasible. For example, it may be appropriate to have a standard machine setup time and standard run rate for a machine or line. In the case of build-to-order environments, standards may be set for options or the standard hours drawn from the estimate for total hours for a job or for the hours estimated at each work center.



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Some basic math on the productivity figure allows for relatively easy conversion of the productivity measure to an estimate of the impact on costs. If Labor Productivity were the number of Standard Hours of Product produced divided by the number of labor hours worked, the financial impact can be determined with some accuracy. The formula is:

$$\text{Budgeted Productivity} = \text{Budgeted Standard Hours} / \text{Budgeted Total Hours}$$

$$\text{Cost} = \text{Budgeted Cost} \times (\text{Budgeted Productivity} / \text{Actual Productivity})$$

If total wages were budgeted to be \$1M at 80% productivity, increasing productivity to 95% would have the following impact on annual labor cost:

$$\text{Cost} = \$1M \times (80\% / 95\%) = \$842,105$$

That is almost a \$160k reduction. Reductions in productivity can be calculated similarly. With a reduction in productivity to 50%, the cost would be:

$$\text{Cost} = \$1M \times (80\% / 50\%) = \$1,600,000$$

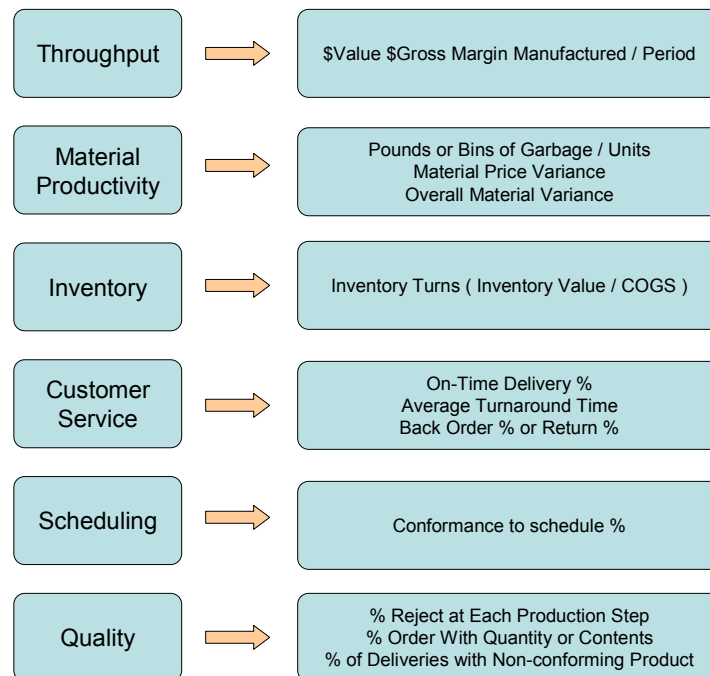
Standards and estimates can also be used to determine the variance on a particular order. The "actual hours" on a job become the standard or estimate hours + the "variance" hours. Some firms use the following definition:

$$\text{Utilization} = \text{Actual Hours} / \text{Total Hours Worked}$$

Other uses of time frequently include "shop time" and "unreported" time. Shop time is time spent on activities unrelated to a work order, which can include cleaning, maintenance, moving machines, and so on. Unreported time results when the hours in the tracking system do not match the payroll system. In practice, MRSI has frequently been able to reduce this to zero by combining reporting for work orders with time cards. However, this is not always possible. Generally, shop time and unreported time should be minimized, although there are times when shop time should be higher or lower than normal, such as following seasonal fluctuations in demand or when improvement programs are being implemented.

Other Measures in Manufacturing

Up to now we have been focused on measures that can be used for labor, work center, or machine productivity measurements. The following is far from an exhaustive list of the measures that are possible in manufacturing, and the details of how each one should be employed in a given company or industry varies. But it is intended to give the reader an idea of what is possible.



The list excludes measures for factors such as location productivity in the warehouse. For more on measures in the warehouse, see our white paper on Measures for Distribution & Wholesale.

Implementation

There are numerous potential pitfalls with implementation of measures that can reduce their effectiveness or even lead to their complete failure. The first step in any such endeavor is to see that key staff understand why a measure is important to the business and its strategy. To reduce fear, they must also understand how management will use the information and how it will benefit

them. The method of capturing the data must be thought through thoroughly. After implementation, expect hiccups as staff change the way that they work in order to capture the data or get in the habit of using reports. During this period, management usually needs to sustain its focus on the new measures, with more frequent reviews and requests for the data. It is important that staff actually see management using the data and don't believe that they are pointlessly doing work to produce data or reports that no one will ever look at.

Next Steps

Consider the following questions before embarking your endeavor to install new process measures in your manufacturing facility.

- How will we prioritize the right measures?
- How will we deal with questions about what should be included in the numbers for our environment? For example, should Team Leads, sales managers, CAD/CAM people, and so on be included in the overall productivity measures for production? Or should it just include line staff?
- How will we determine standards or estimated hours?
- How will we connect those standards and estimates to the floor?
- Are there risks in implementing this in our company culture or with our union?
- Do we have the resources to proceed with this effort alone?
- What other barriers to implementation will we face?

Resources

The Balanced Scorecard, Robert S. Kaplan and David P. Norton, Harvard Business School Press, Boston, Massachusetts

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Management Research and Solutions, Inc. is a full-service benchmarking and change management firm committed to delivering lasting change in small and medium-sized businesses across the United States and Canada. Researching best practices from multiple industries, we take companies from where they are now to where they want to be, so they may achieve their goals and fully actualize their potential.