



How far have you gone with lean? This review of some concepts and steps to success by a world-renowned expert is designed to help you move higher and higher.

Long a guiding principle in U.S. and European industries, the concept of "lean" (manufacturing and maintenance) seems to have vastly increased in popularity over the past five years. Simply put, the idea behind lean is that those things that need to be delivered are to be produced on time with fewer resources. In other words, you need to be eliminating waste wherever you can. In the area of lean maintenance, cutting out waste is all about executing the basic elements of good maintenance management *better*.

To become "lean," all losses in the processing of raw material and delivery of products to customers must be eliminated. For readers of this magazine, that translates into preventing maintenance needs and performing remaining maintenance more effectively. The payoff? Production reliability will rise and production costs—including *maintenance and storage costs*—will fall. The biggest improvement opportunities include:

- **Manufacturing Reliability**

Part I: From Good To Great With Lean Maintenance

Written by Christer Idhammar, IDCON, Inc.
Wednesday, 01 September 2010 12:23

- Dealing with loss of quality
- Dealing with stop times
- Dealing with loss of speed

- **Partnership With Operations/Maintenance/Engineering**
- Reliability- and maintenance-related design
- Operator-based maintenance

- **Elimination Of Root Causes Of Problems**
- Choosing problems to eliminate
- Eliminating problems
- Educating and teaching

- **Storage**
- Reducing store value while preserving service level to maintenance

- **Integration And Application Of Increased Knowledge And Skills**
- Educating/training craftspersons to enable multi-crafts or multi-skills
- Implementing flexible work systems

- **Over-Manufacturing**
- Not making more than what's been sold
- Not manufacturing too early

- **Over-Maintenance**
- Performing the right amount and the right type of preventive maintenance
- Performing preventive maintenance when it is needed
- Prioritizing and performing corrective maintenance in the right order

- **Use Of New Technology**
- Needing fewer resources for maintenance
- Improving maintainability
- Deploying smart tools and methods

Before exploring these points in more detail, it's important to review some fundamental

Part I: From Good To Great With Lean Maintenance

Written by Christer Idhammar, IDCON, Inc.
Wednesday, 01 September 2010 12:23

concepts of manufacturing reliability (refer to Figs. 1 and 2).

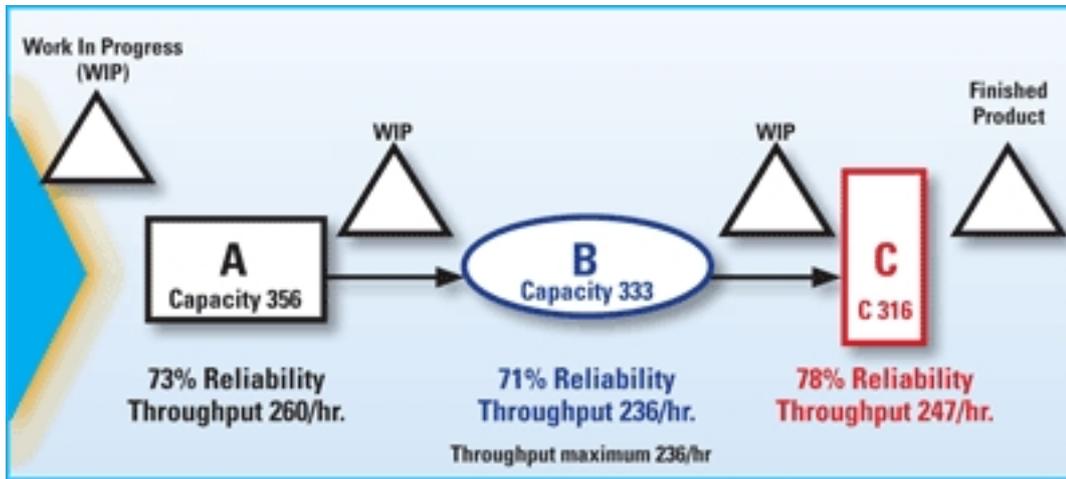


Fig. 1. Basic Reliability Mathematics.

It's not always clear where the most cost-effective place to implement improvements in a manufacturing chain will be. Product flow is the result of Capacity x Reliability. At first glance, you might think that C is the bottleneck in the production chain. Capacity there is 316 pieces per/hr compared with the higher capacity in A (356) and B (333). If you calculate the flow, you'll find that the bottleneck is at manufacturing stage B. This is compensated for and hidden by increasing storage of Work In Progress (WIP), which can sometimes makes it seem as though throughput isn't a problem. WIP is a big hidden cost for many companies. With low reliability throughput of product in the manufacturing chain, WIP takes longer and its costs are increased.

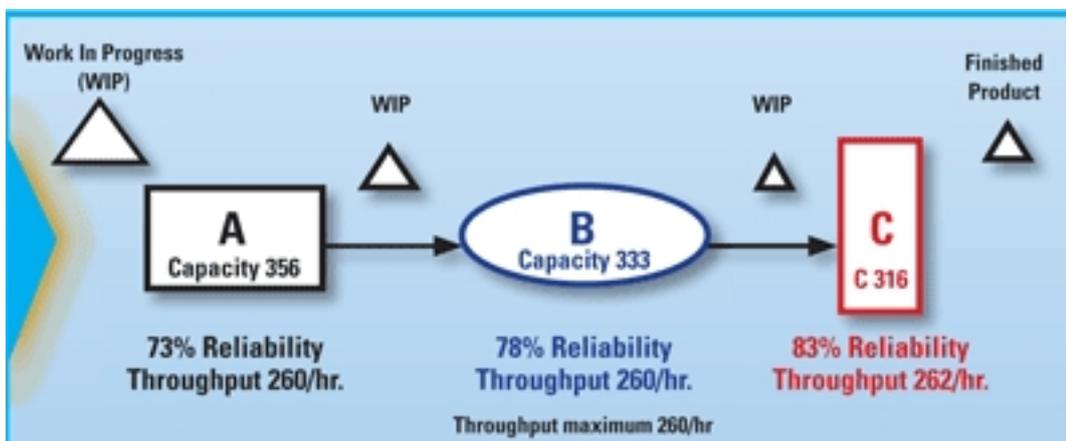


Fig. 2. Additional Basic Reliability Math.

By raising the reliability in step C to 83%, the increased throughput is 260 per hour. The WIP is reduced since the manufacturing steps are now balanced. Other solutions include procurement of increased capacity through investing in a parallel machine for C. This would lead to unnecessary high capacity in step C. Moreover, the cost of buying more capacity is at least 10 times higher than investing in measures that will increase reliability.

Lean manufacturing's sub-target is to reduce WIP and speed up throughput in the manufacturing chain. Reliability includes quality, time and speed. Lean maintenance has a crucial key role in raising the part of reliability that is affected by the manufacturing equipment. Since the manufacturing process is more and more dependent on automation, good maintenance becomes more and more important.

Availability or reliability?

Many organizations use availability as a key measurement for manufacturing efficiency, but availability encompasses only the percent of planned time—or *available time*—that a production process produces. Availability excludes the quality of that which is produced. To produce something that isn't up to quality standards is often more expensive than to not produce at all. To slow down a process because, for example, a part of the process can't operate at full speed is also expensive. So we must focus the improvement initiative on all elements of what we call manufacturing reliability: quality, time and speed.

Manufacturing reliability can be measured in various ways. The most simple way is to calculate how much is manufactured at the right quality, divided by how much could have been manufactured at the right quality ($\% \text{ Quality} \times \% \text{ Time} \times \% \text{ Speed}$). Overall, nothing should be manufactured before it has been sold and is to be delivered.

In many heavy process industries, people are still living with the idea to always produce as much as possible. That's not "lean thinking," which says nothing is produced until it needs to be delivered because it has been sold. However, having a lean production process and being able to produce things "Just in Time" is possible only if the production reliability is very high. With a raised automation level, a company becomes more and more dependent on reliable equipment—and *the maintenance that ensures the reliability of that equipment*. Reliable production equipment is the most important result a maintenance organization generates. It can be seen as the maintenance department's income-generating section.

Part I: From Good To Great With Lean Maintenance

Written by Christer Idhammar, IDCON, Inc.
Wednesday, 01 September 2010 12:23

For an organization striving to be lean, it is important to know where the greatest benefits are. What is the worth of reducing the difference between how good you are and how good you could be? In a market situation where you can sell everything you can produce the equation is simple. Consider the following: In certain industries, the sales price of what you are selling can drastically fluctuate. Thus, let's base our hypothetical manufacturing example on the average sales price and variable cost of a product over five years.

Average sales price / five years	\$510/unit
Average variable cost / five years	\$340/unit
Benefit per produced, sold, delivered unit	\$170/unit

The value of producing and delivering a sold unit is \$170. If you produce/deliver 25,000 units a year and production reliability is 88%—*but it could reach 94%*—then the value of increasing manufacturing reliability would be 6%.

$$1500 \text{ units} \times \$170 = \$255,000 \text{ per year}$$

The next questions you should ask are these: Can you achieve even better results by lowering maintenance costs? Would it be beneficial to lower maintenance costs if you can maintain manufacturing reliability at 88% without lowering them? The answer seems to be obvious, but it isn't unusual that some are so focused on lowering visible costs they don't see the large, invisible opportunities that are concealed in increased production or faster throughput of product. An idea worth repeating—*as we are doing here*—is that when you increase manufacturing reliability, production costs (including maintenance and storage costs) will decrease.

If you can't sell the increased volume that you reach via higher manufacturing reliability, then the savings most often lie in more reliable and faster delivery of goods sold, less energy expenditure, improved safety and less overtime. Consider the following example from the pharma sector, which also shows the importance of including the quality component of the reliability formula.

Part I: From Good To Great With Lean Maintenance

Written by Christer Idhammar, IDCON, Inc.
Wednesday, 01 September 2010 12:23

The XYZ Pharmaceutical Company had a lot of over-capacity. As a result, manufacturing reliability wasn't considered to be "that important." After all, it was assumed that the plant could make up losses with the extra capacity and turn to overtime to compensate for any production losses. Management reasoned that it was much more important to have lower maintenance costs. When manufacturing efficiency was measured, the only thing really taken into account was availability.

Alas, one day a tumbler broke in the end-stage of a tablet-manufacturing process. (Tablets in the tumbler were covered with a coating before packaging and shipping). The breakdown of the tumbler was caused by a burned, worn-out V-belt. Although the resulting shutdown lasted only 45 minutes, plenty of expensive medicine had to be scrapped—to the tune of over \$62,000. Since a similar costly incident had occurred two years before, management realized it needed to change the way it thought about some things. That's why instead of talking only in terms of availability, this plant now also considers the aspect of quality performance when it identifies losses and measures manufacturing reliability.

What is "good" manufacturing reliability?

Increased manufacturing reliability will increase product throughput and reduce the time between incoming raw materials to the finished product. Better reliability is the foundation to a faster and safer manufacturing flow. This will result in fewer losses from delayed deliveries, over-production, work-in-progress and energy consumption. Here lie the biggest gains if you can't sell everything you produce. Remember, though, these gains won't materialize if you don't have highly reliable equipment. If you do have this type of equipment, you will be able to apply the "Dell model" or "Just-In-Time" manufacturing principles very successfully. In addition, work-related injuries are always positively affected by high reliability.

As to the question of what constitutes "good manufacturing reliability," the answer has a lot to do with your process and equipment quality. Note that we aren't only talking about equipment efficiency here. It is common to use the OEE—*Overall Equipment Efficiency*—when measuring manufacturing reliability, but that's only one part of the reliability concept. The other part is Overall Process Efficiency, which is the manufacturing process or chemistry that goes into making your product, including raw materials, pressures, temperatures, chemical mixtures, packaging material, operating practices, etc. What this boils down to is OMR—*Overall Manufacturing Reliability*.

From the maintenance point of view, there are three elements that affect how good OMR can

be:

1. Equipment quality
2. Number of components that can cause a problem
3. Efficiency of the maintenance organization

Equipment quality...

Equipment quality, including issues associated with designing for maintainability and reliability, is beyond the scope of this article. This element affecting OMR is such a complex (and crucial) topic that it requires an entire article unto itself.

Number of components that can cause a problem...

As a consultant, I often use paper machines as a guideline when projecting reliability in processes for which I don't have data. The most reliable paper machines produce, for example, towel and tissue paper. They often incorporate one or two driers—*so-called "yankee" cylinders or driers*—each with a drive unit. A paper machine with several layers and surface coatings, however, has many more components that can cause problems. Such a machine can incorporate 100 drier cylinders. Thus, OMR differs between 96% for a tissue/towel machine and 82% for the more complicated units.

A package line with good OME can reach 85-90%. (All of these calculations are based on 8760 hours per year.)

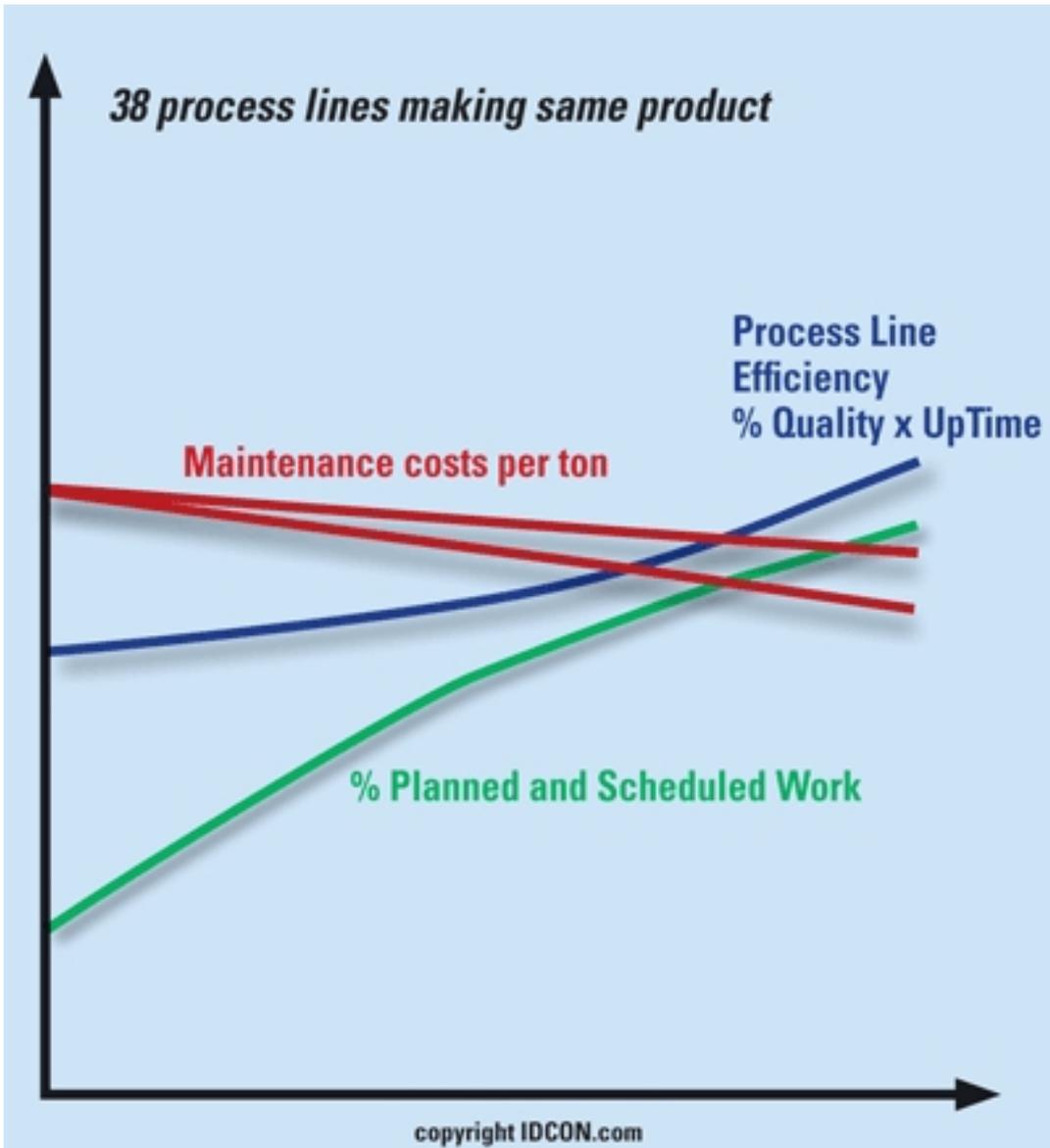
Efficiency of the maintenance organization...

One of the best indicators of effective maintenance is still the degree of planned and scheduled maintenance. This is because it greatly affects both manufacturing reliability and maintenance efficiency. Furthermore, a high level of planning and scheduling cannot be reached without the support of all of the other elements of good maintenance, including maintenance prevention, preventive maintenance, storeroom support, root-cause problem elimination, etc.

Studies have established a strong correlation between high manufacturing reliability and a high degree of planning and scheduling of all maintenance and operations work (see Fig. 3).

Part I: From Good To Great With Lean Maintenance

Written by Christer Idhammar, IDCON, Inc.
Wednesday, 01 September 2010 12:23



For more information, please contact info@idcon.com or visit our website at www.idcon.com.