Lean Maintenance for **Lean Manufacturing**
(Using Six Sigma DMAIC)

Before putting new and 30 or 40 year old machines together into Lean Manufacturing lines, do you know how to get near 100% uptime? Or, will "maintenance" become the "tail that wags your dog"?

A Barrier To Lean

To compete in today's global economy and to increase profits, many factories are moving to "Lean Manufacturing," the next step beyond "Just In Time." Others claim "lean" but hedge on the concept with hidden WIP inventories because they fear what they've seen in the past, when critical path machines go down for a "maintenance break." Other managers simply budget for and bolster their maintenance department with people, training, equipment and spare parts so they can more quickly "put out the fires" when downtime occurs. Others increase budget (expense) to hand off maintenance responsibility to outside subcontractors. Outside service vendors may service you better with superior skills, equipment and spare parts but at what cost? And, their motivations are not "lock-step" with yours, as we'll see. But, the larger problem here is equipment reliability and uptime (some call it maintenance reliability). It's finding ways to eliminate unscheduled equipment downtime. The problem is this, "You can monitor it, measure it, log it, report it, attack it, or delegate it, but *downtime* will not go away until you *eliminate* it–prevent it from happening in the first place.

The Maintenance Problem

What? How does one "fix machines so they don't break down again."? To prevent downtime from happening before it occurs, you must eliminate the basic stresses that cause the downtime. What is needed is a methodology for protecting computers, automation controllers, PLCs, CNC machines and their electronic and hydraulic control systems from the stresses that cause malfunctions and failures. Amemco, a maintenance engineering firm which has been applying this methodology and perfecting it since 1977, now calls it "Lean Maintenance ™ for Lean Manufacturing." This practical and most cost effective methodology can help most any facility from data centers to telecom to medical, from semi-conductor manufacturing to plastics & metal manufacturing. You can avoid malfunctions, failures, unscheduled downtime, scrap parts, re-work, missing delivery schedules, etc. and get the near 100% reliability, repeatability, yield and uptime needed.

Improved uptime is also needed as companies push to lower costs by shedding:

- Onsite spare parts,
- Onsite board or component repair, and
- Onsite CNC technicians, maintenance engineers, etc.

The few skilled technicians are getting old. In 3 - 7 years most of this rare breed will be retiring and replacements are not present in training. It is, therefore, critical in today's Lean Manufacturing environment to achieve truly "Lean Maintenance," a method that allows reduced maintenance support and reduced maintenance overhead (often 50% or better)

while achieving maximum permanent reduction of unscheduled downtime, typically;

- 50% reduced mechanical downtime,
- 80% reduced hydraulic systems downtime, and
- 92% reduced electronic systems downtime.

Cost of Downtime

So what is the cost of downtime? Is it something worth eliminating? Different companies calculate or toss different figures; typically $500 per hour for a stand-alone machines, $1,500 - $8,500 per hour for a cell or line of machines, and up to $3,500 per minute ($181,500 per hour) for an entire auto factory line. One practical way to give your "cost of downtime" figures a reality check is to compare them to the price you would pay, or do pay, when you have to farm out a part or assembly because your capacity is temporarily or permanently limited. What do they charge you per hour for this capacity? That's the cost of your downtime. Believe it. Any profit margin they have calculated in is quickly offset by your own continued need to pay support and regular production personnel who now stand idle. Add to this your scrap and rework costs and you see the true hourly cost of downtime.

Scrap/Error Cost + Cost of D.T. * Total Hrs. D.T. = $_____.___

Only after you have a firm grasp on your cost of downtime can you then calculate the importance and impact *Lean Maintenance* methods can provide by way of increased profits, decreased cost of goods sold and the impact this can have on increased market share.

In Lean Manufacturing the cost of a single machine going down for maintenance is multiplied by the number of machines in that cell. With no parts in inventory, a single machine going down results in no parts shipped. Broken delivery schedules that cannot be made up, if the next parts made are "just-in-time." It's not only lost sales, its reduced level of integrity and less satisfied customers which can result in long term loss of sales revenue. Downtime then results in a higher cost-of-goods sold which means reduced ability to expand or maintain sales and business volume.

Lean Maintenance Methodology

The key objective of Lean Maintenance is to give your company the near 100% equipment uptime and reliability it demands while cutting your maintenance expense by 50% and more. This is done by systematically surveying or analyzing each machine and control system to determine which basic stresses are effecting each machine, over time, and laying out a scheme to protect each machine or system from those stresses. This certainly includes but goes beyond the normal oil change, filter change PM procedures given in the maintenance manual. We must first understand the three categories of downtime:

1. Downtime from Operator or Programmer Error,
2. Downtime from inadequate PM procedure or performance
3. Downtime from chronic *wear & stress* to circuit boards, hydraulic components and other system components, such as:
    a. Heat

b. Vibration
c. Oxidation & Corrosion
d. Dirt build-up
e. Electrical voltage transients and current surges
f. Hydraulic contaminations of dirt, water & acids

Six-Sigma, ISO-9000 and TPM books and strategies often cover the first two issues (above), but they may get passed over. "Lean Maintenance" stresses the importance of all three (above) and focuses on the third. "It's like preventing fire hazard," says Howard Cooper, maintenance engineering consultant and founder of Amemco. "You can have fuel stored or flowing anywhere, but do away with oxygen and heat and you can not have a fire." "Similarly if you do away with the chronic stresses that cause 'maintenance fires,' ie.; malfunctions, errors, failures, rework, scrap and downtime, then you can not have those fires, malfunctions nor downtime. The beautiful thing about this method is that for the most part, it's all "one time installation" of protective devices to produce ongoing savings and to reclaim older or less reliable systems to near 100% uptime," Mr. Cooper says, "You might call this kaizen for maintenance reliability, or how to truly jump from "four sigma" to six sigma." If you are already at six sigma, Lean Maintenance can put you at "seven sigma."

Six Sigma, D.M.A.I.C. Steps to implement Lean Maintenance

Define the problem: Unscheduled equipment malfunctions and the resulting rework, scrap parts, and downtime.

Monitor & Measure the problem: Monitor your downtime and measure or calculate what it is really costing (see above).

Analyze how to solve or eliminate the problem: Your maintenance engineer, or an experienced consultant or contract engineer will analyze and identify, for each computer, each machine and each control system how to cost most cost-effectively achieve ongoing protection from the above stresses. Have them write a report detailing, machine by machine, the exact means to protect from each these stresses (as each may apply) and give protective device model numbers, connection points and installation instructions along with costs for each and a total cost summary. Cost can then be justified against increased uptime benefits.

Then **Install or Implement** the solutions via your own maintenance personnel.

Controlling this project in the future should require little or no effort. Steps taken to avoid hydraulic system malfunctions and downtime can reduce by 90% current hydraulic system PM labor and scheduled downtime, and prolongs machine tool life. Most other methods are single step protective methods that need no future monitoring or PM labor effort.

When Amemco conducts the Analysis survey they start with a three hour in-plant Lean Maintenance orientation seminar for all responsible personnel from VP of Mfg. down to engineers and maintenance technicians. This orientation reveals exactly how these stresses cause malfunctions and downtime and the various methods for eliminating these stresses once and for all! Other common or factory specific anomalies, that cause unscheduled downtime, are also discussed. They then do the 2 – 3 day equipment stress/reliability

Analysis, taking notes on each system and machine to later generate a 20 – 30 page report detailing a protective solution package for each machine and control system.

Conclusion

"Lean Maintenance" is protecting from the real causes of equipment downtime–not just their symptoms. Any maintenance engineer or manager can begin Lean Maintenance by protecting automation, electronics, hydraulics and computer-controlled equipment from the real cause of malfunctions, failures, and downtime–chronic stress. Circuit board failures, hydraulic system failures and other malfunctions are only symptoms, not the underlying cause of unscheduled equipment downtime. You can thus achieve;

1. Near 100% uptime required for Lean Manufacturing,
2. Achieve greatly reduced maintenance overhead, and
3. Reduce dependence on outside support.

Lean Maintenance is maximizing uptime, yield, productivity, and profitability.

Report – Request Amemco's Free 7 page Report,
"How To Eliminate 92% of Your Unscheduled Equipment Downtime – Within 30 Days!"