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White Paper

Holistic Medicine for Machines:

Condition Monitoring Improves OEE Outcomes

Improving overall equipment effectiveness (OEE), the measurement of performance for industrial equipment, requires information decision action (IDA) based on equipment data and human factors, with both playing key roles. While diagnostics remain an important troubleshooting tool, advanced condition monitoring systems focus on the root causes of potential problems, effectively serving as 'holistic machine doctors' working to improve OEE outcomes.

Average (Availability + Performance + Quality) = OEE

Three main components contribute to OEE:

1. **Availability** – A percentage based on how much time a machine actually runs production versus a fixed period. Example: When a machine runs six hours over an 8-hour shift, or 75 percent of the time, OEE takes a hit.
2. **Performance** – A percentage based on the actual production rate versus a fixed maximum production rate. Example: If, during the machine's six hours of run time, the machine produces 80 parts per hour, but is capable of 100, OEE takes another hit.
3. **Quality** – A percentage measurement based on good parts versus total parts produced. Example: If only 60 of those 80 parts produced are good, then OEE takes still another hit.

Imagine the scenario above showing a 2-hour red block (downtime), which must shrink to improve OEE. Traditionally, this required automation and control networks that had the ability to identify the failure and a solution. While such diagnoses remain important, plant managers and operators typically don't become aware of problems until just before or soon after failures occur — too late to head off productivity losses. However, as the emphasis shifts from traditional diagnostics to condition monitoring technology, the three components (availability, performance and quality) improve and higher OEE becomes the norm.

Defining Condition Monitoring

Condition monitoring is comprised of technology and practices that detect faulty conditions long before a failure occurs. Like medical professionals who stress the importance of getting wellness exams to avoid health problems early on, the same goes for manufacturing equipment. In general, condition monitoring can be divided into two methods – electrical (measuring current) and mechanical (measuring vibration).

Here's an example of the electrical method:

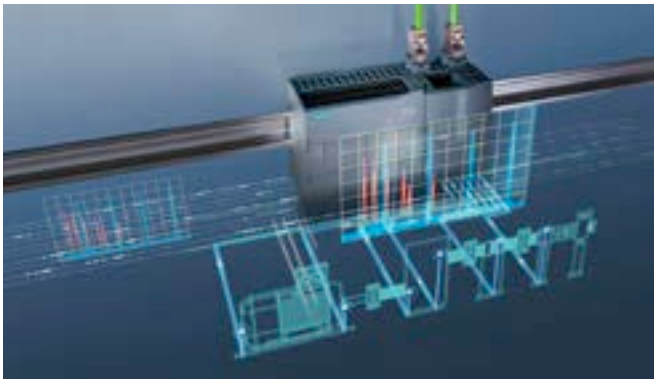
A motor that typically runs at five amps is now running at seven amps. If the manufacturer detects that change early on and makes appropriate adjustments before the motor overheats and the process stops, the manufacturer will have treated the root cause, avoiding downtime and lost productivity. Siemens SIMOCODE pro motor management is a good system to provide electrical-based condition monitoring.

SIMOCODE pro motor management system

Here's an example of the mechanical method:

A condition monitoring system such as the CMS 1200, based on the SIMATIC S7-1200, provides vibration monitoring of machine components. With a system such as the SIPLUS CMS 1200 by Siemens, as many as seven modules with up to four vibration sensors per module can be used. Since everything that rotates is subject to wear, the technology effectively serves as a tool for preventive maintenance. For example, a condition monitoring system would detect a crack in the base of a motor. Earlier detection of changes allows the manufacturer up to months to react when compared to only days or hours traditionally provided by watching and listening for unusual sights and sounds or touching the equipment for unusual spikes or drops in temperature.

In fact, the integrated software used in the Siemens SIPLUS CMS condition monitoring system provides information that can be used to help determine how much time remains until equipment fails, if the damage/error remains untreated. How? By using spectral analysis; the physics concept that measures and analyzes the properties of matter based on the material's interactions with electromagnetic energy. Simply put, every mechanical issue has its own fingerprint.



Siemens SIPLUS CMS 1200

Game-Changing Accountability

Another game-changer in improving OEE outcomes is the accountability of operators and technicians. In other words, understanding who does what and when. Perhaps there is a difference in productivity ranges between operators, indicating a need for further training. Or in the case of the earlier scenario showing 6 hours of availability and 2 hours of downtime, perhaps it took just 15 minutes to fix the equipment, but an hour and 45 minutes for the technician to arrive.

Common practices for tracking technicians and operators provide limited information for effective IDA. Technicians typically arrive and use a generic key to access the system. After putting the machine in maintenance mode, the technician gets information on a problem via the on-board diagnostic technology. Or, the technician may use the HMI panel and enter a handwritten passcode found under the screen before updating a paper log used to record who shows up and when. Such well-intended and antiquated practices should not be relied upon for accuracy and accountability.

There is a better way. Using SIRIUS ACT RFID keys, supervisors can assign user-specific keys to technicians and operators.

Benefits include:

- No two keys are the same, every key contains an embedded RFID chip with a unique hex code identifier;
- Each code is matched by the programmable logic controller (PLC) with previously stored values to identify the owner;
- If lost, the key can be identified if ever used again;
- Multiple keys can be assigned to a single owner; and
- The unique shape provides protection against tampering or duplication.
- SIRIUS ACT RFID communicates to the controller using an IO-Link.

Not only does the technology protect against misuse, it allows for varying levels of equipment access. For example, Operator A, an expert on Machine X, may have a coded key providing a higher level of access on that particular type of equipment, but not on Machine Y, for which he lacks adequate experience. Information is key, literally. Such systems are adaptable per machine, production line and factory location simply by accessing the database. Moreover, the database does not need to reside in the PLC, but rather it could reside in a central server with which the PLC communicates. The result is a much easier access process — one server talking to multiple machines, with the server determining who accesses what.

SIRIUS ACT RFID keys

Yet there is more to the technology than simply providing tailored equipment access to designated operators. Accountability plays an important role. For example, Operator A at the start of the shift inserts the RFID key. The system identifies Operator A, records the date and time, and notes equipment status. Then, several hours into the shift, the equipment's condition monitoring diagnostics may show that the machine is running hot, so Operator A removes his key and requests maintenance. Maintenance arrives, inserts his key and begins troubleshooting. Once done, maintenance removes the key, and the database captures an availability measurement. Perhaps it shows that the fix took just 15 minutes, but that it took 1 hour and 45 minutes for maintenance to arrive. This explains the reason for the 2-hour red block and provides management with important information for effective IDA in determining whether downtime in this scenario has more to do with a personnel or logistics situation than it does a mechanical condition. Another scenario: Operator A data shows much higher equipment availability than Operator B, revealing, perhaps, a need for additional training.

In each of these instances, WinCC HMI software by Siemens displays recorded events and provides reliable analytics on:

- OEE;
- Mean Time Between Failures (MTBF);
- Mean Repair Time (MRT); and
- Additional Key Performance Indicators (KPI).

These key analytics also make it possible to improve your IDA model according to specific equipment, plants and operators. Customized data may be stored either in an internal server or a cloud-based system, such as MindSphere, with data analytics performed using MindApps to increase uptime, optimize energy efficiency and enhance cyber security. Moreover, recognizing that dashboards sometimes show too much data, customized dashboards may be configured to show only the required data.

The Best of Both Worlds

Today's condition monitoring technologies, when effectively used, have the ability to break down traditional communication barriers that often exist between Information Technology (IT) and Operational Technology (OT).

With one architecture connecting the control and networking systems, sensor networks provide IT and OT with the same information. Furthermore, systems are scalable from single machines and plants to multiple systems and factories, making condition monitoring the best medicine for manufacturers everywhere looking to improve OEE outcomes.

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