WHITEPAPER

ei^{3}'s QUALITY for Smart Manufacturers

SIX SIGMA IN THE AGE OF IIoT

To many in the manufacturing industry, Six Sigma has become synonymous with efficient quality management.

Originally of the 1920s, developed as an evolution over the bare-bones method of statistical process control, the Six Sigma process goes even further.

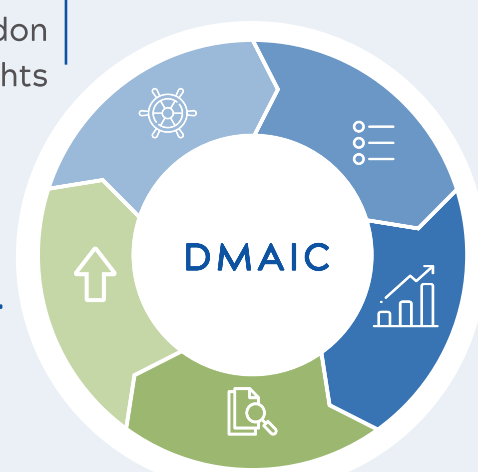
Six Sigma promises quality heaven by ensuring processes stay within sub-bounds around theoretically acceptable tolerances to ensure defect rates. On top of these purely numerical controls, Six Sigma goes further.

Six Sigma adds an operating culture focused on continuous improvement.

Over the years, Six Sigma practices have brought billions of savings to the manufacturing sector, and its adoption has been far and wide. It has been, by anybody's standards, a resounding success. But that is not to say that Six Sigma cannot or should not evolve to meet ongoing challenges.

THE CORE STEPS OF THE SIX SIGMA PROCESS IS BROUGHT TO NEW LEVELS OF SOPHISTICATION WITH ei3's IIoT TECHNOLOGY

01 | **Define** CTQ trees and input performance standards online with ei3's easy to use web forms



02 | **Measure** results and any deviations using real-time SPC run-rules

03 | **Analyze** process variation sources using our powerful RTQ (Related to Quality) Explorer

04 | **Improve** and verify the solution by setting recipe limits to alert if machine goes out of spec

05 | **Control** the quality effectiveness by providing operator's dahsboards and andon displays with actionable insights

1. Define

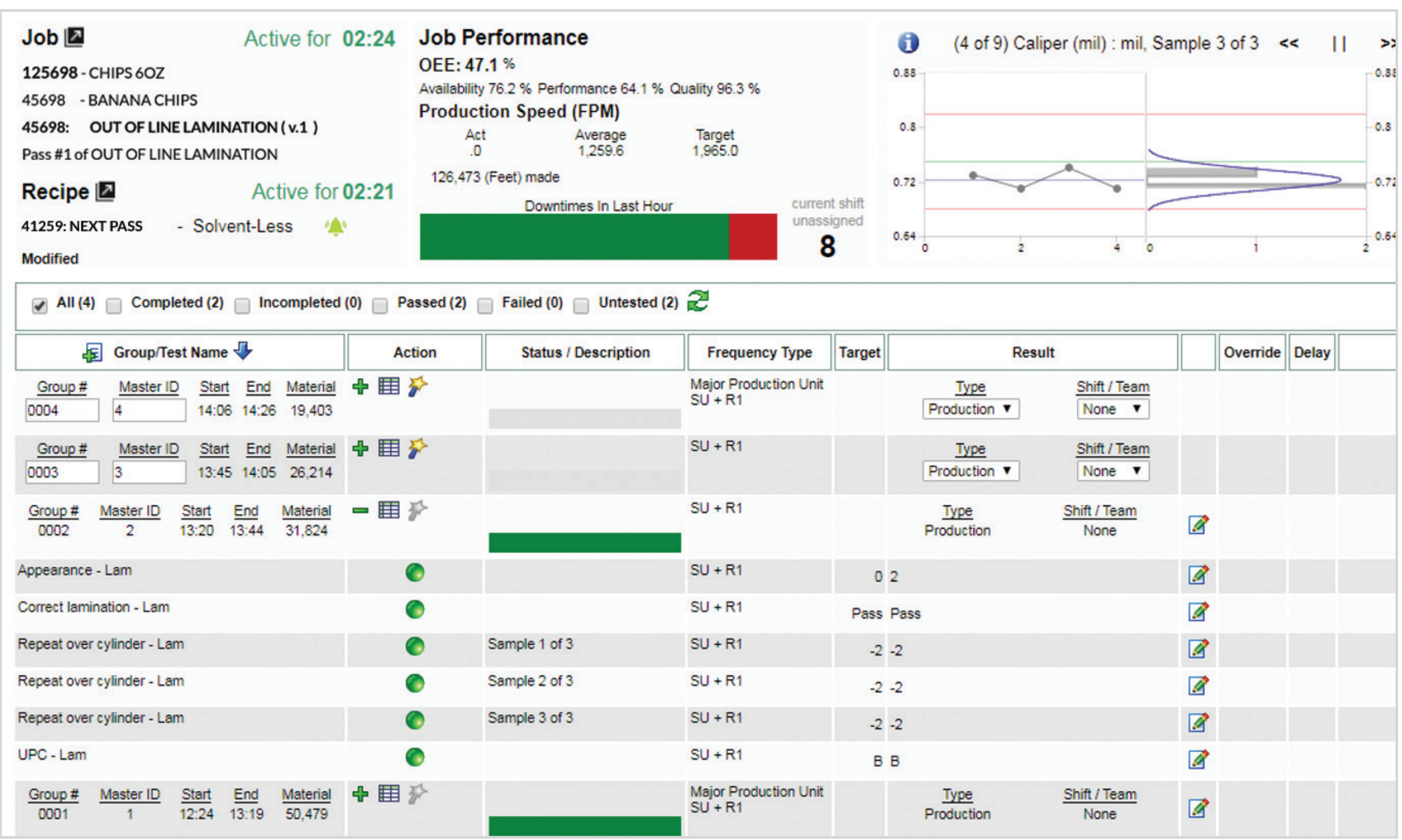
Manufacturing processes must define quality standards, maybe manufacturing tolerances, against which results can be measured. Once a static or at best periodic process that took into account cost targets, functional requirements, and tooling, real-time information on the state of the tool chain, and the client requirements, can be reviewed continuously to set goals that may change from batch to batch, or even part to part.

Online systems, such as the IIoT system provided by ei³, allow operators to set performance standards easily and ensure identical parameters are applied across uniformly — whether it's a single machine with shifts running under the watch of a small crew of operators, or a multi-national operation. Definitions set digitally on a platform will apply to all in the same manner.

2. Measure

When Statistical Process Control (SPC) was first envisioned in the 1920s, quality control required manual intervention on a few samples taken from a conveyor belt. Statistical methods were then applied to extrapolate the quality of a larger batch from those few parts. Over the years, measurement techniques have evolved, and automation has now brought us to a level wherein many cases "100% inspection" is possible and also economically viable. As a result, quality deviations and drift will be visible quickly, and corrective actions are possible across a fully automated process control system to ensure minimum scrap.

With ei³, users measure continuously and automatically as part of the process control flow. The data is collected centrally and can be visualized and inspected by operators, quality control, and management, from every machine, every line, every plant.

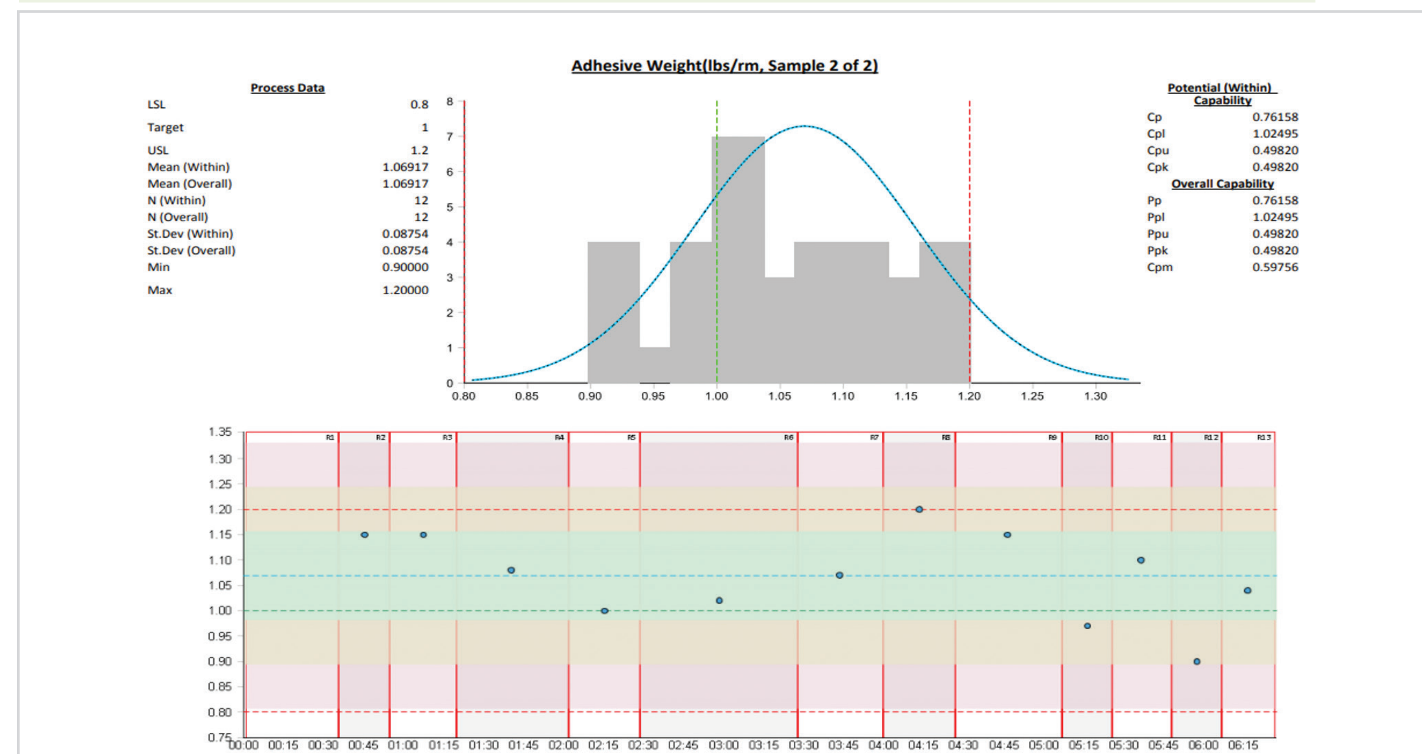


In the screen show above, the ei³ system visualizes continuous measurements taken on an operating line; immediately giving operators feedback on results, including "Pass" and "Fail".

3. Analyze

The third step of the Six Sigma process is often misunderstood as identifying scrap parts as such. However, if correctly done, this step identifies the causes of process deviations. Is a machine tool showing signs of wear and tear? Is a process running against physical constraints? Is there a material issue? A process issue? With ei3's complete and real-time data, 100% trending is a viable reality, allowing this analysis to be done with unprecedented speed and accuracy.

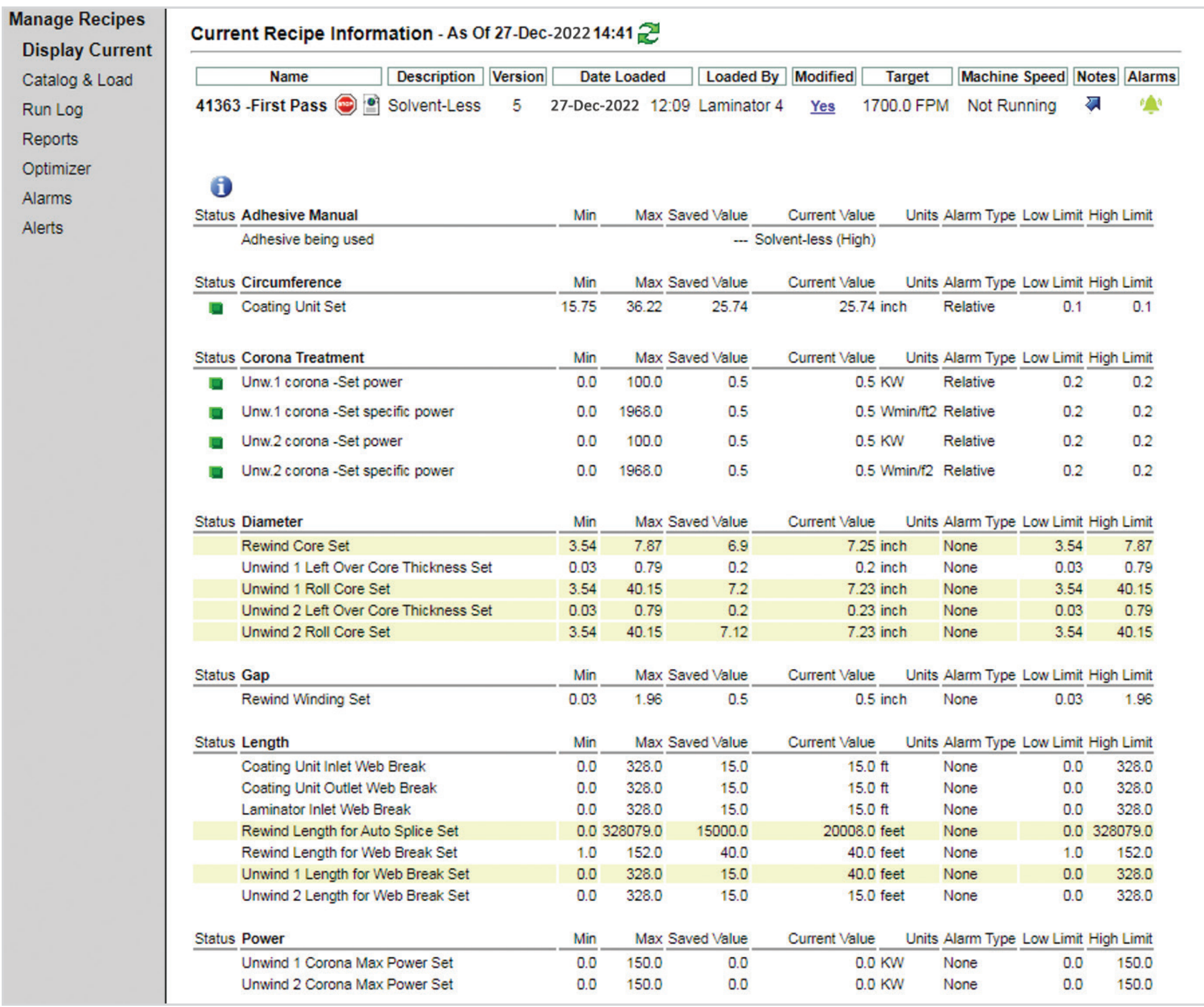
With ei³'s IIoT solution, analysis is not confined to data review by quality control. Instead, the study is conducted continuously as real-time process data is collected. Alarm conditions can be set to create alerts whenever and wherever a measurement falls outside allowable tolerances. But ei3's analysis goes further. With the amount of data available and because it's collected continuously, failures can be traced back to identify the root cause. Forward-looking predictive functions can create alerts before tolerances are violated, reducing scrap and improving machine output. The system also generates automatic Certificate of Analysis (COAs) in minutes for ISO 9000 Compliance.



In the screenshot above, the ei³ system summarizes measurements taken in the continuous manufacturing process, visualizing the spread of the measurement variable across the desired value. Cut-off lines on either side visualize allowable bands. Operators immediately see if the plant is operating at excess waste, i.e., measurements falling outside those bands.

4. Improve

Action time! Root cause analysis is done; it is time to change whatever needs to be changed, updated, or removed to avoid a repeat occurrence of a problem. Fully integrated IIoT solutions, like ours, enable continuous implementation of actions on real-time systems and monitoring for effectiveness. As part of this process, SOP documents are provided to testers and operators to ensure proactive corrections.



Manage Recipes
- Display Current
- Catalog & Load
- Run Log
- Reports
- Optimizer
- Alarms
- Alerts

Current Recipe Information - As Of 27-Dec-2022 14:41

Name	Description	Version	Date Loaded	Loaded By	Modified	Target	Machine Speed	Notes	Alarms
41363 -First Pass	Solvent-Less	5	27-Dec-2022 12:09	Laminator 4	Yes	1700.0 FPM	Not Running		

Status	Adhesive Manual	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Adhesive being used			---	Solvent-less (High)				

Status	Circumference	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Coating Unit Set	15.75	36.22	25.74	25.74	inch	Relative	0.1	0.1

Status	Corona Treatment	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Unw.1 corona -Set power	0.0	100.0	0.5	0.5	KW	Relative	0.2	0.2
	Unw.1 corona -Set specific power	0.0	1968.0	0.5	0.5	Wmin/ft2	Relative	0.2	0.2
	Unw.2 corona -Set power	0.0	100.0	0.5	0.5	KW	Relative	0.2	0.2
	Unw.2 corona -Set specific power	0.0	1968.0	0.5	0.5	Wmin/f2	Relative	0.2	0.2

Status	Diameter	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Rewind Core Set	3.54	7.87	6.9	7.25	inch	None	3.54	7.87
	Unwind 1 Left Over Core Thickness Set	0.03	0.79	0.2	0.2	inch	None	0.03	0.79
	Unwind 1 Roll Core Set	3.54	40.15	7.2	7.23	inch	None	3.54	40.15
	Unwind 2 Left Over Core Thickness Set	0.03	0.79	0.2	0.23	inch	None	0.03	0.79
	Unwind 2 Roll Core Set	3.54	40.15	7.12	7.23	inch	None	3.54	40.15

Status	Gap	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Rewind Winding Set	0.03	1.96	0.5	0.5	inch	None	0.03	1.96

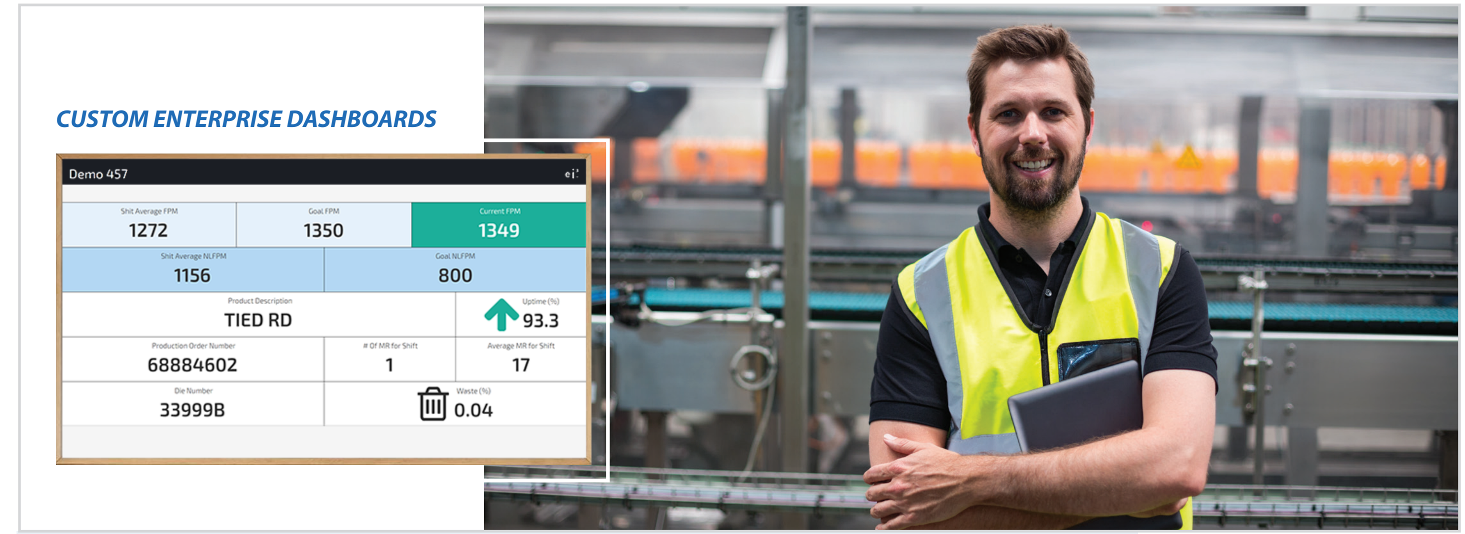
Status	Length	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Coating Unit Inlet Web Break	0.0	328.0	15.0	15.0	ft	None	0.0	328.0
	Coating Unit Outlet Web Break	0.0	328.0	15.0	15.0	ft	None	0.0	328.0
	Laminator Inlet Web Break	0.0	328.0	15.0	15.0	ft	None	0.0	328.0
	Rewind Length for Auto Splice Set	0.0	328079.0	15000.0	20008.0	feet	None	0.0	328079.0
	Rewind Length for Web Break Set	1.0	152.0	40.0	40.0	feet	None	1.0	152.0
	Unwind 1 Length for Web Break Set	0.0	328.0	15.0	40.0	feet	None	0.0	328.0
	Unwind 2 Length for Web Break Set	0.0	328.0	15.0	15.0	feet	None	0.0	328.0

Status	Power	Min	Max	Saved Value	Current Value	Units	Alarm Type	Low Limit	High Limit
	Unwind 1 Corona Max Power Set	0.0	150.0	0.0	0.0	KW	None	0.0	150.0
	Unwind 2 Corona Max Power Set	0.0	150.0	0.0	0.0	KW	None	0.0	150.0

Lessons learnt on one machine become more valuable when they are shared with other machine and plant operators. ei³'s IIoT solution collects lessons learnt in a systematic way so they can become the foundation of knoweldge that helps drive best practices everywhere.

5. Control

Six Sigma uses SPC tools such as run or control charts to provide ongoing control tools to operators and managers. ei³ provides these at unprecedented speed and precision, through dashboards and "andon" displays.



Visit www.ei3.com/products/andon-display/ to see the full gallery

Hundreds of Six-Sigma black belts and quality assurance personnel use ei³ daily to improve product yield.

IN A NUTSHELL, HERE'S WHAT THEY LIKE:

- Tools to identify correlations between test results & machine parameters.
- Seamless integration with existing quality management systems to promote collaboration.
- Application of real-time SPC methods to monitor deviations of parameters important to product quality.
- Operator dashboards that can pinpoint & address problem areas quickly. Proactive quality assurance, reducing overall machine downtime and decreasing labor costs.
- Data delivered using APIs that can feed into business systems for streamlined functioning.

IIoT - "Six Sigma Reloaded"

For fans of Six Sigma, the Industrial Internet brings whole new opportunities to make better what they love already: a focus on setting, managing, and verifying goals, and the culture that revolves around continuous improvement. IIoT allows more angles of the manufacturing process to be scrutinized and subjected to that circle. Errand machine behavior - previously missed by irregular or low-frequent inspection cycles, are a thing of the past as the machines must deliver status and measurements on a never-ending continuous basis.

For those who have not yet tried Six Sigma in their shop, the Industrial Internet gives them a chance to do so now. Modern machines create data at overwhelming rates; making good use of the data will soon be a necessity to maintain competitiveness by reducing waste and increasing machine utilization. And while the data is there anyway, why not look at it through the Six Sigma glasses and figure out a way to manage your machine park in a whole new, fact-based fashion.

www.ei3.com

Access our growing list of client success stories, read up on our products.

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