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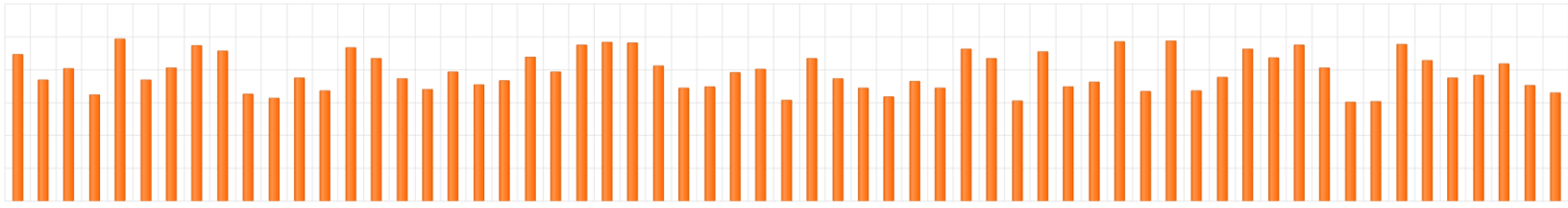
MANUFACTURING ANALYTICS

Where's the Value? White Paper



Introduction

Manufacturing is changing. Gone are the days of simply making physical products. Changes in consumer demand, supply chain, and technology are forcing manufacturers to evolve and adapt. These trends are expected to continue. As companies embrace the future of manufacturing, more automation will be in place and more data will be generated.

The most successful manufacturers are the ones that will collect, understand, and leverage their data to make smart decisions to give them a competitive edge.

With the inclusion of greater demand on the supply chain and increased automation, companies will need to determine how the lines and equipment are running, in real-time to improve performance and create efficiencies.

This is where manufacturing analytics is critical for modern manufacturers. In this paper, we will review what manufacturing analytics is, how it's different than existing manufacturing software, and how your company can use it to create a competitive advantage and dominate the market. This white paper will cover:

- What is Manufacturing Analytics?
- What's Different About Standalone Manufacturing Analytics Software vs. Other Platforms?
- How Do You Use Manufacturing Analytics?
- Going Beyond OEE

What is Manufacturing Analytics?

As its name suggests, manufacturing analytics can be described as an application that helps companies understand their machine data, but it actually goes beyond that. A true manufacturing analytics application must do 4 things well:

- Acquire Data
- Clean & Contextualize Data
- Calculate Manufacturing KPI's
- Produce Role Based Visualizations & Dashboards

Acquire Data

A manufacturing analytics system, like Mingo, must have the ability to collect data directly from equipment on the factory floor. It should be able to connect directly to the PLCs, sensors, controls, and DCS while extracting and contextualizing meaningful information.

Acquiring data directly from operators and supervisors on the factory floor is also critical. These employees can provide context that cannot be gathered directly from the equipment.

Clean & Contextualize Data

Data must be cleaned and filtered as it is collected from the equipment as all data coming from the machines may not be relevant and should not be processed. Some data is filtered inside the plant and some data is sent to the cloud. This is done to reduce the noise and make sure the data used by the manufacturing analytics system is ready for display and calculations without further processing.

As the data is ingested, context should be added in relation to the associated department, facility, shift, product, team, operator, and production line, etc. The reasons for quality issues and downtime should also be added to help with analysis. Additional supporting data can be gathered to help with diagnosis of issues such as equipment parameters and settings, pressures, speeds, and fill rates. **Without context, this data is essentially meaningless.**

Calculate Manufacturing KPI's

Precise KPI's are key to any continuous improvement project but you must have the right metrics before ever getting started. The system should calculate things like OEE, throughput, cycle times, first pass yield and downtime in-real time. These are standard formulas which come out of the box in manufacturing analytics solutions and don't have to be created from scratch.

Role-Based Visualizations

Being able to visualize data in meaningful ways is critically important to analytics project ROI. A user wants the right data at the right time, and they don't want to look for what they need. A manufacturing analytics system shows users the right data, at the right time, nothing more and nothing less. Most systems have default dashboards by job role out of the box so everyone from maintenance to plant managers to supervisors and schedulers have the data they need to do their jobs.

What's Different About Standalone Analytics?

Analytics on their own aren't particularly useful.

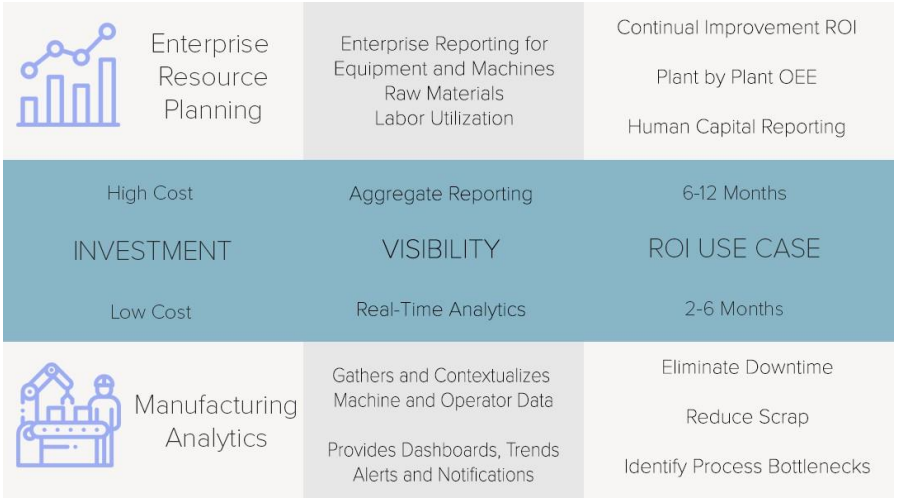
In the case of the factory floor, context, such as the time of day, shift, specific operator, cell, or line are what provides the value of any view. Many manufacturing software platforms use or require analytics as part of their basic function, but that's just what is, basic.

Solutions like Mingo contain all the components needed to collect, transform, contextualize, and report on machine and operator data. Whereas the tools in this section require IT or specific experts to configure, test, and deploy them.

Here, we briefly describe what each manufacturing system platform does that's different than what a standalone manufacturing analytics solution provides:

ERP – Enterprise Resource Planning

ERP, as its name suggests, focuses on planning and accounting - looking at demand and creating the appropriate supply. Because of its transactional nature, ERP does not handle high volumes of streaming machine data. It is a key part of any manufacturing company but should not be used day to day on the factory floor to directly manage and measure production. ERP's role in production is to create and manage the schedule and track progress against the schedule. Inventory is a key part of what ERP does as well.



MES/MOM – Manufacturing Execution System or Manufacturing Operations Management System

These are two different categories of software, but they perform the same functions. MES systems track the execution of production orders in real-time; collecting data from operators and machines to ensure a quality product is delivered on time. Manufacturing analytics has some overlap with MES because manufacturing analytics systems can collect data from machines and operators. The difference is that manufacturing analytics systems focus on trends and the analysis of data from many different sources to get a full picture of what is happening on the factory floor. **While MES focuses on current issues, manufacturing analytics focuses on what happened in context.**

BI, EMI, & MII

Business Intelligence (BI), Enterprise Manufacturing Intelligence (EMI), or Manufacturing Integration & Intelligence (MII), are all systems that can analyze data on production lines and factories. These tools can be used with others to create an application similar to manufacturing analytics. **The biggest difference is that manufacturing analytics isn't just a complex tool.** A company can quickly deploy manufacturing analytics software without spending a lot of time or money on consultants.

SCADA - Supervisory Control and Data Acquisition

SCADA is a very wide-ranging breed of a software category. It uses computers to control and collect data on production lines in a factory. This includes many different components. SCADA systems and manufacturing analytics overlap in their ability to collect data. However, manufacturing analytics does not control processes like SCADA does. SCADA systems can visualize data, but it is typically what is happening now rather than trends over time.

OEE Solutions

Since the creation of the OEE metric, many software packages have been created to collect data to calculate OEE. Manufacturing analytics can calculate OEE and do it well, but **manufacturing analytics also goes far beyond OEE.**

As we mentioned above, solutions like Mingo Manufacturing Analytics can collect OEE data and any other data points that affect the process and put it in context of a production record. Mingo can also collect data from operators via custom built HMIs or the Mingo application.

How Do You Use Manufacturing Analytics?

Manufacturing analytics allows manufacturers the ability to:

- Identify causes of issues
- Unlock hidden capacity
- Monitor and track improvement and consistency over time

Manufacturing is about throughput, meeting customer demand on-time with a quality product at a price that makes the company money, and where the customer can see value. Below, we review specific scenarios where a manufacturing analytics solution, like Mingo, can help a manufacturing company.

Availability

Availability measures the amount of time the machine is running compared to the planned schedule. You have to measure it to reduce downtime. To determine the availability of a machine or cell, Mingo collects and calculates downtime using alarms and other signals directly from the controls or PLCs on the equipment. Mingo can also augment this information with input from operators or supervisors.

Reducing Downtime Means Tracking All Downtime

Reducing downtime includes reducing short stops or micro stoppages as well. Short stops are stoppages that would not normally be recorded by the operator, for example if a small adjustment needed to be made that took less than 5 minutes. However, these short stops can happen many times a day and add up to significant numbers.

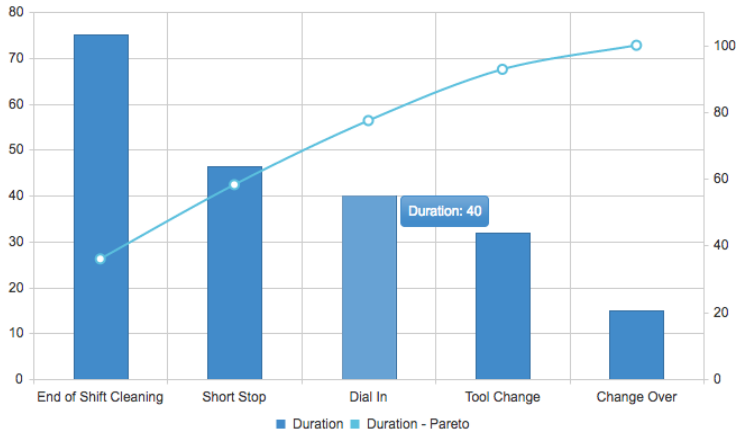
Reason	Count	Total	Avg
Change Over	1 —	15 —	15.00 —
Dial In	4 —	40 ↓	10.00 ↓
End of Shift Cleaning	2 —	75 ↓	37.50 ↓
Short Stop	36 —	46 ↑	1.29 ↑
Tool Change	1 —	32 —	32.00 —

Pareto Charts

Mingo offers Pareto Charts out of the box to help determine the most common causes of downtime.

The Pareto chart (pictured) shows downtime in minutes. It is easy to see that 80% of the downtime is caused by 3 reasons:

- End of Shift Cleaning – 75 minutes
- Short Stop – 46 minutes
- Dial In – 40 minutes



With end of shift cleaning taking up most of the time, reducing end of shift cleaning will have the greatest time impact on production. Users can dive deeper into the data to determine if this is the right issue to focus on.

Reduce Downtime – Details by Reason

In the table at the beginning of this section we saw 3 things:

- Number of downtime events by reason
- Total duration in minutes
- Average duration in minutes

Looking at the downtime details by reason code, you can determine the most common reasons of downtime. In this example table, there is a high number of short stops and almost the same

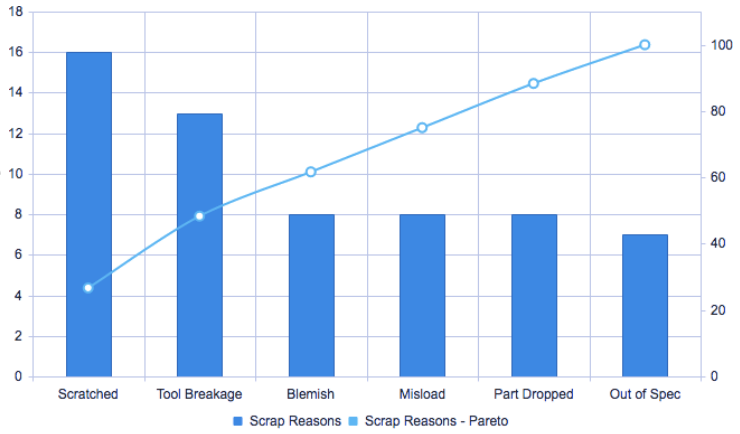
amount of time in Dial-In. The production and engineering teams may be able to completely eliminate both of these problems and give back 86 minutes of production time.

Top Downtime Events

Users can dive further into the details by looking at individual downtime events to see how long they lasted and if there are any comments associated with them to give additional context on the problems.

Downtime Trends

Mingo allows users to track trends in data allowing them to see over time how a plant is running. Using trends, you can easily see the effect of process or system changes over the long term. You can also notice when downtime is increasing or decreasing and quickly take action to resolve the issue.



Quality

Quality largely centers around one core element, scrap, and measuring the amount of good parts produced versus total parts produced. This data can be gathered from equipment and reason codes data such as; temperature, pressure, speeds, vision systems, and any other data points accessible from the equipment.

But, how do manufacturers improve or affect their scrap rates? It all starts with having the right data. If you have the right data sets and have the ability to understand the data, you can implement change.

Scrap Reason

Understanding the reasons behind scrap and turning these reasons into reliable metrics that you can use can allow a clearer look into what may be your biggest, and potentially most easily fixable problem.

Cell	Scrap Reason	Count	Avg	Total
HAAS VF-5	Scratched	10 —	1.60 ↑	16 ↑
HAAS VF-5	Tool Breakage	10 —	1.30 ↓	13 ↓
HAAS VF-5	Blemish	8 —	1.00 —	8 —
HAAS VF-5	Misload	8 —	1.00 —	8 —
HAAS VF-5	Part Dropped	8 —	1.00 —	8 —
HAAS VF-5	Out of Spec	7 —	1.00 —	7 —
		51	**1.18**	**60**

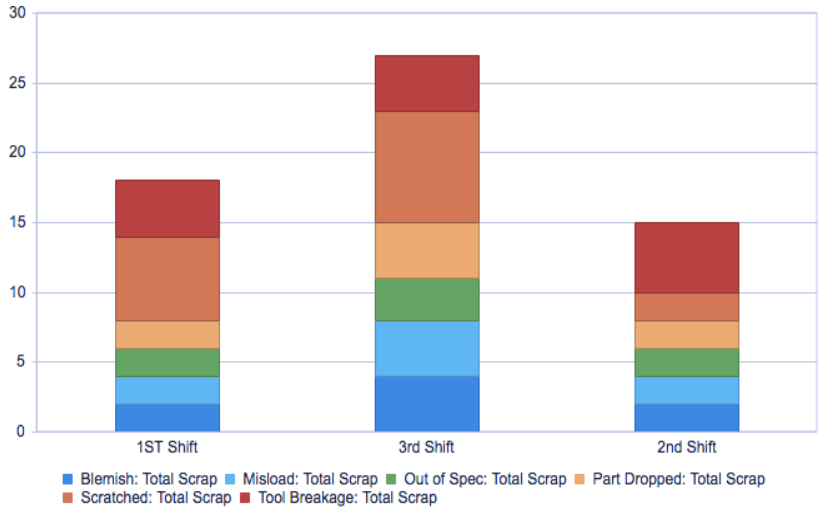
3 Great Points to Start at...

- Number of times a scrap reason occurred
- Average number of scrapped parts per entry
- Total number of scrapped parts by reason code

Looking at reason code trends we can get a better idea of what may be the biggest problem in true context. Are you producing more scrap or less over time? When and why?

Scrap in Context

Manufacturers need to look at scrap in true context. In many cases, it is looked at retroactively and never fully realigned back with the reason why one shift may be producing 50% greater scrap than another during a certain time period.



If you can't see how each shift is performing day over day, you'll never know when problems arise until it is far too late. Even if one shift is always producing more scrap, that's fine, as long

as it's consistent. The waste is always in the inconsistencies. Even if consistency is the main goal, comparing shifts may give you valuable staff training opportunities if one is being significantly outperformed by another.

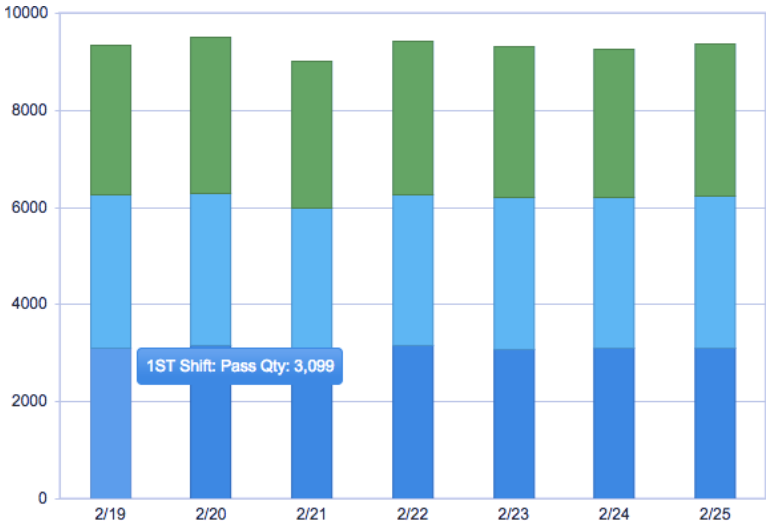
Trends

Measuring and looking at scrap rate trends, you can easily see the effect of process or system changes over the long term. The problem most have with this is the same as our point above regarding shifts. Many only look at their trend data retroactively. This means not seeing a negative trend until the opportunity to save money is gone!

Above, you can see that scrap rates are varying greatly in this time period, but the trend line is clearly moving up. What if you didn't see this until 4 months down the road? What would that have cost you?

Throughput

Performance or throughput of a machine, cell, or production line is extremely important to a manufacturer's ability to meet their schedules and deliver to their customers on time. It is also an important factor in controlling cost if the company cannot meet its production goals. For each shift of production losses, they will have to schedule unplanned overtime which is costly.



Performance measures the actual cycle time versus the ideal cycle time. To calculate performance, Mingo collects part or product counts from the machines and compares them against the ideal cycle time in the system. This data is collected directly from the existing controls and PLCs on the machine or production line.

Throughput in Context

Users can look at throughput and performance by shift to look for opportunities for improvement. Many times, different shifts run machines and production lines slower or faster than others. One shift will figure out how to do something better or faster but neglect to share it with the other shift leaders. Using the data, companies can find the opportunities to share knowledge and improve performance.

Performance Trends

With manufacturing data, and especially performance data, it is all about the trend. Is the line getting faster or slower, has the bottleneck moved? Mingo allows you to track trends in your data so you can see over time how your plant is running. Using trends, you can easily see the effect of process or system changes over the long term.

Performance Alerts

Using Mingo, a user can easily setup alerts when cycle times or throughput is higher or lower than normal. These alerts can notify employees; from maintenance engineers to manufacturing supervisors to operators of a production line. Everyone will benefit from this real time information.

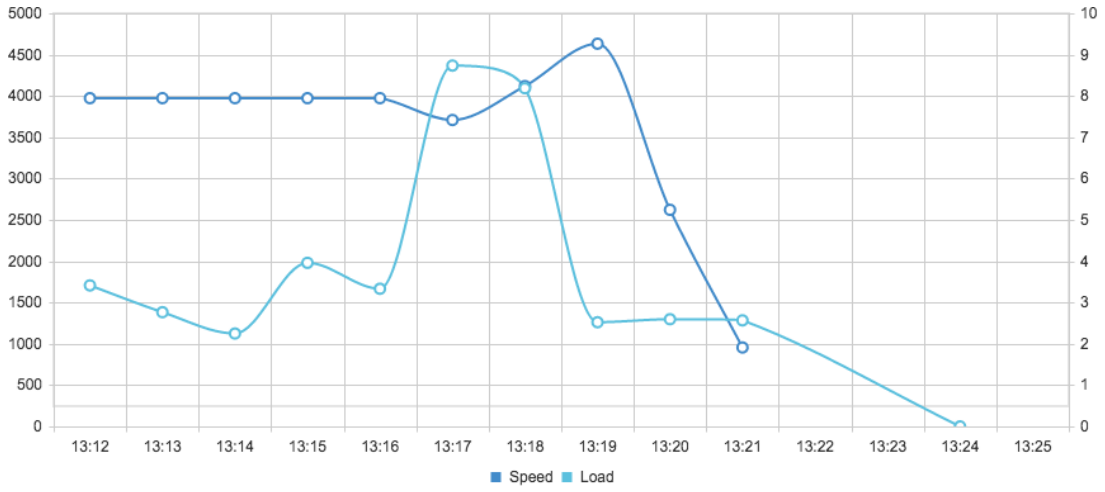
OEE

OEE (overall equipment efficiency) is a great metric for improving and monitoring processes. It helps companies quickly and easily identify issues on production lines and equipment on the plant floor. But as smart manufacturers already know, OEE does not tell the whole story. Read more about OEE here and here.

Going Beyond OEE

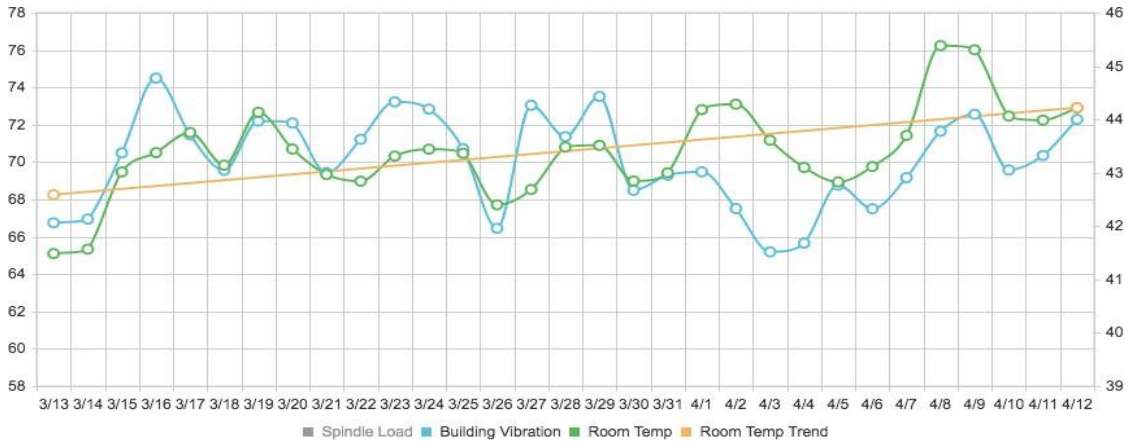
Using Mingo, you can go beyond OEE, and beyond Availability, Performance, and Quality to second by second details of what was happening when a line went down, was running slow, or produced a bad part.

Mingo can show you speeds, feeds, pressure, temperature and any other metrics gathered from a sensor on that same line. This data is shown in the context of the production records and can be used to solve and fix issues at the source of the problem.



Parameters in Context – Spindle Load and Speed Example

This chart is looking at the load on the spindle when a tool has broken. We can see that spindle speed and load are somewhat correlated, but not completely. A high rate of spindle speed does not mean the tool is actually cutting.



External Data in Context – Temperature Example

Your production temperature, whether it is ambient temperature or temperature of a machine component, can have a big effect on quality. Tracking temperature, and linking it to quality and performance data, can help the shop floor figure out where adjustments might need to be made.

Settings in Context – Pressure Example

Pressure in pneumatic and hydraulic systems is very important to proper operation of equipment. It can be hard to diagnose leaks and problems with equipment without long- term data collection. Again, just like the two examples above, pressure data can be correlated with quality, performance, and availability to understand why a system is running slow, producing a bad product or to determine why the system went down.

Complete View: Smart Sensors and Devices

Right now, many companies are working with smart sensors and devices to help monitor and improve the reliability of equipment. These sensors do a great job of detecting problems on a single piece of equipment, a valve, motor, or pump for example. But what about the system as a whole?

That pump or valve is always a part of a larger system and manufacturers must be able to understand how the performance of that equipment fits in the overall picture. Mingo helps customers understand the root cause of production issues by surfacing data from these dependent devices automatically.

Conclusion

The increased customer demand, expansion of the supply chain, implementation of automation, and increased reliance on machines to optimize themselves will require better data and more data-driven decisions from manufacturers. This will be the role of manufacturing analytics in the near future for modern manufacturers.

About Mingo

Mingo, The Manufacturing Productivity Platform, provides visibility into the factory floor by automatically collecting data from machines, devices, and people and puts it all into context. Mingo is revolutionizing manufacturing by offering a complete solution from sensors to data collection to analytics that provides real-time insights into the productivity of the factory. Those insights give a manufacturer the ability to reduce costs, ensure customer on-time delivery, and improve quality.

Mingo enables companies to start small, think big, move fast and easily grow from a single machine at one plant to thousands of machines across the globe with manufacturing analytics. https://gomingo.io/