ei³

The Path to Predictive

Machine Builder's Roadmap

Introduction

Create a global market for predictive IIoT services on your machines

Will the Industrial Internet of Things help make a better world? We think it will, because whether it's watering crops at just the right time or timing street lights to reduce traffic, we are surrounded by opportunities to predictively solve problems and help make people and business more efficient.   Machine builders are no exception. Many have a vision to monitor equipment performance and create new service programs to predict key outcomes. Their vision is driven by the ability to process data, understand machine operation, and proactively alert on valuable events. For example, value is created by predicting when a consumable is needed, or by scheduling a part replacement during a routine maintenace session. Predictions like these foster new business models that alert people and systems to take action before something goes wrong. Becoming predictive is a major value driver of the Industrial Internet of Things and as such, many companies are searching for practical ways to provide predictive services to their customers.

Since our start in 1999, ei³ has provided OEM solutions using the IIoT.   From this vantage point of 17 years' experience, we have created a roadmap for machine builders to reach the promised value of predictive services. We call this the "Path to Predictive". Here we present this roadmap along with reasons why it is built upon a successful Industrial IoT strategy.

Install IIoT Hardware

Add connection equipment to your machine

Putting a global install base of machines online is a daunting challenge. It is achievable by adhering to a broad vision of having all your machines online. Once a commitment is made to this vision, the first step is to standardize machine designs and install equipment so that every machine is ready to connect.

Add secure internet communications equipment to your machine bill of materials. This step "future-proofs" machines and builds an addressable market for your new business of IIoT services. Every machine shipped contributes to a growing install base. Your customers will appreciate the ability to put their machines online and benefit from your predictive cloud-based IIoT services.

TIP:

Choose a connection solution that works with new and existing machines. Your customers enjoy the benefits of the IIoT and they will want to put your solution on all equipment. Make it easy to connect to existing machines.

Connect Machines

Make secure communication links part of the start-up of every machine

Etablishing a secure connection should be an integral step of commissioning a new machine .   Technicians can use the connection to check out and calibrate machines from their desk. Doing this usually reduces travel costs in warranty reserve so much that it creates a ROI for the hardware and connection simply by reducing the startup and warranty costs. Network security is an important concern so the machine connection solution must have features to enable controlled, audited remote access for authorized and authenticated technicians and engineers.

One ei3 customer has measured a more than 80% reduction of service trips for start-up and warranties. Their machine owners are aware that the IIoT brings value by reducing unplanned downtime. This awareness has changed their attitudes and policies about connecting equipment. If you deliver a solution with world class security, your customers, the machine owners, will allow connections to be made to plant floor equipment. And they know that IIoT will provide a solid return on investment.

TIP:

Share the benefits and cost savings with your customers. This will provide them with the incentives needed to allow machine connections.
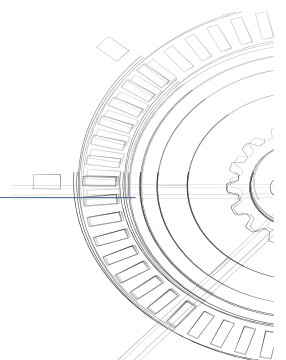
Monitor Machines

Accumulate the data needed to understand machine operations

In all machines that are digitally controlled, everything that is important to the productivity and quality of a machine is controlled by a Programmable Logic Controller, industrial PC, or embedded computer. Internet communications using standard protocols make instantaneous readings of key values readily available to be collected as data.

There is a growing list of IIoT standards that make it easier to gather machine data. Examples include OPC-UA, PackML and others. But don't wait. There is no need to redesign machine controls around these standards. Valuable data monitoring can already be done using existing legacy communication methods.

Machine data is collected online by cloud servers that gather and store key values in a database. This forms the foundation for analytic-driven insights that ultimately improve machines and production. Six-sigma practitioners appreciate having convenient access to a secure source of the data that they need to understand their process and machine operations. Machine data can also be used for compliance reporting because it provides traceability and is safely backed up off-site.

A common question is what data to collect? There is no real answer to this question but a good place to start is to capture everything shown on the machine's operator interface – set points, feedbacks, states, and faults.

| TIP: | Start by storing every value shown on the machine HMI. It is better to start the IIoT journey with this data than wait to complete a complex data definition project. More monitored points and sensors can be added later. |

Track Key Performance Indicators

Use a standard method for measuring machine performance to create a common global benchmark.

Organizations relentlessly strive to maximize the output of their shop floor machines.   Sharing real time machine performance across the shop floor is a proven way to boost production.   Studies show that displaying machine KPIs creates a ROI by improving plant floor OEE by up to 5% per year.

Displaying OEE performance can be challenging for manufacturing plants. The IIoT provides plant managers with a perfect solution to capture, store, analyze, and display machine Key Performance Indicators.   Monitored data from securely connected machines is analyzed in the cloud to generate informative performance numbers e.g. OEE. This information is delivered to plant people via web pages, dashboards, reports, and mobile apps. Performance information is also shared with computing systems, ERP, and business software using RESTful APIs to exchange data.

Machine owners will pay for Software-as-a-Service subscriptions that provide these real time measurements. This is one way the machine builder is rewarded for delivering IIoT services.   Performance KPI data becomes a global machine standard measurement that helps product development engineers understand performance in different settings at different customers.   The aggregation of performance information is a key requirement for analytics to be able to understand– and find – the golden nuggets of information that drive predictive services.

TIP:

Make equipment OEE a part of your culture. Most manufacturing organizations that pursue Lean Manufacturing/Six Sigma use OEE as a benchmark KPI to measure productivity. They will appreciate your IIoT solution for OEE tracking.

Discover Improvement Opportunties

Reduce downtime by tracking machine stop codes and reasons

The largest improvement opportunities usually come from the largest sources of unplanned machine downtime. So the most fruitful efforts start by finding the largest sources of unplanned downtime. This requires capturing every downtime event and the reason behind it. Pareto analysis and tree maps of these unplanned downtime events separates the vital few from the trivial many and quickly reveals problems that hold promise for machine improvement.
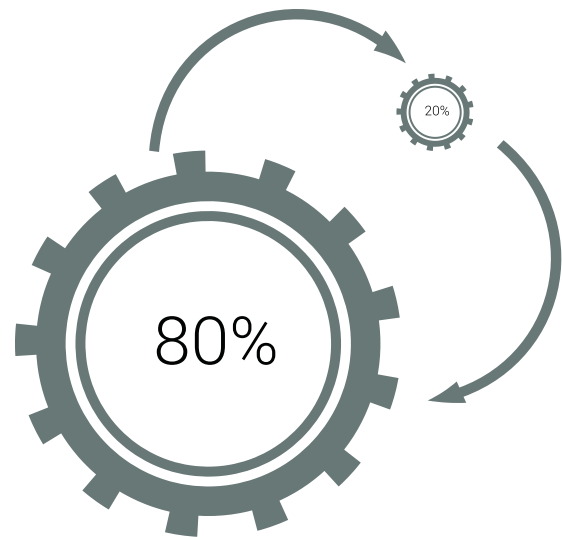
Making changes and solving the root causes of the top culprits behind unplanned downtime across an entire installed base yields a strong return on investment for both the machine owner and the machine builder. Downtime data is best analyzed using cloud services because data from many machines can be aggregated. By bringing in data from multiple machines across multiple plant sites - and for the OEM even across customer company boundaries, - makes it possible to find the most common major causes of problems.

It is a perfect application for the IIoT, because unlike an in-the-walls solution, the cloud solution can measure the aggregate stop reasons for an entire global install base. This powerful technique reveals the top reasons for machine stoppage – independent of customer use,

product, geography and many more factors. The resulting information leads to better performance and better machine designs.

Further, most digitally controlled machines have logic that automatically stops the machine if something goes wrong. These stop reasons are known and categorized by the machine controller as "stop codes" or "fault codes". The communications channel that monitors machine data also monitors these stop codes. This makes it easy to deploy solutions that capture, analyze and display machine stops. It is not unreasonable to expect a 10-50% reduction of downtime by pursuing this methodology.
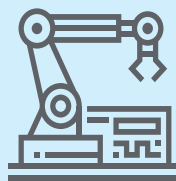

Performing a Pareto Analysis of the total downtime caused by each machine stop codes will reveal where to focus attention for a predictive application.

TIP: Make sure all machine stop reasons described as "Faults" in your machine control program are collected in the cloud.

The Path to Predictive

1 Connect all Machines

Checklist

☐ Ship every machine with connection equipment installed, configured, and ready to go online.

2 Collect Machine Data

Checklist

☐ Give customers incentives to connect their new machines.

3 Track KPIs & Downtimes

Checklist

☐ Capture data for everything that is important to machine operation and product quality

4 Data Science Analysis

Checklist

☐ Use Data Science to identify relationships that lead to major reasons for unplanned machine downtime

5 Monitor Data & Send Alerts

Checklist

☐ Set up predictions to dispatch alerts to the spare parts sales team

6 Create a Predictive Business

Checklist

☐ Communicate a value proposition with a strong ROI to customers and support your sales teams.

Develop Prediction Models

It seems like every discussion about predicting things in machines ends up trying to predict absolutely everything that could possibly happen on a piece of equipment. It is a great goal and one that may be achieved one day, but it can lead to a project too large to approach. We recommend a stepwise approach. For example, consider the value of being able to reasonably predict the few things that cause up to 80% of unplanned downtime. Putting a prediction system like this online immediately creates value for the machine owner and gives your engineering team the experience necessary for taking further steps towards building ever more reliable equipment.

To be done right, even this step requires data – lots of it. In most cases, many machine-years of operational and service data might be needed to perform an analysis that produces reasonably reliable prediction models. This is why taking steps 1-5 of our Path to Prediction right away are so important. With this data, a data scientist can perform deep analysis and produce practical, predictive models.

These models are developed by studying machine events and their operational impact. Using multiple analytic methods, the data scientist discovers key relationships in the monitored data that leads up to the most common events. These relationships are compiled into predictive

models which can be programmed into cloud-based applications to set up alerts that deliver the promised value.

Predictive Models look for characteristics, i.e. patterns in machine operational data that lead to costly unplanned machine downtimes and service. Predictions delivered by the machine builder give the machine owner the opportunity to proactively address these items and thus reduce unplanned downtime and its related expense.

At ei3 we believe that the resultant prediction models should be proprietary Intellectual Property of the machine builder. These models are based on deep understanding of the dynamics of their equipment. By providing their market with proprietary predictions, the machine builder can create a differentiating competitive advantage for their equipment.

> **TIP:** Have a data scientist develop prediction models for the controllable unplanned machine events that lead to 80% of machine downtime.
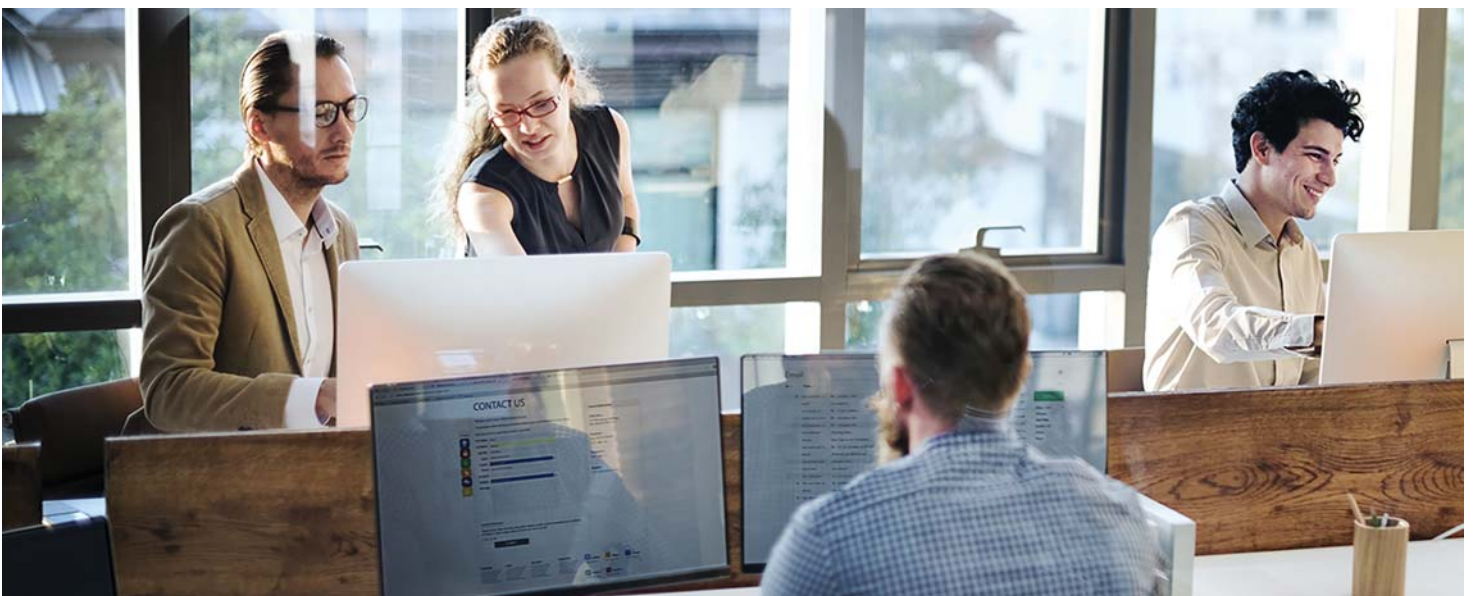
Improve & Measure Progress

Once a machine's set of predictive models are defined, they are ready to be run in the cloud. Incoming real time data from monitored machines is compared to the predictive models. If the evaluation of a model indicates probable trouble, then an alert is sent to the machine owner, the machine builder or both. These alerts can take many forms; a status report, a web page, or an immediate email or mobile alert. The preferred form is determined by the customer and the business model behind the prediction.

Predictive information can drive spare parts and consumables sales, help plan maintenance, reduce quality failures, or all of the above. The Path to Predictive is a journey. By putting predictive measurements in place, the models are continually improved and refined to develop increasingly sophisticated, reliable and valuable predictions. One benefit of having the performance measurements in place from the earlier steps is that progress is easy to measure, and it shows a very definitive return on investment.

A good starting place is to set up predictive models for the most common spare parts that your machine needs to have replaced at defined usage intervals. It will create immediate business value to your customer and boost your spare parts sales.

TIP: Set up predictive models to dispatch alerts to the spare parts sales team and grow the business for consumables and replenishment parts.

Conclusion

This is an exciting time. The Industrial Internet of Things is creating profoundly positive impacts for adopters in the machinery industry.   Solutions are ready and available to reduce service costs, increase machine performance, save energy and improve quality. For leading machine companies who are formulating their strategies to create predictive services, the IIoT has become a significant enabler that can get them to market quickly, create additional savings, and provide profitable revenues. With so much at stake, machine builders are thinking deeply about their strategy to deliver predictive services.

ei3 has a proven step-by-step approach for achieving and delivering these new services – a roadmap that leverages the value of ei3's robust and market-tested IIoT platform solution. ei3 has been delivering secure solutions for machine IoT since 1999, and has a long reference list of successful deployments of connected machine on the plant floors of thousands of companies. ei3's white-label platform is ready for machine builders to immediately begin the journey on the path to predictive, a journey that will undoubtedly yield fruitful results.

The ei³ proposition to Machinery Builders

ei³'s rrobust and market-tested IoT solution saves machine builders time and money. Founded in 1999 with the vision to use the Internet to manage and monitor machines, ei3 has remained focused on, and has evolved with the latest technologies. ei3 delivers OEM solutions for leading machine builders serving a diverse range of industries, including Plastics, Paper, Converting, Printing, Packaging, Processing, and others.

Since the ei3 platform can be used with a machine with minimal to no customization, it is easy to pilot and instantly demonstrates value to machine builders and their end customers. Our white label solution is comprised of four pillars: gateway hardware, a secure global network, a private cloud, and a suite of SaaS applications. All of these together provide a single source for a complete and comprehensive OEM offering.

In the spring of 2017, ei3 added Data Science services to it's portfolio of offerings. At our office in Zurich, Switzerland, the ei3 team focuses on analyzing and building machine predictive models. The team was expanded to help machinery companies by providing access to data scientists who are skilled and experienced at applying the latest big data analytical methods to understand and predict behavior of industrial machines.
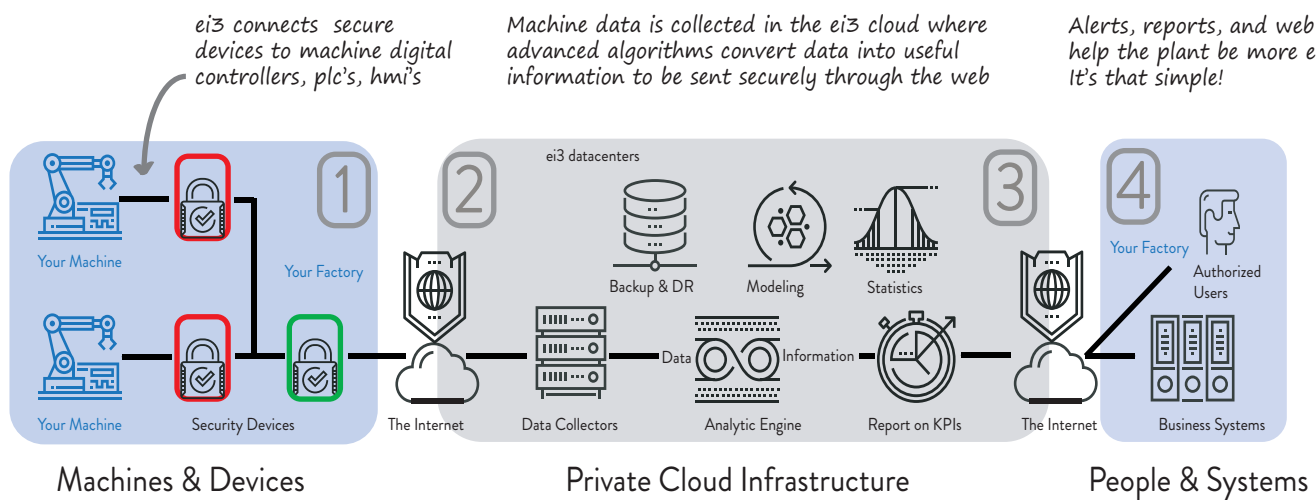
Machine companies who see opportunity in developing an IIoT strategy that follows the Path to Predictive should contact us.

Concentrate on your core business

Stay Current

Save Time

Save Money

ei3 connects secure devices to machine digital controllers, plc's, hmi's

Machine data is collected in the ei3 cloud where advanced algorithms convert data into useful information to be sent securely through the web

Alerts, reports, and web pages help the plant be more effective. It's that simple!

Machines & Devices

Private Cloud Infrastructure

People & Systems

Your Source for Branded IIoT Solutions

Secure Remote Service	Data Aggregation	Production Analytics	Machine Stop Analysis
Predictive Maintenance	Quality Management	RESTful API	Platform for Integration