CASE STUDY

RIT | Golisano Institute for Sustainability

Brunner evaluates machine monitoring to improve productivity of stamping process

Company	Sector	Size	Location
Brunner	Heavy-duty, commercial vehicle brake components	325 employees	Medina, New York

At a glance

- Brunner is a mid-sized business that has specialized in the production of heavy-duty commercial vehicle drum brake components for over 40 years.
- With an interest in improving component quality and reducing equipment downtime, Brunner partnered with Rochester Institute of Technology's (RIT) Industry 4.0 Transition Assistance Program to investigate opportunities for process monitoring and predictive analytics to reduce unscheduled downtime in stamping and forging operations.
- RIT's engineers first reviewed material and information flows related to Brunner's business and shop-floor processes, and also reviewed service histories on a 2000-ton stamping press. They evaluated recurring problems on the press, and documented its existing sensors and controls. Then they collected operational data from the machine for analysis.
- Following the initial evaluation, RIT designed a monitoring system that could be used in production, powered by the Industrial Internet of Things (IIoT). A pillar of Industry 4.0, IIoT uses hardware and software to collect manufacturing shop-floor data and store, analyze, and visualize it for decision-makers. The monitoring system was designed to be easily replicated and applied to other stamping and forging equipment onsite.
- The goal of the IIoT-enabled machine-monitoring system was to provide Brunner's operators and engineering team with early indicators of changes in press performance, which may result in non-conforming parts or long downtime due to maintenance. Analysis of data from the existing press identified specific metrics for monitoring different phases of the stamping process. Once implemented, the monitoring system will allow operators to be proactive about reducing defects and unscheduled downtime.

Company

Brunner manufactures brake systems for heavy-duty, commercial vehicles in Medina, New York. The company produces brake shoes and drum brake S-cams for commercial vehicle, bus, and trailer markets.

Business challenge

For example, broken counterbalance shafts in the stamping presses can require a day or more to obtain parts, schedule a rigging company, and have the repairs performed. Also, worn stamping dies can result in poor quality parts and an increase in defects. Brunner wanted to utilize machine monitoring as a pathway to reduce both downtime and defects, providing a warning mechanism for process degradation and potential press failures and allowing for proactive repairs.

The Industry 4.0 solution: Machine monitoring through the Industrial Internet of Things (IIoT)

IIoT is a term for a set of technologies that can be used to collect, analyze, and interpret manufacturing data. IIoT's namesake—the Internet of Things (IoT)—was first coined to describe the system of software and hardware for consumer products that facilitates data collection with sensors, public and private networks, and web-based software. Everyday conveniences, like smartphones, smart thermostats, and doorbell cameras, are all consumer-level IoT applications. IIoT offers this same kind of connectivity and automation to manufacturers.

A steady stream of new hardware and software on the market is reshaping how data can be used in the factory environment to monitor equipment performance in real time. On the manufacturing shop floor, access to a network is critical to IIoT; wireless networks are increasingly being used for this purpose. Cloud-computing leaders like Google, Microsoft, and Amazon all have IIoT software platforms that provide architectures for data management and software deployment.

At its heart, IIoT-enabled machine monitoring carries data across a manufacturing plant in three phases, outlined below.

1. **Measure and connect:** First, digital sensors measure a specific parameter that a business defines, such as temperature, pressure, load, etc. These sensors are physically installed on equipment. In addition to sensors and measuring equipment like probes, data connectivity is established at this point, typically over Ethernet or a Wi-Fi gateway.
2. **Connect, collect, and visualize:** A computer—usually an edge device—is installed on relevant equipment. It features software that allows it to "talk" to the sensors and collect data. From there, the data is sent to an information network and displayed on a dashboard on a digital device for staff members to interpret.
3. **Collect, store, and notify:** Once data has been collected and displayed, it needs to be recorded and archived so it can be retrieved for broader analytics activities, such as tracking of historical trends. Data can be stored on a local network or on a cloud-based service, as security and access considerations allow. Alarms can also be set—technically, coded—to signal when specific conditions are met within the data.

IIoT provides a framework for managing acquisition, transport, and analysis of machine-monitoring data. There are many software applications available on the market that are advertised as predictive maintenance tools and can link into an IIoT system and provide advanced data-analytics capabilities, such as machine learning. However, these solutions usually do not provide the know-how on what data to measure or how it should be analyzed to achieve predictive maintenance. This requires an understanding of how to link equipment failure to patterns observable in machine data. For standard industrial equipment, like pumps, motors, or blowers, some predictive-maintenance software tools provide off-the-shelf solutions.

Why machine monitoring?

- **Spend less time recording data and addressing issues:** IIoT-enabled machine monitoring provides a direct value-add when it replaces manual condition-monitoring activities. Manually collecting data from machines can require significant labor hours and lead to inconsistent results due to human error and variation between how technicians record those data.
- **Know before it blows:** Leveraging hardware to collect machine data and software to analyze and display it, a machine-monitoring system can warn operators or maintainers when a piece of machinery is running abnormally or nearing failure to prevent costly quality spills or unscheduled downtime.
- **Brings everything under one umbrella:** Machine-monitoring technologies can be applied to a wide range of critical production equipment and infrastructure systems, from CNC (computerized numerical control) machines and injection-molding equipment to air compressors and chillers. An IIoT system allows process data from different machine makes and model years to be brought together, thereby integrating them into a single, unified system.

Approach

To start, the RIT team visited Brunner's facility in Medina to review its production processes and assess what existing data was available to understand the stamping press's operating conditions. In many cases, machine monitoring requires an understanding of what task the machine is performing. It is also important to bring together other data, such as quality or maintenance data, in order to link a machine's operating conditions to other events. RIT performed a material and information flow analysis to understand current data flows related to Brunner's stamping and forging processes (e.g., what parts are running on what machine, what dies are in service, or why did the machine go down).

> *"We were interested in the possibility of monitoring our stamping and forging presses to reduce unscheduled downtime. RIT demonstrated the value of capturing data from our existing tonnage monitor and also provided a scalable concept design for press monitoring. We look forward to the next steps of implementing this solution."*
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> *Saamir Rahman, Continuous Improvement and Materials Manager, Brunner*

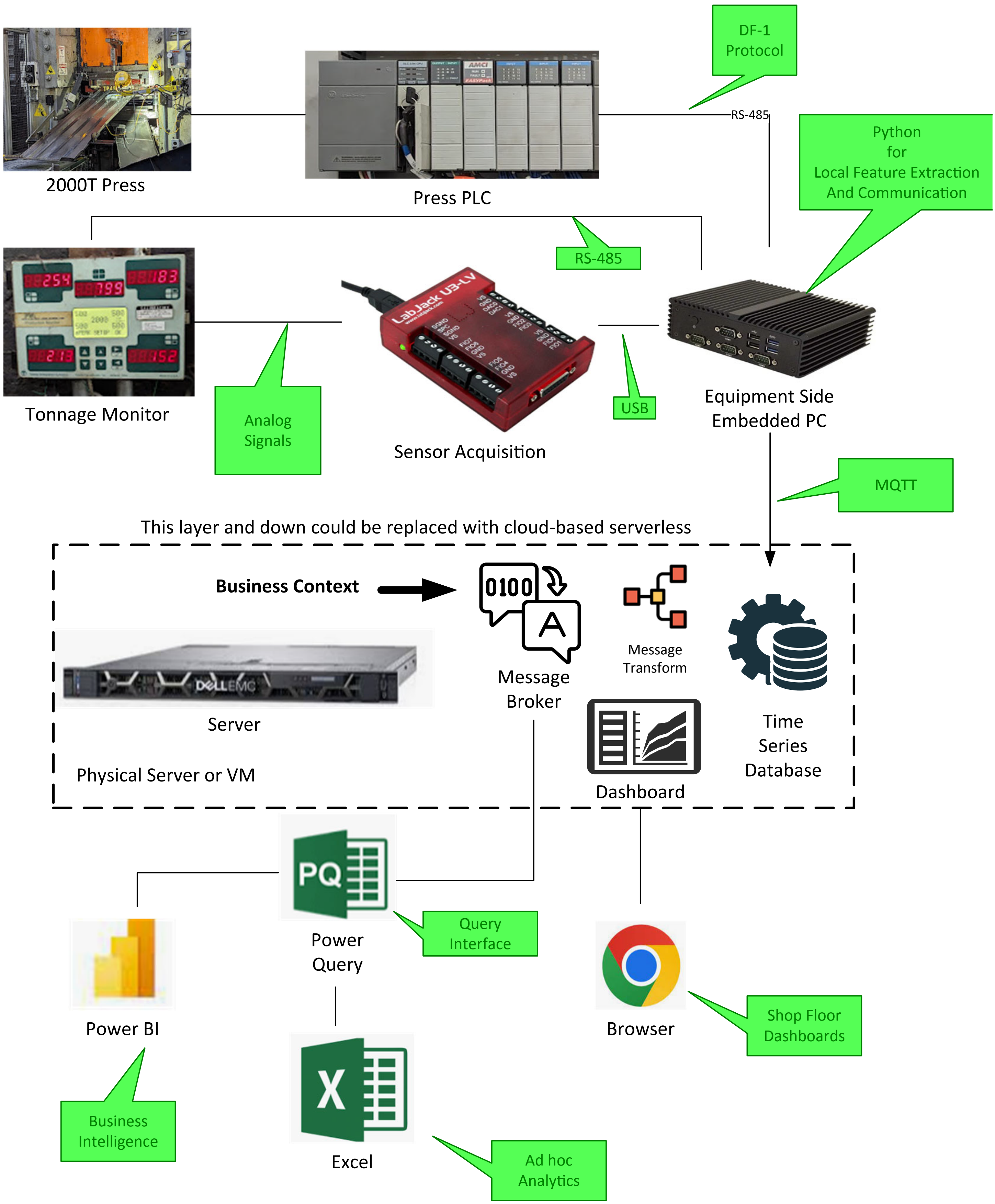
RIT's engineers next focused on evaluating the feasibility of monitoring the condition of Brunner's 2000-ton stamping press. This involved understanding maintenance histories and critical failure modes, and linking these to existing or new sensors that could provide insight into the press's condition. An existing Toledo Integrated Systems (Toledo) tonnage monitor provided dynamic data related to the overall stamping operation's condition. Strain gauges were subsequently added to monitor counterbalance shaft loads. A temporary data-acquisition system was created to collect data from the press over the course of several weeks. The resulting data set allowed the RIT team to build analysis methods and associated metrics for tracking the health of the press process. The information also facilitated the design of a production-grade monitoring system, including both hardware and software components.

Solution

The 2000-ton press operates with an Allen-Bradley PLC (programmable logic controller) for control and utilizes the Toledo tonnage monitor to measure stamping force. Despite both systems generating valuable data, they exist as "data islands," lacking connectivity and leaving any associated data underutilized.

The RIT project developed a set of metrics from analysis of the Toledo tonnage-monitor data and demonstrated that the metrics were indicative of the condition of the stamping press and stamping die. Further, the project resulted in the design of an IIoT-enabled system to bridge the connectivity gap characterizing Brunner's stamping process. This system will enable the stamping press to transmit real-time status updates, alarms, and other critical measurements directly to the network. The live streaming of data will facilitate real-time analytics as well as analysis of historical trends. To accommodate additional sensors in the future, the design incorporates a USB (universal serial bus) data-acquisition device.

Brunner IIoT Stack



Node-RED, a low-code development software widely adopted in IIoT, provides seamless machine-to-network integration. This software will run on a cost-effective industrial computer, serving as the interface between the machines and the network. The standardized data format will be transmitted to an IIoT stack that will include Timescale (a time-series database engine), Grafana (an open-source graphing and visualization tool), as well as analysis and reporting tools such as PowerBI Desktop, and Power Query. To optimize data extraction and reduce storage requirements, Python tools will be employed to derive the condition metrics from the high-resolution machine data. This IIoT approach not only ensures efficient data management but also supports scalability for future integration with other machines across the entire factory.

Next steps

RIT delivered the design for the monitoring system concept at the end of the project. Next, RIT and Brunner will pilot an implementation of the proposed solution on the 2000-ton press over a longer period of time. This will serve to verify the value of the system prior to a wider deployment to other stamping and forging presses. RIT will develop any needed software for the production-intent design and support Brunner to install the system.

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This material was prepared by Rochester Institute of Technology using federal funds under award No. 01-79-15124 from the Department of Commerce Economic Development Administration and using funds from the NYS Department of Economic Development. The statements, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Commerce, the Economic Development Administration, or the NYS Department of Economic Development.