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Automating Simple Tasks Using Sensors

How Can Your Business Benefit?

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Executive Summary

1. As labor shortages continue, large-scale automation strategies will become even more important.
2. Simple tasks can be replaced by sensor technology in many industries.
3. The implementation of sensors for climate-tracking purposes has been proven to cut operating costs.

Key Findings

With fewer people available to work and higher demand for production, the use of technology will become even more pervasive. Automated technology is one of the first steps in incorporation of simple tasks.

This paper explains how the use of climate-tracking sensors can not only replace workers but also lower the cost of production over time with more efficient output, as our ROI calculations show. For instance, this paper explores a scenario in a sawmill where it costs about $5,000 per year for an operator to check and adjust humidity levels. Because the costs of the sensor are around $4,000, the technology will pay for itself within one year.

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About E+E Elektronik

For more than 30 years, E+E Elektronik has been the sensor specialist for humidity, CO2, moisture in oil, dew point, air velocity, flow, temperature and pressure. E+E Elektronik develops and manufactures products that help their customers optimize environments in meteorology, HVAC, Agriculture, Automotive, Pharma and Food, industrial production, energy and environmental technology, and cleanroom technology for maximum output.

E+E Elektronik is headquartered in Austria, with subsidiaries in China, Germany, France, India, Italy, Korea and the United States.

Introduction

The concept of automation invites thoughts of robots operating along a line of conveyor belts, working in concert to build parts. Sensors monitor the position of these components and communicate this into a controller. The controller sends commands to the robot to grab the part and perform the next function until a product is assembled. While this scenario exists, it represents the highest end of automation technology working to perform complex tasks.

Automation is more commonly used to perform simple tasks. For example, a smart thermostat is a sensor that monitors room temperature. It transmits information over a digital network into a controller. If the room is 70°F and needs to be 65°F, then the air conditioning is turned on automatically. So, instead of relying on a person to walk into the room, check a thermometer, and then adjust the air conditioning, this is automatically handled by the integrated control system. It works on its own all day every day.

Automation can be integrated into nearly every operation. It just requires analysis to discover which functions are repetitive and cumbersome. This paper will help explore these operations and describe how automation can be used to manage simple tasks, reduce operating costs and save money.

Using Automation to Combat Labor Shortages

> **According to the Bureau of Labor Statistics, in July 2022 there were over 11 million job openings in the United States[1]. Simultaneously, fewer than 6 million people were looking for jobs[2]. If every open job were to be filled, then 5 million openings would still exist, representing a significant labor shortage.**

Filling certain jobs, especially those considered simple and repetitive, is more difficult under these circumstances. Installing automation to perform these jobs is possible today using available technology. This does not mean replacing a person with a robot. It could mean installing a smart thermostat to maintain the climate or a series of sensors counting inventory.

For commercial and industrial applications, the sensors might need to communicate with a sophisticated controller. Upgrading to this can be costly. Luckily, automation has improved to encompass cost-effective options.

Sensor Technology

RTD vs Capacitor

When selecting a sensor, it is important to consider the type of technology and how it integrates into a process. Measuring temperature and humidity require a combination of two types of sensors - a resistance temperature detector (RTD) and capacitor humidity detector. Each reacts to environmental changes differently.

The electrical resistance of a RTD sensor changes as the temperature does. Measuring the resistance of the component gives a very accurate temperature reading. This is computed as a readable value such as 65°F.

A capacitor works by having two electrically charged plates set parallel to one another with a material sandwiched in between. For electricity to pass between the plates a bridge must be created. Water vapor absorbing into the sandwiched material acts as that bridge, affecting the capacitance. This change is computed as water volume in the air.

Knowing these readings is important. Without a display or communication device it is impossible to know what values the sensor reads. So, it is just as important to select a sensor with the ability to output the values in a useful way.

[1] https://www.bls.gov/news.release/jltst.nr0.htm
[2] https://www.bls.gov/news.release/empsit.nr0.htm

Digital vs Analog

Analog outputs adjust their signal based on the electrical conditions of the sensor. It might transmit a signal that ranges anywhere from zero volts all the way to 10 volts. If zero volts represents 0% humidity and 10 volts represents 100% humidity, then an output of 7.5 volts represents 75% humidity. Another option is a signal outputting electrical current ranging from 4 to 20 milliamps. This works the same.

One downside is that analog outputs limit data transmission. A sensor with two outputs will only transmit two values. Even if the sensor calculates a dozen values, only two can be transmitted.

Digital communication protocols allow all values to be transmitted. But this must be done over a digital network. Ethernet is a common network technology and ubiquitous as modern digital communication. RS485 is an older technology but is incredibly simple and reliable.

These network technologies perform the same essential function – moving electrical pulses over wires. These pulses create the protocol, or language, that is interpreted as data. This is like someone using a phone to speak English or Spanish to another person. The phone represents the physical network, and the language is the protocol. Common automation protocols are Ethernet, Modbus and CANopen[3].

At a minimum, a network needs a sensor with built-in communication, wires to power the sensor and transmit pulses, and a receiver to interpret the pulses as data. A sensor that can reliably perform these functions can work with practically any existing system.

A Practical Application of Automation: Sawmills

Sawmills are scattered across North America and contain significant operational capabilities. Lumberjacks cut down trees and then transport them to the mill. Here, large machines remove the bark and then cut the tree into boards. These boards are then loaded onto specialized pallets and placed into large kilns where they dry.

It is the drying process that requires precise temperature control as a large heater is used. Nearly all the lumber produced at sawmills is for building and needs to be dimensionally accurate. Overdrying could cause the boards to warp or shrink excessively. Out-of-dimension boards are scrapped.

[3] https://en.wikipedia.org/wiki/List_of_automation_protocols

Traditionally, kiln temperature is monitored using wet-bulb technology[4]. This consists of two thermometers placed into the heated area. One is uncovered and the other is wrapped with a wet sock. As the freshly cut wood heats up, it releases water trapped in its cells as steam and increases the humidity in the kiln.

At 100% relative humidity, both thermometers read the same temperature and indicate that the wood is still releasing water. As the wood dries, less water is released, and the uncovered thermometer will read a higher temperature than the wrapped one. This temperature difference is interpreted as the humidity of the kiln.

This method presents several challenges. An operator must manually monitor the temperatures and prevent the sock from freezing in the winter. If not properly monitored, the wood can overdry. Product quality depends on the kiln conditions and automation can provide real-time insight of those conditions.

> **A single digital sensor can take the place of a dual thermometer system. Instead of relying on a person to measure the wet-bulb system, the sensor can monitor and send a signal to turn off the heater once the proper dryness has been reached. This represents a very simple use of automation to control product quality.**

Selecting the Right Sensor

Automation can be expensive. Integrating technology to manage simple tasks can be a tough financial pill to swallow. Break even points can also be difficult to calculate. If labor shortages become endemic, then it will be necessary to automate certain tasks. This does not have to cost a fortune. Starting small with affordable existing technology offers a reasonable payback period.

In the dry kiln, the operator is tasked with:

1. Monitoring the condition of the wet-bulb sock,
2. Measuring the humidity in the kiln by comparing the two thermometers, and
3. Turning off the heater when the humidity reaches an acceptable level.

Off-the-shelf sensors can manage this.

E+E Elektronik offers the EE310 temperature and humidity sensor[5]. It accurately measures humidity and contains a smart relay. When the humidity decreases, the smart relay will physically close, creating a circuit that turns off the heater, just as an operator would.

EE310 Temperature and Humidity Sensor

[4] https://www.sciencedirect.com/topics/engineering/wet-bulb-temperature
[5] https://www.epluse.com/products/humidity-instruments/transmitters-for-industrial-applications/ee310/

Setup is straightforward – install the sensor, connect the power wires from the smart relay to the heater and turn on everything. Setting trigger points in the sensor will ensure this runs automatically. The operator can now manage other tasks.

Calculating Benefits

The installed sensor can cost around $4,000. Calculating payback for such an investment requires thinking of existing costs. There are a couple costs to consider in the dry kiln scenario, as we will examine below.

Cost Without Automation

The Expense of Manual Data Collection

The operator is tasked with operating the kiln. Checking the thermometers and calculating the humidity level takes time, which costs money. At the beginning of the drying process, fewer checks need to be made. Once the kiln has been run for a while the operator must focus frequently on this, which can be time consuming. The following calculations below illustrate the operator costs, scrap cost savings and breakeven point.

Figure 1. Operator Costs

Wage:	$30 per hour
Time to Check:	2 minutes (0.03 hours)
Focused Frequency:	10 per hour
Focus Time per Batch:	2 hours
Batches per Day:	1

Cost to check humidity levels:
$30 per hour x 0.03 hours per check = $1

Knowing this, the annual cost for the operator to make these checks is:

Daily Cost:	$1 per check x 10 checks per hour x 2 hours per batch x 1 batch per day	= $20
Yearly Cost:	$20 per day x 5 days per week x 50 working weeks per year	**= $5,000**

> **It costs about $5,000 per year for the operator to check and adjust the humidity levels. This is more than the cost of the investment. Solely considering this, it will take under one year for the investment to pay for itself.**

Scrap

Boards that are overdried are scrapped or sold at a large discount. Kilns can hold large amounts of lumber, which is measured in thousands and millions of board feet. A kiln at a sawmill might dry around 50,000 thousand board feet (thsd bf) annually. Sawmills will always see some amount of scrap. A 0.5% scrap rate would be calculated as follows:

Figure 2. Scrap Costs

Scrap Rate:	50,000 thsd bf per year x .5% = 250 thsd bf

Dried board in 2023 is expected to fetch $400 per thousand board feet[6]. This calculation assumes a gross margin of around 50% or $200:

1. Cost to manufacture product	$200
2. Retail price for product	$400
3. Margin at 50% (revenue)	$200

The annual scrap cost is calculated using the scrap rate and product margin lost:

Annual Scrap Cost:	250 thsd bf per year x $200 per thsd bf = $50,000

[6] https://tradingeconomics.com/commodity/lumber

Figure 3. Savings After Automation

After automation is incorporated into the sawmill, there will be a smaller scrapping rate and a large cost reduction. Of course, not all scrap will be eliminated. Reducing this by 80% results in a savings of $40,000 annually. These savings contribute to the payback period calculation and increase the return on the investment in automation:

Annual Scrap Savings:	$50,000 * 80% cost reduction = $40,000 savings annually

Combining the figures calculated above,

- the cost you will save by eliminating manual data collection ($5,000)
- the savings from scrap reduction due to implementing sensors ($40,000)

The sawmill can save $45,000 every year by automating this simple process.

Calculating the break-even point now becomes straightforward.

$$\frac{\textbf{\$4,000 investment}}{\textbf{\$45,000 savings per year}} \times \textbf{12 months per year = 1 month}$$

Based on this scenario, upgrading the process with automation will pay for itself in about one month. A system like this will last for a decade without fail. This longevity ensures that break-even will be reached quickly, and long-term savings will be realized.

How Can Automation Help Your Business?

This paper is intended to help the reader understand available automation technologies, brainstorm where these can be used in their own operation and how to justify the investment.

Automation does not have to be expensive. Nor does it only apply to complex processes. Automation simply needs to handle tasks that are repetitive and cumbersome, such as controlling the heater in a dry kiln. There are many operational costs to consider that can be reduced with automation. Understanding these will make it easier to calculate the financial benefit.

Ultimately, automation should improve a process, reduce human intervention, and allow the team to focus on more complex tasks. When properly integrated, technology works alongside people to help them do their best work.

For questions about automation and technologies available to improve your processes, please reach out to E+E Elektronik by visiting www.epluse.com.

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