Five essential data domains to track with integrated sensing on production lines

Digital transformation can feel overwhelming, especially with the constant stream of evolving technologies. Yet the manufacturers that achieve operational excellence, share a trait: they rely on precise, targeted operational data, captured through integrated sensing. Not excessive data, just the right data.

Across industries, five data domains are essential for operational excellence: efficiency, energy, quality, maintenance, and cost. Mastering these areas gives production managers a clear line of sight into performance, bottlenecks, and profitability. Without requiring a complex digital overhaul.

1. Efficiency: Turning assumptions into measurable reality

Production leaders often assume their lines are running efficiently, until actual data reveals a very different picture. Metrics like uptime, cycle time, and target versus actual output frequently uncover significant gaps between perceived and real performance.

Where to begin
Basic sensing technologies make efficiency measurement accessible:
- Sensors provide real-time cycle counting.
- IO-Link enabled devices track machine states with high precision.
- Environmental sensors monitor temperature, humidity, or airflow conditions that subtly affect machine behaviour.

Why should you consider this in your operations
With accurate efficiency data from manufacturing operations, you can:
- Understand true utilization
- Identify root causes of downtime
- Address recurring disruptions
- Optimize staffing and material flow

Efficiency improvement starts with visibility. Without concrete data points, planning and optimization are based on guesswork rather than reality.

2. Energy: From cost control to ESG Intelligence

Energy management has moved far beyond tracking kilowatt-hours on a monthly bill. Modern production environments draw on multiple forms of energy and environmental conditions: power, compressed air, temperature, humidity, pressure, and flow. All of these directly influence performance, waste, and sustainability.

Why should you consider this in your operations:
- Energy now impacts both production margins and ESG compliance.
- Customers increasingly request energy-per-unit data.
- Hidden inefficiencies—idle consumption, over-cooled zones, leaking air systems—often remain undetected without granular visibility.

How integrated sensing helps

Sub-metering and distributed sensing provide machine- and process-level clarity. Flow sensors, thermal sensors, and pressure transmitters reveal consumption patterns across lines, zones, and individual assets. This enables:
- Identification of energy-intensive machines
- Early detection of leaks or cooling inefficiencies
- Accurate reporting for sustainability and customer audits

With the right sensors in place, energy becomes a controllable variable instead of an unpredictable overhead.

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3. Quality: Product quality and process compliance

Quality spans two parallel dimensions:

1. Product quality: Ensuring the part is correct, complete, and defect-free.
2. Process quality: Proving that production conditions remain within specified parameters.

Both aspects are critical for customer satisfaction, regulatory readiness, and operational reliability.

Smart inspection for product quality

Advancements in machine vision and inline sensing have transformed quality assurance:
- Vision sensors and smart cameras now detect geometric defects, colour inconsistencies, missing components, and misalignments at high speed.
- Displacement sensors verify dimensional accuracy.
- Colour sensors check labelling, printing, and packaging integrity.

These technologies create consistent, automated quality gates that reduce dependence on manual inspection.

Compliance through automated process monitoring

Standards such as ISO 9001 and FSSC 22000 require tight control of environmental and process parameters.
Automated sensing removes the need for manual data collection by continuously monitoring:
- Temperature and humidity
- Pressure differentials
- Oven, curing, or sterilization conditions
- Cleanroom and storage environments

With integrated sensing, data is collected once, stored centrally, and flagged only when out of tolerance.
This helps streamline audits and reducing compliance risk.

4. Maintenance: From reactive interventions to predictive insight

Traditional calendar-based maintenance remains valuable, but it doesn't account for differences in machine usage or early signs of degradation. Condition-based maintenance bridges that gap by monitoring machine health in real time.

Key indicators
• Vibration: Early warning of imbalance or wear
• Power draw: Indicators of friction, load change, or mechanical failure
• Surface temperature: Detection of overheating components

Operational impact
By layering condition data on top of scheduled maintenance, you can:
• Prioritize machines that show early warning signs
• Avoid unexpected breakdowns
• Reduce unnecessary inspections
• Extend equipment lifespan

5. Cost: Moving from budgeted estimates to data-verified profitability

Without actual data, unit cost calculations rely heavily on assumptions and historical averages. Integrated production data enables accurate, real-time costing that reflects what actually happens on the line.

Data inputs for accurate costing
• Start/stop times and cycle durations
• Energy consumption from sub-metering
• Labor involvement through operator logins or presence detection
• Scrap and rework rates
• Material usage deviations

Why should you consider this in your operations
Real production cost transparency gives manufacturers the ability to:
• Identify high-cost or low-margin orders
• Compare planned vs. actual resource consumption
• Determine which products or lines should be optimized or discontinued
• Improve quoting accuracy and customer profitability

The path forward: Start small, grow fast

Implementing integrated sensing does not require a massive project or a complete digital overhaul. The technology is mature, the sensors are affordable, and the integration is easier than ever.
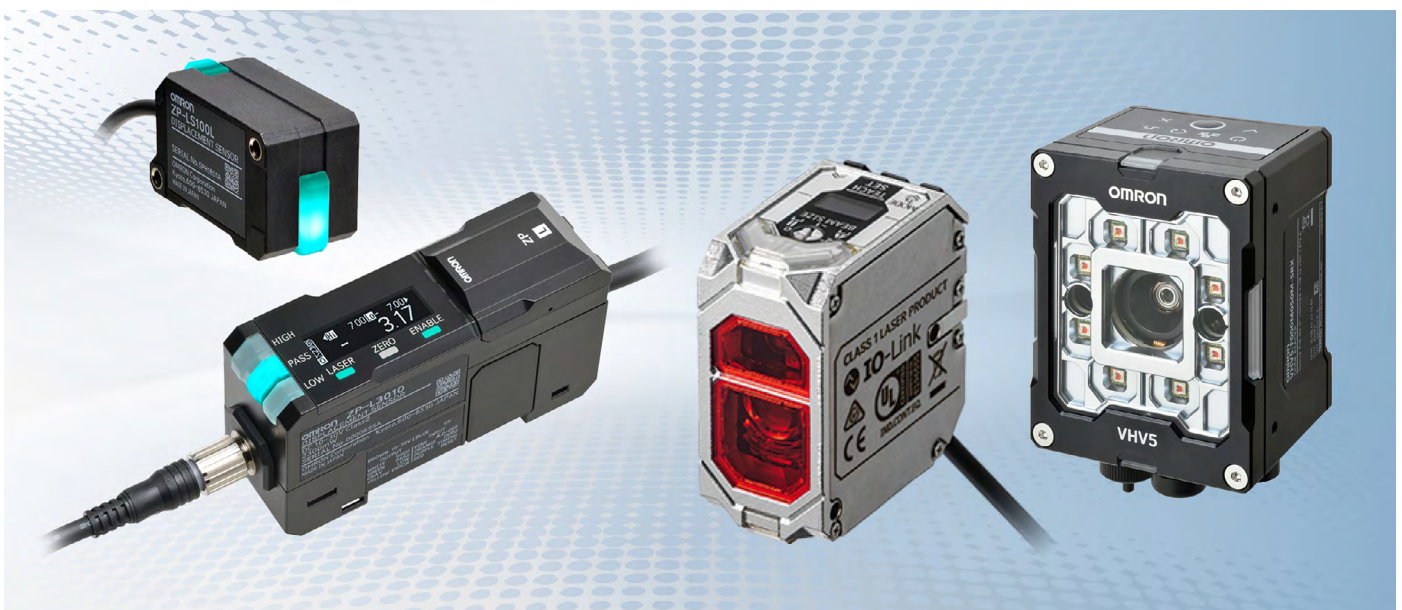
Most successful manufacturers begin by focusing on the single area where the business is currently under the most pressure. Whether that's energy waste, downtime, scrap, maintenance costs, or inefficient changeovers. Once the first data set proves its value, scaling becomes straightforward.

Integrated sensing brings visibility, and visibility brings control. In a competitive market, the plants moving fastest are those already using data to run cleaner, cheaper, and smarter.

OMRON sensors supporting data-driven production

Many of the capabilities described in this article can be implemented directly with OMRON's sensor portfolio. Across detection, measurement, environmental monitoring, and condition sensing, OMRON provides a comprehensive sensor lineup capable of supporting virtually any production requirement. Integrated seamlessly with the Sysmac automation platform that brings together sensing, control, safety, motion, robotics, visualization and networking.

For more information, please visit: http://industrial.omron.eu/sensing

About OMRON
OMRON has established itself as a leader in automation solutions, known for high performance and reliability. With its Integrated Development Environment Sysmac Studio, OMRON empowers machine builders to navigate the complexities of customization with ease. By streamlining the development process and enhancing operational efficiency, OMRON contributes to the success of its customers and is shaping the future of machine automation.
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