



Printer Availability: Driving OEE and Uptime on Packaging Lines

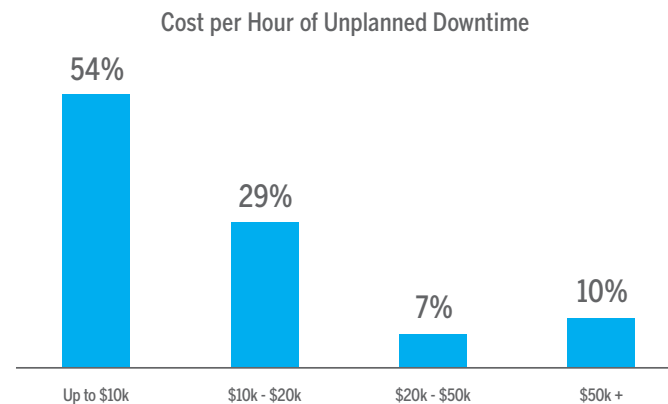
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Especially in a sluggish economy, manufacturing and packaging companies need to make every second of production time count. Uptime is vitally important to Overall Equipment Effectiveness (OEE), one of the most widely used measurement systems for helping producers understand their operations better and drive continuous improvement. OEE is the measure of how closely the production line's actual performance tracks to its theoretical performance limits, with uptime playing a crucial role.

But maximum uptime can be hard to achieve. Dun & Bradstreet reports that 49 percent of Fortune 500 companies experience at least 1.6 hours of downtime per week. That translates into more than 83 hours per year. (Source: Henry Martinez, "How Much Does Downtime Really Cost?" Information Management, August 6, 2009).

Understanding the True Costs of Downtime

Everyone needs their machines up and running – no debate on that point. Profitability depends on it. The true cost of downtime, on the other hand, is debatable. Thomson Industries (a Danaher company) has surveyed companies across numerous industries and found a wide range in the average cost per hour of unplanned downtime.



Unplanned downtime caused unacceptable costs for all companies, with a total of 46% of companies losing more than \$10,000 per hour. (Source: Thomson Industries Inc., Preventative Maintenance Survey, 2012.)

Unplanned downtime costs vary considerably between industries and also between companies within any particular industry. These cost differences arise from variances in business size and scale, operational models, current demand levels, regulatory and business requirements, geographic location and several other factors. For example, we estimate that the cost of downtime in the food and beverage industry varies between approximately \$5,000 to \$10,000 per hour, with much of the unplanned downtime occurring on the second and third shifts.

Understanding what's happening during those second and third shifts could be crucial to minimizing downtime and future losses. The time of day may be a valuable clue – or a mere coincidence – but it's a long way from understanding the root cause and correcting it. Many factors can cause unplanned downtime and influence its total costs. To minimize losses, companies first need to investigate root causes as well as both the direct and indirect costs of unplanned downtime.

Calculating the Cost of Unplanned Downtime

Labor Costs

- Number of employees
- Average labor rate (full)
- Duration of outage
- Percentage of employees affected

+

Lost Revenue

- Direct loss due to unplanned downtime
- Penalties
- Future revenue at risk

+

Other Expenses

- Expediting freight
- Overtime
- Regulatory & legal damages
- Scrap & rework
- Lost discounts

Of all the cost drivers, labor costs are usually the most straightforward to calculate, although you need to remember to include non-direct labor costs (maintenance, quality, etc.) in the calculation. Use the following equation:

$$\text{LABOR COST} = E \times R \times O$$

Where:

E = number of employees impacted

R = average employee cost per hour – fully loaded

O = hours of outage

Lost revenue is a bit more speculative, but can be estimated using the following equation:

$$\text{LOST REVENUE} = (S / H) \times O \times R + I$$

Where:

S = gross annual sales

H = total yearly business hours

O = number of hours of downtime

R = estimate of ability to recover business post outage (%) (100% = totally unrecoverable, 0% = completely recoverable)

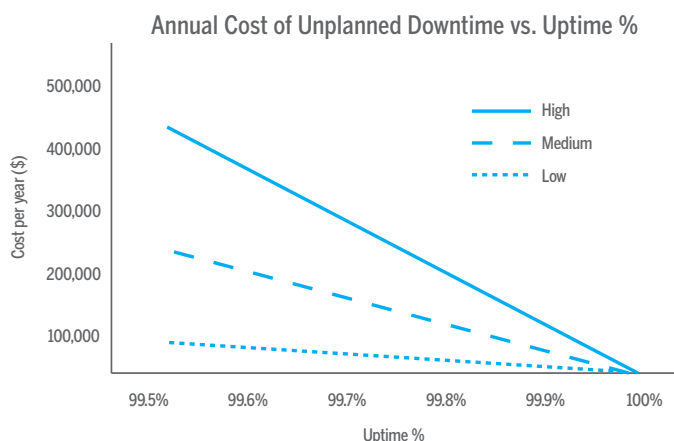
I = estimated dollars permanently lost due to outage

Other expenses that occur as a result of unplanned downtime can be harder to quantify. In addition to the costs shown under "Other Expenses," you should include any other factors for which you can provide a reasonably approximate estimate. These may include brand reputation, personnel distraction and morale, cash flow issues, costs of idle capital equipment and so on.

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Let's focus on costs first. While labor costs may be the easiest to identify and quantify, it would be a mistake to overlook other cost drivers. Key factors are shown in the sidebar (page 2).

Even with the highly simplified examples shown in the following graph, it's readily apparent that each 0.1% increase in unplanned downtime can have a powerful effect on your revenues and margins.



Increasing uptime by a fraction of a percent results in big savings.

The graph above plots costs per year for each additional 0.1% of unplanned downtime, from 100% uptime at the right side to 99.5% uptime at the left. "High," "Medium" and "Low" refer to the hours that the packaging equipment is expected to be up and running and the estimated costs per hour of unplanned downtime:

- High = 24 hours/day, 7 days/week, 50 weeks/year; \$10,000/hour of unplanned downtime
- Medium = 16 hours/day, 7 days/week, 50 weeks/year; \$7,500/hour of unplanned downtime
- Low = 8 hours/day, 5 days/week, 50 weeks/year; \$5,000/hour of unplanned downtime

It's clear that even a small increase of 0.1% in unplanned downtime can result in a substantial shift in net profitability. The larger the operation, the larger the total impact – but even small companies can ill afford unnecessary costs that represent a significant percentage of their overall revenue.

Maximizing Uptime Through Smart Optimization of OEE

Leading manufacturers quantify the OEE (Overall Equipment Effectiveness) of their processing and packaging lines as part of their efforts to drive uptime and productivity. Improving OEE is seen as an important key to gaining and maintaining a sustainable advantage over competitors. But smart optimization of OEE requires more than just analyzing uptime and throughput numbers. It requires a deep dive to discover the reasons behind the numbers and the opportunities for improvement.

Methods of measuring OEE vary, but all attempt to provide an objective measure of actual manufacturing unit performance against theoretically ideal performance. Most OEE methods focus on three key measures: availability, performance and quality.

OEE = Availability X Performance X Quality

| | | |
|--|---|--|
| The percentage of time equipment is available for production use | The speed at which equipment runs as a percentage of its designed speed | Good units produced as a percentage of total units |
|--|---|--|

OEE depends on availability, performance and quality.

This illustration shows how losses to machine availability, performance and production quality accrue to drive down actual production output well below the theoretical maximum.

Availability Percentage = Uptime/Potential Production Time



OEE is affected by cumulative losses in availability, performance and quality.

Note how downtime losses set a baseline of lost productivity that is only exacerbated by production output and quality losses. In other words, if the machine isn't running at all, there's no opportunity for improving OEE through higher production output or quality. Uptime is the keystone that everything else depends on.

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All components of processing and packaging equipment contribute to the OEE of the production line, or can add to the total unplanned downtime and detract from OEE. Having data on availability, performance and quality is useful, but it's only part of the solution. Understanding what this information means provides a basis for action.

Processing and packaging equipment typically capture high-level data to help you evaluate performance. In most cases, however, they don't quantify availability and quality in a useful way – if they report on these OEE measures at all.

If availability data is provided, it's usually as a simple uptime or availability percentage with no distinction between planned and unplanned downtime, and no additional information that you can use to analyze the causes of unplanned downtime. Some companies run their own offline analysis, which often relies on busy production staff to enter reason codes to describe what is happening as it occurs. This is a time-consuming burden, and any system that relies on human intervention is subject to human error. Critical data may often be incorrect or missing when it's needed to understand when and why equipment is unavailable.

Moreover, the data received from equipment must be configurable to the type of OEE system being used, and it must provide enough information to support analysis that can lead to actionable fixes for future OEE improvements. These fixes could point the way to changes in standard operating procedures, staff training, equipment selection and more – but these avenues for improvement can go undiscovered without adequate data and appropriate analysis tools.

The Role of Coding Printers in Uptime and OEE

A key piece of equipment on any processing and packaging line is the coding printer – a critical element in the overall uptime performance of the line. To help minimize unplanned downtime, the printer should provide availability data along with information that gives users a clear understanding of the root causes of any issues. What's required, ideally, is not just data about when the printer was down and what technical errors occurred, but actionable information that can be used to identify both printer and operator-caused errors – and fix them.

Although the following discussion is based on Videojet technology incorporated in our advanced continuous ink jet printers, you should look for similar features in any coding printer you buy.

Actionable Information: Drill Down to the Root Causes of Unplanned Downtime

Many systems capture and report availability statistics, but this information has little value for actually improving availability. With more complete data – including what's happening operationally as well as at human touchpoints – you have the information you need to drill down to root causes and address them permanently. For this data to be useful, you also need a system that facilitates this drill-down analysis, so you're not just confronted with a long list of raw data that's hard to decipher. Ideally, the system should provide quick access to useful information that helps you reliably identify key drivers of downtime.

Equipment builders have taken various approaches to meeting this need, with various degrees of success. At Videojet, we've built extensive data-collection capabilities into our new 1550 and 1650 continuous ink jet printers. To make this data useful, our detailed Availability reports provide click-through drill-down analysis. For example, the screen below shows Availability statistics broken down by various time periods and also by Printer Availability and Operational Availability.

| Timeframe | Printer Availability | Operational Availability "Jets On" time |
|---------------|----------------------|---|
| Last 30 days | 98.8% | 98.5% |
| Last 90 days | 99.6% | 99.0% |
| Current Month | 98.8% | 98.5% |
| July 2012 | 100.0% | 99.3% |
| June 2012 | 100.0% | 99.1% |
| May 2012 | 98.8% | 98.5% |

Top-level Availability information displayed by time and Availability type.

The two Availability columns help you determine whether downtime was caused by a printer fault or operational fault. For example, if the Printer Availability column shows 100% for a given time period, you know that the printer was able to power on with all systems functioning properly. If the Operational Availability for the same time period shows less than 100%, you're likely experiencing problems which can be improved with operational changes – for example, you might need to clean the printhead on a more frequent schedule.

To discover more detailed information about the cause of a problem, click on any cell that displays a right arrow. For example, the following screen shows a drill-down to the type, duration and frequency of faults encountered during one of the time periods from the previous screen.

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Drilling down from raw availability information to specific root causes.

As you can see, two types of faults occurred. The duration and frequency information helps you address the most serious problem first, and you can drill down further to reveal information about when the errors occurred, what printer parameters were affected and countermeasures you can take to fix the problem on a long-term basis.

For example, click on the Frequency cell shown for the EHT/HV Trip fault to learn more about each of the three occurrences. The system displays the date, time and duration of each fault.



Drilling down to reveal the date, time and duration of each fault.

The EHT/HV Trip fault occurred every 30 days, on the 20th of the month. That's valuable information. The root cause of this fault is most commonly a dirty printhead. Scheduling a printhead cleaning every 25 days will most likely solve

the problem, and you can ensure the solution is sustainable by checking over the next 30, 60 and 90 days to verify a significant reduction or elimination of EHT/HV Trip events.

The system can be configured to best reflect your own definition of planned production time – for example, tracking availability based on Jets-On, when the printer is expected to be productive, rather than just at Power-On. So you can get an accurate accounting of your uptime performance, along with quick access to the meaningful information you need to determine root causes of downtime events and help prevent them from occurring again.

For a more detailed walkthrough of the diagnostic capabilities we've incorporated into the Videojet 1550 and 1650 printers, see our white paper, *Problem Solving Through Root Cause Analysis: Getting the Most from Your Coding Printers*.

Minimize Unplanned Downtime

Although our next-generation continuous ink jet printers provide powerful tools for diagnosing the causes of unplanned downtime, it's better to avoid downtime in the first place. We've engineered several design features that minimize the most common causes of downtime due to print quality and printer reliability issues.

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Dynamic Calibration™: Correct Ink Temperature and Viscosity Helps Ensure Print Quality

Even small changes in ambient temperature and humidity can have a big effect on ink viscosity and resulting print quality. When these parameters are not set precisely, the result can be scrap and indefinite downtime as you attempt to track down and resolve the problem.

Videojet minimizes these issues with an innovative Dynamic Calibration™ system. The system maintains constant jet velocity, ink viscosity and drop formation by dynamically controlling pump speed, nozzle drive and printhead heater temperature. The result is better print quality with less need for printhead cleaning in the ever-changing conditions typically found in manufacturing environments (See Figure 1).

Optimal Printhead Design: Less Ink Buildup Means More Reliable Printing

The most frequent cause of unplanned printer downtime is the need to clean the printhead. Any extension of ink buildup below the printhead leads to clipping and other print quality issues, potentially causing scrap and always requiring a production stop and operator intervention to resolve.

High-quality inks are part of the solution, and printheads can be designed to minimize ink buildup to allow much longer intervals between printhead cleanings. In addition to inks formulated for optimal performance in a wide variety of specific applications, our CleanFlow™ printhead features a perforated cover design and an internal pump that delivers a positive airflow, filtered to eliminate dust contamination. The result is higher-quality printing with fewer printhead cleanings, without the need to provide factory air.

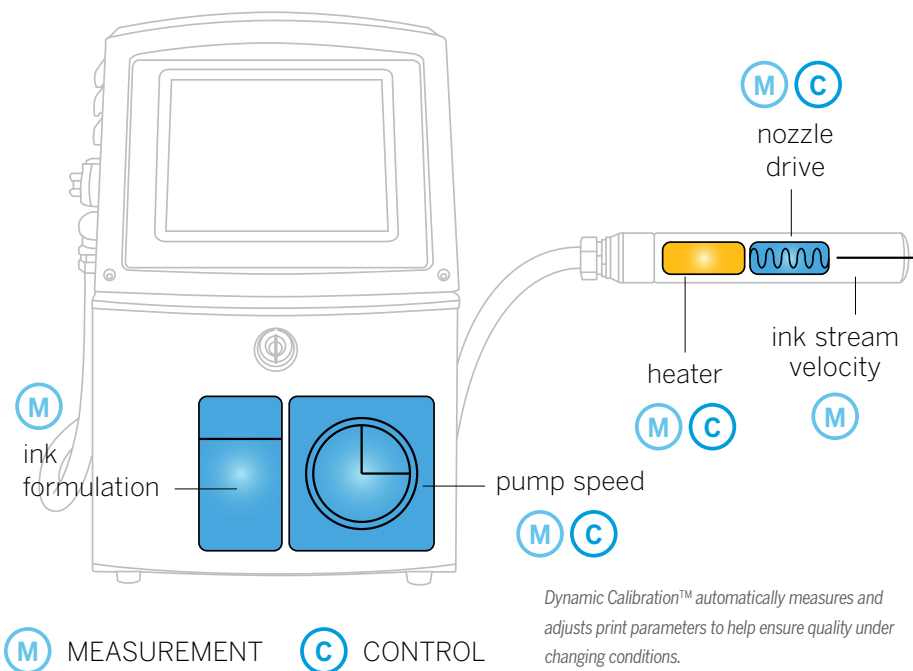
Automatic Printhead Cleaning: Start the Printer Successfully Even after Extended Idle Time

It's not unusual, especially for older ink jet printers, to encounter print quality problems upon startup. This is especially true if the printer has been idle for a period of time – for example, over the weekend.

Our solution to improve productivity on Monday mornings – or anytime you're starting up the production line – is to incorporate a printhead autocleaning procedure that is performed with every start and stop of the printer. This system eliminates ink buildup for more reliable startup for the ink jet, helping deliver long-term performance and print quality with minimal intervention.

Automatic printhead cleaning illustrates a general principle that can help improve uptime across the entire production line: Automation of equipment setup and maintenance removes the burden and risk of operator intervention and provides greater assurance that essential procedures are performed correctly.

Figure 1



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Simplified and Predictable Maintenance: Minimize the Frequency and Duration of Planned Downtime

Our focus so far has been on unplanned downtime, the largest source of customer pain. But planned downtime also plays a role, and minimizing the time and frequency of required maintenance can substantially increase your planned plant operating time.

Planned maintenance is inevitable, but it doesn't need to mean excessive downtime. Vendors who understand your need to maximize productivity design their equipment for long and predictable maintenance intervals, including maintenance procedures that can be quickly performed by your own staff. This allows you to significantly improve the baseline of planned operating time.

For example, while most people understand the need to replace filters periodically, it's a fact of life that components like valves and solenoids eventually wear out and need replacement. If the printer design doesn't account for this as a necessary part of planned maintenance, chances are that these parts will be run to failure and create unplanned downtime.

Our solution is an advanced core design that incorporates all ink system filters and common wear parts – matched for a predictable maintenance interval as long as 14,000 running hours – housed in a single, customer-replaceable unit. The Videojet approach to planned maintenance means everything that needs to be changed can be changed in one simple operation, with maximum runtime in-between.

On any type of manufacturing equipment, features that simplify and speed maintenance while extending planned maintenance intervals can contribute substantially to uptime.



The advanced core design enables 1000 Line printers to perform up to 14,000 hours between maintenance.

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Videojet Delivers

We've discussed general requirements for understanding the causes of downtime and correcting them, with specific reference to Videojet's technical solutions. Other providers may offer corresponding solutions, and we encourage you to investigate your options thoroughly before committing to a coding printer vendor.

But there's more to selecting a partner than the technology, and we'd like to conclude by briefly mentioning the people and services behind the technology at Videojet. The organization you select can be just as important in assuring uptime as the features of the printer itself.

Proven application support. Every application and environment is unique, providing its own set of challenges. Videojet understands this and has the expertise to help you choose, configure and install the right printer – and keep it functioning optimally for years to come. We have the knowledge and expertise that comes from installing and supporting many thousands of printers worldwide, and a huge portfolio of top-quality inks and supplies formulated for virtually any coding requirement.

A proven professional service network. Videojet maintains an extensive worldwide service network to provide our customers with the industry's most responsive support. Our service experts mount the quickest possible response to service and maintenance requests, helping you stay productive and profitable without delays or hassles. And Videojet collaborates with you to optimize performance from day one and to continuously improve for even greater success tomorrow.

Proven results. Videojet recently conducted a global survey of approximately 50 customers across different market segments – running over four hundred 1000 Line printers. We asked customers to report any production losses due to their printers over the previous 30 days. The outcome was quite positive, showing an average Availability of 99.9%, and over half reported zero lost production time.

With years of experience designing, producing and installing continuous ink jet printers, we take great pride in listening to our customers and delivering what they need. High uptime is one of their top priorities, so naturally it's one of ours. We provide systems designed to maximize availability, productivity and quality – and we equip you with powerful tools to help determine root causes of downtime and prevent them from happening again.

We believe the survey results – 99.9% Availability – are the best that the industry has to offer today. But it's still not good enough. We're committed to helping you strive for our shared goal of achieving 100% Availability. Because maximizing OEE through improved uptime is the key to maximizing profitability.

As part of a recent survey, we asked customers to share their thoughts. Here's what a few of them had to say about Videojet:

"Support [is] hyper fast and friendly. The whole staff and technicians at Videojet are very helpful."

- Ettore Grossi, Maintenance Planner, Nestle Pharma

"You can't mess them up once you have them going. Open it up, put in the ink and away you go."

- Scott Reinke, Lead Operator Stort Line, Gehl Foods, referring to a 1000 line printer

"My experience with the 1000 Line is really good. I have tested Markem Imaje and Domino and I was not satisfied. The 1000 Line is equipment that you put in the line and you can almost forget about it."

- Guillermo Robles, Maintenance Director, Lactiber - Operations

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