REDUCING PLANNED/UNPLANNED DOWNTIME WITH VISION SENSORS

White Paper
Using vision-based sensors in many stages of the packaging process can dramatically reduce planned downtime with repeatable decreases in production and product changeover time. In many cases, vision sensors can replace and even add flexibility to sensor arrays in the packaging process. Vision sensors can also reduce unplanned downtime with reliable and flexible error proofing that can be used for in line detection and product rejection. In this whitepaper, we will explore how vision-based sensors can be used to achieve these results.

Packaging Process Stages

Packaging encompasses many different industries and has several stages to the process. Each industry uses packaging to accomplish specific tasks that go well beyond being a container for a product. The pharmaceutical industry, for example, typically uses its packaging as a means of dispensing as well as containing. The food and beverage industry uses packaging as a means of preventing contamination and creating differentiation on the store shelf. The consumer goods industry generally requires unique product containment methods and has a need for the “on-the-shelf” differentiation.

Within the packaging process itself, there are several stages. These stages include: primary, secondary, and tertiary. In the primary packaging stage the product is first placed into a package, whether that is form-fill-seal bagging or bottle fill and capping. Secondary packaging is typically what the consumer sees on the shelf, like cereal boxes or six packs of bottles. Finally, there is tertiary packaging or transport packaging in which the primary or secondary packaging is grouped for storage and transportation. Each of these stages typically requires verification or inspection to ensure the process is running properly and the products are correctly packaged.

With the use of vision-based sensing technology, greater flexibility and more reliable operation of the packaging process can be achieved. In the past as well as today, discrete sensors have often been used to look for errors and manage product changeovers. However, these simple discrete sensing solutions can cause limitations in flexibility, time consuming fixture changeovers, and more potential for errors – which all together cost thousands of dollars in rejected product and lost production time. This of course translates into more expensive and less competitively priced products on the store shelves.

Breakdown of Scheduled Line Runtime

Let’s take a look at the different activities that decrease actual runtime to see how uptime can be improved. Each packaging line is scheduled to run an amount of time, for example, one shift of 8 hours or 480 minutes. Of that scheduled time, it can be broken down into planned downtime and planned runtime. Within the planned runtime, however, there is also unplanned downtime and actual runtime. Reducing planned and unplanned downtime directly increases the total actual runtime.

How Vision Can Reduce Planned and Unplanned Downtime

Planned downtime can encompass many planned activities. These might include time needed for: changing over to another product type or package, performing routine maintenance, sanitizing the line, and operator breaks. For the sake of this investigation, we will only consider procedures that affect changeover or maintenance on the line, such as routine calibration or verification of discrete sensors and their fixturing during product changeover. A vision sensor can replace the discrete sensing method, reducing the changeover time to only the time needed to switch to a new software program and adjust any lighting (if required). In most vision applications, lighting and fixturing don’t usually require adjustment, so the total time for a product changeover with a vision sensor would be the time required to change the electronic program, which is typically less than one second.
Unplanned downtime occurs when the line is shut down due to a run time error in the packaging process. This time is usually accrued in minutes, unless a line configuration process was improperly followed. If jamming occurs, unplanned downtime may take several hours to correct the improper setup configuration. Unplanned downtime is usually caused when a process jams or improperly packaged products are detected without dynamic or inline rejection. For every occurrence of unplanned downtime due to jamming, an amount of product might have to be discarded. That discarded product must also be included in the overall operating costs. By using a vision sensor, this type of unplanned downtime can be prevented or detected right away, thus increasing actual runtime and reducing waste costs. Both of these cost savings can be directly factored into the return on investment of the vision sensor.

There are two key ways that implementing vision-based sensors can improve the scheduled line time. The first is reducing planned downtime during product changeover that requires fixturing changes. This is the area that vision sensors can have the greatest effect on improving the scheduled line time. This is a repeatable benefit that can dramatically reduce operating costs and increase the planned runtime. The other way is to decrease unplanned downtime by catching errors right away and dynamically rejecting them or bringing attention to line issues thereby preventing large amounts of waste. Examples of this include line jams that occur because of incorrectly fed packaging materials, miss-aligned packages, or undetected open flaps on cartons. Other examples could be improperly capped bottles that cause jams or spills and improper adjustments, or low ink levels that cause bad labeling. Implementing vision-based sensors in any of these examples can improve scheduled line time.

Discrete vs. Vision based Error Proofing

Cost and reliability of any technology that improves the packaging process should always be proportional to the benefit it provides. Unlike the older, more expensive vision systems, today's vision-based sensors can replace an entire discrete sensor array, and in many cases the fixturing as well. They do this at or even below the cost of the sensor array while also providing greater flexibility. They can significantly reduce manual labor costs for inspection, in addition to reducing planned and unplanned downtime thereby providing longer actual runtime during scheduled operation for greater product throughput. A vision sensing solution can typically be installed for under $2500, including fixturing, lighting and labor. (See Cost Example below.) The vision sensors can also be changed over in functionality for the next package or product type within a matter of seconds with little or no manual intervention.

### Items:

<table>
<thead>
<tr>
<th>Vision Sensor</th>
<th>Photoelectric Sensors</th>
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</thead>
<tbody>
<tr>
<td>Trigger sensors</td>
<td>1 x $66</td>
</tr>
<tr>
<td>Inspection sensors</td>
<td>1 vision based x $1350</td>
</tr>
<tr>
<td>Fixturing hardware</td>
<td>1 bracket x $140</td>
</tr>
<tr>
<td>Cabling</td>
<td>3 x $65</td>
</tr>
<tr>
<td>Lighting</td>
<td>1 x $500 (if needed)</td>
</tr>
<tr>
<td>Wiring labor</td>
<td>$60</td>
</tr>
<tr>
<td>Sensor setup time</td>
<td>$60</td>
</tr>
<tr>
<td>PLC program time</td>
<td>$30</td>
</tr>
<tr>
<td><strong>Total install cost:</strong></td>
<td><strong>$2,401</strong></td>
</tr>
<tr>
<td><strong>Product change-over time</strong></td>
<td><strong>&lt;1 min</strong></td>
</tr>
<tr>
<td><strong>Flexibility level</strong></td>
<td><strong>High</strong></td>
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</tbody>
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Example of inspection cost for a cases content (12 bottles)

In the cost example shown above, there is no significant cost impact to the machine builder to install a vision-based solution, yet the impact on the time for product changeover is a significant and repeatable time benefit in reducing the user's planned downtime. Moreover, the vision-based solution provides significantly greater flexibility to add additional product packaging types in the future on the same line with little to no additional sensor modification.
Vision Sensing Making A Difference

In the following examples, a vision based sensor was used to solve a packaging problem or to replace an existing but ineffective sensing installation.

Detects improperly seated cabled carton cap

Detects wrong medication bottle cap type

Verifies cap presence and proper sealing

Verifies improperly closed freshness seal

Verifies proper PET blow molding

Detects proper box flap closure
Case Studies

Case #1 – Medical Vial Manufacturer
A medical vial manufacturer produces caps with foil and paper liners inserted into several different caps of various sizes and colors to seal glass medical sample vials. This manufacturer can produce 100 vials and caps per minute with 2 shifts, 5 days a week. There are approximately 100 to 200 vials per case and they have been using manual inspection to error proof cap production. They found that in order to maintain these higher volumes, they would need to have automated inspection with in-line rejection to manage the planned downtime for setup of all the different cap types and to minimize unplanned downtime if the cap liner was not properly being cut or inserted into the cap. One bad cap could cause the rejection of an entire case of caps and vials costing over $200 in product, shipping, and manual re-inspection.

The images below show one good and one defective inspection being done by a vision-based sensor. 100% error proofing of each cap is done before proceeding to bagging and then casing.

Aluminum cap with cut paper insert in top cap and missing insert in the bottom cap. A pattern matching tool was used for inspection.

A red plastic molded cap with cut Teflon insert in top cap and missing insert in bottom cap. Edge counting was used for inspection.
Because of the variations of cap materials and colors, using discrete sensors would be difficult to use and adjust every time a new cap type was run. Using a vision sensor minimized the changeover time to milliseconds and provided 100% inspection. These changes enabled them to completely eliminate manual inspection and product case rejections by customers. The pictures below show the in-line error proofing and rejection station.

Case #2 – Mainstream Dairy Bottler
A mainstream dairy produces 130 half gallon specialty drink bottles per minute, 7 days a week, 3 shifts per day up to 150,000 bottles per day. They change drink flavors as often as several times a day. When a single bottle of liquid is not properly capped and sealed, it becomes a “leaker”. The “leaker” contaminates a pallet of cased bottles that can cause the entire loss of the pallet. The “leaker” is found either at the palletizer or even worse, at the store, causing the entire pallet to be rejected at a greater expense. The leaking bottle can also contaminate the delivery vehicle requiring the vehicle to be taken out of service for cleaning. The estimated loss for a single “leaker” can be in excess of $5000 if the pallet was not detected until it reached the store. According to the dairy, detecting just one “leaker” before it reached the palletizer easily paid for the entire vision sensor error proofing station. They also noted they were experiencing a “leaker” as often as once a week before using a vision sensor to check for improperly capped bottles.

The images below illustrate the installation of the vision sensor and the inspections being preformed just downstream of the rotary capping machine.

The intention of the error proofing station was to catch missing or improperly capped bottles before they reached the secondary case packaging or palletizing stage, when detection would be virtually impossible. If a capping problem is detected on a bottle, the filling line is stopped so the bottle can be removed before secondary packaging. Once the vision based sensing station began operation, it was almost immediately detected that there were two slightly different sized bottles because of the multiple PET bottle suppliers. Without vision inspection, they would have had to manually sort and identify the bottles and the capper would have required difficult adjustments before production could begin. These adjustments increased planned downtime by over 20 minutes, not including manual bottle sorting.
The implementation of the vision sensor error proofing station eliminated the few but costly “leakers” from reaching the casing machine or proceeding to the palletizer. This allowed them to run all the bottles without sorting or making any capper machine adjustments, thereby significantly reducing planned downtime and lost product costs.

**Answering Today’s Packaging Challenges**

Using vision-based sensors within any stage of the packaging process can provide the flexibility to dramatically reduce planned downtime with a repeatable decrease in product changeover time. Vision sensors can also provide reliable and flexible error proofing that can significantly reduce unplanned downtime by providing in-line detection and rejection to eliminate jams and prevent product losses, especially by customer rejections. In today’s competitive market with constant pressure to reduce operating cost, increase quality, and minimize waste, vision-based sensors can make those differences for your packaging process.

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