ORMEC
Container Labeling Machine

This is an application report written to inform the reader of how ORMEC motion control systems makes an improvement a particular machine or manufacturing process. It illustrates productivity increases, increased machine flexibility, and a decrease in operator intervention.

GENERAL DESCRIPTION OF THE MACHINE PROCESS

The container labeling machine system pictured in Figure 1 is used to apply sleeves over bottles for the purpose of labeling the bottle without using glues of any kind. The sleeve is constructed as plastic tubing that is preprinted with the label information, perforated between the print forming a web that is wound on a spool. The sleeving machine starts out with this spool of labeling. The web of labeling is unwound and fed into the machine.

Each sleeve of the web is attached to the previous sleeve with a perforation and needs to be separated. At the front end of the machine the

QUICK GLANCE

Application Highlight -- Increase of label application rate of four times over the previous machine.

Market -- labeling machine is used in the plastic and glass bottling industry for food and nonfood products

Motion Control Servoaxis -- *Carousel Axis* -- axis to spin the table holding the bottles.

Label Axis -- axis to position and feed the label sleeves onto a vacuum drum using a registration mark printed on the label sleeve.

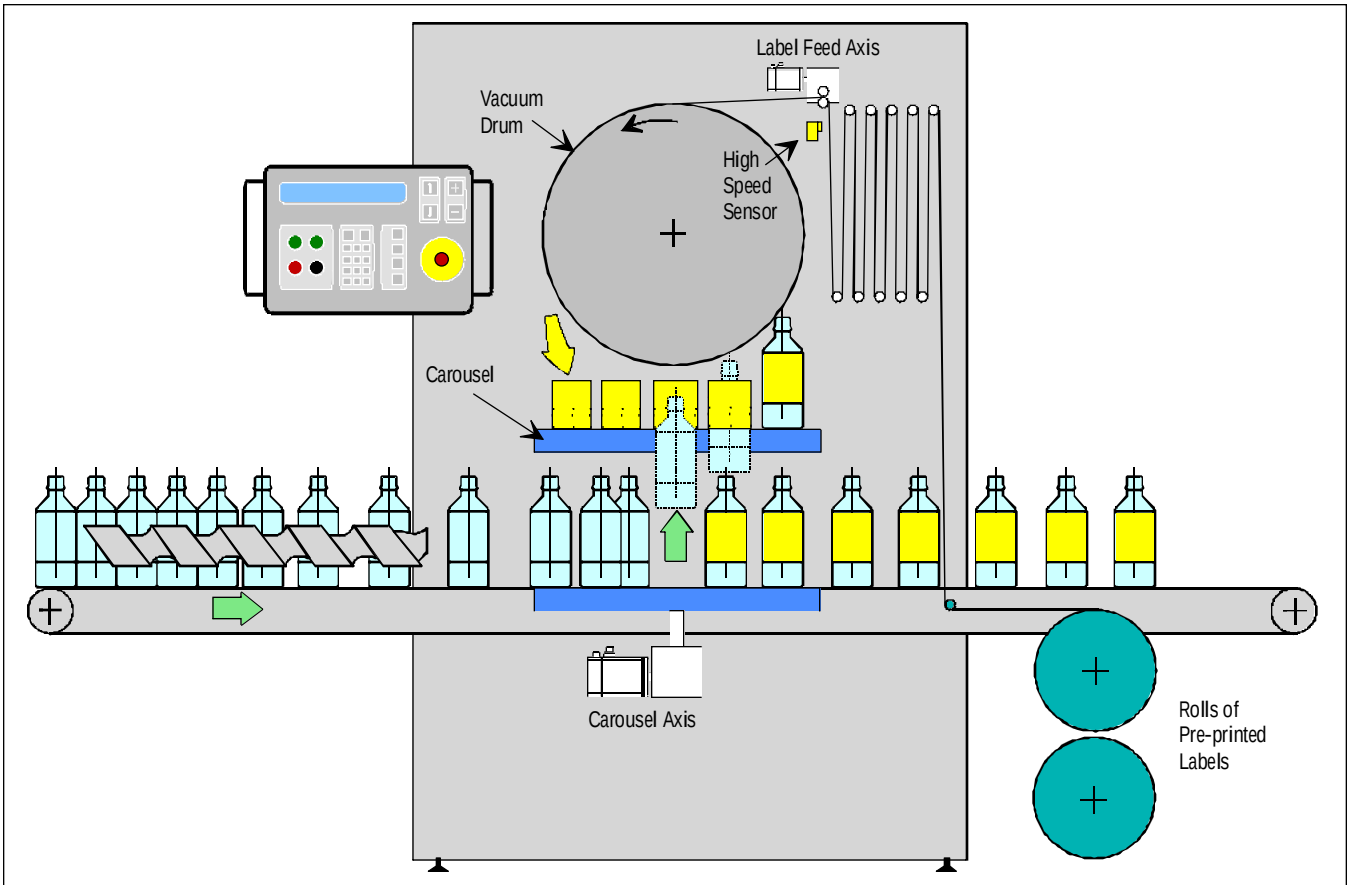


Figure 1 Container Labeling Machine

bottles are feeding into a Carousel table. Before the bottle is positioned into the sleeve, the sleeve is separated, placed on the vacuum drum, taken down to the carousal, placed on finger holders and then stretched wider than the bottle's diameter. Each bottle is then fed into the center of the sleeve. The sleeve is positioned onto the bottle at a precise distance from the top of the bottle every 112 milliseconds (400/minute) at its maximum speed.

The bottle is pushed up through the sleeve that is stretched wide enough at one end to fit over the bottle. Then the bottle is picked up away from the part of the machine that is stretching the label to let the label snap onto the bottle. At this point the bottle is placed back down and carried out of the machine by the Carousel.

How Motion Control Was Used

Labels need to be synchronized to the Carousel to achieve one label for one bottle. Also, the label must be positioned at the proper distance from the top of the bottle. The motion control system is controlling the speed of the Carousel and the speed of the Label Feed. By sensing the position of the label reference mark, it is able to vary the relative distance of the Label Feed motor at operating speed and synchronize the reference mark on the sleeve to the bottle position on the Carousel.

HOW THE PROCESS BENEFITED FROM THE ORMEC SERVO SYSTEM

Machine Speeds up Approximately Four Times

The new generation labeling machine operates at speeds up to 400 containers/minute (24,000 containers/hour), compared to the previous mechanical design which operated at 90 containers/minute.

Electronic Gearing & Registration Control

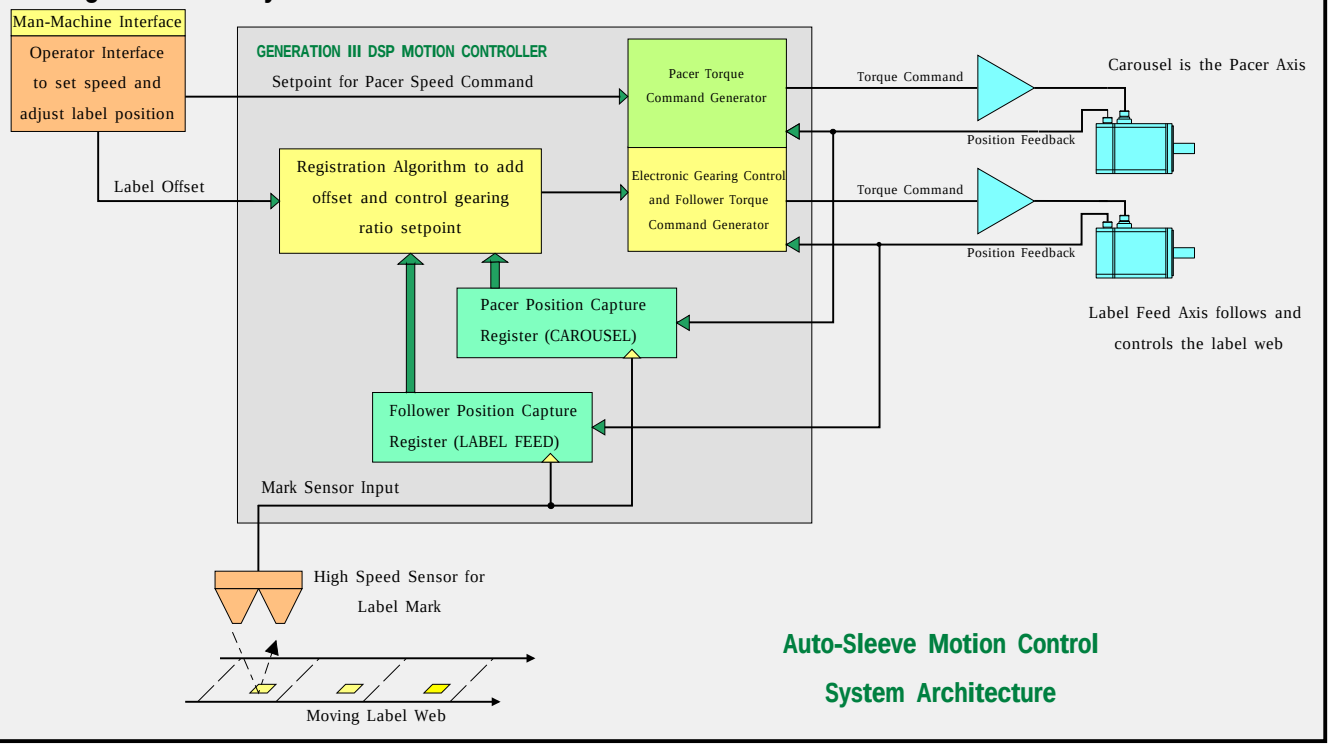
The ORMEC motion control system is used to provide the synchronizing method between the Carousel Axis and the Label Feed Axis. The Carousel axis is driven by a servomotor and is consider the master or *pacer axis.* The Label Feed Axis is also driven by a servomotor and is setup as the slave or *follower axis* with the ability to control the electronic gear ratio between it and the Carousel Axis. This *electronic gearing* ability will allow the Label Axis position and speed to the modified based on the ORMEC *registration algorithm.* The ORMEC registration algorithm implemented using DSP (digital signal processor) technology senses the mark on the printed material and adjusts the position of the web before the label is separated from the web. Once off the web, the label is placed on the vacuum drum and carried to the finger holders. The registration algorithm also allows an offset to be added to the system to adjust the position of the label on the vacuum drum and the fingers which in turn adjusts the placement of the label on the bottle. Synchronization is not lost during the acceleration and deceleration of the machine.

Machine Setup / Flexibility

Due to the fact that the ORMEC System is controlling the Carousel Axis, additional features were found to be very beneficial to the total system. The ORMEC controller is able to monitor external events and change the behavior of the system in the attempt to compensate for the change. For example, the system will monitor the incoming flow of bottles and the outgoing flow of bottles. When the incoming flow has stopped, the system will shut down and wait for more bottles. Then start up again when bottles are present without intervention of an operator. If the outgoing bottle rate slows down, the controller will automatically reduced the speed of the machine by 20%. The Generation III motion controller also has an external speed control input to allow other plant equipment, before the sleeving machine or after it, to set the base machine speed.

All adjustments and machine setup parameters are entered into the Generation III

Figure 2 Servo System Architecture



motion controller by the operator interface panel at the front of the machine. Factory network protocol "Modbus" is used as the communication scheme between the operator interface and the Generation III controller.

Dynamic Response to Bottle Jams

The high dynamic response of the servo system to bottle jams is especially important. The motion control software monitors inputs for bottle jam detection, and the software responds to slow down or shut down the machine process as appropriate. A mechanical brake on the Carousel axis that can be asserted from software provides emergency braking capabilities.

Operator Interface / Indicator Lights

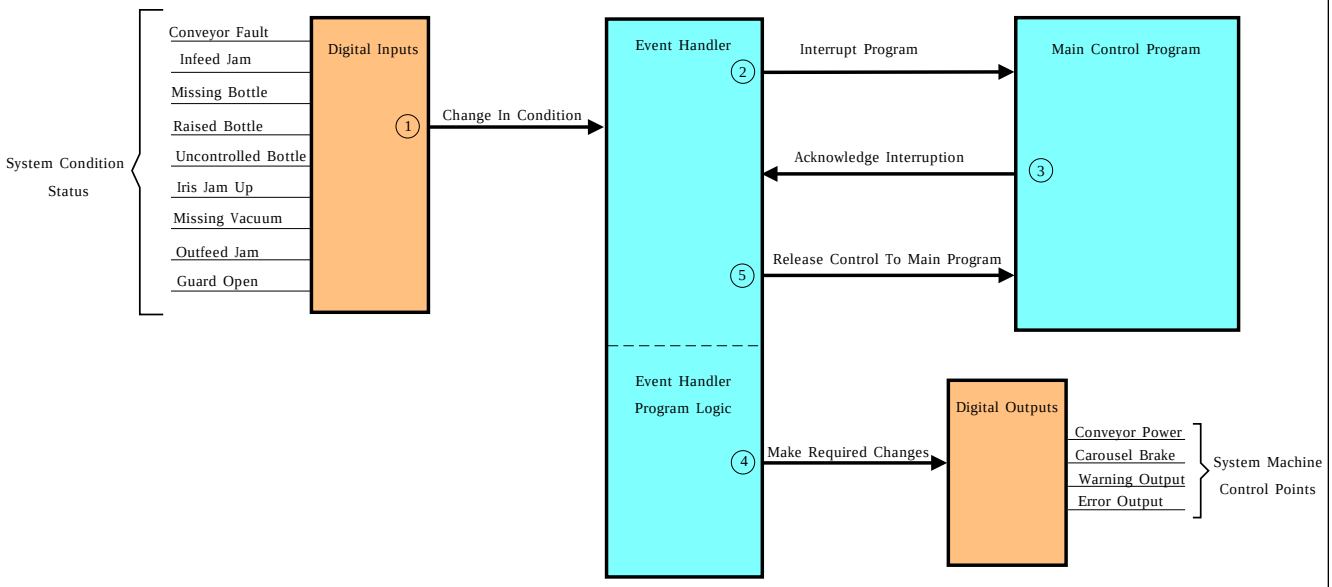
A sophisticated operator interface coordinates machine operation. Alarm lights on the top of the machine are used to indicate fault conditions—since the machine does not require a full-time operator.

ELECTRONIC MACHINE CONTROL ARCHITECTURE

Electronic Gearing and Registration Input

The heart of the servo system in this application (as seen in Figure 2) is the electronic gearing ability teamed up with hi-speed position capture. Quick response to changing web position is achieved by using a special registration algorithm which combines both instantaneous correction and long term trending observations to provide smooth control over a wide speed range. The algorithm constantly compares position of the web against the position of the carousel and keeping the web on track by fine tuning the gear ratio between the carousel servomotor and the label feed servomotor that is driving the web. With consistent control of the web, offset adjustments between the web position and the Carousel position become accurate and have fine incremental correction ability due to the high feedback resolution of the servomotors. This in-turn allows adjustment of the label position on the bottle through the operator interface as the machine runs and keeps the label position consistent on the container during normal stopping and

Figure 3 System Event Handler



Critical Fault Event Handler In The GENERATION III

starting conditions.

Torque Control Servomotors

Dynamic response and controllability are the result of using Digital Signal Processing technology and the Torque Mode control scheme. Digital signal processing allows tightly coupled control of the servo loop with the added advantage of software control of the loop stability allowing on-line adjustment of the servoloop coefficients compensating for machine load variation. Torque mode control puts the controller as close to the motor current control as possible for full and immediate access needed to supply the torque demands of the machine.

Machine Input and Output Control

The Generation III motion controller monitors the condition of the machine and will stop when it is notified that a problem exists. A circuit of sensors is placed on the machine to detect the following critical conditions:

- ❒ Conveyor Fault
- ❒ Infeed Jam
- ❒ Missing Bottle
- ❒ Raised Bottle
- ❒ Uncontrolled Bottle
- ❒ Iris Jam
- ❒ Missing Vacuum
- ❒ Outfeed Jam
- ❒ Guard Open

Any of these conditions will cause the motion control system to stop as quickly as it can. Critical fault conditions will cause large down times if not caught in the shortest amount of time physically possible. The fault inputs are fed directly into 'event handler' section of the motion control software program (as seen in Figure 3) to get the quickest attention of the Generation III controller. The 'event handler' will interrupt the regular program execution to take care of the immediate critical condition. Once the process of stopping the machine is under way, the Generation III controller reports the fault condition to the operator panel, turns on the error light mounted on top of the machine and sounds the alarm horn.

Noncritical 'input states' control the regular operation of the machine. The operator interface panel will assert an 'ON' condition into the START/STOP register of the Generation III controller to start the machine.

The festoon 'OK' input indicates there is label material in place and ready to go. As the label material runs out during a product run, the

festoon 'OK' will drop out. At this point in time the Generation III controller will calculate how long to run before stopping, so when it stops the festoon will be empty and the operator can splice new roll onto the web, clear the stop condition and the machine will accelerate back up to its running speed without having to rethread the web.

The Infeed conveyer system has two sensors that provide status of the conveyer to the Generation III controller. The primary infeed condition and the secondary infeed condition. A primary infeed condition tells the Generation III that the conveyer is getting empty and to start slowing down by a percentage specified as a setup parameter. A secondary infeed condition tells the Generation III that the conveyer is empty and to bring the Carousel to a stop. The Outfeed conveyer has similar sensors use to present to the Generation III status on the condition of the outfeed conveyer system. The primary outfeed condition indicates that the containers are starting to backup and to slow down the Carousel speed by a percentage also specified as a setup parameter. The secondary condition indicates a total backup exists and to stop the Carousel before a jam up is created.

Maintenance and Setup Modes

Maintenance and setup functions are built into the Generation III Controller software program. To help in manual operations for setting the machine up and clearing a jam, special modes of operation are implemented to:

- ❒ index the Carousel one station,
- ❒ jog the Carousel in the reverse direction,
- ❒ run Carousel without applying sleeves,
- ❒ allow machine to unload containers by ignoring the infeed sensors.

These special modes help setup and reduce overall down time. Machine product change overtime becomes fast as well as unjaming the machine and rethreading the web. All these functions reside in the Generation III motion control program.

SUMMARY

Advantages of Integrated Electronic Machine Control

Integrated electronic machine control organizes the machine functions in the flexible environment of software control. This environment in the Generation III controller allows the machine designer to configure the machine functions to accomplish the task the machine is designed for and at the same time, allow any auxiliary monitoring on the condition of the machine process for the purpose lowering the overhead that is associated with operating high speed machinery.

The use of ORMEC electronic motion controllers allows the designer to place torque where it is needed, in a convenient manner, and gives the ability to manipulated the torque profile, coordinating its function for the most efficient use on the machine. By the utilization of electronic lineshafting, electronic gearing and electronic cam profiling, the designer is now able to synchronize separate functional parts of the machine, that otherwise would be physically prohibitive using mechanical methods.

Flexibility utilized by the designer in building the machine can also be brought into the forefront of the machine operator. The machine functions can be selected by the operator to configure the process for different product variations without the large setup costs previously found on mechanical-only designs for the same machine.

This flexibility can be extended further by connecting the machine to the enterprise networks in the factory for the purpose of setting up production orders, monitoring maintenance schedules, and collecting statistical data; there by creating an environment for increased throughput and lower production costs. ■

MOTION CONTROL SOLUTIONS

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