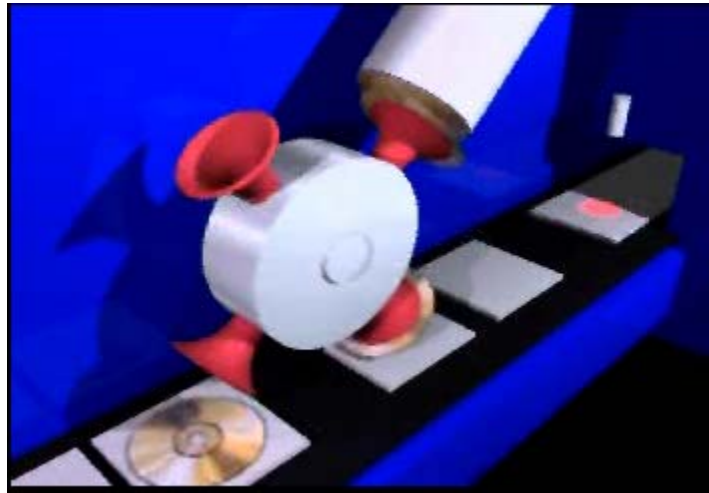


Product Application Note

Random Rotary Placer

Applicable Product: MP940 with MotionWorks+



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Application Overview

Random rotary placers are used for placing a product from a magazine onto a corresponding product being fed on a conveyor at random intervals. This application controls the rotary axis of the placer to insure accurate placement as well as providing management of the vacuum placing mechanism.

Application Highlights

Industry:	Packaging
SIC Code:	
Major Features:	Synchronized placement on random in-feed, Position based CAMMING, Position Registration, On-the-fly CAM Shift.
Results:	Accuracy = +/-0.125", Speed = 200 placements/min.

Application Challenges

- Random Product In-feed – Controller must be able to account for product being fed at unpredictable intervals and realign to place product in the correct location.
- Increased throughput – Higher productivity should result from the addition of this motion control solution, due to higher speeds and lower downtime.
- Smooth Motion – The solution must yield smooth motion to reduce machine wear produced by jerky accelerations, resulting in increased machine life and lower maintenance (more uptime).
- Matching Conveyor Speed – As product is being placed, speed matching is critical to insure precise location for applications such as a label placer.
- Product Selection from Magazine – Controller must discern and anticipate when to pick a product from the magazine, so that product is only grabbed if material is being fed down the conveyor.

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Products Used

Component	Product and Model Number
Servopack	Yaskawa Sigma II Amplifier, SGDh
Motor	Sigma II Series Servomotor, SGMPH with 20:1 Gearbox
Controller	MP940 Single-Axis Motion Controller
Software	MotionWorks+ Icon Based Programming Environment
HMI	n/a
Third Party Devices	n/a

Application Requirements

The control system needs to precisely adjust the rotary placer heads in position to pick up a disc product from an unloaded magazine and synchronously place it on a carrier case passing on a conveyor below it. The unique challenge about this application is that the carrier cases are randomly spaced on the variable speed conveyor below. The rotary head must increase or decrease its speed to anticipate the next place position, and match the speed for a specified window, while the product is placed on the case.

Application Specifications and Constraints:

- Cycle Speeds: Need 200 places per min.
- Accuracy: +/-0.125" placement accuracy.
- Load-to-Rotor Inertia Ratio: Rotary placer axis = 4.5:1.
- Transmission: Direct coupling via 20:1 planetary gearbox.
- Placer speed synchronization window = +/-15 degrees.
- Min distance between latch sensor and placer = 16", to insure proper buffer.
- Conveyor line master encoder resolution = 0.001" per pulse.
- Case Spacing range = 4" to 12".

Machine & Motion Control Requirements:

- Product must not be placed when a case is not present.
- Operator may wish to manually advance/retard the placement phase position, but it must be residual upon power cycle.
- Placement must be made without violent motion profiles.

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Application Solution and Benefits

The product chosen for this application is an MP940/SGDH single-axis system programmed via MotionWorks Plus (MW+) Icon based programming. This is chosen because the customer viewed the simplicity of the Icon-based platform, as a way to leverage-programming efficiency into cost savings. The hardware platform also allows the use of one-way CAMMING to solve the precise motion-control requirements. By using this technology, any changes in the conveyor speed will not affect the accuracy of the placement, because the slave follows the master conveyor on a position basis. Machine jerk is thus controlled via customizing the profile and programming the points into a CAM table – acceleration and deceleration profiling can then be custom designed.

Because of the flexibility, this implementation technique can be used in similar applications such as a rotary knife.

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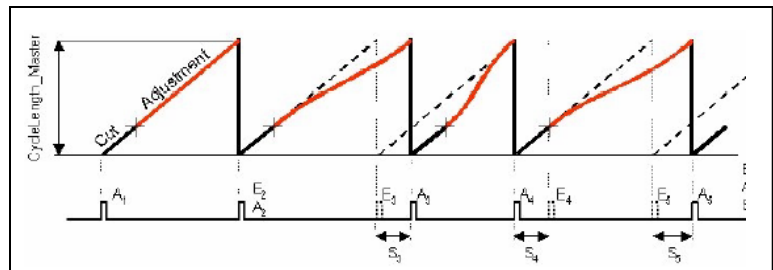
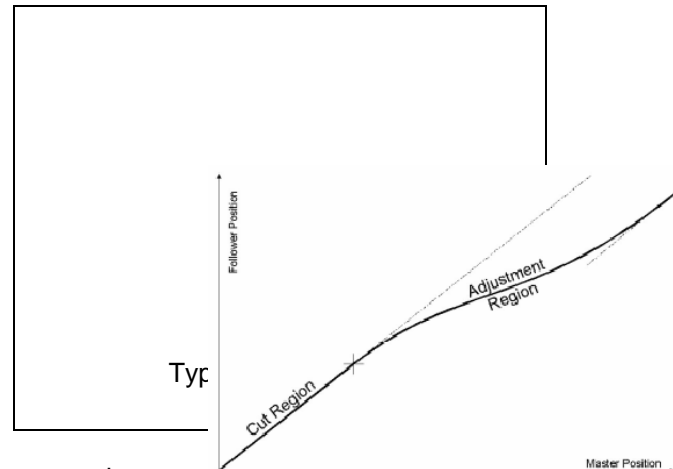
Implementation Method of Core Operation

The core operation is the placement of the discs on the randomly spaced carrier cases. The MP940 system is programmed via icons to simplify sequential program flow and monitor tracking for ease of troubleshooting. To accomplish the synchronized product placement, a position based CAM table is used. As the conveyor moves, the differential encoder is dynamically read in as the master position. During start-up, the carrier case pitch separation distance is automatically sensed, stored, and used as the *machine cycle* for the CAM operation. Each time a new machine cycle is stored, a new CAM table is calculated. The CAM table is carefully calculated to account for: 1:1 matched speed in place window, matching the placing head separation distance with the carrier case pitch, and smooth CAM table point transition. Note that if the place head separation distance (circumference/# place heads) was equal to the carrier case pitch (case separation distance), then the CAM cycle would simply be a straight line and could be represented by two points.

During run-time, the system will modulate the master-position signal according to this stored machine cycle. This modulated cyclic signal is then fed into the CAM table (internally this is a function generator), which in turn outputs a corresponding slave position, that the rotary placer head is commanded to follow.

Accommodating for Random in-feed:

Carrier cases are detected by a high-speed registration sensor, at which time the conveyor position is latched within 25usec, thus signaling a “case position store” event. Each case’s exact position is stored in a data array for later use, and the store pointer is incremented. When a placer head (one of the four) reaches the place position, a place position is read, and the read pointer is incremented. As long as the store and read pointers are not equal, the placer is signaled to grab the next product out of the unload magazine (otherwise the head will pass by the magazine without grabbing product). At this point, the current position of the conveyor, case latched position, and distance between sensor and placer are compared. A new place profile is calculated for the next place cycle, and is used for the CAM Shift. The CAM table is shifted in reference to the master via the CAM Shift Icon, this adjustment takes place outside of the cut region and is a time based S-Curve adjustment (position based adjustment is also available).



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Logistics note: To prevent an extra product picked up when no case exists (due to the physical position of the unload magazine at a 45 angle), requires that the sensor is back far enough to allow for product to buffer so product picking can be anticipated, and that the logic checks for this.

The control diagram is shown below:

