Machine Control with "Soft Motion" and Servo Systems with SERCOS interface™

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1. Introduction

Sanyo Denki's product family includes the software-based controller called "AML®" that is provided by Automation Intelligence (AI), a subsidiary of Sanyo Denki. "AML" software is available with two hardware platforms: the "SMS-10/15" stand-alone controller and the "SMS-PCI" open controller. The "SMS-10/15" only runs "AML" software while the "SMS-PCI" allows "AML" to operate on any Windows-based PC along with other Windows applications such as web browsers or HMI applications. The capabilities of "AML" are identical for either hardware platform. Also, AML-based controllers use the fiber-optic SERCOS interface™ to connect with servo systems and input/output (I/O) stations which includes the Sanyo Denki "PV" and "PE" servo systems with the SERCOS interface. All the hardware for these various products is developed and provided by Sanyo Denki.

In addition to "AML" development, AI serves as a sales channel for Sanyo Denki in North America and Europe. AI's *Partners in Motion* network of distributors sells Sanyo Denki servo and control system products. AI also has a control system integration service that provides custom control solutions for both OEMs and end users, and serves as an important sales and support channel for Sanyo Denki products.

This article discusses a machine that was recently developed by an OEM in Texas, USA. The success of this new machine is a good example of the marriage between AI & Sanyo Denki technology along with the combined capabilities of the customer (Waldrop), AI's local *Partner in Motion* (GEA of Texas), and AI's system integration service.

2. Machine Description

The MW Waldrop Company of Houston, Texas has been making machines for the meat packing industry since 1960. Until recently, these machines have been primarily mechanical with no electronic motion control. The redesign of the Pad Placing & Labeling Machine to replace mechanical components with servo technology had two primary purposes: increased speed and greater flexibility.

In preparation for the addition of meat in downstream operations, the Pad Placing & Labeling Machine inserts an absorbent pad into a meat packing tray and applies a label on the bottom of the tray. Fig.1 shows an overview of the mechanical design, as well as the major control components.

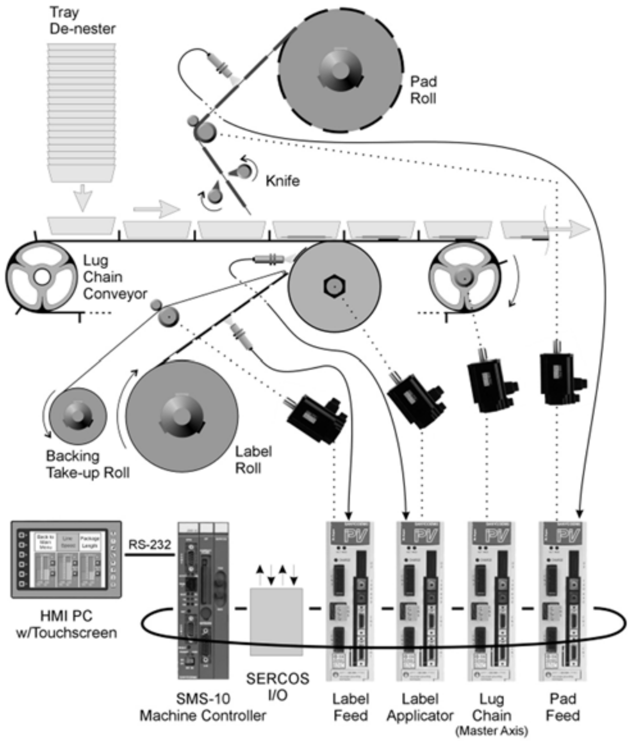

Fig.1 Overview of the Mechanical Design

Trays are placed one-by-one into a servo-driven Lug Chain Conveyor from a stack of trays at the de-nesting station. Fig.2 shows the entry of trays on the Lug Chain Conveyor.

Fig.2 Lug Chain Conveyor

As the individual trays advance with the Lug Chain Conveyor, software-programmable limit switches (PLS) in AML fire outputs to turn glue guns on and off at precise positions in the cycle, depositing glue in the bottom of the trays. A servo-driven roller pulls a fixed length of laminate encased padding from an overhead web. By using a servo drive that electronically gears the drive roll to the lug chain, the length of padding can be adjusted simply by altering a recipe value from the HMI. Registration corrections are used to position the webbing relative to the knife, ensuring that the cut occurs between the pads. The knife and pad depositing mechanism are mechanically linked to the main drive that controls the Lug Chain Conveyor. Fig.3 shows Pad Placer Labeler.

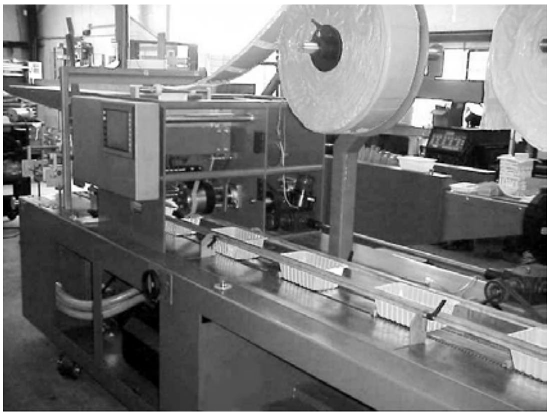

Fig.3 Pad Placer Labeler

On the underside of the machine, two servo axes are used to apply a label to the bottom of the tray. The pre-printed labels (safe handling instructions or recipe suggestions) may range from 25-100 mm (1-4 inches), and have only a small gap of approximately 6 mm (1/8"). The labels must be applied to the trays that are running at speeds of up to 350 trays per minute. The Label Feed axis ensures that one label is delivered per tray, while the Label Applicator applies the label to the tray. Both servo axes use photo-eye sensors tied to their built-in high-speed probe inputs to capture the axis position when the label edge is detected. "AML" uses that information to apply registration corrections (or position adjustments) to both axes to ensure that the label is applied precisely in an indentation on the tray.

At the end of the Lug Chain, the trays are stacked using a mechanical re-nester. Fig.4 shows the Tray Re-Nester.

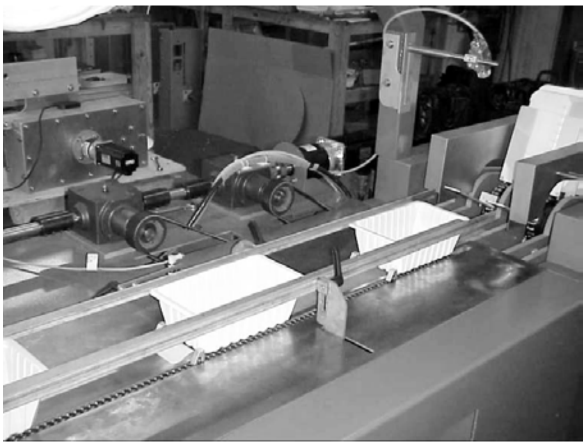

Fig.4 Tray Re-Nester

3. Control System Description

At the heart of the machine control system is the "SMS-10" with "AML" (Fig.1). The "SMS-10" serves as a complete machine controller, communicating with industry-standard SERCOS interface (IEC-61141) to four Sanyo Denki "PV" servo drives and an I/O station. An operator interface with color touch-screen is connected to the "SMS-10" using a serial port. The serial data is transferred using the DF-1 protocol, originally developed by Allen-Bradley, but now available as a standard on many industrial control devices.

The Lug Chain axis serves as the drive-train master. It runs at a recipe-configurable speed that is set through the HMI. All other axes are electronically geared to the Lug Chain using the drive-train capability of "AML". This ensures precise synchronization between all axes, and allows for electronic ratio changes for easy product changeover. Registration control, another key feature built into "AML", makes accurate positioning of the labels and pads straightforward.

Programmable limit switches are used to trigger I/O at precise positions within the machine cycle, based on axis position, ensuring that glue application remains consistent throughout the entire range of speeds. In addition, "AML" uses the PLS function to check for the presence of a tray at a specific position in each cycle. Empty lugs are tracked though the machine so that gluing, labeling, and pad placement operations are not performed on any missing trays.

"AML" also provides recipe support for easy changeover to different size products, allowing up to 128 recipes to be stored on the controller and reloaded from the HMI. In addition, a "teach mode" was developed to allow new recipes to be set up very quickly. The operator simply enters a few key parameters, such as Label Pitch, Pad Length, and Tray Size, then runs the machine slowly in "teach mode" for 5 cycles. Based on position readings and calculations, the recipe parameters are automatically determined by "AML".

4. Evolution of the Design

The Servo-driven Pad Placing & Labeling Machine was originally conceived as a 3-axis machine, with the label applicator controlled by a single servo. GEA of Texas and AI customer support engineers worked with Waldrop to specify the control system and to develop the application, a process that took only 8 weeks from initial specification until successful demonstration at the International Poultry Exposition in Atlanta, GA in January, 2002. However, it became apparent very quickly that the existing label applicator would prevent the machine from operating consistently at the desired speeds.

After the successful show, Waldrop enlisted the help of AI's system integration group to rework the label applicator. Collaboration between Waldrop, GEA of Texas, and AI engineers resulted in a new labeler concept that was quickly fabricated by Waldrop. Tommy Thompson, Staff Controls Engineer at AI, made several trips to the Waldrop facility to help write the AML application program for the new 2-axis label applicator. He also worked with Waldrop engineers to add exception handling to the existing application and to add functionality such as the "teach mode".

The first machine is now in production at a meat packing facility with additional machines produced on an ongoing basis. Waldrop is now evaluating the benefits of adding a 5th servo axis for de-nesting the trays and a 6th servo axis for controlling the knife. Both of these additional axes would be mapped to the Lug Chain, running electronic cam profiles to improve the product handling capabilities.

5. Features and Benefits

The servo-driven machine, controlled by Sanyo Denki's "SMS-10" with "AML" and the "PV" drives with SERCOS interface, offers numerous advantages over the traditional mechanical version of this machine as follows:

1) The most obvious benefit is the ease of product changeover. This not only provides enormous flexibility to the end user, but it simplifies the design requirements of Waldrop. With only two machine configurations (the lug pitch differs to accommodate different tray sizes) to design, manufacture, and support, they can satisfy the diverse needs of their customer base.

2) The SERCOS interface for communication between the controller, servo drives, and I/O simplifies panel fabrication by reducing the wiring complexity and electrical noise concerns. A single fiber-optic ring links all the components, providing high-speed data transfer in a digital and noise-immune environment.

3) The HMI with color touch-screen makes the system simple to operate and set up. This includes the "teach mode" along with extensive adjustment and diagnostic capabilities.

4) Use of servo systems provides more precise control of the mechanical assemblies, allowing the machine to run at higher speeds as compared to the traditional mechanical machine.

5) Finally, the simplified mechanics that result from the use of servo drives makes for more quiet operation and reduced maintenance.

Combined, these features make the Servo-driven Pad Placing & Labeling Machine a higher-performance and more cost-effective solution when compared to the traditional mechanical machine. Also, Waldrop has a machine that has capabilities that the competition cannot provide in one machine at this time.

6. Conclusion

The combination of AI and SDC technology, and the know-how and ingenuity of the machine builder (Waldrop), the distributor (GEA of Texas), and the AI support and integration engineers, all came together in this application to produce a successful machine. Through this cooperative effort, all parties are on the winning side.

AI wishes to thank Waldrop for their participation and cooperation in the writing of this article. They have been a pleasure to work with in all regards. Also, many thanks to GEA of Texas for recognizing the opportunity, and for providing continued support and service throughout the process.

Ann Hamil

Director of Engineering

Ann received her BSEE from Georgia Institute of Technology. After graduation, she worked for Lockheed and a small engineering firm, where she began working with custom, high-speed servo controlled packaging equipment. In 1983, after two of her associates started Automation Intelligence, a system integrator specializing in high-speed servo control systems, Ann joined them as the VP of Engineering.
At AI, she has been involved with many of the company's integration projects, primarily writing application software. As the development of the machine control products began, Ann shifted her focus to the product development, focusing on real-time motion control. She is now Director of Engineering & Marketing, defining and managing the "AML" product development, while continuing to develop software and solve tough application problems.

Tommy Thompson

Staff Control System Engineer

Tommy is an Electrical Engineer with an undergraduate degree from the Georgia Institute of Technology. At the beginning of Tommy's 20-year career in engineering, he worked with the Lockheed Company as a systems engineer. For the past thirteen years, Tommy has been with Automation Intelligence. As a project engineer, Tommy has designed and implemented countless control systems using both digital and analog servo motion systems. He was also instrumental in the design and implementation of Automation Intelligence's motion controller, "AML".