

additional hardware or application programming, the district was able to configure an existing pump station to Store & Forward between the SCADA master and the new pump station. In addition, its SCADA master data update times were more than twice as fast, even after the new stations were brought online.

The illustration on page 13 provides an example of how commands and replies propagate through the Store & Forward nodes. Nodes 2 and 3 are configured as Store & Forward nodes. In their Store & Forward configuration tables, Node 2 is configured to rebroadcast messages between Nodes 1 and 3 and Nodes 1 and 4 (bits 1, 3 and 4 are set), and Node 3 is configured to rebroadcast messages between Nodes 1 and 4 (bits 1 and 4 are set).

When Node 1 initiates a command (CMD 1) to Node 4, it's received by Node 2. Within the header of the CMD 1 packet, the source node (SRC) of this packet is identified as Node 1 and the destination node (DST) is identified as Node 4. Since Node 2 is configured to rebroadcast messages between Nodes 1 and 4, it retransmits the packet "as is" so that it is next received by Node 3.

Note that the CMD 1 packet is also received back at Node 1 at this point, since anything transmitted by Node 2 is simultaneously received by

both Node 1 and Node 3. When Node 1 receives any packet that it previously transmitted (SRC = 1), it ignores the packet.

Since Node 3 is configured to rebroadcast messages between Nodes 1 and 4, it retransmits the packet as is so that it is next received by Node 4.

The CMD 1 packet is also received back at Node 2 at this point, since anything transmitted by Node 3 is simultaneously received by both Node 2 and Node 4. Any node configured for Store & Forward also implements a duplicate packet detection algorithm that remembers the last 20 packets received. When Node 2 receives this packet (CMD 1) a second time, it ignores it based on being a duplicate packet.

When Node 4 receives the packet, it replies to the packet, because DST=4. The reply packet (REPLY 1) propagates back to Node 1 through Store & Forward Nodes 3 and 2.

When Node 4 receives any packet that it previously transmitted (SRC=4), it ignores the packet. Also, When Node 3 receives this packet (REPLY 1) a second time, it is ignored based on being a duplicate packet.

### **DF1 Radio Modem Protocol**

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## Troubleshoot Packaging Lines

Simulation can help adjust labeler without stopping line.

By Brent Stromwall, Polytron, Inc.



High speed filling and packaging lines process between 300 to 1,200 bottles per minute. At those speeds, the containers are susceptible to stability problems and require an intricate and well-balanced control program to ensure high system throughput. Historically, a control program could only be tested on the finished system as the last step in a multimillion-dollar project. This placed tremendous pressure on the controls engineers to complete the project.

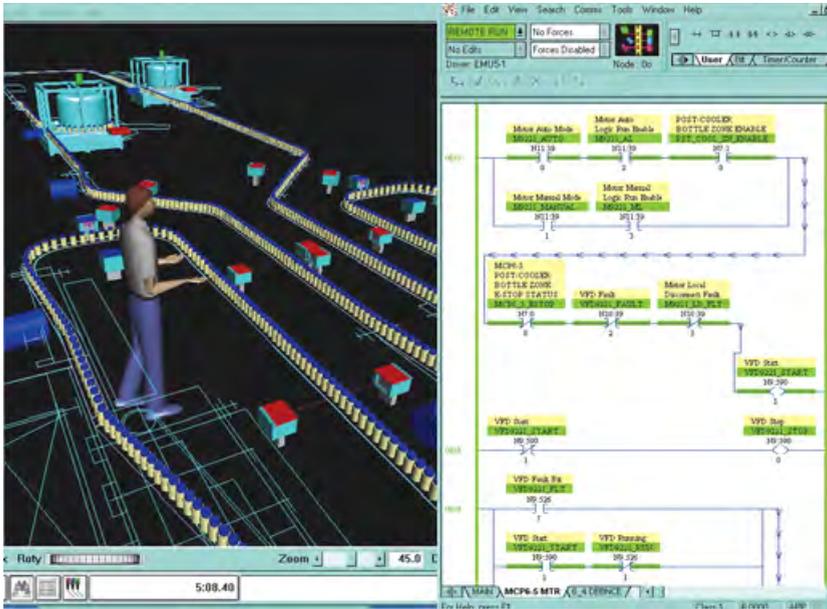
To reduce this pressure and decrease the time required to start up a system, developers can functionally test control logic on a three-dimensional simulation of the line. Rockwell Automation Solution Provider partner Polytron Inc., along with its partner E<sup>2</sup>M, Inc. design and install integrated packaging systems. Their engineers use PolySim, a method of applying simulation technology to dynamically verify programming before start-up. They combine an equipment model based on imported CAD drawings with information from Allen-Bradley controllers and HMIs to create real-time visual simulations. The following is a case study of its troubleshooting ability.

The label application area on one major bottling line application has

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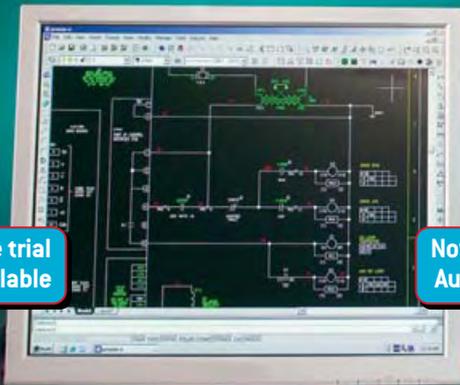


The 3D model allows Polytron controls engineers to accurately diagnose and improve the PLC code, which stabilized the labeling area.

mass accumulation before and after it to minimize the effects of periodic labeling machine jams on the overall line efficiency. Since the labeling machines require a single file arrangement of bottles, the mass of incoming bottles is routed through two single filers (see illustration). Once the bottles are in single file, it is critical to maintain the right backpressure feeding each labeler. This backpressure is maintained by subtle variations in the conveyor speeds in front of the labelers. Adjusting the control logic to produce the right mix of speeds is a tedious and time-consuming process.

Operators reported the labelers were going offline frequently and that much of the labeler room

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downtime was attributed to this problem.

Through the application of their modeling techniques, Polytron created an animated model that revealed that the flow rate of bottles through Labeler B dropped to zero every two minutes. By watching the PolySim animation and the PLC logic as the model ran, the problem was traced to the timers on one specific photo-eye. These timers were causing the single filer to start and stop about every two minutes, thus starving Labeler B. Operating the model further showed that this problem went away once the mass accumulation in front of the labeler area was at least 10 percent full.

Troubleshooting this type of problem through the use of modeling is ideal for the controls engineer. In the real system, the controls engineer must deal with unstable bottles that jam the labeler and cause a backup. This hides the rhythmic shutdown of the labeler that the controls are causing. It further makes the problem look like no more than an occasional bottle jam. In this instance, Labeler B simply appeared to not work as well as Labeler A.

Based on what the simulation revealed, the controls engineers adjusted the logic to balance the system. When they adjusted the timers on the photo-eye to match the corresponding eye controlling Labeler A, they stabilized Single Filer B. The model, however, then showed both labelers running worse. Watching the PolySim animation revealed that the labeler area was starving itself by primarily running at high speed. Analyzing the speed graph showed that the labeler's low speeds were only being used for 10 seconds before they stopped because of low

prime. To use low speed longer, engineers moved the low speed photo-eye in the model 10 feet further upstream. This allowed the labelers to move into low speed long enough to avoid stopping.

As a final step in the PolySim process, the analysis of the problem and the proposed solution were reviewed with Polytron's senior controls engineers. After watching the improvement and identifying no other significant opportunities, they were authorized to implement the control logic updates in the field. Changes were called in to the field engineer the next morning and made before the line started up. The line efficiency jumped 11 percent that day, and the labeler area has been stable since that time.

Because PolySim is a method of applying modeling technology, it allows engineers to not only recreate a three-dimensional scaled visual of the line. It also lets you define package dimensions of the product, allowing production variables such as motor speed, photo-eye placement and control devices to be changed and tested. In a Rockwell Automation environment, the communication between a PolySim model and Allen-Bradley components is dynamic. The model receives information from ControlLogix controllers and RSView

HMIs and at the same time sends information to the components to trigger variable responses in the emulation.

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