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USING EMULATION TO REDUCE COMMISSIONING COSTS ON A HIGH SPEED BOTTLING LINE

Geoff Mueller

E2M, Inc.
6734 Jimmy Carter Blvd.
Norcross, GA 30071, U.S.A.

ABSTRACT

E²M/Polytron builds high speed filling and packaging systems for Fortune 100 companies. In the last year we have developed a process to improve the quality of these systems that uses the new emulation technology in Brooks Automation's AutoMod simulation tool. The method, called PolySim, enables us to functionally test control logic on a simulated 3D model of a system prior to startup. Our first application was on a new line for Gerber Baby Food. The project had been done without the use of the new technology and there were some on-going controls problems with the high speed label application area a month after startup. Using our PolySim method enabled us to isolate and fix these controls problems in two weeks without interfering with production. With the problem fixed, Gerber saw an 11% increase in line efficiency.

1 INTRODUCTION

E²M/Polytron works with fortune 100 companies to develop Integrated Manufacturing and Packaging Systems (I.M.A.P.S.®). Most of these systems are high speed filling and packaging lines that run between 300 and 1200 bottles per minute. The containers are susceptible to stability problems at these speeds and require an intricate and well balanced control program to ensure high system through put.

E²M/Polytron builds multiple I.MA.P.S® systems a year for our clients. The complex programs developed to control these systems run on programmable logic controllers (PLC's). In the past, the control program could only be tested on the finished system as the last step in a multi-million dollar project. This placed tremendous pressure on the controls engineers to complete the project.

To reduce this pressure, and decrease the time it takes to start up a system, E²M/Polytron turned to the new emulation technology in Brooks Automation's AutoMod simulation tool. Using their Model Communications Module we developed a method to functionally test our control logic on a 3D simulation of the line. We call this emulation method PolySim.

Our first major use of the PolySim method was on a 1000 bottle per minute line that we had just installed for Gerber Baby Food. The project had been done without the use of the new technology and there were some on going controls problems with the high speed label application area of the line a month after startup.

Before describing the problems, it is important to understand the complexity of the system. The label application area on this line has 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 as shown in Figure 1. Once the bottles are in single file, it is critical to maintain the right back pressure feeding each labeler. This back pressure 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.

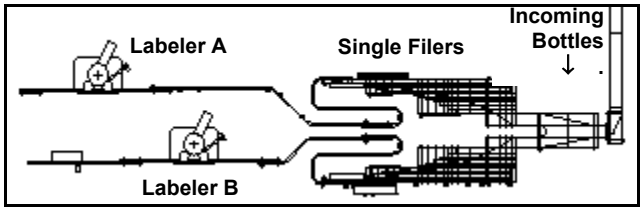

Figure 1: Layout of the Label Application Area

2 THE PROBLEM

There had been feedback from the operators that the labelers were going off and on frequently. Much of the labeler room downtime was attributed to this problem. To identify the specific cause, we utilized our PolySim method. It enables us to see how different control logic affects the line. After modeling the system and graphing the flow rate through each labeler we found the following pattern, shown in Figure 2.

The flow rate of bottles through labeler B dropped to zero every two minutes. By watching the animation as the

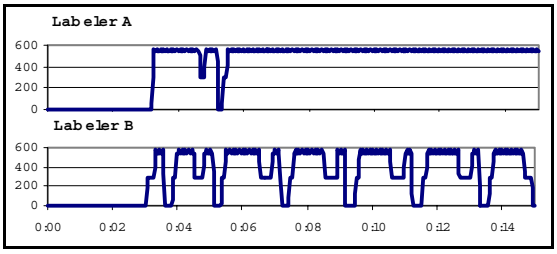

Figure 2: Bottle per Minute Flow Rates through Each Labeler

model ran, the problem was traced to the timers on photo-eye PE4510 shown in Figure 3. These timers were causing the single filer to start and stop about every two minutes starving labeler B. Watching the animation further showed that this problem went away once the mass accumulation in front of the labeler area was at least 10% full.

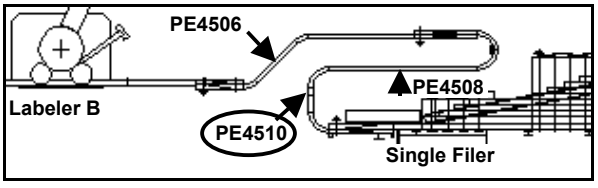

Figure 3: Location of Photo-Eye PE4510

This type of problem is very hard for our controls engineer to find without the use of the PolySim method. This is because it results in unstable bottles in the real system which jam the labeler and cause a back up. This hides the rhythmic shut down of the labeler that the controls are causing. It further makes the problem look to be no more than an occasional bottle jam. In this instance, labeler B appeared to just not work as well as labeler A. This coincided with what the operators told our controls engineer.

3 THE SOLUTION

Using the PolySim method, we adjusted the control logic to balance the system. Changing the timers on photo-eye PE4510 to match the corresponding eye controlling labeler A stabilized single filer B. Now, however, the speed graph in Figure 4 showed both labelers running worse. Watching the PolySim run revealed that the labeler area was starving itself by primarily running at high speed. Analyzing the graph showed that the labeler's low speeds were only being used for 10 seconds before they stopped due to low prime.
To utilize low speed longer we moved the low speed photo-eye 10 feet further up stream. This allowed the labelers to move into low speed long enough to avoid stopping. The optimized system is shown below in Figure 5. Now, both labelers drop to low speed three times during low prime, but don't stop.

As a final step in the PolySim process the analysis of the problem and the proposed solution were reviewed with

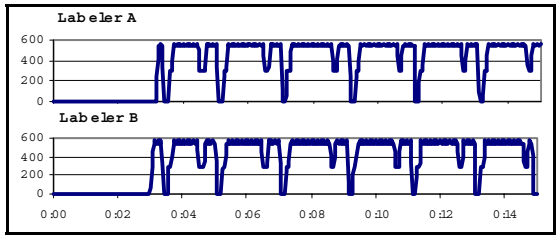

Figure 4: Bottle per Minute Flow Rates through Each Labeler with Timers on PE4510 Fixed

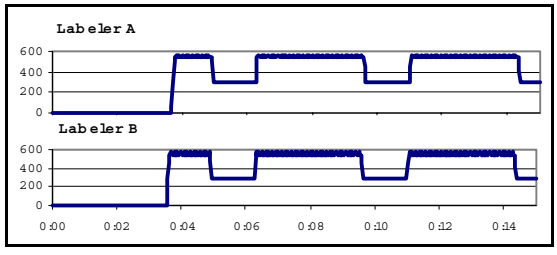

Figure 5: Bottle per Minute Flow Rates through Each Labeler with Low Speed Photo-Eye Reassigned

our senior controls engineers. After watching the improvement, and identifying no other significant opportunities, we were authorized to implement the control logic updates in the field.

The changes were called in to our field engineer the next morning and made before the line started up. The line efficiency jumped 11% that day and the labeler area has been stable since that time.

4 FOLLOW UP

As a follow up to our successful stabilization of the labeler area we were asked to investigate alternatives to spending $15,000 on upgrades to the single filers in the label area. These upgrades were needed to allow the machines to slow down to a 300 bottles per minute rate required for some new lower speed products.

After four hours of testing in the office, our controls engineer developed an alternative that did not require upgrades to the single filers. This alternative was to slow the single filers down to their lowest current rate of 350 bottles per minute while using the in-feed conveyors to allow only 300 bottles per minute on to each single filer. The concept and control modifications were proved out in the model and then implemented, saving the project $15,000.

AUTHOR BIOGRAPHY

GEOFF A. MUELLER is a Design Engineer at E²M, Inc.. He in charge of all simulation and emulation projects. His email and web addresses are < gmueller@e2m.com> and <www.imaps.com>.