

HK Systems Integration Helps Poultry Supplier Meet Increased Demands

Scope of Work

An HK Systems engineer spent a number of days observing the operations of a poultry supplier to find opportunities to increase the overall system throughput. HK Systems initially designed and installed an integrated system for this poultry supplier; however, due to increased demand and SKU proliferation, the system's output capabilities needed to be enhanced by 50%.

Primary Objectives

- Review the initial system simulation. Compare the current system operations to the simulation model and justify any differences in operation.
- Monitor the current system operation. Define current areas that had been limiting the system's overall throughput. Define enhancements to current areas to increase throughput and prevent bottlenecks in the system flow.
- Work with HK Systems engineers (software, controls, mechanical, etc) to develop best approach to correcting each item noted above.
- Present poultry supplier a list of proposed enhancements and develop a plan of action to execute the chosen enhancements.

System Overview

There are many parts to this integrated system. However, the focus was placed on improving the system output of the WPL Area (Weigh-Price and Label).

Stacks of product are stored in the AS/RS. There are four (4) aisles in the AS/RS, each serviced by a Storage and Retrieval Machine (SRM). When an order for product is placed, the SRM's will retrieve all the necessary stacks of product to fulfill that order. These stacks of product will travel along conveyor to any one of eight (8) WPL stations. Once at the stations, the stacks of product are broken down and the product in the stack is conveyed to one of several packaging stations where it will be packed and shipped.

Summary of Observations/Improvements

In order to meet the customer's increased throughput demand, the system would ultimately need to deliver more product to the WPL stations. However, there were other items that needed to be addressed as well. To get a better understanding of how to attack this problem HK decided to perform a time-study so that those involved would have a better idea of where improvements were needed.

There are two critical times involved in this system. The first time is referred to as T1. This is the amount of time it takes for an operator to consume a stack of product at the WPL station. This time is not something that HK Systems can modify. The customer has a desired rate for this value and it should be a constant value. After performing the time study, the importance that T1 remain constant became very critical.

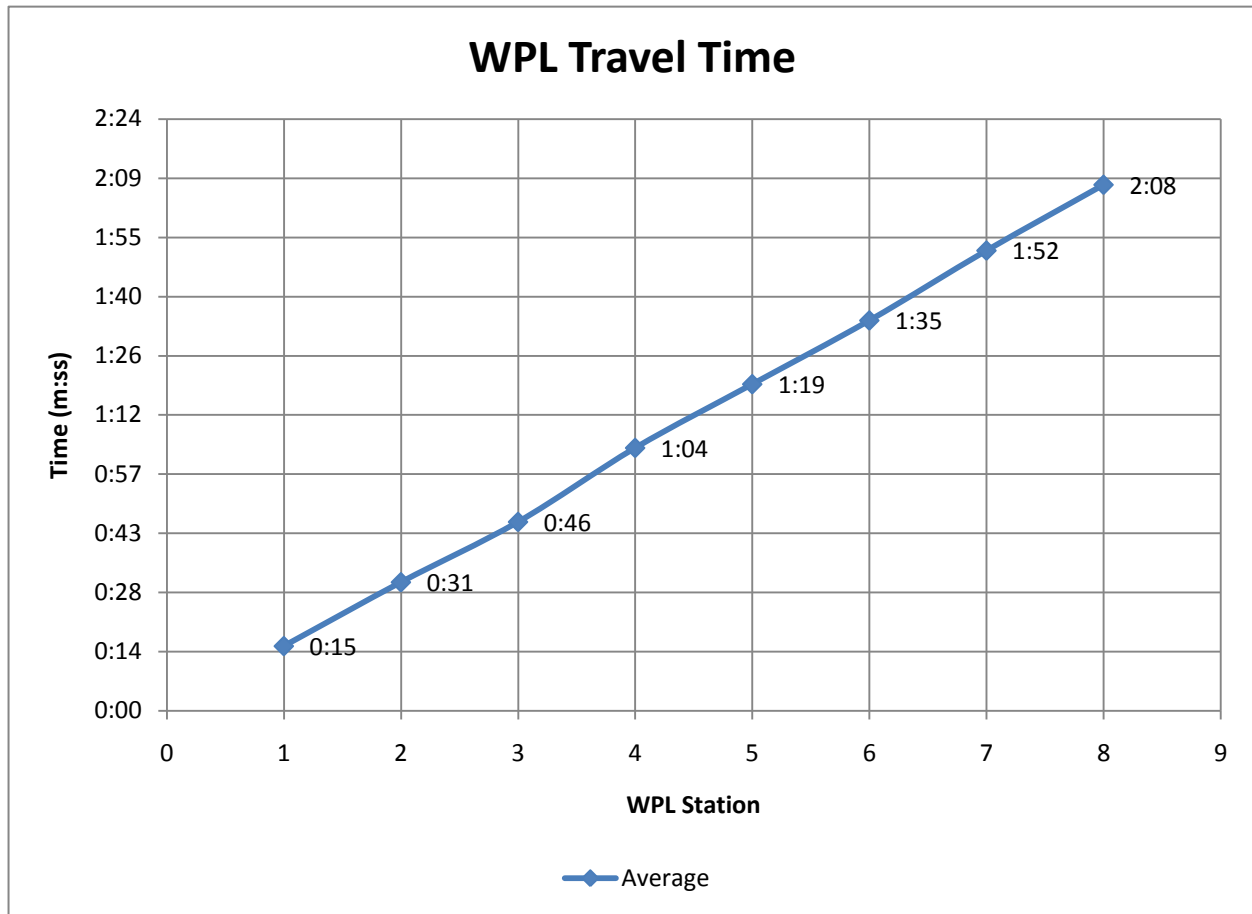
The second critical time involved is T2. This is the time it takes for a stack to be ordered, delivered, and to arrive at the WPL station. Most of this duration is easily captured; however, some of it is not so easily captured. While on site, HK's engineer recorded the amount of time it takes a load to travel through the AS/RS conveyor, through the WPL transition conveyor and to arrive at each WPL station. Data was collected from each AS/RS aisle to each WPL station. Since it is impractical to watch a stack be consumed and to know which stack in the AS/RS storage is being picked to replace that consumed stack,

we did not attempt to measure this portion of T2. There is a certain amount of time it takes for the SRM machine to move to, pick, and deposit a specific load at the Pickup and Deposit station. This was not included in measuring the value of T2 for the reasons stated above.

T2 can be significantly higher than T1 and the WPL station should never run out of loads. For this example we use a consumption rate (T1) of 3 minutes per stack and a Replenishment travel time (T2) of 4 minutes. If these rates are maintained at a steady state, the WPL station will equalize with 2 stacks always present at the WPL station and 2 stacks always in transition to the WPL station. This conflicts with initial conceptions, but it must be considered that replenishment stacks are being ordered at a rate of 1 per 3 minutes, so once the first replenishment stack arrives at the WPL station, each subsequent stack will also arrive at the station each 3 minutes.

After several hours of observation, it became clear that the rate of consumption of the stacks (T1) is quite variable and not constant. It was observed that early in the shift, operators have more energy and tend to work very fast. This will quickly diminish the stacks at the WPL workstations because while T2 is not significant over a sustained amount of time, T2 is very critical after the first couple of stacks are consumed. If an operator works fast enough, it is very possible that he/she may exhaust all four stacks of product in his/her queue before the first replenishment stack arrives. In this scenario, after the fourth stack has been consumed, no additional stacks can be ordered until the first replenishment stack arrives at the station. This surge of product being retrieved will also tax the AS/RS system. While the system is capable of supplying the WPL's with 180+ stacks/hr, they will not be able to supply 300 stacks/hr for 10 minutes and then 100 stacks/hr for 50 minutes. When the system gets in a wave type scenario like this where all the WPL queues fill up, then are consumed, the AS/RS is taxed at 100%, then at 25% and so forth. This is not an optimal way to run the system because there is never a steady flow of product outbound. By forcing T1 to become more constant, we could eliminate this wave effect on the system and transition into more of a steady state concept, as the simulation model indicates.

With this in mind there are some operational type changes the customer can make to help eliminate this problem. For one, the operators can be monitored and the faster workers can be assigned to the WPL stations nearest to the ASRS. The time-study performed shows that product takes considerably less time to arrive at WPL #1 than WPL #2, #3 etc. Please see the chart below. The WPL Travel Time refers to the amount of time it takes a load to travel from the ASRS outbound decision point into the respective WPL Station.



In addition, faster operators can be assigned to work on products with higher counts/basket. The amount of product per basket varies from approximately 8 items per basket to 20 items per basket. This will significantly affect the consumption rate T1. This will not only optimize their abilities, but also minimize the amount of wave effect they can induct into the system. When orders are assigned to a WPL station, it would be most effective to assign the orders with the highest density to WPL #1 and orders with the lowest density to WPL #8. With the most energetic workers assigned to WPL #1, #2, and so on and the slower/average workers at WPL #6, #7, and #8, this should balance all of the workers' potential, minimize the wave effect on the system, and cost next to nothing.

In addition to the operational changes as described above, there are also controls/software modifications that can be implemented to minimize T2.

Due to the system layout, product coming out of the AS/RS aisle #1 will arrive at a given WPL station faster than product coming out of the AS/RS aisle #2, #3, and #4. As discussed above, product being delivered to WPL station #1 will arrive faster than that headed for WPL #2, #3, etc. This yields the fastest and slowest possible time for T2 (as measured) being 2:36 and 6:18 respectively.

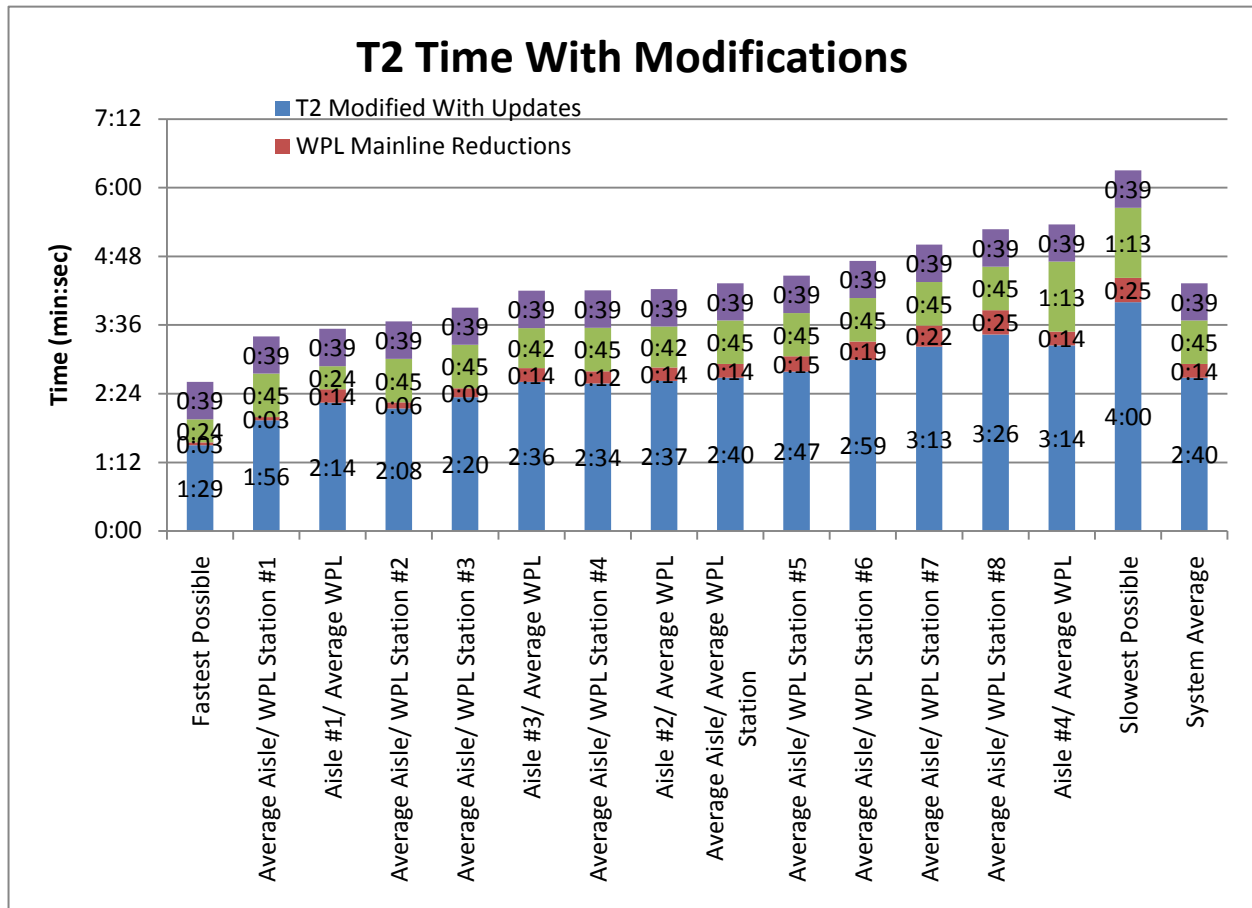
The AS/RS outbound chain conveyor sections can be retrofitted with Variable Frequency Drives (VFD) so that they can be run at up 200% of current speed. This would increase the speed from 45fpm to 90fpm.

After much observation of the stacks of baskets in transit, HK believes that they should be able to travel at these speeds without any problems. The aluminum carrying tray under each stack of baskets makes for a very slick surface on the metal rollers/chains, so even when the loads need to square up, coming to a dead stop at this rate should not cause the loads to tip. Since the conveyor will be sped up dramatically, we would also recommend a pop-up stop solution be implemented. It is simply too difficult to accurately position a stack at these speeds without squaring, and the AS/RS area is a very critical area for throughput. A jammed load here could potentially eliminate 75% of the product flow to the WPL lines.

VFD's are already installed along the WPL mainline feed conveyor. This consists of several sections of straight conveyor that feed the WPL stations. These are currently running at 150% of rated speed (60fpm) and need to get sped up to 200% (90fpm). Again, pop-up stops will be needed at each divert location with the increased speed.

Finally, each motor section of the conveyor between the AS/RS conveyor and the WPL mainline, which is referred to as the WPL Transition conveyor, can have a VFD added and run at 200%. Since there are no divert areas on this conveyor, no pop-up stops will need to be added here. This again will help decrease the T2 time, and the further we decrease T2, the less "waves" will impact the system.

Below are the results of the time study showing how adding VFD's in each section can decrease the value of T2. One important thing to note: not only does this lower the average value of T2, but it makes it more consistent between aisles as well. Thus, more time is chopped off of the higher values to give a better overall average. This will add to the robustness of the system, making faults and other unpredictable events have less impact.



These changes will effectively lower the average T2 time from 4:19 to 2:40. Even more significantly, the slowest possible sequence is now only 4:00, which is 19 seconds faster than the overall average without these changes being implemented.

There is yet one additional change that we would recommend making. Adding additional buffer zones to each WPL workstation will not decrease T2 but it will help eliminate waves created by fluctuating T1 times. The exact number of additional buffer zones to add to each WPL station is difficult to quantify, but a balance can certainly be struck between efficiency and economy. HK would recommend adding two (2) double sections of conveyor. This will minimize electrical costs initially and still give the Owner the flexibility to break each of these sections in half if need be, creating a total of up to four (4) additional buffer sections per WPL workstation.

After observing this system, there are a number of items that can be improved upon to increase the capacity of the system. In addition to providing several solutions to the known problem of not getting enough product to the WPL stations, we have also identified and worked towards solving a second problem; countering possible fluctuations in the consumption rates of stacks and minimizing the effect this will have on the overall system. With these changes, we can effectively reduce the replenish time for stacks of product by approximately 60%, which should in turn allow the customer to achieve the desired 50% increase in product through the WPL workstations.