AUTOMATION OF THE SLEETER PRODUCTION LINE

James B. Allen

Department of Mechanical Engineering, The University of Adelaide, Adelaide SA 5005, Australia.
Detmold Packaging, Brompton SA 5007.

ABSTRACT

For a company to become increasingly successful, research is required to continually improve the process by which production is carried out. This includes benchmarking the current process and then analysing different areas to determine where time can be saved. In reference to the Sleeter production line at Detmold Packaging, automation needs to be considered to improve production speeds as well as decrease the possibility of contamination from human contact. The project undertaken therefore involves research into various options which Detmold Packaging can implement with the aim of satisfying the objectives. Other aspects of the project which need to be investigated are to enclose the Sleeter machine to exclude foreign objects, dust and insects as well as inbound raw material cleaning and inline code printing.

KEYWORDS: Packaging, Operating Speed, Payback Period, Automation

1. INTRODUCTION

One of main production lines at Detmold Packaging is the Sleeter, which cuts and then stacks both McDonalds and KFC burger wraps as shown in Figure 1. The Sleeter takes either two or three rolls of pre-printed, waxed burger wrap and then cuts them initially parallel then perpendicular to achieve the desired final wrap size. Once the waxed paper is cut into the final dimensions, it is stacked into bundles of 1000 wraps which are transported to a packer. The packer's task, is to take the bundle off the conveyor belt, place it onto a stack of pre-cut brown paper sheets and then fasten the paper around the bundle before placing it into a box.

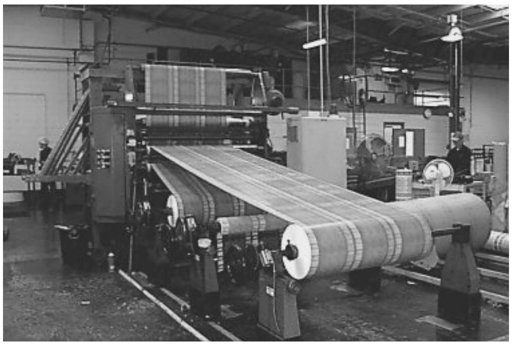

Figure 1 (a and b) Sleeter Machine, Packer on Sleeter

1.1 Project Aims

To initially start a feasibility study of upgrading the Sleeter production line with the main aim of automating the packaging process, the current set-up needs to be analysed in reference to the speed of production. Benchmarking the production will allow the benefits and costs of proposed changes to be evaluated in comparison to the current set-up. The secondary aim of the project is to overcome possible contamination issues resulting from human contact with the product. This affects the importance of meeting the companies specified payback period of a project, allowing more flexibility in the expenditure allowed as the goal is not purely for economical issues.

1.2 Benchmarking on Operating Speed

Benchmarking the production line entailed both observing the machine in operation and recording operating speeds, speeds of conveyor belts and packing speeds as well as observing a stock sheet, listing all the products which go through the Sleeter, and the average demand per week. As the options proposed involved removing all human contact with the burger wraps after they have been cut, special emphasis had to be placed on monitoring the packer, and recording the time taken to complete the numerous tasks.

The initial project focus was in reference to the operating speed of the machine. The average running speed of the machine is between 65-70 metres/min compared to its theoretical maximum speed of 180 metres/min. The limiting factors setting the machine to this average speed were due to the packer's limiting packing rate, and problems which have recently been overcome with the paper.

Although 180 metres/min is the theoretical maximum operating speed of the machine, this is not a practical speed which can be reached without significant alterations to the machine. This theoretical speed was set for a new machine running one roll up with width of approximately one metre. The machine is now relatively old and is running two or three rolls up with five or four webs respectively at a width of 1510 mm. This adds extra pressure onto the draw roll, which now has to produce a larger force to pull the webs through the machine. It also means that underneath the second knife, which cuts the webs into the final wrap size, there are now 10 or 12 webs, adding thickness and putting more strain on the knife.

<u>Trial on Maximum Speed</u>

To determine what the maximum speed the machine could operate at, a trial had to be requested to release the operator from any fault if anything went wrong when the operating speed of the machine was increased. An additional packer was used for the trial to assist the original packer. The results of the trial showed that the Sleeter was able to operate at speeds of 100 metres/min but above this speed an error in the PLC program prevented it from operating any faster. This problem will be rectified, but not until a new PLC is installed later in the year. The new PLC is not the solution to the problem, but the code will not be modified until the new one is installed. After observing this trial it was established that 120 metres/min was probably the maximum speed which the machine could be set before major problems caused considerable downtime.

As the main products that go through the Sleeter are for McDonalds and KFC, the majority of the analysis is in relation to their production demands. Using the information gathered from the stock list, a spreadsheet was set-up enabling different operating speeds to be entered and the corresponding production time for the average weekly demand to be calculated. The result given is based purely on theoretical times as it assumes once the machine is operating, it continually operates at this speed until it has finished producing the amount needed. The spreadsheet fails to take into consideration that for each product there will be roll changes, problems with the machine and other instances where downtime occurs. However, for the purpose of comparing the effect of setting different operating speeds this additional information does not need to be considered.

From the set-up of the machine and from the results of the trial, it is possible to see that when the machine operating speed is increased from 65 metres/min to 120 metres/min, then the total production time will decrease from 60 hours and 6 minutes to 32 hours and 34 minutes, a reduction of 27 hours and 32 minutes. This substantial difference would indicate a large saving in labour costs of around $605 per week based on hourly labour rate of $22/hour. Using this figure and assuming the demand per week is relatively constant for one year, then the savings are approximately $31,460 per annum. Also from analysing Figure 2 below, it can be seen that initial changes in operating speed have more impact than changes at higher speeds. Therefore, it will not be beneficial to push the machine to a greater speed, as the increased production will be nulled by the amount of downtime caused by machine faults from running the machine too quickly.

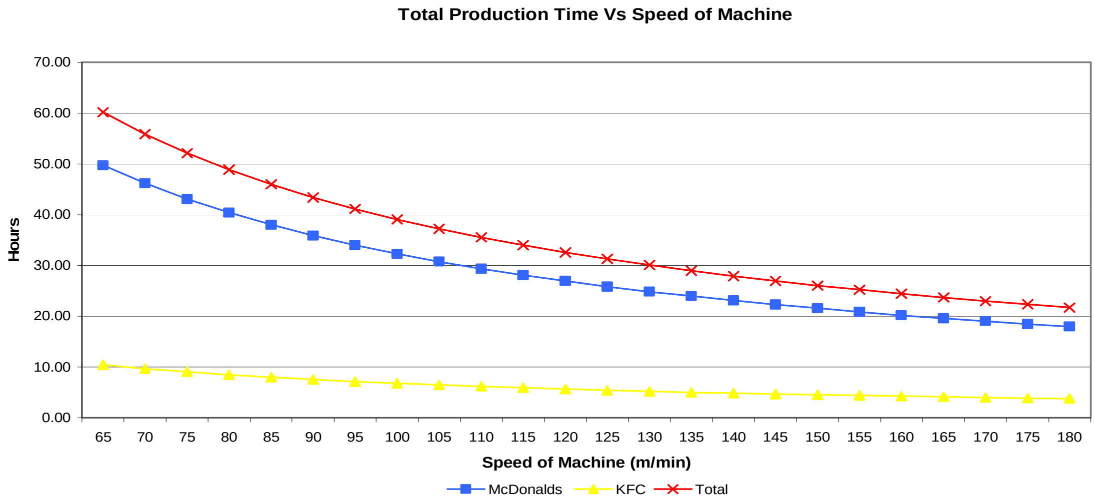

Figure 2 Outcome from changes in operating speed

2. REMOVAL OF HUMAN CONTACT

To remove the risk of contamination from human contact, the packer needs to be replaced with an automated packing device to ensure that once the rolls go through the Sleeter, there will be no human contact before being placed in a box. Due to budget constraints, only pre-fabricated machines will be used and therefore design of a specialist machine will not be considered as a solution. Two of the main machines proposed to wrap the bundles are the L-Bar Sealer and an Overwrapper (shown in Figure 3-(a) and (b)) and they need to perform a similar task to the packer as described in the introduction.

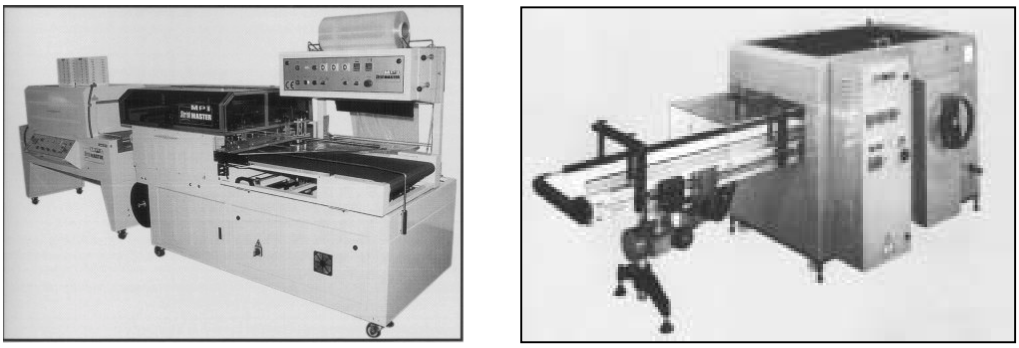

Figure 3 (a and b) L-Bar Sealer, Overwrapper

2.1 L-Bar Sealer

The L-Bar Sealer wraps the bundle in shrink film and will enable the bundle to come directly off the conveyor belt and then onto the conveyor belt of the L-Bar Sealer. It will then travel through the L-Bar sealer and then the heat tunnel, wrapping the bundle in film, providing a strong and tight seal. The plastic provides rigidity to the bundle and allows it to be picked up by a packer or a robot.

The maximum sealing area (product size) is 700 x 500 x 120-mm, which is large enough to wrap all the customer sizes and is capable of wrapping up to 20 bundles per minute. The cost to implement an L-Bar Sealer will range from $30,000 to $36,000 depending on the company of purchase and the heat tunnel will cost approximately $10,000.

Shrink Film

Due to the large amounts of shrink film needed to wrap the bundles, a suitable film, which will meet the requirements as well as being relatively inexpensive, needs to be selected. Currently, D940 Cryovac is being used as the shrink film in Detmold Packaging. D940 is a Cryovac Performance Soft Shrink Film and is a 'C' Gauge, 15-micron film which is ordered in three different widths of 505, 555 and 605 mm. This is a relatively expensive film due to it having good shrink properties and therefore research was carried out with aim of finding a cheaper film, which still met the requirements. A trial performed on Cryovac Shrink Tuff Performance Shrink Film resulted in positive results and will replace the D940 Cryovac Film once stock on the premises has been used. The cost of the two films with the percentage saving from the current film is shown in Table 1.

Table 1 Comparison of Shrink Films

	D940 Cryovac		Shrink Tuff		
Width (mm)	**Price / Roll**	**Price / Metre**	**Price / Roll**	**Price / Metre**	**Percent Saving**
505	$281.50	$0.21	$230.05	$0.17	18.28
555	$308.75	$0.23	$252.83	$0.19	18.11
605	$336.22	$0.26	$275.60	$0.21	18.03

Roll = 1332 metres

If the L-Bar Sealer is to be used as an alternative wrapping process, then using this cheaper shrink film will result in an approximate saving of over $5000 per year which helps reduce the payback period as well as making this solution a more viable long term option.

2.2 Overwrapper

Another alternative to wrapping the bundle is to use an Overwrapper machine, which wraps the bundle in paper or polypropylene instead of shrink film. The Overwrapper has maximum size constraints of 450 x 350 x 175-mm and is capable of wrapping 40 bundles per minute. The machine has a much larger initial capital cost of approximately $170,000, almost 6 times the cost of an L-Bar Sealer. The polypropylene however is much cheaper than the shrink film costing $136.50 per roll of length 2500 metres. This evaluates to $0.055 per metre in comparison to approximately $0.19 per metre for 555mm width shrink film.

3. COST PER 1000

To calculate which of the two options has the best financial outcome, a study comparing the two machines in relation to a manual packer has to be applied with the relevant costs compared. To compare all the different options, a spreadsheet was created comparing the cost to wrap 1000 wraps. To create this spreadsheet, two important parameters in regard to the film needed to be calculated, one being the width of film to be used on each individual burger wrap, and the other the length of shrink film that is needed to contain the bundle. The information needed on the packer is the time taken to pick a bundle off the conveyor, wrap the bundle in paper and then place in an awaiting box. This time had to be averaged as after every three or five bundles the box needed to be pushed through an automatic case sealer and a new box collected. Therefore the average time taken was recorded to be approximately 17 seconds for both McDonalds and KFC products. The downtime of the machine also needed to be taken into consideration as this contributes to the cost of the packer as they still are getting paid even if the machine is not in operation. The average downtime per 1000 wraps is 5.41 seconds for McDonalds and 8.28 seconds for KFC (downtime includes roll changes).

Using the spreadsheet, the cost per 1000 wraps and the saving per week in relation to employing a packer is calculated, with the results shown in Table 2. The payback period is also calculated on the assumptions that the Sleeter operates 16 hours per day and 5 days per week and that the packer is removed from the production line.

Table 2 Comparison of Options

Packaging Option	Cost per 1000	Saving per week	Payback Period
Packer	$0.141	-	-
Shrink Film	$0.050	$713	5 months
Polypropylene	$0.015	$1000	1.7 years

3.1 Other Additions

To make the project feasible by removing the packer and not having the operator perform all the tasks, automated machines will need to be put in place after the L-Bar sealer to place the bundle into the box and then be able to push the box through the automatic case sealer. Without designing anything 'in house', the main solution to pack the bundles into the box is to use a packing robot for an approximate cost of $70,000. Another addition, which would remove more of the operator's tasks, is to put an automatic case erector inline at a cost of $97,500.

If both of these implementations are to be made with the addition of an L-Bar Sealer the payback period increases to 2.8 years or 3.4 years with the addition of an Overwrapper.

4. MAIN OPTION

After consideration of all available equipment the proposed main option is the combination of the Sleeter production line with the Guillo production line. The Guillo cuts burger wraps and then packages them in a similar way to the Sleeter. The main advantage of combining the two lines is that the Guillo already runs with an L-Bar Sealer and heat tunnel, therefore if the two lines were combined and a common packer used for both production lines, instant benefits would be seen. The L-Bar Sealer on the Guillo has enough spare capacity to be able to run both production lines without causing delays.

The main advantages of the proposal are the removal of one packer, reduced risk of contamination for the Sleeter products, increased production speeds, increased use of the current L-Bar Sealer and that there are no extra costs apart from the shrink film.

The cost of shrink film for the yearly demand would be approximately $23,000 with the saving of $88,000 from removing the packer. Therefore the total benefits of merging the two production lines, shown in Figure 4, would be approximately $65,000 per annum.

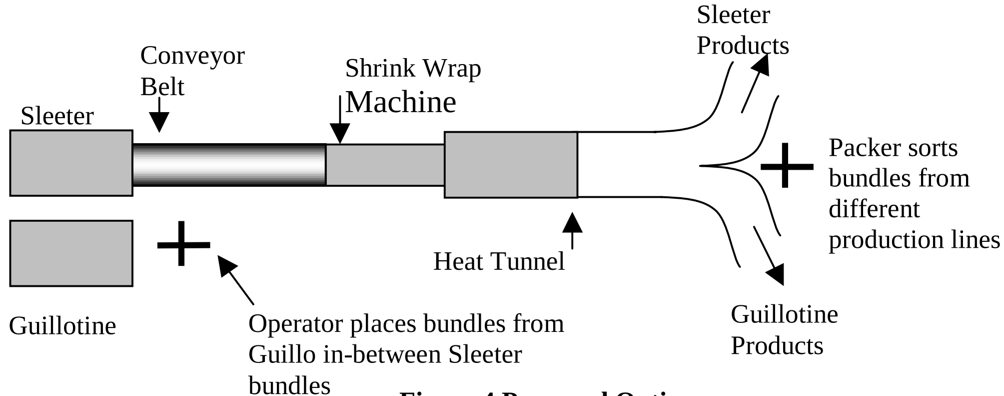

Figure 4 Proposed Option

4.1 Additions to Main Option

From this arrangement, further automation is possible by replacing the packer with a robot which is able to initially erect cartons for both lines, sort the bundles and place the correct bundles in the correct box, then push the box through an automatic case sealer when full and also palletise the boxes. The approximate cost of the multipurpose robot is $120,000 but the payback period is only 1.1 years as the savings from removing the packers from the lines is $132,000 per annum. It is not yet known whether the robot will realistically be able to perform all these tasks but the speed at which bundles are released from the Sleeter is not extremely fast. At 120 metres/min there will be on average 1 stack every twelve seconds. With the Guillo production line, there are bursts of bundles followed by none, so the bundles will be staggered amongst the Sleeter bundles. Therefore, it is required to see how fast boxes can be erected to see if there is enough time to palletise the boxes automatically, or have the operators palletise them manually.

5. CONCLUSION

Initially, the two production lines will be combined to receive the benefits as mentioned above, with the main advantage being the saving of $65,000 per annum with no initial outlay. This will allow both an increase in production speeds from the Sleeter as well as removing the risk of contamination, satisfying both criteria of the project. After this alteration has occurred, the possibility of implementing a multipurpose robot will be explored, to further automate the process and allow continual operation if needed.

6. ACKNOWLEDGEMENTS

Many thanks go to Detmold Packaging who initiated the project as part of the Project Plus scheme and in particular Tod Greeneklee, whose help and guidance through the project has been invaluable. Thanks also go to Tien-Fu Lu whose guidance at the University has helped the project progress to its current state.