

# Optimization of Food Production (Ready-To-Eat Meat Sticks) by Becky Brusky

## ABSTRACT:

In the optimization of food production, the ultimate goal is to meet the demand in the most cost effective and timely manner. This concept is not always as straight forward as one might think. In the production of ready-to-eat meat sticks, the bottlenecks (dependencies) need to be minimized and number of sticks produced needs to be maximized. These dependent components include equipment flow constraints, smoke room duration and downtime for cleaning. Through research on a production line, it was determined that if the cutters and wrappers could run with minimal stoppage time, the goal of maximizing production could be met. The largest contributing factor to downtime is the required four-hour cleaning when switching to a non-compatible flavor. This poster documents how a six-flavor production line governed by a set of flavor ordering rules and production demands can be optimized. A bi-weekly schedule is created with all constraints satisfied.

## OBJECTIVE:

The objective is to maximize the throughput of the cutters and wrappers. This process contains 3 cutters and 4 wrappers. Since the machine that contributes the most to stoppage for mid-shift cleaning is the long cutter and long wrapper, this is the section where my project focus. We will answer the question. What flavors should be processed on which days by the long cutters and wrappers?

## DATA COLLECTION:

The process of making a beef sticks is straight forward. There is a batching system where the beef and spices are mix together. The plant I visited produces six different flavors.

- 1) Mild                  3) Chipotle                  5) Nacho
- 2) Medium                4) Pepperoni                6) Jalapeno.

The batching systems feeds the six casing stuffers. After the casing have been filled, they are put onto rolling racks. The racks are placed into smoke houses for the cooking process. The Slim Jims are smoked for 22 hours before they are packaged. After the racks are removed from the smoke houses the beef ropes are feed into the cutting machine and then the wrappers. Once the beef sticks are wrapped, they pass from the clean room into the secondard packaging room, where they are put in cartons and cardboard cases.

Flavors can be switched during the day. Depending on the flavors, the cutters will need to be shutdown and cleaned between flavors. The only flavor changes that don't require the four-hour cleaning are:

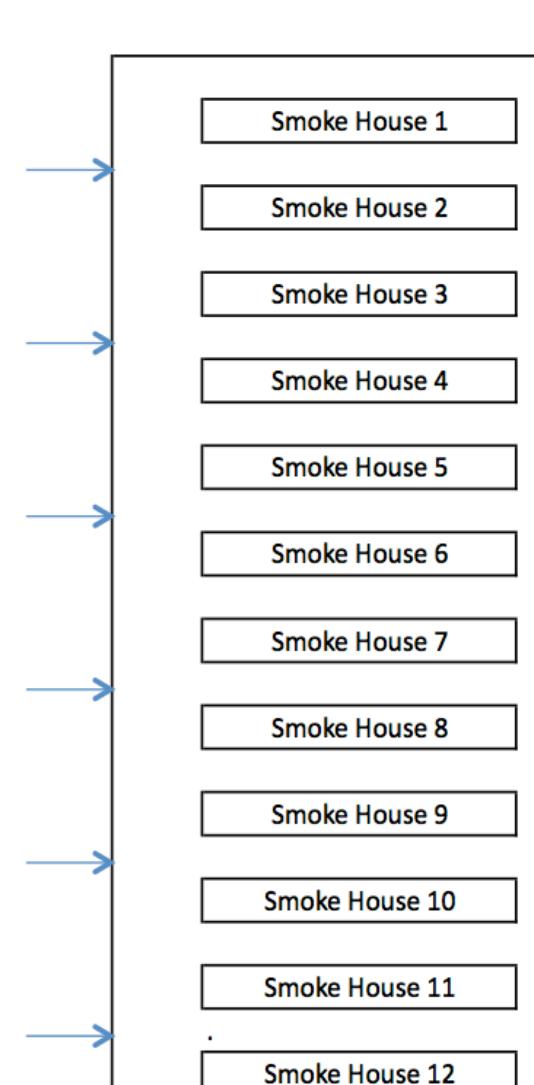
- A) Flavor 1 (Mild) can be followed by any other flavor.
- B) Flavor 2 (Medium) can be followed by flavors 3-6.

## Packaging Options

Product	Flavor	Sticks per Carton	Cartons per Case	Ounces per Carton	Pounds per Case	Raw lbs Need per Case
Long Sticks	ALL	18	8	141.12	8.82	13
Long Sticks	ALL	24	6	141.12	8.82	13
Short sticks	ALL	4	72	80.64	5.04	8
Short sticks	ALL	16	8	35.84	2.24	3
Short sticks	ALL	28	8	62.72	3.92	6
Short sticks	2	50	10	140	8.75	13
Short sticks	2	100	10	280	17.5	27

## CASING STUFFERS:

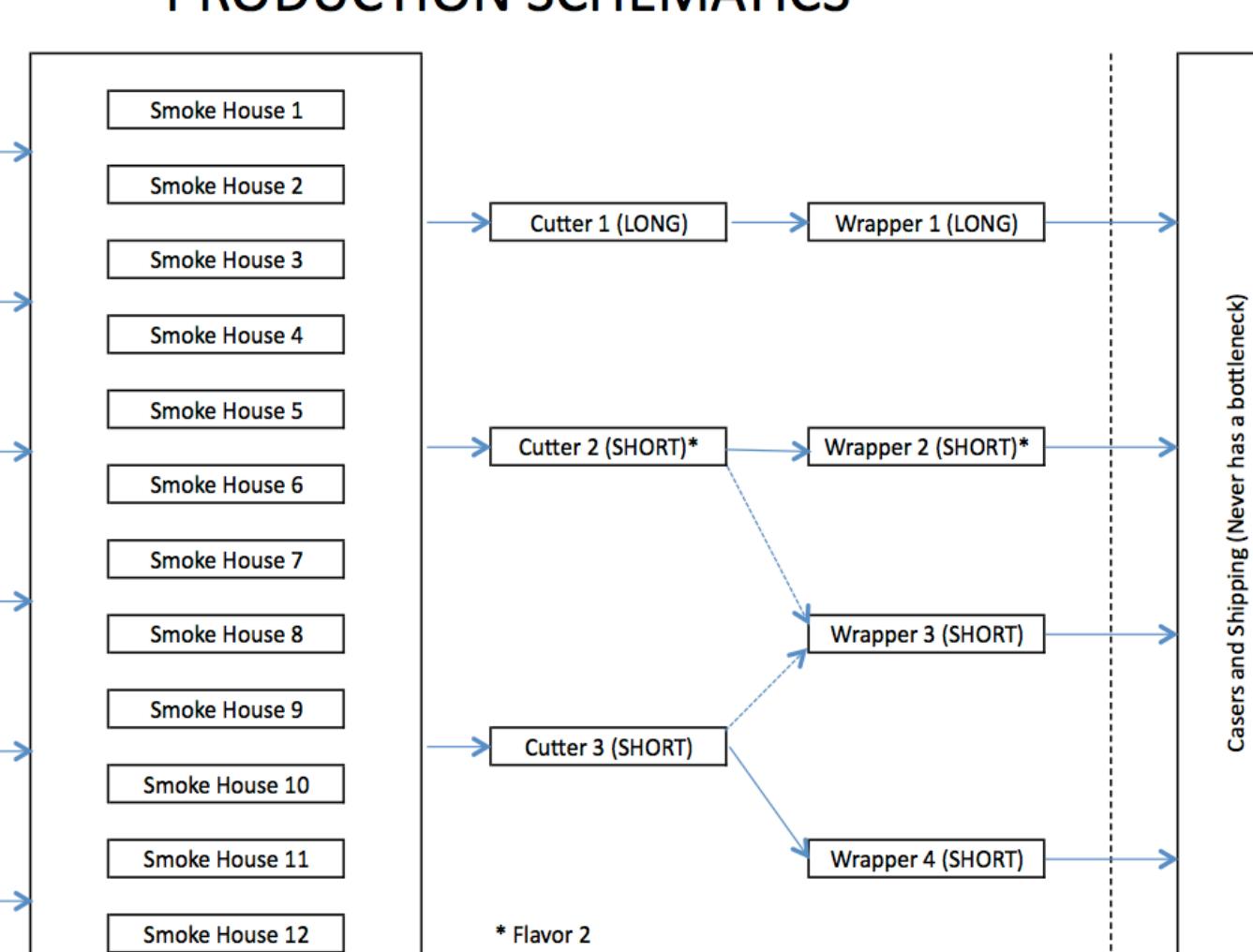
1. 12:00 - 6:00 AM down for cleaning.
2. If recipe changes, must do the 6 hour cleaning cycle.
3. Max run time per day is 18 hours.
4. 3000 pounds per batch uses all 6 stuffers (RAW).
5. Can produce 3 batches per hour, or one every 20 minutes.
6. One batches make 2.5 full racks. (Rack weighs 1200 lbs.)
7. Must go immediately into a smoke house.



## SMOKE HOUSES:

1. The smoke house cooks the meat.
2. Must cook for 22 hours
3. Max run time per day is 18 hours.
4. Each house gets 12 racks.
5. A smoke house can have only ONE flavor.
6. Once the smoke house is started racks can not be added.
7. It is good practice that the smoke house is full.
8. After the smoke house is empty, there is a two hour cleaning before the house can be filled.
9. There is a 42% reduction in weight due to dehydration.

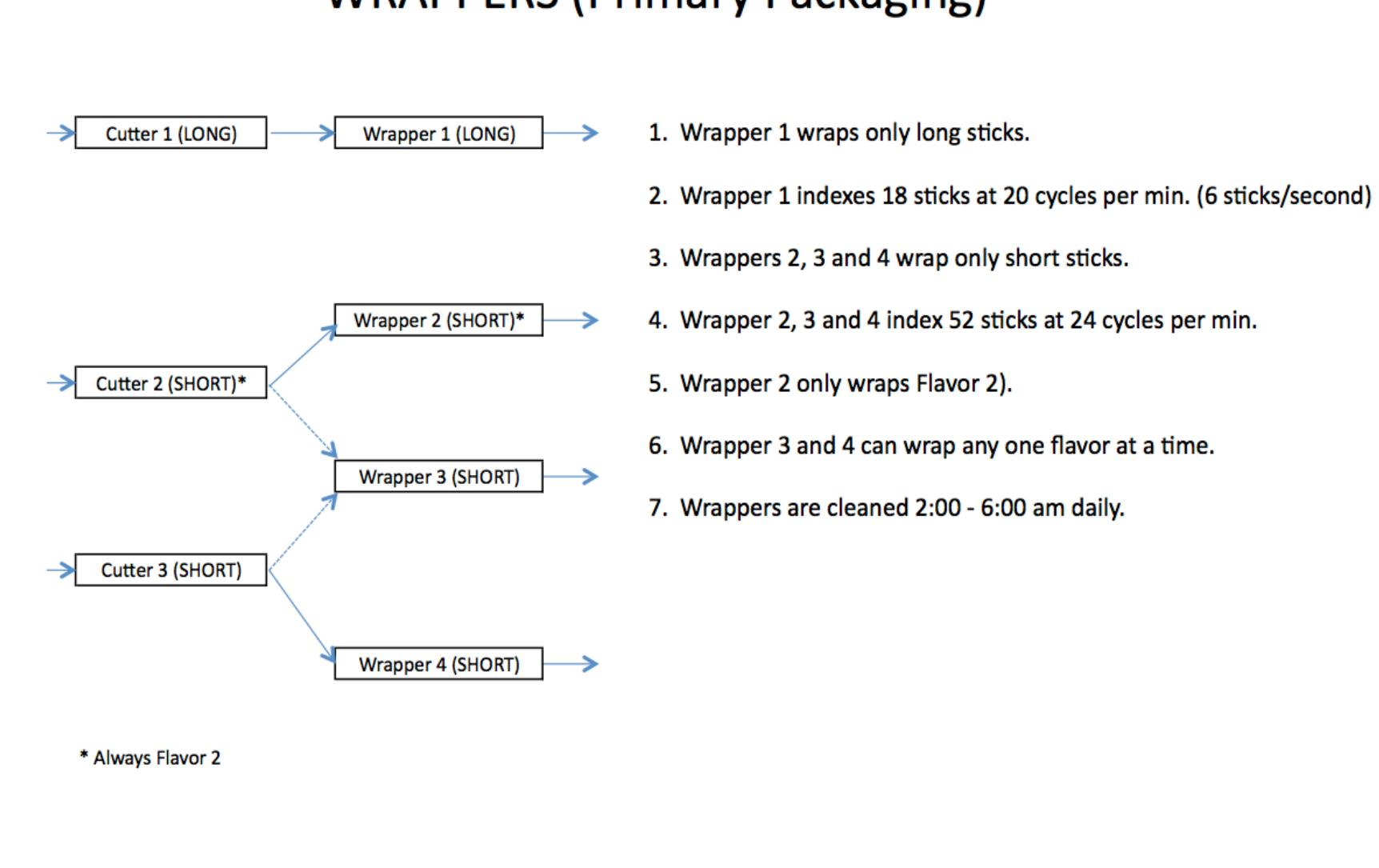
## PRODUCTION SCHEMATICS



## CUTTERS:

1. Cutters are cleaned 2:00 - 6:00 am daily.
2. There is a 14% loss by weight during cutting.
3. Cutter 1 cuts only long sticks and feeds to only wrapper 1 for primary packaging.
4. Cutter 2 and 3 cut only short sticks.
5. Cutter 2 only Flavor 2 and Cutter 3 any flavor.
6. Cutter 2 feeds to wrapper 2.
7. Cutter 3 feeds to wrapper 4.
8. Cutter 2 and 3 can feed to wrapper 3.
9. If both Cutter 2 and Cutter 3 are feed to Wrapper 3, then the flavor must Flavor 2.
10. Any flavor can follow mild (Flavor 1) without cleaning.
11. Flavor 3-6 can follow flavor 2 without cleaning.
12. If a cleaning is needed during production it take 4 hours, an all 3 cutters must be shut down for safety reasons.
13. The cutters are much faster than the wrappers, so timing

## WRAPPERS (Primary Packaging)



## Optimal Solution

LINDO DATA		DAY 1	DAY 2	DAY 3	DAY 4
D1L2	345600.0	F2: 345,600	F3: 345,600	F2: 115,200	F3: 326,880
D2L3	345600.0				F4: 230,400
D3L2	115200.0				
D3L4	230400.0				
D4L3	326880.0				
D5L4	345600.0			DAY 5	DAY 6
D6L1	345600.0			F4: 345,600	F1: 345,600
D7L2	72000.0				F2: 72,000
D7L5	273600.0				F5: 273,600
D8L1	43200.0				F6: 302,400
D8L6	302400.0			DAY 9	DAY 10
D9L2	195840.0			F2: 195,840	F1: 259,200
D9L3	149760.0			F3: 149,760	F5: 86,400
D10L5	86400.0				
D11L2	345600.0				
D12L4	345600.0			DAY 13	DAY 14
D13L2	345600.0			F2: 345,600	Cleaning

Note: The LP did not select any day where the process was shut down for 4 hours for cleaning between flavors.

The only day that did not run at capacity was day 4.

Where the minimal stick production time count was 4,474,080.

This LP needed 52 int variables. Four for each of the 13 days. My software can only handle 50. The solution was to start day 1 with all original. This is actually what the plant does on day 1 of 13.

## CONCLUSION:

My recommendation to the plant is not to run a flavor until it is done and then start the next flavor. The LP results indicate that most days should start with either flavor one or two, then switch to another flavor to finish out the day. The list of the thirteen days do not have to completed in the daily order, only within an individual day.

Further study should be done to optimize the other cutters and smoke houses.

## SOFTWARE:

LINDO 6.1 was used to produce the results.

## RESOURCE:

Rader, David J. *Deterministic Operations Research: Models and Methods in Linear Optimization*. Hoboken, NJ: John Wiley & Sons, 2010. Print.

## SPECIAL THANKS TO:

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