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**HotDog Project Team**

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CSS 408 – Spreadsheets Models for Mangers

Course Project

###### HOTDOG Project

Final Report

## Introduction

We began this project with a great deal of excitement since we believed that it would provide us the opportunity to accomplish all our major project objectives, and because we knew that what appeared to be a quite simple problem was, in reality, quite complex and a real challenge. It belongs to a class of problems (mix problems) which have broad applicability in businesses. They occur whenever a variety of factors contribute to the overall whole and can be mixed or weighted in some manner to accomplish a goal, e.g., lowest cost, highest yield, smallest volume, etc.

As the following paragraphs and sections will show, we accomplished the technical objectives of our project. But equally important we were able to deal with a variety of issues that would arise in a real world situation.

• Even with very diverse backgrounds and heritages, we were able to **work as an effective team**. When we first constructed the team we did so knowing full well that we were all very different, and four team members might be difficult to manage. Some had strong technical backgrounds; some had experiences dealing with customer projects; some were good at planning, others at model building. There were slight language differences, as well as differences in approach and technique. We quickly were able to leverage the strengths of each member and compliment his weaknesses.

• The ability to work as an effective team made dealing with **design decisions in the face of ambiguity** much easier. While we knew the model would be complex, we had not developed a clear picture of the number and type of design decisions that would need to be made. Fortunately, the strength of the individuals and their ability to work together saved the day.

• This was never more evident than trying to **make approximations and simplifications** that still preserved the fidelity of our efforts. A real Meat Processor would use tools like Linear Programs and optimization capabilities (e.g., Excel SOLVER) to perform much of the work in the Model. We were able to create substitution policies and guidelines to approximate those facilities.

## Problem Statement

American’s eat over 20 billion hot dogs per year. That’s about 75 hot dogs per person. It’s quite a big business, and small changes in the mix of ingredients that are used to make them can mean millions of dollars to the producers. But would you be surprised to find out that in many cases, using the best, most expensive cuts of meats is the most profitable way to make them? It’s true. And it results from the volatility of the meat products used to make them.

The process starts when a Meat Processor (e.g., ConAgra, Tyson) purchases animals and begins the process of converting them into meat products like steaks and hot dogs. Not only does the meat processor pay hundreds of dollars for the animal, but now he must also expend additional dollars to feed, house, and keep them healthy. Should they lose weight, become ill, diseased or die, his investment takes a loss. So he wants to processes them as quickly as possible … the longer he doesn’t, the more they cost him to maintain and the more likely it becomes that something happens that diminishes his investment. He chooses the number of animals to purchase and process by examining the forecasted demand for the type and quality meat products he will get from the animal.

The animals are sent to the “abattoir” (slaughterhouse) where they are “processed” (slaughtered and butchered) into three products: (1) large pieces or cuts of meat[[1]](#footnote-1) (e.g., whole, half or quartered carcasses; pork shoulders, loins, etc); (2) offal[[2]](#footnote-2) (internal organs); and (3) inedible parts (hoofs, hide, and etc). The meat is then hung in large cooling rooms[[3]](#footnote-3), waiting to be sold[[4]](#footnote-4), delivered or processed further into the cuts that you and I buy at the retail store. So as those large pieces hang there, they represent so many pounds of T-bone steaks ($5.99/lbs), Tenderloin ($10.59/lbs), Pork Roasts ($4.95/lbs), etc.

However, as the meat hangs there a funny thing begins to happen: it begins to lose water (shrinkage) and the quality begins to degrade as the air oxidized the surface of the meat. And as Martha Stewart might say, this is not “a good thing”. Remember, a pound of the T-bone **water** is worth $5.99. So once you slaughter the animal the meat needs to be sold quickly since the longer it hangs there the less it is worth. And that’s where Hot Dogs come in.

As the value remaining in the meat product continues to decrease with time, at some point it will become lower than the value of making Hot Dogs out of it (see Figure 1). At this point, it makes more sense to use the meat product in Hot Dogs than to continue trying to use it to satisfy future orders for more expensive meat cuts.

Most recipes[[5]](#footnote-5) for Hot Dogs combine together a blend of meats (pork, beef, chicken, or turkey), meat fat, a cereal filler which could be either bread crumbs, flour, or oatmeal, a little bit of egg white, and an array of herbs and seasonings including garlic, pepper, ground mustard, nutmeg, salt, and onion.

Once these ingredients are ground together, the stuffing is squeezed into sausage casings. Following the stuffing process is the pre-cooking cycle in which the Hot Dog links are tossed into boiling water for approximately 15 minutes. Finally, the dogs are packaged, loaded on delivery trucks, and sent off to food markets.

 Figure 1

At the end of each day, the meat processor matches the orders he received for various kinds of products that day, against the meat types/cuts he has on hand, and he matches his abattoir (production) schedule and livestock-purchasing plan against forecasted future orders. His costs are increasing, his products are degrading and shrinking, and the price[[6]](#footnote-6) of livestock and the prices he can charge his customers are always in flux. In this environment, maximizing his profits can be quite formidable.

##### The Model

Our model, named “HOTDOG”, helps the Meat Processor determine which ingredients to use and when to use them, to make the various types of Hot Dogs and maximize his overall Gross Profit. The flow of our model is quite straightforward (see Figure 2 below, and the User and References Guides).

Firm orders for the next 12 days are combined with a forecast of other orders likely to be received. The forecasted orders are estimated by using the forecast parameters (linear regressions for each product built from data points over the trailing 3 months). Then the current inventory (what’s in the cool rooms) is combined with the production schedule (what the abattoir plans to slaughter and when) and adjusted to make sure that the order plan can be accomplished. Orders are then (hypothetically) filled and the remaining projected inventory (All Beef Inventory) for each day can be used to make all beef hot dogs for that day. In the process both shrinkage (from water loss) and yield (how much meat will result after bone, internal organs, hoofs, etc are removed) are applied to give a more realistic picture of the resulting inventory.

Firm Orders

Available

All **Beef** Inventory

Yield

Parameters

All **Beef**

Inventory

Fulfill Orders

Order Plan

Forecast Parameters

Forecasted Orders

Current

Inventory

Order

Policies

Production Schedule

Shrinkage

Parameters

All **Beef**

Plan & Profit

All **Beef** Orders

Substitution

Policies

Forecasted

Costs & Price

Available

All **Meat**

Inventory

All **Meat**

Plan & Profit

All **Meat** Orders

 **Figure 2**

All beef hot dogs are then “made” by using the meat (beef only) available in the all beef inventory to make the quantities required. This is done by using the all beef substitution policy to choose which beef products to use first, which second, etc in the mix. This policy is the basis for our scenarios.

After the all beef hot dogs are accounted for, the remaining inventory (the all meat inventory) is used ( beef and pork this time) to make the all meat hot dogs using a procedure similar to the all beef hot dogs.

In both cases the sales price and costs are used to estimate the profitability of making the hot dogs using the substitution policy.

**The Scenarios**

In addition to building the model our project deals with two different scenarios: (1) sharply falling prices with forecasted order uncertainty, and (2) the same, with the addition of an aggressive substitution policy.

**Scenario I** - sharply falling prices with forecasted order uncertainty.

As described above, future orders are forecasted using a linear regression of the actual quantities ordered over the trailing three months. As in any regression, the dispersion of the data points (distance they are from the mean) is directly related to the uncertainty of the results. To compensate for that uncertainty, we introduce a positive padding factor that over estimates the forecasted orders. Since the future orders are used to estimate the inventory levels required in the future (and subsequently what will be available to use in making hot dogs) it is important to develop an accurate picture while not running out of product. In a sense, the padding is a safety factor that keeps the producer from being unable to satisfy an order. The larger the uncertainty, the larger the required padding factor.

In scenario I we assume a high degree of uncertainty, and hence establish a padding that will result in a 20% over estimate in our forecasts.

At the same time, the real world prices for various kinds of meat products vary daily as the amount of livestock and their price vary with all kinds of conditions: from weather and the cost to develop, feed and house the animals, all the way to the availability (or lack thereof) of the animals when needed.

This first scenario assumes a large supply of animals at relatively good prices resulting in lower costs for the producer and, therefore, falling meat product prices in the marketplace.

**Scenario II** – a more aggressive substitution policy.

In scenario I we used the oldest meat, then cheapest meat policy ... Use day 5 (then within day 5, cheapest to expensive), then use day 4 (then within day 4, cheapest to expensive), etc. This substitution policy assumes that old product will need to be discarded frequently (because of over ordering and the inability to sell it), and in the long run it is better to keep inventory free from old material so less needs to be discarded, resulting in better costs and higher profits. In a sense, it is a substitution policy that favors optimizing inventory.

In the second scenario we assume that the need to discard product occurs very infrequently and that it is best to use very inexpensive meat, almost irrespective of its age. When the prices of two products are the same, we would then use the oldest before any others. This approach seems to favor optimizing profit rather than inventory. In that respect, we it is considered more aggressive.

##### Scenario Comparison

[This section will be completed when we know the results of each scenario. Basically, it will describe which scenario is better when pricing is falling]

**Lessons Learned**

**It’s the simple things that can kill you**. When evaluating whether the HOTDOG project was the kind of project that we wanted to do, we were careful in strategizing how we could accomplish the more complex aspects of the decisions and calculations that we would need to perform. We believed we had come up with innovative ways to sidestep the need for using linear programming or optimizing tools like Excel Scenarios or Excel Goal Seeking capabilities. We had a pretty good picture of the flow and difficulty of our model, and even some creative ways to index through the data sets.

But we had not realized that the majority of our work evolved managing relatively large numbers of large tables (22 products x 12 forecast days x 5 days in inventory) most of the time. This quickly increased the size of our model.

With the (resource) limitation of no more that 1.44 MB for both scenarios and the three reports imposed by the project, much of our time was spent searching for ways to implement an idea in less and less space. This put an additional level of complexity on an already complex project, and continuous pressure on planned time budgets. We considered further reducing the number of meat products or other table parameters but felt that more reduction would effect the fidelity of the model and make it somewhat trivial.

**The inability to include all the features that you may want, and investigate all the potential scenarios that you may desire will always leave you with an empty feeling.**

Again, based on space and time limitations and the restrictions on tool use imposed by the project’s requirements we were only able to investigate a few scenarios. But so many more questions exist: what happens in a market with sharply increasing prices?; what is the relationship between the level of uncertainty in the linear regression line and the amount of padding use to deal with it?; in an up/down price market, what substitution policy yields the highest profit?; Lowest costs? ……

In a real life situation additional projects should be proposed to deal with the plethora of questions in a more formal manner, using advanced tools.

With access/interface to a real linear programming system, constraint equations could be developed and many of the questions resolved. Even the Excel Scenario feature could be used to test many different alternative at the same time. This could lead to the potential optimization of several variables at the same time.

In the real world there will always be budget limitations (there is always a limit on the amount of money that can be spent or the amount of time that can be allocated or space that could be used) and there will always be tool restrictions (some software will not run on the computers you use, or may not interface well and may compromise important application systems). So, one would never be able to include all the features wanted or do all the investigations desired.

Nonetheless, there is a balance point were not being able to use better tools and investigate some of the more interesting questions, suggests that the project is of minimal interest and should not be pursued.

**On the other hand, keep it simple**. If there is one mistake that is easy to make it is to try to include to many grandiose ideas into the model, including features that are of marginal utility to the user/customer, and in the end doing little but adding complexity. This is obviously the other side of the coin. Investigating scenarios or developing answers to questions that no one cares about is easy to do but little more than a waste of time and resources.

It is imperative that you reach the balance point so as to increase user/customer acceptance and optimize resources.

**Performance against Plan**

Over all, we feel that we did well against our original estimates of the time needed to complete our project (see the table below). However, Planning and Modeling activities took longer than expected due to constantly revisiting the model to change our approach in key areas in order to save space. This involved a fair amount of re-planning and re-coding of our model.

The good news is that the constant re-evaluations led to a clearer understanding of the model itself. And in turn, that resulted in our estimated time to complete the Documentation, Execution, and Testing.

|  |  |  |
| --- | --- | --- |
| (hrs) | Budget | Actual |
|  | Minimum | Maximum |  |
| Planning | 15 | 20 | 24 |
| Modeling | 30 | 35 | 62 |
| Documentation | 20 | 30 | 23 |
| Execution & Testing | 15 | 30 | 18 |
| Total | 80 | 115 | 127 |

1. A 1,000 pound Angus steer yields 465 pounds of retail beef cuts from a 600-pound carcass: 25% are steaks, 25% are roasts, 25% is burger and ground beef, and 25% is lost due to bone, fat, hide, etc. [↑](#footnote-ref-1)
2. You gotta love the names these guys come up with. [↑](#footnote-ref-2)
3. The meat is usually not frozen since that may degrade its quality. [↑](#footnote-ref-3)
4. Large Meat processors usually sell to wholesalers, retailers, and food service distributors who order by the rail carload and/or hundredweight (cwt). [↑](#footnote-ref-4)
5. The content of Hot Dogs is regulated by Law in the U.S. “All-beef” or “beef” Hot Dogs can contain only beef with no soybean protein or dry milk solid fillers added. “Kosher” Hot Dogs can only be all-beef. “All-meat” Hot Dogs are a mixture of only pork and beef, usually 40% pork and 60% beef with no fillers. “Frankfurters” can be made from a combination of meats and can contain up to 3.5% fillers. [↑](#footnote-ref-5)
6. See Chicago Mercantile Exchange Livestock futures options prices [↑](#footnote-ref-6)