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PROFIT IMPROVEMENT IN BAKERIES BY USE OF METHODS ANALYSIS

by

STEVEN ALBERT JOHNSON

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Approved by

Frank B. Tillman

Major Professor

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FOREWARD

We have been taught there are five classical steps to systematically solving any problem. These are:

1. Define problem
2. Analysis of problem
3. Make a search for possible solutions
4. Evaluation of alternatives
5. Specify best solution

I would like to add a preface to these five steps, that is la., problem identification. Before one can attempt to define a problem, the problem must be perceived as a problem. From my experience, many problems in bakeries remain unsolved because they are not recognized as a problem by the management.

The major objective of this report is to describe some of the problems encountered in the baking industry and methods used by this author for their solution.

The areas covered are in no way complete and the methods used are not necessarily the "single - best".

Background for writing this report is a combination of studying Bakery Management and Industrial Engineering and working at both plant line management and at the corporate staff level in the baking industry for the past ten years. More specific examples were derived from studies conducted by this author while working for two of the larger wholesale baking companies in the United States.

CHAPTER 1

1.1 Introduction

The baking industry is a major factor in the economy of the United States. Bakery products make up about 8 percent of consumer purchases of food (1). Bread and other baked products form an industry that is the tenth largest U.S. manufacturing industry in sales--exceeding the drug, rubber, nonferrous metal, machinery, and appliance manufacturing industries. In 1971, shipments amounted to approximately $7.1 billion, and were exceeded only by such industries as automobiles, petroleum, and steel. The baking industry is heavily dependent on labor. There are approximately 397,000 employees in the baking industry, outnumbering all but five other manufacturing industries (textile, chemical, steel, motor vehicle, and aircraft). (2)

Baking companies can normally be classified into one of the following major categories:

1. Wholesale bakeries.
2. Vertically integrated grocery chain bakeries.
3. Home service bakeries.
4. Retail bakeries.

The wholesale bakeries manufacture for an distribute to multiple retail outlets. Comparing wholesale bakeries to captive bakeries, production facilities are similar in design and capacity. The major difference between wholesale bakeries and captive or retail bakeries

is the marketing and distribution methods. Wholesale bakeries do not own the stores in which the bread is sold; therefore they do not have control of the final distribution of their products. The retailers income is determined by the difference between retail and the wholesale price times the net units sold in the store. The driver-salesman who delivers the product to the retail outlet is paid a percentage of the net units sold in the store. The cost of the product that is delivered to a store, but not sold (stale returns), is absorbed by the wholesale baker.

Many grocery chain stores (Safeway, Dillions and A & P) have found it profitable to own and operate bakeries to supply their own retail outlets. These bakeries, commonly called captive bakeries, are in effect vertically integrated chain bakeries. Major advantages enjoyed by captive bakeries are mainly due to their tighter control of distribution costs. Cost advantages can be attributed to three major differences.

1. The captive chain can control the shelf space in its own outlets. This limits competition because wholesalers can only leave a limited quantity of bread, and this is usually placed in an inconvenient place for the shopper.
2. The volume of bread delivered to their own supermarket is larger than to the average store served by the wholesaler; therefore deliveries can be made with large semi-trailer units, with the bulk of the trailer cargo being dropped at two or three stores.

3. The driver-salesmen of the wholesale bakers are paid a base plus a commission percentage for all product sold. For example; a wholesale bakery driver in Detroit with a $1700.00 weekly route average sales, will gross $297 per week (17.5% of sales). Captive chains, however, pay their drivers on a hourly basis ($300 /week). A driver for a captive bakery can deliver approximately ten times the dollar volume as the wholesale driver for the same wages.

In 1950, bakeries sold considerable volume directly to the consumer on home service routes. As distribution costs soared, it became unprofitable to sell a few loaves of bread to a single stop. Today it is difficult to find home service routes. The reason for discussing them in this report is that, in the past, this method was viable and profitable. As distribution costs increased faster than manufacturing costs or retail prices, the only way to stay profitable was to sell more product per stop. In many wholesale bakeries today, serving the small mama-papa stores can be likened to serving the individual homes years ago.

Retail bakeries normally produce and sell their products at one location. They have been serving a limited market with demands for decorated cakes, pies, pastries, and speciality breads. Historically, due to price differential, there has been little competition between retail and wholesale bakeries. For this reason, retail operations will not be discussed in this report.

Table 1 shows the trends and relative importance of the four components of the baking industry.

The purpose of this report is to discuss methods to increase bakery profits through cost reduction. Major emphasis is placed on studying the operation within the wholesale segment of the baking industry. Many of these techniques used are readily applicable in captive bakeries. Before specific areas are discussed, it would be helpful to review more general long range problems plaguing the wholesale baking industry.

1.2 General Industry Problems

In recent years, there have been pressures within the wholesale baking industry which make it difficult to maintain profit rates achieved in the forties and fifties. In 1950, the average after tax profits for the four largest baking companies was 41.1% of sales. This average fell to 7.5% in 1965. While more recent figures are camouflaged with mergers and acquisitions, profits per dollar sale in wholesale bakeries have fallen to an all time low of approximately 2 to 5 %. Some of the more visible signs of recent profit problems in the wholesale baking industry are:

1. Continental Baking Company, with annual sales over $1,000,000,000 has merged with International Telephone and Telegraph.
2. Interstate Brands Corp. has shown net operating losses in the last year (1972).

TABLE 1

TRENDS AND RELATIVE IMPORTANCE OF SUPPLIERS OF BREAD FROM 1958 to 1967**

Industry Measure	1958	1963	1967	% change 1958-1967
1. Number of Establishments (over 20 employees).				
a. Wholesale Bakeries	1768	1546	1387	-21.5
b. Grocery Chain Bakeries	128	122	104	-18.7
c. Home Service Bakeries	146	97	24	-83.6*
d. Retail	119	139	93	-21.8
e. Total	2161	1904	1608	-25.6
2. Number of Employees. (000's)				
a. Wholesale Bakeries	194.4	180.4	188.5	- 3.0
b. Grocery Bakeries	18.9	19.1	18.4	- 2.6
c. Home Service Bakeries	30.5	24	5.7	-81.3*
d. Retail	14.1	13.5	9.1	-35.5
e. Total	257.9	237.	221.7	-14.0
3. Value of Shipments ($000,000)				
a. Wholesale Bakeries	3130.4	3508	4400.7	+40.6
b. Grocery Bakeries	382.5	465.5	468.3	+22.4
c. Home Service Bakeries	406.1	333.5	98.2	-75.8*
d. Retail	179.6	198.8	135.4	-24.6
e. Total	4098.6	4505.8	5102.6	+24.5

*In 1973 Home Service Bakeries are Practically Non Existant

**More Recent Information will be Available in Early 1974.

Source: Census of Manufactures 1967 MC67(2)-20E

3. American Bakeries ($350,000,000 annual sales) became under the control of Grant Capital Management Corp.
4. American Bakeries closed 20 of its original 56 operations from 1966 to 1973, and overall have shown a net operating loss for the past two years in the wholesale bakeries (1971-72).

While profits have been declining in the wholesale baking industry, this is merely a symptom for more serious problems that must be tackled to insure long term survival. It may be possible to classify existing industry problems into three broad categories:

1. Excess production capacity.
2. General educational levels of personnel in the baking industry.
3. Lack of sufficient technological changes.

Excess Production Capacity

In 1965, the National Commission of Food Marketing (3) found that among 284 wholesale baking plants, there existed 20 percent excess capacity. While there appears to be no newer information, an observation can be made that during strike conditions in a market there seldom is a lack of bread. Excess production capacity has resulted mainly from technological changes in the past twenty years and the increased vertical integration of grocery chains. Changes in product formulation and oven design has reduced the average baking time from 35 minutes to 18 minutes, effectively doubling oven capacity.

Continuous mix machines have also increased the output of existing plants.

The philosophy of many bakery managers is: "If the bakery is at full capacity, I have to make a profit." As proven in recent years, this thinking is not always valid. The drive to fill the excess capacity has led managers into a competitive situation in which only the fittest can survive.

Common methods used by sales management to help fill excess capacity of a plant is:

1. Direct and indirect discounts.
2. Multiple service stops per day.
3. Stocking the grocers shelves.
4. Building displays for the grocer.
5. Supplying a complete line of baked products, even when certain products cannot absorb their share of variable cost.
6. Performing many of the bookkeeping functions of the bakery department of the grocery.
7. Spread distribution to less competitive marketing areas, usually at an increased transportation expense.

The wide spread and increasing use of these tactics have in many cases continued to erode plant profits. The total impact on plant profitability by the use of these techniques is hard to quantify. In fact, most bakeries do not know the profitability of individual customers or products. It has been in the last two years that the two major bakeries have attempted to identify profitability by product

variety. To the authors knowledge no major baker has attempted to identify profits contributed by customers. This point was highlighted by the fact that a large baking company had over 90 million dollars worth of sales to restaurant customers in 1971. Apparently no one in the entire company had quantified whether this 90 million dollar business was profitable or not! Actual profit contribution by any single or, for that matter, group of customers is most difficult to quantify with precision. What is needed in most bakeries are simple guidelines that will help determine when sales are becoming marginal. In the basic drive to fill production capacity, the managerial team should keep the difference between sales and profitable sales in perspective.

Education Level

Where the major product of a company is hard to differentiate from its competitors product and is a low priced convenience item, continual efforts must be made to attain rigid cost controls. Historically there has been little training of managers in cost control techniques. Even more basic, the general education level in the baking industry is very low. This does not imply that advanced education has a captive market on intelligence or is a single best measure of management ability. The only true measure of that can be sustained bottom line profits. This author has made an observation that as the education level of bakery managers increases, they tend to be more receptive to new methods or ideas and less defensive about past practices. One major baking company in the U.S., with total

employment of over 11,000, has only 56 college graduates. Of the 56 graduates, 32 are at the corporate headquarters in relative ineffective positions in a highly decentralized company. Two of the largest bakery companies in the U.S. have historical patterns that tend to state that the only way to break into plant management is to first start in route sales. Route salesmen are very customer orientated and are given little exposure to cost control techniques. If a route salesman is chosen for plant management, chances are slim that there will be a formalized training program. Most managers are trained by the manager they will succeed. The basic assumption here is that the previous manager was a good one. Imagine turning a 12 to 20 million dollar per year business over to such poorly trained personnel.

Staff assistance in cost control has been non-existant in most bakeries. The three largest bakery corporations have only in the last year and one half added an Industrial Engineering function. The lack of recognition for the need of training in cost control techniques coupled with the inbreeding caused by promotion policy has made the adaptation of cost reduction programs difficult.

Lack of Sufficient Technological Changes

It has been said that, generally, the food industry is slow to adopt technological changes. Within the baking industry reasonable progress has been made in increasing the loaves per minute by introducing larger capacity ovens and mixers. Yet, basic methods used in production and distribution have remain unchanged over a fifty year

period. The baking time from start to finish still takes approximately eight hours, the same as for hundreds of years. Figure 1 is an operations process chart outlining the steps necessary for the manufacturing and distribution of product in a wholesale bakery. Table 2 shows percentage costs for manufacturing and distribution of baked products manufactured during 1972 for one of the four major wholesalers.

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FIGURE 1. OPERATION PROCESS CHART FOR BREAD PRODUCTION

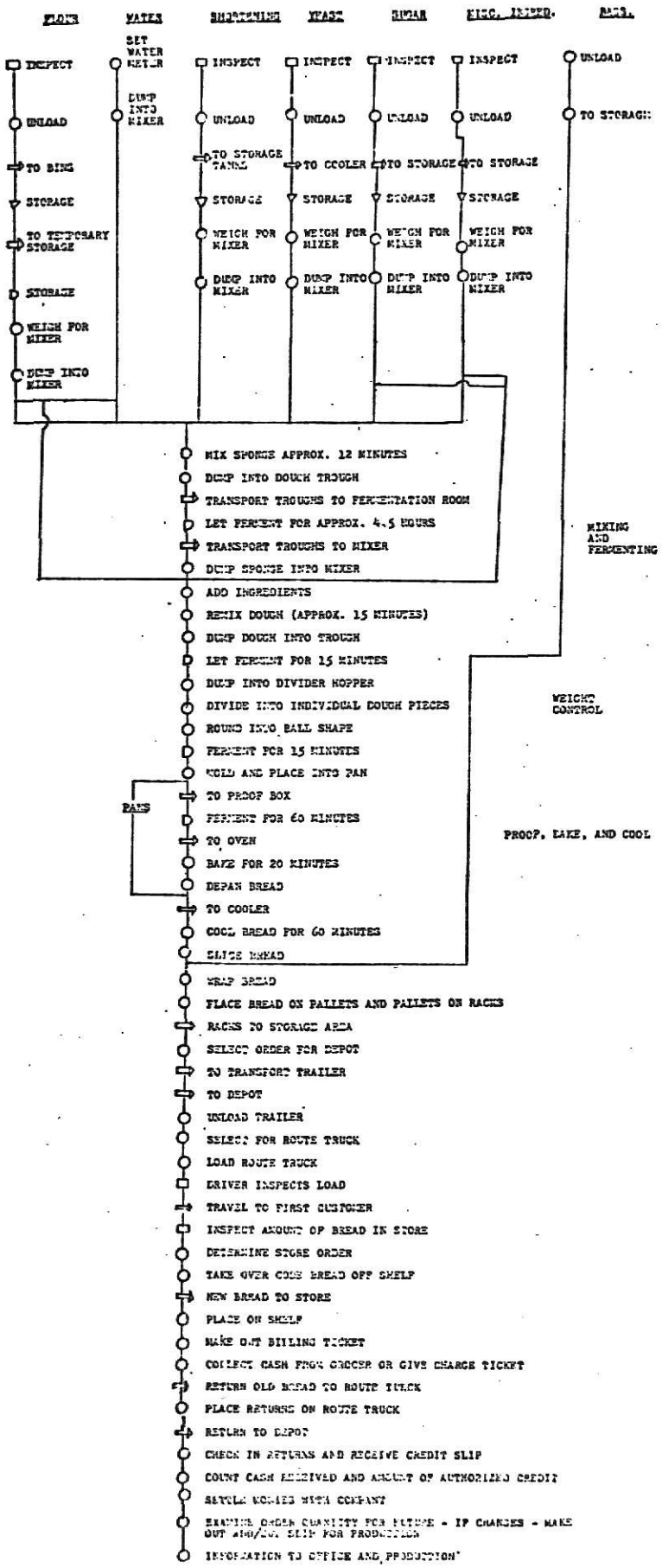


TABLE 2

COSTS OF BREAD BASED ON A PERCENT OF NET SALES OF THE CORPORATION*

	Amount (000.)	Percent
Gross Sales	360,601	113.6
Returns	33,239	10.5
Price Reductions	9,934	3.1
Net Sales	317,427	100.00
Materials	116,062	36.6
Labor**	52,404	16.5
Plant Overhead	12,728	4.0
Total Manufacturing Expense	181,194	57.1
Gross Margin	136,232	42.9
Distribution Expenses		
Shipping	12,487	3.9
Garage Labor & Expenses	9,691	3.1
Sales (routemen) and Supervisors	69,245	21.8
Depot Rent	1,701	.5
Total Distribution Expense	93,125	29.3
Other Expenses***		
Office	5,928	1.9
Advertising and Promotion	1,866	.5
Thrift Store Rent	4,506	1.4
Other Selling Expense	5,287	1.7
Allowances and Discounts	20,104	6.3
Other Administrative Expenses	11,450	3.6
Total Other Expense	49,198	15.4
Before Tax Operating Profit (loss)	(6,091)	(1.9)

* Recent figures from one corporation

** Including Maintenance, sanitation, and direct manufacturing labor

*** A large portion of these costs are indirectly related to the method of route distribution.

CHAPTER 2

2.1 The Manufacturing Process

A brief background of long term problems that plague the wholesale baking industry was given in Chapter 1. These problems are not likely to be solved in the immediate future, and if solved, would not generate the quick profits needed by many operations. There are many departments within each bakery that potential savings could be achieved by utilizating Industrial Engineering methods. Significant savings are possible in the manufacturing process which are 57.1% of one company's cost (Table 2) and these are studied in this report on a passing basis. However, it appears that physical distribution has possibly the greatest potential for saving (29.3%, Table 2) because it has more opportunity for improvement. This is primarily because this area has not received the attention in the past to the degree the other areas have. Certain segments of distribution will be treated in depth in Chapter 3. In looking for potential savings in manufacturing, it is appropriate to start at the beginning--the receiving dock. These areas discussed here can be located on the flow chart (Figure 1) to keep the operation and flow of products and material in view.

2.2 Receiving and Storage of Material

Statistical acceptance inspection of incoming ingredients and scientific inventory control techniques have not been utilized to any

extent in the baking industry. There are definite potential savings that can be derived by closer inspection of weights of received ingredients.

It is generally felt within the industry that because of the fast usage of raw ingredients (few days to several weeks), major savings impact would not be achieved by tighter inventory control. Because finished products are usually on the grocers shelf within 12 to 36 hours after being produced, there is little problem controlling inventory of produced products. There are a few bakeries starting to use freezers to gain longer production runs. This presents an interesting inventory control problem.

Another area worth studying is the feasibility of establishing centralized warehousing of raw materials. For instance, a bakery close to a supply of polyethylene bags could purchase larger amounts to supply both itself and sister plants, thus gaining quantity discounts. Most bakeries have an elaborate network of transport routes that could then be utilized to avoid inbound freight costs. One baking company had an established network of transports that could take materials from New York to Dallas in approximately five days. Because of the relatively short delivery time, safety stock could be reduced at most plants. One large safety stock should be less than the total of the smaller safety stocks, thus reducing the capital tied up in inventory. In most companies there is a lack of communication and standardization of equipment that must be first considered. Never the less, there are major economics to be gained by the use of centeralized warehousing and existing transport networks.

2.3 Mixing and Fermentation

In the past ten years, major improvements have been made in weighing and mixing of ingredients. To date, the most advanced system utilizes plastic "formula cards" that can be inserted into a scanner or reader. The reader device signals controls that automatically activate ingredient feeders and weighing mechanisms.

Major advances in fermentation appear to be on the forefront. Presently, in conventional sponge-dough makeup, sponges (a mix of flour, water, yeast and yeast food) are fermented 4.5 hours. The reason for the 4.5 hours is to give the yeast time to generate the flavors that create the smell and taste of bread. Scientists at Kansas State University (4) have isolated and artifically reproduced the chemicals generated by fermentation. With the addition of these chemical substitutes, the fermination time will be eliminated. Savings attainable through the elimination of fermentation in the conventional bread making process are:

1. Labor reduction of one man per eight hour shift.
2. Reduction of fermentation losses in doughs.
3. Decreases the "lead time" needed between the determination of product demand and production enabling the bakery to be more responsive to last minute market variations.
4. Decrease the floor space requirements needed for production.
5. Decrease in equipment cost. Only one mixer is required in place of two, because of an elimination of one of the re-mixing operations.

Even so, actual throughput of production facilities at this time will not be increased because the oven capacity is the usual production bottleneck.

2.4 Weight Control

The divider, commonly called the cash-register of the bakery, cuts the large batch of dough into small pieces prior to placing it in the pan. Normally, a divider has six to eight pockets or cylinders that, in effect, measure a volume of dough. An operator has individual controls for each pocket plus a master control for all pockets concurrently. Once the individual pockets are set to weight equal volumes, this control does not need to be altered frequently. The main point for control during the dividing is the "master" volume control. There has been little use of statistical quality control procedures in bakeries. In fact, operation auditors have an almost impossible task of reconciling the units produced times the scaling weight to the ingredient usage. Random samples taken of various products have shown up to 46% overscaling of product. Common explanations of why bakery managers knowingly tolerate overscaling of product are:

1. "I need the extra weight to make my product look right in the bag."
2. "My competition is doing it."
3. "If the product has a label weight of 16 ozs., and I put 17 ozs. in the bag, it costs me only one ounce of material."
4. "I have to overscale to be safe on weights and measures."

These statements are heard often enough to warrent further comment. A bakery manager must first produce a product that he thinks will be acceptable to the customer, then design a bag to fit the product, not visa versa.

Today when unit pricing is becoming increasingly popular, the consumer is told on the product shelf what the price per unit is. In the case of bakery products, unit pricing takes the form of price per pound. There is little competitive leverage to be found in overscaling, because the customer normally does not weigh the product, and unit billing uses the price per "label weight" pound to determine the per unit cost.

What does it cost to overscale a 16 ounce loaf of bread by one ounce? One large bakery company produced 1,104,244,400 pounds of product in 1972. The cost of ingredients for this poundage was $62,758,200. At that rate of production, overscaling by 6.7% would cost $3,922,286 annually. This is all profit and very significant! With recent flour and other ingredient increases, the average cost per pound has increased from 5.6 cents per pound to over 7 cents per pound, making weight control even more important.

The fourth point signals a lack of understanding of statistical quality control procedures. After the package label weight is determined, the actual scaling weight can then be determined. The main influences on the amount of the "safety factor" that must be added to the label weight is the variability of the machinery and the balance between cost benefits of underscaling and overscaling.

The following approach might be used to establish a statistical weight control program:

1. Before any weight control program can be established, desired label weights must be established and agreed upon. This weight should not contain a "safety factor" to eliminate underscaling, but be the minimum weight needed to attain desired customer acceptance. The point of customer acceptance is not trivial and could be a base point for a marketing study to determine the correlation between scaling weights and customer preferance.
2. A set of guide lines from the state department of weights and measures should be obtained. Try to determine what the actual penalities are for underweight product.
3. Before undertaking a full scale statistical weight control project, estimate what the potential savings might be versus the cost. Table 3 shows actual average weights of product found in one bakery. Savings from tighter weight control can be accomplished by decreasing the variability of the process and/or concurrently decreasing the process average.
4. After management has resolved that the savings appear large enough to continue the study, a format should be established for data collection. Before attempting data collection, the accuracy of scales should be checked. The typical scale in a bakery has .25 ounce divisions, an old crusty dough piece on the counter-balance to achieve zero balance, and tends to stick on a particular setting. Consideration should be

TABLE 3

ACTUAL WEIGHTS AND OVERWEIGHT COSTS OF THREE PRODUCTS FOUND IN A BAKERY

Product	Label Weight (Oz.)	Average Actual Weight (Oz.)	Average Units Produced Per Week	Pounds Overweight Per Week	Ingredients Cost Per Pound, $	Yearly Cost of Overweight (Dollars)
Brown & Serve Buns	10	14.69	19,100	5598	.07877	22,929
Small Cake	3	3.6	30,840	1325	.12800	8,819
Bar Cake	18	21.69	2,250	518	.13490	3,633
					TOTAL	35,401

given to purchasing a gram scale. Since there are 28.3 divisions per ounce in a gram scale as compared to 4 for normal scales in a bakery, a greater degree of accuracy can be achieved.

There are some complexities in bakeries that should be discussed at this point:

(a). Weights of baked products decrease during the baking process.

(b). Because flour is hydroscopic, consideration should be given to atmospheric humidity changes from summer to winter, especially in northern areas.

The weight requirement that must be satisfied is the label weight of the package. Since there is a loss of weight from the time the product is first weighed to the time it is purchased by the customer, allowances should be considered before determining the actual weight at the divider.

Table 4 shows actual weights of product taken at the divider and two hours after being wrapped. From this data the weight that must be added onto the label weight due to moisture loss between the time the product is first weighed and finally purchased by the customer can be determined. As expected, the weight loss after the divider is some what constant. Most of the variance was at the divider operation. Since the label weight was 24 ozs., and the average moisture loss was 4.3 ounces, the prebaking weight must be at least 28.3 ounces before allowing for divider variation. When weighing deposits on a

TABLE 4

WEIGHT OF PRODUCT AT DIVIDER AND 24 HOURS AFTER BAGGING

Observation	Divider Weight (Oz)	Bagged Weight (Oz)	Loss (Oz)	% Loss
1	28.87	24.68	4.19	14.5
2	28.12	23.87	4.25	15.1
3	28.81	24.37	4.44	15.4
4	28.37	24.12	4.25	15.0
5	28.25	24.12	4.13	15.0
6	28.62	24.19	4.43	15.5
7	28.25	23.94	4.31	15.3
8	28.81	24.56	4.25	14.8
9	28.68	24.69	3.99	14.6
10	28.56	24.19	4.37	15.3
11	28.94	24.69	4.25	14.7
12	28.81	24.50	4.31	15.0
13	28.44	24.06	4.38	15.4
14	28.62	24.25	4.37	15.3
15	28.75	24.44	4.31	15.0
Average =	28.59	24.31	4.28	
Sample Std. Dev.	.24	.26	.07	
Coef. of Variation	.8%	1.1%	1.6%	

conventional bread line, approximately 20 deposits from each pocket should be weighed in rapid succession. This will lessen the effects of changing specific gravity of the dough when determining the average weight in the individual divider pockets. Before data gathering is continued, the individual pockets should be adjusted to minimize the weight variance between pockets. After the individual divide pockets are set so their average weights are equal, additional data should be collected in the same format as above in order to determine the amount of weight variance in the normal process of bread weighing. At this point, the amount of weight to be added to the label weight plus bakeout weight, considering the variance of the process, can be determined. As mentioned earlier, the amount of extra weight (over and above moisture loss) should be set to achieve a balance between the costs of overweight product and the costs of underweight product. To help managers gain a perspective on these costs, a simulation program was written that would, in effect, allow "what if" questions concerning weight decisions.

Figures 2 and 3 are a listing and sample run of the simulator WTSIM (written in basic language). This simulation model was very effective as an aid in explaining the cost of "zero defects" and the costs of excessive process variance. Table 5 shows the incremental costs of approaching "zero-defects." One input to the simulation model that was difficult to determine was the probability of a product being checked for weight and the cost of a detected underweight product. A discussion was held with the Michigan State Department of Weights and Measures concerning how weight laws were enforced. Questions asked were:

FIGURE 2. COMPUTER PROGRAM OF WEIGHT SIMULATION

```
WTSIM       19:58EST    04/27/73

100 PRINT " THIS MODEL SIMULATES SCALEING WT. DECISIONS"
102 PRINT " ****************************************"
103 PRINT
104 PRINT
106 PRINT " WHAT IS THE LABEL WT. AND BAKE OUT WT. OF THE PRODUCT (OUNCES)"
110 INPUT A,B
115 LET C1=A+B
120 PRINT
140 PRINT " WHAT IS THE COST OF THE DOUGH (DOLLARS PER OUNCE)"
150 INPUT C
160 PRINT
165 PRINT " WHAT IS THE COST OF DETECTED UNDERSCALED PRODUCT AND"
166 PRINT " IS THE PROBABILITY OF DETECTION"
170 INPUT D,E
180 PRINT
190 PRINT "WHAT IS THE ACTUAL SCALEING WT. AND THE STANDARD DEVIATION OF"
191 PRINT "THE PROCESS"
192 INPUT F,G
193 PRINT
194 PRINT "HOW MANY TIMES DO YOU WANT TO RUN THE SIMULATION"
195 INPUT N1
196 PRINT
210 LET H=0
211 LET P1=0
220 LET P=0
230 LET O=0
240 LET R=0
241 LET D1=0
242 LET M=0
243 LET O1=0
250 FOR X=1 TO N1
260 LET A1=SQR(-2*LOG(RND))+COS(6.2831853*RND)
270 LET B1=A1*G+G
280 LET D1=D1+B1
282 LET H=H+B1*C
290 IF B1<C1 THEN 400
300 LET P=P+1
302 LET P1=P1+B1-C1
310 GOTO 500
400 LET O=O+1
405 LET M=m+C1-B1
410 LET R=RND
420 IF R>E THEN 500
422 IF O1=1 THEN 500
425 LET O1=O1+1
```

FIGURE 2. (continued)

```
440 LET H=H+D
500 NEXT X
520 PRINT " AVERAGE SCALEING WEIGHT WAS";D1/N1
525 PRINT
530 PRINT " AVERAGE COST (PER UNIT) OF DECISION WAS";H/N1
535 PRINT
545 PRINT " NUMBER OF UNITS OVERSCALED WAS";P;"AND AVERAGE AMOUNT OF"
550 PRINT " OVERSCALE WAS";P1/P
560 PRINT
570 PRINT " NUMBER OF UNITS UNDERSCALED WAS";O;"AND THE AVERAGE"
580 PRINT " AMOUNT OF UNDERSCALEING IS ";M/O
590 PRINT
600 PRINT " NUMBER OF TIMES DETECTED WAS";O1
```

FIGURE 3

```
WTSIM       18:35EST     04/11/73

THIS MODEL SIMULATES SCALEING WT. DECISIONS
*****************************************

WHAT IS THE LABEL WT. AND BAKE OUT WT. OF THE PRODUCT (OUNCES)
? 16.,2.

WHAT IS THE COST OF THE DOUGH (DOLLARS PER OUNCE)
? .004675

WHAT IS THE COST OF DETECTED UNDERSCALED PRODUCT AND
IS THE PROBABILITY OF DETECTION
? 10.,.01

WHAT IS THE ACTUAL SCALEING WT. AND THE STANDARD DEVIATION OF
THE PROCESS
? 18.,4.8601

HOW MANY TIMES DO YOU WANT TO RUN THE SIMULATION
? 1000

AVERAGE SCALEING WEIGHT WAS 17.9314

AVERAGE COST (PER UNIT) OF DECISION WAS 9.38293E-2

NUMBER OF UNITS OVERSCALED WAS 489 AND AVERAGE AMOUNT OF
OVERSCALE WAS 4.06726

NUMBER OF UNITS UNDERSCALED WAS 511 AND THE AVERAGE
AMOUNT OF UNDERSCALEING IS 4.02642

NUMBER OF TIMES DETECTED WAS 1

USED    1.04 UNITS
OLD
```

TABLE 5

COST OF APPROACHING ZERO UNDERWEIGHT LOAVES

NUMBER OF PIECES WEIGHED = 4000
Label weight & bakeout = 18.25 oz.
Standard deviation = .25 oz.
Dough cost per ounce = $.004675
Incremental material cost of increasing process average by 1 oz = 4000 x .004675 = $18.70

DIVIDER WEIGHT	NUMBER OF UNITS OVERWEIGHT	NUMBER OF UNITS UNDERWEIGHT	PERCENT OF TOTAL LOAVES UNDERWEIGHT (DEFECTIVE)	AVERAGE MATERIAL COST PER PIECE, $	CHANGE IN UNITS FROM UNDER TO OVERWEIGHT	ADDITIONAL COST PER. LOAF, $
18.3	2280	1720	43	.0855270		
					536	.0348
18.4	2816	1184	30	.0859758		
					465	.0402
18.5	3281	719	18	.086424		
					374	.0500
18.6	3656	344	8.6	.0869339		
					191	.0979
18.7	3847	153	3.8	.0873937		
					89	.2101
18.8	3936	64	1.6	.0878492		
					42	.4452
18.9	3978	22	.5	.0883394		
					17	1.1000*
19.0	3995	5	.1	.0887817		

*Note: It costs $1.10 per loaf to move 17 loaves from an underweight to an overweight position!

1. How often are bread products checked?
2. What rules are used to determine if there is a violation?
3. Are there differences between the first offense and the second or third offense?
4. What is the history of judgements against similar weight control offenses?

Answers received were vague and it was implied that the level of inspection and the degree of enforcement varied greatly from one locality to another. It is this authors impression that spot checks were made in two or three stores on a monthly basis depending on the availability of inspectors and the priorities placed on them by their superiors.

The method that the interviewed inspector used was to pick at random 10 samples of one variety. If one out of ten loaves showed more than two percent underweight, another ten loaves were sampled. If this sample showed more than one unit underweight by more than 2%, the inspector would then confiscate the underweight product and call the bakery management.

The first offense was a verbal warning with no financial exposure, other than the confiscated loaves of bread. After being caught with underweight product, the inspector stated that increased inspections could be expected. If there are repeated occurances of underweight product on the market, the violation would fall in the misdemeanor class. First time fines averaged 25 to 100 (this appeared to be a function of how flagrant the offense was).

In summary the probability of getting caught and the financial exposure appear to vary significantly from one locality to another.

The total financial exposure in any case, especially considering the fast turning of the product, is very low in relation to the savings attainable through stricter weight control.

It is possible that the moral obligation to the public far outweights the exposure to fines from the government. One way to view a moral obligation to the public would be to assume a penalty cost for every underweight loaf that will leave the bakery undetected. By increasing or decreasing the process average, management can influence the probable number of underweight loaves that are produced. Figure 4a shows that, as the process average is increased in relation to the label weight and bake out loss, fewer defectives will occur. Another observation is that, as the process average is increased sufficiently above the label plus bake out weight, further increases in the process average offer disproportionately less improvement in the number of defectives produced. The objective is then to balance the cost of increased material useage versus the penalty cost associated with each underweight loaf. Figure 4b shows the overweight, underweight, and total cost curves assuming various moral fines for underweight product. From this figure, total cost is derived by summing the material cost and various penalty costs associated with every underweight loaf. If management preceives its penalty cost to be 1 cent for every underweight loaf, the process average would have to be approximately 18.6 oz. If the penalty cost were reduced to .1¢/loaf, the model shows that the ingredient savings of underweight product will be greater than the penalty cost of underweight product.

FIGURE 4a. EFFECT ON PERCENT REJECTION BY MOVING PROCESS AVERAGE

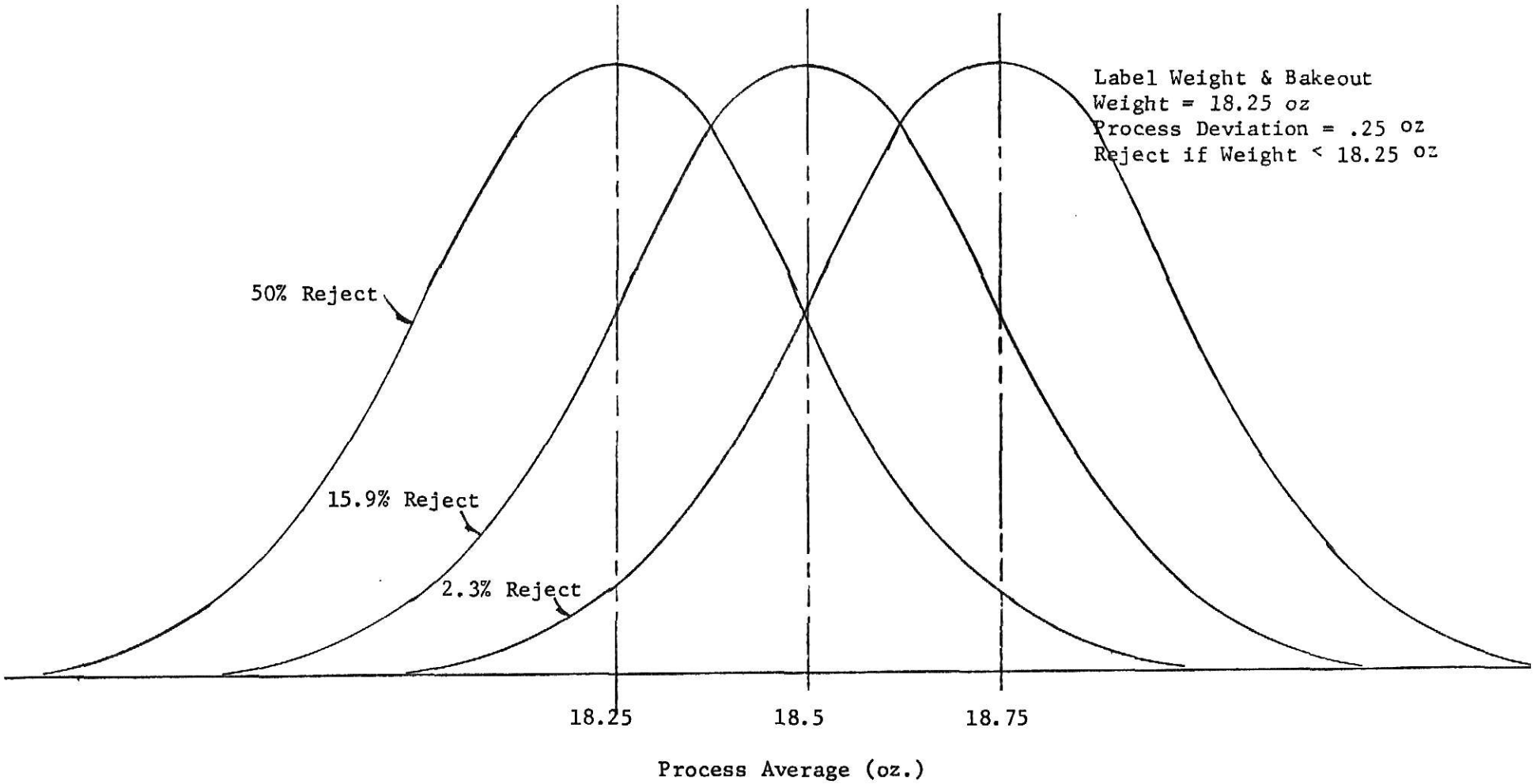
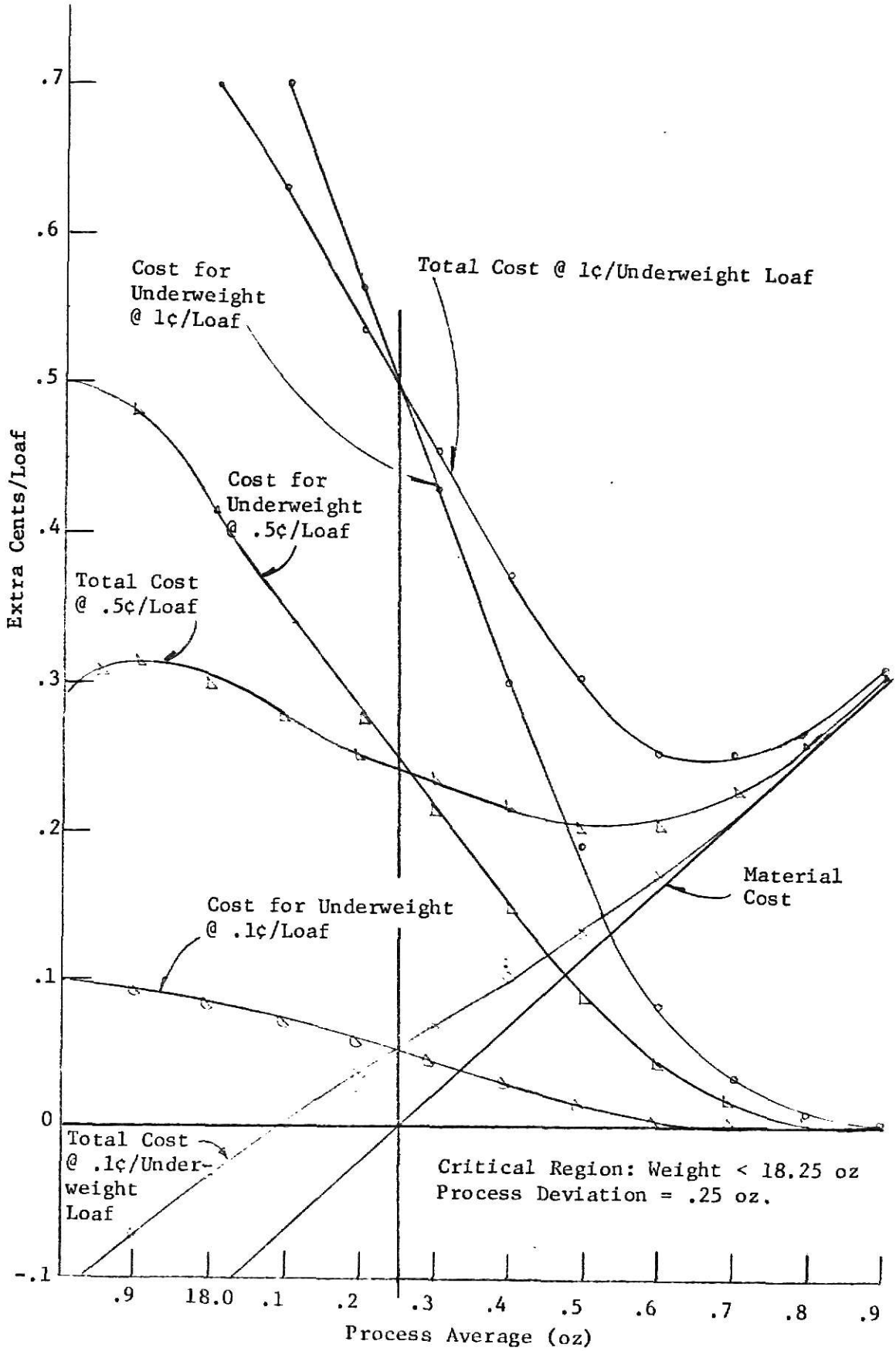


FIGURE 4b. COST CURVES FOR DIVIDER WEIGHT DECISIONS



This does sound reasonable if one can assume a constant penalty cost over all process averages. In the real world, this is not a valid assumption since the actual cost of marketing consistant underweight product will, in the long run, carry greater costs. What this model does say is that an occasional underweight product is not costly enough to force unreasonably high process averages.

Once management has made a decision concerning divider weight, and the variance of the equipment is acceptable, $\bar{X}$ and R control charts should be installed on the production line. Figure 5 is an example of a completed control chart.

At this time, it was not known what the total savings would be by using statistical weight control. Management of a plant in Detroit were very impressed by the gains in yield. One fact that surfaced was that a tremendous amount of work still needs to be done by the equipment manufacturers and bakery management in designing more accurate dividers.

2.5 Proofing, Baking, and Cooling

The sequence of operations following the dividing of the dough (weight control area) is proof, bake, and cool. Proofing is where the bread rise begins from the action of yeast cells and fermentation. These areas have been highly mechanized and in general a good job as been accomplished in labor reduction. Further cost reductions may be possible through the use of microwave energy in speeding up the proof and bake process. Major savings would come from increasing the throughput of the equipment and, in effect, moving the baking process closer to the market. Many times, product is produced before the actual demand for that product

FIGURE 5. $\bar{X}$ & R CONTROL CHARTS

Plant Detroit Product 16 oz White Bread

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Time																		
1																		
2																		
3																		
4																		
5																		
Sum																		
Avg. x																		
Range																		

Average $\bar{X}$

Range R

is known. If the baking process could be sped up, the time to start the baking process could be delayed, therefore, allowing more information on demands to be available.

Micro-wave proofing and baking may in the future alter the economy of plant sizes. In areas where population is dispersed, as in Western Kansas, smaller localized bakeries may become more economically feasible. Putting savings on proofing, baking and cooling improvements into perspective, much work has already been accomplished in labor reduction in this area as compared to the selling and distribution functions.

The next process after the cooling is bagging or wrapping of the bread. Bagging of the bread has been almost completely automated and offers little potential for labor cost reduction. The following step, the placement of the bread on the pallet, does warrant further discussion.

2.6 Placement of Bread on the Trays

At the completion of bagging, the bread is manually placed on a wire or plastic tray. The number of loaves placed on one tray depends on the tray size and the physical dimensions of the bread. For a one pound loaf, 8 to 12 loaves are common. After a tray is full, it is placed on a metal rack which holds anywhere from 26 to 56 trays of product.

There are machines designed to group bread on trays and automatically place the trays on the rack. This equipment has not been successful because:

1. The number of different varieties of product produced in a plant requires numerous change overs.

2. Many trays and racks are bent or in disrepair, causing jams in the loading equipment.

Major savings can be gained by close examination of the tray size and better rack design. A possible approach in determining the best tray size might be to quantify the various package sizes (height, width, depth, and whether the packages can be double stacked) and the quantity sold of each product size. A simulation program could then be written that would:

1. Determine the best packing pattern for each product on a given tray size.

2. Calculate the number of trays needed for present (or future) sales.

It is quite possible that the best tray size will not be the best for any single product, but over all, require the least floor space. That is the one size that minimizes the expected required floor space or min. E[total space volume].

It is interesting to note that historically one pound bread has accounted for most bakery sales. Consequently, trays in many operations were designed around the one pound loaf. As consumer preference changed and one and one-half pound loaves became the dominant seller, the continued use of the one-pound loaf trays for the larger loaves resulted in a 10 to 25 percent air space.

The next area of potential savings is in the shipping department they can be achieved by a thorough analysis of product flow, methods and procedures, followed by the establishment of time standards and labor requirements.

CHAPTER 3

3.1 Product Distribution

Physical distribution in the baking industry is complex and, as shown in Table 2, one of the more costly segments of the business. Some of the characteristics that complicate and add cost to the distribution function are:

1. Short product shelf life.
2. Wide geographic area of distribution.
3. Low average sales volume per stop.
4. Marketing techniques such as the acceptance of all product not sold (returns).
5. Fragility of the product.
6. No mechanical pacing of employees making productivity more difficult to attain.
7. High variance in daily and seasonal demand due to consumer buying patterns.
8. Large variety of products being distributed.

As mentioned earlier, if major cost reductions are to take place in the baking industry, they will most probably come in the distribution phase of the operation which fall in between the wrapping machine and the consumer.

For one to study and quantify the problems in physical distribution, it is helpful to break the flow of the products into the following modules.

1. Selection of product for depot demands and transport loading (classically called the "shipping department").
2. Delivery of product from the bakery dock to the dock of the sub-distribution locations.
3. Final selection of the product for a route order (route packers).
4. Route salesman - order determination and final delivery of product to the grocery shelf.
5. Information system - two way flow of information between sales, production, and shipping departments.
6. Maintenance of delivery equipment.

These areas are very dependent upon one another and in many operations, the first three functions are organizationally treated as one. The remainder of this report will detail techniques that can be used in a cost reduction program for the shipping department, product selection by route packers, and the bakery to depot transport operations.

3.2 Establishing a Shipping Room Study

The shipping department is a good example of how industrial engineering methods can be used to improve the operation. For instance:

1. There is very little mechanical pacing of people.
2. There has been very little standardization in the layout of product flow, material handling methods, equipment, or job design.

3. There is little published standard data or time studies in the shipping department of bakeries.
4. There are generally few staff positions established to train or help line people solve problems in the operation of the shipping department. At the corporate staff level, the shipping department is normally under the guidance of production or transportation management.
5. Total cost in the shipping department is large enough to show some significant effects on plant profitability through cost reduction. To emphasize the effect of cost reduction on plant profitability, lets assume that there is an average of 3% profit before tax on sales. An annualized cost reduction of $100,000 is equivalent to the before tax profit associated with a sale of $3,333,333.

Because there is little similarity between bakery operations in product flow, product mix, production or transport schedules, all bakeries must be studied individually. This lack of standardization prevents the establishment of a "general purpose" study in one single plant and a fast, low cost implementation among the remaining plants. It should be noted that all of these studies should not be made with the idea of optimizing the operation of the shipping room. The main emphasis should be to achieve reasonable cost reductions in short amounts of time.

3.3 Picking the Plant to Study

If one is not familiar with the methods used in specific plant operations, it is helpful to analyze the costs of the various plants and quantify the plants that appear to have the greatest opportunity for savings. These costs can be obtained directly from plant operating statements. Some of the methods that are used for identifying high cost plants are:

1. Visual observation of the plant operation and costs.
2. Graph costs versus some form of work performed (possibly packer cost versus pounds produced).
3. Determine the correlation between various accounts (costs or production and sales data) and the packer costs. The correlation coefficient is a measure of mutual relationship between two variables. After the correlations are found, the accounts with the higher correlation can be used in developing a regression model to predict what the expected packer cost should be. The plants with the largest deviation from the "expected" packer cost would be candidates for further study.

In most cases, graphical methods or observations would suffice in giving direction to a particular plant or set of plants to study. The more elaborate method of building a regression model was used because:

1. A computer with library programs was readily available.
2. Once the basic operating data was put into the computer data base, it could easily be used for other studies.

3. A regression model can dramatically show the cost differences between plants.

Information for determining the correlation between the following accounts were taken directly from plant operating statements:

1. Shipping room personnel salaries.
2. Transport drivers salaries.
3. Gross sales in dollars.
4. Gross pounds produced.
5. Sales salaries and commission.
6. Sales supervisory salaries.
7. Garage labor salaries.
8. Gasoline expense.

For one study the G.E. information system with their "supercenter" located in Cleveland was used. Correlation and curvilinear subroutines of the STATSYST* library program were used for the analysis of costs. Table 6 shows the form of the data input for the computer model. Table 7 is the matrix showing the correlation between the accounts. As one can see, gross sales proved to have the highest correlation with the packer costs (.9666). On most operating statements, the packer cost is compared as a percentage of net sales (gross sales minus returns). This comparison can lead to false conclusions because the shipping department must sort, select, and ship the gross amount of sales. The shipping costs may,

---

*STATSYST PUB. #5707.01A G.E. Information Systems, Bethesda, Md.

TABLE 6

DATA INPUT FOR CORRELATION DETERMINATION

```
DATA        14:430DT    08/15/73

 1 AMAR,ANDE,CHAR,CINC,DETR,DULU,FAYE,FLIN,FLOR,HOUS,JACK,KANS,KNOX,LOUI
 3 MIAN,NEWA,NYCY,BROO,ORLA,ROCK,STLO,STPA,TOLE,WINS,BARB,CLEV,BELL,PORT
 5 JOSE,SEAT
 7 18465,61978,226789,96427,102724,20275,27991,37126,54859,39743,70139
 9 87511,33160,48645,100152,43246,53855,76410,116890,71086,121998,148164,29814
11 53241,153275,51705,234570,21095,220406,129110
13 9462,45677,137347,78571,50509,12697,16476,*,53767,9999,34584,69768
15 20326,17386,34611,41895,10293,46978,80998,70250,51204,60297,7811,55389
17 71536,43000,112306,5588,332640,84134
19 903393,3572133,8910834,7077410,7047445,1498765,1706210,2448454,4535167
21 2574423,3204612,4988786,1796474,2520462,3850495,4005545,3625719,6302631
23 6810703,4292177,6966129,6182898,2179664,4193347,5523048,2740498
25 8541985,1856282,12579973,6434222
27 4122667,12916644,42118239,23662235,87842,23684231,4095381,5459134
29 16817057,12256922,10542539,16077540,5841356,10750866,12979093,13205484
31 13264611,19458993,26294410,16571008,25134123,23321812,7016204,14852547
33 22887291,5783441,27223944,4210542,48200383,22189531
35 72700,342234,679008,584977,957154,183930,170579,297538,532971,259457
37 360342,445128,201282,288342,421540,530096,504045,963399,646584,487989,772984
39 722520,29422,472590,785404,251197,1213573,248562,1781527,801489
41 13294,78835,126947,127491,224771,17166,21393,46768,96498,50452,68828,88758
43 40178,76727,95288,101553,146413,124553,98446,137218,121371
45 52140,118767,136080,59658,194135,29038,323041,143123
47 7220,12835,26110,14322,12972,2790,1048,8587,13276,16538,14446,17261,3754
49 3277,18223,18598,10029,21918,34854,15277,16045,21272,4567,19081,17212
51 7417,32739,914,46558,10387
53 10145,28894,70122,70927,94024,13151,16645,23705,42256,22324,37025
55 49219,19992,18338,34238,51361,42247,83457,58390,47628,73654,51914
57 28108,50384,81255,36714,111016,19519,164963,47579
59 11169,42259,84335,47988,42315,12618,9885,13317,51212,14416,36753
61 46876,18943,19785,28727,22177,14056,23230,52152,65730,39498,49272
63 18097,57060,32993,23822,59544,7879,131844,59439
```

TABLE 7

CORRELATION MATRIX FOR VARIOUS ACCOUNT VALUES

	TRAN	GSAL	GPOU	SALC	SUPV	GLAB	GASS	PAK
(TRAN)	1.00	0.90	0.89	0.90	0.90	0.91	0.94	0.88
(GSAL)	0.90	1.00	0.94	0.98	0.98	0.97	0.95	0.96
(GPOU)	0.89	0.94	1.00	0.91	0.89	0.90	0.93	0.93
(SALC)	0.90	0.98	0.91	1.00	0.99	0.99	0.93	0.94
(SUPV)	0.90	0.98	0.89	0.99	1.00	0.98	0.94	0.93
(GLAB)	0.91	0.97	0.90	0.99	0.98	1.00	0.92	0.93
(GASS)	0.94	0.95	0.93	0.93	0.94	0.92	1.00	0.92
(PAK)	0.88	0.96	0.93	0.94	0.93	0.93	0.92	1.00

TRAN = Transport Driver Expense

GSAL = Dollar Amount of Gross Sales

GPOU = Gross Pounds Produced

SALC = Salesmans Salaries and Commission

SUPV = Salesmans Supervisors Salaries

GLAB = Garage (Truck Maintenance Labor) Salaries

GASS = Gasoline Expense

PAK = Shipping Department Expense

in fact be reasonable, but may show up excessively high on the operating statement if the return sales are high. From the high correlation, plus the intuitive reasonableness, it appears sound to use actual gross sales to predict expected packer costs.

The "curvilinear-fit" subroutine can be used for building the predictive model. Table 8 is a listing of the output of a curvilinear-fit. In this case exponential curve had the best fit (as indicated by the highest index value). The predictive model is expected packer cost = .00420229 x (gross sales)↑1.09234.

Note that because the exponent is close to one, the curve is almost a straight line, but the slope of the curve increases slightly as the gross sales increases. Table 9 is a listing of the amount of "expected savings" (actual packer cost - expected packer cost) by plant and the percentage of deviation from the expected.

It should be remembered that this type of analysis does not give the actual savings that might be realized from a shipping study, or which plant will have the most excessive costs. The main thrust of this study would be to indicate the plants with the greatest potential for savings.

As one can see from Table 9 , plant #3,27, and 25 show the highest difference between expected labor cost and actual labor cost. From this analysis, plants #27 and #25 would be selected because of their high cost and close proximity to each other and thus would be studied for potential cost reduction. Plants showing significant lower than

TABLE 8

OUTPUT OF CURVILINEAR FIT

Y VARIABLE: Packer Cost
X VARIABLE: Gross Sales
XMEAN: 4.628996E+06 YMEAN: 8.502830E+04

NUMBER	CURVE	INDEX	A	B
1	Y=A+B*X	0.81142	-1.10010E+04	2.07452E-02
2	Y=A*EXP(B*X)	0.80837	2.17135E+04	2.42777E-07
3	Y=A*(X↑B)	0.87279	4.20229E-03	1.09234E+00
4	Y=A+(B/X)	0.45430	1.43824E+05	-1.90038E+11
5	Y=1/(A+B*X)	0.62184	3.77576E-05	-4.04465E-12
6	Y=X/(A*X+B)	0.85978	1.02071E-06	5.82251E+01

FOR WHICH CURVE ARE DETAILS DESIRED (NUMBER OR DONE) ?3

COEFFICIENTS:

	EXPECTED VALUE	95 PCT CONFIDENCE LIMITS	
A:	4.20229E-03	3.59490E-04	4.91231E-02
B:	1.09234E-00	9.30497E-01	1.25418E+00

TYPE 1 FOR CONFIDENCE LIMITS ON ESTIMATED Y,
OR 2 FOR PREDICTION LIMITS ON OBSERVATIONS OF Y.
WHICH ?1

PLANT	X-ACTUAL	Y-ACTUAL	Y-ESTIM	95 PCT CONFIDENCE LIMITS	
1	9.03E+05	1.84E+04	1.34687E+04	1.04208E+04	1.74080E+04
2	3.57E+06	6.19E+04	6.04654E+04	5.47800E+04	6.67407E+04
3	8.91E+06	2.26E+05	1.64118E+05	1.39136E+05	1.93584E+05
4	7.07E+06	9.64E+04	1.27607E+05	1.11286E+05	1.46321E+05
5	7.04E+06	1.02E+05	1.27017E+05	1.10825$+05	1.45574E+05
6	1.49E+06	2.02E+04	2.34144E+04	1.94896E+04	2.81295E+04
7	1.70E+06	2.79E+04	2.69762E+04	2.28482E+04	3.18499E+04
8	2.44E+06	3.71E+04	4.00243E+04	3.53686E+04	4.52930E+04
9	4.53E+06	5.48E+04	7.84774E+04	7.09732E+04	9.67751E+04
10	2.57E+06	3.97E+04	4.22789E+04	3.75410E+04	4.76148E+04
11	3.20E+06	7.01E+04	5.37032E+04	4.84544E+04	5.95207E+04
12	4.98E+06	8.75E+04	8.70902E+04	7.83903E+04	9.67556E.04
13	1.79E+06	3.31E+04	2.85388E+04	2.43336E+04	3.34708E+04
14	2.52E+06	4.86E+04	4.13118E+04	3.66095E+04	4.66182E+04
15	3.85E+06	1.00E+05	6.56304E+04	5.95234E+04	7.23639E+04
16	4.00E+06	4.32E+04	6.85225E+04	6.21440E+04	7.55556E+04
17	3.62E+06	5.38E+04	6.14568E+04	5.56968E+04	6.78126E+04
18	6.30E+06	7.64E+04	1.12427E+05	9.92739E+04	1.27323E+05
19	6.81E+06	1.16E+05	1.22363E+05	1.07171E+05	1.39709E+05

TABLE 8 (continued)

PLANT	X-ACTUAL	Y-ACTUAL	Y-ESTIM	95 PCT CONFIDENCE LIMITS	
20	4.29E+06	7.10E+04	7.38960E+04	6.69460E+04	8.15675E+04
21	6.96E+06	1.21E+05	1.25417E+05	1.09571E+05	1.43553F+05
22	0.18E+06	1.48E+05	1.10096E+05	9.74006E+04	1.24447E+05
23	2.17E+06	2.98E+04	3.52499E+04	3.07668E+04	4.03864E+04
24	4.19E+06	5.32E+04	7.20393E+04	6.52966E+04	7.94784E+04
25	5.52E+06	1.53E+05	9.73270E+04	9.69769E+04	1.08909E+05
26	2.74E+06	5.17E+04	4.52669E+04	4.04144E+04	5.07020E+04
27	8.54E+06	2.34E+05	1.56711E+05	1.33586E+05	1.83840E+05
28	1.85E+06	2.10E+04	2.95782E+04	2.53249E+04	3.45460E+04
29	1.25E+07	2.20E+05	2.39191E+05	1.93359E+05	2.95887E+05
30	6.43E+06	1.29E+05	1.14994E+05	1.01327E+05	1.30504E+05

TABLE 9

ANALYSIS OF EXPECTED COSTS BY PLANTS

Note: All Figures Reflect the 6th Period-Year to Date.

Plant #	Actual Gross Sales	Actual Packer Cost	Estimated Packer Cost	Positive Deviation (Actual-Expected)	% Deviation (Deviation/Expected)
1	903,393	18,465.4	13,468	4997	37.1
2	3,572,130	61,978	60,465	1513	2.5
3	8,910,630	226,789	164,118	62671	38.2
4	7,077,410	96,427	12,760		
5	7,047,450	102,724	127,017		
6	1,498,770	20,275	23,414		
7	1,706,210	27,991	26,976	1015	3.8
8	2,448,450	37,126	40,024		
9	4,535,170	54,859	78,497		
10	2,574,420	39,743	42,278		
11	3,204,610	70,139	53,703	16436	30.6
12	4,988,790	87,511	87,090	421	.5
13	1,796,470	33,160	28,538	4622	16.2
14	2,520,460	48,645	41,311	7334	17.8
15	3,850,500	100,152	65,630	34522	52,6
16	4,005,550	43,246	68,522		
17	3,625,720	53,855	61,456		
18	6,302,630	76,410	112,427		
19	6,810,700	116,890	122,363		
20	4,292,180	71,086	73,896		
21	6,966,130	121,998	125,417		
22	6,182,900	148,164	110,096	38068	34.5
23	2,179,660	29,814	35,249		
24	4,193,350	53,241	72,039		
25	5,523,050	153,275	97,327	55948	57.5
26	2,740,500	51,705	45,266	6439	14.2
27	8,541,990	234,570	156,711	77856	49.7
28	1,856,280	21,095	29,578		
29	12,580,000	220,406	239,191		
30	6,434,220	129,110	114,994	14116	12.3
			TOTAL DEVIATION	$325,954	

expected costs may also warrent study to examine the methods used. They may have ideas that could be used in the higher cost plants.

3.4 The Shipping Room Study

Before starting a plant cost reduction study, it is best to have a well thought out plan to follow. The format that is suggested can be broken into the following major parts:

1. Management orientation.
2. Background data gathering.
3. Observation of product flow and job function definitions.
4. Method analysis and the establishment of time standards.
5. Discussion and agreement on method recommendations and labor standards.
6. Training the employees on new methods.
7. Establishing a tracking system.

3.4.1 Management Orientation

Common concerns that plant management have are:

1. Why is our plant being studied?
2. How can people, unfamiliar with our operation, tell us how to improve it?
3. These people will make recommendations that assume ideal operations, and will not consider the unexpected problems that seem to occur on a daily basis.

4. This study will point out our weak areas and these will be directly reported to the corporate headquarters.

All of these fears are natural and have occurred in every plant this author has entered. The main objective of an orientation meeting is to outline the purposed basic methods to be used in the study, enlist the support of the people in the concerned areas, and in general to help diminish the natural resistance to an outside study. One of the most important points to stress in the first meeting is why their plant was picked for a cost reduction study. This point was made vividly clear at one plant where a vague comment was made about shipping costs being high in comparison to other plants of similar size. After continuing an informal discussion about study objectives and methods, the department head asked, "how do you know my costs are high?" It was then apparent that the operating people had no information on similar costs in other plants or standards on which their performance could be measured. The only guidelines for measure of performance were historical costs within the isolated operation. This type of measurement can give indication as to increase or decrease in productivity, but it does not compare costs to what they could or should be. After this experience, a point was made to rank the plants based on a measure of productivity (as done in identifying which plant to study), then exposing these costs to all the plant managers. Until this is done, a manager or department head can think that his operation is one of the most efficient, when in fact it may be ripe for achieved major savings.

Another fact stressed was that this type of study would benefit the local operating people. While industrial engineering staff is measured on contributions to improvements in profitability, the line management is partially measured (or should be) by their ability to meet productivity standards. The only way for a company (or union for that matter) to guarantee a job is to produce a product with demand with the least total cost in that particular industry. This point has been made very clear in plants that have been recently closed due to high labor cost with relatively low productivity.

During this orientation, one should try to have the supervisors and operating people discuss their problems and talk about possible alternatives. Some leading questions that are helpful in drawing people to surface their problems are:

1. Are there many times when you are forced into paying overtime because production is late?
2. Do you feel there are enough racks and pallets to keep from running empty trucks out to depots to pick up equipment?
3. What is the product "add and cut" policy for the sales department? Is it realistic? Is it adheared to? Does this cause excessive double handling of product?
4. Are the transport trucks on schedule most of the time?

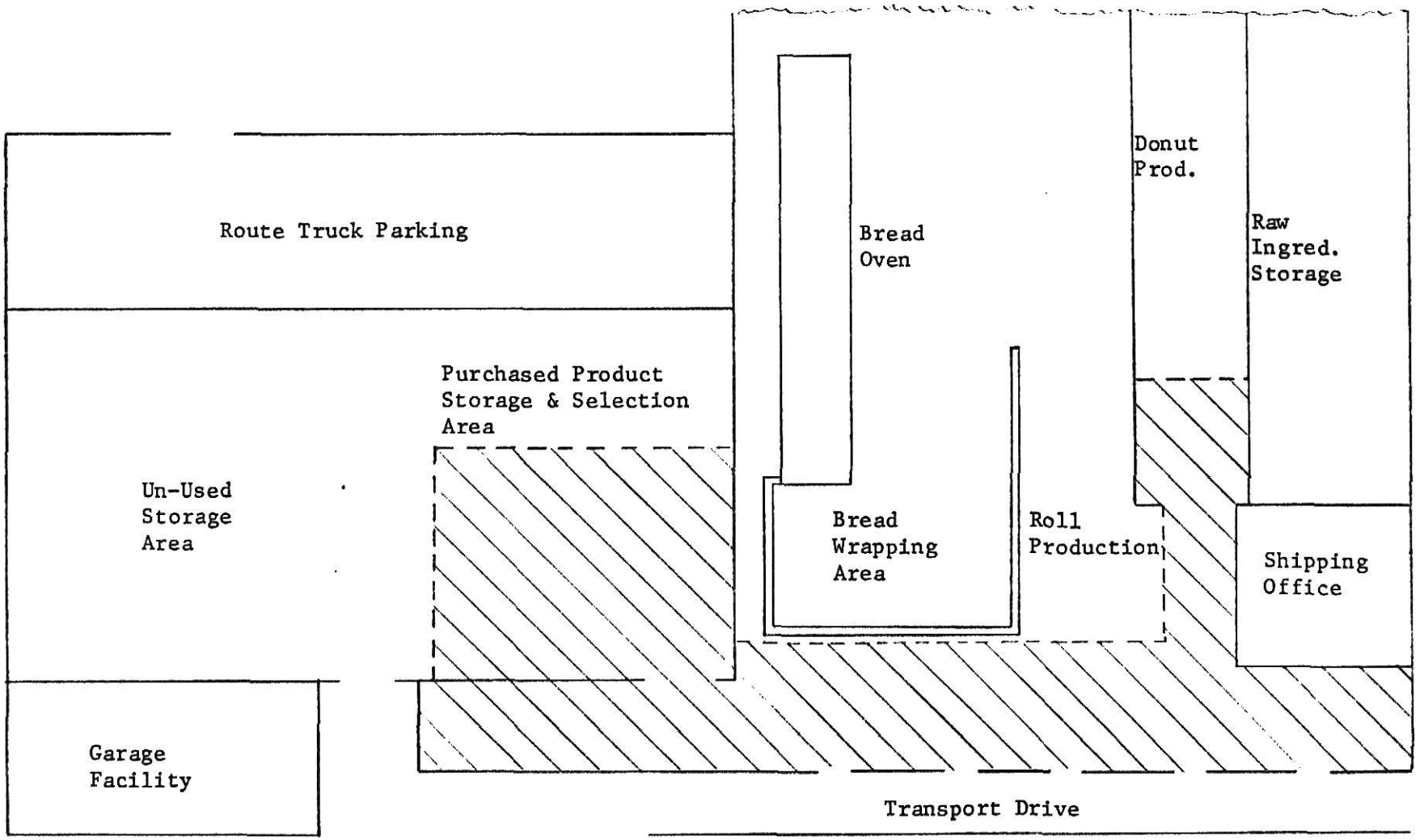
These types of questions highlight very common problems in the shipping department. They have worked well in getting the management to openly discuss their "frustrations" about their job.

3.4.2 Background Data Gathering

Other information that is needed for the study. This includes:

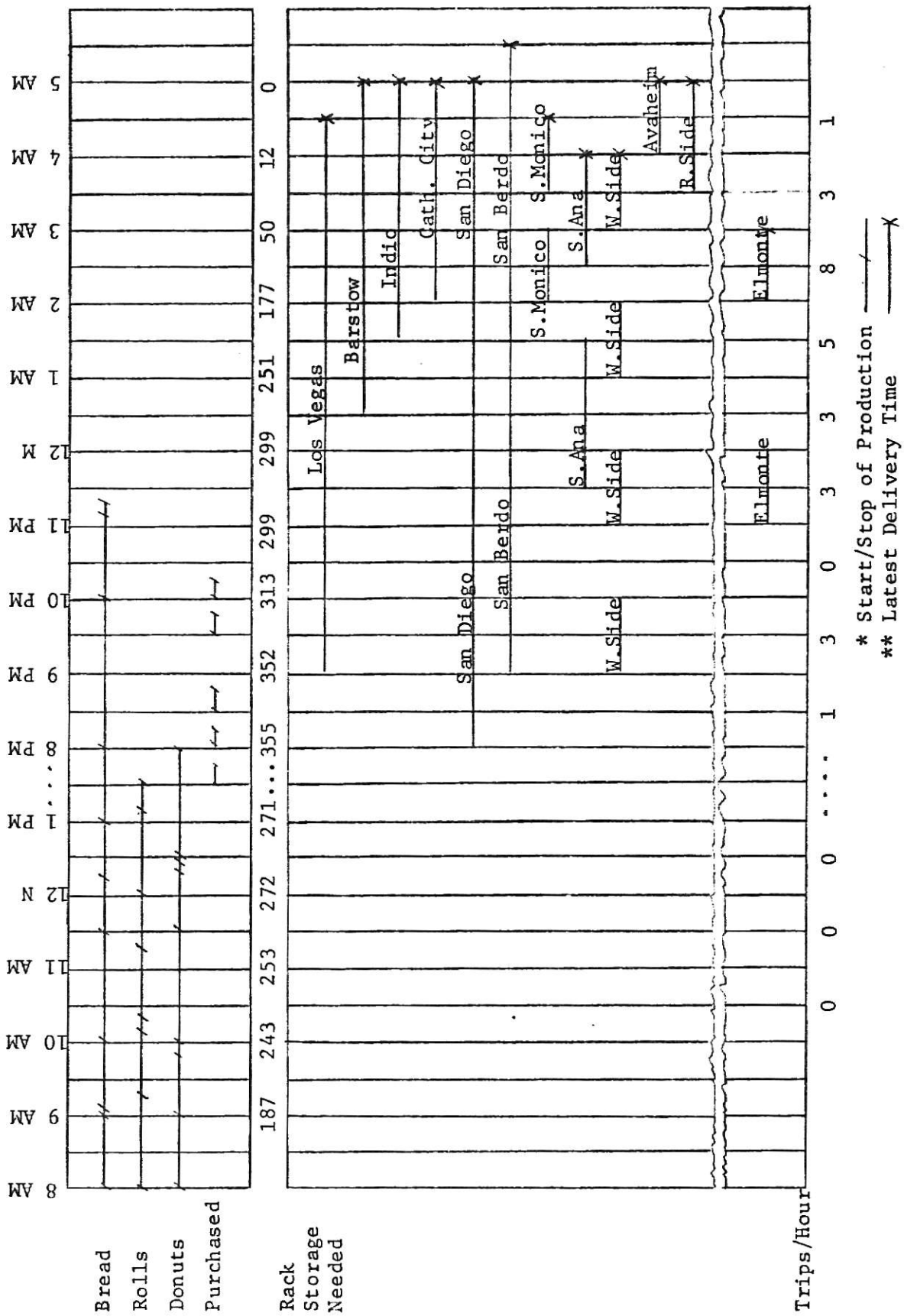
1. A blue print of the bakery shipping department. This will be used for studying product flow. (Figure 6)
2. Payroll records for the shipping department. It is helpful to inspect payroll records for trends of hours worked, percent of overtime, and amount of absenteeism.
3. Job description of each person on the payroll. Most bakeries have not clearly defined the job descriptions for their employees. Asking the shipping superintendent for a list of his employees and their respective job descriptions forces him to quantify what each of his people do. This information will also aid the industrial engineer in determining how the department is structured and the level of knowledge the superintendent has about his own department. (To my surprise, I have found superintendents that could not identify what their employees jobs were).
4. Gantt charting techniques are very helpful in identifying problem areas caused by poor synchronization between the shipping department and production. Figure 7 is a Gantt chart of production and shipping activities of the plant that was studied. The following information can be pictorially displayed:
    (a). Time restrictions (latest acceptable) for depot delivery.

FIGURE 6. LAYOUT OF BAKERY SHOWING SHIPPING AREA.



Shaded Area - Selection and Storage Area for Shipping

FIGURE 7
GANTT CHART OF PRODUCTION AND TRANSPORTATION SCHEDULES



(b). Time standards for transport runs (to be discussed later).

(c). Time restrictions (latest acceptable) for transport loading.

(d). Times of product availability, irrespective of where produced.

(e). Material handling (rack and pallet) requirements by hour of the day.

(f). A graphical display of dock and transport utilization.

(g). Display times where production is possibly "out of sycronization" with shipping, or there is surging of labor requirements due to tight time restrictions. Some of these constraints are caused by trying to force more trucks through a conjested dock in a unrealistically short time span, or short time intervals between where the product is available and when it has to be shipped.

One can then inspect the Gantt chart (eg. Figure 7) for possible problem areas. More obvious observations would include:

1. There appears to be a high number of trucks scheduled to leave the bakery in a short time interval (six are scheduled to depart at 2:00 A.M.). This may be causing a surging of labor and dock requirements prior to 2:00 A.M.

2. Short run products are baked (or received from suppliers) late in the daily schedule. This forces all trucks needing that product to wait, possibly the reason behind observation #1.
3. The transport trucks are under-utilized earlier in the day. Only two trucks are on the road before 7:00 P.M.
4. With present production and transport schedules, room is needed for approximately 375 racks. This room must be either in the bakery or in the transport trailers.

There are many other observations and references that can be made from the Gantt chart. Without further delay, two recommendations should be made to the plant management:

1. Re-align production schedules so that long run items are at the end of the production day. This is especially helpful when most of the depots require only one truck per day for their demand.
2. Production schedules should be indexed forward to increase the time available to select product and load transports. Until time standards are established, it may be assumed that a two to three hour lead time is needed between when product is to be loaded on a transport and when it was produced.
3. Pressure should be put on suppliers to deliver their product earlier in the day. From the Gantt chart, it appears that a few minor suppliers are dictating entire fleet scheduling.

After these basic modifications are made, time pressures should be relieved, and physical product flow and job design could then be studied.

3.4.3 Observation of Product Flow and Job Function Definition

After obtaining the basic information about production flow quantities, the number of people on the payroll, and the scheduling of production and transportation, the job functions should be broken into manageable segments for further study. Product flow for one plant studied, as graphically displayed on the Gantt chart comes from four lines:

1. Bread line
2. Roll line
3. Donut line
4. Incoming or purchased products.

These lines are independent until the product is staged for a depot location. At the time of staging, product lines merge and the methods or flows become more a function of product destination.

To illustrate this point, in one plant studied bread was selected directly off a monorail system as per depot orders, while incoming purchased product were selected off the rack supplied by the producer. After bread and purchased products were selected and moved (on racks) to the depot staging area, the methods used and the product flow was a function of the depot location (ie. if the product is for in plant routes, the product does not flow through the transport loading process).

Shipping department jobs can normally be fragmented into the following areas for a more detailed methods analysis and time study:

1. Product selection (for depot orders).
    (a). Purchased product
    (b). Bread
    (c). Roll and donut
2. Transport loading.
3. Route order selection.
4. Pallet removal from racks.

Table 10 is a man power count that was assigned to the above job functions in one plant studied.

3.4.4 Methods Analysis and the Establishment of Time Standards

In developing time standards to be used in measuring the productivity of labor, there is a definite sequence of events that should be followed. These are:

1. Segment each job into well defined operations.
2. Study each operation trying to:
    (a). Eliminate all unnecessary work.
    (b). Combining operations.
    (c). Changing the sequence of operations.
    (d). Simplifying all operations.
3. Establish time standards for each operation after the methods are standardized. Time standards can be determined either by a direct time study or by predetermined time standards.

TABLE 10

PRESENT LABOR ASSIGNED TO BASIC JOB FUNCTIONS

JOB		NUMBER OF PEOPLE ASSIGNED
1.	Purchased Product Selectors	3
2.	Roll and Donut Selection	3
3.	Bread Selection	6
4.	Transport Loaders	8
5.	Route Order Selection	4
6.	Working Foremen	5
7.	Pallet Unloaders	3
8.	Order Clerk and Production Reconciliation	1
9.	Shipping Superintendent	1
	Total	34

4. Make allowances for non-scheduled delays and fatigue.

An important point to remember is that time standards must come after methods analysis. If this is not the sequence used, the analyst may establish standards on a job that can be easily improved by the worker and put his rate out of line. If methods analysis and time standards are new to a bakery, large amounts of detail may not be necessary to accrue substantial labor cost reductions. The following sections describe the analysis of methods and the establishment of time for the major jobs performed in the shipping department. The examples and data presented was collected and evaluated at one particular plant, but many of the methods used and standards established could be readily adopted in other plants.

Purchased Product Selection. Purchased product selection is similar to order picking or the breaking down of larger quantities to many smaller quantities. Figure 8 and 9 is a operation chart and layout of the job as it was being performed before the study. There were approximately 3 men x 35 hours per week, or 105 man-hours per week associated with performing this function. Racks of incoming product were accumulated until approximately 2:00 P.M. when one man would start setting up the selected product area. The second man started at 4:00 P.M. and the third at 4:30 P.M. The main part of the purchased product selection job is inspecting orders, breaking the bulk product into individual depot orders (27 depots), and marking (check mark) the depot order to signify that particular demand for the items to show that it has been filled.

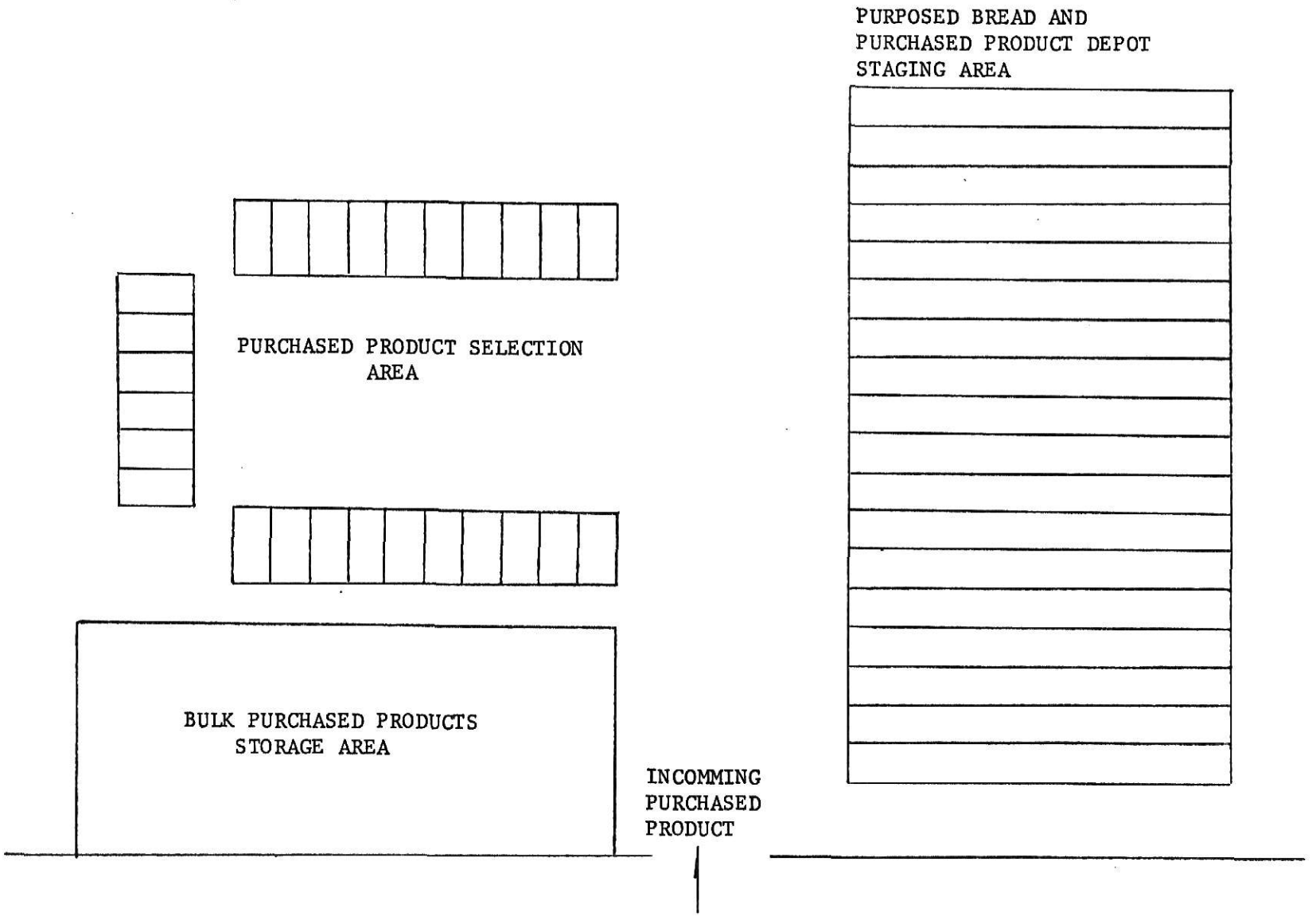
FIGURE 8

OPERATIONS CHART FOR PURCHASED PRODUCT SELECTION

Time in Mins.	Chart Symbols	Operation Description
	⇒	Obtain Depot Orders for Purchased Product
20	0	Allign Empty Racks in Order Selection Area
	0	Hook Depot Order on Respective Empty Depot Rack
	⇒	Get a Rack of Bulk Purchased Product, Move to Order Selection Area.
	Δ	Inspect "First" Depot Order
	0	Remove Quantity of "Bulk" Product as Per Depot Order, Place on Depot Rack
Variable	⇒	Move "Bulk" Rack to "Second" Depot Rack
	Δ	Inspect "Second" Depot Order
		. . .
		When Bulk Rack is Unloaded, Move Empty Rack to the Side of Selection Area. When a "Depot" Rack is Full, the Full Rack was Moved into a General Area That Stored Completed Orders (Very Unorganized).

FIGURE 9

LAYOUT OF PURCHASED PRODUCT SELECTION



As this job was presently being performed, little opportunity for methods changes was found. The only methods change made was to have the selectors, when completing a depot rack, move that rack to a designated depot staging area (previously the racks were tagged and rolled into a general product storage area). This change did not affect the time requirements for the selectors, but did drastically affect the transport loader times (as described later). The next step is to make a time study of the job. Because over 95% of the time is spent in actual order selection, this need be the only function studied with any accuracy. A fixed amount of time (20 minutes) was alloted for getting the depot orders and preparing the work center.

By observing the process of order selection, it is obvious that the time to unload a rack of bulk product is a function of the average order per depot for that product. For instance, if the average order per depot is only 2 pallets, and a rack had 56 pallets, 18 depot orders would have to be inspected, filled, and checked before the bulk rack was emptied. Conversely, if the average demand for each depot was 28 - 30 pallets, an average of only two orders would have to be inspected and only one-half of the rack emptied (because the other half would be used for the second depot and filled with other product). With this variability in unloading time from rack to rack, the products can be segmented into three groups:

1. High volume demand (3 or more racks total order).
2. Medium volume demand (between 1 and 3 racks demand).
3. Low volume demand (one rack or less).

Time standards can then made for the three product groups. Since this study was rather low-key, no attempt was made to determine the number of observations necessary to be within 95% confidence limits*, but the breakdown of the products into three categories tended to reduce the time variability of the job.

Approximately 25 observations were made for each group. The following times were accepted by the local people as fair standards (before fatigue and delay allowances):

No. of Racks, X	Time Standard (minutes)
$X \geq 3$	6.50
$1 < X < 3$	8.25
$X \leq 1$	10.75

To determine these times, an observation should start when a man grabs the "first" rack, unloads it, moved it to its storage area, and returns to grab the "second" rack (a complete cycle). After the establishment of time standards, the bakery product demand sheet can be inspected to determine the volume of product for each of the three groupings.

In determining the expected time needed to select the purchased product before allowances, the number of racks for each product volume category should be multiplied by its time standard. Time allowances should then be added to allow for fatigue and any double handling of racks or product. An example of calculating expected time standard calculations would be:

---

*For determining the number of observations necessary see page 359, Motion and Time Study, by Ralph M. Barnes.

Rack Volume	Number of Racks per Category		Time Per Rack (minutes)		Total Expected Time (minutes)
$X \geq 3$	30	X	6.50	=	195
$1 \leq X \leq 3$	32	X	8.25	=	264
$X \leq 1$	23	X	10.75	=	248
Total Variable Time				=	707 Minutes
Total Fixed Time				=	20 Minutes
Normal Time Before Allowances				=	727 Minutes
Allowances for double handling and fatigue @ 15% of variable time				=	106 Minutes
Total standard time to select purchased product				=	833 Minutes

The work day of the plant being studied (by union contract) consisted of 7 hours minus 30 minutes of break time or 6.5 hours per day per man.

6.5 man hours X 60 minutes per hour = 390 man--minutes

$$\frac{\text{Required man-minutes} = 833}{\text{Available per man} = 390} = 2.14 \text{ men or 2 men plus one hour overtime.}$$

The above calculations were based on a heavy sales demand day (Friday or Saturday). A point to remember is that the volume fluctuates from one day to the next. The above study showed that it was possible to reduce the labor cost by one man with the implimentation of time standards. In this case, there was in excess of $12,000 annualized savings. ($5.45/hrs. x 35 hrs./wk. x 52 wks. x 1.23% fringes = $12,200).

Bread Selection. Bread products normally enter the shipping room pre-palletized, with the pallets on a moving conveyor or in the case of the plant studied an overhead monorail. Two bread selectors would

inspect the depot order for the product currently on the conveyor and then remove the quantity of pallets from the monorail as per the depot demand recap. Figure 10 and 11 are operations and flow charts of bread selecting in the studied plant. There was little opportunity found by the changing of methods or the work content of the job, so setting time standards was the next phase of the analysis.

The timing of the major part of the job (the removal of bread on pallets from the monorail conveyor and the placement on depot racks as per orders) took an average of 3.3 seconds for one cycle (over 100 observations were made). An analysis was then made by examining the flow rates of the pallets from production (units produced/minute divided by the units per pallet = pallets per minute). The top speed item was 1 1/2 pound round top bread at 120 units per minute and 8 loaves per pallet (effective pallet flow of 15 pallets per minute). With a maximum pallet flow of 15 per minute, the top speed a man had to work was one pallet every 4 seconds. From this data it was concluded that only one man was needed work in the selection of bread per shift. Since there were three shifts, or a total of six selectors there was a net reduction of three bread selectors.

Roll and Donut Selectors. Roll and donut products are normally selected by methods similar to those used in selecting purchased products. In the study plant the only methods change was to have the roll and donut selectors move the racks to predetermined depot staging areas. Similar to the purchased product selectors, this change would not materially

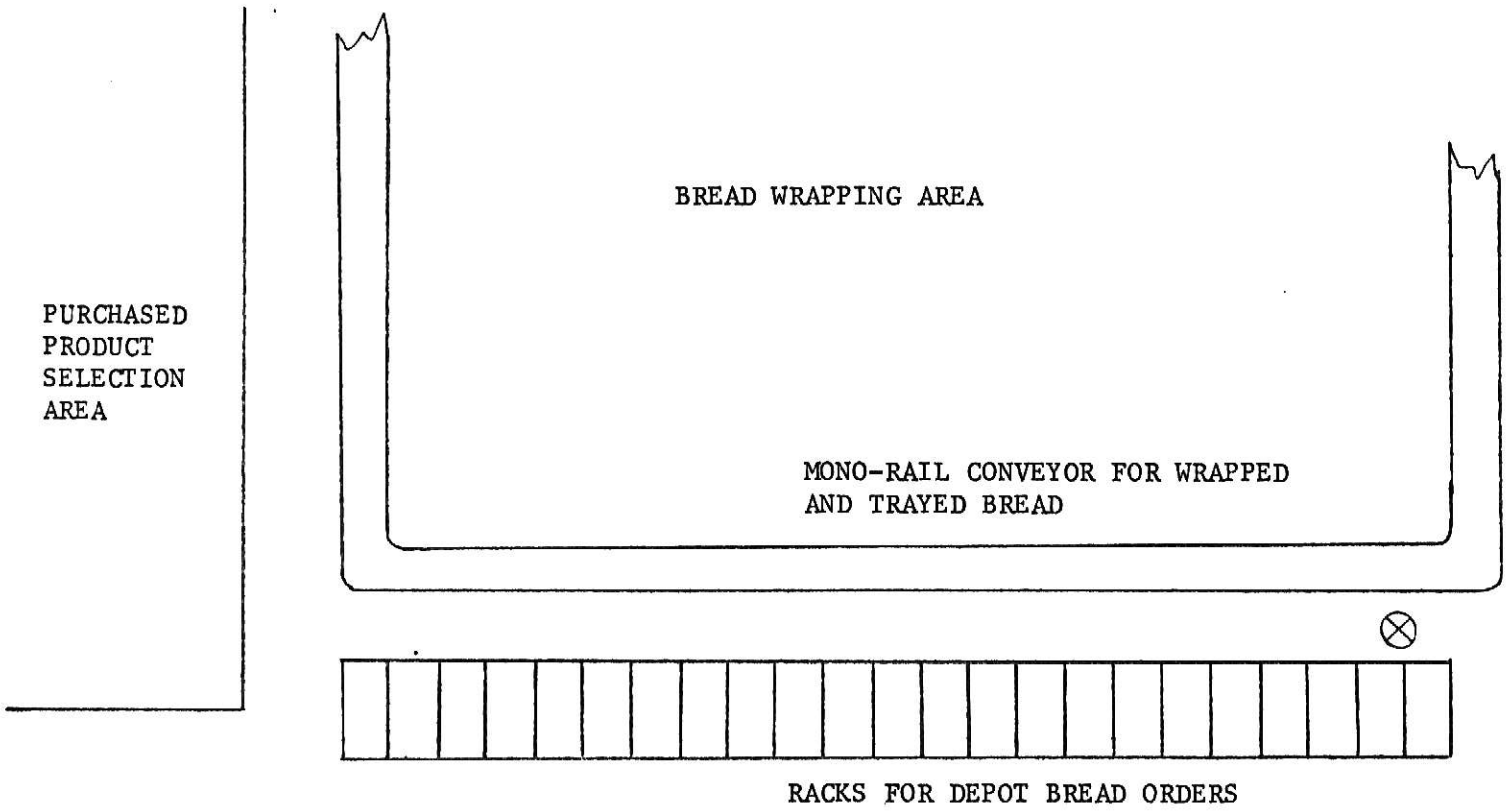
FIGURE 10

OPERATIONS CHART OF BREAD SELECTION

Time in Mins.	Chart Symbols	Operations Description
	Δ	Inspect Depot Order
3.3 Sec.	0	Turn to Face Monorail
	0	Grasp Pallet of Bread
	0	Turn to Face Empty Rack
	0	Unload Pallet on Rack
		.
		.
		.
		If Depot Order is Satisfied, Move to the Next Depot's Order and Repeat Process.
		If a Depot Rack is Full, Remove Depot Order, Tag Rack and Push Full Rack into Aisle. (A Transport Loader will Take to Staging Area and Furnish Empty Replacement.)

FIGURE 11

LAYOUT OF BREAD SELECTION



alter the work content of the job, but would reduce the time spent by transport loaders. After product flow changes are made, several observations should be taken of times to unload a rack of product. From observations taken it appeared that time standards developed for selection of purchased product were adequate as standards for roll and donut selection:

Racks/Variety Order	Time Standard
(3 or more racks)	6.5 min./rack
(between 1 and 3 racks)	8.25 min./rack
(1 rack or less)	10.75 min./rack

Number of racks in each volume category were as follows:

	Donuts	Rolls	Total
$X \geq 3$	11	31	42
$3 < X > 1$	10	36	46
$X \leq 1$	8	19	27
	29	86	115

An example of expected man-hour calculations for roll and donut selection would be:

High volume = 42 racks x 6.5 min./rack =	273 min.
Medium volume = 46 racks x 8.25 min./rack =	379.5 min.
Low volume = 27 racks x 10.75 min./rack =	290.25 min.
Total variable time for roll and donut selection =	942.75 min.
Fixed time for setting up work center =	20.00 min.

Allowances for misc. product searching and fatigue
= 15% of variable time = .5 min./rack 142 min.

Total expected time for roll and donut selection = 1104.75 min.

$$\frac{\text{Required man-minutes} = 1104.75 \text{ man-minutes.}}{\text{Available time per man} = 390 \text{ minutes.}} = 2.83 \text{ men}$$

Formerly there were three men or approximately 1170 man-minutes per day spent in performing this job function. From the time standards, there is an approximate savings of 160 minutes per day. The actual achievement of these savings or any other savings will be difficult to attain unless the methods of work assignments used by the first line management (foremen) are reviewed. Barring sudden surge of business or a rush of people quitting, the only way to guarantee the savings is to reduce the number of people on the payroll, and to utilize to the fullest extent (as per time standards) the manpower remaining on the payroll. One practical method that can be used to help increase the utilization of remaining manpower is short interval scheduling. This technique will be discussed later in this chapter.

Transport Loading. Transport loading in many bakeries is the most labor intensive job function in the shipping department. Eight men with the part time assistance of four working foreman were being used to load pre-selected products onto and empty racks and pallets off of transport trailers in the plant being studied. The following observations, while made at the specific plant, have a commonality with most bakeries in the United States.

1. Double and triple handling of the transport trucks. This was necessary with the present flow of product caused by conjested conditions in the shipping area. Figure 12 is a layout of the shipping department showing the staging areas and their capacities. Total area for produced products (excluding purchased products) allowed for only 79 racks, but approximately 400 racks were produced. This inbalance, and the fact that most of the depots required only one transport (or less) for their entire load, caused the prevalent double handling of product and transports. Observations were made of a loader:

   (a). Moving a trailer out of one of the two loading pits.

   (b). Moving the required truck into the loading pit.

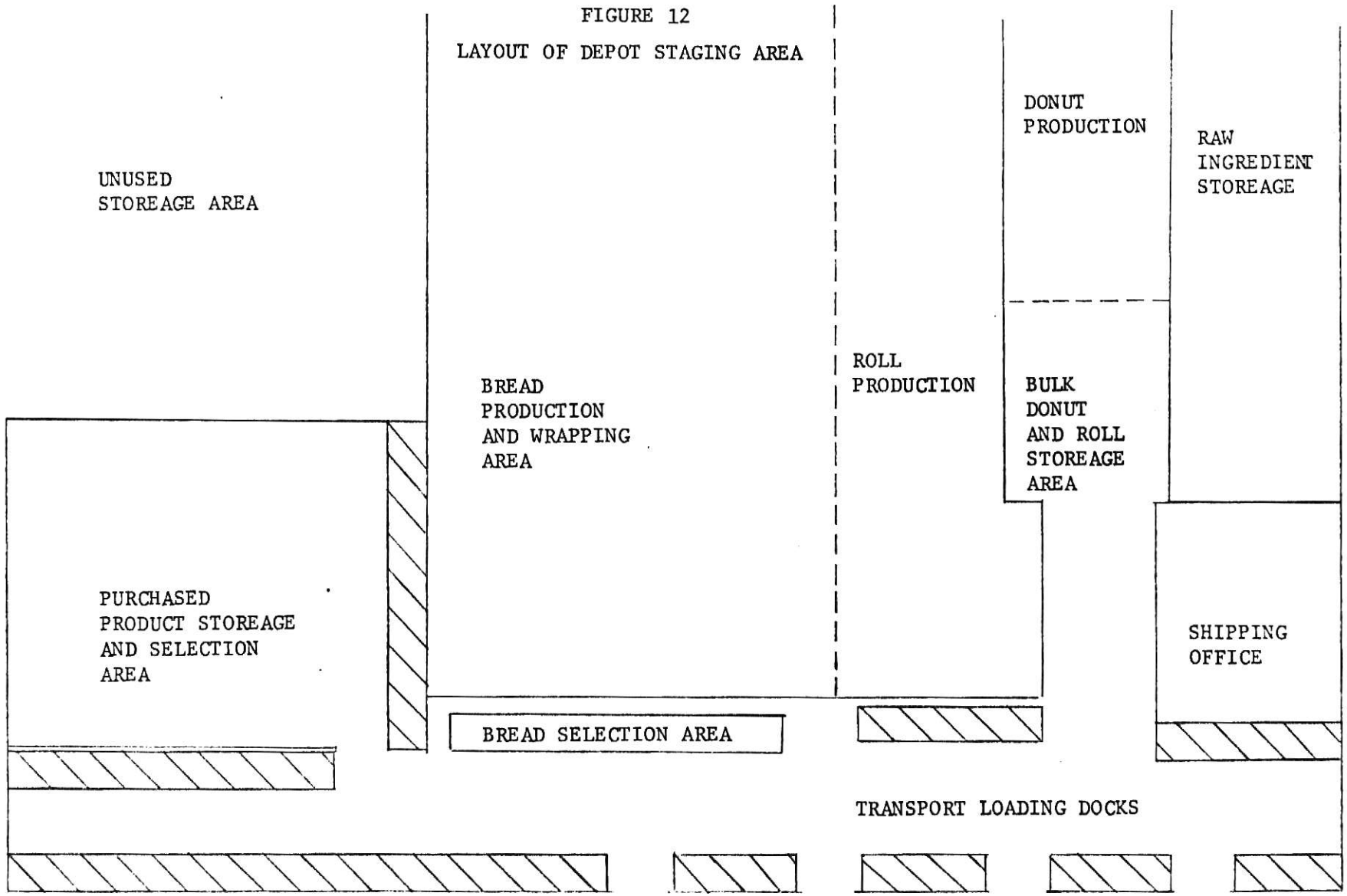
   The average time for this operation was approximately fifteen minutes. If every truck had to be moved three times for a complete load (this is a conservative estimate), the time spent per load for truck movement would be 45 minutes.

2. Delays were encountered in searching for racks of selected product. Before product selection method changes were made (specifying pre-determined locations for the staging of depot orders), the truck loaders would have to inspect each rack to determine if it was the one to be moved onto the transport being loaded.

3. The truck loaders had no specific job assignment other than to "load the trucks". This lack of control of labor made the amount of work being performed by each truck loader questionable.

FIGURE 12

LAYOUT OF DEPOT STAGING AREA



SHADED AREAS ARE PRESENT DEPOT STAGING AREAS
CAPACITY - APPROXIMATELY 79 RACKS

With the foregoing problems, it become apparent that a major revision of the methods used and product flow was necessary. Major time consuming functions of the job can be broken into three areas:

1. Truck movement.
2. Rack movement.
3. Product searching.

Figure 13 is a typical operations chart of a transport loader. It should be noted that the searching operation was not included in the job function. Searching can be eliminated by the designation of staging areas for every depot. The actual time saved by this type of product flow change need not be quantified. No benefit is derived by studying times of elements that are eliminated. If major labor savings are to be attained in the loading of transports, double handling of trucks and equipment must be reduced.

In the reduction of truck movement in the studied plant, two solutions become apparent:

1. Add more shipping docks, and use the transport trailers as "staging area".
2. Use existing space in the old route truck parking area for depot staging--thus allowing room for the staging of a full truck load before loading the transport.

The first alternative was abandoned due to the problems of designing a dock to accommodate existing side-load double tandom trailers (versus back door loading single trailers). There were also space and zoning

FIGURE 13

OPERATION CHART OF TRANSPORT LOADING

Time in Mins.	Chart Symbols	Process Description
15 minutes	Δ	1. Inspect Transport Dock if Needed 2. Move Truck at Dock to Parking Area.
	⇒	3. Move Desired Truck into Loading Position.
	O	Unbolt Transport Doors and Remove First Rack
f(distance)	O	Remove Empty Rack Walk Empty Rack to Rack Storage Area
	⇒	Walk to Depot Staging Area
	Δ	Inspect Rack Tag to Find Desired Rack for Loading
	⇒	Walk Rack to Truck, Check off Rack Tray on Load Invoice
	O	If There is a Complete Load Ready, Finish Transport Loading, Replace Loading Bars and Close Doors, Move Truck to Parking Lot; This Cycle Must be Repeated if the Load was not Completed.

problems associated with the adding of dock facilities. The second alternative could be implemented by the moving of the monorail bread conveyor and the raising of the floor in the garage area by 6 inches to match the bakery-dock floor level. Total cost of this alteration was $17,500. This modification allowed for a depot staging area of 334 rack capacity (an increase of 261 racks). To prove the cost effectiveness of this flow change, a time study was made to determine the expected man-hours required for transport loading. The total job of transport loading can be broken into two basic segments for time studies:

1. Truck movement
2. Rack movement

The total expected time is then a function of the number of trucks loaded and the number of racks moved. It is worthwhile noting that the load factor or the ratio of racks per truck changes from day to day; therefore it is false to base expected work content on just trucks loaded or racks moved. Correct time standards must consider both.

Time standards for truck movement and associated paperwork of 15 man-minutes per truck load was agreed as fair. Major savings impact can be achieved through the reduction of number of times the trucks would have to be moved. The other time causing function of the job is rack movement. Time spent in rack movement is dependent on the number of racks to be moved and the distance over which they had to travel. Average distances for racks can be determined by measuring the walking path from the centroid of the depot staging areas to the centroid of

the truck dock area. An extra 20 feet should be added for walking distances in a trailer (20 ft. box/2 (side door loader) x 2 (load and unload distance). The following is a list of the number of racks to be moved and the average distance of travel in the studied plant:

Rack Movement	Rack Feet
130 racks x 232 feet =	30,160
270 racks x 164 feet =	44,280
85 racks x 48 feet =	4,080
Total one way movement	78,520
Allowance for return trip	78,520
Allowance for movement in truck	9,200
Total rack movement	166,740 feet

The next step is to determine a velocity for rack movement. To measure velocity, a one-hundred foot distance should be measured on the floor of the shipping department. Racks can then lined up at one end of the shipping room so that observation can be made of men moving a number of loaded and unloaded racker over the 100 foot distance. Observation times should be started when a man grabs the rack in preparation of moving it. This is done to allow for time needed to start the rack in motion. When marking the times of movement, it should also be noted whether the rack is full or empty of product. From data collected, an average velocity of 3.0 feet/second (approximately 2 mph) was determined to be fair labor standards. From distances and number of racks to be moved, we can now determine the expected savings from purposed product flow and methods changes.

Below are sample calculations showing the determination of expected labor content for loading transport trailers.

Time for moving racks 166740 ft. x 3 ft./sec/3600 sec./ft. =	15.4 hrs.
Truck movement and paperwork @ 15 min./truck x 30 trucks =	7.50 hrs.
Allowances for fatigue @ 20% of time for rack movement =	3. hrs.
Total expected time for truck loading =	26. hrs.
Manpower requirement: 26 hours/6.5 hours (available per man) =	4 men

Before any methods analysis or the establishment of labor standards, eight men were doing a job that was capable of being done by four men. If we can assume a standard 35 hour week (with no overtime) the savings of four men (paid at $5.435 hr.) would equal almost $40,000 per year before considering fringe benefits.

Pallet Unloaders. The basic job of the pallet unloaders is to remove empty pallets from a product rack and place them on a 4 wheeled dolly. This is done so the wrapping machine operators can re-use the pallets for wrapped product. In the analysis, the cause of the job was the fact that pallets were placed on the racks for transporting back to the bakery. With no further study, it was decided to have the route men place the pallets directly on the dolly at the depot locations, thus eliminating the need for double handling of pallets at the bakery. This basic method change required approximately 40 extra dollies (at $50 each) but allowed the elimination of two men on the payroll. This exemplifies the fact that it is much more beneficial to identify the cause of a job and eliminate that cause before trying to establish labor standards.

Route Truck Loaders. Order selections for route truck drivers is one of the more rewarding areas to study for cost reduction in the wholesale baking industry. Reasons for this are:

1. Order selection is very labor intensive, with normally one man for every eight or ten routes.
2. The methods used for picking orders are somewhat universal; therefore once standards are determined they can easily and swiftly be applied to other plants.
3. Normally, a high percentage of the route order selection is done away from the main plant, and between the hours of 8:00 P.M. and 4:00 A.M. in the morning (thus under little supervision).
4. As in the shipping department, labor standards have not been established by most baking companies.

Figure 14 is a operations chart showing the main functions of route truck loaders. From this chart, it is obvious that a high percentage of the time is spent in inspecting orders and loading the route trucks.

The main improvements from methods analysis of the job fall in two areas:

1. Minimizing the required moving distance of racks.
2. Standardizing the ordering of the salesmen.

The first method in one instance was accomplished by parking the route trucks in a U shape (formerly they were in a straight line). This change allowed the selectors to finish an empty rack close to the empty

FIGURE 14

OPERATIONS CHART OF ROUTE TRUCK LOADERS

Time in Mins.	Chart Symbols	Operations Description
Variable	⇒	Walk Full Rack to First Truck
	Δ	Inspect Order
	0	Remove Product from Rack and Place on Route Truck
	0	Mark Salesmans Order Form - Signifying that Product Demand has been Satisfied
	⇒	Walk to Next Route Truck
	Δ	Inspect Order
	.	.
	.	.
	.	.
	⇒	When Rack is Empty - Move Rack to Empty Rack Storage Area
		If all Orders are Filled and there is an Excess of Product, Divide Remaining Product According to Depot Managers Request.

rack storage area and also reduced the non-productive walking distance after a rack was emptied and before a full rack was started.

Extra time in selecting orders is taken when the order is not in full quantity pallets. One method suggested to the bakery manager was that the salesmen, when placing an order, would automatically round the order up (or down) if the amount added (or subtracted) did not exceed ten percent of his original order for that item. This change would eliminate much of the double handling of the product in order selection and would not substantially increase the financial exposure of returns. These types of changes should be adopted before the actual timing of the operations is started. It should be noted that many alternative methods, some more desireable than others, are available but were not researched in depth, due to time that would be needed to determine the advantages-disadvantages. One of the more promising method changes is the selecting of route truck, or possibly even retail store, orders directly off a wrapping machine. This would eliminate considerable double handling, but would require a good information system and possibly more stable market conditions.

Upon completion of methods work, time standards can be determined. Many people in the baking industry have expressed feelings that the number of route order selectors is a function of, and can be measured by, the number of trucks at a particular depot. In a very broad sense this is true, but for a cake route (characterized by small orders per variety and large number of varieties) the time per truck can be several times

larger than a bread route. Another fact making the number of trucks per man a poor index to productivity is the variation of demands between routes. For these reasons, standards should be based on two criteria:

1. The total volume packed.
2. The mixture of product to be packed.

Although standards can be established for product selectors (for depot orders), there is enough differences to warrent a separate study. In order to adjust for variances in times to pick orders, the product can be segmented into three categories, based on their total volume at the depot level. The segmenting is similar to that used for picking depot orders.

Volume Categories	Volume	
Low volume	1 rack or less	$X \leq 1$
Medium volume	1 to 3 racks	$1 < X < 3$
High volume	3 racks or more	$3 \leq X$

Time observations should begin when the route truck loader first grabs a rack of product for selection and ends when the rack is empty, returns to the bulk staging area, and the next full rack is grabbed.

Approximately thirty observations were made in one study on each demand group. The four men who regularly performed this job were used for the time study. The average for each group was used as the time standard.

Time standards for route order selection are:

	Minutes/Rack	Demands	Man-Min.
1. Racks $\geq$ 3	6.6	30	198
2. 1 > Racks > 3	8.3	22	183
3. Racks $\leq$ 1	11.0	16	176
		68	557

Allowances for misc. double handling and fatigue at 15% of time standard for product selection = 84 minutes

Total expected man-minutes for route truck loading = 641 minutes

Expected man-power for route truck product selection = 641 man minutes/60 min./hr./6.5 hours available per man = 1.64 men or approximately two men.

There were formerly four men performing this function where only two were required, a net expected savings of approximately $24,000 annualized.

Now with methods analysis completed and labor standards set, it would be easy to obtain agreement with management, write a letter of the findings to corporate headquarters and travel to the next operation. Actually at this point the industrial engineers job is only half done. There still remains two fundamental areas before the shipping room study is complete:

1. The training of foremen in scheduling techniques that utilize the developed work standards.
2. The establishment of a tracking or audit system by which management can more objectively measure employee performance.

3.4.5 Discussion and Agreement on Method Recommendations and Labor Standards

Through out the study, line management should be kept well informed as to the progress of the study. All method changes should be agreed upon by the supervision who have to live with the changes. Most labor standards should be established after the method changes are implemented and the employees are familiar with the methods. Since line management helped with the time studies and the establishment of the standards, no problem should be encountered in getting approval. It should again be stressed that the work load fluctuates from day to day and month to month, so that the labor calculation is accurate only for the volumes studied. The value of the study is to reduce labor cost through better methods and give line management a way of measuring the productivity of the labor in the shipping department. From this, determinations can be made based on volume changes as to when it is time to hire or lay off personnel. Before great savings can be expected and achieved over a long period of time, foremen will have to be trained in how to use the labor standards in scheduling the work force, and a convenient method of tracking or auditing productivity should be implemented

3.4.6 Training the Foremen in Techniques of Crew Scheduling and General Foremanship

Training of the foremen in management techniques is possibly one of the most neglected aspects of bakery management. Foremen are the key

to cost reduction because they have the most direct control over labor cost. Decisions made by foremen are, for the most part, short range in nature, as compared to higher management positions in the company. The cost impact of any single decision has very little impact on the viability of the company. It is possible that for these reasons, plus the steady turnover of labor, that foremanship training is not widely prevelant in the baking industry. An overlooked fact is that improperly trained foreman can make decisions, that when accumulated, have more impact on the profits of the company than decisions made by the executive positions. A book that has found to be valuable as an aid in training foremen is Martin Smiths, Short Interval Scheduling.

Short interval scheduling can be used where:

1. All work entering a system or work area is scheduled by one person (or one person per shift). Normally the expected time to completion of a job is short. This can be measured in minutes or hours as compared to days or weeks.
2. An employee is assigned to a very specific job duty and told the expected completion time.
3. Job performance is evaluated to insure on-time completion.

Short interval scheduling, when properly applied, will help insure that time standards established earlier will be used in practice and intended savings will be achieved.

3.4.7 Establishing Management Tracking Systems

After time standards are established, a tracking system should be implemented that would identify when labor costs are deviating from expected costs. Established time standards can be incorporated into a convenient recording form that would give an indication of actual productivity.

3.4.8 Summary of a Shipping Room Study

The suggested methods work in the shipping room can best be described as a rough cut at cost reduction. Additional work needs to be done in method analysis in shipping rooms. One promising area that was studied is the use of powered trains in the movement of racks. Detailed design work is required for further study, but there are indications that significant labor reductions can be made with a method where multiple racks can be moved by one person. Another area important enough to warrant a study is the quantification of the cost benefit of daily service for all products. If certain varieties could be delivered on a "every other day" basis, tremendous reduction could be made in both the production and product selection area.

Method studies should be held on an on-going basis for two simple reasons:

1. People change their jobs; therefore there is always a need for re-education.
2. When new pay raises are put into effect, or new equipment becomes available, a capital expenditure that was previously marginal may become a worth while investment.

CHAPTER 4

4.1 Introduction to Transport Scheduling

Scheduling of transport trucks for product distribution from the manufacturing plant to the depots is a very complex and costly problem. Today, when bakeries are tending to become larger, the distribution system is increasing in complexity due to the greater areas being serviced. There has been little research in the baking industry, or for that matter, little management attention given to reduce transport costs through better scheduling and increased utilization of distribution resources. Possible reasons for the general lack of attention by management might be:

1. A good decision today may be a terrible decision tomorrow, because of fluctuation in consumer demand.
2. An accounting system that relates incremental dollars spent to incremental profit is hard to develop. An example of a problem in the determination of efficiency is the use of cost per mile as a productivity index. Cost per mile, a figure used by most companies, measures gas, oil, and tire consumption; it is an index of the adequacy of a maintenance program. In trying to measure the efficiency of a distribution system, cost per mile has serious faults. If newer, larger capacity trucks are purchased, the cost per mile will normally increase tremendously, but the total cost should be reduced, due to the reduction of miles traveled caused by increased load factor.

3. In most bakeries, there is not an adequate information system upon which prior decisions can be based.

In addition to the above problems, baked products, as proven by their low profit margin and high perishability, have limited ability to support high distribution costs. For this reason, bakery products have definite geographical limits for shipment beyond which all profits are negative. Determination of these limits must consider the incremental volume increases and their associated profit or loss, compared to the incremental cost of added distance. Full discussion of this point is beyond the scope of this report, but the recognition of these physical limits is important to plant management. The four basic areas of transport management in a bakery operation that will be examined are:

1. Development of information flows.
2. Using a computerized distribution model as an aid in selecting routes.
3. Techniques that increase utilization of resources (men and equipment).
4. The use of the computer as a simulation model for aiding the decision making process.

4.2 Development of Information Flows

Before an efficient computerized scheduling system can be implimented, the foundations and disciplines of a workable manual system must be in place. Reasons for this are:

1. Computers do not make decisions; only people can make them. Computers can only aid in the decision process.
2. Input required by a computer is the same basic input required by a manual system.

To make intelligent decisions in distribution scheduling, a basic information system must be in place. *Good information systems* must be adequate in both the quality of information and the speed of the information. Poor quality information usually has the effect of adding to actual distribution costs. If the wrong product is shipped to the wrong depot, a cost is incurred in undoing the mistake as well as implementing the correct decision. Lack of quality in the information also introduces surprises. If they occur frequently, the plant management tend to add additional labor and equipment to cover all possible unexpected situations, fostering poor utilization of resources. Usually, an efficient distribution network is more sensitive to disruptions to information flow. This is because, in the efficient systems, there are not extra resources waiting for the unexpected.

If the speed of the information is slow, options that once were feasible may possibly be closed. For instance, if an added product demand is known before the final service to the depot, it is possible that there will be no additional cost incurred for the delivery.

Information needed for decision making concerning route scheduling can be segmented into fixed and daily inputs. Fixed inputs change infrequently, normally on a monthly or yearly basis. This information should contain:

1. The number of vehicles and their respective capacities.
2. Time restrictions imposed upon the distribution system:
    (a). Latest depot arrival times.
    (b). Product availability times. The Gantt chart similar to the one in Chapter 2 will give availability times.
3. Physical restrictions that would limit the area of feasible solutions. For instance, because of unloading conditions, a 40 foot trailer may be the maximum length trailer allowed to service a particular depot (as opposed to 45 foot or tandom trailers).
4. Physical locations of points that are to be served by the distribution network. This input, when the scheduling is done manually, should be in the form of a map with point to point distances or costs denoted. In highly congested areas, costs including tolls would be more appropriate.
5. Union contracts, government, and company regulations will often force a company to utilize sub-optimal operating procedures. One such agreement in a Dallas baking operation forced management to put "runs" (pre-scheduled trips) up for bid. If changes were made from the bid runs, a penalty would have to be paid. This penalty cost would have to be compared to expected savings before changes could be implemented.

Daily inputs consist of the information about volume demands for each depot.

A sample of the forms that can be used for tabulation of daily depot demands can be seen in Figure 15. These forms will give the shipping supervisor the basic demand information he needs in the day to day scheduling of the transport trailer operation. The design of the Daily Demand Sheet allows for the tracking of the amount of last minute adds or cuts, and differences between actual and expected loads.

Before the actual process of re-scheduling can be started, the accuracy of the data must be within certain tolerance limits. An arbitrary limit of $\pm$ 5% could be set as the goal to attain. If an error occurred outside the $\pm$ 5% limit, an attempt should be made to determine and eliminate its cause. If inaccuries occur frequently, possible causes to be explored are:

1. Clerical errors in the office.
2. Damage of equipment (bent racks), causing a decrease in holding capacity.
3. Loaders not loading racks to designated capacity (possibly because the top and bottom slots require more physical exertion and the loader "knows" the truck load will not be full).
4. Not enough of the right kind of trays or baskets. For example: if pies (36 pies per pie tray) are put on bread trays (12 pies per bread tray) because there was not enough pie trays, there would be three times the number of racks required to handle the same volume of pies.
5. Last minute adds or cuts (subtractions) to depot orders by salesmen create fluctuations that are difficult to predict.

FIGURE 15

DAILY DEMAND SHEET
(Rack Equivalents)

Date:

Depot Location	No. Miles	Office Computed Demand	Shipping Adds Or Cuts	*Total Demand	*Actual Shipment	Rack Miles	Notes:

*Explain All Differences Between Total Demand and Actual Shipment

Once accurate daily depot demands are achieved three to four weeks of demand history should be collected. In most bakeries, the high demand day can be up to 100% above the low demand day, while individual days change very little from week to week (Monday this week is similar to Monday last week).

Driver bids should be established for each day of the week, thus decomposing the scheduling problem into five smaller problems (one for each distribution day). In some plants, the union has gained (possibly through naive management negotiating) the right to have drivers "own" runs or trips. This forces management to schedule for its heaviest days, and suffer with under utilization the remaining days. By scheduling each day as a separate problem, the effect of variances in product demand can be reduced.

4.3 Routing of Transport Trucks

The problem of routing the trucks is a basic combinatorial problem. In combining depots to make up a set of routes, the scheduler must consider the demand at each depot, the number of trucks and their capacity, the various time and physical restrictions, and of course, cost.

To help solve this problem, a heuristic algorithm was developed by Tillman (5,6) and programmed for the computer. The Distribution Scheduling System (D.S.S.) was installed on a time sharing system so that the plant personnel could have ready access to the computer. Basic information required to run the D.S.S. package is similar to that needed for manual scheduling:

1. Point to point distances.
2. Number of trucks and their capacity.
3. Time restrictions.
4. Demands at each depot (in similar units used to designate truck capacity).

Figure 16 lists the conversational front-end driver to D.S.S. (written in basic language). Figure 17 shows a typical output, listing combinations that should be considered.

The attempts to install systems like D.S.S. as a on-line decision making tool were slow and painful. Major problems occurred because a number of constraints that needed to be considered were not built into the computer system. Another problem encountered was one of training the personnel in the operation of the system. For these reasons, it was decided that a more sound approach would be to use systems such as D.S.S. as a "simulator", or as a "guiding tool" rather than to develop the daily transport routings.

In retrospect, this author doubts if ever a general computer program will be developed that will "solve" all of the scheduling problems faced by distribution managers. At the same time, the value of an approach such as D.S.S. should not be minimized because it can give management new route configurations that were not explored before.

To determine actual combinations for each day of the week, four weeks of previous history on depot demands should be fed into the computer system. Output for each day could then be analyzed for combinations of depots on routes, and allocation of different size trucks

FIGURE 16

CONVERSATIONAL INPUT TO D.S.S.

```
DSSCO     22:12     03/27/72

DATA PREPARATION FOR DISTRIBUTION SCHEDULING SYSTEM

**************************************************

DO YOU WANT INSTRUCTIONS (YES OR NO)? NO


ENTER THE TOTAL # OF TERMINALS TO BE CONSIDERED.
?1

ENTER TERMINALS TO BE SCHEDULED WITH QUOTES?"1"

DO YOU WANT TO USE TIME CONSTRAINTS(YES OR NO)?YES
ENTER TIME LIMIT, FIXED DOCK TIME, VARIABLE DOCK TIME, VELOCITY?14.,.5,0.,50.

END OF DATA PREPRATION FOR DISTRIBUTION SCHEDULING
SYSTEM. DSS PROGRAM WILL NOW BE PROCESSED.


TO INQUIRE ON STATUS OF JOB, TYPE 'INQ DSS' AFTER TERMINAL
TYPES 'READY'.

22:13  RAN 0 MINS  0.26 SECS
```

FIGURE 17

OUTPUT FROM DSS

PT.	DEMANDS	
1	AUST	56
2	BELT	27
3	BRYN	15
4	DORS	221
5	FORR	205
6	FTWR	72
7	GREE	491
8	HOUN	342
9	HOUS	364
10	HUNT	284
11	LONG	214
12	MTPL	116
13	OAKC	736
14	PARI	209
15	PALE	261
16	SANT	281
17	SHER	564
18	SPRT	305
19	TEXA	150
20	TYLR	49
21	WACO	65

CARRIERS AVAILABLE FOR TERMINAL DALL

CAP.	500	NO.	3
CAP.	410	NO.	6
CAP.	380	NO.	2
CAP.	360	NO.	99

TERMINAL	DEMAND POINTS	DIST.	NO. TOURS	LOAD SIZE	TRUCK CAP.	TIME
DALL	-SHER-	140	1	500	500-	3.30
DALL	-OAKC-	14	1	500	500-	.78
DALL	-BELT-AUST-SANT-	573	1	364	380	12.96
DALL	-BRYN-HOUS-	554	1	379	380	12.08
DALL	-FORR-	77	1	277	360	2.54
DALL	-HOUN-WACO	499	1	407	410	10.98
DALL	-LONG-TYLR-	275	1	263	360	6.50
DALL	-MTPL-TEXA-	375	1	266	360	8.50
DALL	-PARI-SHER-	246	1	273	360	5.92
DALL	-CORS-	112	1	221	360	2.74
DALL	-GREE-	102	1	491	500-	2.54
DALL	-HUNT-	360	1	284	360	7.70

FIGURE 17 (continued)

TERMINAL	DEMAND POINTS	DIST.	NO. TOURS	LOAD SIZE	TRUCK CAP.	TIME
DALL	-OAKC-	14	1	236	360	.78
DALL	-PALE-	220	1	261	360	4.90
DALL	-SPRT-	402	1	305	360	8.54
TOTALS		3963	15	5027		

OSCK OSC85F 27 MAR 72 22:14:35 USER IBJ001 DSS
CARDS IN 401 OUT 0 LINES 124 PROCESSING TIME 7.21 SECONDS

that would generate savings over present routings. After basic routes are agreed upon, driver bids, or workloads and fleet utilization can be studied. Table 11 shows an example of the final routes for one days operation.

4.4 Techniques Used for Increasing the Utilization of Drivers and Equipment

A majority of cost reductions in transport operations can be derived from the establishment of trip time standards and the combining of previously determined routes into bids or work loads for the drivers. Data gathering for the establishment of trip standards is made easy through the use of tack-o-graph charts that are on most transport trucks. Tack-o-graph charts measure the time a truck is running and the speed of operation. In one instance, from the inspection of past charts, it was determined that 45 miles per hour would be a fair expected average for depots not located in the same city as the bakery.

Standards for non-driving time at these depots were set at 30 minutes per depot. Within this time limit, the driver was expected to unload the product from his truck and re-load empty racks for the return trip to the bakery. A standard such as this is a crude measure at best, but was found adequate in most cases. Individual allowances can be made for depots requiring service during congested driving hours, or for depots located in the same town as the bakery, or unusual loading and unloading conditions.

TABLE 11

POSSIBLE ROUTES FOR ONE DAY DELIVERY

Trip Number	Points on Route	Vehicle Capacity Needed (racks)	Trip Time (hours)
1	Plant - Hooks -	50	6.5
	Plant - Oakcliff	50	1.0
2	Plant - Huston	50	9.5
3	Plant - Sherman	50	4.0
4	Plant - Greenville	50	3.0
5	Plant - Ardmore -	41	5.0
6	Plant - Fort Worth -	41	2.5
7	Plant - Ataka -	41	5.5
8	Plant - Fort Worth	41	2.5
9	Plant - Waco - Huntsville -	41	9.0
10	Plant Shreveport # 1 -	41	7.5
11	Plant - Longview - Tyler	41	6.0
12	Plant - Oakcliff -	41	1.0
13	Plant - Shreveport # 2 -	41	7.5
14	Plant - Bryan - Huntsville -	41	10.5
15	Plant - Mt. Pleasant - Texarkana	41	7.75
16	Plant - Shreveport # 3	41	7.5
17	Plant - Shreveport # 4	41	7.5
18	Plant - Waco - Belton - Austin - Saatino	41	12.0 (two driver relay)

TABLE 11 (continued)

Trip Number	Points on Route	Vehicle Capacity Needed (racks)	Trip Time (hours)
19	Plant - Shreveport # 5	38	7.5
20	Plant - Palestine	36	5.0
21	Plant - Fort Worth	36	2.0
22	Plant - Rush - Lufken - Beaunot	36	5.5
23	Plant - Sherman - Sulpher	36	6.5
24	Plant - Forest Hills	36	2.5
25	Plant - Paris - Sherman	36	5.0
26	Plant - Carsicana	36	3.0

With time standards established for the previously determined routes, sets of routes can be combined to form truck and driver schedules. Again, the technique that proved to be very helpful was Gantt charting. Procedures used in the development of Gantt charts for truck assignments were:

1. List available trucks, ordered from the highest capacity to the lowest capacity.
2. Assign routes to individual trucks. Start with the larger capacity trucks first and work down to the smaller capacity trucks. A basic rule to remember is that the more distant depots should be given, in most instances, a priority in case of conflict over truck allocation.
3. The larger trucks should be assigned to be on the road as much as possible. The reason for this is that if the utilization of the larger trucks could be increased, some smaller trucks (and their associated costs), may not be required. This procedure may involve adjusting route starting times until a feasible solution is obtained. It should be noted that the assignment of trucks to trips is not firmed up at this point, but several tries should be made and the one which indicated the best utilization of driver and equipment should be selected.

One goal should be to assign a driver, to as nearly as possible, a minimum eight hour work day. As in truck assignment, the Gantt chart is useful in driver scheduling. The procedure is illustrated in Figure 7 and involved:

1. Numbering the left hand side of the Gantt chart from one to the number of available drivers.
2. Assigning trips starting with the longest trip and work down, with trips over four and one-half hours being assigned to separate drivers.
3. Assigning all remaining trips, trying to achieve as close to an eight hour work day as possible.

During the process of trip assignment to drivers, binding restrictions, caused by product availability or time restrictions, may force "give-away" or non-productive time for drivers. Possible alternatives for reduction of nonproductive times would be:

1. Make the product available earlier in the day.
2. Relax time restrictions at the depot level.

To obtain a higher utilization of both trucks and drivers the starting times of trips and drivers may have to be revised in a trial and error fashion. Gantt charting of the final schedules highlights periods of under-utilization of equipment and men. It is the duty of the scheduler to try to fill in these non-productive times.

On the lighter distribution days of the week, ingredient pick-up runs should be made or, if a definite future overload condition is known, steps should be taken to correct the condition. With all depot trips scheduled, and the utilization of equipment and drivers being satisfactory, the actual biding for work assignments by the drivers can begin. Table 12 illustrates a typical bid sheet, giving destinations by day and starting times for trips. Table 13 indicates the associated miles and expected pay for each bid.

TABLE 12

DRIVER BID SHEET FOR SCHEDULED ROUTES

BID NO.	TO	TRIP TIME	START TIME	FINISH TIME	VEHICLE CAPACITY	DAYS
A	Hooks	6.5	7:00 AM	2:00 PM	50	S M W T F
	Oak Cliff	1.5	2:30 PM	3:30 PM	50	S M W T F
B	Sherman	4.0	8:00 PM	12:00 PM	50	S W T
	Greenville	3.0	12:30	3:00 AM	50	
	Houston N	9.5	5:30 PM	3:30 PM	50	M F
	Houston N	9.5	5:30 PM	3:30 AM	50	S W T
C	Sherman	4.0	8:00 PM	12:00 PM	50	
	Greenville	3.0	12:30 PM	3:00 AM	50	M F
D	Ardmore	5.0	7:30 AM	12:30 PM	41	S M W T F
	Fort Worth	2.5	1:00 PM	3:30 PM	41	S M W T F
E	Bryan					
	Houston S	10.5	4:00 PM	3:00 AM	41	S W T
	Shrv'pt #2	7.5	3:00 PM	10:30 PM	41	M F
F	Atoka	5.5	11:00 AM	4:30 PM	41	S M W T F
	Fort Worth	2.5	5:00 PM	7:30 PM	41	S M W T F
G	Waco					
	Huntsville	9.0	8:00 PM	5:00 AM	41	S M W T F
H	Shrv'pt #1	7.5	12 Noon	7:30	41	S M W T F
I	Longview					
	Tyler	6.0	8:00 PM	2:00 AM	41	S M W F
	Oak Cliff	1.0	2:30 AM	3:30 AM	41	S M W F
	Mt. Pleasant					
	Longview-Tyler					T
J	Shrv'pt #2	7.5	3:00 PM	10:30	41	S W T
	Bryan-Hunts	10.5	4:00 PM	3:00 AM	41	M F
K	Mt. Pleasant	7.75	11:00 PM	6:45 AM	41	S M W F
	Texarkana					
	Texarkana					
	Shrv'pt.					T
L * *	Shrv'pt. #3	7.5	1:30 PM *	8:00 PM	41	S M W T F
M * *	Shrv'pt. #4	7.5	3:00 PM	10:30 PM	41	S M W T F
N	Waco-Belton	6.0	12 Noon	6:00 PM	41	S M W T F

* From Shreveport - Dallas
** Shreveport - Dallas - Shreveport

TABLE 12 (continued)

BID NO.	TO	TRIP TIME	START TIME	FINISH TIME	VEHICLE CAPACITY	DAYS
O	Belton-Austin					
	San Antonio	6.0	6:00 PM	12:00 AM	41	
P	Shrv'pt #5	7.5	7:00 PM	2:30 AM	38	S M W F
	As Assigned	8.0				T
Q	Palestine	5.0	8:00 PM	1:00 AM	36	S M W T F
	Fort Worth	2.0	1:30 AM	3:30	36	
R	Dallas					
	Rusk	5.5	1:30 PM	7:00 PM	36	S M W T F
S	Rusk-Lufkin					
	Beaumont	7 hrs.	7:00 PM	2:00 AM	36	S M W T F
T	West Texas (Abilene-S.Ant. Odessa)					S W
U	Sherman					
	Sulphur	6.5	10:00 AM	4:30 PM	36	S M W F
	Forest Hills	2.5	5:00 PM	7:30 PM	36	S M W F
	As Assigned	8.0				T
V	Paris					
	Sherman	5.0	8:00 PM	1:00 AM	36	S M W T F
	Corsicana	3.0	1:30 AM	4:00 AM	36	

TABLE 13

MILEAGE AND PAY FOR SCHEDULED ROUTES

BID NO.	DESTINATION	MILES	WEEKLY TOTAL	PAY
A	Hooks	320 x 5 = 1600	1750	160
	Oak Cliff	30 x 5 = 150		
B	Sherman	130 x 3 = 390		
	Greenville	96 x 3 = 288		
	Houston South	520 x 2 = 1040	1718	160
C	Houston	440 x 3 = 1320		
	Sherman	130 x 2 = 260		
	Greenville	96 x 2 = 192	1772	160
D	Ardmore	226 x 5 = 1130		
	Fort Worth	70 x 5 = 350	1480	160
E	Bryan-Houston S	520 x 3 = 1560		
	Shrvpt. #2	370 x 2 = 740	2300	190
F	Atoka	256 x 5 = 1280		
	Fort Worth	70 x 5 = 350	1630	160
G	Waco - Huntsville	386 x 5 = 1930	1930	190
H	Shreveport #1	370 x 5 = 1850	1850	190
I	Longview-Tyler	258 x 4 = 1032		
	Oak Cliff	30 x 4 = 120		
	Tyler-Long-Mt.Plest.	310 x 1 = 310	1462	160
J	Shreveport #2	370 x 3 = 1110		
	Bryan-Houston	520 x 2 = 1040	2150	190
K	Mt. Pleasant-Texak.	348 x 4 = 1392		
	Texar-Shreveport	431 x 1 = 431	1823	190
L	Shreveport #3	370 x 5 = 1850	1850	190
M	Shreveport #4	370 x 5 = 1850	1850	190
N	Waco - Belton	260 x 5 = 1300	1300	160
O	Belton-Austin-S.Ant.	286 x 5 = 1430	1430	160

FIGURE 13 (continued)

BID NO.	DESTINATION	MILES	WEEKLY TOTAL	PAY
P	Shreveport #5	370 x 4 = 1480	1480	160
	As Assigned	--		
Q	Palestine	214 x 5 = 1070		
	Fort Worth	70 x 5 = 350	1420	160
R	Rusk	256 x 5 = 1260	1260	160
S	Rusk-Lufkin-Beaumont	302 x 5 = 1510	1510	160
T	West Texas	738 x 2 = 1476	1476	160
U	Sherman-Sulphur	297 x 5 = 1485		
	Forest Hills	70 x 5 = 350	1835	190
V	Paris - Sherman	230 x 5 = 1150		
	Corsicana	102 x 5 = 510	1660	160

In actuality, rarely do the bid sheets satisfy all depot demands. In fact, if all the demands are always met with no problem, or overloads, the schedule probably has built in under utilization and should be reviewed. The total cost of a transport operation is a function of how well the "exception" or overload conditions are met. To aid the shipping or transport superintendent in the solution of these conditions, a decision chart should be made. Figure 18 and Figure 19 illustrates the instructions and a decision chart for truck routing. Since most changes to a route have penalities or "extra pay" costs associated with them, the decision maker needs a quick method of determining their extra costs. A table of the most probable or most likely alternatives should be made with the added charges that are agreed upon by the management and the union. Management could then use this table in conjunction with the decision chart in resolving overload conditions.

In the day to day communications within the shipping-transport department, a load and dispatching sheet can be useful (Figure 20). This form is partially filled out earlier in the day by the dispatcher and given to the shipping department for completion. This same form could be used in conjunction with short interval scheduling discussed in the shipping department study. Upon completion, these forms would be sent back to the transport supervisor for review. If deviations from expected trip times occur, tach-o-graph charts from the transport truck could be inspected.

For plant management information, deviations from driver base pay and transport costs should be tracked on a weekly basis (Figure 21).

FIGURE 18

INSTRUCTIONS FOR DECISION CHART

1. Add all branch demands that are to be on a bid route. (Add Belton, Austin and San Antonio's demands if they are on a bid route).
2. Reduce the accumulated branch demands on a trip by the smaller of either the demand or truck capacity. Mark this number on the decision chart. If there is no remainder, zero out the branch demands on the demand sheet. On multi-stop routes with remainders, mark that remainder as a demand to the branch that is closest to the bakery. San Antonio's, Austin and Belton remainder goes to Belton.
3. Return to Step 2 and continue until all bids on decision chart are completed.
4. Upon completing the decision chart, return to the top of the demand sheet. All remainders on this sheet are overloads. When an overload occurs, your objective is to make a least cost decision. Your alternatives are:

    (a). Can I satisfy the demand by a larger truck?

    (b). If yes, do I have a larger truck?

    (c). Is a low priority shipment causing the overload? Can I ship it tomorrow?

    (d). If no, are there any one or more routes that are in close proximity to which I can add the remainder?

    (e). If all these alternatives fail, an extra run must be scheduled.

FIGURE 19

DECISION CHART FOR DAILY ROUTING

BID	A	A	F	D	D	U	U	Q	S	T	COMMENTS
Veh. Cap.	50	50	41	41	41	36	36	36	36	38	
Destination / Date	Hooks	Oc	Atoka	Ardm.	F.W.	Suld. Sher.	Forr.	Pale.	Rusk Lufk. Beau	West. Texas	
Mon 4-3	40.1	50.0	41.0	37.2	35.5	12.6	23.1	31.9	29.2	36.0	4.6 Sher on Paris
Tues 4-4	38.9	50.0	41.0	41.0	32.9	6.3	22.9	27.4	28.0	34.6	3.9 Sher on Sulp
Thur 4-6	43.6	50.0	41.0	41.0	35.8	17.4	21.6	30.1	28.5	37.0	No overloads

FIGURE 20

LOADING AND DISPATCH
INSTRUCTIONS

Section I

Trip No. _____ Date _____

Deliver (Racks) _____ Office _____ Shipping _____ Total

_____ Actual

Complete Staging By: _____ Complete Loading By: _____

Section II

Trailer Size _____ Trailer Capacity (Racks) _____

Routing _____

Driver _____ Scheduled Departure _____

Dock At _____ (Time) Actual Departure _____

Section III

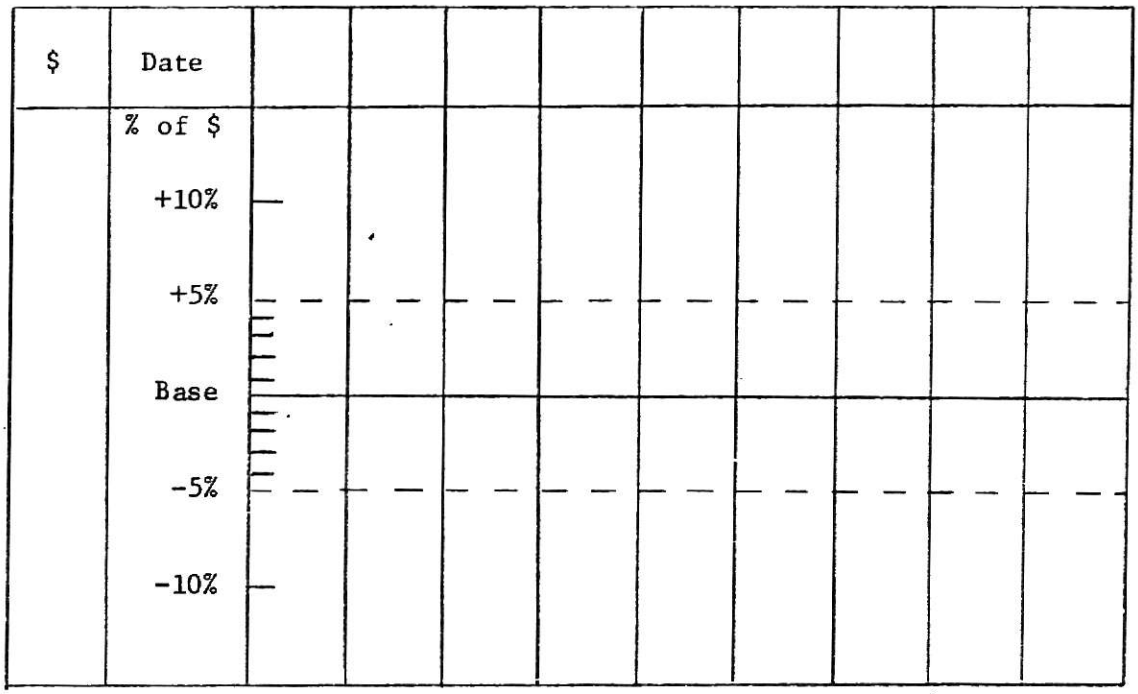
Remarks:

_____ Transport Supervisor

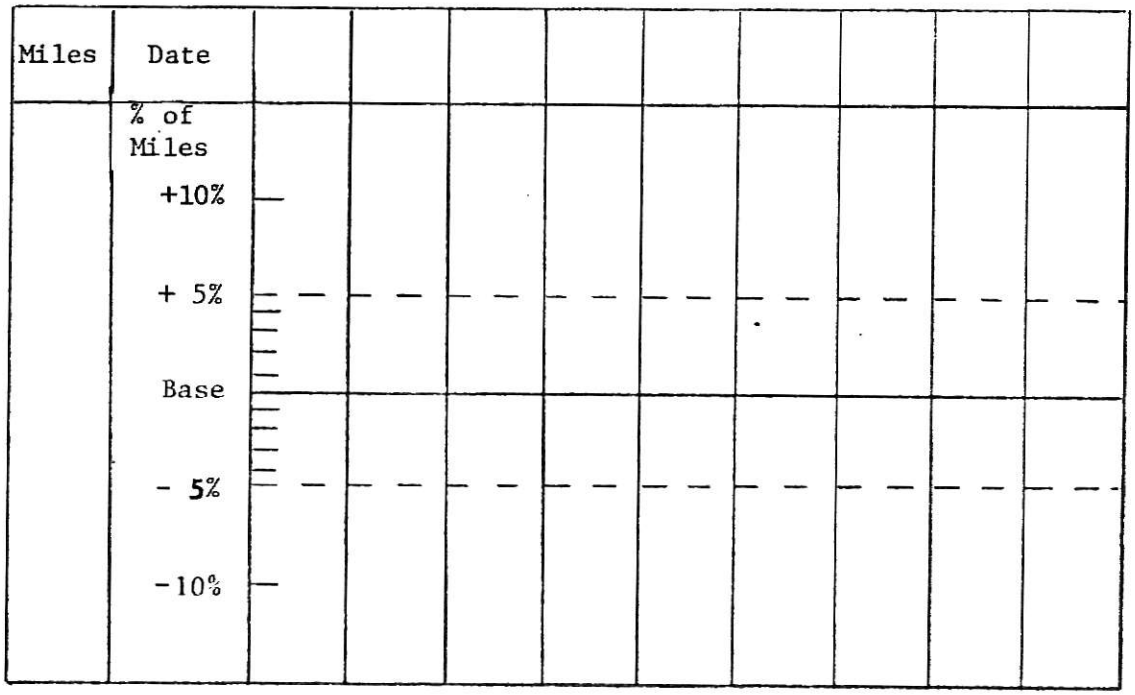
_____ Shipping Supervisor

FIGURE 21
DRIVER PAY AND MILEAGE VARIANCE REPORT

WEEKLY TRANSPORT DRIVER PAY
IN
PERCENT OF DOLLAR VARIATION FROM BASE PAY



WEEKLY TRANSPORT TRUCK MILEAGE
AS A
PERCENT OF VARIATION OF BASE MILEAGE



If costs or mileage get out of the 5% (this is an arbitrary limit) limit a review would be in order. The following is a summary of savings achieved at one of the midwest plants of a large concern:

	Approx. Annual Savings
1. Reduction of 6 drivers plus fringes.	$ 76,700
2. Reduction of estimated 4,000 miles per week at 20¢ per mile	$ 41,600
3. Net cost avoidance by picking up sugar on a light distribution day	$ 6,500
Total expected annualized savings	$124,800

The interesting fact is that by studying a rather small but uncontrolled part of the total cost of the bakery operation, the savings can increase the plant profits by significant amounts.

4.5. D.S.S. as a planning model

The true value of a system such as the Distribution Scheduling System appeared to be in the long range planning of equipment purchases and the analysis of cost associated with various customer servies as it relates to company policies.

To test alternative truck sizes, management can change the fleet description and run the model for typical depot demands. A comparison of the mileage with each configuration is then made with the present mileage. In most cases, the pay off for the purchase of new larger

trailers will be less than one year. Most managers do not review the savings associated with the purchase of equipment until the equipment is in physical disrepair. This is a very short sighted approach since the company may be wasting thousands of dollars trying to use inefficient equipment. They may be ahead to sell the smaller equipment at book value or less and to purchase larger equipment. Again, this type of analysis is made easy with simulation runs from a system such as D.S.S.

Another area where computerized distribution models are useful is in trying to determine the cost of customer related service policies. An often heard statement is: "It costs me nothing to service that small depot or distributor because it is on the way to my larger depot". Often, the true cost of serving this type of customer is more than its marginal contribution to profit and overhead. The reason for this is that the small customer may order just enough product to eliminate more efficient routings. This was made vividly clear where one small distributor (in a stabilized population area) in Texas with weekly sales of approximately $1200 forced added transportation expenses in excess of $400 per week.

Time restrictions imposed on the distribution system can be quite costly. A cost on these time restrictions can be tested by developing a schedule with no time constraints, and then comparing it with the routings with the constraints.

As wholesale bakeries find it increasingly difficult to fill production capacity in larger metropolitan areas, it is most natural

to try to spread the distribution channels into less competitive, outlying and rural areas. This strategy must be exercised with great caution because of increasing distribution costs (not to mention possible loss of management control in distant markets). When a bakery plans future expansions into new markets, or the addition of extra depots in existing markets, D.S.S. can be a valuable aid in the selection of possible locations, and the quantification of costs to serve these new depots.

4.6. Summary

While bakery to depot transport costs are not massive in relation to other operating expenses, there can be significant savings generated through sound management planning and control. The techniques described above have been applied by the author in several bakeries and, in every case, significant savings have resulted. However, the largest savings cannot be directly measured immediately when a study of this type is made. Since transport schedules are good only as long as the demands are relatively stable, schedules must be revised often in the baking industry. It appears that the most important part of any study is the training of the local people in methods of transport scheduling. Also, the training of the local management in methods that will identify and solve their problems will have continuing benefits versus a "one time" solution to a re-occurring problem.

CHAPTER 5

5.1 Conclusion

The previous chapters have outlined techniques used by the author in cost reduction studies in bakery operations. The methods used or areas studied are in no way complete. Much more work needs to be done in almost every area of management. A summary list of projects that are candidates for indepth studies would be:

1) Profit identification by variety.
2) Profit identification by customer.
3) Salesmen route restructuring.
4) Indirect labor costs.
    a) Office labor costs.
    b) Maintenance labor and parts costs.
    c) Sanitation labor costs.
    d) Salesmen supervisor/salesmen ratio.
5) Manpower scheduling considering seasonal changes in product demand.
6) Decision theory of product placement at the customer level.
7) Private label and branded product pricing policies and their effect on profit.
8) Linear programming applications in resource allocation problems. This will help to quantify for multiplant operation questions like:
    a) Do I need all of my present plants and production capacity?
    b) If not, which ones should I close?

c) How can I allocate my production and transport resources to minimize my total cost?

9) Strategies concerning number and location of thrift stores and re-distribution depots.

This list is not complete or comprehensive, but is suggested as areas which offer potential savings. With competitive pressures being placed on wholesale bakers by captive bakery chains, it is paramont that all alternative methods available to increase productivity and profitability are investigated. The key for an individual plant to survival rests in its ability to market a quality product at a cost less or equal to than its competitor. Survival of the wholesale baking industry, as we perceive it today, will require a reduction in the duplication of distribution services. Presently, unlike FAA route control in the airline industry, the government is opposed to the reduction of competition. If this is not changed, there will continue to be a high attrition rate of wholesale bakeries.

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PROFIT IMPROVEMENT IN BAKERIES BY USE OF METHODS ANALYSIS

by

STEVEN ALBERT JOHNSON

B. S., Kansas State University, 1967

AN ABSTRACT OF A MASTER'S REPORT

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This research is concerned with studying various functions in the wholesale baking industry and in applying Industrial Engineering techniques to improve their overall operation. The techniques that are illustrated show specifically how to increase productivity and how to reduce material costs in bakeries.

Flow from the beginning of production to the placement of product on the grocery shelf is discussed. Each phase of the operation is treated with special emphasis on implementing a statistical weight control program. Improved methods are illustrated in the selecting and transporting of product. Time standards are established for the major job functions in the shipping and transport departments of bakeries.