COST OF DOING BUSINESS FOR A READY MIX CONCRETE PLANT

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PREFACE

This thesis is a direct result of holding personal interviews with various ready mix concrete producers in the State of Oklahoma. During these interviews, it became apparent that these ready mix concrete producers were in need of a standardized method and form to report their costs of doing business on a monthly or yearly basis.

It should be noted that this is a pilot study on the cost of doing business and is not an all inclusive report on the costs which a producer might experience over a period of years.

The purpose of this thesis is to:

1. Define the various expenses and to categorize these expenses into three divisions.

2. Develop a method whereby ready mix concrete producers may compare their expenses with other producers.

3. Outline a standard form that will enable all the ready mix concrete producers to report their expenses in a similar manner to the Oklahoma Ready Mix Association.

4. Emphasize the importance and value of comparing expenses between producers to determine which expense or expenses are above or below other producers in the ready mix concrete industry.

5. Discuss various aspects of the ready mix concrete industries encountered in interviews with the many producers.

It should be noted that the mathematics and analyses of the cost data presented in this thesis are not statistically oriented. The

ultimate goal of this thesis is to provide ready mix concrete producers with a standard method and form to report their costs. The mathematical calculations used lend themselves to an understanding by a person without formal course work in inferential statistics.

It is my hope that this thesis will make producers of the ready mix concrete industry cognizant of the importance of comparing their expenses with other producers and the advantages which may be gained from knowing exactly how each individual expense compares throughout the industry.

I would like to express my thanks to the Ideal Cement Company for granting me the research fellowship which has made this study possible.

I would like to express my graditude to Professor Wilson J. Bentley and Dr. Paul E. Torgersen for their invaluable guidance and assistance in the preparation of this thesis.

In the actual investigation, the writer wishes to acknowledge the immeasurable and helpful information made available by the following officials of Ready Mix Concrete companies: Mr. Fred Hammond and Frank Sessions, Lawton Transit Mix, Inc., Lawton, Oklahoma; Mr. Roy T. Hoke, Jr., Hoke Concrete Company, Stillwater, Oklahoma; Mr. Vernon L. Rogers, Rock Island Lumber Company, Ponca City, Oklahoma; Mr. Huey Hughes, Cimarron Concrete Company, Cushing, Oklahoma; Mr. Kermit Ingham, Sr., Ingham Concrete Plant, Stillwater, Oklahoma; Mr. Joe Offutt, Secretary, Oklahoma Ready Mix Association, Oklahoma City, Oklahoma; Mr. James R. Spear, Vice-President, The Dolese Company, Oklahoma City, Oklahoma; and Mr. Vincent P. Ahearn, Managing Director, National Ready Mixed Concrete Association.

In particular, I take this means of expressing my gratutude and indebtedness to my wife, Shirley D. Martin, for her advice, encouragement, and confidence in me throughout this research project. The assistance, contributions, and invaluable guidance in the typing of this thesis are duly appreciated.

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CHAPTER I

INTRODUCTION

Nearly every producer in the ready mix concrete business has developed his own particular method for recording the various expenses associated with the operation. Consequently, each producer has either formally defined or by past experience devised a workable scheme for reporting these expenses. Due to the obvious inconsistencies which appear when expense comparison between producers are attempted, it is apparent that a standard form for reporting and comparing these expenses would be most helpful. If a standard form were adopted by all the members in the Oklahoma Ready Mix Association, it would prove invaluable as a guide for comparing costs between producers in the concrete business. It should be noted, however, that each individual expense item should be defined and explained to fully utilize and understand such a form. Defining each expense would enable a producer to categorize them in their respective divisions. Thus, a standard form would allow producers to compare expenses on a similar basis.

"To make better competitors out of my competitors makes me a better competitor." This statement was made by one producer in the course of an interview and was made in relation to devising a method so that producers could compare their costs of operation. To be able to compare costs and determine which costs are high relative to other producers is a necessity if a producer is striving to maintain an economical and efficient operation.

The major objective of any business is to realize a profit. One of the most important aspects of finding these profits is to keep an accurate account of all costs incurred in the plant operation. If all expenses are recorded then the chief objective of every accounting system can be attained; that is, to assist management in keeping the costs below the ceiling prices fixed by the Government, or below the selling prices the consumer is able and willing to pay for the product in a competitive market.

To keep costs down, it is necessary to guard expenditures carefully and to get full value from all expenditures of time and money. Safeguards must be established at the point where costs enter the functions of production, of distribution, and of general administrative expenses, rather than at the point where they culminate at the end as final cost of the product made or sold.

In the concrete business, not only are plans needed for the activity of production, the sequence of operations, the quality and quantity of the product, the method and place of performance of labor, but also equally adequate plans are required for the important costs to be incurred. Not only is it necessary to plan production, delivery and administrative functions, operation by operation, but it is also necessary to plan costs, operation by operation.

Statement of the Problem

The cost of doing business in a ready mix concrete industry could have immeasurable favorable results if all producers would use the same method of reporting their costs. It is the objective of this thesis to present to the management of a ready mix concrete plant operation a

standard form for reporting the costs of doing business, and to allow these producers to compare their costs with the other producers throughout the ready mix concrete industry.

The initial area discussed in this thesis is the history of ready mix concrete. This chapter should be of interest to anyone either in or associated with the ready mix concrete business. In Chapter II, an attempt is made to discuss all of the various cost factors involved in the production phase of concrete. From the production phase, the next discussion is the costs involved in delivery operation. Chapter IV consists of the costs in the general and administrative aspects of the business. It should be noted that costs should be used primarily as a method of control. Without this control, no company is operating at its peak performance. In each chapter, the costs which are associated with each of the phases are defined and set down in a standard form. Also, there are various discussions on several topics that were discussed during the personal interviews with the various concrete producers. These topics are discussed in Appendix A.

The method outlined in this thesis is a relatively simple procedure to follow. However, it should be emphasized that if all of the concrete producers would employ this standard form, it would aid them in comparing their costs and facilitate the determination of which of their expenses are above or below those of other producers in the industry. Consequently, a producer could take the necessary steps to correct these deficiencies and provide for a more efficient and economical operation. The figures used in this thesis are merely examples, or averages, and are not actual cost figures as much of the information collected was of a confidential nature.

CHAPTER II

EARLY HISTORY OF READY MIXED CONCRETE

Undoubtedly, the first concrete produced contained some sort of a mixture of cement, sand, rock, and water. The tool used to mix these ingredients was some sort of an implement such as a hoe or shovel. These ingredients were, in all probability, placed on some dry surface and agitated according to the desire of the user.

One of the first reports of a mobile concrete apparatus appeared in the "Press" in Sheridan, Wyoming, in April 2, 1909. This featured story on a portable concrete mixer described it as follows:

> The mixer is in the shape of a cube, about two and one-half feet square, and is constructed upon two wheels, with a tongue, and is drawn by two horses. It holds about a quarter of a yard of material. A small tank on the mixer supplied water, and the mixer operated as the horses drew it along the street, within a block mixing the contents more thoroughly than could be done by hand, thus saving considerable time and labor.[1]

This cube-shaped mixer was the beginning stage in the evolution of the modern day cylindral mixers mounted on massive trucks. The article stated that the delivery of concrete by ordinary dump trucks from central mixing plants began just prior to World War I. Baltimore, Maryland, has been cited as the scene of the first such delivery. By the early 1920's two Oklahoma companies were producing as much as 1,000 cubic yards of concrete per day in central plants. By observing a ready mix plant in operation today, it is apparent why ready mix concrete has had such a

tremendous growth. Ready mixed concrete is convenient to use, economical, and has accelerated construction beyond previous expectations.

There have been many experimental truck designs to facilitate the hauling of concrete. Some of the early experimentors proposed truck bodies with swinging rear gates, as well as bodies with crank operated gates in fixed rear ends. Others supported trucks with fish-tail rear ends, or with bodies with "bath tub" or curved sections. Some trucks were equipped with an agitator unit to prevent the concrete from "setting up" while it was in transit.

The first man to be given credit for designing a self discharging motorized transit mixer was Mr. Stephan Stepanian of Columbus, Ohio. He applied for a patent in 1916, but was refused because the Patent Office did not agree that there were sufficient grounds for patenting a truck and mixer combination.

Through the 1920's, various experiments were conducted with trucks and mixer attachments. However, it was not until 1930 that several truck manufacturers began offering transit mixers specifically designed to haul ready mix concrete. In 1937, the first high discharge mixer appeared on the market. This mixer was an overnight success and manufacturers accelerated their production rate to fill their ever-growing demand for high discharge mixers. The popularity of this mixer stimulated the manufacturers to increase the capacity of the mixer. Consequently, several manufacturers began making transit mixers of 3-, 4-, and 5-cubic yard capacities.

Due to increase in capacities of mixers, it was necessary to change the methods of batching the concrete into the mixers. Many techniques for batching the concrete were tried. Many were disgarded. There were

various methods for disseminating the components of concrete in the correct proportions, until it was found that weighing each of the ingredients was the most efficient and economical way.

The general trend since 1930 has been toward greater efficiency in handling and standarization of the product. The formation of the National Ready Mixed Concrete Association in 1933 has given the industry an immeasurable boost. There are many State Ready Mix Associations who also facilitate the dissemination of new ideas and developments for improvement in the concrete industry. Both the State and National Association have worked hand-in-hand to establish the standards of a ready mix producer. The growth of Ready Mix producers speaks for itself. In 1925, there were 25 ready mixed concrete operations in the United States. Today, there are several thousand plants in the industry.

CHAPTER III

PRODUCTION EXPENSES

The major objective of a ready mix concrete business as well as any other business is to realize a profit. One of the most important factors in maximizing these profits is to control the cost of doing business. The control of costs depends on how well the management endeavors to actually pinpoint each individual cost. If each of the expenses are defined and a cost value determined, it is a relatively simple matter to discover the costs which are too high when compared with the costs of other producers in the concrete industry. This is the apparent reason for separating these costs into three divisions; namely, Production, Delivery, and General Administrative expenses. There is no guarantee that this method will reduce costs, but it will serve as a basis for determining which area should receive concentration in reducing costs. Each expense related to the production phase will be discussed individually.

To determine which expenses should be included in the production operation, it is first necessary to define the production phase. The production phase in a ready mix concrete company encompasses all of the activities needed to ready the raw materials for making concrete. This includes the purchasing and receiving of the cement, rock, sand, and other additives at the plant and the conveyage of these ingredients into storage bins where they are then stored for immediate dispatch until an order has been received. In terms of the concrete industry -

production expenses are defined to include all costs to the point of charging the batch or mix into the trucks.

For clarification, it is deemed necessary to make an attempt to define and explain each production expense individually and to relate the duties of the jobs in this phase. The following is a suggested list that would be representative of this phase of the operation:

Purchase of Raw Materials

A. Cement - This should include the cost of cement and the freight charges. (Usually purchased by the barrel, ton, or carload, or 94-pound bags.)

B. Rock - This should include the cost of rock and freight charges. (Purchased by the ton.)

C. Sand - This should include the cost of the sand, plus the freight charges. (Purchased by the ton.)

D. Other Additives - This should include the cost of the additives and delivery charges, if any. (Purchased in various containers, such as 100-pound bags, barrels, etc.)

To record the expenses associated with the purchase of raw materials, it is necessary to take a physical inventory of these items. Since there is no exact method for obtaining how many tons of cement, rock, and sand a producer will have on hand at the end of an accounting period, an estimate must be made. Thus, a producer, by past experience, will estimate how many tons of each item is remaining in inventory. Due to the chance of human error in this estimate, a producer should attempt to account for these items accordingly. To further illustrate this discussion, suppose the following is a particular case:

Item	
Rock	
Beginning Inventory	100 tons
Rock Purchases	50 tons
Total Inventory	150 tons
Less Amount Sold from Orders	60 tons
Ending Inventory	90 tons

Suppose that a producer, after checking his customer orders, estimates his ending inventory of rock to be 95 tons. Therefore, according to the producer's estimate, there is a 5-ton overage. To balance his accounting procedure, this 5 tons should be termed as income and recorded as such. Similarily, if the estimate proves to be 5 tons short, it should be recorded as an expense.

Salaries (Production)

A. Batch-Man - The duties of this job includes the weighing of each ingredient that is dispatched from the storage bins directly into the mixers onto the trucks. The batch-man is informed by the dispatch clerk that an order has been received. He then dispatches the raw materials according to customer specifications.

B. Dozer Operator (Conveyor Operation) - The duties of the dozer operator consists of supplying the storage bins with rock and sand by use of a conveyor belt system.

C. Cement Unloader (Railroad Cars) - Railroad cars must be unloaded by hand. The cement unloader stands on top of the car and uses a long-handled hoe to unload the cement through the bottom of the car onto a conveyor directly below the tracks. This conveyor transports

the cement up into the cement storage bin. If the cement is hauled in trucks, the trucks are unloaded by an air operated device directly into the cement storage bins.

D. Crane Operator (Crane Operation) - The duties incompassed in this job consist of supplying the storage bins with rock and sand via a crane.

E. Other Yardmen - This category should include any other personnel employed in the production phase.

The two methods used to transport rock and sand into the storage bins are: (1) a tractor-conveyor system, and (2) a crane loading operation. Due to the interest shown by the various concrete producers concerning which type of operation would facilitate production, a discussion of the advantages and disadvantages of both systems is included in Appendix A.

Rentals

In the operation of a ready mix plant, it is almost certain that at one time or another, it will be necessary to rent some type of equipment. In general, this equipment will be a dozer, tractor, dirt mover, etc.

Utilities

The utilities, include gas, lights, and water. The gas and lights used would be for heating and lighting the batch-man's office and the general offices. Water is, by far, the biggest expense of the utilities. Water is one of the major ingredients of concrete, and is used extensively for cleaning the mixer after each delivery.

Depreciation

Broadly speaking, depreciation is the lessening in value of physical assets with the passage of time[2]. Depreciation in the production phase consists of the plant, the conveyor, and the tractor (dozer) or crane. Most of the producers interviewed employed a public accountant outside of the ready mix plant to calculate depreciations. This is due largely to the ever-changing laws pertaining to depreciation.

Insurance

The insurance in this division was on the plant building.

Payroll Taxes

Employers' taxes for old age benefits and unemployment compensation represent additional costs to the business and should be considered a part of the cost of production. This also includes state and federal taxes as required by law.

Other Taxes

This item would include all other taxes charged to the production phase of the ready mix operation.

Repairs

This category includes maintenance on the plant building, conveyor, tractor or crane, or any equipment used in the production phase.

Miscellaneous

This listing is designed as a "catchall" item to include any expenses which a producer might experience that would be related to the production aspect of a ready mix operation.

Control Precaution in the Production Phase

Since the largest expense associated with production expense is that of cement, control of this expense item is necessary. Cement, as well as rock and sand, is added to the mixer by weighing each of the ingredients individually. Should the scales become unbalanced, the apparent result would be an inferior concrete and would fail to pass the concrete standards. Too much cement would be expensive. Consequently, many producers have contracts with scale manufacturers to check their scales periodically. This precaution is imperative if a producer is striving to maintain a quality product and still operate as efficiently as possible. This particular point was emphasized during one interview. The producer found that after many months of operation, his scales were not balanced and that too much cement was being added to the concrete according to specifications.

An attempt has been made to define the expenses that are related to the production phase of a ready mix concrete plant. This list is not all inclusive and it is realized that many producers would have additions and/or deletions of the previous-mentioned expenses. The important factor to take into consideration when making additions or deletions to this list is to do so only when the expense is related to the production phase and not to one of the other two divisions. In

other words, make sure that the expense under consideration is related to that phase of the operation when it is placed in that category.

One of the major objectives of this thesis is to provide a basis for comparing expenses between ready mix concrete producers throughout the State of Oklahoma. There are many ways and means of comparing expenses. In the ready mix concrete business, concrete is sold by the cubic yard. Since concrete sold by the cubic yard is a common factor to all producers, this should be the basis used for expense comparisons. If all expenses are based on the cubic yard of concrete sold, and is reported as such to the Oklahoma Ready Mix Association, it would be a simple task for the Association to calculate the costs for each expense item and distribute these figures to all member producers.

Once these comparisons have been made, based on the cubic yard of concrete sold, a producer could immediately decide which of his expenses are above the calculated values and strive to take the necessary corrective measures. Table I is a suggested form for listing all expenses associated with the production phase of the operation. Each of the expenses listed in this table is also based on the cubic yards of concrete sold. It should be noted that these expenses are merely examples and not an actual expense listing from a company that was interviewed.

Following are sample calculations used to express production expenses in Table I in cents per cubic yard of concrete sold:

A. Average selling price per cubic yard

$$\frac{\text{Total sales}}{\text{Total yards sold}} = \frac{\$23,370}{1,635\ \text{yd}^3} = \$14.29/\text{yd}^3$$

TABLE I

PRODUCTION EXPENSE LIST

Month of January, 1962	Per Yd*			Total to Date** Per Yd.		
Income:						
Total Sales			$23,370			
Production Exp.						
Cement	4.8920	$8,000				
Rock	2.8920	3,600				
Sand	1.0640	1,740				
Additives						
Salaries	.6700	1,095				
Rentals	.0110	18				
Utilities	.1500	245				
Depreciation	.2780	455				
Insurance	.0980	160				
Payroll Taxes	.0306	50				
Other Taxes	.0196	32				
Repairs	.0477	78				
Miscellaneous	.0281	46				
TOTAL	9.4900		$15,519			

Yards Sold 1635 Yards Sold _____

*Expressed in cents per cubic yard sold.

**The total to date columns are explained in Chapter V under General Administrative Expenses.

B. Expressing each individual production expense in terms of cents per cubic yard.

Cement	$\frac{\$8,000}{1635\ yd^3}$	=	$\$4.892/yd^3$
Rock	$\frac{\$3,600}{1635\ yd^3}$	=	$\$2.201/yd^3$
Sand	$\frac{\$1740}{1635\ yd^3}$	=	$\$1.064/yd^3$
Additives			
Salaries	$\frac{\$1095}{1635\ yd^3}$	=	$\$0.670/yd^3$
Rentals	$\frac{\$18}{1635\ yd^3}$	=	$\$0.011/yd^3$
Utilities	$\frac{\$235}{1635\ yd^3}$	=	$\$0.150/yd^3$
Depreciation	$\frac{\$455}{1635\ yd^3}$	=	$\$0.278/yd^3$
Insurance	$\frac{\$160}{1635\ yd^3}$	=	$\$0.098/yd^3$
Payroll taxes	$\frac{\$50}{1635\ yd^3}$	=	$\$0.036/yd^3$
Other Taxes	$\frac{\$32}{1635\ yd^3}$	=	$\$0.0196/yd^3$
Repairs	$\frac{\$78}{1635\ yd^3}$	=	$\$0.0477/yd^3$
Miscl.	$\frac{\$46}{1635\ yd^3}$	=	$\$0.0281/yd^3$

Thus, each individual expense item is expressed in cents per cubic yard of concrete sold. Producers could easily compare costs on this basis. There are many ways the Oklahoma Ready Mix Association could calculate these costs and distribute this information to its members. Due to the fact that the cost data collected was limited and confidential, the method chosen in thesis was to represent some example figures as percentiles.

Explanation of Cost Data Analyzation

Since this thesis is considered to be a pilot study, serious consideration was given to the various ways of analyzing the cost data that was collected from the ready mix concrete producers. To analyze the cost data on an average basis would present a distorted over-all picture, due to the limited number of producers interviewed. It was deemed necessary, however, to present a method for analyzing cost data on an average basis. If all producers would conform and adopt the suggested standard form outlined in this thesis, it would then be possible to present cost data on an average basis. In all probability, the normal curve would be used to compare costs on a national basis. This method is presented in Appendix B of this thesis.

To summarize the cost data of this limited number of producers, the median will be used and calculation of various percentiles are performed to show the relative costs between each individual expense item. A ready mix concrete producer could use these percentiles to compare each of his expense items with other producers in the concrete industry. To explain the method used in the following example, several terms should be defined. These terms are defined and explained in the following paragraphs.

The median may be most simply defined as the middle measure in a series in which all measures have been arranged in the order of their size.[3] In other words, the median is that point on the scale above and below which an equal number of the items or frequencies lie. As an example, (a) in a series such as 2, 4, 7, 8, 9, 13, 15, the median would be 8 (the middle measure). (b) In a series such as 2, 4, 7, 8, 9, 13, the median would be 7.5.

The steps to be followed in computing the median are a special case, in general, of calculating percentiles. A percentile is the point on a scale of values below which any given per cent of the items fall.[3] The median is the 50th percentile, or may be considered as the value below which 50 per cent of the items will fall. It may be that the 10th, 25th, 87th, etc. percentile is desired. These percentiles would be found in a similar manner.

It should be noted that the 25th, 50th, and 75th percentiles are known as the quartile points in a given distribution. Therefore, after the median is located, each half of the sample may again be divided into equal parts by the quartiles. The lower quartile, usually called the first quartile, is the observation which separates the lower quarter of the observations from the upper three-quarters. Thus, the lower quartile is the 25th percentile and is usually denoted by Q_1. The 75th is the third quartile, or Q_3, while the 50th is the second quartile, or median. The even 10th percentiles are often referred to as the deciles. Thus, the 20th percentile is the second decile, the 30th, the third, etc.

To illustrate the above procedure, assume that the Secretary of the Oklahoma Ready Mix Concrete Association has received cost data from ten ready mix producers. These producers have presented their expenses in the suggested standard form (shown in Table I). Each have attempted to list their production expenses according to the descriptions and definitions given in this chapter. In Table II, these ten companies have reported their depreciation cost. These depreciation charges were calculated so as to express these costs in cents per cubic yard sold. In Table II, it is obvious that the median lies

TABLE II

PRODUCTION PHASE DEPRECIATION

Companies	Depreciation*
Producer #1	0.07
Producer #2	0.11
Producer #3	0.14
Producer #4	0.15
Producer #5	0.17
Producer #6	0.18
Producer #7	0.19
Producer #8	0.22
Producer #9	0.28
Producer #10	0.34

*Cents per cubic yard sold.

between the fifth and sixth depreciation value (the middle measure). The median would be equal to 0.175. A graphic illustration of these depreciation costs are shown in Figures 1 and 2. Figure 1 shows depreciation costs on the horizontal scale and the number of companies on the vertical scale in a histogram. The histogram is the most common graphical presentation of frequency tables. These figures consists of rectangles, the bases of which are supplied by the class intervals, (in this case the depreciation costs) and the heights of which are determined by the corresponding frequencies (in this case the number of companies reporting). It should be noted that only by observation of the data, the .08 intervals were chosen. These .08 intervals are purely arbitrary and could be any numerical value depending upon the number of classes the analyst wishes to represent.

Figure 2 shows depreciation costs on the horizontal scale and percentiles on the vertical scale. This line graph presents the depreciation costs in terms of percentiles so that a producer could look at this graph and determine how his depreciation costs compares with the other nine companies in Table II.

From Figure 1, a producer could determine the number of companies that reported their depreciation cost below or above a certain amount. A producer could determine if his depreciation were about average when compared to other producers. From Figure 2, a producer could find the per cent of companies that reported above or below his costs. Suppose a producer reported his depreciation costs to be 0.16. To find the percentile of the cost, Figure 2 would be used. On the horizontal axis a producer would locate 0.16 moving vertically to the line of the graph, then horizontally to the left to find that his depreciation costs were

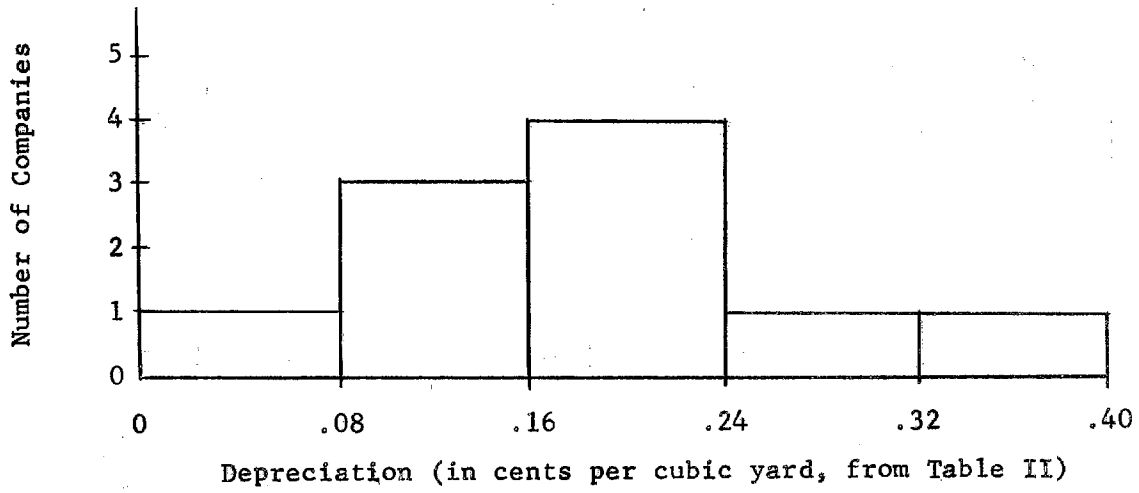

Figure 1. Histogram of Depreciation Costs

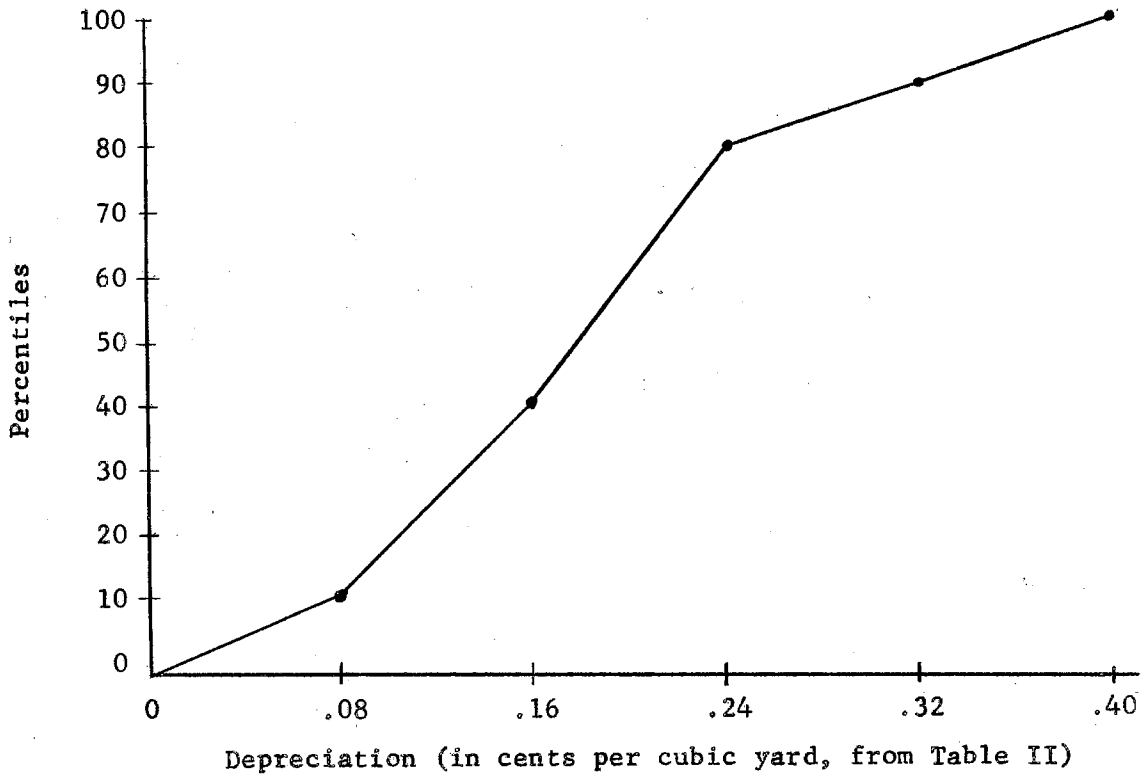

Figure 2. Line Graph of Depreciation Costs

approximately in the 40th percentile. In other words, this producer's depreciation costs are ten per cent below the average. From these two illustrations, it is easily seen that producers could compare depreciation expenses, or any expense, and determine what percentile of the entire industry their depreciation expense lies.

Each individual production expense could be calculated and presented in this manner and producers could easily compare his expense to those reported by other producers. If an expense was above the industry's average, a producer could concentrate his efforts to reduce this particular item. This could only be accomplished if all producers would define and categorize their expenses in an identical manner. It is realized that every producer has devised his own method for accounting for his production expenses, but it would be necessary for clarification purposes for all producers to attempt to list their expenses in a standard form if comparisons are to be accomplished.

A problem that arises in some industries is determining where the cost of production ends and the expense of selling and distributing the product begins. As a general rule, the cost of production is considered as ending when the product reaches a salable condition.[3] Sometimes the difficulty of deciding what is a salable condition makes it difficult to determine whether certain expenditures are costs of production or delivery expenses. In this thesis, the writer is assuming that any expense incurred in the purchasing and handling of the raw materials (cement, rock, sand, and other additives), the equipment used to handle this material, the rentals used, the depreciation, insurance and repairs on the equipment and building, the salaries of yard personnel, the utilities utilized, and any other expense experienced just prior

to disseminating the raw materials into the mixer are production expenses.

CHAPTER IV

DELIVERY EXPENSE

Delivery expenses in a ready mix concrete company operation consists of all expenses incurred on the equipment involved in deliveries, the salaries of all truck drivers and mechanics, depreciation and repairs on the equipment, insurance, truck licenses, i.e., any expense which occurs from the time that the raw materials (cement, rock, sand, and additivies) are received from the storage bins into the mixers on trucks until the concrete is delivered to the customer location and unloaded of its contents and truck is returned to the plant site to await further concrete orders. More simply, delivery expenses include all costs from the point of charging the batch or mix into the trucks to delivery of the concrete at the job site.

During the personal interviews with the producers, it was frequently found that they did not attempt to categorize their expenses in a division such as delivery expenses. Many attempted to breakdown this function as truck expense to include gas, oil, grease, tires, repairs, depreciation, etc. In most cases, the personnel involved with delivery was not charged to this particular section. Some of the producers operated on a day-to-day basis and arrived at their profits on a sales versus cost of materials basis. This method will undoubtedly suffice at least for a short period of time; however, if producers are to maximize profits, they must be able to pinpoint any excessive cost and seek a remedy for this extravagance.

In a ready mix concrete operation, a producer must define and analyze these delivery expenses if an economical and efficient business is to be maintained. Economy of delivery expenses requires careful control of these costs to insure that these expenditures are made as effectively as possible in achieving the purposes of the enterprise.

To enable a producer to report his costs to the Ready Mix Association, an effort is made to define and explain the various expenses which should be classified as delivery expenses. The following is a suggested list for delivery expenses:

Salaries

The salaries relative to the delivery phase would include truck drivers and mechanics. The purchasing of manpower is one of the highest expenses in any business concern and this is particularly true of a ready mix concrete operation. One of the greateast problems a producer is confronted with is the utilization of manpower in the slack periods of the business. A ready mix company must rely on customers to order concrete continually if it is to fully utilize the manpower it must maintain on the payroll at all times. If a producer is not fully utilizing his manpower and equipment, a larger sales force should be employed or other remedies sought.

Depreciation

The depreciable amount of a truck and mixer should be spread in equal amounts over the life span of the asset; the amount is ordinarily expressed as a per cent of cost. The most widely used method to figure this depreciation is the straight-line method. Ordinarily, depreciation computed by this method represents the actual diminution in

value from year to year as closely as the depreciation computed by any other method. The practical simplicity in accounting records required and the ease and facility by which revisions or changing life estimates may be applied tend to make this method the most acceptable one for general use.

In most cases, however, the mixer will remain in operative condition much longer than the truck. Therefore, the depreciation for the mixer and the truck should be calculated separately and adjusted accordingly. The straight-line method of depreciation assures that depreciation is equal each year of the life of the asset. For example, suppose a ready mix concrete truck and mixer has an original cost of $8,000 and $6,000, respectively. To correctly account for the depreciation of the truck and mixer, each should be separately calculated as shown in Figure 3 and 4. To explain these figures, the following is given as an example:

	Truck	Mixer
Original Cost	$8,000	$6,000
Estimated Life	5 yrs.	8 yrs.
Estimated Salvage Value	1,000	400
Total Depreciation =	($8,000-$1,000) = $7,000	($6,000-$400) = $5,600
Depreciation each year =	$\frac{\$7,000}{5 \text{ yrs.}}$ = $1,400	$\frac{\$5,600}{8 \text{ yrs.}}$ = $ 700

Insurance

Expenditures for insurance premiums include a various array of coverages against losses from differing causes and, in this case, the insurance is related to the delivery aspect of a ready mix concrete

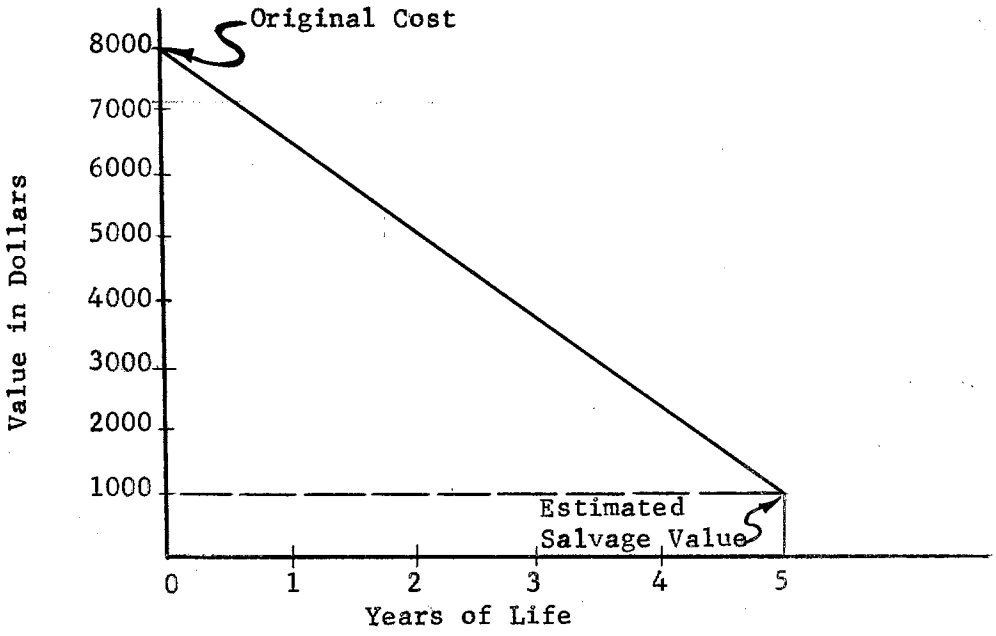

Figure 3. Straight-Line Method Depreciation for Truck.

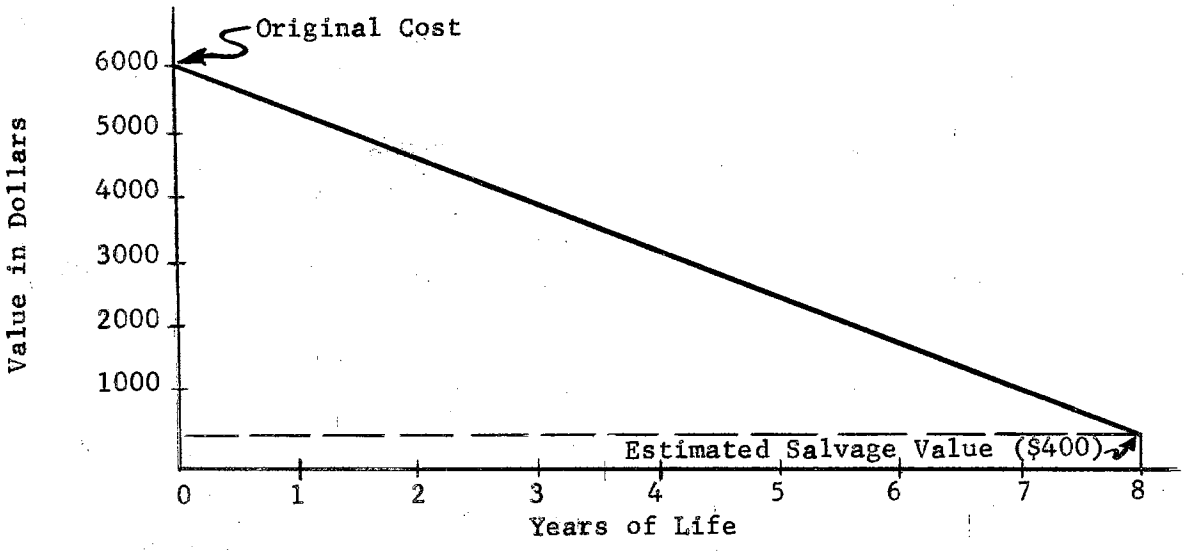

Figure 4. Straight-Line Method Depreciation for Mixer.

organization. This particular item would consist of health and accident insurance, liability, comprehensive, workmens' compensation, etc.

Payroll Taxes

In some states, personal income taxes must be withheld from employee's pay by the employers. The same problem is presented in any withholding tax requirement, such as the various federal withholding taxes.

Although no signed authorization is required of the employee to start deductions for personal income taxes, a signed statement of personal exemptions is usually necessary to determine the starting point of tax deductions each year.[5] The taxes referred to are those charged against the truck drivers and mechanics.

Repairs and Maintenance (truck and mixer)

Maintenance and repair expenditures are costs of maintaining the trucks and mixers in efficient working condition without increasing the productive capacity or appreciably extending the life of assets beyond the span contemplated in setting depreciation rates. In a ready mix concrete operation, this item is one of the largest problems of the producer. To maintain a constant maximum output, the producer must consistently employ ways and means to keep his ready mix trucks in operation the full time. The responsibility of maintaining a full operating truck force should be shared by the truck drivers and the mechanics. The truck drivers should report any equipment on the truck or mixers which are not operating correctly. The mechanics should check and repair any inoperative functionary equipment on the trucks

and mixers daily. The truck drivers should remain alert to any malfunction of the equipment and should be aware of the hazards and dangers involved to the equipment when making deliveries to congested or close quartered areas, such as building construction, highways, etc.

Gas, Oil, and Grease

These items are particularly expensive to delivery costs. However, it is the duty of the truck drivers and mechanics to insure that the equipment is properly lubricated and a gas level maintained so that the truck will not run out of gas in the course of a delivery.

Tires and Tubes

Another item which can be controlled to an extent are the tires on the trucks. Again, truck drivers should inspect the area of delivery and arrival to insure that the area is free of any foreign materials which could cause a puncture. Needless to state, that one blow-out could affect the expected profits from the customer order.

Repairs (tires and tubes)

This self-explanatory item includes the repairs of tires and tubes in the course of everyday delivery operation.

Truck and Automobile Licenses

Plant automobiles and truck licenses are expenditures charged to prepaid accounts. In turn, they should be reduced to delivery expenses and prorated evenly over a one-year period.

Two-Way Radio Control Unit

The repair and maintenance on radio control units is, in general, relatively small compared to the function the unit performs in everyday operations.

Included in Appendix A is a discussion concerning radio-controlled trucks versus non-radio-controlled trucks. One producer in particular and others expressed concern about the advantages and disadvantages of maintaining radio-controlled trucks.

The delivery expenses in Table III, expressed in cents per cubic yard, were calculated in the same manner as those expenses of production listed in Table I. Following are the calculations used:

Expressing each delivery expenses in terms of cents per cubic yard.

A. Salaries $\frac{\$1080}{1635\ yd^3} = \$0.6610/yd^4$

B. Depreciation $\frac{\$419}{1635\ yd^3} = \$0.2562/yd^3$

All of the individual expenses in Table III were divided by 1635 cubic yards sold to express them in terms of cents per cubic yard.

To further explain the method used in Chapter II of expressing each individual expense in terms of percentiles, suppose the cost data for ten companies for repairs and maintenance were reported as shown in Table IV. It should be noted that the costs have been listed from the lowest cost to the highest. Also, the .12 intervals shown on the horizontal axis of Figure 5 and 6 are chosen arbitrarily.

Once again, an individual expense item is expressed in terms of percentiles. From Figures 5 and 6, those producers below the 50 percentile (the median) have repairs and maintenance costs of 0.12 or less, those in the 90th percentile have repair and maintenance costs

TABLE III

DELIVERY EXPENSE LIST

Month of January, 1962	Per Yd*		Total to Date	Per Yd.		
Income:						
Total Sales			$23,370			
Delivery Expense:						
Salaries	.6610	$1,080				
Depreciation	.2562	419				
Insurance	.0599	98				
Payroll Taxes	.0465	76				
Repairs & Maint.	.3110	508				
Gas, Oil, Grease	.3119	510				
Tires & Tubes	.1223	200				
Truck Licenses	.1529	250				
Two-Way Radio	.0031	5				
Miscellaneous	.0226	37				
TOTAL	1.9474		3,183			

Yards Sold 1635 Yards Sold _____

*Expressed in cents per cubic yard sold.

TABLE IV

DELIVERY PHASE - REPAIR AND MAINTENANCE

Companies	Repair and Maintenance Expense*
Company #1	0.11
Company #2	0.18
Company #3	0.23
Company #4	0.30
Company #5	0.31
Company #6	0.33
Company #7	0.35
Company #8	0.43
Company #9	0.46
Company #10	0.52

*Expressed in terms of cents per cubic yard sold.

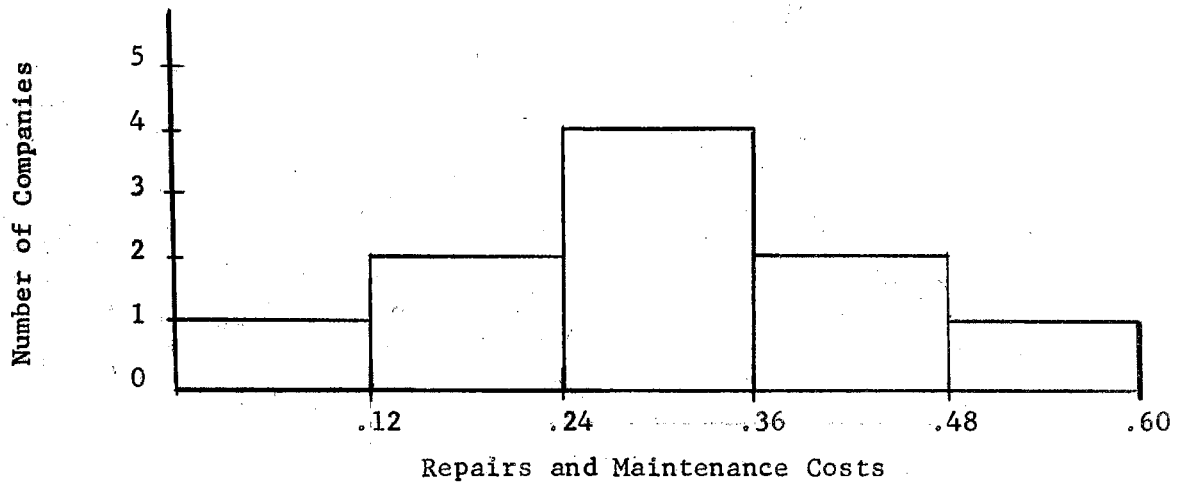

Figure 5. Histogram of Repairs and Maintenance Costs

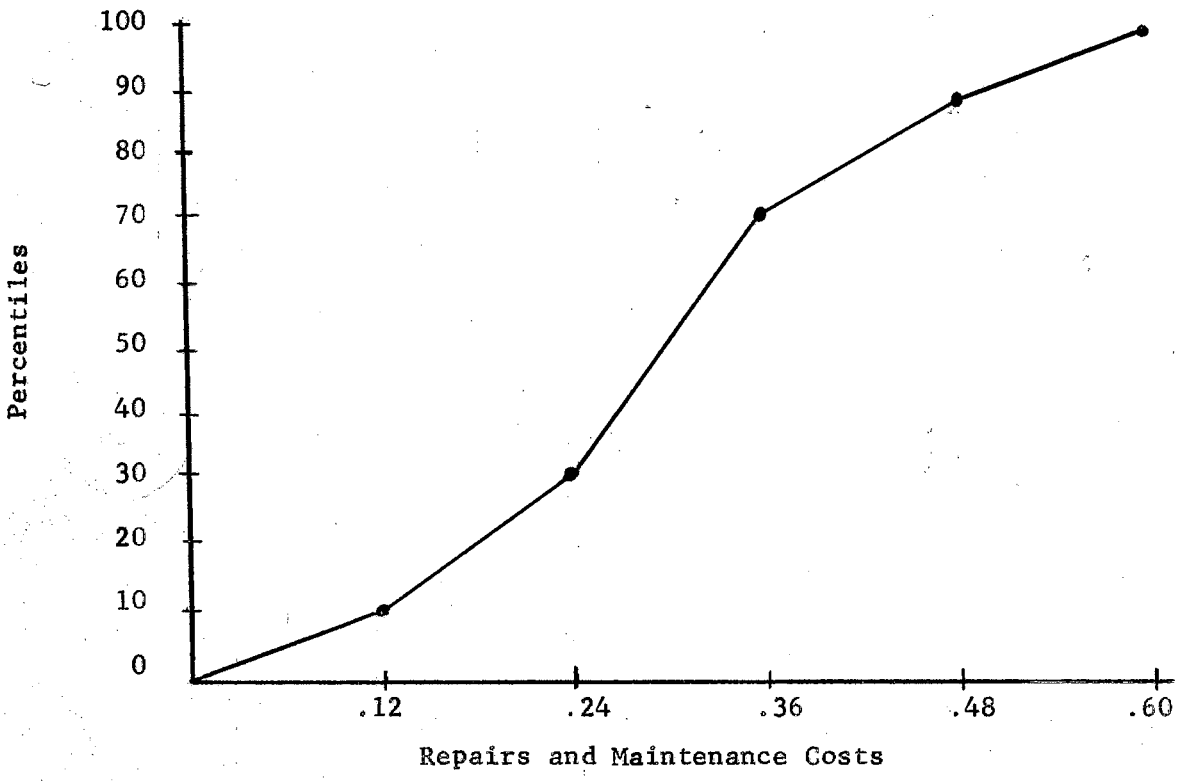

Figure 6. Line Graph of Repairs and Maintenance Costs

of 0.48 or more. Thus, a producer could easily compare his repair and maintenance costs with the other producers if this were an actual representative sample.

CHAPTER V

GENERAL ADMINISTRATIVE EXPENSE

Complications involved in preparing the general administrative expense list are few and the area covered is generally well-known. General administrative expenses are based largely on the past experience of the ready mix concrete producer. The most important item to be included in this category is salary. If a company has a well-defined salary policy and all the adjustments of salaries are considered before the beginning of the expense period, the most likely variable to arise results from increases on reductions in administrative personnel. Most other items encompassed in general administrative expenses may be forecast on the basis of past experience modified by any prospective changes in the organization or the available income.

Since many of these expense items are generally familiar, little discussion is required, if any. The following is a proposed list to be included in the general administrative expense classification:

Salaries

In most cases, the companies that were interviewed listed their administrative salaries in the following category:

A. Officers' Salaries

Most ready mix concrete companies are one-owner companies. However, some are family-owned organizations. The officers' salaries are usually delegated as those of the owners or major stockholders.

B. Sales Salaries

The size of the producer will have a large effect on this sub-category. In the larger firms there is usually a sales manager and a various number of salesmen. In smaller organizations, the solicited sales is handled by the owner or the plant foreman.

C. Other Salaries

This "catchall" salary item includes the dispatcher, accountants, bookkeeper, or any other clerical personnel that is required.

Rent

Most ready mix concrete plant sites are located adjacent to the railroad tracks. Many times the land (right-of-way) is owned by the railroad, and must be leased from them. If this is the case, the lease expense should be prorated on the lease period.

Depreciation

Depreciation in this particular instance, includes the general office building, company automobiles, and office equipment. Depreciation for these items are generally handled by an accountant not employed by the firm.

Payroll taxes

This expense should be the same for administrative personnel as was previously discussed in the chapter on production expense.

Supplies

Supplies would be items such as customer order blanks, office stationery, pencils, etc. Also, the postage required to send monthly

statements and any form of written communication with the exception of telegrams.

Travel and Entertainment

This should be an expense encompassing the entertainment of businessmen visiting the firm. Also, it would consist of any travel expenses by employees and officers in the line of duty, such as attending various ready mix concrete association meetings, etc.

Telephone and Telegrams

Any communication expense such as, telegrams, long distance telephone calls, and monthly telephone charge.

Advertising

In advertising, the important item of cost relates to the advertising media used. The media most used by ready mix concrete companies are magazines, newspapers, and car cards. The amount designated for this item would depend on the size of the company involved.

Automobile Expense

This would include gas, oil, tires, and maintenance of the company cars.

Bad Debts

This particular account can be handled in various ways. If an account is not paid at the end of the accounting period, it should be written off and charged to the account allowance for bad debts. If

the customer pays this account at a later date, the account should be cleared to protect the customer's good name. There are numerous methods for manipulating this procedure and a qualified accountant should be consulted on this matter.

Donations

Donations to charity and gratuitous gifts to various organizations are listed as this expense item.

Subscriptions and Dues

Subscriptions are capitalized if it represents a substantial amount. The capitalized amount is reduced to an expense item by equal annual and monthly expense charges. It includes industry journals, pamphlets, magazines, etc. The dues refer to the ready mix concrete association fees.

Legal and Auditing

Services rendered by attorneys in connection with purely organizational matters, or of a general character when not excessive, may be treated as regular administrative expense.

The auditor's fee should be charged to administrative expenses. The auditor relies on the accounting system used and firm's files to validate his findings. His purpose is to protect the producer in any way deemed legal.

Rentals

In this category would be the rentals of office equipment, or machines needed in the everyday operations.

Miscellaneous

Under this item, producers could list the specific expenses not included elsewhere in the General Administrative division. These general administrative expenses are listed in Table V.

An effort has been made to list expenses related to a general administrative division. Each individual expense is based on cents per cubic yard of concrete sold. It is realized that many of the expenses in this particular category could be combined, but since one of the objectives of this thesis is to define and explain each expense, only the very minor expenses are combined.

To further show the significance of this method, an analysis of these expenses is illustrated below. From Chapter II, Page 13, Item A, the average selling price per cubic yard of concrete sold = $14.29. To check the calculations performed for this particular accounting period, the "per yard" column, plus the profit per yard should equal the average selling price. The following example illustrates the above procedure:

Income:	Per Yard		
Total Sales	14.29		$23,370
Less Expenses:			
Total Production Exp.	9.4900	$15,519	
Total Delivery Exp.	1.9474	3,183	
Total Gen. Adm. Exp.	.5269	862	
Total Expenses			$19,564
Net Profit or Loss	2.3280		$ 3,806
Total	14.2923		

This total provides a producer a further check to insure accuracy in his accounting procedure.

TABLE V

GENERAL ADMINISTRATIVE EXPENSE LIST

Month of January, 1962	Per Yd*			Total to Date Per Yd.		
Income:						
Total Sales			$23,370			
Gen. Adm. Exp.						
Salaries	.3058	$ 500				
Rentals	.0061	10				
Depreciation	.0018	3				
Payroll Taxes	.0122	20				
Supplies	.0146	24				
Tr. & Ent'tain.	.0306	50				
Tele. & Teleg.	.0171	28				
Dues & Subscrip.	.0085	14				
Advertising	.0122	20				
Bad Debts	.0416	68				
Auto Exp.	.0355	58				
Donations	.0183	30				
Legal & Auditing	.0153	25				
Rent						
Miscellaneous	.0073	12				
TOTAL	.5269		862			

Yards Sold 1635 Yards Sold _____

*Expressed in cents per cubic yard sold.

To enable a ready mix concrete producer to know his exact standing at any period during the year, a "total to date" column should be employed. These columns provide for the same identical information as the month columns except that the producer has a current running account of his standing. Table VI provides for the month of February in addition to reporting expenses for January and February combined. The January totals are merely added to the February totals and the same calculations performed.

For example:

		January		February		Total January & February
Yards Sold		1635		1816		3451
Income:						
Sales		$23,370		$26,300		$49,670
Less Expenses:						
Total Prod. Exp.	$15,519		$16,802		$32,321	
Total Del. Exp.	3,183		3,439		6,222	
Total Gen. Adm. Exp.	862		874		1,736	
Total Expense		$19,564		$21,115		$40,679
Net Profit or Loss		$ 3,806		$ 5,185		$ 8,991

The average selling price for January and February = $\frac{\$49,670}{3451}$ = $14.39

To insure that the calculations are correct, simply total the values obtained in the "per yard" column in Table VI. This has been done and the figures total to the average selling price for the two months combined.

This method would facilitate the accounting procedure and the producer would be able to more closely control his expenditures from knowing his exact standing at any given period of the year.

TABLE VI

OPERATING STATEMENT

Month of February, 1962	Per Yd*			Total to Date Per Yd.		
Income:						
Sales		$26,300				
Misc. Mdse.						
Net Sales	14.48		$26,300	14.39		$49,670
Less Expenses:						
Prod. Exp:						
Cement	4.741	8,610		4.810	16,610	
Rock	2.134	3,875		2.166	7,475	
Sand	1.027	1,865		1.045	3,605	
Additives						
Salaries	.7114	1,292		.6916	2,387	
Rentals	.0099	18		.0104	36	
Utilities	.0842	153		.1153	398	
Depreciation	.2748	499		.2764	954	
Insurance	.1096	199		.1040	359	
Payroll Taxes	.0281	51		.0293	101	
Other Taxes	.0231	42		.0214	74	
Repairs	.0859	156		.0678	234	
Miscellaneous	.0231	42		.0249	88	
TOTAL	9.2521		$16,802	9.3221		$32,321
Del. Exp.						
Salaries	.7687	1,396		.7170	2,476	
Depreciation	.2307	419		.2428	838	
Insurance	.0539	98		.0567	196	
Payroll Taxes	.0534	97		.0510	173	
Repairs & Maint.	.3596	653		.3360	1,161	
Gas, Oil, Grease	.2346	426		.2712	936	
Tires & Tubes	.0330	60		.0753	260	
Truck Licenses	.1376	250		.1448	500	
Two-Way Radio	.0027	5		.0029	10	
Miscellaneous	.0143	35		.0209	72	
TOTAL	1.8935		$ 3,439	1.9186		$ 6,622
Gen. Adm. Exp.						
Salaries	.2753	500		.2890	1,000	
Rentals	.0066	12		.0064	22	
Depreciation	.0027	5		.0023	8	
Payroll Taxes	.0110	20		.0116	40	

TABLE VI (Continued)

Month of February, 1962	Per Yd*			Total to Date Per Yd.		
Supplies	.0137	25		.0142	49	
Tr. & Ent'tain.	.0275	50		.0290	100	
Tele. & Teleg.	.0176	32		.0174	60	
Dues & Subscr.	.0077	14		.0081	28	
Advertising	.0110	20		.0116	40	
Bad Debts	.0325	59		.0368	127	
Auto Expense	.0429	78		.0344	136	
Donations	.0137	25		.0159	55	
Legal & Auditing	.0137	25		.0145	50	
Rent						
Miscellaneous	.0077	14		.0075	26	
TOTAL	.4836		$ 874	.5049		$ 1,736
NET PROFIT OR LOSS	2.8552		$ 5,185	2.6000		$ 8,991
	Yards Sold 1816			Yards Sold 3451		

*Expressed in cents per cubic yard sold.

CHAPTER VI

SUMMARY AND CONCLUSIONS

In this thesis, an attempt has been made to establish methods by which the producers of ready mix concrete could compare their costs. Comparisons of the costs of doing business depends upon developing a standard form which would be usable and easily applicable to all producers in the ready mix concrete industry. The costs associated with each phase of the operation should be defined and categorized in their respective divisions.

There are numerous methods possible to calculate costs. Often, the basis used is a percentage of sales. The method chosen in this thesis was to base the costs on the cents per cubic yard of concrete sold, since this is a common factor to all producers and is not dependent on local conditions. The significance of this method is that every producer, large or small, can compare costs which will have a meaning and not reflect the size of the operation. This workable method will enable a producer to compare his costs with other producers and still keep his costs anonymous.

The methods selected to analyze the cost data would be relatively easy to apply. The mathematical calculations are basic and easily understood. To illustrate the cost data graphically, a histogram and line graph was presented. These two graphic techniques are easily explainable and would be useful to ready mix concrete producers.

One of the major problems encountered in this research project was that of attempting to compare the cost data that was collected. Through the years of operation, each producer has devised his own accounting method. The difficulty, in general, was that each producer did not list and categorize his expenses in the same manner as any other producer. It is a necessity that the producers adopt a standard form and method if they are to accomplish the comparison of the cost of doing business. Only by controlling costs can a producer establish his optimum performance level. Comparing the costs of doing business enables a producer to determine the expenses which are excessive and allows him to concentrate his efforts in this particular area.

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APPENDIX A

IMPORTANT ASPECTS OF A CONCRETE OPERATION

During the personal interviews with the concrete producers, some of the producers suggested topics which they would like investigated and discussed. Two of the most frequent topics suggested are presented to further enlighten these producers to facilitate them in their operations.

Radio Control Units Versus Non-Radio Control Units

Those ready mix concrete producers which did not have radio control units in their trucks frequently asked, "Is it economical to install radio control units in our trucks?". In the personal interviews with producers, those who did have two-way radio control always stated that they couldn't operate their business efficiently or economically without these units and couldn't possibly understand how any ready mix concrete company would be without these units. From the comments of these producers, the writer of this thesis shall attempt to describe and discuss the advantages and disadvantages of those producers who have and those who do not have radio control units.

Advantages of Installing Two-Way Radio Control Units

A. Two-way radio control units provide control and maximum utilization of manpower and equipment. This is apparent from the following

examples which occur in everyday operations of a ready mix concrete company.

Example #1: Suppose, Job A has just been completed on the south side of town. The plant is 10 miles from Job A and Job B. Driver #1, via a two-way radio, calls in to report that Job A has been completed and that there is approximately one yard of concrete remaining in the mixer on this truck. Now, assume that Driver #2 calls in to report that Job B, also in the south part of town, approximately one mile from Job A, lacks one yard of concrete to be completed. The dispatcher would immediately inform Truck #1 that Job B needs one yard of concrete to be completed. Thus, from this example, Driver #2 is free to begin hauling to another customer and Driver #1 can complete Job B and also be free to haul to another customer. It is easily seen that if the trucks were not radio controlled that the manpower and equipment of these two trucks would be wasted.

Example #2: Suppose that a producer is hauling concrete to a newly built suburban housing project. Due to some unforeseen circumstances, the truck stalls at the pouring site. Assume further that the nearest phone is 3/4 of a mile away. A driver can inform the dispatcher of this predictament and the dispatcher can immediately send help. Thus, by the time a driver could walk to a phone, a mechanic or another truck can be on the scene to assist the driver in getting the truck in an operating condition. Once again, time has been saved.

From these two simple examples, it can be seen that time and money has been saved. Example #1 occurs daily and can save the producer an unestimable amount, both in the utilization of manpower and equipment.

B. The radio control unit provides the drivers with a feeling of belongingness. The drivers are in contact with every delivery function of the ready mix operation. For instance, suppose a driver has misintrepreted the address of a customer pouring site. The driver calls in to report this misunderstanding. Many times another driver will give the necessary directions before the dispatcher has the opportunity to do so. This is due in many cases, to the fact that the dispatcher is taking orders over the telephone or his other duties are demanding immediate attention at this particular time.

C. The two-way radio control units provide for an efficient operation in that the driver can contact the dispatcher to inform him of the needs of the customer, and the dispatcher can, in turn, inform the batch-man that the driver is reporting these needs and will be returning to obtain a specific desired concrete mix, thereby, permitting the batch-man to prepare this order in advance. Thus, radio control units facilitate the use of all the manpower and equipment of the entire ready mix operation.

Disadvantages of Installing Two-Way Radio Control Units

A. The initial investment of installing these units in each truck is relatively expensive.

B. Some producers state that the drivers do the selling and this should be handled by more capable sales personnel.

From all the comments and actual observing both methods in operation, the initial expense of installing these two-way radio control units would seem to merit these installations due to the savings in man hours and equipment utilization. To quote a particular dispatcher,

"I don't understand how any producer could operate efficiently or economically without these two-way radio control units if the producer has more than two trucks."

Crane Vs. Tractor-Conveyor System

In the investigation of this study, one of the questions which was frequently asked, was "Which operation is the most economical and efficient, a crane loading operation, or a tractor-conveyor system?". Both types of operations were observed and discussed with the concrete producers interviewed. Some producers were strongly in favor of the tractor-conveyor system, others were likewise proponents of a crane operation. Due to the interest that was shown in this aspect of the concrete business, the writer of this thesis feels that it is necessary to discuss the advantages and disadvantages of both operations.

In the discussions, it was found that the initial investment of either operation was approximately the same. However, there are advantages in both operations that needed further attention.

Advantages of a Crane Operation: The crane operation is definitely preferred for temporary installations. The primary reason for this is the mobility of the equipment. The repairs and upkeep of the crane is somewhat less than a tractor-conveyor system.

Disadvantages of a Crane Operation: The crane is limited on the amount of material that can be handled at one time. Therefore, the volume of material that can be loaded is restricted and the amount of concrete batched is likewise contained. A crane operator is considered to be a skilled worker and, consequently, demands more pay. An open inventory must be maintained and a small tractor is needed to pile the

raw materials in some form so that the crane can lift these materials off the ground and into the storage bins.

Tractor-Conveyor System Advantages: The tractor-conveyor system is preferred for a permanent operation. The major advantage of this type of operation is that the volume of material that can be supplied to the storage bins is virtually unlimited. Another reason for using a tractor (dozer) is that in general almost any of the personnel associated with a ready mix concrete plant is capable of operating the tractor. Therefore, as opposed to skilled crane operators, the tractor operator is considered as an unskilled worker and receives less wages.

Disadvantages of Tractor-Conveyor System: As the initial investment is approximately the same, the primary disadvantage is in the repair and upkeep associated with the tractor and conveyor. Generally, the tractor and conveyor will require more repairs than a crane. The permanancy of the conveyor is considered a disadvantage in some cases where the land is leased and the lease may expire. Some kind of pit must be constructed to feed the raw materials onto the conveyor which is an added initial expense. It is apparent from the brief discussion that both loading systems have their merits. The factor which should control which type of operation would be best in given circumstances would be the volume of concrete that is sold.

APPENDIX B

COMPARISON OF COSTS ON AN AVERAGE BASIS

This alternate method for comparing costs is presented to aid the National Ready Mix Concrete Association. To compare costs on a national basis, it may be desirous to display the cost data in the form of a normal curve. This would be possible since the National Association could obtain samples of cost data large enough to base their comparison on an average basis without distorting the over-all picture.

As this study is a pilot study, the normal curve used in this demonstration is to emphasize the value that it could have to the ready mix concrete business. The equation of the distribution is:

$$Y = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(X-\mu)^2}{2\sigma^2}} \qquad (6)$$

where

Y = calculated ordinate value

X = the calculated variable of each company

μ = the arithmetic mean

σ^2 = the variance from the mean

e = 2.71828

The application of this equation requires the following calculations:

Arithmetic Mean

The arithmetic mean of a set of n observed numbers is the sum of

the numbers divided by n. This statement may be expressed in algebraic terms as follows:

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_n}{n}$$

where the symbol $\bar{X}$ represents the arithmetic mean, an X_1, X_2, X_3, etc., represents the specific observed values. n is the number of observations.

For many statistical purposes, the most useful measure of dispersion of a frequency distribution is the standard deviation (σ). This is the root-mean square deviation of the observed numbers from their average. Expressed in algebraic terms, this is

$$\sigma = \sqrt{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + (X_3 - \bar{X})^2 + \ldots (X_n - \bar{X})^2} \qquad (7)$$

An example to illustrate the use of the preceding equations with respect to production costs is shown below. Assume that:

1. The average selling price of concrete per cubic yard is \$14.
2. The total production expenses for one year = \$34,400.
3. The total cubic yards of concrete sold = 38,400 cu. yds.

Sample Calculations:

A. The production expenses should be expressed in terms of cubic yards of concrete.

$$\frac{\text{Production expense for one year}}{\text{Average Selling Price of a cu. yd. of concrete}} = \frac{\$34,400}{\$14/\text{cu yd}} = 2400 \text{ cu yds}$$

B. Each specific observed value (X) must be calculated.

$$X = \frac{\text{Production Expense (in cu. yds. of concrete)}}{\text{Total cu. yards of concrete sold}} = \frac{2400 \text{ yd}^3}{38,400 \text{ yd}^3} = .0625$$

Thus, specific values of X_1, X_2, X_3, ... X_n would be calculated and from these values an average $\bar{X}$ could be found. Once the arithmetic mean is calculated, (σ) the standard deviation can be found. These

calculations were performed on the cost data that was collected from the various producers and is presented below:

Total Production Expenses (in Percentage of Sales)

Companies	Calculated X Values
#1	.067
#2	.123
#3	.105
#4	.067
#5	.084
Total	.446

$$\hat{\mu} = \bar{X} = \frac{\Sigma X}{n} = \frac{.446}{5} = .089$$

where, $\hat{\mu}$ = estimated average production expense as a percentage of sales

X = specific observed values

n = number of observation

$$\hat{\sigma}^2 = \sum_{i=1}^{5} \frac{(X_i - \hat{\mu})^2}{n-1}$$

where, $\hat{\sigma}^2$ = variance as a percentage of sales

$$\hat{\sigma}^2 = \frac{1}{4}\left[(.067-.089)^2 + (.123-.089)^2 + (.105-.089)^2 + (.067-.089)^2 + (.084-.089)^2\right]$$

$$\hat{\sigma}^2 = .000601$$

In order to plot this cost data, it is necessary that various assumptions be made. These assumptions are:

1. Assume that the five samples (cost data) are random samples from the population of all cement companies.

2. Assume that all the desired expense quantities associated with the population of cement companies are all normally distributed about the mean.

3. Assume that the estimates of μ and σ^2 given by $\hat{\mu} = \frac{1}{n} \Sigma Xi$ and $\hat{\sigma}^2 = \frac{1}{n-1} \Sigma(X_i - \hat{\mu})^2$ are "close enough approximations" to the actual mean and variance such that negligible error is introduced by letting $\hat{\mu} = \mu$ and $\hat{\sigma}^2 = \sigma^2$.

Practically speaking, no company has a negative expense; thus, the portion of the normal distribution to the left of X = 0 will not have any significance.

The above calculations were performed on the cost data that was assembled from various concrete companies. Based on the preceding assumptions, the cost data was analyzed and the results are given on Page 53.

In order to plot the data given on Page 53, it is necessary to make a transformation of the normal curve. This transformation process is shown below.

1. $\bar{y} = \frac{1}{\hat{\sigma}\sqrt{2\pi}} e^{-\frac{(X-\hat{\mu})^2}{2\hat{\sigma}^2}}$

This is the equation of normal distribution with $\bar{y} = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}}$ for production costs shown on preceding page.

2. By letting $z = \frac{X-\hat{\mu}}{\hat{\sigma}}$

3. then, $\bar{y} = \frac{1}{\hat{\sigma}\sqrt{2\pi}} e^{-1/2\, z^2}$

4. Multiplying both sides of the equation by $\hat{\sigma}$,

$\hat{\sigma}\,\bar{y} = \frac{1}{\sqrt{2\pi}} e^{-1/2\, z^2}$

This equation has transformed the normal curve over to the left where $\hat{\mu} = 0$, and $\hat{\sigma}\,\bar{y} = \frac{1}{\sqrt{2\pi}}$

5. Integrating both sides of the equation in (4)

$$y(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-1/2\, z^2} dz$$

The graphic solution of this integral is presented in statistic books as the "Cumulative Normal Frequency Distribution." From these tables the graph in Figure 7 is shown. This graph is plotted by letting z take on values from 0. to 2.4 on the right hand side of the graph. From the cumulative normal frequency distribution table .5 was added to values found as z varied from 0 to 2.4. On the left hand side of the graph, the values in these tables were substracted from .5 as z varied from 0 to -2.4.

Possibilities of Using Transformation of Normal Curve

To illustrate the possibilities of using this transformation graph, a hypothical situation would have to exist. Assume that all the ready mix concrete producers adopted the suggested standard form for reporting their production expenses. From the calculations on Page 52, the x value of production expense can be found. Then from the assumptions on Page 52 and manipulation (2), z could be determined. As an example, (using values obtained in Table II) $\hat{\mu} = .089$, $\hat{\sigma} = .03$ and the calculated production expense for a specific period, $X = .105$ (for Company #3) then $z = \frac{X-\hat{\mu}}{\hat{\sigma}} = \frac{.105 - .089}{.03} = \frac{.016}{.03} = .53$. For $z = .53$ in Figure 7, the corresponding y value equals .67, and the y value is the percentage of companies whose production expense is less than or equal to z, also, y is the percentage of companies with production expense less than or equal to x. Hence, for a $y = .67$, this company's

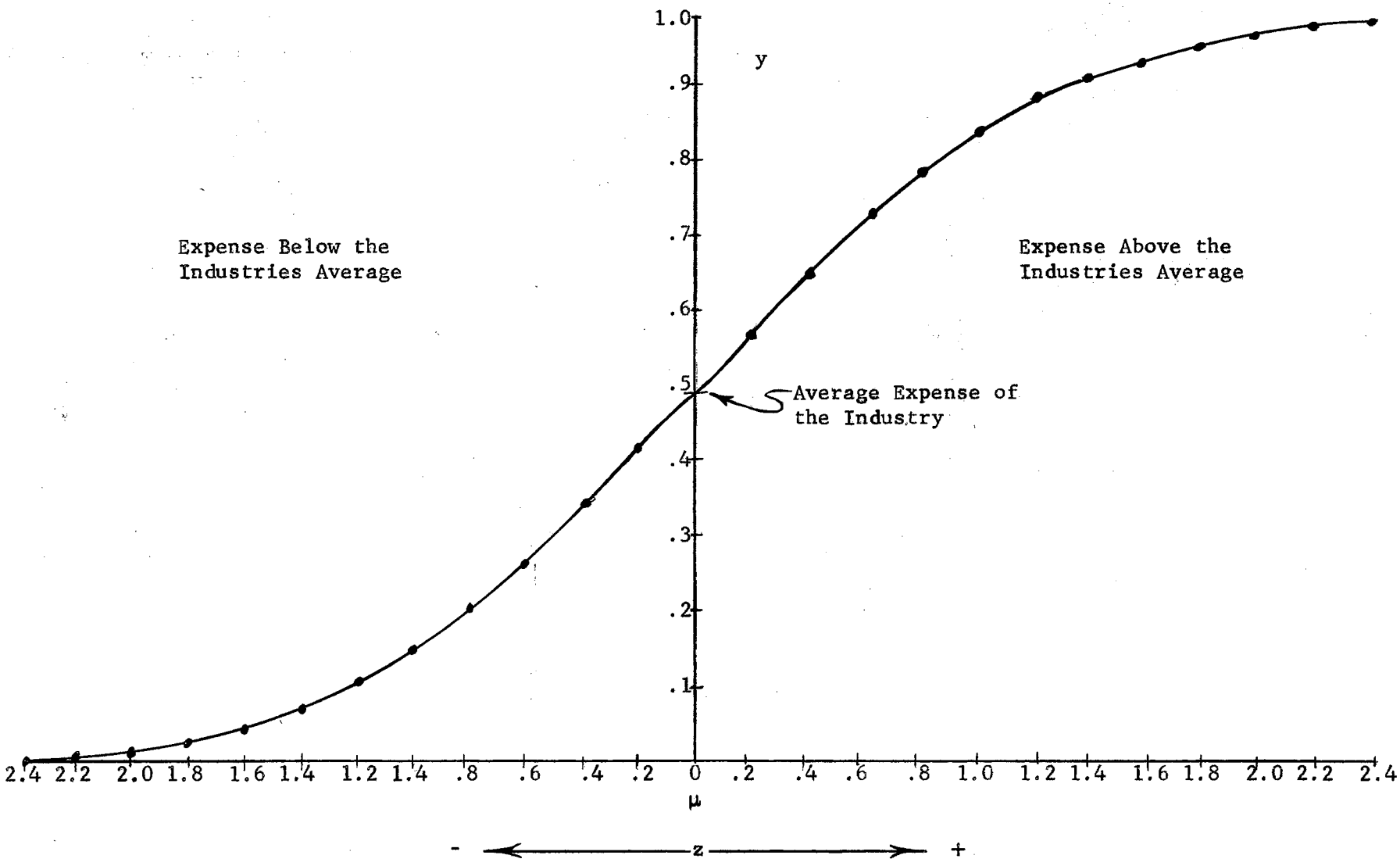

Figure 7. Transformation of a Normal Curve

production expense would be 17% above the average of the other companies in the industry.

Referring to Page 53 for Company #1 and #4, the production expense x value equals .067, then from manipulation (2) on Page 54. The corresponding y value for z = -.73 is equal to 22%. Therefore, Companies #1 and #4 are 28% below the average of the other companies in the industry.

Therefore, the apparent possibilities of this graph would inform a ready mix concrete producer whether his production expenses were below, above, or on an average with other producers in the industry.

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