

AN ANALYSIS OF COST RELATIONSHIPS
IN GRAIN PLANTS

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY

Carson D. Keyes

1961



PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
04-22-93 6132444	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

MSU is An Affirmative Action/Equal Opportunity Institution

c:\circ\datedue.pm3-p.1

AN ANALYSIS OF COST RELATIONSHIPS IN
GRAIN PLANTS

by

CARSON D. KEYES

AN ABSTRACT

Submitted to the College of Agriculture of Michigan
State University of Agriculture and Applied
Science in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1961

Approved by Herbert L. Loomis

AN ANALYSIS OF COST RELATIONSHIPS IN
GRAIN PLANTS

by

Carson D. Keyes

AN ABSTRACT

Michigan elevators operate in a diverse agricultural and industrial economy and must be able to adjust to a continually changing environment, both in product and factor markets. These changing conditions require that management act cautiously when considering investing in new facilities or in remodeling old facilities. This study is designed to provide information required in the planning process, in making decisions pertinent to plant reorganization, and in adjusting firms to meet future physical and economic needs. It is anticipated that the results of this study will provide useful guides to elevator owners and managers, boards of directors, management consultants and research or extension personnel in analyzing and operating Michigan grain elevators.

This study is limited to an investigation of the grain merchandising operation since this operation is the focal point around which the rest of the firm's activities are adjusted.

An "economic-engineering" type of analysis is used to compare the cost-volume relationships between different sized

model plants. The model plants were developed by using information from elevators that are actually operating in Michigan and from information received from elevator designers and builders, machinery manufacturers, and people actively engaged in the Michigan elevator industry. The plants were developed and constructed in light of economic conditions existing in Michigan during 1961.

Each model plants' operating cost and annual volume were estimated as affected by the following conditions: plant size or scale of plant, annual hours of operation, receiving mix (percent of small grain and ear corn received by time), and average load size received.

Economies of scale were observed between the various sized model plants. Economies of scale were greatest for those plants operating at a low capacity utilization level, 300 hours annual operation. As the number of hours of operation are increased the economies of scale between plants decrease. Thus, the economies of scale that were observed for the model plants operating 1200 and 1500 hours per year were negligible.

The results of this study indicate that, based on plant size alone, there are two ways of looking at economies of scale in the operation of grain elevators. Those economies which exist for low levels of plant utilization and those existing for full or higher plant capacity utilization. If management is interested only in economies of operation during the harvest season, a period of low capacity utilization, then

it would pay them to construct a large plant to take advantage of the economies of scale that exist at these production levels. But if management is more concerned with full or annual plant capacity utilization it would not pay to construct as large a plant. However, most elevator operators are interested in both of the above types of economies. Therefore location factors and the economic environment in which the plant operates becomes of utmost importance in determining plant capacity utilization and should be considered before deciding on a scale of plant for a particular area.

AN ANALYSIS OF COST RELATIONSHIPS IN
GRAIN PLANTS

by

CARSON D. KEYES

A THESIS

Submitted to the College of Agriculture of Michigan
State University of Agriculture and Applied
Science in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1961

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to all individuals who assisted in the development and completion of this thesis.

The author is particularly indebted to Dr. Vernon L. Sorenson, Associate Professor, Department of Agricultural Economics, under whose supervision this study was conducted. The guidance offered and the interest shown on the part of Dr. Sorenson regarding the author's research was an important part both in the conduct of this study and in the author's total graduate program.

The author wishes to express his appreciation to Mr. Alvin L. Rippen, Extension Specialist in Food Science, who has given freely of his time and advice when they were sought by the author.

Dr. Larry L. Boger, Head, Department of Agricultural Economics, made this study possible by making available to the author financial assistance in the form of a research assistantship. His aid in this manner is greatly appreciated.

The author is grateful to those individuals, firms, and organizations too numerous to list who supplied helpful information in developing elevator facilities and cost for the model plants used in this study.

Full responsibility remains with the author for any omissions or errors that are found in the manuscript.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	ii
LIST OF TABLES.....	vii
LIST OF FIGURES.....	xii
 Chapter	
I. INTRODUCTION.....	1
Previous Studies.....	2
Objectives of Study.....	4
Organization of Remainder of The Thesis....	6
II. THE MICHIGAN ELEVATOR INDUSTRY.....	7
Introduction.....	7
Current Status of The Michigan Elevator Industry.....	8
Environmental Factors Affecting The Oper- ation of Grain Elevators.....	9
Michigan's Agricultural Industry.....	9
Michigan Agricultural Trends.....	11
Characteristics of Michigan Grain Elevators	14
Multi-Purpose Plants.....	15
Complementary Relations Within Grain Elevators.....	16
Competitive Relations Between Grain Elevators.....	18
The Grain Merchandising Operation of Grain Elevators.....	19
III. THE THEORETICAL FRAMEWORK AND ANALYTICAL MODEL.	21
Economic Theory and Its Application to Cost-Volume Studies.....	21
The Nature of Short-Run Cost-Output Functions.....	22
Planning and Its Relation to Long-Run Decisions.....	28
Economies and Diseconomies of Scale....	30
The Analytical Framework and Model.....	33

Chapter	Page
Methodology and Procedures.....	33
Model Plants.....	33
Product Flow.....	35
The Receiving Process.....	38
The Cleaning Process.....	38
The Weighing Process.....	39
The Storage Process.....	40
The Load-Out Process.....	41
The Economic Unit.....	41
Sources of Data Used in The Construction of Model Plants.....	42
Direct Observations.....	43
Equipment Manufactures.....	44
Engineering Estimates of Building Cost.....	44
Plant Records and Audits.....	45
Other Sources of Data.....	45
Assumptions.....	45
As to Operating Conditions.....	46
As to Size Requirements for Michigan	46
As to Location Factors.....	46
As to Storage Requirements.....	46
As to Economic Model and Conditions	46
IV. MODEL PLANT SPECIFICATIONS AND OPERATING CONDITIONS	48
Model Plant Receiving Capacities and Facilities Provided.....	48
Single and Double-Line Plants.....	53
Storage Facilities.....	54
Railroad Siding.....	55
Land and Land Improvements.....	57
Trucking Equipment.....	58
Office Facilities.....	58
Model Plant Operating Conditions.....	58
General Operating Conditions.....	60
Plant Scale and Annual Hours of Operation	60
Receiving Mix.....	63
Average Load Size Received.....	64
Seasonality and Its Affect on Operating Grain Elevators.....	66

Chapter	Page
Annual Volume as Affected by The Model Plants Operating Conditions.....	69
V. BUDGETING OF COST AND MODEL PLANT COST FUNCTIONS	77
Introduction.....	77
Investment in Durable Assets.....	77
Cost Associated With Owning Durable Assets.....	79
Variable Cost Associated With Volume and Plant Operations.....	82
Total Annual Cost and Total Cost Functions	91
Short-Run Average Cost and Average Cost Curves.....	98
Long-Run Average Cost Curves and Economies of Scale in Model Plants.....	112
VI. SUMMARY AND CONCLUSIONS.....	116
APPENDIX A. DURABLE ASSET INVESTMENT ESTIMATES.....	124
Estimated Investment in Land and Land Improvements.....	124
Estimated Investment in Buildings for Model Plants.....	125
Estimated Investment in Storage Facilities.....	126
Estimated Investment in Machinery and Equipment.....	129
Estimated Investment in Office Buildings	136
Estimated Investment in Office Fur- niture and Equipment.....	137
Estimated Investment in Railroad Siding.....	139
Estimated Investment in Trucking Equipment.....	140
Estimated Investment in Corn Cob Burners.....	141
APPENDIX B. FIXED COST ESTIMATES.....	143
Depreciation Expense.....	143
Insurance Expense.....	152
Personal Property Tax Expense.....	152
Repairs and Maintenance Expense.....	154
Interest on Investment.....	156

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

	Page
APPENDIX C. VARIABLE RESOURCE REQUIREMENTS AND CCST ESTIMATES.....	160
Labor Requirements and Labor Cost Estimates.....	160
Model Plants Clerical Requirements and Cost Estimates.....	163
Model Plant Management Requirements and Cost Estimates.....	164
Social Security Tax.....	165
Workmen's Compensation Insurance.....	166
Inventory Insurance.....	166
Interest on Seasonal Capital.....	168
General Liability Insurance.....	168
Maintenance as A Variable Expense.....	169
Utilities.....	170
Miscellaneous Expenses.....	172
BIBLIOGRAPHY.....	173

LIST OF TABLES

Table	Page
1. Percentage of Total Gross Margin Derived from Different Sources for 34 Michigan Elevator-Farm Supply Businesses.....	9
2. Michigan Agricultural Trends, 1940 to 1959.....	12
3. Storage Facilities Provided for Model Grain Elevators, Michigan, 1961.....	56
4. Railroad Siding Provided for Model Grain Elevators, Michigan, 1961.....	57
5. Allocation of Operating Time to Receiving Grain and Ear Corn According to Receiving Mix and Total Annual Hours of Operation, Michigan, 1961.	65
6. Actual Hourly Receiving Rates for Model Grain Elevators Receiving Grain and Corn in Various Load Sizes, Michigan, 1961.....	67
7. Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of The Time and Corn 25 Percent of The Time, Michigan, 1961.....	70
8. Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961.....	72
9. Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961.....	74
10. Total Estimated Investment in Machinery and Equipment and Total Annual Depreciation for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	78
11. Estimated Investment in Durable Assets for Model Grain Elevators, Michigan, 1961.....	80
12. Total Investment and Annual Fixed Expenses for Model Grain Elevators, Michigan, 1961.....	83

Table	Page
13. Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of The Time and Corn 25 Percent of The Time, Michigan, 1961.....	85
14. Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961.....	87
15. Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961.....	89
16. Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of The Time and Corn 25 Percent of The Time, Michigan, 1961.....	92
17. Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961.....	94
18. Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961.....	96
19. Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of The Time and Corn 25 Percent of The Time, Michigan, 1961.....	102
20. Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961.....	104
21. Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961.....	106
22. Regression Coefficients and Associated Statistics for Model Single and Double-Line Grain Elevators, Michigan, 1961.....	111
23. Estimated Investment in Land and Land Improvements for Model Grain Elevators, Michigan, 1961.....	125

Table	Page
24. Estimated Investment in Buildings for Model Grain Elevators, Michigan, 1961.....	126
25. Estimated Investment in Storage Facilities for Model Grain Elevators, Michigan, 1961.....	128
26. Equipment List and Estimated Equipment Investment for The Receiving Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	129
27. Equipment List and Estimated Equipment Investment for The Cleaning Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	131
28. Equipment List and Estimated Equipment Investment for The Weighing Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	132
29. Equipment List and Estimated Equipment Investment for The Storage Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	133
30. Equipment List and Estimated Equipment Investment for The Load-Out Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	134
31. Miscellaneous Equipment List and Estimated Equipment Investment for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	135
32. Estimated Investment in Office Buildings and Office Space Provided for Each Model Grain Elevator, Michigan, 1961.....	137
33. Equipment List and Estimated Equipment Investment for Office Equipment for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	138
34. Estimated Investment in Railroad Siding for Model Grain Elevators, Michigan, 1961.....	140
35. Equipment List and Estimated Annual Depreciation for The Receiving Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.....	144

• • • • •

• • • • •

Figure 1. The effect of the number of trials on the number of correct responses. The number of correct responses was plotted against the number of trials for each condition. The number of correct responses increased with the number of trials for all conditions. The number of correct responses was highest for the condition with the highest number of trials (10 trials) and lowest for the condition with the lowest number of trials (2 trials).

■ ■ ■

[illegible]

.....

Figure 1. The effect of the number of trials on the mean accuracy of the four groups. Error bars represent standard error of the mean.

• • • • •

• • • • •

— — — — —

Table	Page
48. Annual Average Inventory for Model Grain Elevators, Michigan, 1961.....	167
49. General Liability Insurance Rates for Model Grain Elevators, Michigan, 1961.....	169

LIST OF FIGURES

Figure	Page
1. Hypothetical Average Variable Cost Curve for Grain Elevators.....	25
2. Process Flow Chart for Michigan Grain Elevators, 1961.....	37
3. Total Annual Cost For A Model Grain Elevator Operating Under Various Conditions, 750 Bushel Per Hour Capacity, Michigan, 1961.....	99
4. Total Annual Cost For A Model Grain Elevator Operating Under Various Conditions, 4500 Bushel Per Hour Capacity, Michigan, 1961.....	100
5. Short-Run Average Cost Curves for Model Grain Elevators Receiving an Average Load Size of 150 Bushels, A Receiving Mix of 50 Percent Grain and 50 Percent Corn, and Operating Various Hours Per Year, Michigan, 1961.....	108
6. A Family of Cost Scale Long-Run Average Cost Curves for Model Grain Elevators Operating Various Hours Per Year, Receiving an Average Load Size of 150 Bushels, and A Receiving Mix of 50 Percent Grain and 50 Percent Corn, Michigan, 1961.....	113

.....

.....

.....

.....

.....

.....

CHAPTER I

INTRODUCTION

Grain elevators serve as the initial link in the movement of grain from the farm, through the marketing system, and into the hands of consumers. They serve as receiving and assembling points for grain to be shipped from local producing areas to terminals for storage or to processing plants. In addition they serve as major distributors of items required in the production of field crops and livestock products. Though the primary function of grain elevators has changed little in recent years, many changes have taken place in the operation and construction of plants as well as in farming, transportation, and other related businesses.

Michigan elevators operate in a very diverse agricultural and industrial economy and must be able to adjust to a continually changing environment, both in product and factor markets. Changes are continuing to take place in technology, agricultural production, and the organization of agricultural industries. These changing conditions require that management consider long-run adjustments when considering investing in new facilities or in remodeling old facilities. This study is designed to provide information required in the planning process, in making decisions pertinent to plant reorganization, and in adjusting firms to meet future physical and economic needs.

Previous Studies

The research that has been conducted in the area of elevator operating efficiency has all had a common objective. That is, the development of better techniques to be used in the evaluation of elevator firms and to develop some useful tools that management might use in planning and operating their businesses.

This study was set in its proper perspective in accordance with previous studies made of the Michigan elevator industry.¹ Further guidance was then obtained by looking at three previous types of studies. Those dealing with elevator operations as such,²

1

Arthur J. Pursel, "The Use of Functional Analysis in Evaluating The Operations of Michigan Elevator-Farm Supply Businesses," Unpublished Master's Thesis 1957, Michigan State University, East Lansing, Michigan, 1957, 72 pages; George G. Greenleaf, "A Study of Cost Relationships in Michigan Country Elevators," Unpublished Master's Thesis 1959, Michigan State University, East Lansing, Michigan, 1959, 68 pages; H. E. Larzelere and R. M. King, "Ratios As Measuring Sticks for Elevator and Farm Supply Organizations," Special Bulletin 380, Michigan State College, Agricultural Experiment Station, Department of Agricultural Economics, East Lansing, Michigan, August 1952, 29 pages; and Vernon L. Sorenson and David Spaeth, "Elevator Outlook Committee Progress Report," Agricultural Economics 742, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, December 1958, (mimeographed) 46 pages.

2

Richard Phillips, "Managing for Greater Returns In Country Elevators and Retail Farm Supply Businesses," Farmers Grain Dealers Association of Iowa, Des Moines, Iowa, October 1951, 558 pages.

those dealing with planning elevator facilities,³ and those dealing with methodology and research procedures.⁴

An economic-engineering approach to cost-volume analysis is used in this study. This method is used extensively by agricultural economists in studying various types of agricultural marketing firms including elevators.⁵

Some previous studies have attempted to evaluate the elevator as a firm rather than as a group of distinct and different operations.⁶ Many are concerned with the elevator industry of a

3 Heber D. Bouland and Lloyd L. Smith, "A Small Country Elevator for Merchandising Grain, Designs and Recommendations," Marketing Research Report No. 387, U. S. Department of Agriculture, Agricultural Marketing Service, Transportation and Facilities Research Division, Washington, D. C., June 1960, 52 pages, and Perry S. Richey and Thew D. Johnson, "Factors To Be Considered In Locating, Planning and Operating Country Elevators," Marketing Research Report No. 23, U. S. Department of Agriculture, Production and Marketing Administration, Washington, D. C., June 1952, 94 pages.

4 B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency In Plant Operations With Special Reference To The Marketing of California Pears," Hilgardia, Vol. 24, No. 19, University of California, Berkeley, California, July 1956, pages 543-721; and R. G. Bressler, "Research Determination of Economies of Scale," Journal of Farm Economics, Volume 27, 1945, pages 526-39.

5 Thomas E. Hall, "New Country Elevators, Influence of Size and Volume on Operating Costs," Farmer Cooperative Service Circular 10, U. S. Department of Agriculture, Farmer Cooperative Service, Washington 25, D.C., June 1955, 29 pages; Thomas E. Hall, Walter K. Davis, and Howard L. Hall, "New Local Elevators - Cost-Volume Relations In The Hard Winter Wheat Belt," Service Report 12, Farmer Cooperative Service, U. S. Department of Agriculture, Washington D. C., May 1955, 112 pages; and Stanley K. Thurston and R. J. Mutti, "Cost-Volume Relationships for New Country Elevators in The Corn Belt," Service Report 32, Farmer Cooperative Service, U. S. Department of Agriculture, Washington, D. C., September 1957, 78 pages.

6 Pursel, op. cit., 72 pages and Greenleaf, op. cit., 68 pages.

particular state rather than with the evaluation of particular firms or operations within the firm.⁷ This greatly limits their effectiveness and usefulness in a state such as Michigan that is characterized by multi-purpose elevators operating in a multi-purpose agricultural and industrial economy. Wide variations exist in type of crops grown, and market areas served, hence a great deal of variation exists between elevators within the state. For this reason it is difficult to apply the general conclusions drawn from most studies to a particular Michigan Elevator.

Objectives of Study

The dynamic conditions in agriculture are such that planning will be needed to adjust to changing future conditions. With this in mind and recognizing the fact that most elevator and farm supply businesses are small, individual leaders in the Michigan feed and grain trade set up a study committee. This committee posed the following question: "What can be done to help individual elevator managers take a look into the future and do a better job of adjusting to change or of 'keeping up with the times?'" This thesis is in part an attempt to develop some guides that will help the individual elevator operator answer this question.

⁷ Phillip C. Baumel and John W. Sharp, "A Financial Analysis of Ohio Elevator Operations," Research Bulletin 813, Ohio Agricultural Experiment Station, Wooster, Ohio, June 1958, 25 pages; and R. J. Mutti, "Differences in The Financial Organization and Operation of Country Grain Elevators in The Northern Half of Illinois, 1954-55," AERR - 17, Department of Agricultural Economics, University of Illinois, February 1957, 25 pages.

To answer this question in its entirety would require several studies covering the various aspects of the grain trade and the many factors which influence the operation of grain elevators.

To analyze the entire elevator operation in light of the many contributing factors would be an almost impossible task. This study is therefore limited to an investigation of the grain merchandising phase of grain elevator operations. Grain merchandising is one of the many activities found in Michigan elevators. Grain merchandising in this study refers to the receiving of bulk grain and ear corn, shelling corn, cleaning, assembling or temporary storage, and the shipping of grain. Feed mixing and grinding are omitted from this study because the physical handling of unprocessed grain and grain processed as feed are quite different. The handling of feed is usually thought of as a separate operation.

Grain drying and permanent storage are also omitted from this study. However, these two activities are closely related to the grain merchandising operation, which will determine to a great extent the size and amount of investment made in grain drying and storage facilities. The storage considered in this study is assumed to be adequate for the grain merchandising operation and can be used for some permanent storage.

The major objectives of this study were to develop some economic benchmarks to aid in the formulation of operating policies and to develop some tools to be used in planning for the most efficient use of resources in the future. Some guides were also

developed which will help in making future economic adjustments, especially in the construction and location of new elevators.

Organization of Remainder of the Thesis

The Michigan Elevator industry and factors affecting the operation of elevators are discussed in Chapter II. Environmental as well as economic operating conditions are included in the discussion. Chapter III contains a discussion of the analytical framework and model. This chapter includes a discussion of the methodology and procedures used in the analysis. Chapter IV deals with the specifications and operating conditions of the model plants used in this study. The physical plant resource requirements and the methods of estimating cost are the subject matter of Chapter V. This chapter includes an evaluation and discussion of the economies of scale which exist in the model plants. The last chapter, Chapter VI, contains the summary and conclusions drawn from this study. The study also includes several appendixes which contain the major portion of the statistical data on which this study is based.

CHAPTER II

THE MICHIGAN ELEVATOR INDUSTRY

Introduction

Many factors contribute to the successful operation of Michigan elevators. They operate in a diverse agricultural economy within which changes are continually taking place. The elevator industry is highly competitive in that it includes many small firms that are relatively homogeneous. Each firm is usually composed of several different "operations", grain merchandising being but one of several principal or "sideline" activities. This study was designed and directed to the solution of problems within this diverse and competitive industry by providing information and methods for planning present as well as future physical and economic adjustments.

The following discussion considers the environmental and economic framework within which this study was developed. A short discussion of the current status of the Michigan elevator industry is followed by a discussion of the agricultural economy of the state and how it affects the operation of grain elevators. This is followed by a discussion of the multi-purpose nature of grain elevators and the competitive interrelations resulting from such operations. The final section shows the importance of and how the grain merchandising operation fits into the firms overall operation.

Current Status of the Michigan Elevator Industry

The Michigan elevator and farm supply industry might be classified as a mixture of the old and the new. Many plants were built 30 or 40 years ago. Most of these older facilities have been remodeled and patched up to meet changing conditions, and as a result are rather complex in design and in arrangement of equipment. They tend to be uneconomical to operate and obsolete in many phases of modern grain handling. On the other hand, Michigan also has some new and well equipped elevators.

Michigan elevators are multi-purpose concerns. Pursel, in his functional analysis work with 34 firms found that total gross margin was derived from several major sources as shown in Table 1.⁸

About 60 percent of the total gross margin of the 34 firms studied comes from merchandised grain, processed grain and services pertaining to the grain operation. Grain handling is therefore a primary source of income for Michigan grain elevators.

The major portion of Michigan's elevators are located in the southern half of the lower peninsula, with the heaviest concentration in the cash crop thumb counties of Huron, Tuscola, Sanilac and Saginaw. The number of elevators in the various farming areas tend to vary with the amount of cash crop farming in that area.

Michigan elevators fall into three general categories: independent or privately owned, cooperatives and the line or elevator

⁸ Pursel, op.cit., page 9.

Table 1:--Percentage of Total Gross Margin Derived from Different Sources for 34 Michigan Elevator-Farm Supply Businesses

All Grain Operations a				Farm Production Supplies				
60.42%				39.58%				
Merchan- dised Grain b	Pro- cessed Grain c	Service Income d	Ferti- lizer	Petro- leum	Seeds	Miscel- laneous Farm Supplies		
%	%	%	%	%	%	%	%	%
18.08	20.09	22.25	6.56	10.08	5.71	17.23		

- a Merchandised grain, processed grain and service income are grouped together because of the high degree of complementarity existing between them.
- b Unprocessed grain which is sold directly to terminal grain elevators, processing companies, other country grain elevators and farmers.
- c Derived primarily from custom feed grinding, mixing operations and from retailing "complete" feed mixes.
- d Derived primarily from grain handling and processing operations, which include: (1) custom grinding and mixing of livestock feed, (2) handling, trucking and storing grain, and (3) cleaning and treating grain for seed.

chains. They range in size from those with a few thousand bushels' capacity to those with several hundred thousand bushels' storage capacity.

Environmental Factors Affecting the Operation of Grain Elevators

Michigan's Agricultural Industry

Michigan has a very diversified type of agriculture. This is due primarily to the wide variations in climate, soil types, topography and markets that are found within the state. Farming in

Michigan ranges from the very intensive fruit and vegetable farms to the more extensive farms of the northern cutover areas.

Agricultural production in Michigan is confined primarily to the southern half of the lower peninsula. In 1959 the southernmost 41 counties, all those south of and including Oceana, Newago, Mecosta, Isabella, Midland and Bay, accounted for over 90 percent of the total harvested acreage of the major cash field crops. This area included 95% of the total harvested acreage of corn and winter wheat, 81% of the oats acreage, 99% of the dry bean acreage, 90% of the barley acreage and 100% of the soybean and sugar beet acreage.⁹

When cash receipts from farm marketings are compared the relative importance of the various types of farming become quite evident. In 1959 56% of the cash receipts from farm marketings came from livestock and livestock products, 14% from fruits and vegetables, 25% from field crops, and 5% from miscellaneous sources. A breakdown of the field crop category shows that winter wheat accounted for 9% of the total cash receipts from farm marketing, dry beans 4%, corn 5%, soybeans 1%, sugar beets 2%, potatoes 2%, and other field crops 2%. Dairy products accounted for 28% of the total cash receipts in 1959.¹⁰

⁹ "Michigan Agricultural Statistics," Michigan Department of Agriculture, Lansing, Michigan, July 1960, page 3.

¹⁰ Ibid., page 45.

The above facts point out the importance of field crops to the Michigan agricultural industry and in particular to the Michigan elevator industry. A major portion of the field crops sold for cash, with the exception of potatoes and sugar beets, are handled by elevators in one form or another. Winter wheat, dry beans and soybeans are marketed almost entirely as cash crops, with the local elevators serving as the primary outlets. Part of the corn, oats and barley crops are also marketed as cash crops, but the major share of these commodities is retained on the farm to be used as feed. However, custom grinding is one of the many functions performed by elevators and much of the grain retained on the farm as feed will pass through the local elevators in the process of grinding and mixing custom feeds. This may become even more important if elevators continue to expand in the operation of grain banks.¹¹

Michigan Agricultural Trends

Some of the changes that have taken place in Michigan's agriculture are listed in table 2. Many of these changes directly or indirectly affected the operation of grain elevators. The number of farms and percent of total land in farms have both declined steadily since 1940. At the same time the average size of farms

¹¹ Grain bank refers to a system of operation whereby the farmer delivers his grain to the elevator at harvest time and receives it back in the form of mixed feed. This system works on the same principle as a bank. The farmer can withdraw any amount of feed at any time he desires and in the mix he desires. The elevator makes adjustments for handling and for any other ingredients that are added to the mixed feed.

has steadily increased. Over the same period farm mechanization has greatly increased as evidenced by the increased number of grain combines, corn pickers, motortrucks and tractors on Michigan farms. Commercial fertilizers consumption has also increased 4.5 times during this twenty year period.

Table 2.--Michigan Agricultural Trends, 1940 to 1959

Item	Census of Agriculture Years				
	1959	1954	1950	1945	1940
Number of farms:	111,817	138,922	155,589	175,268	187,589
Percent of total land in farms:	40.5	45.1	47.3	50.4	49.4
Average size of farms (acres):	132.2	118.5	111.0	104.9	96.2
Number of grain combines on farms:	45,804	43,313	27,234	12,920	
Number of corn pickers on farms:	31,294	23,514	10,681		
Number of motortrucks on farms:	75,713	71,075	56,966	41,303	33,095
Number of tractors on farms:	194,205	187,481	149,377	110,120	66,524
Commercial fertilizer consumption (tons):	756,739	598,475	506,743	340,066	166,564

- a "United States Census of Agriculture - 1954, Volume 1, Counties and State Economic Areas, Part 6, Michigan, U. S. Department of Commerce, Bureau of the Census, Washington, D. C., page 2.
- b Preliminary - 1959 Census of Agriculture.
- c Includes garden tractors.
- d "Michigan Agricultural Statistics," Michigan Department of Agriculture, Lansing, Michigan July 1960, page 51.

Just what has this meant to the Michigan elevator industry? First, the increased use of commercial fertilizer is but one indication of increased per acre production. Mechanization, larger farms, improved seeds, and better farming techniques have also added to this increased production. This has increased the volume of material that passes through elevators. In addition to increasing production, mechanization has also speeded up the farming process. This has meant that elevators must be able to receive the larger volume in a much shorter time. In recent years the harvest season for winter wheat in Michigan has been reduced from several weeks to only a few days. This has been brought about not only by the increased number of grain combines on farms but also by the development of larger and more efficient combines.

The increased number of larger and faster motortrucks has also affected elevators. As the farmer increased his harvesting capacity he also had to increase his transporting capacity. As a result elevators have had to increase their receiving capacity. This meant larger truck hoist, larger receiving pits, larger and faster elevating legs and higher capacity cleaning and processing equipment. Larger, faster and better trucks have also expanded the area that any particular elevator can now serve. This has increased competition between plants.

Other recent developments are also affecting and will continue to affect the grain elevators of Michigan. Opening of the Saint Lawrence seaway has given the state another means of transporting farm commodities. The seaway has also affected the instate

transportation of some products. The shorter hauls required to get grain to a shipping point have increased the use of trucks in transporting bulk grain to port facilities.

These are but a few examples of how a changing agriculture can affect related businesses. The elevator operator has had to adjust and remodel his business to keep up with the dynamic changes that have taken place. We can expect Michigan's agriculture to change even more in future years. Urbanization will continue to affect Michigan's agriculture, transportation methods will continue to change and advances will also be made in both on farm and off farm technology. These rapidly changing conditions and the long range nature of elevator construction and investment puts added importance on planning as an activity of management. Planning to avoid obsolescence in physical facilities as well as planning to allow for the flexibility needed to meet changing conditions.

Characteristics of Michigan Grain Elevators

Individual elevators differ widely in their operations. These variations may appear in the volume of business, market area served, organizational structure, technology employed, marketing and retail services offered, and quality of personnel and management. Though technical differences exist among the individual plants, in terms of size and kind of equipment, the overall technology of the plants is quite similar.

Multi-Purpose Plants

Most of the elevators in Michigan are made up of several enterprises or activities. The relative importance of any one enterprise to the entire firm may vary widely between firms.¹² The number of enterprises making up a firm may also vary depending on the environmental and economic conditions surrounding the plant. The problem then becomes one of getting these different enterprises integrated in the right combination to maximize returns. Many factors will contribute to the proper adjustment of a firm - such as, location, type of farming area, competing firms, degree of specialization, and available capital.

The adjustments will result in differences between plants based on three important relationships: (1) that firms of equal size, measured by total gross income, may be composed of different enterprises of various sizes; (2) that the relative importance of the different enterprises composing a firm may vary widely between firms; and (3) that firms vary in size because of the size and number of enterprises composing the firm.

The factors and reasons causing these relationships are many. Historical as well as current economic conditions have influenced the development and location of many of the elevators in Michigan. Location and the economic conditions in a particular area are probably the most important reasons for the many differences found between plants.

¹² Firm as used in this study refers to an elevators entire operation of which, the grain merchandising operation is a part.

Complementary Relations Within Grain Elevators

The difference between firms and between enterprises within a firm is easily pointed out. However, the relationships and importance of the relationships between activities within a firm are very hard to isolate, much less evaluate. Pursel points out that there is a great deal of technical and market complementarity between the grain merchandising, grain processing and the service operations of a firm. "Technical complementarity exists because some of the facilities used for other operations may be used for grain processing and merchandising. Market complementarity exists because grain merchandising and processing volume may be increased as a result of providing the service."¹³ Such complementarity will exist in varying degrees for a particular firm depending on its size and location. For example, an elevator located in the cash crop area of Michigan may have a relatively small feed operation simply because it is located in an area where livestock is of only minor importance. The feed operation, in order to fully exploit the technical complementarity of inputs, could be much larger in regards to the grain merchandising operation. Technical complementarity between these two activities permits higher utilization of machinery and equipment, and consequently absorbs idle capacity caused by the highly seasonal nature of the grain merchandising activity.

¹³ Pursel, op.cit., pages 6-7

Beyond the point of proper proportions for ideal complementarity facilities that provide operational flexibility also reduce risk caused by shifts in the composition of the grain volume handled by the firm.

A competitive relationship could also develop between these two activities. This situation is not likely to develop because of the seasonal nature of agricultural production and the seasonal demands placed on the various operations and facilities within the plant. A competitive relationship develops when the various activities become large enough so that they are competing with each other for the use of certain facilities. Bottlenecks are created and the only way to overcome these competitive relationships is to separate the various grain and feed facilities. However, to do this often requires increased investment in fixed facilities, more specialized employees, and consequently the necessity of increased overall volume.

To carry this problem of complementarity one step further, one might even consider all sideline activities as complementary to the grain handling operation. Economic opportunities for adding sidelines arise from various kinds of unused capacity. Elevator facilities are sitting idle much of the time because of the seasonal nature of grain marketing. This creates idle capacity in regards to labor, plant facilities and managerial ability. Sideline operations absorb some of this idle capacity and provide an opportunity to gain additional grain volume from the same farmers who purchase sideline items. In this respect, sideline items and grain are complementary to each other both in the market and in resource use.

These complementary relations create the complex relationships that develop between enterprises. Because of these complementary relations the success or failure of one enterprise may depend largely on another enterprise. However, the affect of one activity on the success or failure of another is very hard to isolate and evaluate.

Competitive Relations Between Grain Elevators

There are two cases that are of interest to the elevator manager. The first of these is the competitive relationships between similar activities of different firms. These competitive relations directly affect only the operation of those activities involved, but because of the complementary relations between activities within an elevator the entire plant is indirectly affected. For example, the grain merchandising operation of all plants within an area compete for the grain business within that area. Directly this is the only activity affected. However, indirectly the entire plant may be affected because of the complementary relations between activities within the plant. The entire firm is affected because other business may be attracted as management strives to increase the annual volume of grain received. On the other hand, one or the other activities within the firm may attract grain business because of some special service rendered in conjunction with that activity. The important point is that as management strives to increase the business volume of one enterprise other business may be attracted to the plant.

There are also competitive relations existing between entire firms. These competitive relationships are caused by circumstances and management decisions which affect the entire firm and include such things as physical plant size and facilities provided, management, location, degree of specialization and any other factors that affect the entire firms operation.

These two competitive relationships overlap considerably and no clear cut distinction can be made between the two. However, their existence does serve to point out the complex nature of the Michigan elevator industry and the diversity of competitive interrelationships. These interrelationships make the elevator firm and industry difficult to study and evaluate.

The Grain Merchandising Operation of Grain Elevators

Because of the multiplicity of interrelationships within the firm it would be difficult to undertake a study of the cost scale relations for complete firms. For this reason it was necessary that we limit the scope of this study to an area that is homogeneous enough to handle, but which still has meaning when considered by itself in respect to the entire firm. This study was therefore limited to a cost evaluation of the grain merchandising operation. The procedure followed is to develop seven similar model plants, which differ only in physical size and not in design, layout or processing facilities provided.

The grain merchandising plant throughout this study denotes a facility specifically designed, constructed, and used as an

assembling point for whole grain from farms, and equipped to handle and move grain to points farther along in the marketing channel.

The grain merchandising operation was selected over all other activities because the grain merchandising operation is the focal point around which the rest of the firms operations are developed or adjusted. Many of the complementary relationships found within elevators are a direct result of the facilities required by this operation. The seasonal nature of grain harvest creates excess plant capacity and to overcome this excess capacity other activities and sidelines are added.

CHAPTER III

THE THEORETICAL FRAMEWORK AND ANALYTICAL MODEL

Economic Theory and Its Application To Cost-Volume Studies

Cost as used in static economic theory usually refers to the cost associated with the production of certain commodities.¹⁴ Knowledge of cost-volume relations are important for various kinds of managerial problems and decisions - such as; expense control, profit prediction, pricing, and product promotion. Cost functions and more important cost-volume relations are studied for the purpose of explaining their firm or for determining useful guides to be used in making future forecasts and predictions.

Explanation and prediction are the goals of economics as well as of most other sciences. Both theoretical analysis and empirical investigations are necessary for the achievement of these goals. The two approaches are complementary, since theories provide guides for empirical studies and empirical studies provide tests of the assumptions and conclusions of theories. In empirical studies many of the simplifications of theory are changed, different classifications adopted, and some of the assumptions dropped. Pure theories therefore provide insight into economic

¹⁴ Cost of production is often divided into several different categories. The same costs often have different meanings in different settings. The cost concept used in a particular situation depends upon the business decision to be made. For a discussion of the various cost concepts see Joel Dean, Managerial Economics, Prentice-Hall, Inc., New York, 1951, pages 257-72.

processes and serve as a background and starting point for applied theories and specific empirical studies.¹⁵

Economic theory provides an indication of the shape of cost curves as related to output. The accepted economic doctrine has been that marginal cost rises continuously as output rate increases above some given level, and that the resulting average cost curve has a U-shaped relation to output.¹⁶ Using this theoretical foundation as a guide or model we can build graphic and statistical evidence to use as means of comparing theory with actual results.

It should be pointed out that economic theory, although an important foundation of cost-volume studies, is not the only discipline to be drawn from. Cost research to be done thoroughly must draw upon economic and statistical analysis, as well as accounting, engineering and other disciplines. Forecasts and predictions based upon cost functions developed from cost-volume studies are subject to error. This does not destroy their usefulness, but to reduce the size and possibility of error as many contributing factors as is feasible should be investigated.

The Nature of Short-Run Cost-Output Functions

In the short-run there exists a functional relation between cost and a number of independent variables. These independent

¹⁵ James M. Henderson and Richard E. Quandt, "Microeconomic Theory A Mathematical Approach", McGraw-Hill Book Company, Inc., New York, 1958, pages 1-2.

¹⁶ Dean, op.cit., page 272.



variables include volume of production, capacity utilization, prices of input services, size of production lot, variety of output (product mix), and others. Some of the input factors, e.g., land, buildings, heavy machinery and management, are assumed to be physically fixed and not capable of immediate adaptation to changes in rate of output within the short run limits of flexibility. Input factors such as labor, power, raw materials, and the like can be varied in the short-run. These are the firm's "variable resources".¹⁷

The "fixed resources" determine the scale or size of the firm. The scale of plant sets the upper limit to the amount of output per unit of time which the firm is capable of producing in the short-run. Output can be varied up to that limit by increasing or decreasing the quantities of variable resources used in the fixed scale of plant.¹⁸

Empirical cost-volume studies are often not directly comparable with the economic cost model of static economic theory. Static economic theory assumes that all factor and product prices remain constant, that the state of the arts is constant, production and consumption functions are constant, institutions and institutional factors remain constant, perfect knowledge is assumed, that persons and groups making up the economy are rational, and

¹⁷ Dean, op.cit., page 273.

¹⁸ Richard H. Leftwich, "The Price System and Resource Allocation," Revised Edition, Holt, Rinehart and Winston, New York, 1960, page 140.

... ..

... ..)

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

that consumer units and producer units are motivated to maximize the satisfactions derivable from their real incomes and to maximize money profits respectively. These assumptions do not necessarily hold true in the real world.

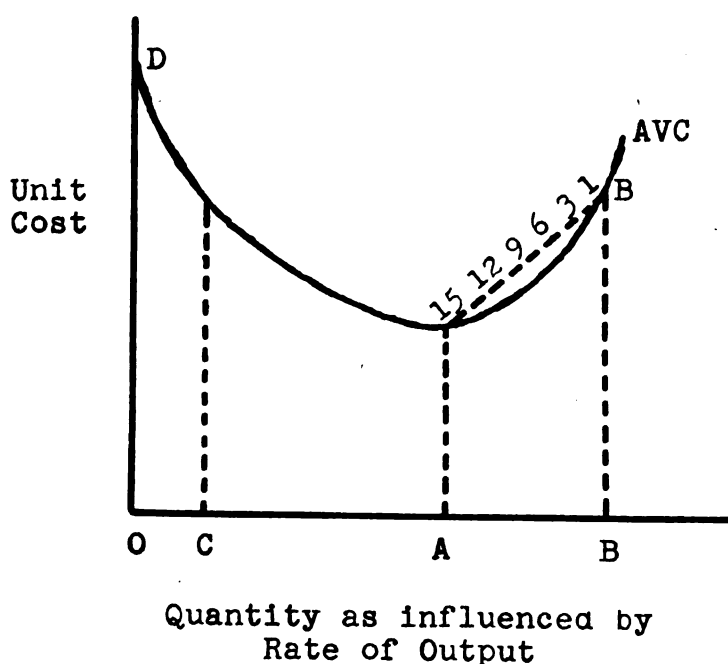
This study, using economic engineering data for the basic cost dimensions, does not lend itself to complete specification in terms of this static economic model. Certain factor prices are allowed to vary with volume. Power and certain insurance rates are two examples. Power rates decrease as the amount of power used increases and certain charges for liability insurances decrease as the amount of business or volume increases. However, despite these adjustments the cost-volume relationships developed in this study are close approximations of the static economic model.¹⁹

When dealing conceptually with cost as a function of output a distinction is often made between short run and long run cost functions. The short run cost function refers to the relationship between cost and rate of output with a given physical plant and assumes that all other independent variables are kept constant. One of the items that is held constant in deriving theoretical cost curves is time. However, in looking at empirical cost relationships in agricultural market firms the relationship between time and unit cost becomes important. It is in fact necessary to

¹⁹ A detailed discussion of the application of this model in economic engineering studies can be found in French, et.al, op.cit., pages 557-64.

separate cost relationships into those which deal only with rate of output for any unit of time and those which incorporate time into the analysis. From the viewpoint of rate firms will maximize unit profits or minimize unit losses in the short run by operating at a rate of output where average variable cost is at a minimum, point OA in Figure 1. This point represents an optimal

Figure 1:-- Hypothetical Average Variable Cost Curve for Grain Elevators



technical relationship in resource use with a given set of input prices. If these optimum technical conditions are maintained costs will increase in some linear relationship to the number of hours operated. Operating at a rate greater than that specified by OA will be undertaken only if all available time is used up and additional profits can be earned by increasing the rate of output to some larger amount say OB. Theoretically the point beyond OA at which operations are undertaken will depend on the equating of marginal cost and marginal revenue hence the extent to which rate will be increased with the given cost relationship is determined by the price of the product or the margin obtained.

This is in fact the situation faced by many agricultural processing plants. Many plants, especially those which handle perishable commodities operate for a fixed period of time during the year. The period of time in which they operate is usually fairly constant and they strive to operate at the lowest possible cost throughout this period. If for some reason they are unable to handle all the produce in this limited time they are then faced with the problem of increasing the per hour rate of operation.

Most merchandising firms and some processing plants that must operate throughout the year cannot and do not operate at a continuous hourly rate. Grain elevators are a case in point. These plants remain open the year around and the volume handled per unit of time fluctuates depending on the circumstances under which the plant is operated. They operate at an accelerated rate

during one season or certain days of the week, at other times they may operate at a normal rate where technical input relationships are optimal and other times at a very low rate where the plant and labor as well as possibly some other inputs normally considered variables are underemployed. These fluctuating hourly operating rates have a profound and definite effect on the per unit cost of operation. Point A represents the rate at which the plant operates at a normal technically optimum basis with the existing or normal labor force that must be maintained. Normal labor force here refers to the number of men usually employed the year around. During these periods even if the plant operates continuously the physical facility is not fully utilized but the normal labor force is fully utilized. The elevator is not concerned with operating at full capacity during these periods because material is not arriving at a rate that warrants an increase in the hourly receiving rate and hence hourly unit costs. Thus, there is no pressure on plant facilities during these periods. However, as grain harvest approaches the elevator is concerned with increasing the hourly receiving rate so that they can operate at or near the capacity of the plant. This accelerated rate is achieved by adding labor and other variable resources such as power. Since this is not the technical optimum relationship within the plant per unit cost is increased to that which exists at point B.

Still one other concern exists in elevators and other farm supply businesses that have continually fluctuating volumes of

traffic. Point C represents a point where the plant is operating at a very low hourly rate. Per unit costs are increased here because the normal labor force cannot be reduced and the plant has a great deal of unused capacity as well as unused labor. In any given hour, the plant may operate to the left of point A with the extreme being point D where zero volume is being handled and unit variable costs become infinite. The problem of empirically specifying the short run cost that exists in any given firm then is the index number problem of attempting to determine the number of hours that are operated at any given rate between say maximum plant capacity at point B and a lesser rate from there to zero. Because the labor force in an elevator cannot be reduced below that which exists at point A the problem is handled in this study by computing variable unit cost at the normal or optimal technical point A and at the harvest season capacity point B. This then is related to the time operated at each rate to compute a total variable cost for the season. The average rate-cost point that emerges will be some point on a straight line between point A and point B, between 15 and 1 in Figure 1. The precise point along this line will depend on the number of hours operated at each rate.

Planning and Its Relation to Long-Run Decisions

The long-run refers to a situation where it is possible for management to vary the quantities of all resources used. The scale of plant is no longer a limit to what the firm can produce.

The long-run cost-volume relationship is often thought of as a series of alternative short-run situations into any one of which the firm can move. The firm can build any one of the possible scales of plant, or it can shift from one to another.

The analytical procedure followed in this study is to develop several model plants and to analyze the cost-volume relationships of these plants. Each individual plants cost-volume relationship is analyzed as being short-run in nature. However, since these results are to be used and viewed as guides to planning, the several short-run relationships can be viewed together as a long-run analysis. This is possible because the long-run average cost or planning curve is a curve that is tangent to all possible short-run average cost curves representing the different scales of plant which the firm conceivably could build. The long-run average cost curve is therefore made up of very small segments of the various short-run average cost curves and is called an "envelope curve" to the short-run average cost curves. The long-run average cost curve can therefore be defined as a curve which shows the least possible cost per unit of producing various outputs when the firm has time to build any desired scale of plant.²⁰

This procedure has merit in that the various model plants are analyzed individually and at the same time it is possible to see the cost scale relationships between plants of various sizes.

²⁰ Leftwich, op.cit., pages 152-55.

Economies and Diseconomies of Scale

"If the long-run average cost curve decreases as output increases, this must mean that successively larger scales of plant are more efficient than the smaller ones; i.e., their short-run average cost curves lie at successively lower levels as well as farther to the right."²¹ This phenomenon is called "economies of scale".

If "long-run" average costs increase this means that successively larger firms or plants become less and less efficient; i.e., their short-run average cost curves lie at successively higher levels and farther to the right. The limitations of certain factors of production beyond a certain point which cause the long-run average cost curve to rise are called "diseconomies of scale."

Economies of scale may be caused by many factors. Two important economies of scale are (1) increasing possibilities of division and specialization of labor, and (2) increasing possibilities of using advanced technological developments and/or larger machines.

The division and specialization of labor are almost impossible in plants that employ only a few men. The elevator is a case in point. Most elevators hire only a few men and due to the diverse nature of most elevator operations it is impossible for any one man to specialize at any one particular job. The seasonal

²¹ Ibid., page 156.

nature of agricultural production does, however, allow for short periods of specialization within the plants, i.e., during the harvest season one man may do nothing but receive and clean grain. Many elevators also have one man whose primary task is to grind and mix custom feeds. However, it is usually found that elevator employees are required to be able to do many different jobs. This leads to inefficiencies in several ways. Time is wasted in moving from one task to another; it is impossible to take advantage of special talents; and the worker usually does not have the time or desire to develop short cuts and speed in performing the many different tasks.

The efficiency of the worker is likely to be higher and cost per unit of output correspondingly lower where division and specialization of labor are possible. Since the nature of elevators greatly limits the amount of specialization possible the primary concern in this study is with the second type of economies of scale - increasing possibilities of using advanced technological developments and/or larger machines.

As the scale of plant increases the possibilities of lowering costs per unit of output by technological methods also increases. The model plants developed in this study, both large and small, are up to date technologically. Therefore, the technological efficiencies that are the major concern of this study are the efficiencies resulting from the use of larger processing machines and equipment. Technological efficiencies of this sort result from the fact that in order to double the capacity of a machine to

produce, a doubling of material, construction, and operating costs of the machine may not be necessary.

The U-shaped long-run average cost curve of static economic theory not only shows economies of scale but diseconomies of scale as well. Diseconomies of scale are represented by that section of the long-run average cost curve that turns upward to the right as production is increased. The reason usually given for diseconomies of scale beyond a certain level of production, is that there are limitations in the efficiency of management in controlling and coordinating a single firm. As a firm gets larger and larger the problems of decision-making and coordination increase. The paper work, travel expenses, telephone bills, and additional employees necessary for coordination increase greatly beyond a certain size of firm.

Managements coordination and decision-making abilities are very hard to measure, let alone evaluate. For this reason empirical studies usually do not show the diseconomies portion of the long-run average cost curve, if in fact they exist. The empirical long-run average cost curve usually falls rapidly at first and then levels off and remains fairly constant over a wide range of production possibilities. One reason for this phenomenon, in empirical studies, is that the scale of plant may not become sufficiently large for the diseconomies of scale to become apparent.

The Analytical Framework and Model

Methodology and Procedures

The "economic-engineering" method of estimating cost functions is used in this study.²² This approach is also often referred to as the "synthetic" approach.²³ Using this method the researcher estimates the costs of operating plants that do not actually exist and then compares these "synthetic" plants for efficiencies.

This method employs a combination of the tools of economics, statistics, accounting, engineering, and other technical subjects pertaining to the industry under investigation.

The economic engineering approach was selected for this study because it lends itself to an evaluation of modern plants using the latest technological developments. This is in keeping with the major purpose of this study.

Model Plants

The model plants developed in this study are designed and constructed for the purpose of receiving and shipping bulk grain only; the grain is received directly from farmers, in the farmer's

²² L.L. Sammet and B. C. French, "Economic-Engineering Methods In Marketing Research," Journal of Farm Economics, Vol 35, 1953, pages 924-30; and French, et.al., op.cit., pages 543-721.

²³ Guy Black, "Synthetic Method of Cost Analysis In Agricultural Marketing Firms," Journal of Farm Economics, Vol 37, No. 2, August 1955, pages 270-79.

vehicle, inspected for weeds and dumped into elevator receiving dump pits. From the dump pit it moves through cleaners, is weighed and tested for weight and moisture, and elevated into storage bins or loaded directly into railroad boxcars or trucks for shipment. Ear corn is shelled before cleaning and the cobs and husks cleaned from the grain and blown to a corn cob burner. All grain movement is by mechanical means with little manual labor except in the operation and maintenance of equipment. Gravity flow is used wherever possible.

The model plants used in this study were constructed to conform as nearly as possible to the standard type of elevator found in Michigan. The model plants differ only in physical size and not in operational techniques or technology employed. The model plants are based on the design and equipment specifications of most of the recently built elevators in Michigan. They were designed and developed from information received from elevator designers and builders within the state.

The model plants developed range in size from 750 to 4500 bushels per hour and cover all the various sizes of grain elevators now found in Michigan. This study includes both single and double-line plants as both are found within the Michigan elevator industry. Single-line plants are used for the smaller plants and double-line plants for the larger plants. The 2250 bushel per hour plant, which is very common in Michigan, is used as the breaking point. Both a single and double-line plant is used for this particular size.

Michigan elevators buy several commodities from farmers. These commodities include corn, winter wheat, soybeans, dry beans, oats, barley and some quantities of rye, buckwheat and other grass seeds produced in the local areas. The plants developed in this study are designed and equipped to handle all crops produced in Michigan. However, the major portion of the analysis is based on the receiving and shipping of winter wheat and field corn, either ear or shelled.

The nature of grain and corn harvest requires that elevators be equipped to receive and ship or store large quantities of grain in rather short periods of time. However, storage is usually used only for assembling car load lots. Most commodities are shipped out immediately to make room for the next crop. Corn, a feed crop, and navy beans may be stored longer because they are harvested at the end of the season and require more processing before they are shipped or sold.

Wide variations are found in the amount and type of storage provided by various elevators. The scope of this thesis does not permit a complete evaluation of the various types of available storage facilities. For this reason all model plants are equipped with concrete stave silos, which are extensively used in Michigan and which fulfill the necessary requirements of elevators receiving and shipping grain.

Product Flow

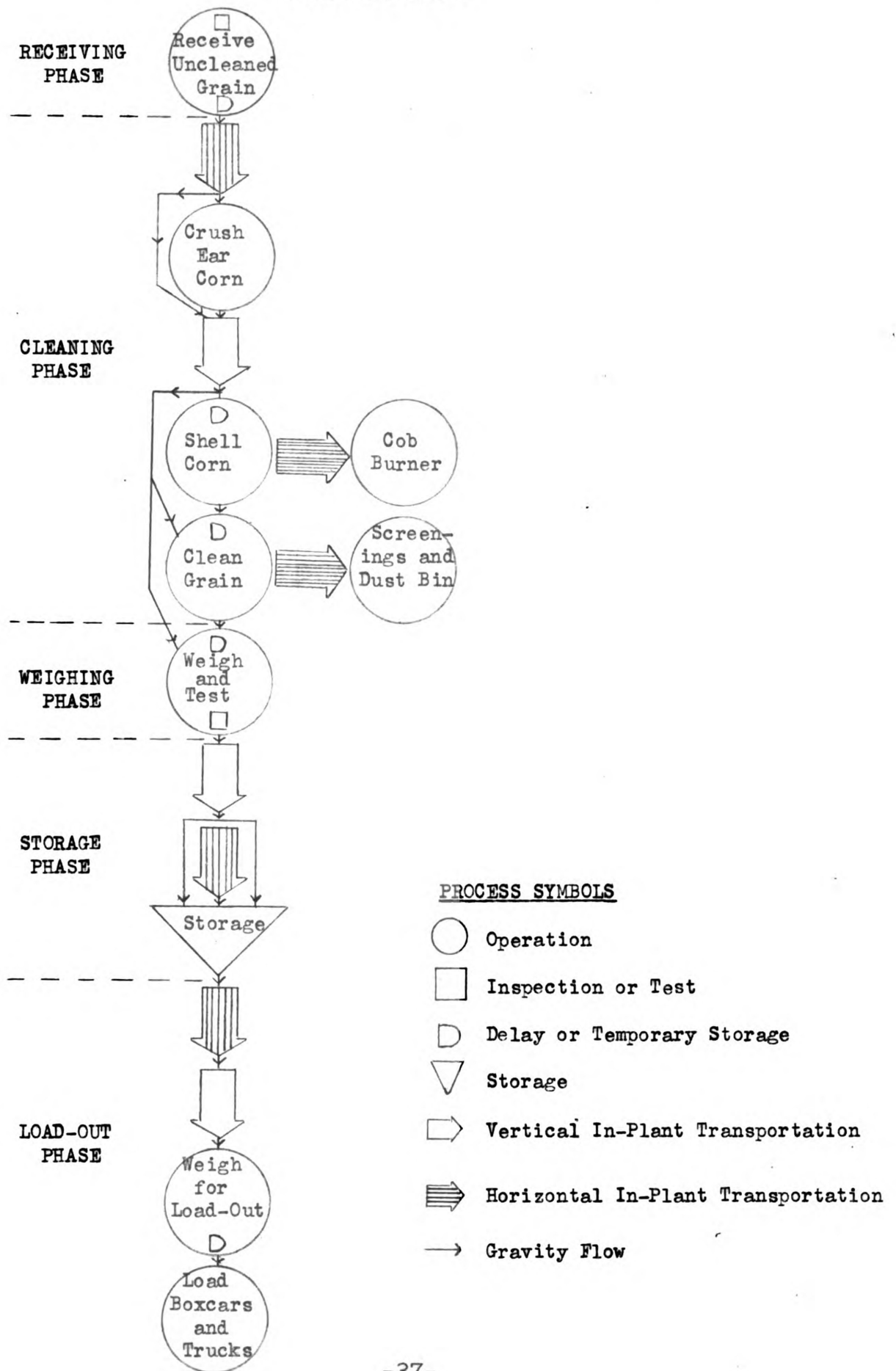
The operations found within a grain elevator differ from other agricultural processing plants in that the raw material is

not altered except for the removal of foreign material, shelling ear corn being one exception. The major function is the assembling and standardization of material for bulk shipment to processing plants or to terminals for storage.

The receiving and cleaning of grain for shipping requires an integrated temporal sequence of elementary processes in each of which the basic raw material changes in location. The process flow chart in Figure 2 shows the various phases and operations involved in the flow of material through the model plants. For the purposes of this analysis, the sequence begins with the arrival at the plant of a farmer's vehicle loaded with ear corn, wheat or some other small grain and ends when the same are loaded into trucks or railroad cars for distribution to other elevators, terminals or processing plants. This long sequence of processes is split into five subsequences or operating phases, each followed by a temporary delay or storage operation and each connected by some means of transportation. The five operating phases are receiving, cleaning, weighing, storage, and load-out. Each of these consists of all productive services - durable or nondurable - that cooperate in performing a single activity or a group of minor but closely related activities. Within each of these phases, equipment was selected and operated so that the product output rate of the preceding elementary process was approximately or exactly the same as the product input rate of the following elementary process.

Temporary delays are provided wherever necessary in the form of hoppers or garner bins. These temporary delays help to even out

Figure 2.--Process Flow Chart for Michigan Grain Elevators, 1961.



and maintain the flow of material through the plant and are especially useful in maintaining the flow of material through particular pieces of equipment. These delays are of importance because many operations are being performed at the same time and it is not always possible to get a perfect synchronization of material flow through the various operations. They also separate the various operations found within the plant. By-passes are also provided where necessary to allow the material to by-pass those operations which are not required. This condition is brought about by the fact that the same facilities are used for ear corn and other small grains, both of which do not require the same processing.

The Receiving Process - The receiving process starts when the farmer arrives at the elevator and drives his vehicle over the dump pit and onto the truck hoist. Once the material has been dumped into the receiving pit it may either be held there for several minutes or it may be moved directly to the next process. The receiving pit acts as the temporary storage point at the end of the receiving process. Material is usually stored for only short periods of time in the receiving pit.

During the harvest season, one man usually operates the truck hoist and helps the farmer position and dump his vehicle. At times other than the harvest season one man may be running the entire plant and will help receive as well as operate all other operations.

The Cleaning Process - The cleaning process includes several operations which follow in direct order. Gravity flow is used,

after the initial elevation. The foreign material, corn cobs and screenings are removed along the way and disposed of.

The labor required by the cleaning process consists mainly of machinery adjustments on the cleaning and processing equipment; starting, stopping and controlling the flow of material through the various operations; and the removal or bagging of screenings. During the harvest season one man usually performs these operations in conjunction with the weighing and storage processes. The receiving operator usually does the bagging of screenings and assists the cleaning operator in any way possible. At times other than during the harvest season one man may perform the cleaning operations as well as all other operations.

This phase requires an operator who is familiar with the cleaning equipment and who is capable of making the necessary equipment adjustments. He must have a thorough knowledge of the various spouts, by-passes, and various routes the material can take as it passes through the cleaning process. The operator must also possess a knowledge of grain and corn grades and the necessary foreign material tolerance associated with each grade.

The Weighing Process - The weighing process is composed of one operation and is a very important part of the total operation. It is at this point that the clean grain is sampled and tested for moisture and test weight. The farmer's receipt ticket is also made out at this point.

The cleaning operator usually operates this phase in conjunction with the cleaning and storage phases. His primary task is the sampling, testing for moisture and test weight, weighing the

partial drafts, and writing the farmer's receipt ticket. This operator must be familiar with the sampling and testing techniques used in testing grain for moisture and test weight. In addition he should also possess a knowledge of grain and corn grades so that he can separate the different grades as they are received. He must be familiar with the farmers he serves as he is the one who weighs their grain and who comes in direct contact with them. He must be able to explain the various test he has made and why he has graded the commodity as he has. He must also be able to explain the firm's pricing and dockage policy.

The Storage Process - The storage process starts as the material flows from the scales hopper into the main elevating boot. The material is elevated, distributed to one of the storage bins, or loaded directly into a truck or railroad boxcar. If the material is distributed directly to a truck or boxcar then the sequence of operations stops at this point. However, if the material is distributed to one of the storage bins then the sequence of operations must continue with the storage bins serving only as the terminal point of the storage process.

The labor required by this operation consists primarily of adjusting and operating the elevating equipment and seeing that the material is distributed to the right bin or outlet. This phase is usually operated in conjunction with the weighing phase and requires very little labor other than that used by the weighing phase.

The Load-Out Process - The load out process starts with the gravity flow of the material from the storage bins and ends when it is placed in the boxcar or truck for shipment. The demand for labor by this phase is primarily in the form of preparing boxcars for loading. The boxcars have to be boarded up and cleaned out for the shipment of grain. Some means is also needed for moving loaded cars and for spotting empty cars at the loading spout. Less labor is required when loading trucks than when loading boxcars.

The actual loading is done by mechanical means and requires very little labor. The main labor requirements are in the form of starting, controlling and stopping the flow of material through this operation. The flow of material through the plant ends with the loading of grain into boxcars or trucks.

The Economic Unit - An economic unit is distinguished from a technical operation in that it is composed of several technical operations. For purposes of cost comparison the joint operations must be redefined into a single operation which is called an economic unit. The minimum cost technologies can be determined only by joint consideration of all operations that are technically related.²⁴

A plant or firm may be composed of several economic units, depending on the rate at which the various phases are capable of operating. This is not the case with grain receiving and shipping elevators. The only difference in the model plants used in this

²⁴ French, et.al. op.cit. page 574.

study was in the size of equipment used and not a functional difference. They were not limited in their output because of bottlenecks found in certain technical operations. The model plants were budgeted as a unit and each plant is under one manager or management and is confined to one group of buildings. They are therefore composed of one economic unit which takes in the entire plants operation. The cost-volume comparisons between the various sized plants are evaluated in this manner.

The economic unit is composed of the several technically related operations which involved the physical handling of the material and all of the management functions which consist of all the non-physical operations. These non-physical management functions include the keeping of records, the buying and selling of grain, making payments to farmers for grain receipts, keeping personnel and payroll records, and keeping all other records of management and control. These non-physical functions can be thought of as including all those task involved in the operation of the grain merchandising enterprise other than the physical handling of material within and through the plants.

Sources of Data Used In The Construction of Model Plants

All cost of plant construction and all operating cost must be estimated. Therefore, many sources of data may be required to obtain the necessary estimates. The cost data gathered must be as accurate as possible as well as applicable to the conditions as they exist in the state at the time of their estimation. The

data gathered for this study were obtained from several sources and represent as near as possible the conditions existing in Michigan during 1961. Operating data as well as cost data were collected for use in constructing the model plants. Sources of data used throughout this study are discussed below.

Direct Observations - Several recently built plants were visited throughout the state and observations made on plant operations during the harvest season. The data collected from these plants covered a wide range and to maintain consistency the same data were collected from all plants visited.

Two plants were visited in the cash crop thumb area, two were visited in the central part of the lower half of the lower peninsula, and one each was visited in the southeastern and southwestern part of the state. Since the plants visited were all located in different parts of the state, their overall operations varied widely but the grain merchandising enterprise was found to be similar in each plant visited.

Time studies were made on various operations at each of the plants visited to obtain labor requirements, equipment capacities, and delays, both normal and during the harvest season. The primary purpose of these timings was to find the time required for the various operations within the plant. Timings were made on all grain moving and cleaning equipment. The time required by the operator to perform various operations was also obtained. Operating as well as delay time was observed at all phases of the operation. Position and unloading times were obtained for different types and sized farm vehicles. Timings were also made on the time required to prepare boxcars for loading.

1. The first part of the document is a letter from the President of the United States to the Congress.

2. The second part is a report on the state of the Union.

3. The third part is a report on the state of the Treasury.

4. The fourth part is a report on the state of the Navy.

5. The fifth part is a report on the state of the Army.

6. The sixth part is a report on the state of the Commerce.

7. The seventh part is a report on the state of the Education.

8. The eighth part is a report on the state of the Agriculture.

9. The ninth part is a report on the state of the Industry.

10. The tenth part is a report on the state of the Science.

11. The eleventh part is a report on the state of the Arts.

12. The twelfth part is a report on the state of the Literature.

13. The thirteenth part is a report on the state of the Music.

14. The fourteenth part is a report on the state of the Painting.

15. The fifteenth part is a report on the state of the Sculpture.

16. The sixteenth part is a report on the state of the Architecture.

17. The seventeenth part is a report on the state of the Engineering.

18. The eighteenth part is a report on the state of the Medicine.

19. The nineteenth part is a report on the state of the Law.

20. The twentieth part is a report on the state of the Religion.

21. The twenty-first part is a report on the state of the Philosophy.

22. The twenty-second part is a report on the state of the History.

23. The twenty-third part is a report on the state of the Geography.

24. The twenty-fourth part is a report on the state of the Meteorology.

25. The twenty-fifth part is a report on the state of the Botany.

26. The twenty-sixth part is a report on the state of the Zoology.

27. The twenty-seventh part is a report on the state of the Geology.

28. The twenty-eighth part is a report on the state of the Astronomy.

29. The twenty-ninth part is a report on the state of the Mathematics.

30. The thirtieth part is a report on the state of the Natural History.

In addition to the various timings and observations made at each of the plants visited, the manager was also asked a series of questions pertaining to the plants actual operation. They supplied much of the necessary data on such things as wages for various types of labor and general operating conditions.

An inventory was made of all the equipment found within the plants visited. This inventory included the location of the machine, a sketch, its operating characteristics and any other pertinent remarks. This inventory was used in determining the required equipment for the model plants.

Equipment Manufactures - The equipment required for the synthetic plants was determined from data obtained when the various plants were visited. The equipment needed by each of the various sized plants was listed and equipment manufacturers and their catalogs were consulted as to specifications and price. This information was then used in making the cost estimates for the machinery and equipment used in the model plants.

Engineering Estimates of Building Cost - Several contractors were visited throughout the state to obtain information about specifications and model plant designs. These specifications and the data obtained from direct observations were then used to develop the designs for the various model plants.

The actual costs of elevators constructed in Michigan during 1960 were obtained. The costs of constructing the model plants including silos, were estimated by using this cost data in conjunction with the specifications obtained from the contractors, equipment specifications, and engineering requirements.

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

3. The third part of the paper is devoted to the study of the

4. The fourth part of the paper is devoted to the study of the

1. The first part of the paper is devoted to the study of the

2. The second part of the paper is devoted to the study of the

Plant Records and Audits - Additional information was obtained from plant audits. These audits were not used for specific cost data. They were used to get some indication of the relationship between various cost categories and total operating cost.

Other Sources of Data - The previous studies made pertaining to the Michigan elevator industry were also used to advantage in several phases of this study. These studies were used primarily as guides in the development of the model plants.

Personal contacts with people actively engaged within the elevator industry provided valuable assistance in the development of the model plants and in estimating the various operating costs. These contacts included contractors, equipment manufacturers, and their representatives, insurance companies, managers and employees of local elevators and related businesses. In addition, people who have done previous research in this field were also able to provide and make many valuable suggestions.

The department of agricultural engineering at Michigan State University was also called upon for suggestions in the development of the model plants. They were especially helpful in checking the engineering feasibility of all phases of the model plants.

Assumptions

This study was based on certain assumptions pertaining to the Michigan elevator industry and the conditions found within this industry. The model plants and the various operating conditions used were based on these basic assumptions.

As to Operating Conditions - It is assumed that the grain merchandising enterprise is operated the same throughout the state. The only difference between plants is in physical size and importance depending on the location and agricultural conditions surrounding a particular plant.

As to Size Requirements for Michigan - The model plants developed for this study were assumed to cover the range of sizes now found in Michigan as well as the size of those which might be built in the near future.

As to Location Factors - The environmental conditions surrounding a particular plant will determine the most economical size of plant to be used in that particular area. However, analysis related to location is not included in this study. It is assumed that management will determine the location factors in an area before deciding on the scale of plant to be constructed in that area.

The model plants developed in this study lend themselves to this assumption in that they differ only in size and were developed according to the existing conditions found within Michigan during 1961. The model plants are therefore applicable to any area of the state. Differences may exist, however, between areas in the cost of labor, power, and other factors of production.

As to Storage Requirements - The storage provided for the model plants was assumed to be adequate for the merchandising process for which the model plants were developed.

As to Economic Model and Conditions - The economic problem studied was formulated in terms of cost efficiency criteria. The

1. The first line of the document is a header line.

2. The second line of the document is a header line.

3. The third line of the document is a header line.

4. The fourth line of the document is a header line.

5. The fifth line of the document is a header line.

6. The sixth line of the document is a header line.

7. The seventh line of the document is a header line.

8. The eighth line of the document is a header line.

9. The ninth line of the document is a header line.

10. The tenth line of the document is a header line.

11. The eleventh line of the document is a header line.

12. The twelfth line of the document is a header line.

13. The thirteenth line of the document is a header line.

14. The fourteenth line of the document is a header line.

15. The fifteenth line of the document is a header line.

16. The sixteenth line of the document is a header line.

17. The seventeenth line of the document is a header line.

18. The eighteenth line of the document is a header line.

19. The nineteenth line of the document is a header line.

20. The twentieth line of the document is a header line.

21. The twenty-first line of the document is a header line.

22. The twenty-second line of the document is a header line.

23. The twenty-third line of the document is a header line.

24. The twenty-fourth line of the document is a header line.

25. The twenty-fifth line of the document is a header line.

26. The twenty-sixth line of the document is a header line.

27. The twenty-seventh line of the document is a header line.

28. The twenty-eighth line of the document is a header line.

29. The twenty-ninth line of the document is a header line.

30. The thirtieth line of the document is a header line.

31. The thirty-first line of the document is a header line.

32. The thirty-second line of the document is a header line.

33. The thirty-third line of the document is a header line.

34. The thirty-fourth line of the document is a header line.

35. The thirty-fifth line of the document is a header line.

firms were assumed to operate in a perfectly competitive market, and the economic model employed was that of static production economics. The assumptions of this model pertaining to static production functions, consumption functions and institutions; those which eliminate random elements; and those concerning motivations were maintained.

CHAPTER IV

MODEL PLANT SPECIFICATIONS AND OPERATING CONDITIONS

Model Plant Receiving Capacities and Facilities Provided

There are many ways of measuring plant size as related to capacity. The most commonly used is either storage or handling capacity. Since this study is directed to grain handling the latter is a more relevant measure of capacity. The grain cleaner was therefore used throughout this study as the primary determinant of plant capacity. The grain cleaner determines the rate at which a plant operates, provided there are no bottlenecks to hinder or slow down the receiving and loading out processes. The model plants rated capacities are based on discrete cleaner sizes. All other machinery and equipment was then selected in such a way that its operating capacity coincided with that of the grain cleaner.

Grain cleaners come in a wide range of capacities and makes. A general purpose cleaner, capable of handling the several commodities received by Michigan elevators, was selected for this study. Cleaners were selected in six rated capacities ranging from 1000 to 6000 bushels per hour. It was apparent, however, in making time studies at the elevators visited that grain cleaners cannot be operated at the manufacturers rated capacities. A considerable range in operating rates was observed with the maximum being around 75 percent of the manufacturers rated capacities. The rated capacities of the model plants used throughout the remainder

of this study are therefore as follows: 750, 1500, and 2250 bushels per hour single-line plants, and 2250, 3000, 3750, and 4500 bushels per hour double-line plants.

The plant capacities used throughout this study cover the more common plant capacities found within the Michigan elevator industry. However, the large plant capacities, especially the 3750 and 4500 bushel per hour plants, are rather large and uncommon for Michigan grain elevators. They were included as representing sizes which might be considered in future years. They should also serve as valuable planning guides and as a means of comparing the relative efficiencies of the smaller plants.

It was also observed that equipment, other than cleaners, found in an elevator is not operated at the manufacturers rated capacity. The speed with which the shaker pit is emptied depends primarily on the elevating leg which removes the grain from the pit and elevates it to the cleaner floor. The speed and slope of the shaker pit also had some affect on its capacity. Elevating legs are usually operated at about 90% of their rated capacity. Elevator leg capacity depends on many factors such as, cup size, spacing of cups on belt, speed at which the elevator is operated, material being handled and the degree of cup capacity utilized. The elevating legs used in the model plants were calculated at 90% of the manufacturers rated capacity. Manufacturers recommendations were followed in regards to bucket size, spacing and speed of operation but, cup capacity was computed at 90% of the manufacturers volume. A similar procedure was followed in estimating the required capacity of all screw conveyor systems.

Corn handling equipment varies in operating rate depending on the moisture content of the corn being processed, the degree of husk and other foreign material, the speed at which they are operated, and the size of ear corn crusher or corn sheller. It was observed that the ear corn crusher, under reasonably favorable conditions, was capable of being operated at the manufacturers rated capacity.

Corn sheller manufacturers usually list the capacity of corn shellers as a range rather than as a certain per bushel capacity. The low capacity corresponding to very wet corn and the high capacity corresponding to very dry corn. It was observed that shellers operate within this range depending on the moisture content of the corn and whether or not an ear corn crusher preceded the corn sheller. Ear corn crushers preceding the corn sheller usually increase the recommended capacity of the sheller from 15 to 20 percent, again depending on the moisture and foreign material content of the corn. Ear corn crushers also have many other operating advantages such as, preventing scrape iron, stones and other foreign material from entering the corn sheller. The model plants were therefore equipped with ear corn crushers operating at the manufacturers rated capacity and corn shellers operating at 90 percent of the dry corn rated capacities.

The remaining equipment, which was primarily gravity flow equipment, was selected so that there would be no bottlenecks. Gravity flow spouts, distributors, bin slides and shut-offs, and load-out spouting were all selected according to engineering recommendations and specifications, spout diameter being the primary consideration.

The discussion thus far has been in terms of the discrete sizes of various pieces of equipment. However, the exact size of equipment desired was not available in all cases. In those cases the next largest size was selected. Larger capacities were selected in all cases to avoid bottlenecks. Garner bins or hoppers were then provided at convenient places to help even out the flow of material through the plant and to take up some of the slack created by the imperfect synchronization of certain operations.

The procedure followed in this study was to develop and design the model plants as though they were grain handling operations. The corn receiving and shelling operation was then designed to fit the plant. The same intake leg could be used by using a corn receiving and shelling capacity of 50 percent of grain handling capacity. This permitted the use of ear corn crusher and sheller sizes that were readily available and easily synchronized into the plants overall operation. The model plants used throughout this study are therefore synchronized with respect to handling all small grains except ear corn on a shelled basis. Ear corn receiving capacity, on a shelled basis, is limited to 50 percent of the grain receiving capacity.²⁵

If the corn shelling capacity of the model plants was to be synchronized with the cleaning capacity of the model plants larger intake legs, more than one sheller, and larger ear corn

²⁵ One bushel of shelled corn (56 pounds) is approximately equivalent to two bushels (70 pounds) of husked ear corn. The plants are therefore able to receive only half as much corn on a shelled basis as on an unshelled or ear basis.

crushers would be required. These are all possible and could be provided if so desired. Several shellers could be used as a group, larger intake legs are available, and large double-roll ear corn crushers are also available. These double-roll ear corn crushers have about twice the capacity of single-roll crushers and have many additional operational advantages. However, if ear corn receiving is the primary function to be performed by the elevator, then plant designs other than those used in this study should be investigated.

Ear corn receiving capacity, on a shelled basis, is computed at 50 percent of the grain receiving capacity of the model plants. This appears to be reasonable in light of the fact that corn harvest usually does not proceed as rapidly as grain harvest and is not as important a cash crop as other grains. Large amounts of the ear corn produced within the state are retained on the farm to be utilized as feed or stored in cribs to be sold in the spring of the year. This puts less pressure on the local elevator at corn harvest and reduces the need for large corn receiving capacities.

Another important development affecting corn harvest is the increasing use of field picker shellers. The use of these machines is increasing in Michigan and eliminates the need for local elevators having large crushing and shelling capacities. Shelled corn received by the local elevator is processed in the same manner as other small grains. The ear corn crusher and sheller no longer are a limiting factor when receiving corn.

1. $\frac{1}{2} \log 2$
2. $\frac{1}{2} \log 2$
3. $\frac{1}{2} \log 2$
4. $\frac{1}{2} \log 2$
5. $\frac{1}{2} \log 2$
6. $\frac{1}{2} \log 2$
7. $\frac{1}{2} \log 2$
8. $\frac{1}{2} \log 2$
9. $\frac{1}{2} \log 2$
10. $\frac{1}{2} \log 2$
11. $\frac{1}{2} \log 2$
12. $\frac{1}{2} \log 2$
13. $\frac{1}{2} \log 2$
14. $\frac{1}{2} \log 2$
15. $\frac{1}{2} \log 2$
16. $\frac{1}{2} \log 2$
17. $\frac{1}{2} \log 2$
18. $\frac{1}{2} \log 2$
19. $\frac{1}{2} \log 2$
20. $\frac{1}{2} \log 2$
21. $\frac{1}{2} \log 2$
22. $\frac{1}{2} \log 2$
23. $\frac{1}{2} \log 2$
24. $\frac{1}{2} \log 2$
25. $\frac{1}{2} \log 2$
26. $\frac{1}{2} \log 2$
27. $\frac{1}{2} \log 2$
28. $\frac{1}{2} \log 2$
29. $\frac{1}{2} \log 2$
30. $\frac{1}{2} \log 2$
31. $\frac{1}{2} \log 2$
32. $\frac{1}{2} \log 2$
33. $\frac{1}{2} \log 2$
34. $\frac{1}{2} \log 2$
35. $\frac{1}{2} \log 2$
36. $\frac{1}{2} \log 2$
37. $\frac{1}{2} \log 2$
38. $\frac{1}{2} \log 2$
39. $\frac{1}{2} \log 2$
40. $\frac{1}{2} \log 2$
41. $\frac{1}{2} \log 2$
42. $\frac{1}{2} \log 2$
43. $\frac{1}{2} \log 2$
44. $\frac{1}{2} \log 2$
45. $\frac{1}{2} \log 2$
46. $\frac{1}{2} \log 2$
47. $\frac{1}{2} \log 2$
48. $\frac{1}{2} \log 2$
49. $\frac{1}{2} \log 2$
50. $\frac{1}{2} \log 2$
51. $\frac{1}{2} \log 2$
52. $\frac{1}{2} \log 2$
53. $\frac{1}{2} \log 2$
54. $\frac{1}{2} \log 2$
55. $\frac{1}{2} \log 2$
56. $\frac{1}{2} \log 2$
57. $\frac{1}{2} \log 2$
58. $\frac{1}{2} \log 2$
59. $\frac{1}{2} \log 2$
60. $\frac{1}{2} \log 2$
61. $\frac{1}{2} \log 2$
62. $\frac{1}{2} \log 2$
63. $\frac{1}{2} \log 2$
64. $\frac{1}{2} \log 2$
65. $\frac{1}{2} \log 2$
66. $\frac{1}{2} \log 2$
67. $\frac{1}{2} \log 2$
68. $\frac{1}{2} \log 2$
69. $\frac{1}{2} \log 2$
70. $\frac{1}{2} \log 2$
71. $\frac{1}{2} \log 2$
72. $\frac{1}{2} \log 2$
73. $\frac{1}{2} \log 2$
74. $\frac{1}{2} \log 2$
75. $\frac{1}{2} \log 2$
76. $\frac{1}{2} \log 2$
77. $\frac{1}{2} \log 2$
78. $\frac{1}{2} \log 2$
79. $\frac{1}{2} \log 2$
80. $\frac{1}{2} \log 2$
81. $\frac{1}{2} \log 2$
82. $\frac{1}{2} \log 2$
83. $\frac{1}{2} \log 2$
84. $\frac{1}{2} \log 2$
85. $\frac{1}{2} \log 2$
86. $\frac{1}{2} \log 2$
87. $\frac{1}{2} \log 2$
88. $\frac{1}{2} \log 2$
89. $\frac{1}{2} \log 2$
90. $\frac{1}{2} \log 2$
91. $\frac{1}{2} \log 2$
92. $\frac{1}{2} \log 2$
93. $\frac{1}{2} \log 2$
94. $\frac{1}{2} \log 2$
95. $\frac{1}{2} \log 2$
96. $\frac{1}{2} \log 2$
97. $\frac{1}{2} \log 2$
98. $\frac{1}{2} \log 2$
99. $\frac{1}{2} \log 2$
100. $\frac{1}{2} \log 2$

Another practice that is sometimes followed in receiving corn which reduces the need for large corn receiving capacities is the scheduling of corn shelling activities in the spring. This practice is followed to assure a steady flow of material through the plant and to eliminate line-ups and long waits during the spring when farmers are removing their ear corn from storage cribs. The major difficulty encountered when following this practice is that usually all farmers in an area find it convenient to move their corn at about the same time.

Single and Double-Line Plants

Double as well as single-line plants are common to the Michigan elevator industry. A double-line plant has two receiving pits, intake legs and grain cleaners as opposed to only one in the single-line plants. The model plants developed in this study include both single and double-line plants. The smaller plants (750 and 1500 bushel per hour plants) were both single-line plants and the larger plants (3000, 3750 and 4500 bushel per hour plants) were all double-line plants. The 2250 bushel per hour plant, which was found to be a very common size in Michigan, was included both as a single and a double-line plant.

The need for more than one receiving line arises because of the time required to position and unload a vehicle of a particular size. As the single-line plant capacities were increased they were equipped to receive and clean more grain than it was

physically possible to unload in a given period of time. It is uneconomical to have a plant equipped to handle more material than it can possibly receive.

A double-line plant also adds some flexibility to the operation. With only one cleaner it becomes necessary to change the cleaner's screens every time a different commodity is received.

The greatest advantage of double-line plants is during the harvest season when large volumes are handled in relatively short periods of time. With two receiving lines the number of vehicles that can pass through a plant of a particular size is increased, thus increasing the volume of material handled.

Storage Facilities

The storage facilities found throughout the state vary widely between elevators and localities. These differences are found not only in the size and amount of storage provided but also in the various kinds of storage facilities provided.

Several factors determine the amount of storage provided at any particular elevator. Among these are the length of time that material is to be stored, number of crops handled by the elevator, amount of blending to be done and the amount of processing required by the commodity under consideration. Most Michigan elevators do not store grain any longer than from one harvest season to the next. A common practice is to store only enough for their own needs and to empty all storage bins before the next crop is harvested. However, feed crops may be stored for longer

periods of time because they are sold to farmers in the area and are sold over a period of several months. Navy beans require more processing than other crops and may require a longer storage period.

The model plants developed in this study were assumed to be primarily assembling plants. Adequate storage was provided to accomplish this assembling process without regards for permanent or long term storage arrangements.

Each model plant was equipped with at least six storage bins to provide adequate flexibility for receiving and handling several different crops. The storage facilities provided ranged from 20,000 bushels for the 750 bushel per hour plant to 120,000 bushels for the 4500 bushel per hour plant. The storage was increased between model plants in 20,000 bushel increments. Table 3 shows the number of bins and total storage capacity provided for each of the model plants. These amounts were provided on the basis of maximum potential storage requirements during the harvest season.

The storage facilities provided for the model plants were all concrete stave silos with hoppers bottoms for self cleaning. The size of bins used were popular sizes found in many parts of the state.

Railroad Siding

Very closely associated with the amount of storage provided are the facilities needed for spotting railroad boxcars. It was

Table 3:-- Storage Facilities Provided for Model Grain Elevators, Michigan, 1961.

Plant Capacity (B.P.H.)	Number of Bins	Approximate Capacity Per Bin (Bushels)	Total Storage Capacity (Bushels)
750 B.P.H.- Single-Line	6	3,333	20,000
1500 B.P.H.- Single-Line	6	6,666	40,000
2250 B.P.H.- Single-Line	6	10,000	60,000
2250 B.P.H.- Double-Line	6	10,000	60,000
3000 B.P.H.- Double-Line	8	10,000	80,000
3750 B.P.H.- Double-Line	10	10,000	100,000
4500 B.P.H.- Double-Line	12	10,000	120,000

assumed that the primary means of shipping grain from the model plants would be via railroad boxcars. Enough railroad siding was provided so that the elevators could operate at capacity during the harvest season. Assuming that boxcars were available and that at least one switch was made per day by the railroad company.

The amount of railroad siding was estimated by determining how much grain could be loaded out each day if plants operated a 10 hour day at full capacity. Table 4 shows the number of boxcars for which space was provided at each plant. Adequate track was provided for switching, for holding filled boxcars in front of the loading spout, and for holding empties behind the loading spout.

Table 4:--Railroad Siding Provided for Model Grain Elevators,
Michigan, 1961.

Plant Capacity	Number of Railroad Boxcars to Be Spotted at Each of The Model Plants
(B.P.H.)	
750 B.P.H. - Single-Line	4
1500 B.P.H. - Single-Line	6
2250 B.P.H. - Single-Line	8
2250 B.P.H. - Double-Line	10
3000 B.P.H. - Double-Line	12
3750 B.P.H. - Double-Line	14
4500 B.P.H. - Double-Line	16

Land and Land Improvements

Though economic engineering studies often omit land costs they are included in this study because they are an important factor to be considered in the overall planning of any particular elevator.

Land provided for the model plants ranged from 2 acres for the smallest plant to $4\frac{1}{2}$ acres for the largest. This includes adequate space for buildings, storage facilities, railroad siding and driveways. The greatest demand for land is not for the actual building site, but for adequate space to prevent bottlenecks and to maintain a uniform flow of material into the plant during the harvest season. Improvements included driveways, fences, sidewalks and landscaping.

Trucking Equipment

Each model plant was equipped with one two-ton truck with grain box. The truck was included as part of the plants operating equipment and not as a means of transporting grain long distances or as a source of income from such activities. Its primary use is for the removal of screenings, transporting grain short distances, and as a means of power for moving railroad box-cars.

Office-Facilities

Each plant was equipped with office facilities and furnishings. The office space provided was assumed to be adequate for the grain merchandising operation only.

The offices or plants were not equipped with a large truck scales. It was assumed that all material received and loaded out by the plants would pass over the auto-matic in-plant scales.

Model Plant Operating Conditions

In the short-run only part of the factors determining cost can be varied. Some of the input factors, e.g., land, buildings, heavy machinery and top management, are assumed to be physically fixed and not capable of immediate adaptation to changes in rate of output within the short-run limits of flexibility. These are the firm's short-run "fixed resources" and are the durable fixed assets referred to in this study. These fixed resources determine

the scale or size of the firm's plant. The scale of plant sets the upper limit (maximum capacity) to the amount of output per unit of time which the plant is capable of producing in the short-run. Output can be varied up to that limit in the short-run only by increasing or decreasing the quantities of "variable resources" used in the fixed scale of plant.²⁶ The fixed resources therefore determine the upper limits of production but the quantities of variable resources used determine the level of production or the degree to which maximum capacity is utilized.

The fixed expenses associated with owning a plant of a particular hourly capacity normally remain at a relatively constant level from year to year regardless of volume.²⁷ However, as output or production approaches capacity the per unit cost of handling grain declines rather sharply with increases in volume. Thus, it is to elevator management's advantage to plan and provide facilities which can handle expected volume increases and then to plan to use the facility as near capacity as is possible.

The firm's variable resources are input factors such as labor, power, raw materials and the like which can be varied in the short-run. These variable resources are of major importance because output can be increased or decreased in the short-run primarily by increasing or decreasing the quantities of variable

²⁶ Lertwich, op.cit., page 140.

²⁷ Capacity here refers to the plants rated hourly receiving rate. Annual capacity is a function of this hourly rate and annual hours of operation.

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

... () ...

resources used in the fixed scale or plant. The operating conditions which affect and determine the use of the various variable resources are discussed below. These are also the factors which determine the total annual volume handled by the model plants.

General Operating Conditions

It was assumed that the model plants were operating in a competitive environment. It was assumed that the price of all variable resources was constant and that no differences existed within the state.

The conditions used throughout this study, which affect cost, are scale or size of plant, annual hours of operation, receiving mix and average load size received. Each of these and their affect on operating cost and annual volume are discussed separately.

Plant Scale and Annual Hours of Operation

Plant scale or size of plant affects operating cost and annual volume handled because, as pointed out above, it sets the upper limit to the amount of output per unit of time which the firm is capable of producing in the short run. This is often referred to as the rate dimension and is concerned only with annual volume as affected by the plants hourly rated capacity. Annual volume can be increased or decreased by changing the rate at which the plant operates, holding the number of hours operated, load size and product mix constant. This, however, is not

the only means of obtaining a desired annual volume. French refers to this other method as the time dimension and points out that a failure to distinguish clearly between the rate and time dimension leads to confusion concerning the nature of cost curves.²⁸

For the purpose of this study the rated capacity of the model plants serves as the rate dimension and the annual hours of operation serve as the time dimension. The different rates show that each of the model plants has a different hourly receiving capacity and that each could achieve a different annual volume provided they were all operated the same number of hours per year. The time dimension refers to the fact that annual volume could also be increased by increasing the number of hours of annual operation, while holding the plant rate, load size and mix constant. A plant with a low receiving rate could possibly receive as much material in a given year as a larger plant simply because of a difference in the number of hours operated per year. There are therefore two ways of looking at annual volume. First by how much material it is possible to receive in any given hour of operation, or the plants receiving rate, and second by how many hours a year the plant operates at a given rate.

The rate dimension is of major importance to agricultural processing plants which are affected by the seasonal nature of agricultural production. This is especially true with those firms which process the highly perishable commodities and to a

²⁸ French, et.al., op.cit., page 548.

lesser extent with firms handling the storable commodities such as small grains. The seasonal nature of agricultural production requires that agricultural processing plants be equipped to handle rather large volumes in relatively short periods of time.

Many agricultural processing plants are equipped to receive large seasonal volumes and often operate only a few weeks or months each year. To a degree this is also true with the elevator industry. However, because of the storable nature of small grains and because of sideline activities they usually remain open the year around. They are nevertheless faced with the problem of being equipped to handle large volumes during the harvest season as opposed to having a lower receiving rate and operating more hours per year. Elevators usually add part time labor during the harvest season so that the plant can be operated as near capacity as is possible. At the same time they operate many hours per day (as high as 18 or 20 hours) and for as many days as required to complete the harvest season.

Elevator management usually follows a practice of using both the rate and time dimension to obtain the desired annual volume. A rated capacity is selected that makes it possible to handle the harvest rush in the limited time available and still not so large that great inefficiencies are present at other operating times. This is also an advantage of having double-line as opposed to single-line plants. During the harvest season both lines can be operated as near capacity as possible but at other times only one line need be operated.

For the purposes of this study both the rate and the time dimensions were used. The annual hours of operation used for the model plants were 300, 600, 900, 1200 and 1500 hours per year. This includes only the time during which the model plants are actually operating or receiving grain. The model plants are however assumed to operate the year around. The difference between these annual hours of operation and total annual hours is idle time. Each model plants annual volume and total annual cost were therefore calculated for these annual hours of operation.

Since elevators operate the year around, as opposed to operating only during the harvest season, an adjustment had to be made in the annual hours of operation to allow for the harvest season. It was therefore assumed that each of the model plants would operate the same number of hours during the harvest season regardless of size or total annual hours of operation. One hundred hours was therefore allocated to each model plant as time spent during the harvest season. The remaining time being allocated as non-harvest season operating time. The 100 hours harvest season applies only to grain harvest and not to corn harvest. The affect of harvest season hours on annual volume is discussed below.

Receiving Mix

The grain merchandising operation of the model grain elevators are multi-purpose in nature. This fact requires that some

distinction be made between the annual hours of operation as to time spent on receiving the different commodities. The receiving mix used throughout this study refers to the allocation of the total annual hours of operation to receiving grain and ear corn. Three receiving mixes were used throughout this study, they were: 75% grain and 25% ear corn, 50% grain and 50% ear corn, and 25% grain and 75% ear corn. Receiving mixes of 100% grain or ear corn were omitted because plants designed for one purpose or the other do not exist within the state nor is it likely that this high a degree of regional specialization will occur. The actual hours of operation allocated to receiving grain and ear corn for the various annual hours of operation are shown in table 5.

Average Load Size Received

An important factor affecting annual volume and annual operating cost is the average load size received. This factor is of even more importance when one considers that management has no control over the size or type of vehicle used by farmers. The elevator must therefore be equipped to handle very large loads as well as the very small loads.

The average load sizes used throughout this study were 75 bushels, 150 bushels and 225 bushels. Seventy loads of wheat actually received during plant visitations averaged 140 bushels per load. The range was from a low of 20 bushels to a high of 420 bushels.

Average load size was found to be important because it was observed that it takes about as much time to position and unload

Table 5:--Allocation of Operating Time to Receiving Grain and Ear Corn According to Receiving Mix and Total Annual Hours of Operation, Michigan, 1961.

Receiving: Mix	Hours of Operation									
	300 Hours	600 Hours	900 Hours	1200 Hours	1500 Hours					
	Grain	Corn	Grain	Corn	Grain	Corn	Grain	Corn	Grain	Corn
	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)	(Hr)
Receiving: Grain 75%: of the Time and Corn 25% of the Time	225	75	450	150	675	225	900	300	1125	375
Receiving: Grain 50%: of the Time and Corn 50% of the Time	150	150	300	300	450	450	600	600	750	750
Receiving: Grain 25%: of the Time and Corn 75% of the Time.	75	225	150	450	225	675	300	900	375	1125

a small load as it does a larger load. This becomes important when one considers that a large number of small loads would be required to maintain the hourly capacity of the model plants. Whereas, only a few large loads would be required to maintain the same capacity.

The average time per load for the 70 loads observed was 6 minutes and 20 seconds. This includes only the time required to

_____) _____) _____) _____) _____) _____)

position and to actually unload the vehicle. It should be noted that many things contribute to the speed with which a particular load can be received. Many of these depend on the individual farmer and the type of vehicle he uses to haul his grain. Such things are beyond the control of management and in many cases little can be done to speed up the receiving process. It should also be noted that the above observations were made during the harvest season when the elevators were operating beyond a normal rate. These observations do not include the delay time observed between loads. Table 6 shows the actual hourly receiving rates of the model plants when receiving grain and ear corn in the different average load sizes.

Average load size received was also found to be a determining factor as to whether a single or double-line plant is best. The starred rates in table 6 show the different situations where the actual receiving capacity of the model plants was limited because of the time required to dump grain. It should be noted that even with a double-line plant the actual receiving rates were limited, in some cases, when receiving 75 bushel loads. If these model plants were all single-line plants, the hourly receiving capacity would not exceed 727 bushels per hour, regardless of the plants rated capacity.

Seasonality and Its Effect on Operating Grain Elevators

Large volumes of material pass through grain elevators in relatively short periods of time. This is due to the seasonal

Table 6:--Actual Hourly Receiving Rates for Model Grain Elevators Receiving Grain and Corn in Various Average Load Sizes, Michigan, 1961.^a

Plant Capacity	Average Load Size for Receiving Grain and Corn					
	75 Bushel Load		150 Bushel Load		225 Bushel Load	
	Grain	Corn	Grain	Corn	Grain	Corn
	(BPH)	(BPH)	(BPH)	(BPH)	(BPH)	(BPH)
Single-Line						
750 B.P.H.	554	319	611	336	632	342
1500 B.P.H.	727*	554	1029	611	1091	632
2250 B.P.H.	727*	727*	1190*	837	1440	878
Double-line						
2250 B.P.H.	1454*	890	1674	960	1756	986
3000 B.P.H.	1454*	1108	2058	1222	2182	1264
3750 B.P.H.	1454*	1281*	2219*	1448	2531	1510
4500 B.P.H.	1454*	1454*	2380*	1674	2880	1756

^a Corn here refers to shelled corn. These figures should be doubled to obtain the ear corn equivalent. One bushel of shelled corn (56 pounds) is approximately equivalent to two bushels (70 pounds) of husked ear corn.

* In these cases handling capacities were limited because of the time required to position and dump incoming loads. The plants in these instances are equipped to handle more grain than it is physically possible to dump.

nature of the harvest and because of the speed with which it is now accomplished. The elevator therefore finds it necessary to be equipped to receive as much grain as is possible in the few days that the harvest season lasts.

The receiving phase often creates a bottleneck because of the time required for the farmer's vehicle to be positioned, unloaded and moved through the receiving process. The load-out phase creates delays if the receiving process has to be stopped while operators prepare boxcars or trucks for loading. Therefore, additional labor is usually added during the harvest season to help with the receiving process, to board up boxcars, and to help with the loading out process.

It was assumed that material would arrive at the plant, during the harvest season, at a rate that would maintain the actual hourly receiving capacities shown in table 6. It was assumed that during non-harvest periods material arrives at the plant at a rate no faster than that which could be handled by a "normal" labor force, consisting of one or two men, depending on plant size, who operate the entire plant and all of the various technical phases making up that plant. Since a continuous flow of material is no longer a necessity certain phases are operated independently.

Certain of the operating phases need not and usually are not operated as a unit during non-harvest periods. The receiving and loading out phases can be operated as individual operations because of available storage. These operations can be performed independently without interfering with the other three phases of the operation. The delay time between these two phases and the other three phases may be only a few minutes or as high as several months in the case of loading boxcars or trucks. Cleaning, weighing and storage are usually operated as a unit because once

the material starts through the cleaning process it does not stop, except for temporary delays, until it reaches the storage bins.

During these non-harvest season periods the elevator operator usually helps the farmer dump his grain. He then adjusts and starts the various equipment necessary for the cleaning, weighing and storage processes. While the material is being cleaned the operator may do one of several things. He will have to attend the screenings, he will have to adjust and watch the cleaner, he will have to test the grain for moisture and test weight, he will also have to prepare a ticket and weigh the partial draft. One man cannot possibly accomplish all of these tasks while the grain is being cleaned. A common practice is to dump the load, start the cleaner and do those tasks that can be done while the grain is being cleaned, leaving those tasks for which he does not have time until the entire load has been cleaned. This includes such things as testing for moisture, testing for test weight and writing the farmer's ticket. There may then be a several week delay before the material is actually loaded out, depending on the time required to assemble a boxcar or truck load.

Annual Volume as Affected By The Model Plants
Operating Conditions

Tables 7, 8 and 9 show the total annual volume for each of the model plants operating under each of the various operating conditions. It should be noted that annual volume changes not

Table 7.--Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961. a/

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H.	4500 B.P.H.	
	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	
300 Hours:								
75 Bushels	148,575	205,125	218,100	393,900	410,250	423,225	436,200	
150 Bushels	162,900	277,350	330,525	448,650	554,700	607,875	661,050	
225 Bushels	167,850	292,875	389,850	469,050	585,750	682,725	779,700	
600 Hours:								
75 Bushels	297,150	410,250	436,200	787,800	820,500	846,450	872,400	
150 Bushels	325,350	554,700	661,050	897,300	1,109,400	1,215,750	1,322,100	
225 Bushels	335,700	585,750	779,700	938,100	1,171,500	1,365,450	1,559,400	
900 Hours:								
75 Bushels	445,725	615,375	654,300	1,181,700	1,230,750	1,269,675	1,308,600	
150 Bushels	488,025	832,050	991,575	1,345,950	1,664,100	1,823,625	1,983,150	
225 Bushels	503,550	878,625	1,169,550	1,407,150	1,757,250	2,048,175	2,339,100	

(continued)

Table 7.—Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961—Continued. a/

Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received	Single-Line Plants					Double-Line Plants			
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H.	4500 B.P.H.		
	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)		
1200 Hours:									
75 Bushels	594,300	820,500	872,400	1,575,600	1,641,000	1,692,900	1,744,800		
150 Bushels	650,700	1,109,400	1,322,100	1,794,600	2,218,800	2,431,500	2,644,200		
225 Bushels	671,400	1,171,500	1,559,400	1,876,200	2,343,000	2,730,900	3,118,800		
1500 Hours:									
75 Bushels	742,875	1,025,625	1,090,500	1,969,500	2,051,250	2,116,125	2,181,000		
150 Bushels	813,375	1,386,750	1,652,625	2,243,250	2,773,500	3,039,375	3,305,250		
225 Bushels	839,250	1,464,375	1,949,250	2,345,250	2,928,750	3,413,625	3,898,500		

a/ Total annual volume is total volume in bushels of both grain and shelled corn. The respective annual volumes of grain and corn are calculated from tables 5 and 6. The hourly receiving capacities for the various model plants, receiving different average load sizes, are obtained from table 6. The total annual volumes of grain and corn are then obtained by multiplying these hourly capacities by the hours of operation, from table 5, for a plant receiving grain 75 percent of the time and corn 25 percent of the time. The sum of these two separate annual volumes yields the total annual volume for the respective model plants.

Table 8.—Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961. a/

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)
	750 B.F.H. : 1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.F.H. :	3750 B.F.H. :	4500 B.P.H.	
300 Hours:								
75 Bushels	130,950	192,150	218,100	351,600	384,300	410,250	436,200	
150 Bushels	142,050	246,000	304,050	395,100	492,000	550,050	608,100	
225 Bushels	146,100	258,450	347,700	411,300	516,900	606,150	695,400	
600 Hours:								
75 Bushels	261,900	384,300	436,200	703,200	768,600	820,500	872,400	
150 Bushels	284,100	492,000	608,100	790,200	984,000	1,100,100	1,216,200	
225 Bushels	292,200	516,900	695,400	822,600	1,033,800	1,212,300	1,390,800	
900 Hours:								
75 Bushels	392,850	576,450	654,300	1,054,800	1,152,900	1,230,750	1,308,600	
150 Bushels	426,150	738,000	912,150	1,185,300	1,476,000	1,650,150	1,824,300	
225 Bushels	438,300	775,350	1,043,100	1,233,900	1,550,700	1,818,450	2,086,200	

(continued)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Table 8.--Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961--Continued. a/

Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received	Single-Line Plants					Double-Line Plants			
	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H.	4500 B.P.H.		
1200 Hours:									
75 Bushels	523,800	768,600	872,400	1,406,400	1,537,200	1,641,000	1,744,800		
150 Bushels	568,200	984,000	1,216,200	1,580,400	1,968,000	2,200,200	2,432,400		
225 Bushels	584,400	1,033,800	1,390,800	1,645,200	2,067,600	2,424,600	2,781,600		
1500 Hours:									
75 Bushels	654,750	960,750	1,090,500	1,758,000	1,921,500	2,051,250	2,181,000		
150 Bushels	710,250	1,230,000	1,520,250	1,975,500	2,460,000	2,750,250	3,040,500		
225 Bushels	730,500	1,292,250	1,738,500	2,056,500	2,584,500	3,030,750	3,477,000		

a/ Total annual volume is total volume in bushels of both grain and shelled corn. The respective annual volumes of grain and corn are calculated from tables 5 and 6. The hourly receiving capacities for the various model plants, receiving different average load sizes, are obtained from table 6. The total annual volumes of grain and corn are then obtained by multiplying these hourly capacities by the hours of operation, from table 5, for a plant receiving grain 50 percent of the time and corn 50 percent of the time. The sum of these two separate annual volumes yields the total annual volume for the respective model plants.

Table 9.--Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961. a/

Annual Hours of Operation and Average Load Size Received		Capacity of Single and Double-Line Model Grain Elevators							
		Single-Line Plants				Double Line-Plants			
		(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)
		750 B.P.H. : 1500 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 3000 B.P.H. : 3750 B.P.H. : 4500 B.P.H.							
300 Hours:									
75 Bushels		113,325	179,175	218,100	309,300	358,350	397,275	436,200	
150 Bushels		121,425	214,650	277,575	341,550	429,300	492,225	555,150	
225 Bushels		124,350	224,025	305,550	353,550	448,050	529,575	611,100	
600 Hours:									
75 Bushels		226,650	358,350	436,200	618,600	716,700	794,550	872,400	
150 Bushels		242,850	429,300	555,150	683,100	858,600	984,450	1,110,300	
225 Bushels		248,700	448,050	611,100	707,100	896,100	1,059,150	1,222,200	
900 Hours:									
75 Bushels		339,975	537,525	654,300	927,900	1,075,050	1,191,825	1,308,600	
150 Bushels		364,275	643,950	832,725	1,024,650	1,287,900	1,476,675	1,665,450	
225 Bushels		373,050	672,075	916,650	1,060,650	1,344,150	1,588,725	1,833,300	

(continued)

Table 9.---Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961. a/

		Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received		Single-Line Plants					Double Line-Plants				
		(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)
		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :		
300 Hours:											
75 Bushels		113,325	179,175	218,100	309,300	358,350	397,275	436,200			
150 Bushels		121,425	214,650	277,575	341,550	429,300	492,225	555,150			
225 Bushels		124,350	224,025	305,550	353,550	448,050	529,575	611,100			
600 Hours:											
75 Bushels		226,650	358,350	436,200	618,600	716,700	794,550	872,400			
150 Bushels		242,850	429,300	555,150	683,100	858,600	984,450	1,110,300			
225 Bushels		248,700	448,050	611,100	707,100	896,100	1,059,150	1,222,200			
900 Hours:											
75 Bushels		339,975	537,525	654,300	927,900	1,075,050	1,191,825	1,308,600			
150 Bushels		364,275	643,950	832,725	1,024,650	1,287,900	1,476,675	1,665,450			
225 Bushels		373,050	672,075	916,650	1,060,650	1,344,150	1,588,725	1,833,300			

(continued)

Table 9.--Total Annual Volume for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961--Continued. a/

		Capacity of Single and Double-Line Model Grain Elevators					
Annual Hours of Operation and Average Load Size Received		Single-Line Plants			Double-Line Plants		
		(Bu)	(Bu)	(Bu)	(Bu)	(Bu)	(Bu)
		750 B.P.H. : 1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H.
1200 Hours:							
75 Bushels		453,300	716,700	872,400	1,237,200	1,433,400	1,589,100
150 Bushels		485,700	858,600	1,110,300	1,366,200	1,717,200	1,968,900
225 Bushels		497,400	896,100	1,222,200	1,414,200	1,792,200	2,118,300
1500 Hours:							
75 Bushels		566,625	895,875	1,090,500	1,546,500	1,791,750	1,986,375
150 Bushels		607,125	1,073,250	1,387,875	1,707,750	2,146,500	2,461,125
225 Bushels		621,750	1,120,125	1,527,750	1,767,750	2,240,250	2,647,875
							3,055,500

a/ Total annual volume is total volume in bushels of both grain and shelled corn. The respective annual volumes of grain and corn are calculated from tables 5 and 6. The hourly receiving capacities for the various model plants, receiving different average load sizes, are obtained from table 6. The total annual volumes of grain and corn are then obtained by multiplying these hourly capacities by the hours of operation, from table 5, for a plant receiving grain 25 percent of the time and corn 75 percent of the time. The sum of these two separate annual volumes yields the total annual volume for the respective model plants.

only between the various sized plants operating under the same conditions but also as the receiving mix is changed, as the annual hours of operation are changed and as the average load size received is changed. Annual volume is therefore a function of: (1) The scale of plant, which sets the upper limit to the hourly receiving capacity. (2) The annual hours of operation, which influences the annual volume from a time dimension and from which the harvest season hours and receiving mix were calculated, both of which affect annual volume. (3) Receiving mix, which determines the annual hours that wheat and ear corn were received. Total annual volume of wheat and corn, on a shelled basis, is a function of the actual receiving rate and the number of hours that each is received, and (4) The average load size received, which in part determines the actual hourly receiving rate of the model plants and which has an affect on the total annual volume received.

CHAPTER V

BUDGETING OF COST AND MODEL PLANT COST FUNCTIONS

Introduction

Accuracy of budgeting expense items in a model operation depend on intimate knowledge of actual operations and practical judgment. In building the model elevators used in this thesis the individual consideration of each item of expense was assumed to be the most accurate procedure to follow in estimating the various expenses. The description of and the reasons for procedures used by individual items of expense, have been confined to Appendixes A, B, and C.

All operating costs are grouped into fixed and variable expenses, fixed expense items being those related to property and facilities (durable assets) and their valuations. Their amount is not influenced by the amount of annual volume. Variable expenses make up the balance of the elevators' operating expenses and change in varying degrees with volume and management decisions. The various items included in each of these categories are discussed below.

Investment In Durable Assets

Budgeting of investment in durable assets represents the basis for computing fixed costs. The assets included in this category are: land and land improvements, buildings (commonly called the plants work area), storage facilities, machinery and equipment, cob burner, railroad siding, trucking equipment,

office building and office furnishings.

Machinery and equipment is the largest single investment item. Investment in machinery and equipment was estimated for each operating phase of each model plant. Included in this estimate is the cost of machinery installations which amounted to about 40 percent of the list price of the equipment. Miscellaneous equipment was also estimated and included. A detailed list of the machinery and equipment provided for each phase of the model plants operations and the associated office equipment are included in Appendix A.

Table 10 shows the total installed cost of equipment for the various operating phases and for the entire 2250 bushel per hour double-line model plant. Total annual equipment depreciation is also shown in table 10.

Table 10.--Total Estimated Investment in Machinery and Equipment and Total Annual Depreciation For A Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Operating Phase	Installed Cost of Equipment	Annual Depreciation
	(dollars)	(dollars)
Receiving	\$ 8,922	\$ 480
Cleaning	41,193	2,417
Weighing	8,459	630
Storage	13,700	730
Load-Out	12,039	695
Miscellaneous Equipment	3,056	238
Plant Total	<u>\$87,369</u>	<u>\$5,190</u>

Table 11 shows the total estimated investment in durable assets for the model plants used in this study. The details as to procedures used in making the various cost estimates are shown in Appendix A.

Cost Associated With Owning Durable Assets

This category includes all those fixed costs associated with owning the physical assets discussed above. These fixed costs have no relation to the plants actual operations and are based entirely on the total investment made in the various durable assets. The fixed expense items used are: insurance on buildings, equipment and truck; depreciation on buildings and all equipment; maintenance and repairs; personal property taxes; and interest on investment. These fixed expenses were estimated on an annual basis. The actual estimates and estimating techniques are presented in Appendix B.

These are all expense items based on valuations or a specific service necessary if the plant is to operate. They are not associated with volume changes. Once they are fairly well established for a specific plant, they are not subject to change from year to year by management. Thus, their amount has a fixed character for a given plant in relation to the various volume situations that may prevail for that plant.

Depreciation expense was by far the most important item included in this cost category. The depreciation expense for each fixed asset was estimated separately and as accurately as possible. The techniques used are the same as those now being

Table 11.---Estimated Investment in Durable Assets for Model
Grain Elevators, Michigan, 1961.

Durable Assets	Capacity of Single and Double Line Model Grain Elevators					
	Single-Line Plants	:	Double-Line Plants	:	:	:
	750 B.P.H. : 1500 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 3000 B.P.H. : 3750 B.P.H. : 4500 B.P.H.	:	:	:	:	:
	(Dollars)	(Dollars),	(Dollars)	(Dollars)	(Dollars)	(Dollars)
Land and Land Improvements	\$ 2,500	\$ 3,125	\$ 3,750	\$ 3,750	\$ 4,375	\$ 5,000
Buildings	12,650	14,600	16,450	29,000	30,000	34,300
Storage Facilities	23,200	37,200	46,750	46,750	61,950	77,450
Machinery and Equipment	41,937	51,477	59,392	87,369	99,075	110,388
Corn Cob Burner	7,000	7,000	7,000	7,000	14,000	14,000
Railroad Siding	8,100	9,300	10,500	12,900	14,100	15,300
Trucking Equipment	4,300	4,300	4,300	4,300	4,300	4,300
Office Building	7,650	7,650	9,200	9,200	11,500	11,500
Office Equipment	3,526	3,526	3,848	3,848	4,175	4,175
TOTAL	\$110,863	\$138,178	\$161,190	\$204,117	\$243,475	\$303,343

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	----

used for accounting and income tax purposes throughout Michigan.

Insurance cost includes fire and wind coverage on all buildings and equipment and liability, collision, and comprehensive insurance on the one truck provided for each plant. Insurance costs are based on the actual durable asset cost estimates and are based on rates in effect during 1960.

Personal property tax was calculated for each model plant according to data obtained from elevators now operating in Michigan. Property tax varies widely within the state and the expense included here was calculated at an average rate which was representative of state conditions.

Total repairs and maintenance expense was broken down into variable and fixed categories. The fixed expenses included here are for those repairs and maintenance which show no relation to the plants operation or volume handled. This includes such things as the painting of buildings and an estimate of general deterioration associated with time. The repairs and maintenance included as variable expenses include the upkeep and replacement of parts caused by actual operations and volume handled. This includes spouting replacement, electric motor repairs, and any worn machinery parts. These costs are discussed in detail under the variable cost category.

Interest on investment or on long-term capital differed from interest expense commonly found in operating expense statements since it includes an interest return to equity capital. Interest on seasonal capital is included as a

variable expense because it is needed primarily during the harvest season and depends on the average annual inventory maintained. To keep the models on a comparable basis, interest expense was calculated on all long-term capital. Long term capital here refers to the total investment per model plant in fixed durable assets.

Fixed costs of depreciation, insurance, personal property taxes, repairs and maintenance, and interest on investment are summarized in table 12.

Variable Cost Associated With Volume and Plant Operations

This category includes the cost of all variable resources associated with the plants actual operations and volume handled. Variable expenses change in varying degrees with changes in volume and management decisions. The degree of variation differs sharply among the various expense items. That is, some expenses, respond slowly to volume and size changes while others respond more proportionately to such changes. For this reason, each variable expense item was budgeted separately, see Appendix C.

Such expenses as utilities, advertising, donations, auditing, repairs, directors' fees, and travel fall within the group that do not vary in direct relation to volume. They are often characterized by a minimum, either actual, as in the case of electric power, or set by the manager as in the case of advertising or donations. Other variable expenses such as office supplies, and insurance on stocks and plant supplies vary more directly with volume than the groups just mentioned.

Table 12.--Annual Fixed Expenses for Model Grain Elevators, Michigan, 1961.

Expense Item	Capacity of Single and Double-Line Model Grain Elevators					
	Single-Line Plants			Double-Line Plants		
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
Annual Fixed Expenses:						
a/ Depreciation	\$5,197	\$6,201	\$7,026	\$9,065	\$10,609	\$11,760
b/ Insurance	341	390	441	595	713	776
c/ Personal Property Tax	2,217	2,764	3,224	4,082	4,870	5,528
d/ Repairs and Maintenance	370	461	537	680	812	921
e/ Interest on Investment	2,772	3,454	4,030	5,103	6,087	6,910
Total Fixed Expenses	\$10,897	\$13,270	\$15,258	\$19,525	\$23,091	\$25,895
						\$28,138

- a/ Assuming a useful life of 40 years all buildings are depreciated at a rate of 2.5 percent. All machinery and equipment, cob burners, trucks and office equipment are depreciated on a straight line basis, each individual piece of equipment was depreciated separately.
- b/ This insurance expense represents almost 100 percent protection from both fire and wind to the cost of the buildings and machinery; and liability, collision and comprehensive insurance for the one truck provided for each plant.
- c/ Taxes calculated at 4 percent of the average undepreciated value over the life of the assets.
- d/ Total repairs and maintenance calculated at 2 percent of total investment with one-sixth of this expense allocated as a fixed expense and the remainder prorated to variable expense according to hours of operation.
- e/ Interest on investment calculated at 5 percent of the average undepreciated value over the life of the assets.

The items included as variable expenses throughout this study are as follows: Personnel expenses, which include salaries, wages, workmen's compensation insurance, and social security taxes; utilities, power and light; repairs and maintenance; interest on seasonal capital; inventory insurance; general liability insurance and miscellaneous expenses. Included in the miscellaneous expense category are such things as advertising, legal and auditing expenses, office supplies, plant supplies, telephone and telegraph, truck expense, allowance for worthless accounts, office heat and other general operating expenses.

The same operating conditions that affect annual volume also affect variable expenses. These operating conditions were discussed in Chapter IV and are: scale or size of plant, annual hours of operation, receiving mix, and average load size received. Variable expenses as affected by these operating conditions are presented for each of the model plants in tables 13, 14, and 15.

Personnel expenses are by far the most important expense included in this category, amounting to about 50 percent of the total for each plant. Wages for plant labor is the most important item, followed by the manager's salary and wages for clerical help. Social security taxes and workmen's compensation insurance account for the remaining cost included in this expense and are directly related to the total cost of wages and salaries.

Table 13.--Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961.

		Capacity of Single and Double-Line Model Grain Elevators					
Annual Hours of Operation and Average Load Size Received		Single-Line Plants		Double-Line Plants			
		750 B.P.H. : 1500 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 3000 B.P.H. : 3750 B.P.H. : 4500 B.P.H.	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
300 Hours:							
75 Bushels		\$11,156	\$13,079	\$14,776	\$16,706	\$18,625	\$20,574
150 Bushels		10,968	12,904	14,728	16,186	18,371	20,485
225 Bushels		10,967	12,845	14,620	15,990	18,097	20,171
600 Hours:							
75 Bushels		13,354	15,865	18,296	21,723	24,685	27,636
150 Bushels		13,041	15,605	18,150	20,104	23,274	26,634
225 Bushels		13,042	15,536	18,075	19,775	22,654	25,759
900 Hours:							
75 Bushels		15,387	18,868	22,304	29,897	33,363	37,271
150 Bushels		15,002	18,292	21,710	25,631	32,736	36,459
225 Bushels		14,936	18,157	21,411	24,242	29,295	36,001

(Continued)

185

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	149
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-----

Table 13.--Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961--Continued.

		Capacity of Single and Double-Line Model Grain Elevators					
Annual Hours of Operation and Average Load Size Received		Single-Line Plants			Double-Line Plants		
		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. : 4500 B.P.H.
		(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:							
75 Bushels		\$17,718	\$26,544	\$30,336	\$39,093	\$43,155	\$47,454 \$50,257 ¹ / ₂
150 Bushels		16,982	21,921	26,933	32,879	38,875	46,993 50,046
225 Bushels		16,869	21,017	26,421	32,409	36,865	42,809 49,735
1500 Hours:							
75 Bushels		21,102	29,341	33,736	44,291	53,028	58,184 61,664
150 Bushels		18,958	28,775	33,453	38,669	47,063	53,507 61,088
225 Bushels		18,827	24,963	33,309	36,314	46,444	51,798 57,075

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	----

Table 14.--Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961.

Capacity of Single and Double-Line Grain Elevators									
Annual Hours of Operation and Average Load Size Received	Single-Line Plants			Double-Line Plants					
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
	750 B.P.H. : 1500 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 3000 B.P.H. : 3750 B.P.H. : 4500 B.P.H.								
300 Hours:									
75 Bushels	\$11,156	\$13,059	\$14,731	\$16,764	\$18,690	\$20,601	\$22,044		
150 Bushels	10,964	12,817	14,675	16,319	18,260	20,343	21,831		
225 Bushels	10,963	12,817	14,678	16,064	18,061	20,078	21,749		
600 Hours									
75 Bushels	13,309	16,003	18,371	21,195	24,384	27,559	30,038		
150 Bushels	13,056	15,577	18,158	20,106	23,009	26,024	28,571		
225 Bushels	12,995	15,510	18,077	19,840	22,677	25,484	27,867		
900 Hours									
75 Bushels	15,492	18,695	22,456	30,014	33,364	37,304	40,533		
150 Bushels	14,999	18,318	21,550	25,061	32,776	36,472	38,988		
225 Bushels	14,995	18,185	21,453	23,767	28,573	36,105	38,777		

(Continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------

Table 14.-- Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of The Time and Corn 50 Percent of The Time, Michigan, 1961--Continued.

		Capacity of Single and Double-Line Model Grain Elevators							
Annual Hours of Operation and Average Load Size Received		Single-Line Plants				Double-Line Plants			
		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :		
		(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:									
75 Bushels		\$17,455	\$23,194	\$30,455	\$35,979	\$43,355	\$47,693	\$51,096	
150 Bushels		17,003	21,445	26,627	33,056	37,814	43,576	50,208	
225 Bushels		16,997	21,085	25,863	29,520	36,953	41,791	46,297	
1500 Hours:									
75 Bushels		20,463	29,425	33,943	43,591	49,951	58,471	62,149	
150 Bushels		19,052	25,528	33,580	37,659	47,258	52,589	57,597	
225 Bushels		18,938	24,972	33,386	36,480	42,660	51,967	55,742	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	----

Table 15.--Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961.

Capacity of Single and Double-Line Grain Elevators									
Annual Hours of Operation and Average Load Size Received	Single-Line Plants			Double-Line Plants					
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
	750 B.P.H. : 1500 B.P.H. : 2250 B.P.H. : 2250 B.P.H. : 3000 B.P.H. : 3750 B.P.H. : 4500 B.P.H.								
300 Hours									
75 Bushels	\$11,037	\$12,870	\$14,498	\$16,417	\$18,283	\$20,151	\$21,606		
150 Bushels	10,829	12,666	14,430	16,000	18,017	19,904	21,340		
225 Bushels	10,828	12,665	14,367	15,854	17,871	19,684	21,257		
600 Hours:									
75 Bushels	13,304	15,911	18,293	20,788	24,049	27,430	30,206		
150 Bushels	12,987	15,604	18,033	20,130	22,860	25,724	27,928		
225 Bushels	12,985	15,542	17,954	19,866	22,527	25,378	27,442		
900 Hours:									
75 Bushels	15,428	18,716	22,676	29,999	33,387	37,246	40,830		
150 Bushels	15,045	18,322	21,508	24,349	29,123	36,377	38,880		
225 Bushels	15,043	18,191	21,368	23,726	27,670	32,236	38,616		

(Continued)

Table 15.---Total Annual Variable Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of The Time and Corn 75 Percent of The Time, Michigan, 1961---Continued.

		Capacity of Single and Double-Line Grain Elevators							
		Single-Line Plants				Double-Line Plants			
Annual Hours of Operation and Average Load Size Received		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :	
		(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:									
75 Bushels		\$17,543	\$23,337	\$30,574	\$34,809	\$43,394	\$47,801	\$51,570	
150 Bushels		16,984	21,010	26,133	33,133	37,400	42,440	46,830	
225 Bushels		16,977	20,874	25,296	28,644	36,925	41,424	44,951	
1500 Hours:									
75 Bushels		19,732	29,472	34,054	43,417	49,294	58,651	62,317	
150 Bushels		18,989	24,882	33,529	37,121	43,776	52,561	56,440	
225 Bushels		18,982	23,785	29,966	36,648	41,571	48,370	55,683	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	14
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	----

Some of the individual expense items included in this category vary as each of the four operating conditions are varied. Power and lights for example are a direct function of plant size, hours of operation, receiving mix and average load size received. Others vary only as certain of the operating conditions are varied. Maintenance expense is a function only of plant size and hours of operation, whereas, interest on seasonal capital and inventory insurance are a function of plant size, hours of operation, and receiving mix. The reasons for these differences plus the details and procedures used in estimating the variable resource requirements and costs are shown in Appendix C.

Total Annual Cost and Total Cost Functions

Total annual cost for the various model plants, operating under the various conditions set forth, are shown in tables 16, 17, and 18. The total annual costs shown in these tables were obtained by adding the total annual fixed costs from table 12 and the total variable costs from tables 13, 14, and 15. The cost shown in tables 16, 17, and 18 are for the corresponding annual volumes shown in tables 7, 8, and 9.

The synthesis of total annual cost is often referred to as combining the building blocks because it is primarily a simple case of addition and is a function of both total annual fixed and variable cost.²⁹ Total cost is therefore a function

²⁹ French, et. al., op. cit., page 660.

Table 16.—Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :	
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
300 Hours:								
75 Bushels	\$22,053	\$26,349	\$30,034	\$36,231	\$41,716	\$46,469	\$50,165	192
150 Bushels	21,865	26,174	29,986	35,711	41,462	46,380	50,067	
225 Bushels	21,864	26,115	29,878	35,515	41,188	46,066	49,991	
600 Hours:								
75 Bushels	24,251	29,135	33,554	41,248	47,776	53,531	57,975	
150 Bushels	23,938	28,875	33,408	39,629	46,365	52,529	57,282	
225 Bushels	23,939	28,806	33,333	39,300	45,745	51,654	56,774	
900 Hours:								
75 Bushels	26,284	32,138	37,562	49,422	56,454	63,166	68,180	
150 Bushels	25,899	31,562	36,968	45,156	55,827	62,354	67,212	
225 Bushels	25,833	31,427	36,669	43,767	52,386	61,986	66,896	

(Continued)

Table 16.—Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961—Continued.

Annual Hours of : Operation and : Average Load : Size Received :		Capacity of Single and Double-Line Model Grain Elevators					
		Single-Line Plants			Double-Line Plants		
		750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H. : 4500 B.P.H.
		(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:							
75 Bushels		\$28,615	\$39,814	\$45,594	\$58,618	\$66,246	\$73,349 \$78,395
150 Bushels		27,879	35,191	42,191	52,404	61,966	72,888 78,184
225 Bushels		27,766	34,287	41,679	51,934	59,956	68,704 77,873
1500 Hours:							
75 Bushels		31,999	42,611	48,994	63,816	76,119	84,079 89,802
150 Bushels		29,855	42,045	48,711	58,194	70,154	79,402 89,226
225 Bushels		29,724	38,233	48,567	55,839	69,535	77,693 85,213

Table 17.—Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators					
	Single-Line Plants			Double-Line Plants		
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H. : 4500 B.P.H.
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
300 Hours:						
75 Bushels	\$22,053	\$26,329	\$29,989	\$36,289	\$41,781	\$46,496 \$50,182
150 Bushels	21,861	26,087	29,933	35,844	41,351	46,238 49,969
225 Bushels	21,860	26,087	29,936	35,589	41,152	45,973 49,887
600 Hours:						
75 Bushels	24,206	29,273	33,629	40,720	47,475	53,454 58,176
150 Bushels	23,953	28,847	33,416	39,631	46,100	51,919 56,709
225 Bushels	23,892	28,780	33,335	39,365	45,768	51,379 56,005
900 Hours:						
75 Bushels	26,389	31,965	37,714	49,539	56,455	63,199 68,671
150 Bushels	25,896	31,588	36,808	44,586	55,867	62,367 67,126
225 Bushels	25,892	31,455	36,711	43,292	51,664	62,000 66,915

(continued)

Table 17.--Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961--Continued.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H.	4500 B.P.H.	
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:								
75 Bushels	\$28,352	\$36,464	\$45,713	\$55,504	\$66,446	\$73,588	\$79,234	
150 Bushels	27,900	34,715	41,885	52,531	60,905	69,471	78,346	
225 Bushels	27,894	34,355	41,121	49,045	60,044	67,686	74,435	
1500 Hours:								
75 Bushels	31,360	42,695	49,201	63,116	73,042	84,366	90,287	
150 Bushels	29,949	38,798	48,838	57,184	70,349	78,484	85,735	
225 Bushels	29,835	38,242	48,644	56,005	65,751	77,862	83,880	

Table 18.--Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators											
	Single-Line Plants						Double-Line Plants					
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	4500 B.P.H.	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	3000 B.P.H.	4500 B.P.H.	
300 Hours:	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
75 Bushels	\$21,934	\$26,140	\$29,756	\$35,942	\$41,374	\$46,046	\$49,744					
150 Bushels	21,726	25,936	29,688	35,525	41,108	45,799	49,478					
225 Bushels	21,725	25,935	29,625	35,379	40,962	45,579	49,395					
600 Hours:												
75 Bushels	24,201	29,181	33,551	40,313	47,140	53,325	58,344					
150 Bushels	23,884	28,874	33,291	39,655	45,951	51,619	56,066					
225 Bushels	23,882	28,812	33,212	39,391	45,618	51,273	55,580					
900 Hours:												
75 Bushels	26,325	31,986	37,934	49,524	56,478	63,141	68,968					
150 Bushels	25,942	31,592	36,766	43,874	52,214	62,272	67,018					
225 Bushels	25,940	31,461	36,626	43,251	50,761	58,131	66,754					

(Continued)

Table 18.—Total Annual Cost for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961—Continued.

Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received	Single-Line Plants			Double-Line Plants					
	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	2250 B.P.H.	3000 B.P.H.	3750 B.P.H.	4500 B.P.H.		
	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1200 Hours:									
75 Bushels	\$28,440	\$36,607	\$45,832	\$54,334	\$66,485	\$73,696	\$79,708		
150 Bushels	27,881	34,280	41,391	52,658	60,491	68,335	74,968		
225 Bushels	27,874	34,144	40,554	48,169	60,016	67,319	73,089		
1500 Hours:									
75 Bushels	30,629	42,742	49,312	62,942	72,385	84,546	90,455		
150 Bushels	29,886	38,152	48,787	56,646	66,867	78,456	84,578		
225 Bushels	29,879	37,055	45,224	56,173	64,662	74,265	83,821		

of the same factors as total annual fixed and variable costs.

The relationship of the synthesized total cost to output was very nearly a linear relation in all cases. Figure 3 shows the linear relation of total annual cost to total annual volume for the 750 bushel model plant. It should be noted that the total cost curve for receiving 75 bushel loads, with the 75/25 and 50/50 mixes, rises sharply at the higher levels of output. At the same time the total cost curves for receiving 150 and 225 bushel loads, with a 25/75 mix, slope downward at the lower levels of output.

Similar cost functions, as those shown in figure 3, were observed for all model plants. Figure 4 shows the total annual cost curves for the 4500 bushel per hour plant. The kinks observed in the 150 and 225 bushel load total cost curves were due to indivisibilities caused by the addition of another full time man. The additional labor charge caused the total cost curve to rise with a new slope at these points.

Short-Run Average Cost and Average Cost Curves

Per unit costs are used extensively for price and output analysis, more so than total cost. They provide the same kind of information as total cost relations, but in a different, and frequently more usable form. The family of unit cost curves that can be computed include the average fixed cost, the average variable cost, the average total cost, and the marginal cost. However, only average total cost and average cost curves are discussed in this section as they include

Figure 3.--Total Annual Cost for a Model Grain Elevator Operating Under Various Conditions, 750 Bushel Per Hour Capacity, Michigan, 1961.

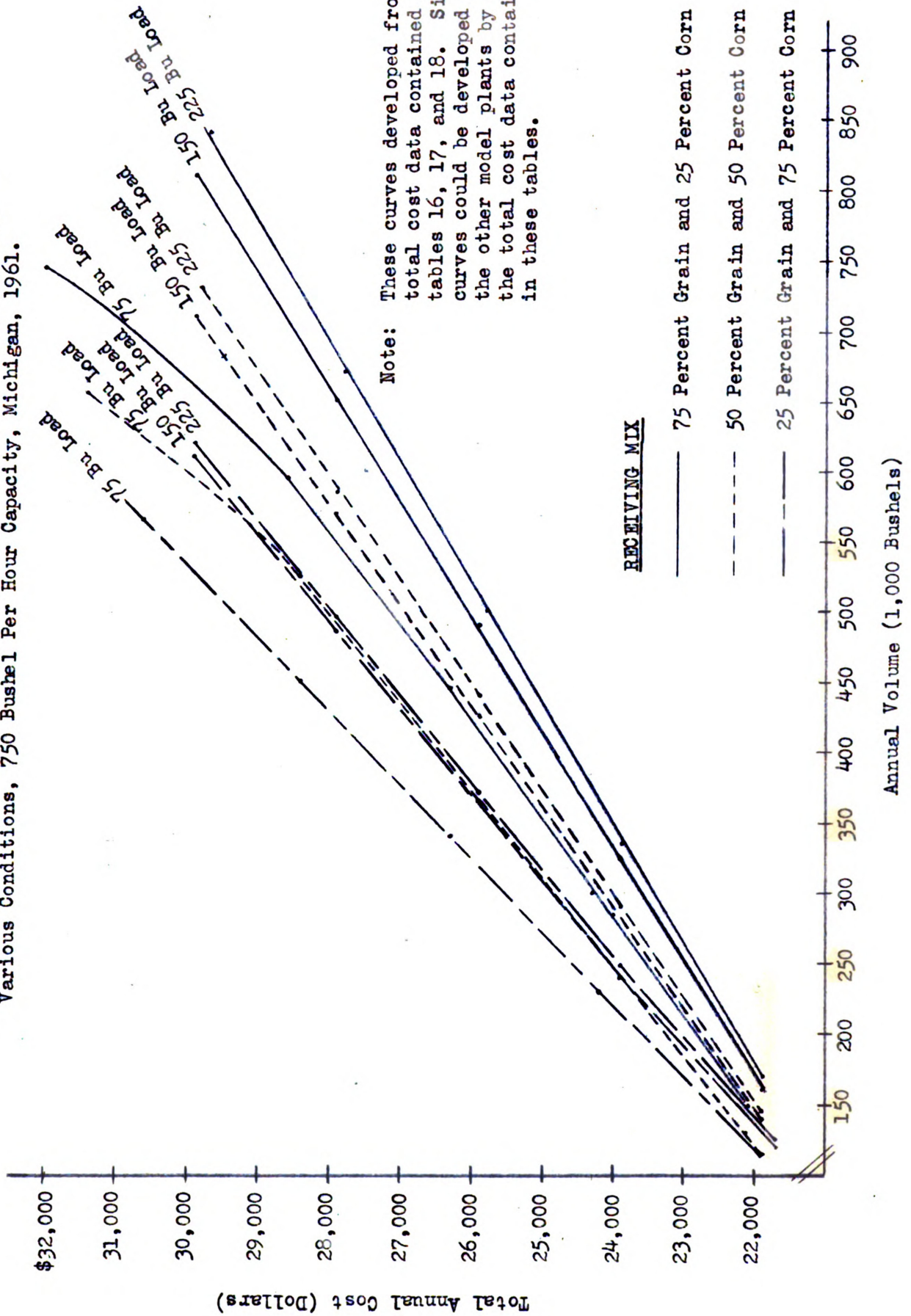
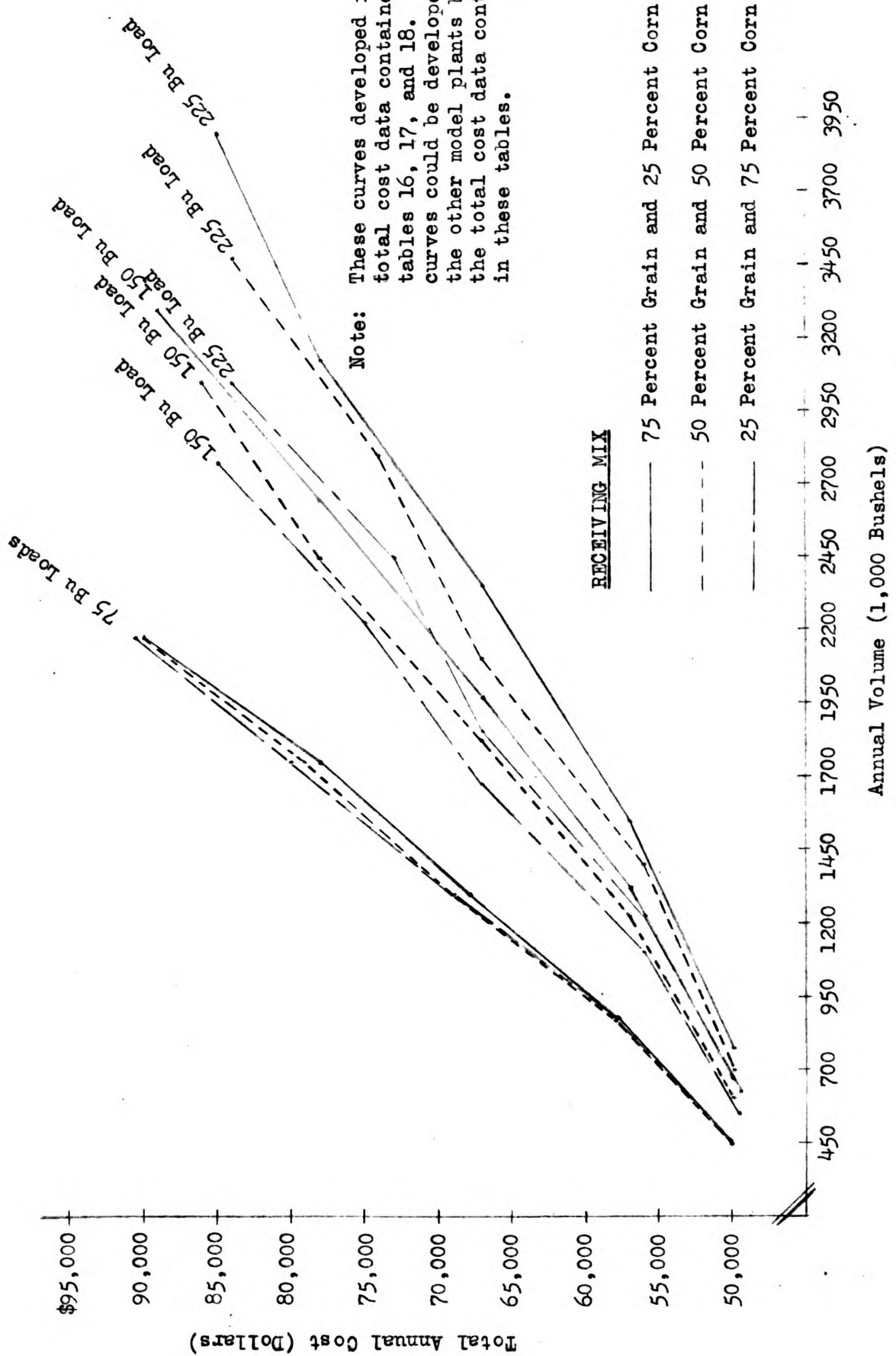


Figure 4.--Total Annual Cost for a Model Grain Elevator Operating Under Various Conditions, 4500 Bushel Per Hour Capacity, Michigan, 1961.



both fixed and variable cost and give some indication of marginal cost.³⁰

Average costs per bushel are shown in tables 19, 20, and 21 for the model plants included in this study. These per bushel cost were obtained by dividing the annual total cost from tables 16, 17, and 18 by the annual volumes from tables 7, 8, and 9.

The primary use of per unit or average cost is for the construction of short-run average cost curves from which economies or diseconomies of scale can be determined. The short-run average cost curve is usually thought to be a U-shaped curve. Its U-shape depends upon the efficiency with which both fixed and variable resources are used.

The short-run average cost curves for the model plants receiving average load sizes of 150 bushels, a receiving mix of 50% grain and 50% corn, and different annual hours of operation are shown in figure 5.

The cost of handling a bushel of grain reflects the relationship between volume handled and the total of all fixed and variable expenses. Unit handling costs tend to decrease with increases in handling volume. Thus, the downward sloping

30 The average total cost curve is the vertical summation of the average fixed cost curve and the average variable cost curve. The Marginal Cost curve bears a unique relationship to the average cost curve which is derived from the same total cost curve. When AC is decreasing as output increases, MC is less than AC. When AC is increasing as output increases, MC is greater than AC. It follows that at the output at which AC is a minimum, MC is equal to AC.

Table 19.--Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961.

		Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received		Single-Line Plants					Double-Line Plants				
		750 B.P.H.	1500 B.P.H.	2250 B.P.H.	3000 B.P.H.	4500 B.P.H.	750 B.P.H.	1500 B.P.H.	2250 B.P.H.	3000 B.P.H.	4500 B.P.H.
		(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)
300 Hours:											
75 Bushels		14.84	12.85	13.77	9.20	10.17	10.98	11.50			
150 Bushels		13.42	9.44	9.07	7.96	7.47	7.63	7.57			
225 Bushels		13.03	8.92	7.66	7.57	7.03	6.75	6.41			
600 Hours:											
75 Bushels		8.16	7.10	7.69	5.24	5.82	6.32	6.65			
150 Bushels		7.36	5.21	5.05	4.42	4.18	4.32	4.33			
225 Bushels		7.13	4.92	4.28	4.19	3.90	3.78	3.64			
900 Hours:											
75 Bushels		5.90	5.22	5.74	4.18	4.59	4.97	5.21			
150 Bushels		5.31	3.79	3.73	3.35	3.35	3.42	3.39			
225 Bushels		5.13	3.58	3.14	3.11	2.98	3.03	2.86			

(continued)

Table 19.--Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 75 Percent of the Time and Corn 25 Percent of the Time, Michigan, 1961--Continued.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	750 B.P.H. : (Cents)	1500 B.P.H. : (Cents)	2250 B.P.H. : (Cents)	3000 B.P.H. : (Cents)	3750 B.P.H. : (Cents)	4500 B.P.H. : (Cents)		
1200 Hours:								-103-
75 Bushels	4.81	4.85	5.23	3.72	4.04	4.33	4.49	
150 Bushels	4.28	3.17	3.19	2.92	2.79	3.00	2.96	
225 Bushels	4.14	2.93	2.67	2.77	2.56	2.52	2.50	
1500 Hours:								
75 Bushels	4.31	4.15	4.49	3.24	3.71	3.97	4.12	
150 Bushels	3.67	3.03	2.95	2.59	2.53	2.61	2.70	
225 Bushels	3.54	2.61	2.49	2.38	2.37	2.28	2.19	

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

.....|.....

Table 20.—Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators					
	Single-Line Plants			Double-Line Plants		
	750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. : 4500 B.P.H.
	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)
300 Hours:						
75 Bushels	16.84	13.70	13.75	10.32	10.87	11.33
150 Bushels	15.39	10.60	9.84	9.07	8.40	8.41
225 Bushels	14.96	10.09	8.61	8.65	7.96	7.58
600 Hours:						
75 Bushels	9.24	7.62	7.71	5.79	6.18	6.51
150 Bushels	8.43	5.86	5.50	5.02	4.68	4.72
225 Bushels	8.18	5.57	4.79	4.79	4.43	4.24
900 Hours:						
75 Bushels	6.72	5.55	5.76	4.70	4.90	5.13
150 Bushels	6.08	4.28	4.04	3.76	3.79	3.78
225 Bushels	5.91	4.06	3.52	3.51	3.33	3.41

(continued)

• • • • •

— — — — —

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Table 20.--Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 50 Percent of the Time and Corn 50 Percent of the Time, Michigan, 1961--Continued.

Annual Hours of Operation and Average Load Size Received	Capacity of Single and Double-Line Model Grain Elevators							
	Single-Line Plants				Double-Line Plants			
	750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :	
	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)
1200 Hours:								-105-
75 Bushels	5.41	4.74	5.24	3.95	4.32	4.48	4.54	
150 Bushels	4.91	3.53	3.44	3.33	3.09	3.16	3.22	
225 Bushels	4.77	3.32	2.96	2.98	2.90	2.79	2.68	
1500 Hours:								
75 Bushels	4.79	4.44	4.51	3.59	3.80	4.11	4.14	
150 Bushels	4.22	3.15	3.21	2.89	2.86	2.85	2.82	
225 Bushels	4.08	2.96	2.80	2.72	2.54	2.57	2.41	

Table 21.—Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961.

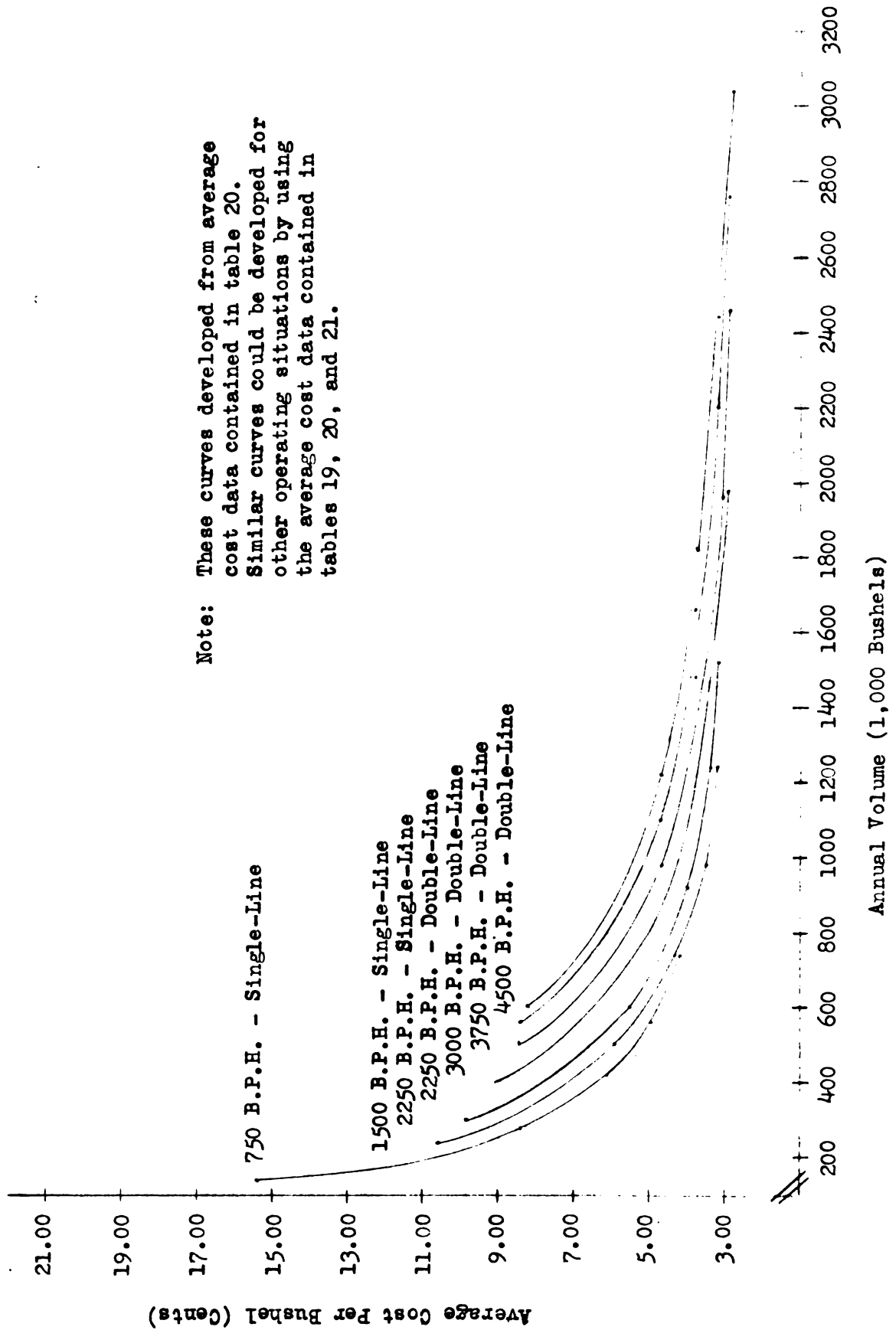
		Capacity of Single and Double-Line Model Grain Elevators									
Annual Hours of Operation and Average Load Size Received		Single-Line Plants					Double-Line Plants				
		(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)
		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H. :		
300 Hours:		(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)		
75 Bushels		19.35	14.59	13.64	11.62	11.55	11.59	11.40			
150 Bushels		17.89	12.08	10.70	10.40	9.58	9.30	8.91			
225 Bushels		17.47	11.58	9.70	10.01	9.14	8.61	8.08			
600 Hours:											
75 Bushels		10.68	8.14	7.69	6.52	6.58	6.71	6.69			
150 Bushels		9.83	6.73	6.00	5.81	5.35	5.24	5.05			
225 Bushels		9.60	6.43	5.43	5.57	5.09	4.84	4.55			
900 Hours:											
75 Bushels		7.74	5.95	5.80	5.34	5.25	5.30	5.27			
150 Bushels		7.12	4.91	4.42	4.28	4.05	4.22	4.02			
225 Bushels		6.95	4.68	4.00	4.08	3.78	3.66	3.64			

(continued)

Table 21.--Average Cost Per Bushel for Model Grain Elevators Operating Under Various Conditions and Receiving Grain 25 Percent of the Time and Corn 75 Percent of the Time, Michigan, 1961--Continued.

		Capacity of Single and Double-Line Model Grain Elevators									
		Single-Line Plants					Double-Line Plants				
		(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)	(Cents)
Annual Hours of Operation and Average Load Size Received		750 B.P.H. :	1500 B.P.H. :	2250 B.P.H. :	3000 B.P.H. :	3750 B.P.H. :	4500 B.P.H.				
1200 Hours:		6.27	5.11	5.25	4.39	4.64	4.64	4.57			
75 Bushels		5.74	3.99	3.73	3.85	3.52	3.47	3.38			
150 Bushels		5.60	3.81	3.32	3.41	3.35	3.18	2.99			
225 Bushels											
1500 Hours:											
75 Bushels		5.41	4.77	4.52	4.07	4.04	4.26	4.15			
150 Bushels		4.92	3.55	3.52	3.32	3.12	3.19	3.05			
225 Bushels		4.81	3.31	2.96	3.18	2.89	2.80	2.74			

Figure 5.--Short-Run Average Cost Curves for Model Grain Elevators Receiving an Average Load Size of 150 Bushels, a Receiving Mix of 50 Percent Grain and 50 Percent Corn, and Operating Various Hours Per Year, Michigan, 1961.



short-run average cost curves in figure 5. However, figure 5 also shows that as the capacity of elevators was increased that unit handling costs for any given volume also increased. This is evidenced by the fact that the short-run average cost curve for the higher capacity plants is higher in each case than the lower capacity plants. This is due to the higher valued durable assets and fixed cost associated with their ownership.

Economy of operation is definitely related to capacity utilization. Annual volume reflects an increase in annual hours of operation, since annual volume is a direct function of hours of operation and hourly receiving capacity. Thus, as annual volume or annual hours of operation increase the plants annual capacity is more nearly utilized and average costs per bushel decrease.

The average cost curves for receiving 75 bushel loads did not show as great a volume range as do the plants when they are receiving 150 or 225 bushel loads. This is due to the volume limitations created by the time required to position and receive 75 bushel loads. This condition was especially noticeable for the double-line plants.

The initial point on each of the above average cost curves represents the point at which the various model plants are operating 300 hours per year. The end points are for 1500 hours of operation per year. It will be noted that the average cost between plants is much flatter for 1500 hours

than when operating only 300 hours. This shows that as the plants operate more hours per year that differences in unit costs between plants decrease.

A multiple regression equation was used to determine the net relationship between the above factors (plant size, annual hours of operation, receiving mix, and average load size received) and total cost. The equation used, which conforms very closely with the observed total cost output relationships, is as follows:

$$TC = A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$$

where TC is the total annual cost, X_1 is the scale of plant or plant size, X_2 is the average load size received, X_3 is the total annual volume of small grain received, and X_4 is the total annual volume of corn received.

A separate regression was made for the single and double-line plants. The resulting statistics for each are shown in table 22.

It should be noted that the partial regression coefficient for the average load size was negative in both cases. This indicates that as the average load size received increases that total annual cost will decrease. This was expected because the smaller loads not only required more man hours and electric power per hour of operation but total annual volume is also limited in many cases where small loads were being received. Higher total cost for the smaller loads can also be observed in figures 4 and 5. In both cases the total annual cost for

Table 22.--Regression Coefficients and Associated Statistics for Model Single and Double-Line Grain Elevators, Michigan, 1961.^a

Type of Statistic	Single-Line Plants	Double-Line Plants
Value of a	+21329.1649	+28155.4186
Values of b-Partial Regression Coefficients:		
Plant Size (X_1)	+3.7073	+5.3003
Average Load Size (X_2)	-27.4155	-70.2899
Total Volume Grain (X_3)	+0.0120	+0.0130
Total Volume Corn (X_4)	+0.0180	+0.0187
Standard Errors of Regression Coefficients:		
Plant Size (X_1)	+0.2967	+0.2990
Average Load Size (X_2)	+2.6526	+4.0395
Total Volume Grain (X_3)	+0.0006	+0.0004
Total Volume Corn (X_4)	+0.0009	+0.0006
R, Multiple Correlation Coefficient	+0.9685	+0.9740
R^2 , Coefficient of Determination	+0.9361	+0.9475

^a Statistics are expressed in dollars.

receiving 75 bushel loads is higher than for receiving 150 and 225 bushel loads. Total cost was positively correlated with plant size, total volume of grain and total volume of corn.

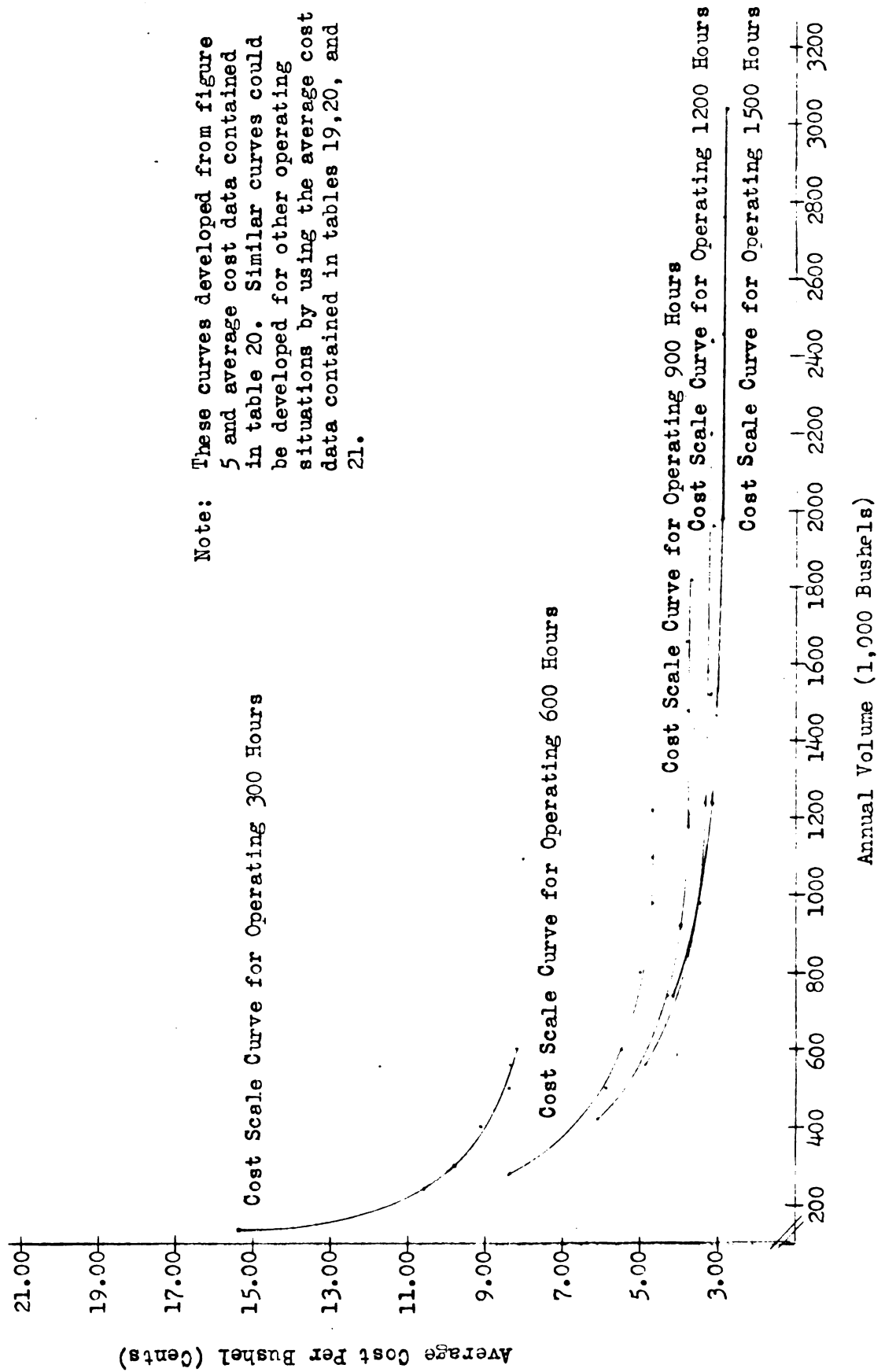
Long-Run Average Cost Curves and Economies
of Scale in Model Plants

In the long-run the firm can change the quantities of land, buildings, machinery, management, and all other resources because all resources are variable. The long-run can be thought of as a series of alternative short-run situations into any one of which the firm can move. The long-run average cost curve then shows the least possible cost per unit of producing various outputs when the firm has time to build any desired scale of plant.

The long-run average cost curve is constructed by holding all factors constant, except the size of plant. By using the data contained in figure 5 a family of long-run average cost curves can be constructed for the model plants developed in this study, figure 6. The family of short-run average cost curves of figure 5 are constructed by holding all factors constant, except hours of operation. Whereas, the family of long-run average cost curves of figure 6 are constructed by holding all factors constant, except plant size. Each point on the curves in figure 6 correspond to a similar point on the short-run average cost curves of figure 5.³¹ These long-run average cost curves are therefore composed of segments or points of the various short-run average cost curves representing

31 The initial point on each of the long-run average cost curves of figure 6 correspond with the points making up the 750 bushel per hour short-run average cost curve of figure 5. The end point on each of these long-run average cost curves corresponds with the 4500 bushel per hour short-run curve of figure 5.

Figure 6.--A Family of Cost Scale Long-Run Average Cost Curves for Model Grain Elevators Operating Various Hours Per Year, Receiving an Average Load Size of 150 Bushels, and A Receiving Mix of 50 Percent Grain and 50 Percent Corn, Michigan, 1961.



the different scales of plant which the firm conceivably could build.

The primary purpose of long-run average cost curves is for showing economies or diseconomies of scale. That the height of the long-run average cost curve decreases as annual volume increases means that as the scale of plant increases the short-run average cost curve lies at successively lower levels as well as farther to the right. This phenomenon is called economies of scale.

The long-run average cost curves of figure 6 show that economies of scale in plant costs exist throughout the range of volumes included in this study.

The configuration of these cost-scale curves, however, is of note. Economies of scale are much more evident and greater for plants operating 300 hours per year than for those operating 1500 hours per year. This is evidenced by the downward sloping long-run average cost curve for plants operating 300 hours as opposed to the rather flat long-run average cost curve for those operating 1500 hours. Each set of curves tends to become flatter as the number of hours of operation is increased. The logic that develops from this is that if plants are used at capacity during a high proportion of their annual operating time scale economies are significant. On the other hand if plants are utilized below capacity or at a normal rate for a large proportion of the annual operating time, scale economies though still existing are negligible.

Annual hours of operation and plant capacity utilization therefore have a profound influence on economies of scale in the operation of grain elevators. The harvest season, assumed to be 100 hours, accounts for a larger share of the annual hours of operation for the smaller hours of operation than for the larger hours of operation. Thus, if elevator management desires economies of operation during the harvest season it would pay to construct a larger plant to take advantage of the economies of scale that are present. If management is concerned with economies of scale in the plants entire operation then it would not pay to construct the largest possible plant because of the very small economies of scale present in these operations. Such economies as are available would be much more quickly offset by increasing transportation costs to deliver grain to the plant.

From an operating standpoint rather large economies of scale do exist between different sized plants for short periods of operation. Harvest season operating conditions are a case in point. However, looked at from an annual operating standpoint rather small economies of scale do exist between plants. How full utilization of plant capacity by adding complementary sidelines influences the operating implications of these scale relations cannot be developed here. However it suggests that sideline activities would tend to reduce the importance of scale economies derived from harvest season handling and improve the competitive position of small firms.

CHAPTER VI

SUMMARY AND CONCLUSIONS

In this study an economic engineering approach was used to determine the relative operating economies of different sized grain elevators in the receiving and assembling of grain for shipment to other elevators, terminal storage or processing plants. The primary objectives were to develop some economic benchmarks to aid in the formulation of operating policies and to develop some tools to be used in planning for the most efficient use of resources in the future. The secondary objective was to develop some guides which would help management in making future economic adjustments, especially in the construction of new elevators. It was hoped that the guides developed in this study would prove useful to management and the people who formulate the operating policies of grain elevators, especially those concerned with proposed reorganization and expansion programs.

Seven model plants were developed, ranging in size from 750 to 4500 bushels per hour. These hypothetical plants were developed in detail and all costs were estimated as accurately as possible. Different operating situations were developed and all operating costs were estimated as influenced by these operating conditions.

Each plant was equipped with similar machinery and equipment, the principal difference being in size and number depending on whether it was a single or double-line plant. Consistency

in method was maintained in estimating operating cost and annual volume for each plant.

Decreasing per unit cost is not a function only of plant size, rather it is a function of many factors, some of which management cannot control or alter. Factors affecting plant utilization are more important in determining economies of operation than plant size. Average load size received, receiving mix, and hours of operation are important as well as the actual receiving capacity of the different model plants. Average load size received and receiving mix depend on the type of farming carried on in the area and are beyond the control of management. Management can influence, to some extent, the actual hours of operation by the size of plant selected and operating decisions regarding sideline activities.

Plants with low capacity utilization, 300 hours of operation, had the greatest economies of scale. The per unit cost at these production levels, however, was considerably higher than for plants with a higher degree of plant utilization. This was due to high per unit fixed cost at these levels of production.

Plants with a high degree of plant utilization, 1500 hours of operation, showed some economies of scale between the smaller sized plants but very little between the larger sized plants.

Plant operating efficiency as indicated by capacity utilization was therefore more important in determining the observed economies than plant scale or size. Plant capacity

utilization is primarily a function of annual hours of operation, receiving mix and average load size received. The higher the annual hours of operation the better the plants capacities are utilized. However, the seasonal nature of agricultural production prevents elevators from actually receiving grain many hours per year. Volume handled in a given period is more important because a large portion of annual volume is usually received during a relatively short harvest season.

Management interested in only harvest season economy should therefore build a larger plant to take advantage of the economies of scale that are present when operating during this period. However, if the firm is more interested in annual operating economy then they should consider a somewhat smaller scale of plant depending on the annual hours of operation. They should choose that size of plant which will allow them to operate as economically as possible in a given area including plant as well as transportation costs.

The average load size received has an influence on annual volume and cost. This is due to the fact that it requires a certain amount of time to position and unload a vehicle regardless of the plants receiving capacity. There is also a delay between each load received. Annual volume and plant utilization is therefore reduced when small loads are received. Average load size as a cost factor is particularly important during the harvest season.

Each model plant showed downward sloping average cost

curves for each average load size received. Scale economies do not exist between model plants when receiving an average load size of 75 bushels. However they do exist between the various plants when receiving 225 bushel average loads. This occurs because as larger loads are received hourly receiving capacities are not reduced and less time is devoted to operating delays. This results in better plant utilization and lower cost operations.

The affect of receiving mix on plant capacity utilization is due to the fact that the receiving capacity for corn is reduced to 50 percent of the plants rated receiving capacity. Therefore, the higher the proportion of grain received the higher the annual volume and thus the lower are unit operating costs for a given number of hours of operation or a given volume.

The conclusion drawn from this discussion is that managers confronted with seasonal production may not build a least cost scale of plant for the grain merchandising operation. A smaller cost plant may be more desirable if it allows adequate flexibility in handling the various volumes of the different commodities and at the same time minimizes average unit costs on an annual basis. Elevator management should provide a facility which can handle expected volume increases and then plan to use the facility as near capacity as possible.

Successful planning of future elevator construction and the reorganization of present operations depends on the determination of future as well as present needs. Physical as well

as economic adjustments will be required if elevators are to keep up with rapidly changing conditions. Management considering reorganization should take these changes into consideration before large investments are made in facilities that may prove obsolete or uneconomical long before their useful life has expired.

The results of this study indicate that firm adjustments should not be based on plant size alone. Since a small plant can receive grain at about the same per unit cost as larger plants attempts should be made to fully utilize existing capacity before considering larger plants. One such adjustment is to build new grain merchandising facilities to correspond with existing environmental and plant conditions or built with the expectation of adjusting the rest of the plants operations around this operation.

Plant flexibility is required in planning multi-purpose grain merchandising operations. This is especially true if the grain merchandising facilities are to be fully utilized by adding or adjusting plant activities around this operation. Grain merchandising facilities should be flexible enough to be able to receive all the various crops produced within an area, the different volumes of each commodity received from year to year, the different load sizes received, and the different proportions of each commodity received from year to year.

Flexibility can be obtained by using dual purpose machinery and equipment, by building receiving facilities that can

handle large as well as small loads, by having several small storage bins rather than large bins, and by having double-line rather than single-line plants.

Based on scale relationships alone, the number of plants now operating in the Michigan elevator industry should not be expected to decrease greatly. The analysis shows that with operations, based on 600 to 900 hours per year actual scale economies are not great. The small economies of scale observed would not offset the added transportation cost of fewer but larger plants. However, reorganization and adjustments might be made in plant receiving rates so that harvest volumes can be received faster.

Further study is needed to determine the feasibility and affect of adjustments made to increase plant capacity utilization. This problem is closely related to agricultural production and environmental conditions within an area and might be considered as part of a location study. However, a more appropriate approach would be to study the cost scale relations of other elevator activities and their affect on plant capacity utilization. This could be done by using the model plants developed in this study and then adding other activities such as, drying, permanent storage, feed mixing and grinding, grain banks, and other sideline activities. In-plant complementary and competitive relationships could be observed and studied as they affect the overall operation and capacity utilization. In this way the entire firm could be evaluated in terms of cost scale relations and adjustments could be recommended accordingly.

Another area closely related to plant location which needs further investigation is the area of transportation and its affect on elevator operations and cost. This is especially important to multi-plant firms that are concerned with combining two or more plants into a single operation. The results of this study tend to indicate that several small plants would be just as efficient as one larger plant. However, this study was based on the grain merchandising operation only and further investigation is needed to determine the transportation advantages or disadvantages associated with larger plants.

APPENDIX A
DURABLE ASSET INVESTMENT ESTIMATES

APPENDIX A

DURABLE ASSET INVESTMENT ESTIMATES

The fixed assets needed are: land and land improvements, buildings (commonly called the plants work area), storage facilities, machinery and equipment, cob burner, railroad siding, trucking equipment, office building and office furnishings. Different techniques were employed in making each of these estimates and are therefore discussed separately.

Estimated Investment in Land and Land Improvements

For the purpose of this study land was valued at \$1,250.00 per acre. It was assumed that this would also cover the cost of any land improvements. This figure was arrived at by studying the value at which land and land improvements were carried on the books of elevators actually operating in Michigan. This figure will not apply to all areas of the state but is included as representative. Table 23 shows the land provided for each of the various model plants and the total investment in land and land improvements.

Table 23:--Estimated Investment in Land and Land Improvements
for Model Grain Elevators,
Michigan, 1961.

Plant Capacity	Acres Pro- vided Per Plant	Estimated Cost Per Acre	Estimated Total Investment Per Plant
(B.P.H.)	(acres)	(dollars)	(dollars)
750 B.P.H. - Single-Line	2	\$1250	\$2500
1500 B.P.H. - Single-Line	2½	1250	3125
2250 B.P.H. - Single-Line	3	1250	3750
2250 B.P.H. - Double-Line	3	1250	3750
3000 B.P.H. - Double-Line	3½	1250	4375
3750 B.P.H. - Double-Line	4	1250	5000
4500 B.P.H. - Double-Line	4½	1250	5625

Estimated Investment in Buildings for Model Plants

The plant designs used in this study were obtained from elevator designers and builders now operating in Michigan. They represent the most common type of facility being built in Michigan during 1961.

The actual building cost estimates were made by estimating the above ground cubic foot capacity of the different model plants. The drive area was then calculated at 45 cents per cubic foot and the work area was calculated at 55 cents per cubic foot. These per cubic foot cost estimates were derived from cost data of buildings actually constructed in Michigan during 1960, and from engineering

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

estimates.

Table 24 shows the estimated building cost for the various model plants. These estimates include only the cost of the steel frame buildings with concrete foundations and basement. The cost of all machinery, equipment and equipment installation are figured separately. Each model plants building requirements and cost were estimated individually.

Table 24:-- Estimated Investment in Buildings for Model Grain Elevators,
Michigan, 1961.

Plant Capacity	Estimated Cost of Building Construction
(B.P.H.)	(dollars)
750 B.P.H. - Single-Line	\$12,650
1500 B.P.H. - Single-Line	14,600
2250 B.P.H. - Single-Line	16,450
2250 B.P.H. - Double-Line	29,000
3000 B.P.H. - Double-Line	30,000
3750 B.P.H. - Double-Line	34,300
4500 B.P.H. - Double-Line	35,800

Estimated Investment in Storage Facilities

For the purpose of this study each plant was equipped with what appears to be adequate storage space for the assembling process

1. *Introduction*

2. *Methodology*

3. *Results*

4. *Discussion*

5. *Conclusion*

6. *References*

7. *Appendix*

8. *Tables*

9. *Figures*

10. *Summary*

11. *Index*

12. *Glossary*

13. *Notes*

14. *Footnotes*

that they perform. The range in storage capacity was 20,000 bushels for the 750 bushel per hour plant to 120,000 bushels for the 4500 bushel per hour plant. Storage capacity was increased between model plants in 20,000 bushel increments. Stave silos with hoppers bottoms are used. These silos are very common in Michigan and are available in a variety of sizes and capacities.

Each model plant is equipped with at least 6 silos, the larger plants having more than six. The number of silos is increased to obtain the desired storage capacity rather than increasing the silo sizes. Table 25 shows the number of silos provided for each model plant, total storage capacity and the estimated investment made in each case.

The actual cost estimates for the various sized silos, with hoppers bottoms, were based on data obtained from construction companies. The foundations, roof and head house costs were then estimated by using cost data from buildings actually constructed in Michigan during 1960. The total cost shown below includes the silo with hoppers bottoms, foundation, roof, and head house. The head house provided will house the shipping scales, elevator legs, overhead screw conveyor and necessary spouting.

Table 25;-- Estimated Investment in Storage Facilities for Model Grain Elevators, Michigan, 1961.

Plant Capacity	Number of Bins	Capacity Per Bin	Approximate Total Storage Capacity	Estimated Investment In Storage Facilities
(B.P.H.)		(Bu.)	(Bu.)	(dollars)
750 B.P.H. - Single-Line	6	3,333	20,000	\$23,200
1500 B.P.H. - Single-Line	6	6,666	40,000	37,200
2250 B.P.H. - Single-Line	6	10,000	60,000	46,750
2250 B.P.H. - Double-Line	6	10,000	60,000	46,750
3000 B.P.H. - Double-Line	8	10,000	80,000	61,950
3750 B.P.H. - Double-Line	10	10,000	100,000	77,450
4500 B.P.H. - Double-Line	12	10,000	120,000	92,950

The storage bins provided for the model plants are not the most economical from the standpoint of investment per bushel. The same amount of storage could be provided at less total cost by having fewer but larger silos. This is due to the fact that the per bushel cost for storage silos decreases as the size of the silo (diameter) increases. It would therefore be cheaper to use the largest possible silos and use as few as possible. However, from a flexible standpoint this is not desirable because it would be possible to have an entire silo tied up with only a small quantity of material. The purpose of the silos provided for each model plant are for ease of operation and are to provide an adequate number of bins so that the plants could operate in as efficient a manner as is possible.

.....

.....

.....

.....

.....

.....

.....

.....

.....

Estimated Investment in Machinery and Equipment

Each plant is equipped with the same machinery and equipment, The only difference being in size and number. The machinery and equipment requirements for the model plants were obtained through actual observations and from equipment specifications for plants actually constructed during 1960.

Tables 26 through 30 contain a detailed list of the equipment provided for each operating phase of the 2250 bushel per hour double-line model plant and the estimated cost of each piece of equipment. Table 31 shows the miscellaneous equipment provided for each of the model plants.

Table 26:-- Equipment List and Estimated Equipment Investment for The Receiving Phase of a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quantity	Capacity	List Price a	Total Cost b
Truck Hoist	2	Cradle Capacity- 4 ton	\$2609	\$2843
Shaker Dump Pit	2	300 Bushels	3424	3666
Itemized Total	...	...	...	<u>\$6509</u>
Installation	...	...	...	2413
Total Installed Cost	...	...	...	<u>\$8922</u>

- a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.
- b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.

The actual cost estimates included in the above tables were obtained from machinery manufactures catalogs and from elevator equipment installation contractors. The various pieces of equipment for which costs were estimated are those which are most commonly found within the state.

The estimated machinery costs include the manufactures list price, plus accessories, plus 4% Michigan sales tax, plus freight from the factory to Lansing, Michigan , and plus a 40% (of list price) installation charge. Discounts were allowed where applicable, but were not known in all cases.

Table 27:--Equipment List and Estimated Equipment Investment
for The Cleaning Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity,
Michigan, 1961.

Item	Quantity	Capacity	List Price a	Total Cost b
Ear Corn Crusher	2	800 B.P.H.-Shelled corn	\$1642	\$1734
Intake Leg	2	1260 B.P.H.	4376	4695
Two Way Valve	2	8-inch outlet	80	86
Garner Bin	2	100 Bushels	360	394
Corn Sheller and Corn Cob Blower	2	900-1100 B.P.H.	7975	8521
Garner Bin	2	100 Bushels	360	394
Grain Cleaner ^c	2	1500 B.P.H.	6004	6395
Screenings Screw Conveyor ^d	2	6-inch.Screw Conveyor	1699	1816
Dust Collector ^e	2	Companion to Cleaner	4885	5241
Scales Hopper	2	Companion to Scales	215	231
Spouting	...	8-inch Spouting	440	472
Itemized Total	...	...	...	<u>\$29979</u>
Installation	...	...	...	11,214
Total Installed Cost	...	...	...	<u>\$41,193</u>

- ^a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.
^b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.
^c List price includes 4 sets of extra screens for each cleaner.
^d List price includes sacking spout and valve for each conveyor.
^e List price includes a dust bin with a capacity of one truck load for each dust collector.

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

1. *Journal of the American Medical Association*, 2000; 284: 1039-1044.

... ..

.....

Table 28:- Equipment List and Estimated Equipment Investment for
The Weighing Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity,
Michigan, 1961.

Item	Quan- tity	Capacity	List Price a	Total Cost b
Auto-Matic Receiving Scales	2	6 Bushel Dump 1800B.P.H.	\$4020	\$4438
Scales Hopper	2	Companion to Scales	215	231
Testing Equipment ^c	2	...	1411	1537
Spouting	...	8-inch Spouting	361	387
Itemized Total	...	...	...	<u>\$6593</u>
Installation	...	...	...	1866
Total Installed Cost	...	...	...	<u>\$8459</u>

a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.

b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.

c List price includes moisture tester, weight per bushel tester, work bench and other necessary accessories.

Therefore, the above prices for some pieces of equipment may be over stated.

Michigan sales tax was included for all items estimated. However, certain items used in processing grain are tax exempt depending on the particular situation and use involved. Since these exemptions depend on the individual situation it was included in all cases.

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

Table 29:--Equipment List and Estimated Equipment Investment for
The Storage Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity,
Michigan, 1961.

Item	Quan- tity	Capacity	List Price a	Total Cost b
Main Leg	2	1260 B.P.H.	\$5408	\$5802
Distributor	2	8-inch	958	1021
Head House Screw Conveyor	1	14-inch Screw Conveyor	1894	2027
Bin Slides and Shut Offs	6	...	360	387
Spouting	...	8-inch Spouting	690	739
Itemized Total	...	...	...	\$9976
Installation	...	...	...	3724
Total Installed Cost	...	...	...	\$13700

a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.

b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.

An installation charge of 40% (of list price) was included for all machinery which requires installation. This figure was based on data obtained from elevators actually constructed in Michigan during 1960 and from elevator equipment installation contractors. A figure of 40% may be high for some of the smaller items but it appears to be a fairly representative average installation charge for all items involved.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Table 30:--Equipment List and Estimated Equipment Investment for
The Load-Out Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity,
Michigan, 1961.

Item	Quantity	Capacity	List Price a	Total Cost b
Basement Screw Conveyor	1	14-inch Screw Conveyor	\$1888	\$2020
Load-Out Leg	1	2850 B.P.H.	3573	3832
Distributor	1	8-inch	135	144
Scales Hopper	1	Companion to Scales	108	116
Auto-Matic Shipping Scales	1	10 Bushel Dump, 2400 B.P.H.	1645	1816
Scales Hopper	1	Companion to Scales	108	116
Load-Out Spouting ^c	...	...	689	737
Itemized Total	...	...	...	\$8781
Installation	...	...	...	3258
Total Installed Cost	...	...	...	\$12039

a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.

b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.

c List price includes flexible load-out spout for trucks and for railroad boxcars, necessary spouting and spout holder for loading railroad boxcars.

Freight was calculated from the factory to Lansing, Michigan.

Railroad freight rates of less than car load lots were used in all cases.

Miscellaneous equipment was also estimated for each model plant. The same procedure was used in making these estimates as was used in

Table 31:--Miscellaneous Equipment List and Estimated Equipment Investment for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quantity	Capacity	List Price a	Total Cost b
Manlift ^c	1	1 man capacity	\$1244	\$1830
Tools	...	...	229	246
Ladders	1	40' Extension	140	150
	2	15' and 12'	38	41
	1	10' Step Ladder	15	16
Grain Scoops	4	...	29	32
Brooms (House Type)	6	...	15	16
Brooms (Push Type)	2	...	7	7
Car Movers (Jacks)	2	...	30	32
Rope	100'	1-inch	20	22
Car Puller Hooks	2	...	16	18
Bag Trucks	1	...	48	51
Portable Scales	1	1,000 pounds	81	87
Trouble Lights	2	...	90	99
Electric Lanterns	2	Battery Type	15	16
Price Board	1	18" x 30"	16	17
Fire Extinguishers	5	Water or Anti-Freeze	204	223
	3	Dry Chemical Type	140	153
Itemized Total	...	...	...	<u>\$3056</u>

a Where applicable the list price includes motor, starter, push button, speed reducer, spouting and any other necessary accessories.

b Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan

c Total cost includes installation in addition to sales tax and freight.

making the estimates for all other machinery and equipment.

Estimated Investment in Office Buildings

The office buildings provided for the model plants used in this study are separate buildings from the main elevator building. They range in size from 480 square feet to 720 square feet. The space required was obtained from elevators actually visited and from elevator designers and builders now operating in Michigan. Each office has a private manager's office, two toilets, storage closet, an area for the clerical staff, adequate room for waiting on customers and necessary space for displays. The office space provided for each plant is shown in table 32. It was assumed that an office larger than 30' x 24' would not be required for the grain merchandising operation.

Office building cost were estimated at \$16.00 per square foot. This includes the entire building, less furniture and office equipment. The estimated investments in office buildings are for concrete block and brick structures. The \$16.00 per square foot was derived from similar types of buildings constructed in Michigan during 1960.

Table 32:--Estimated Investment in Office Buildings and Office Space Provided for Each Model Grain Elevator, Michigan, 1961.

Plant Capacity	Office Size	Square Feet Provided	Estimated Cost of Office Building
(B.P.H.)			(dollars)
750 B.P.H.-Single-Line	24' x 20'	480	\$7650
1500 B.P.H.-Single-Line	24' x 20'	480	7650
2250 B.P.H.-Single-Line	24' x 24'	576	9200
2250 B.P.H.-Double-Line	24' x 24'	576	9200
3000 B.P.H.-Double-Line	30' x 24'	720	11500
3750 B.P.H.-Double-Line	30' x 24'	720	11500
4500 B.P.H.-Double-Line	30' x 24'	720	11500

Estimated Investment in Office Furniture and Equipment

For the purpose of this study audits of existing plants were used as the primary source of information in regards to required office equipment. Table 33 shows a detailed list of the office equipment provided for the 2250 bushel per hour double-line model plant and the estimated cost of each item of equipment provided.

The office furniture and equipment estimates were made by using manufactures catalogs and by consulting various agencies selling the desired items. The estimated costs include 4% Michigan sales tax, freight from the factory to Lansing, Michigan, and installation where applicable. A miscellaneous category was also

Table 33:--Equipment List and Estimated Equipment Investment for Office Equipment for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quantity	List Price	Total Cost ^a
Desk	2	\$245	\$268
Desk Chairs	3	137	150
Office Chairs	6	192	211
File Cabinet	2	122	134
Storage Cabinet	2	140	153
Manager's File and Safe	1	75	82
Office Machine Stand	1	49	54
Bookcase	1	35	38
Testing Equipment	1 set	706 ^b	768
Office Machines	...	1000 ^c	1095
Price Board	1	16	18
Wall Clock	1	14	15
Fire Extinguisher	1	30	33
Stove	1	350	504 ^d
Itemized Total	...	...	<u>\$3523</u>
Miscellaneous	...	...	325 ^e
Total	...	...	<u>\$3848</u>

^a Total cost includes 4% Michigan sales tax and freight f.o.b. the factory to Lansing, Michigan.

^b List price includes moisture tester, weight per bushel tester, work bench and other necessary accessories.

^c List price includes an allowance for a calculator, typewriter, billing machines and check machine.

^d Total cost includes installation in addition to sales tax and freight.

^e Allowance is to cover miscellaneous items such as pencil sharpeners, wastebaskets, display counters, bulletin board, desk lamps and customer counter.

4. The fourth part of the document discusses the implications of the findings. It suggests that the results have significant implications for the field of study and may lead to further research in this area.

5. The fifth part of the document concludes the study. It summarizes the key findings and provides a final statement on the importance of the research.

included for items such as wastebaskets, pencil sharpeners, desk lamps, bulletin boards and display counters.

Estimated Investment in Railroad Siding

Enough railroad siding was provided for each of the model plants so that they would not run out of storage space during the harvest season. Space was provided for the switch and for clearance between the switch and main track. The railroad siding provided should be more than adequate for moving empty cars into loading position and for storing both empty and loaded boxcars. Table 34 shows the maximum number of railroad boxcars that can be spotted at each plant, the feet of track required and the total estimated cost of the railroad siding.

An average boxcar size of 1800 bushels was assumed and an average length of 50 feet per car was used. The number of boxcars required per day, assuming that a switch is made every day, was determined by the plants maximum receiving capacity.

Table 34:-- Estimated Investment in Railroad Siding for Model Grain Elevators, Michigan 1961 .

Plant Capacity	Number of Railroad Boxcars to Be Spotted	Feet of Track Provided	Estimated Investment in Railroad Siding Facilities
(B.P.H.)			
750 B.P.H.-Single-Line	4 boxcars	350	\$8,100
1500 B.P.H.-Single-Line	6 boxcars	550	9,300
2250 B.P.H.-Single-Line	8 boxcars	750	10,500
2250 B.P.H.-Double-Line	10 boxcars	950	12,900
3000 B.P.H.-Double-Line	12 boxcars	1150	14,100
3750 B.P.H.-Double-Line	14 boxcars	1350	15,300
4500 B.P.H.-Double-Line	16 boxcars	1550	16,500

The actual cost estimates were based on cost data obtained from a railroad company now operating in Michigan. The switch itself and enough track for car clearance, between the main track and the siding, cost about \$4,500. The remaining track will cost from \$10.00 to \$12.00 per foot, depending on the particular situation. For the purpose of this study the \$4,500 base price plus \$10 per foot for the remaining track was used.

Estimated Investment in Trucking Equipment

Trucking equipment provided for each model plant was simply one two-ton truck with grain box. The truck for each plant was estimated at \$4,300. This estimate was obtained by contacting

.....

.....

.....

.....

.....

.....

.....

.....

several truck dealers.

Estimated Investment in Corn Cob Burners

Cob burners were provided for each plant according to the size of corn sheller. The cob burner used for all plants was estimated at \$7,000 each and was based on data obtained from elevator contractors now operating in Michigan. This estimated price includes only the cob burner, all necessary spouting was included as part of the corn sheller or cob blower. The larger plants were equipped with two cob burners of equal size.

APPENDIX B
FIXED COST ESTIMATES

APPENDIX B

FIXED COST ESTIMATES

The fixed cost category includes all those costs associated with owning the physical assets and have no direct relation to the actual operation of the model plants. These annual fixed expenses are based entirely on total investment in the various durable assets and do not vary as operating conditions are varied. The following fixed expenses are included in this category: insurance on buildings and all equipment; maintenance and repairs; personal property taxes; and interest on investment. Each of these costs were estimated on an annual basis and the techniques used were those that correspond with existing Michigan conditions and practices. Each of the cost included in this category are discussed separately.

Depreciation Expense

Depreciation expense comprised the major fixed expense for the model plants. It was a function of total investment in the various fixed assets and the rate of depreciation. The estimated life and annual depreciation allowed for each piece of equipment provided for the various operating phases are presented in tables 35 through 41 for the 2250 bushel per hour double-line model plant.

Table 42 shows the total annual depreciation expense allowed for the 2250 bushel per hour double-line model plant. The total annual depreciation expense allowed for each plant corresponded very closely with the depreciation expense found in existing Michigan elevators. No depreciation was estimated for land and land

improvements.

Table 35:-- Equipment List and Estimated Annual Depreciation for
The Receiving Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity, Michigan,
1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Truck Hoist	2	\$2843	17	\$167
Shaker Dump Pit	2	3666	20	183
Itemized Total	...	<u>\$6509</u>	...	<u>\$350</u>
Installation	...	2413	...	130
Total Installed Cost	...	<u>\$8922</u>	...	<u>\$480</u>

Table 36:-- Equipment List and Estimated Annual Depreciation for
The Cleaning Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Ear Corn Crusher	2	\$1734	12	\$145
Intake Leg	2	4695	20	235
Two Way Valve	2	86	20	4
Garner Bin	2	394	20	20
Corn Sheller and Corn Cob Blower	2	8521	15	568
Garner Bin	2	394	20	20
Grain Cleaner	2	6395	18	355
Screenings Screw Conveyor	2	1816	20	91
Dust Collector	2	5241	20	262
Scales Hopper	2	231	20	12
Spouting	...	472	10	47
Itemized Total	...	<u>\$29979</u>	...	<u>\$1759</u>
Installation	...	11214	...	658
Total Installed Cost	...	<u>\$41193</u>	...	<u>\$2417</u>

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

Table 37:--Equipment List and Estimated Annual Depreciation for
The Weighing Phase of a Model Double-Line Grain
Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Auto-Matic Receiving Scales	2	\$4438	15	\$296
Scales Hopper	2	231	20	12
Testing Equipment	2	1537	10	154
Spouting	...	387	10	39
Itemized Total	...	<u>\$6593</u>	...	<u>\$501</u>
Installation	...	1866	...	129
Total Installed Cost	...	<u>\$8459</u>	...	<u>\$630</u>

Table 38:--Equipment List and Estimated Annual Depreciation for
The Storage Phase of a Model Double-Line Grain Elevator,
2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Main Leg	2	\$5802	20	\$290
Distributor	2	1021	20	51
Head House Screw Conveyor	1	2027	20	101
Bin Slides and Shut Offs	6	387	25	15
Spouting	...	739	10	74
Itemized Total	...	<u>\$9976</u>	...	<u>\$531</u>
Installation	...	3724	...	199
Total Installed Cost	...	<u>\$13700</u>	...	<u>\$730</u>

Table 39:--Equipment List and Estimated Annual Depreciation for
The Load-Out Phase of a Model Double-Line Grain Elevator,
2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Basement Screw Conveyor	1	\$2020	20	\$101
Load-Out Leg	1	3832	20	192
Distributor	1	144	20	7
Scales Hopper	1	116	20	6
Auto-Matic Shipping Scales	1	1816	15	121
Scales Hopper	1	116	20	6
Load-Out Spouting	...	737	10	74
Itemized Total	...	<u>\$8781</u>	...	<u>\$507</u>
Installation	...	3258	...	188
Total Installed Cost	...	<u>\$12039</u>	...	<u>\$695</u>

Table 40:-- Miscellaneous Equipment List and Estimated Annual Depreciation for a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quantity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Manlift	1	\$1830	20	\$92
Tools	...	246	10	25
Ladders	4	201	10	21
Grain Scoops	4	32	6	5
Brooms	8	23	1	20
Car Movers (Jacks)	2	32	10	3
Rope	100 ^t	22	6	4
Car Puller Hooks	2	18	10	2
Bag Trucks	1	51	10	5
Portable Scales	1	87	10	9
Trouble Lights	2	99	10	10
Electric Lanterns	2	16	5	3
Price Board	1	17	10	2
Fire Extinguishers	8	376	10	37
Itemized Total	...	\$3056	...	\$238

... ..

... ..

...

...

...

...

...

...

...

...

...

...

...

...

...

...

...

Table 41:--Equipment List and Estimated Annual Depreciation for
Office Equipment for a Model Double-Line Grain Elevator,
2250 Bushel Per Hour Capacity, Michigan, 1961.

Item	Quan- tity	Total Cost	Estimated Life	Annual Depreciation
		(dollars)	(years)	(dollars)
Desk	2	\$268	15	\$18
Desk Chairs	3	150	10	15
Office Chairs	6	211	10	21
File Cabinet	2	134	15	9
Storage Cabinet	2	153	15	10
Manager's File and Safe	1	82	20	4
Office Machine Stand	1	54	10	5
Bookcase	1	38	20	2
Testing Equipment	1 set	768	10	77
Office Machines	...	1095	10	110
Price Board	1	18	10	2
Wall Clock	1	15	10	2
Fire Extinguisher	1	33	10	3
Stove	1	<u>504</u>	10	<u>50</u>
Itemized Total	...	\$3523	...	\$328
Miscellaneous	...	<u>325</u>	...	<u>33</u>
Total	...	\$3848	...	\$361

• ...

... ..

...

... ..

...

...

...

...

...

...

...

...

...

...

...

...

...

...

...

...

...

...

... ..

Table 42:-- Estimated Investment In Durable Assets and Annual Depreciation For a Model Double-Line Grain Elevator, 2250 Bushel Per Hour Capacity, Michigan, 1961.

Durable Asset	Total Estimated Investment	Annual ^a Depreciation Rate	Annual Depreciation
Land and Land Improvements	\$3,750	...	...
Buildings	29,000	2.5 Percent	\$ 725
Storage Facilities	46,750	2.5 Percent	1,169
Machinery and Equipment	87,369	Straight Line ^b	5,190
Corn Cob Burner	7,000	20 years	350
Railroad Siding	12,900	2.5 Percent	323
Trucking Equipment	4,300	6 years	717
Office Building	9,200	2.5 Percent	230
Office Equipment	3,848	Straight Line ^c	361
Total	<u>\$204,117</u>		<u>\$9,065</u>

^a The depreciation rate used here is based mainly on physical factors such as type and quality of construction. Shorter useful lives than allowed above are often used for accounting purposes, in making construction loans and in business planning. No allowance is made here for obsolescence. Depreciation rates are based on manager's recommendations, observations of existing country grain elevators and reference to the following published material; "Income Tax Depreciation and Obsolescence, Estimated Useful Lives and Depreciation Rates," Bulletin F, U.S. Treasury Department, 1942; E.H. Boeckh, "Boeckh's Manual of Appraisals," 5th edition, Cincinnati, Ohio, 1956, pages 711-27; and "Consolidated Catalogs," 7th edition, Chicago, Illinois, 1949. page 270.

^b Depreciation was figured separately for each individual piece of equipment. For details see Equipment List, tables 35 through 40.

^c Depreciation was figured separately for each individual piece of equipment. For details see Office Equipment List, table 41.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Insurance Expense

Fixed insurance expenses included fire and extended coverage insurance on buildings, machinery and equipment, and on trucking equipment. All model plants had the same type of insurance coverage. The building and equipment insurance coverage included almost 100 percent protection from both fire and wind to the cost of the facilities provided for the model plants. The fixed truck insurance expense covered liability, collision and comprehensive insurance for the one truck provided for each plant. Inventory, liability, and workmen's compensation insurance costs were included as part of the variable expenses because the risk involved changed as operating conditions were varied. The estimated annual fixed cost of insurance for the various model plants is shown in table 43. These insurance estimates were based on rates in effect in 1960.

Personal Property Tax Expense

Personal property tax expenses vary widely within the state and there is no uniformity among counties in the property tax rates and assessment values. It was therefore, impossible to determine a uniform formula for establishing tax valuations. In order to obtain uniformity between plants it was assumed that all buildings and equipment were assessed at the same rate.

The procedure followed in this study was to estimate personal property tax at 4 percent of the average undepreciated value over the life of the fixed assets. The estimated annual personal property tax for the various model plants are shown in table 44.

Table 43:-- Estimated Fixed Insurance Expense for Model Grain Elevators, Michigan, 1961.

Plant Capacity	Fire	Windstorm	Truck	Total
(B.P.H.)				
750 B.P.H.-Single-Line	\$194	\$29	\$118	\$341
1500 B.P.H.-Single-Line	237	35	118	390
2250 B.P.H.-Single-Line	280	43	118	441
2250 B.P.H.-Double-Line	427	50	118	595
3000 B.P.H.-Double-Line	530	65	118	713
3750 B.P.H.-Double-Line	587	71	118	776
4500 B.P.H.-Double-Line	627	76	118	821

Table 44:--Estimated Personal Property Tax Expense for Model Grain Elevators, Michigan, 1961.

Plant Capacity	Total Investment	Estimated Annual Personal Property Tax
(B.P.H.)	(dollars)	(dollars)
750 B.P.H. - Single-Line	\$110,863	\$2,217
1500 B.P.H. - Single-Line	138,178	2,764
2250 B.P.H. - Single-Line	161,190	3,224
2250 B.P.H. - Double-Line	204,117	4,082
3000 B.P.H. - Double-Line	243,475	4,870
3750 B.P.H. - Double-Line	276,413	5,528
4500 B.P.H. - Double-Line	303,343	6,067

Repairs and Maintenance Expense

The procedure followed in this study was to estimate the total annual repair and maintenance expense for the model plants and then to allocate it between the fixed and variable expense categories.

Certain expenses, such as painting or other care given the exterior of the plant are a result of weathering, rather than volume. They tend to occur every few years regardless of volume and the amount included here was intended as a yearly average for this kind of expense.

Audits of existing plants were used as guides in determining the average annual repairs and maintenance paid by grain elevators.

It was found that this expense amounted to about 2 percent of the total investment in fixed assets. Total annual repairs and maintenance was therefore calculated at 2 percent of the total investment in fixed assets. One-sixth of this figure was then allocated to the fixed expense category and the remaining prorated to variable expense according to hours of operation.

Table 45 shows the total annual repairs and maintenance expense for the various model plants and the amount allocated as a fixed expense.

The repair and maintenance of such equipment as leg belts and buckets, car loading spouting, and spouting to and from bins are directly associated with volume. Repairs on electric motors and other moving equipment also tend to be closely associated with use and volume handled. Repairs of this type are included as a variable expense and are discussed in Appendix C.

Table 45:--Estimated Repairs and Maintenance Expense for Model Grain Elevators, Michigan, 1961.

Plant Capacity	Total Investment In Durable Assets	Total Annual Maintenance at 2% of Total Investment	Maintenance As A Fixed Expense, 1/6 of Total Maintenance
(B.P.H.)	(dollars)	(dollars)	(dollars)
750 B.P.H. - Single-Line	\$110,863	\$2,217	\$370
1500 B.P.H. - Single-Line	138,178	2,764	461
2250 B.P.H. - Single-Line	161,190	3,224	537
2250 B.P.H. - Double-Line	204,117	4,082	680
3000 B.P.H. - Double-Line	243,475	4,870	812
3750 B.P.H. - Double-Line	276,413	5,528	921
4500 B.P.H. - Double-Line	303,343	6,067	1011

Interest on Investment

Long-term capital generally consists of deferred liabilities and ownership capital. Such capital is required regularly as contrasted with season capital which is needed only during harvests. Interest on seasonal capital is subsequently discussed as a variable expense, whereas interest on long-term capital was considered here as a fixed expense.

This expense item is not entirely comparable to the interest expense commonly found in operating statements or audits. In actual practice, interest on deferred liabilities is usually shown in the operating expense statements. However, the cost of ownership

capital may be shown as a stock dividend or, in the case of reserves and surplus, no interest cost will be shown.³²

The proportion of interest-incurring capital used generally varies considerably among elevators. Thus, to keep the models on a comparable basis, interest expense was calculated on all long-term capital. Long-term capital here refers to total investment per model plant in fixed durable assets.

An interest rate of 5 percent was applied to the average undepreciated value of the physical assets over the life of the assets. Following this procedure resulted in the annual interest on investments shown in table 46.

³² Thurston and Mutti, op.cit., page 22.

Table 46:--Estimated Annual Interest on Investment for Model Grain Elevators, Michigan, 1961.

Plant Capacity	Total Investment in Durable Assets	Annual Interest on Investment ^a
(B.P.H.)	(dollars)	(dollars)
750 B.P.H.-Single-Line	\$110,863	\$2,772
1500 B.P.H.-Single-Line	138,178	3,454
2250 B.P.H.-Single-Line	161,190	4,030
2250 B.P.H.-Double-Line	204,117	5,103
3000 B.P.H.-Double-Line	243,475	6,087
3750 B.P.H.-Double-Line	276,413	6,910
4500 B.P.H.-Double-Line	303,343	7,584

^a Interest on investment calculated at 5 percent of the average undepreciated value over the life of the assets.

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

APPENDIX C
VARIABLE RESOURCE REQUIREMENTS
AND COST ESTIMATES

APPENDIX C

VARIABLE RESOURCE REQUIREMENTS AND COST ESTIMATES

The variable expense category includes all those costs associated with the plants actual operations and volume handled. The various expenses included in this category change in varying degrees with changes in volume and management decisions. The following expenses were included in this category: personnel expenses, which include the manager's salary, clerical wages, plant labor wages, workmen's compensation insurance, and social security taxes; utilities, power and light; repairs and maintenance; interest on seasonal capital; inventory insurance; general liability insurance; and miscellaneous expenses. Included in the miscellaneous expense category are such things as advertising, legal and auditing expenses, office supplies, plant supplies, telephone and telegraph, truck expenses, allowance for worthless accounts, office heat, and other general operating expenses.

Some of these variable expenses respond slowly to volume and size changes while others respond more proportionally to such changes. These expenses are not entirely variable in that they are partially fixed and partially variable. For this reason, each variable expense item was budgeted separately.

Labor Requirements and Labor Cost Estimates

Labor requirements were computed separately for each model plant operating under the various operating conditions set forth. These requirements were calculated on a man-hours per load basis

for each load size received.

The man-hours required per load were based on data obtained from observations made during visits to elevators operating throughout the state. These timings include enough time for all operations within the plants various operating phases and were based on actual timings made during these visits. A 25 percent delay factor was allowed to account for the operators untimed movements and to allow adequate time to move from one operation to another.

The same procedure was followed, for all model plants, for receiving both small grains and ear corn. These figures then became the basis for estimating the labor requirements for the model plants operating under the various conditions set forth.

In addition to the actual man-hours required for operating the plant, an allowance was also made for daily clean up and preventive maintenance. On the average about 45 minutes per 10 hour day is spent on cleaning and sweeping up the plants visited. The annual hours of operation were therefore converted to 10 hour days and 45 minutes per day allowed for each day of operation. One hour per 10 hour day was allowed for preventive maintenance. This allowance was for daily preventive maintenance such as, adjusting elevating legs and belts, oiling machinery, and for making other minor repairs.

One full time man was allowed for each plant regardless of the number of annual man hours required. During the harvest season, which was assumed to be 100 hours, part time labor was added until the man hours required per hour of operation was fulfilled.

Annual hours worked per man was calculated for an average week of 50 hours per week for 52 weeks. This gave a total of $(50 \times 52 = 2600 \text{ hours per year})$ 2600 hours per year. Additional part time help was added for all time required over 1, 2, 3, or 4 full time men (2600, 5200, 7800, or 10,400 man hours), up to and including 1300 hours. For all time over 1300 hours (1300 hours is equivalent to 6 months work at 50 hours per week) another full time man was added. It was found that on the average an elevator does not hire a man for over 6 months as part time labor. The same procedure was followed for both single and double-line plants.

It was assumed that overtime would be paid for all time over 40 hours per week. Therefore 520 of the 2600 hours was figured as overtime $(40 \text{ hours per week} \times 52 \text{ weeks} = 2080 \text{ hours per year and } 2600 \text{ hours} - 2080 \text{ hours} = 520 \text{ hours overtime per year})$.

Regular time for full time labor was calculated at \$1.50 per hour and overtime was figured at time and a half at \$2.25 per hour. This resulted in the following annual cost per full time man:

$$2080 \text{ hours} \times \$1.50 \text{ per hour} = \$3120$$

$$\frac{520 \text{ hours}}{2600 \text{ hours}} \times 2.25 \text{ per hour} = \frac{1170}{\$4290} = \text{Total Cost}$$

The same over time ratio was maintained for all part time labor as was used for full time labor. The ratio being 80% at the regular rate and 20% at the overtime rate. Therefore, for each 100 hours of part time labor 80 hours was at the regular rate and 20 hours was at the overtime rate.

Regular time for part time labor was calculated at \$1.40 per hour and overtime was computed as time and a half or \$2.10 per hour. This resulted in the following cost per 100 hours of part time labor:

$$\begin{array}{r} 80 \text{ hours} \times \$1.40 \text{ per hour} = \$112 \\ \underline{20 \text{ hours} \times 2.10 \text{ per hour} = 42} \\ 100 \text{ hours} \qquad \qquad \qquad \$154 = \text{Total Cost} \end{array}$$

Model Plants Clerical Requirements and Cost Estimates

On the average elevators in Michigan employ one office clerk for each five full time men employed in the plant. This figure was used in calculating office help requirements for each model plant.

It was assumed that each plant would require full time office help during the harvest season. Therefore, 100 hours of clerical help was included for each single-line plant and 200 hours for each double-line plant.

In addition to the harvest season requirements, one-fifth of an hour of clerical help was included for each required hour of plant labor.

All clerical help was calculated at \$1.25 per hour. A 40 hour week was assumed and all hourly estimates were rounded to a 40 hour week. At this rate a full time clerk would work 2080 hours per year (40 hours x 52 weeks = 2080 hours), which would amount to an annual salary of \$2600 (2080 hours x \$1.25 per hour = \$2600).

Model Plant Management Requirements and Cost Estimates

Management cost would be overstated if the manager's salary was allocated entirely to the grain merchandising operation. The time spent by management or the manager on matters pertaining to grain and corn depends on several factors. One very important factor is the percent of the total operation that grain and corn merchandising represents. The following procedure was therefore used in allocating the manager's salary according to the annual hours of operation.

The salary paid a manager usually increases as the size of plant increases. This may be due to either a bonus or commission plan or simply an increased salary because of the larger business and increased responsibilities. The salaries used throughout this study ranged from \$5,200 per year for the 750 bushel per hour plant to \$10,200 per year for the 4500 bushel per hour plant. The \$1,000 increase in salary between plants appears to be reasonable in light of company audits and due to the fact that no allowance was made for a bonus or commission plan, which is a common practice in Michigan.

The manager's salary was allocated according to the number of annual hours of operation with each block of hours receiving a certain percent of the manager's annual salary. In allocating the manager's salary in this way it was assumed that if the plant received grain only a few hours per year that the grain merchandising operation was of relative less importance than if it received

1. The first step in the process is to identify the problem.

2.

3. The next step is to analyze the problem.

4. This involves gathering information and identifying the causes of the problem.

5. Once the causes are identified, the next step is to develop a solution.

6. This involves brainstorming ideas and selecting the best one.

7. The final step is to implement the solution.

8. This involves putting the solution into practice and monitoring its progress.

9.

10. The final step is to evaluate the results of the solution.

11. This involves comparing the results to the original problem and determining if the solution was effective.

12. If the solution was not effective, the process may need to be repeated.

13. The final step is to document the results of the process.

14. This involves creating a report that describes the problem, the solution, and the results.

15. The final step is to share the results of the process with others.

16. This involves presenting the results to a group of people and discussing the findings.

17. The final step is to implement the recommendations of the group.

18.

19.

20.

21. The final step is to evaluate the results of the process.

22.

23. The final step is to document the results of the process.

24.

25.

grain a greater number of hours per year.

The manager's annual salary, hours of operation and the respective percent of salary allocated to each are presented in table 47. The percentages used appear to be representative of conditions as they now exist in Michigan.

Table 47:--The Manager's Annual Salary Allocated According to Annual Hours of Operation For Model Grain Elevators, Michigan 1961.

Plant Capacity (B.P.H.)	Manager's Annual Salary	Hours of Operation and Percent of Total Annual Salary				
		300	600	900	1200	1500
		25%	37.5%	50%	62.5%	75%
750 B.P.H. - Single-Line	\$5200	\$1300	\$1950	\$2600	\$3250	\$3900
1500 B.P.H. - Single-Line	6200	1550	2325	3100	3875	4650
2250 B.P.H. - Single-Line	7200	1800	2700	3600	4500	5400
2250 B.P.H. - Double-Line	7200	1800	2700	3600	4500	5400
3000 B.P.H. - Double-Line	8200	2050	3075	4100	5125	6150
3750 B.P.H. - Double-Line	9200	2300	3450	4600	5750	6900
4500 B.P.H. - Double-Line	10200	2550	3825	5100	6375	7650

Social Security Tax

Social security tax is directly related to the annual cost of wages and salaries. The employer pays 3 percent of the employee's salary up to the point at which the annual salary reaches \$4800. Above \$4800 salary, social security tax was not deducted. This

This rate was used (3%) for computing the social security tax on all plant labor wages, clerical wages, and manager's salary.

Workmen's Compensation Insurance

Another expense item based on payroll is workmen's compensation insurance. The rate of the insurance per \$100 of payroll depends on the risk involved in the particular job covered. The highest rate being for those employees whose principal work is in the elevator and the lowest rate being for the office workers.

In budgeting this expense item an average rate of \$2.58 per \$100 coverage, based on annual payroll, was used. This is an average rate for the types of operation used in the model plants and is representative of rates used in Michigan during 1961.

Inventory Insurance

Inventory insurance was based on an annual average plant inventory. This annual average inventory is based on the model plants storage capacities (20,000 through 120,000 bushels) and the annual hours of operation. The annual hours of operation were assumed to represent the importance of the grain merchandising operation to the various model plants. The annual average inventory allowed for each of the model plants is shown in table 48.

Table 48:-- Annual Average Inventory for Model Grain Elevators
Michigan, 1961.

Model Plant Storage Capacities	Annual Hours Of Operation and Percent of Storage Capacity Allowed As Annual Average Inventory				
	300 Hours	600 Hours	900 Hours	1200 Hours	1500 Hours
	30%	40%	50%	60%	70%
(Bushels)	(bushels)	(bushels)	(bushels)	(bushels)	(bushels)
20,000	6,000	8,000	10,000	12,000	14,000
40,000	12,000	16,000	20,000	24,000	28,000
60,000	18,000	24,000	30,000	36,000	42,000
80,000	24,000	32,000	40,000	48,000	56,000
100,000	30,000	40,000	50,000	60,000	70,000
120,000	36,000	48,000	60,000	72,000	84,000

Annual average inventory was converted to a dollar basis for the purpose of estimating insurance cost. An average price per bushel of storage was used for each plant. The average price was based on the average price of wheat and corn in 1960 and varied between the various receiving mixes as the percent of grain and corn received changed:

The cost of insurance coverage for the annual average inventory maintained by the model plants was estimated at 9.6 cents per \$100 of inventory, based on the value of the material stored. This is an average rate and is representative of rates used in Michigan during 1961.

Interest on Seasonal Capital

It was assumed that the model plants would need operating capital in the form of cash for day to day operations. Capital would also be tied up in the form of inventories. The value of the annual average inventory, used in calculating inventory insurance, was therefore used in estimating the annual interest charge for operating capital. An interest rate of 5 percent was applied to the value of the annual average inventory to obtain the annual cost of operating capital.

General Liability Insurance

General liability insurance varies inversely with total annual sales and total annual volume. This insurance cost also varied depending on whether the plant had more than one truck hoist, manlift, and railroad sidings. Comprehensive and general liability insurance was estimated at \$100,000/\$300,000 bodily injury limits and \$25,000/\$50,000 property damage limits.

This insurance cost was estimated by converting total annual volume, for the various operating situations, to a dollar basis. This was done by using an average price of \$1.85 per bushel for wheat and \$1.10 per bushel for corn. The following rates, table 49, were then used in estimating the cost of this insurance for the various model plants. These are average rates and are representative of rates used in Michigan during 1961.

Table 49:--General Liability Insurance Rates for Model Grain Elevators, Michigan, 1961.

Annual Value of Sales	Insurance Rate
(dollars)	Cents Per \$100 of Sales
(dollars)	(cents)
0 - 650,000	2.50 cents/\$100
650,001 - 1,150,000	1.05 cents/\$100
1,150,001 - 1,650,000	.70 cents/\$100
1,650,001 - 2,150,000	.55 cents/\$100
2,150,001 - 2,650,000	.50 cents/\$100
2,650,001 - 3,150,000	.50 cents/\$100
3,150,001 - 3,650,000	.50 cents/\$100
3,650,001 - 4,150,000	.50 cents/\$100
4,150,001 - 4,650,000	.43 cents/\$100
4,650,001 - 5,150,000	.38 cents/\$100
5,150,001 - 5,650,000	.35 cents/\$100
5,650,001 - 6,150,000	.30 cents/\$100
6,150,001 - 6,650,000	.30 cents/\$100

Maintenance As A Variable Expense

Total annual repairs and maintenance expense was calculated at 2 percent of the total investment in fixed assets. One-sixth of total annual repairs and maintenance was then allowed as a fixed expense (see Appendix B). This expense was to cover repairs resulting from weathering and time rather than volume handled. The remaining annual repairs and maintenance expense is included here as a variable expense to cover those repairs and maintenance requirements resulting from wear due to hours of operation and volume handled.

Maintenance as a variable expense was allocated assuming 1500 hours of annual operation as the maximum. A plant operating 1500 hours per year was therefore allocated 5/6th of the total

maintenance expense as a variable expense and 1/6th as a fixed expense. A plant operating 1500 hours per year was the only point for which the total maintenance expense was allowed for each plant. Each smaller group of hours being reduced by 1/6th of the total annual repairs and maintenance expense.

Total annual repairs and maintenance expense was therefore allocated in the following way for each model plant: 1/6th as a fixed expense plus 1/6th for 300 hours of operation, 1/3rd for 600 hours of operation, 1/2 for 900 hours of operation, 2/3rds for 1200 hours of operation, and 5/6th for 1500 hours of operation.

Utilities

Electric power requirements were computed separately for each model plant operating under the various operating conditions set forth. These requirements were calculated on a kilowatts per hour basis for each piece of equipment that was operating for each of the various load sizes received.³³ The total hourly consumption in kilowatts was then a simple addition of the kilowatts

³³ The formula used in estimating kilowatt hours for each individual motor used in each model plant was as follows, see Max Kushlan, "Handbook of Industrial Electricity," McGraw-Hill Book Company, Inc., New York and London, 1931, page 23-4.

$$KW = \frac{\text{Volts} \times \text{Amps} \times 1.732 \times \text{P.F.}}{1,000}$$

where; Volts = Voltage of the electrical system, 220 volts was used in all model plants.

Amps = Amps used by the electric motor. The motor manufactures recommended full load amperage was used in all cases.

1.372 = A constant used when calculating the kilowatt hours of 3 phase motors.

P.F. = Power factor. A power factor of 80% was used for all motors less than 5 HP and a power factor of 85% was used for all motors 5HP and over.

1,000 = Watts per kilowatt.

KW = Kilowatts per hour.

used by the individual pieces of equipment. The same procedure was followed for receiving both small grains and ear corn.

The actual time that each piece of equipment was operated, when receiving each of the various average load sizes, was obtained from data gathered when the plants were visited. These timings were used to determine the actual time per hour that the individual pieces of equipment were actually operating. Thus, adequate time was allowed for delays and idle periods when the various pieces of equipment were not operating.

The following monthly energy rates were used throughout this study in estimating the monthly cost of electric power.

Energy charge:

\$1.40 per month which shall include 24 KWH or less, this is also the minimum charge per month,
5.0¢ per KWH for the next 26 KWH,
3.6¢ per KWH for the next 950 KWH,
3.15¢ per KWH for the next 2,000 KWH,
2.75¢ per KWH for the excess.

Electricity is charged on a monthly basis and depends on the kilowatt hours used during that month. Therefore the annual hours of operation for both small grains and ear corn were divided between the twelve months so that an accurate approximation could be obtained for each months operation. This resulted in July and August being the high months in regards to electricity consumption, followed by October, September, November, December and January. The remaining 5 months were the low electricity consumption months.

The estimates obtained for electric power were assumed to include electric light consumption. Electric lights are but a

minor part of total electricity charge.

Miscellaneous Expenses

This group of expenses was included to cover the many minor operating expenses faced by grain elevators. Company audits were reviewed to determine the percent of total operating expense that the items in this category accounted for. It was found that the expenses included in this group accounts for approximately 15% of total operating expenses (this includes both fixed and variable expenses). This group of expenses was therefore calculated at 15% of the total fixed and variable expenses. This 15% included the following items:

Advertising	2%
Legal and Auditing	1%
Office Supplies	1%
Plant Supplies	2%
Telephone and Telegraph	1%
Truck expense	2%
Office Heat	1%
Other	5%
Total	<u>15%</u>

BIBLIOGRAPHY

Baumel, C. Phillip and Sharp, John W., "A Financial Analysis of Ohio Elevator Operations," Research Bulletin 813, Ohio Agricultural Experiment Station, Wooster, Ohio, June 1958, 25 pages.

Black, Guy, "Synthetic Method of Cost Analysis in Agricultural Marketing Firms," Journal of Farm Economics, Vol 37 No 2, August 1955, pages 270-79.

Boeckh, E. H., "Boeckh's Manual of Appraisals," 5th Edition, E. H. Boeckh & Associates, Washington, D. C., and Cincinnati, Ohio, 1956, 840 pages.

Boulard, Heber D. and Smith, Lloyd L., "A Small Country Elevator For Merchandising Grain, Designs and Recommendations," Marketing Research Report No. 387, U. S. Department of Agriculture, Agricultural Marketing Service, Transportation and Facilities Research Division, Washington, D. C., June 1960, 52 pages.

Bressler, R. G., "Research Determination of Economies of Scale," Journal of Farm Economics, Vol 27, 1945, pages 526-39.

Dean, Joel, "Managerial Economics," Prentice-Hall, Inc., New York, 1951, 621 pages.

French, B. C., Sammet, L. L., and Bressler, R. G., "Economic Efficiency In Plant Operations With Special Reference To The Marketing of California Pears," Hilgardia, Volume 24 Number 19, University of California, Berkeley, California, July 1956, pages 543-721.

Greenleaf, George G., "A Study of Cost Relationships in Michigan Country Elevators," Unpublished Master's Thesis 1959, Michigan State University, East Lansing, Michigan, 1959, 68 pages.

Hall, Thomas E., "New Country Elevators, Influence of Size and Volume on Operating Costs," Farmer Cooperative Service Circular 10, U. S. Department of Agriculture, Farmer Cooperative Service, Washington, D. C., June 1955, 29 pages.

Hall, Thomas E., Davis, Walter K., and Hall, Howard L., "New Local Elevators - Costs-Volume Relations In The Hard Winter Wheat Belt," Service Report 12, Farmer Cooperative Service, U. S. Department of Agriculture, Washington, D. C., May 1955, 112 pages.

Henderson, James M. and Quandt, Richard E., "Microeconomic Theory - A Mathematical Approach," McGraw-Hill Book Company, Inc., New York, 1958, 291 pages.

Larzelere, H. E., and King, R. M., "Ratios As Measuring Sticks for Elevator and Farm Supply Organizations," Special Bulletin 380, Michigan State College, Agricultural Experiment Station, Department of Agricultural Economics, East Lansing, Michigan, August 1952, 29 pages.

Leftwich, Richard H., "The Price System and Resource Allocation," Revised Edition, Holt, Rinehard and Winston, New York, 1960, 381 pages.

Michigan Department of Agriculture, "Michigan Agricultural Statistics," Lansing, Michigan, July 1960.

Milner, Ross, "How to Build A Better Business At Country Elevators," Agricultural Extension Bulletin MM 173, Agricultural Extension Service, Ohio State University, Columbus, Ohio, 47 pages.

Mutti, R. J., "Differences in The Financial Organization and Operation of Country Grain Elevators in The Northern Half of Illinois, 1954-55," AERR - 17, Department of Agricultural Economics, University of Illinois College of Agriculture, Urbana, Illinois, February 1957, 25 pages.

Norton, L. J., "Business Policies of Country Grain Elevators," University of Illinois Agricultural Experiment Station Bulletin 477, April 1941, pages 279-308.

Phillips, Richard, "Managing for Greater Returns in Country Elevators and Retail Farm Supply Businesses," Farmers Grain Dealers Association of Iowa, Des Moines, Iowa, October 1957, 558 pages.

Pursel, Arthur J., "The Use of Functional Analysis in Evaluating The Operations of Michigan Elevator - Farm Supply Businesses," Unpublished Master's Thesis 1957, Michigan State University, East Lansing, Michigan, 1957, 72 pages.

Richey, Perry S. and Johnson, Thew D., "Factors to Be Considered In Locating, Planning, and Operating Country Elevators," Marketing Research Report No. 23, U. S. Department of Agriculture, Production and Marketing Administration, Washington, D. C., June 1952, 94 pages.

Sammet, L. L. and French, B. C., "Economic-Engineering Methods in Marketing Research," Journal of Farm Economics, Vol 35, 1953, pages 924-30.

Schonberg, James D., "The Grain Trade: How It Works," Exposition Press, New York, 1956, 351 pages.

Sharp, J. W., Fuller, C. E., and Ecker, H. J., "Planning Local Elevator Feed Mill Facilities," Research Bulletin 783, Ohio Agricultural Experiment Station, Wooster, Ohio, January 1957, 28 pages.

Sharp, John W. and Henning, George F., "Modernizing Grain Handling Facilities in Ohio," Department of Agricultural Economics and Rural Sociology, Mimeograph Bulletin No. AE 244, Ohio Agricultural Experiment Station and Ohio State University, Columbus, Ohio, October 1953, 23 pages.

Sorenson, Vernon L. and Spaeth, David, "Elevator Outlook Committee Progress Report," Agricultural Economics 742, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, December 5, 1958 (Mimeographed), 46 pages.

Thurston, Stanley K. and Mutti, R. J., "Cost-Volume Relationships for New Country Elevators in The Corn Belt," Service Report 32, Farmer Cooperative Service, U. S. Department of Agriculture, September 1957, 78 pages.

United States Treasury Department, "Income Tax Depreciation and Obsolescence, Estimated Useful Lives and Depreciation Rates," Bulletin F, U. S. Government Printing Office, Washington, D. C., 1942.

MICHIGAN STATE UNIV. LIBRARIES



31293008489365