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BANKRUPTCY PREDICTION IN THE CONSTRUCTION INDUSTRY:

FINANCIAL RATIO ANALYSIS

A Special Research Problem

Presented to

**the Faculty of the School of Civil Engineering
Georgia Institute of Technology**

By

Romeleo N. Punsalan

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**In Partial Fulfillment
of the Requirements for the Degree of
Master of Science in the School of Civil Engineering
August 1989**

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GEORGIA INSTITUTE OF TECHNOLOGY

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SCHOOL OF CIVIL ENGINEERING

ATLANTA, GEORGIA 30332



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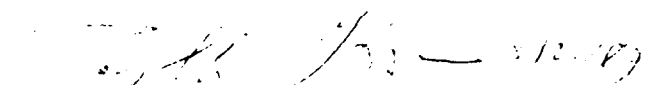
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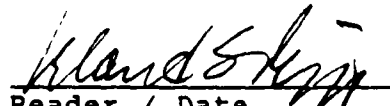
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ABSTRACT

This paper will review the existing bankruptcy prediction models which utilize financial ratios. The most notable models by William H. Beaver and Edward I. Altman will be examined closely. These models were developed from financial data of manufacturing and construction firms. A method of analysis will be developed for distinguishing the significant differences in financial reporting between the two industries. Using this information an effort will be made to modifying the models that can be applicable to the construction industry.

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R. N. PUNSALAN

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CHAPTER 1

INTRODUCTION

1.1 Background

The study of bankruptcy and business failure in general is an important topic of research, especially as it applies in the construction industry. The number of business failures has dramatically increased in this decade as indicated by Dun and Bradstreet Business Failure Records [1], 1988. The construction industry alone accounted for 11.9 percent (6791 out of a total of 57098) of the bankruptcies in the U.S. as shown in Table 1. But this statistic provided by Dun & Bradstreet, Inc. only includes failures of firms registered in their Reference Book. For example, the total number of business bankruptcy petitions filed in 1983 was 95,439, while the number of failures recorded was only 31,334. Based on these numbers, it is apparent that a good deal of research is plausible into the causes and symptoms and prediction on business failures in the construction industry.

Understanding the causes and symptoms business failure helps in the identification and early warnings of impending financial crisis. This is important not only to analysts and practitioners but to commercial loaning agency, bonding companies, investors, and even clients. It is also important to the firm in predicting it's own financial distress to providing new direction of the firm.

TABLE 1 Construction Failures for the Past 20 Years*			
Year	Total for all Industries	Total in Construction	Percent of Total failures
1988	57,098	6,791	11.9
1987	61,111	6,735	11.0
1986	61,616	7,109	11.5
1985	57,253	7,005	12.2
1984	52,078	6,936	13.3
1983	31,334	5,247	16.7
1982	24,908	4,872	19.6
1981	16,794	3,614	21.5
1980	11,742	2,355	20.1
1979	7,564	1,378	18.2
1978	6,619	1,204	18.2
1977	7,919	1,463	18.5
1976	9,628	1,770	18.4
1975	11,432	2,262	19.8
1974	9,915	1,840	18.6
1973	9,345	1,419	15.2
1972	9,566	1,375	14.4
1971	10,326	1,545	15.0
1970	10,748	1,687	15.7
1969	9,154	1,590	17.4

*Source: Dun & Bradstreet, "Business Failure Records" [1].

The problem with previous research [9, 10, 13, 14, and 20] on bankruptcy is that they are based on the analysis of manufacturing companies, small firms, banks, insurance companies, railroads, and savings and loan associations. There have been little studies on bankruptcy prediction in the construction industry. Most business failure prediction models were developed using data from manufacturing firm that went bankrupt or continuing. A summary of the leading studies will be summarized in chapter 2.

The use of existing bankruptcy prediction model for the construction industry may be unwarranted. As there are major differences and goals between construction and the manufacturing industry.

Also these bankruptcy prediction models were developed using large firms as the financial data are made public. The question is whether these models can be applied to smaller firms.

1.2 Objective and Methodology

This paper will review the various bankruptcy prediction models as they may be applied to the construction industry. From the numerous studies [9, 10, 13, 16, and 19] on bankruptcy, it is agreed that financial ratios and its analysis provide useful information. Financial ratio analysis is a technique of using information from financial statements to assess strengths and weaknesses of the current financial posture of a company. One

qualitative characteristic of useful information is its predictive value. Successful prediction of an economic event by means of financial information demonstrates its potential usefulness of such information. The building of models by use of financial ratios to predict events of interest is one method of demonstrating potential usefulness of information. Prior studies in the accounting, economic and finance literature provide evidence that ratio from the balance sheet and the income statements can predict bankruptcy, an economic event of interest to decision-makers. It is accepted that there are many non-financial symptoms that could be used in predicting company failure. Non-financial symptoms, are qualitative rather than quantitative and therefore do not lend themselves to being used in the formation of prediction models. A qualitative study for determining the causes and symptoms of bankruptcy was thoroughly presented by Argenti [2] and Abbinante [3]. In summary, Abbinante stated that "detecting failure using 'common sense' may well be the best prediction of bankruptcy. It only requires being attuned to the realities of the marketplace for obvious signals of failure." He also mentioned that the usefulness of prediction models developed from financial ratios and by statistical methods (i.e. Multiple Discriminant Analysis) could only be increased by concentration on individual industries. It is clear that a prediction model produced from financial ratios and then linked with non-financial analysis would produce a most effective screening procedure.

The goal is to investigate whether bankrupt firms in manufacturing are distinguishable from bankrupt firms in the construction industry. A first step is to identify major significant differences in between their financial reporting. The method used for this study, involves evaluating the financial ratios provided by reporting services of Dun & Bradstreet, Inc. [4], Robert Morris Associates [5], and Leo Troy's Almanac [6]. Also, actual construction and manufacturing firms from the Value Line [7] and Standard & Poor's Corporate Records [8] references were selected in obtaining data for analysis. The Analysis of Variance for the fixed effect model, one-way classification is used as the most appropriate method of determining significance between the two types of industries. Once a particular ratio or set of ratios is determined to be distinguishable between manufacturing and construction, the problem remains on how this can effect an existing bankruptcy prediction model.

The scope of this paper involves determining the significant ratios between construction and manufacturing and developing a bankruptcy prediction model by modifying an existing model. Thus, the model would be applicable to the construction industry. Unfortunately, testing of the modified model could not be done as financial data was not available.

CHAPTER 2

REVIEW OF BANKRUPTCY PREDICTION MODELS

2.1 Introduction

There have been a number of bankruptcy prediction models developed over the past three decades. Most utilize the same set of variables (financial ratios), derived by a statistical search through a number of plausible financial indicators. Two important studies that pioneered the use of financial ratios to predict bankruptcy will be discussed. They are, Beaver's model (1966) using univariate discriminant analysis and Altman's model (1968) using multivariate discriminant analysis (MDA). The other models will also be introduced briefly.

2.2 William H. Beaver's Model

William H. Beaver's 1966 study [9] utilized the first modern statistical evaluation of models to predict financial failure. He defined: "Failure" as the inability of a firm to pay its financial obligations as they mature. Applying this definition to his sample of failed firms, the group included bankruptcies, bond defaults, overdrawn bank accounts, and firms that omitted payment of preferred stock dividends. The seventy-nine failed firms were identified from Moody's Industrial Manual during the time period of 1954 to 1964. The majority of the seventy-nine failed firms

operated in the manufacturing type of business. No construction firms were used. Their asset size range from \$0.6 million to \$45 million with a mean of approximately \$6 million. A set of non-failed firms similar in asset size were also selected to be used to compare and discriminate against the failed firms.

After obtaining the financial statements of both sets for up to five years prior to bankruptcy, Beaver examined thirty ratios between the groups. These thirty ratios were selected based on performance from previous studies and defined in terms of cash flow. The data was analyzed by comparison of mean values and a dichotomous classification test. In comparing the mean values, Beaver concluded that with a degree of regularity the data demonstrated differences in the mean for at least five years before failure, with the differences increasing as the years of failure approaches. This showed that there is a difference in the ratios of failed firms and non-failed firms.

The dichotomous classification test makes a prediction of whether a firm is either failed or non-failed. Under this test, each ratio is arranged in ascending order and for a given ratio an optimal cut-off point is found. This cut-off point is where the percent of incorrect predictions is minimized. Thus, if a firm's ratio is below the cut-off point, the firm is classified as failed and if above it will be classified as non-failed. Using this test, Beaver found that the best ratios to predict failure are cash flow/ total assets, cash flow/ total debt, and net income/ total debt. The cut-off points were then used to classify

firms in a holdout sample (which is not to be confused with the original paired sample of non-failed firms). The results of the test for the fraction of sample that is misclassified is shown in the Table 2 below:

Table 2* Fraction Misclassified Using Dichotomous Test					
Ratio	Years before failure				
	1	2	3	4	5
<u>Cash Flow</u>	0.10	0.20	0.24	0.28	0.28
<u>Total Assets</u>	(0.10)	(0.17)	(0.20)	(0.26)	(0.25)
<u>Cash Flow</u>	0.13	0.21	0.23	0.24	0.22
<u>Total Debt</u>	(0.10)	(0.18)	(0.21)	(0.24)	(0.22)
<u>Net Income</u>	0.15	0.20	0.22	0.26	0.32
<u>Total Debt</u>	(0.08)	(0.16)	(0.20)	(0.26)	(0.26)

*Source: Beaver Study (1966, Table A-4). The fractions in parenthesis are the results from the original sample of the first test. The top fraction are the results from the holdout sample of the second test.

As shown from above table 1, the ratio of the cash flow to total debt misclassified only 13% of the sample firms one year before bankruptcy and 22% of the sample firms 5 years before the bankruptcy. Beaver concluded: "the evidence indicates that the

ratio analysis can be useful in the prediction of failure for at least five years before failure."

2.3 Edward I. Altman's Model

Following Beaver's work, a number of researchers investigated multivariate techniques of selecting a set of ratios which best discriminates between failed and non-failed firms. The most notable study involved Edward I. Altman's 1968 research [10 and 21]. In this study bankruptcy referred to those firms that are legally bankrupt and either placed in receivership or have been granted the right to reorganize. This differs from the broader definition that Beaver used. Altman's discriminant model utilized the financial model of 33 firms declaring bankruptcy during the period of 1946 to 1965 and paired with a stratified sample of 33 firms not declaring bankruptcy. The study used only manufacturing corporations ranging in size from \$0.7 million to \$25.9 million. The use of multiple discriminant analysis (MDA) is appropriate statistical technique in which only 2 groups (bankrupt and non-bankrupt firms) are classified. MDA takes data from distinct group and maximizes the statistical distance between the two groups' data sets, relative to the difference in the data within the groups. All ratios for bankrupt firms are not equal and neither all non-bankrupt firm's ratio. There is thus, a variation in the ratio within each group. But MDA assumes that the ratios between the bankrupt and the non-bankrupt

groups differ systematically. Given such a difference, MDA attempts to maximize the difference between groups relative to the within group differences. The MDA generates a set of discriminant coefficient for each variables (ratios). When these coefficients are applied to the actual firms' ratios, a score is produce as a basis of classification in one of the mutually exclusive groupings, either bankrupt or non-bankrupt.

The form of the discriminant function is:

$$Z = A_1 X_1 + A_2 X_2 + \dots + A_n X_n$$

where:

Z is the value used to classify or predict the firm into one of the groupings.

$A_1, A_2, \dots, A_n$ are the discriminant coefficients.

$X_1, X_2, \dots, X_n$ are the set of predictor variables(ratios).

MDA has the advantage of considering an entire profile characteristic common within the group of firms, while a univariate study can only analyze the ratios one at a time [10].

From the list of 22 ratios, Altman selected the following ratios for the final discriminant function as shown:

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5$$

where:

X_1 = working capital/total assets

X_2 = retained earnings/total assets

X_3 = earnings before interests and taxes/total assets

X_4 = market value of equity/book value of total debt

X_5 = sales/total assets

The above function was first tested with the initial 66 sample firms. The empirical results of the model correctly classified 95% of the total sample, 63/66, one year prior to bankruptcy. The type I error (classifying a bankrupt firm as non-bankrupt) is only 6%, while the type II error (classifying non-bankrupt as bankrupt) was better at 3%. For 2 years prior to bankruptcy, a reduction in accuracy of 83% was noted overall. This evidence suggests that bankruptcy can be predicted at least two years prior to the event. A second test was conducted using a sample of 25 bankrupt firms and correctly classified 24 (96%). Altman also tested a new sample of 66 non-bankrupt firms in manufacturing which suffered losses and net income. The discriminant model correctly classified 79% of the sample firms.

Altman further concluded that firms with the Z scores greater than 2.99 are classified as non-bankrupt and those less than 1.81 are classified as bankrupt. The firms that score

between 1.81 and 2.99 are in the " zone of ignorance " due to the possibility of error classifications.

2.4 Other Bankruptcy Prediction Studies

Other studies of bankruptcy predictions with the use of financial ratios included the following:

1. Beaver's 1968 study [11] which was an extension of his 1966 study investigated the predictability of the stock market prices and accounting ratios. He concluded that stock market was slightly better in predicting failure before the accounting ratios.

2. Deakin's 1972 study [12] used the accounting data and multivariate discriminant analysis on bankrupt and non-bankrupt companies. He concluded that most ratios showed discriminatory ability. The test achieved bankruptcy classification rate of 97% one year prior and over 70% for some previous years.

3. Edmister's 1972 study [13] tested the usefulness of financial ratios for predicting small business failures. He developed a seven - variable discriminant function from nineteen initial ratios using stepwise MDA. A stepwise MDA restricts the effects of multicollinearity of ratios, and results in providing a function of independent ratio variables. A high accuracy

classification rate of 93 percent was noted. He further concluded that for small firms at least three consecutive financial statements be available for analysis. While large firms could be analyzed with a single year financial statement. This is evident from the Beaver and Altman studies.

4. Altman, Haldeman, and Narayanan's 1977 study [14] introduces a new Zeta bankruptcy model using 7 variables. These seven variables out of twenty-seven analyzed are: (1) Return on assets ($\text{EBIT} / \text{Total Assets}$), (2) Stability of earnings (which is the standard error of estimate of a ten-year trend on $\text{EBIT} / \text{total assets}$), (3) Debt service (which is measured by taking the log 10 of familiar interest coverage ratio, i.e. $\text{EBIT} / \text{Total interest payments}$), (4) Cumulative profitability (retained earnings / total assets), (5) Liquidity (current assets / current liability), (6) Capitalization (Market value of equity / Total capital), and (7) Size, which is measured by the firms' total assets. They used large firms (greater than \$20 million in assets) in manufacturing and retailing. MDA technique was used to find both a linear and a quadratic model structure for bankruptcy classification. Their results indicated that the linear model outperformed the quadratic structure in the tests of model validity. Classification accuracy ranges from 96% (93% for holdout sample) for one year prior to 70% five years prior for the linear model.

5. Moyer's 1977 study [15] re-examined Altman's 1968

bankruptcy model and used a stepwise MDA method that developed a model which eliminated the X4, market value of equity/book value of total debt and X5, sales/total assets variables. Both the re-estimate and alternative had high prediction rates of about 90%. The re-estimate function was slightly better.

6. Holmen's 1988 study [16] made comparison of Beaver's 1966 model and Altman's 1968 model for bankruptcies occurring between 1977 and 1984. The majority of the firms were in manufacturing and only one construction firm out of a total of 84. The ratio of cash flow/total debt is used with two cut-off points, 0.3 and 0.7 as determined by Beaver to be the single best predictor of bankruptcy. Based on his analysis, Beaver's simple cash flow to total debt ratio predicted bankruptcy with fewer errors than Altman's five ratio Z-score.

The above studies are only a fraction of the total amount of bankruptcy literature. In general, one may conclude that financial ratios can predict bankruptcy at least two years prior to the event.

CHAPTER 3

FINANCIAL RATIO TEST FOR SIGNIFICANCE

3.1 Test Procedure By Analysis of Variance

As noted from the previous chapter, financial ratio can be used to predict an event of interest, in particular bankruptcy. The models that were generated used financial data from mostly manufacturing firms. Thus, the main question of this paper is whether these models would be applicable to the construction industry. The author believes not. A check of the significant difference of variables (ratio) between construction and manufacturing quantitatively is necessary. To accomplish this, the analysis of variance, one way classification fixed effect model will be used to determine significant difference in financial ratios between construction and manufacturing. The average ratio for each industry of which different branches of construction and manufacturing are listed and obtained from Dun & Bradstreet Industry Norms and Key Business ratios, the Robert Morris Associates Annual Statement Studies, and Troy's Almanac of Business & Industrial Financial Ratios. In Dun & Bradstreet and Troy, construction was branched into six categories. Although, manufacturing has much more categories, only six were chosen, randomly.

The Analysis of Variance [17] is the appropriate procedure for testing the equality of several population means. From this

test statistic, construction and manufacturing are called "treatments". Each ratio from the twelve industry types (six construction and six manufacturing types) provided will be an observation. The parameter associated with the construction treatment is called the construction treatment effect (τ_c), and the manufacturing treatment is called the manufacturing treatment effect (τ_m). Thus, the statistical hypothesis test is as follows:

$$H_0 : (\tau_c) = (\tau_m) = 0$$

$$H_1 : (\tau_c) \neq (\tau_m) \neq 0$$

The statement $H_0 : (\tau_c) = (\tau_m)$ is called the null hypothesis and the statement $H_1 : (\tau_c) \neq (\tau_m)$ is the alternative hypothesis. If the null hypothesis is true, then the treatment effects of construction and manufacturing has no significant difference on the variable (ratio) being tested. If the null hypothesis is rejected, then H_1 is true and we can conclude that the variable is significantly effected between the treatment of construction and manufacturing. The rest of the computation is shown in the following Table 3 below:

Table 3* Analysis of Variance for the One Way Classification Fixed Effect Model				
Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	Fo
Between treatments	SStreatment	a - 1	MStreatment	Fo
Error (w/in treatments)	SSe	N - a	MSe	
Total	SSt	N - 1		

*Source: William W. Hines & Douglas C. Montgomery, "Probability and Statistics in Engineering and Management Science", 2nd ed., John Wiley & Son

Where:

$$SSt = \sum Y_c^2 + \sum Y_m^2 - \frac{(\sum Y_c + \sum Y_m)^2}{N}$$

$$SStreatment = \frac{(\sum Y_c)^2}{n} + \frac{(\sum Y_m)^2}{n} - \frac{(\sum Y_c + \sum Y_m)^2}{N}$$

$$SSe = SSt - SStreatments$$

a = number of treatments (= 2)

n = number of observations per treatment

(Note: Each treatment should have equal number of observations).

$$N = n * a$$

$$MStreatment = SStreatment / (a - 1)$$

$$MSe = SSe / (N - a)$$

$$Fo = MStreatment / MSe$$

The critical region is $F_{\alpha, a-1, N-a}$. If $F_o > F_{\alpha, a-1, N-a}$, then H_o is rejected and conclude significant effects exist between construction and manufacturing on the ratio being tested. The alpha, α , is the level of significance. For this test $\alpha = 0.05$. Appendix A shows the calculations.

3.2 Results of the Tests

The following financial ratios [see Appendix B] between construction and manufacturing were tested. From the Almanac of Business and Industrial Financial Ratios by Leo Troy, Ph.D., they are:

1. Current ratio
2. Quick ratio
3. Net sales/ Net Working Capital
4. Coverage Ratio
5. Asset Turnover
6. Total Liability/ Net Worth
7. Debt Ratio
8. Return on Assets
9. Return on Equity
10. Retain Earnings to Net Income

This test was done for corporation with and without net income and for corporation with net income only. For corporations with and without net income, the following ratios were determined

to be significant:

1. Total Liability/ Net Worth
2. Debt ratio

Note: Return on equity, retained earnings to net income could not be test, since data was not available for some industry types.

For corporations with net income only, the following were found significant:

1. Return on Equity
2. Retained Earnings to Net Income

From Dun & Bradstreet's Industry Norms and Key Business Ratios, the following ratios were tested:

1. Quick Ratio
2. Current Ratio
3. Current Liability to Net Worth
4. Current Liability to Inventory
5. Total Liability to Net Worth
6. Fixed Assets to Net Worth
7. Sales to Inventory
8. Assets to Sales
9. Sales to Net Working Capital
10. Accounts Payable to Sales
11. Return on Sales
12. Return on Assets
13. Return on Net Worth

From the ratios above, the following ratios were found to be

significant:

1. Quick Ratio
2. Current Liability/ Inventory
3. Sales / Inventory

From Robert Morris Associates Annual Statement Studies, the following financial ratios were tested:

1. Current Ratio
2. Revenue/ Working Capital
3. Earnings Before Interest and Taxes/ Interest
4. Cash Flow / Current Maturities of Long Term Debt
5. Net Fixed Assets / Tangible Net Worth
6. Total Liabilities / Tangible Net Worth
7. % Profit before Tax/ Tangible Net Worth
8. % Profit before Tax/ Total Assets

From the ratios above, the following ratios were found significant:

1. Current Ratio
2. Revenue / Working Capital
3. % Profit before Tax/ Total Assets

As for further test on significance between construction and manufacturing on financial ratios, the ratios used in Altman's and Beaver's Bankruptcy prediction models were also tested. Actual firm's financial data came from Value Line Reports (see Appendix C) and Standard & Poor's Corporate Records. The

following ratios were found significant:

1. Retained Earnings / Total Assets
2. Working Capital / Total Assets
3. Earnings Before Interest and Taxes/ Total Assets

Other ratios tested on these firms that are important to the construction industry include:

1. Net Profit / Sales
2. Sales / Net worth
3. Profit / Net Worth
4. Profit / Working Capital
5. Sales / Working Capital
6. Current Ratio
7. Current Debt / Net Worth

The following ratios were found significant:

1. Sales / Net Worth
2. Profit / Net Worth
3. Current Ratio
4. Current Debt / Net Worth

3.3 Analysis of Test Results

From the Analysis of Variance test, one can conclude that there exist significant differences between the construction and manufacturing industries' financial data, and thus the make-up of the industry. The following is an analysis and insight of the

significant ratios:

1. Total Liabilities to Net Worth (TL/NW):

Total Liabilities (debt) are all current liabilities and all long term liabilities. This ratio measures the extent that "creditors equity" in assets of the business exceeds that of owners equity. The higher the ratio, the more risk being assumed by the creditors. From the standard ratios by industry [Troy's Almanac], the construction industry's TL/NW ratio is double in value to that for manufacturing industry for reported corporation with and without net income. Average $TL/NW = 2.82$ for construction and $TL/NW = 1.4$ for manufacturing. For corporation with net income, $TL/NW = 2.1$ for construction and $TL/NW = 1.27$ for manufacturing. In general, this means that construction is at more risk than manufacturing for the creditors. The construction industry has twice the debt incurred than manufacturing relative to their own equity.

2. Debt Ratio (Total Debt / Total Assets):

This leverage ratio shows the extent in which the firms are financed by debt and indicates the firms financial risk. It is somewhat similar to total liabilities / net worth. The higher the ratio, the more risk for creditors. It is not surprising here that the construction industry has a higher debt ratio (71.93% to 56.5% for the corporation with and without net income and 65.4% to 53.5% for corporation with net income only).

3. Return on Equity (Profit / Net Worth):

This ratio measures the rate of return on the investment in the business. The tendency in the industry is to look at this ratio as a final criterion of profitability. A high ratio is generally indicative of positive performance. However an unusually high ratio could indicate a company with too little investment. A low ratio may indicate poor performance, conservative management or a mature company that has accumulated a significant amount of wealth relative to its established volume level. This ratio was more than double for the construction industry than that of manufacturing (19.1% to 8.6% on average). This indicates that construction has a higher rate of return than manufacturing, if net income is realized by the firm. Actually, this coincides with the investor saying, "Higher risk investments, yields higher returns".

4. Retained Earnings / Net income:

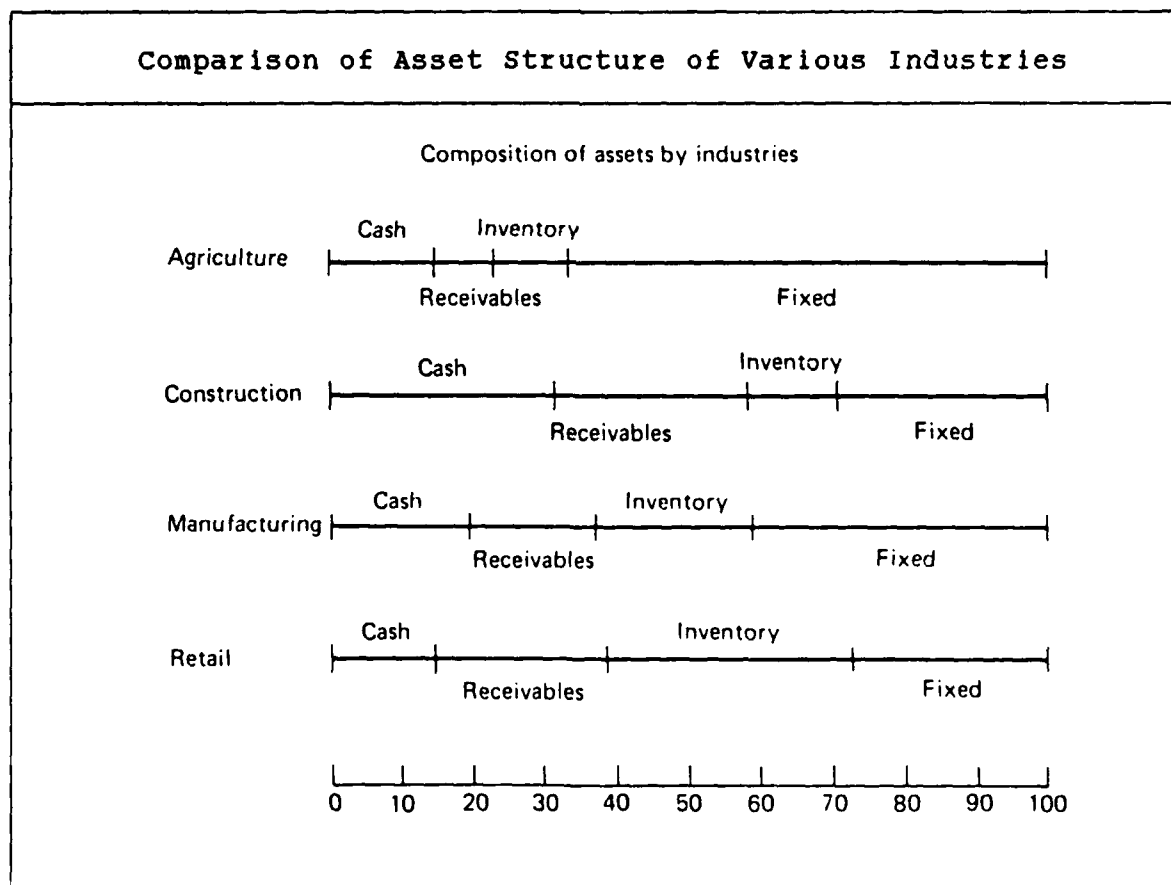
This ratio is the percentage of earnings in the business. For corporations with net income only, construction had approximately a third more earnings than manufacturing relative to net income.

5. Quick Ratio (Cash + Accounts Receivables / Current Liabilities):

This ratio reveals the protection of short - term creditors through the firms cash and near cash assets. The higher the

ratio, the greater the liquidity. But if too high, the firm may have too much capital that is idle. From the industry ratio norms, construction has average of 1.37 and manufacturing has lower value at 1.05. Thus, construction is more liquid than manufacturing. This conclusion can also be verified from the following Figure 1:

Figure 1*



*Source: Daniel W. Halpin, "Financial & Cost Concepts for Construction Management", John Wiley & Son (1985): Fig 6.5

From Figure 1, a larger percentage of the construction industries assets are tied into cash and receivables than in the manufacturing industry.

6. Current Liabilities / Inventory and Net Sales / Inventory:

These ratios are a measurement of how management controls inventory. For both ratio, the construction industry was significantly higher when compared with manufacturing. This says that construction has a smaller amount of inventory relative to sales (also see Figure 1) and total liability as compared to manufacturing. This fact is true since construction contractors use subcontractors and do not normally hold materials in storage for long period of time. A low sales to inventory ratio usually indicates excessively high inventory. By the very nature of the manufacturing industry, these ratios are significantly more important to them than in construction.

7. Current Ratio (Current Assets / Current Liabilities):

This ratio was determined to be significant in RMA's Annual Statement Studies and from the actual firms that were tested. The current ratio compares the amount of current assets with which payments can be made to the amount of current liabilities requiring payment. The higher the current ratio, the more capable the company is of meeting its current obligations. For both test of significance, manufacturing had a higher current ratio (approximately 17% higher) than construction. This difference is

due to the idea that the construction industry in general incurs higher debt (see debt ratio) and less material inventory tied up from capital than does the manufacturing industry.

8. Revenue / Working Capital:

This ratio measures how working capital is used in the business. Too high a ratio may indicate that the company is doing too much work for the available working capital and an unduly high sensitivity to a cash flow interruption. Too low a ratio may indicate an inefficient use of working capital, possibly due to poor market conditions or a poor marketing program. On average construction had a higher revenue (sales) / working capital ratio than manufacturing. This result relates well to the ratios of return on equity and retain earnings to net income. With higher revenues to working capital (current assets minus current liabilities), a higher profit and earnings will be realized.

9. Percent Profit Before Tax / Total Assets:

This ratio reflects the pre-tax return on total assets and measures the effectiveness of the firm in utilizing the available resources. The higher the ratio, the more effective and efficient is the performance of management. The result shows that manufacturing has a significantly higher ratio than construction. Which says that construction is less efficient than manufacturing and this is probably due to higher overhead costs and numerous unrealized work (contracts) from loss bidding.

10. Retained Earnings / Total Assets:

This ratio measures the cumulative earnings over time. As Altman stated: "The age of a firm is implicitly considered in this ratio. A relatively young firm will probably show a low retained earning / total assets ratio because it has not had time to build up it's cumulative profits... It's chance of being classified as bankrupt is relatively higher than another, older firm." Although the firms test here showed that manufacturing had a higher average retained earnings / total assets ratio than construction, the reason is not because the manufacturing firms were older. It may be due to construction firms having a larger total assets in terms of property (i.e. residential builders) and equipment.

11. Working Capital / Total Assets:

This liquidity ratio measures the net liquid assets relative to the firms' total capitalization. Altman noted that, "A firm experiencing consistent operating losses will have shrinking current assets in relation to the total assets". Thus, the higher the ratio, the more liquid and healthier the firm. The tested firms showed that manufacturing had a higher ratio than construction. This means that manufacturing has a greater working capital from less debt (current liabilities). The working capital /total asset ratio relates well to the ratios of debt ratio and current ratio. The construction industry on average borrows more

of its capital relative to it's assets than the manufacturing industry.

12. Earnings Before Interest and Taxes / Total Assets (EBIT /TA):

This ratio measures the true productivity of the firms' assets. It is similar to the ratio, percent profit before tax / total assets and thus produce similar significant test results. Manufacturing has a higher EBIT / TA ratio than the construction industry. Altman stated: "Since a firm's ultimate existence is based on the earning power of it's assets, this ratio appears to be more particularly appropriate for studies dealing with corporate failure. Furthermore, insolvency in a bankruptcy sense occurs when the total liabilities exceed a fair valuation of the firm's assets with value determined by the earning power of the assets".

13. Sales / Net Worth:

The sales to net worth ratio compares sales (revenues) to net worth (equity). This ratio is often times referred to as "Turnover of Equity". This ratio measures how the company's investment is applied in the business. It indicates how effective the company is using its investment. Too high a ratio may indicate the company is overextended with too little of an investment, while too low a ratio may indicate that the company is not effectively using its capital. For this ratio, the test results showed only a minor significant difference between

construction and manufacturing ($F_o = 4.456 > F_{\alpha,1,18} = 4.41$). Construction has a higher sales / net worth ratio, this relates similarly well and coincides with the ratio of return on equity (profit / net worth) test results.

14. Current Debt to Net Worth:

The current debt (current liabilities) to net worth ratio recognizes that as net worth increases in relation to creditors equity, the risk assumed by the current creditors decreases, i.e. the company is more capable of protecting the creditors by absorbing possible losses. The higher the ratio, the more risk is being assumed by the creditors. Conversely, a lower ratio indicates a company with more borrowing capacity and greater long term financial stability. Also, an extremely low ratio can indicate a poorly leveraged condition which might result from under aggressive financial policies. Construction had a higher average current debt to net worth ratio than manufacturing. This ratio is similar and coincides with the results of total liabilities to net worth in that construction borrows more for financing projects.

3.4 Summary of Analysis

The financial ratios analyzed and determined to be significant have some inter-relationship among each other. Thus, if the ratio is found significant then the other related ratio(s)

are also significant. Also, if the ratio tested had a higher average ratio value for the construction industry than the manufacturing industry, then the other related ratio(s) had similar relationships. The ratios using cash flow that Beaver determined to be accurate predictors of business failures were not found to be significant between the two industries. Thus, it could be concluded that the ratios of cash flow / total debt, and cash flow / total assets would be able to predict construction failures. Here, cash flow is defined as net income plus depreciation, depletion, and amortization.

The cash flow is a great importance to the construction industry, actually for any type of industry. It is imperative for construction contractors to use effective cash flow management, due to the nature and practices of the industry. The movement of cash is shown from the following scenario [18]: After a contractor wins a bid, the initial expenses (from ordering material, obtaining labor and equipment, and mobilization cost) are borne by the contractor. In order for pay for these initial capital outlay or to supplement it's own capital, the contractor must obtain a loan from a lending institution. Once the project is underway, the contractor bills the client in the form of progress payments, usually on a monthly basis. These billings are verified by the clients representative, with the work that is completed and if satisfactory to the terms of the contract, will be approved for partial payment. In addition, as a protection to the client and an incentive for the contractor to complete the

project, the client retains a percentage of the approved progress payment, usually 10%. This will depend on the terms of the contract. It may be anywhere from 50% to 90% completion before total retainage is released. Also, these progress payments are typically paid one month later from the time it was requested.

For this scenario, the contractor has to use his own capital or borrowed capital to initially finance a project. Hopefully, with effective cash flow management, the client's payments catches up with the contractor's expense such that at the end of the project a profit is realized. The major risk for the contractor is a non payment or late payments by the client that effects his cash flow position to pay the creditors, laborers, and suppliers. Obviously, this scenario just touched the surface of the problems that could be encountered with cash flow problems, but that is not the scope of this paper. These receivable difficulties are one of the leading causes of financial distress of a firm [1 and 3], especially for the small firms who do not have cushion of large capital assets.

From the results of the analysis of variance test and their causal effects between construction and manufacturing, one can conclude that some of the financial ratios from the two industries are significantly different. It was noted from the bankruptcy studies that financial ratios can predict bankruptcy. These bankruptcy prediction models of Beavers and Altmans were built using bankrupt and non-bankrupt manufacturing firms. Altman's model would not apply to the construction industry, as

three of the five ratios in his Z-score model were significantly different and a modification would need to be made. The Beaver model could be applicable and should be tested further with construction firms.

CHAPTER 4

APPLICATION AND ANALYSIS OF EXISTING MODELS

The application of these significant analysis test results is to determine how it would effect the existing models. For this paper, only the models developed by Beaver's univariate and Altman's multivariate will be looked at. For Beaver's univariate model of ratio of cash flow / total debt, he had two cut-off points of 0.03 and 0.07 from the two subsamples that he tested. As shown in Appendix B, page 51, for the sample of ten financially stable construction firms only two firms were below the 0.03 cut-off and only one of the firms was below the 0.07 cut-off point. The sample of manufacturing firms had only one firm below either of the two cut-off points. From this application of the model, one can conclude that Beaver's model can be equally applied for both construction and manufacturing classification for business failure. Those firms that were below the cut-off points are possible suspect of business failure or were miss-classified by the model.

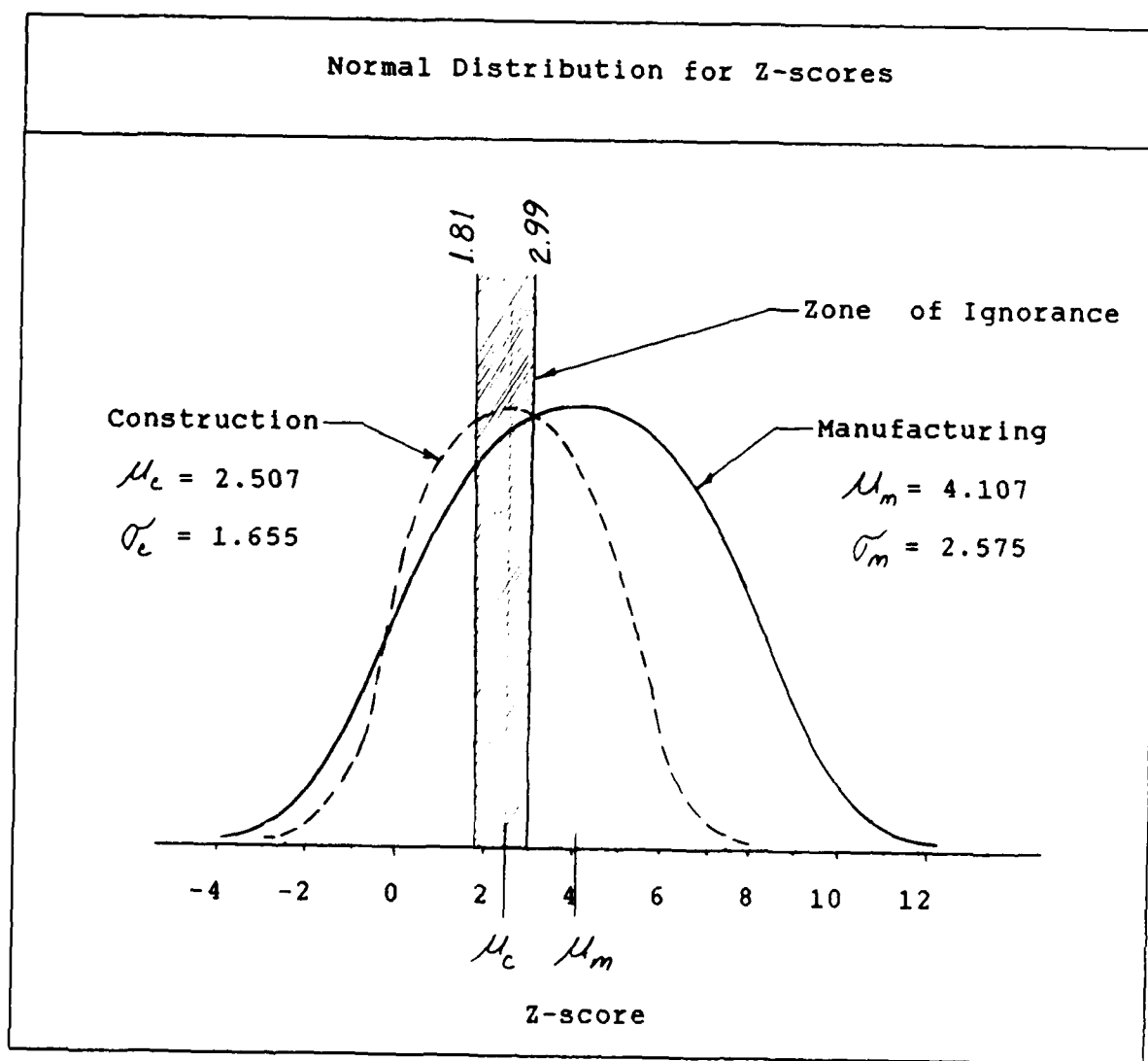
Applying Altman's Z-model function on the sample of construction firms, the average Z-score is 2.507 with a standard deviation of 1.655. Using Altman's cut-off zone of 1.81 and 2.99 (zone of ignorance), only four of the ten samples were above the cut-off zone of non-bankrupt classification, three were below and three were in the cut-off zone. This says that a majority of

these construction firms are suspect for bankruptcy. But based on the financial stability of these firms, the opposite classification would be true. For manufacturing, the average Z-score is 4.107 with a standard deviation of 2.575 (see Appendix D for calculations). This says that the majority of those sampled manufacturing firms would be classified as non-bankrupt. This is true as most are financially stable, and in fact only two were in the cut-off zone and the rest were above the 2.99 cut-off. Those two in zone maybe a signal to the firms as possible bankruptcy two years from now and changes must be made within the company to move in a path of financial stability. From this application of Altman's model, one can conclude that the model is not reliable for the construction industry and requires modification or development of a completely different model all together.

From Figure 2 below, it could be concluded that when applying the Altman model for construction, the "zone of ignorance" cut-off points would likely be located further left of the construction sample normal curve (i.e. less than 2.507). This cut-off point could be found by analyzing samples of bankrupt and non-bankrupt construction firms and with the use of Multiple Discriminant Analysis or other statistical methods like regression analysis. This approach would be similar to Altman's. Also from these statistical methods, new financial ratios other than those five used by Altman could be found to be better predictors in classifying a bankrupt from a non-bankrupt construction firm. Unfortunately, this method approach is not

part of this paper due to the difficulty in obtaining samples of non-bankrupt construction firms.

Figure 2



CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This paper does not try to prove whether financial ratios are useful in predicting bankruptcy. The volumes of literature on the subject has provided such evidence. What this paper does try is prove that the current bankruptcy prediction models which were mainly developed from the manufacturing data and point of view can be made applicable to the construction industry. Through the test of the average (norms) financial ratios of each industry it could be concluded that construction and manufacturing differ significantly between some of the ratios used for modeling.

The model by Beaver with its stress on the importance of cash flow could be directly used for predicting bankruptcy in the construction industry with the two optimal cut-off points provided. Although, the number of tested sample observations was small (ten construction firms and ten manufacturing firms). A larger sample set could effect the location of the optimal cut-off point for the construction industry in classifying failed or non-failed. The cash flow ratios re determined to be the best at predicting financial distress for the tested sample of manufacturing firms [9 and 16]. Together with the facts of this paper that there were no significant differences in the cash flow ratios between construction and manufacturing, further stresses

the importance of cash flow and it's effective management for the construction industry.

The Altman model which utilizes five ratios in a linear function, stresses the following important areas that greatly effects the firms financial status as a going concern:

- Liquidity from Working Capital / Total Assets (TA)
- profitability from Retained Earnings/ TA
- productivity from Earnings Before Interest & Taxes/ TA
- economic market conditions from Market Value of Equity /
Book Value of Total Debt
- competitiveness of the firm from Sales / TA

These ratios all play a major roll in construction. But due to practices and conditions between construction and manufacturing, three (WC/TA, RE/TA, EBIT/BVTD) of the five ratio were reportedly significant. This effects the use of Altman's model for application to the construction industry. Thus, the model needs to be modified to off set these differences. To gain acceptance, testing of a modified model needs to be accomplished using bankrupt and non-bankrupt construction firms.

5.2 Recommendations

The limitations of this paper is that the Beaver and determination of a modified Altman model could not be certified

through sample testing of bankrupted construction firms. The problems involved in finding financial data from bankrupt construction firm. As a note, one Bankruptcy lawyer mention that many construction firms, especially the small firms, do not have strong financial accounting systems and some just play it by ear. Also most construction firms are privately owned and access to financial data is practically nil.

As a recommendation, access of financial data should be made available for researchers even under anonymity. Further research and testing in this subject will only improve and refine the models that were mention in this paper.

The following are recommendations for further research on bankruptcy prediction in the construction industry with the use of financial ratio analysis:

1. Once financial data of bankrupt construction firms is made available, further studies can be accomplished to determine a different cut-off point for Altman's model. Thus, the model can be applied for the construction industry.

2. Development of a new model altogether utilizing financial ratios that are more significantly important or have more "weight" for construction than manufacturing in predicting bankruptcy. Also other factors besides financial ratios could be included in the prediction model like outside influences, i.e. prime interest rate or the company's management effectiveness.

3. Another recommendation would be to shift the construction's normal curve for Z-scores (from Figure 2) to the right by the difference between the two mean Z-scores of manufacturing and construction ($4.107 - 2.507 = 1.6$). Thus, the construction industry model would have a constant added to Altman's Z-model function. Then testing of this modified model using samples of bankrupt and non-bankrupt construction is needed for validity.

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APPENDIX A

The following are sample Analysis of Variance calculations for Altman's financial ratios only. The other ratio calculations were not included as they are repetitive.

Analysis of Variance Calculations

Test for Significant Differences in Financial Ratios

Altman's Financial Ratios:

1. Working Capital / Total Assets:

$$SS_t = [(0.07)^2 + (.118)^2 + \dots + (.279)^2] - \frac{(1.716 + 3.061)^2}{20} = 0.2998$$

$$SS_{\text{treatment}} = \frac{(1.716)^2}{10} + \frac{(3.061)^2}{10} - \frac{(1.716 + 3.061)^2}{20} = 0.09045$$

$$SS_e = 0.2998 - 0.09045 = 0.2093$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F _o
Between Treatments	0.09045	1	0.09045	7.78
Error (w/in treatments)	0.2093	18	0.0116	
Total	0.2998	19		

From table V [17], $F_{0.05, 1, 18} = 4.41$

Therefore, $F_o > F_{0.05, 1, 18}$ and conclude that there is

significant difference between the working capital / total assets ratios of construction and manufacturing industry.

Analysis of Variance Calculations

Test for Significant Differences in Financial Ratios

Altman's Financial Ratios:

2. Retained Earnings / Total Assets:

$$SS_t = [(.198)^2 + (.038)^2 + \dots + (.193)^2] - \frac{(1.613 + 3.349)^2}{20} = 0.522$$

$$SS_{\text{treatment}} = \frac{(1.613)^2}{10} + \frac{(3.349)^2}{10} - \frac{(1.613 + 3.349)^2}{20} = 0.151$$

$$SS_e = 0.522 - 0.151 = 0.371$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F _o
Between Treatments	0.151	1	0.151	7.30
Error (w/in treatments)	0.371	18	0.021	
Total	0.522	19		

From table V [17], $F_{0.05,1,18} = 4.41$

Therefore, $F_o > F_{0.05,1,18}$ and conclude that there is

significant difference between the retained earnings/total assets ratios of construction and manufacturing industry.

Analysis of Variance Calculations

Test for Significant Differences in Financial Ratios

Altman's Financial Ratios:

3. Earnings Before Interest & Tax / Total Assets:

$$SS_t = [(0.104)^2 + (.110)^2 + \dots + (.200)^2] - \frac{(0.655 + 1.460)^2}{20} = 0.1346$$

$$SS_{\text{treatment}} = \frac{(0.655)^2 + (1.460)^2}{10} - \frac{(0.655 + 1.460)^2}{20} = 0.0324$$

$$SS_e = 0.1346 - 0.0324 = 0.1039$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F _o
Between Treatments	0.0324	1	0.0324	5.6
Error (w/in treatments)	0.1039	18	0.0058	
Total	0.1346	19		

From table V, Percentage points of the F distribution [17],

$$F_{0.05, 1, 18} = 4.41$$

Therefore, $F_o > F_{0.05, 1, 18}$ and conclude that there is

significant difference between the earnings before interest & tax / total assets ratios of construction and manufacturing industry.

Analysis of Variance Calculations

Test for Significant Differences in Financial Ratios

Altman's Financial Ratios:

4. Market Value of Equity / Book Value Total Debt:

$$SS_t = [(0.290)^2 + (2.36)^2 + \dots + (1.659)^2] - \frac{(9.442 + 19.799)^2}{20} = 65.00$$

$$SS_{\text{treatment}} = \frac{(9.442)^2}{10} + \frac{(19.799)^2}{10} - \frac{(9.442 + 19.799)^2}{20} = 5.214$$

$$SS_e = 65.00 - 5.214 = 59.786$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F _o
Between Treatments	5.214	1	5.214	1.57
Error (w/in treatments)	59.786	18	3.32	
Total	65.00	19		

From table V [17], $F_{0.05, 1, 18} = 4.41$

Therefore, $F_o < F_{0.05, 1, 18}$ and conclude that there is no

significant difference between the market value of equity / book value of total debt ratios of construction and manufacturing industry.

Analysis of Variance Calculations

Test for Significant Differences in Financial Ratios

Altman's Financial Ratios:

5. Sales / Total Assets:

$$SS_t = [(1.690)^2 + (.888)^2 + \dots + (1.940)^2] - \frac{(12.939 + 16.023)^2}{20} = 9.73$$

$$SS_{\text{treatment}} = \frac{(12.939)^2}{10} + \frac{(16.023)^2}{10} - \frac{(12.939 + 16.023)^2}{20} = 0.474$$

$$SS_e = 9.73 - 0.474 = 9.26$$

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F _o
Between Treatments	0.474	1	0.474	0.91
Error (w/in treatments)	9.26	18	0.51	
Total	9.73	19		

From table V (17), $F_{0.05, 1, 18} = 4.41$

Therefore, $F_o < F_{0.05, 1, 18}$ and conclude that there is no

significant difference between the sales / total assets ratios of construction and manufacturing industry.

APPENDIX B

ALTMAN'S FINANCIAL RATIOS*

CONSTRUCTION	WC/TA	RE/TA	EBIT/TA	MVE/BVTD	S/TA
1 BLOUNT, INC	0.070	0.198	0.104	0.290	1.890
2 DRAVO CORP	0.118	0.038	0.110	2.360	0.888
3 FLUOR CORP	0.233	0.094	0.018	2.214	2.490
4 MORRSN KNSN	0.196	0.255	0.015	1.038	2.125
5 CENTEX CORP	0.309	0.341	0.091	0.784	1.469
6 PHM CORP	0.127	0.053	0.096	0.090	0.315
7 RYLAND GRP	0.048	0.034	0.096	0.980	0.208
8 STD PACIFIC	0.118	0.266	0.055	0.475	2.267
9 M.D.C.HLDGS	0.306	0.080	0.004	0.030	0.580
10 KAUF & BRD	0.191	0.254	0.067	1.181	0.707
SUM Y	1.716	1.614	0.655	9.442	12.939
AVERAGE	0.172	0.161	0.065	0.944	1.294

MANUFACTURING

1 DALLAS CORP	0.367	0.264	0.092	0.991	1.761
2 ELCOR CORP	0.227	0.152	0.083	8.396	1.479
3 INT'L ALUM	0.367	0.614	0.219	3.515	1.471
4 MANVILLE CO	0.283	0.298	0.132	0.274	0.750
5 OWENS-CRNG	0.064	0.550	0.372	0.571	1.774
6 BIRD, INC	0.288	0.104	0.002	0.673	1.768
7 AMERON INC	0.241	0.460	0.099	1.082	1.166
8 JUSTN IND	0.490	0.381	0.122	0.837	1.168
9 MRGN PROD	0.456	0.331	0.139	1.803	2.746
10 CRANE CO	0.279	0.193	0.200	1.659	1.940
SUM Y	3.061	3.349	1.460	19.799	16.023
AVERAGE	0.306	0.335	0.146	1.980	1.602

*SOURCE: VALUE LINE REPORTS AND STD & POOR'S CORPORATE RECORDS

LEGEND:

WC/TA = WORKING CAPITAL / TOTAL ASSETS
 RE/TA = RETAINED EARNINGS / TOTAL ASSETS
 EBIT/TA = EARNINGS BEFORE INTEREST & TAX / TOTAL ASSETS
 MVE/BVTD = MARKET VALUE OF EQUITY / BOOK VALUE OF TOTAL DEBT
 S/TA = SALES / TOTAL ASSETS

BEAVER'S FINANCIAL RATIOS*

CONSTRUCTION	CF/TD	CF/TA	NETINC/TD
1 BLOUNT, INC	0.260	0.051	0.067
2 DRAVO CORP	2.200	0.457	1.972
3 FLUOR CORP	0.979	0.054	0.233
4 MORRSN KNSN	1.230	0.107	0.761
5 CENTEX CORP	0.250	0.057	0.198
6 PHM CORP	0.017	0.011	0.016
7 RYLAND GRP	0.340	0.011	0.296
8 STD PACIFIC	0.296	0.049	0.070
9 M.D.C.HLDGS	0.043	0.026	0.034
10 KAUF & BRD	0.210	0.052	0.173
SUM Y	5.825	0.875	3.820
AVERAGE	0.582	0.087	0.382

MANUFACTURING

1 DALLAS CORP	0.196	0.043	0.061
2 ELCOR CORP	0.024	0.061	0.001
3 INT'L ALUM	0.868	0.145	0.636
4 MANVILLE CO	0.174	0.060	0.077
5 OWENS-CRNG	0.212	0.192	0.131
6 BIRD, INC	0.401	0.118	0.235
7 AMERON INC	0.242	0.075	0.125
8 JUSTN IND	0.252	0.085	0.103
9 MRGN PROD	0.247	0.069	0.119
10 CRANE CO	0.406	0.132	0.275
SUM Y	3.022	0.981	1.761
AVERAGE	0.302	0.098	0.176

*SOURCE: VALUE LINE REPORTS & STD AND POOR'S CORPORATE RECORDS

LEGEND:

CF/TD = CASH FLOW / TOTAL DEBT
 CF/TA = CASH FLOW / TOTAL ASSETS
 NETINC/TD = NET INCOME / TOTAL DEBT

OTHER FINANCIAL RATIOS

CONSTRUCTION	NETP/S	S/NW	P/NW	P/WC
1 BLOUNT, INC	0.064	7.960	0.508	0.227
2 DRAVO CORP	0.043	2.709	0.117	0.325
3 FLUOR CORP	0.011	8.530	0.094	0.365
4 MORRSN KNSN	0.019	8.512	0.165	0.431
5 CENTEX CORP	0.020	4.816	0.095	0.103
6 PHM CORP	0.028	4.632	0.130	0.018
7 RYLAND GRP	0.046	5.236	0.242	0.199
8 STD PACIFIC	0.163	2.206	0.359	0.245
9 M.D.C.HLDGS	0.121	3.784	0.459	0.175
10 KAUF & BRD	0.053	3.896	0.207	0.270
SUM Y	0.568	52.281	2.376	2.358
AVERAGE	0.057	5.228	0.238	0.236

MANUFACTURING

1 DALLAS CORP	0.025	3.346	0.085	0.096
2 ELCOR CORP	0.002	4.006	0.006	0.010
3 INT'L ALUM	0.066	2.193	0.144	0.263
4 MANVILLE CO	0.043	2.585	0.112	0.287
5 OWENS-CRNG	0.070	4.641	0.323	1.931
6 BIRD, INC	0.019	3.909	0.075	0.092
7 AMERON INC	0.033	2.748	0.091	0.161
8 JUSTN IND	0.000	2.530	0.076	0.071
9 MRGN PROD	0.012	5.101	0.063	0.074
10 CRANE CO	0.037	4.782	0.179	0.208
SUM Y	0.307	35.841	1.154	3.193
AVERAGE	0.031	3.584	0.115	0.319

SOURCE: VALUE LINE REPORTS & STD AND POOR'S CORPORATE RECORDS

LEGEND:

NETP/S = NET PROFIT / SALES
 S/NW = SALES / NETWORTH
 P/NW = PROFIT / NETWORTH
 P/WC = PROFIT / WORKING CAPITAL

OTHER FINANCIAL RATIOS

CONSTRUCTION	S/WC	CA/CL	CD/NW
1 BLOUNT, INC	3.545	1.150	2.190
2 DRAVO CORP	7.540	1.493	0.728
3 FLUOR CORP	33.220	1.180	1.330
4 MORRSN KNSN	22.330	1.220	1.737
5 CENTEX CORP	5.230	1.539	1.211
6 PHM CORP	0.648	2.070	6.681
7 RYLAND GRP	4.318	2.483	0.818
8 STD PACIFIC	1.506	4.200	0.458
9 M.D.C.HLDGS	1.444	2.373	1.878
10 KAUF & BRD	5.064	1.529	1.455
SUM Y	84.845	19.237	18.486
AVERAGE	8.485	1.924	1.849

MANUFACTURING

1 DALLAS CORP	3.769	2.743	0.509
2 ELCOR CORP	6.503	2.144	0.604
3 INT'L ALUM	4.010	2.404	0.434
4 MANVILLE CO	6.642	1.737	0.528
5 OWENS-CRNG	27.755	1.174	0.852
6 BIRD, INC	4.800	2.536	0.530
7 AMERON INC	4.842	1.906	0.596
8 JUSTN IND	2.374	3.930	0.364
9 MRGN PROD	6.030	2.867	0.453
10 CRANE CO	5.550	1.977	0.827
SUM Y	72.275	23.418	5.697
AVERAGE	7.227	2.342	0.570

SOURCE: VALUE LINE REPORTS & STD AND POOR'S CORPORATE RECORDS

LEGEND:

S/WC = SALES / WORKING CAPITAL
 CA/CL = CURRENT ASSETS / CURRENT LIABILITIES
 CD/NW = CURRENT DEBT / NETWORTH

TROY'S FINANCIAL RATIOS (CORP W/ & W/O NET INCOME)

CONSTRUCTION	CA/CL	C+AP/CL	NETS/NWC	NIBIT/IP	S/TA
1 GEN B CONT	1.30	0.70	10.60	1.40	1.50
2 OPER BLDR	1.50	0.60	1.70	1.00	1.30
3 HVY CONST	1.30	0.90	16.70	1.70	1.70
4 PLMB,HTG,AC	1.40	0.90	12.30	2.40	*
5 ELEC WK	1.50	1.00	11.00	1.70	2.40
6 OTHER SP TRD	1.50	1.00	12.40	1.60	2.50
SUM Y	8.50	5.10	64.70	9.80	*
AVERAGE	1.42	0.85	10.78	1.63	*

MANUFACTURING

1 MTR VEH&EQ	1.50	1.30	4.10	1.60	1.00
2 ELC CMP&ACC	1.90	1.00	4.00	3.60	1.10
3 G IND MACH	1.60	0.90	5.50	1.60	1.00
4 MIL,PLY&REL	1.40	0.70	13.20	1.60	1.30
5 FURN&FIXT	2.00	1.00	6.10	4.10	1.90
6 PLAS &SYN	1.40	0.80	11.70	2.20	0.80
SUM Y	9.80	5.70	44.60	14.70	7.10
AVERAGE	1.63	0.95	7.43	2.45	1.18

LEGEND:

CA/CL = CURRENT ASSETS / CURRENT LIABILITIES
 C+AP/CL = CASH + ACCOUNTS PAYABLE / CURRENT LIABILITIES
 NETS/NWC = NET SALES / NET WORKING CAPITAL
 NIBIT/IP = NET INCOME BEFORE INTEREST & TAX / INTEREST PAID
 S/TA = SALES / TOTAL ASSETS

TROY'S FINANCIAL RATIOS (CORP W/ & W/O NET INCOME)

CONSTRUCTION	TL/NW	TD/TA	NIBT/TA	P/NW	RE/NI
1 GEN B CONT	4.00	80.20	1.00	1.00	*
2 OPER BLDR	4.50	81.90	0.10	*	*
3 HVY CONST	1.60	62.00	2.00	0.20	*
4 PLMB,HTG,AC	2.70	72.60	2.60	5.00	86.80
5 ELEC WK	1.90	65.80	1.70	0.30	*
6 OTHER SP TRD	2.20	69.10	1.80	1.30	*
SUM Y	16.90	431.60	9.20	7.80	*
AVERAGE	2.82	71.93	1.53	1.30	*

MANUFACTURING

1 MTR VEH&EQ	2.70	73.10	3.10	5.70	43.70
2 ELC CMP&ACC	1.10	51.30	4.70	4.30	55.50
3 G IND MACH	1.20	54.80	1.40	0.30	*
4 MIL,PLY&REL	1.40	58.90	2.30	2.80	6.10
5 FURN&FIXT	1.10	52.90	8.60	9.50	76.20
6 PLAS &SYN	0.90	48.00	3.50	3.40	*
SUM Y	8.40	339.00	23.60	26.00	*
AVERAGE	1.40	56.50	3.93	4.33	*

LEGEND:

TL/NW = TOTAL LIABILITIES / NET WORTH
 TD/TA = TOTAL DEBT / TOTAL ASSETS
 NIBT/TA = NET INCOME BEFORE INTEREST & TAX / TOTAL ASSETS
 P/NW = PROFIT / NET WORTH
 RE/NI = RETAIN EARNINGS / NET INCOME

TROY'S FINANCIAL RATIO (CORP W/ NET INCOME)

CONSTRUCTION	CA/CL	C+AP/CL	NETS/NWC	NIBIT/IP	S/TA
1 GEN B CONT	1.40	0.80	10.20	3.60	1.80
2 OPER BLDR	1.60	0.70	1.20	2.20	0.30
3 HVY CONST	1.40	1.00	14.30	5.20	1.80
4 PLMB,HTG,AC	1.50	1.00	10.80	7.70	*
5 ELEC WK	1.70	1.20	8.40	5.70	2.30
6 OTHER SP TRD	1.70	1.20	9.50	5.80	*
SUM Y	9.30	5.90	54.40	30.20	*
AVERAGE	1.55	0.98	9.07	5.03	*

MANUFACTURING

1 MTR VEH&EQ	1.50	1.30	4.30	1.80	0.90
2 ELC CMP&ACC	2.00	1.00	4.10	5.80	1.20
3 G IND MACH	1.60	0.90	5.40	3.50	1.00
4 MIL,PLY&REL	1.40	0.70	12.50	2.40	1.30
5 FURN&FIXT	2.20	1.20	5.60	6.50	1.90
6 PLAS &SYN	1.40	0.80	11.70	2.90	0.90
SUM Y	10.10	5.90	43.60	22.90	7.20
AVERAGE	1.68	0.98	7.27	3.82	1.20

LEGEND:

CA/CL = CURRENT ASSETS / CURRENT LIABILITIES
 C+AP/CL = CASH + ACCOUNTS PAYABLE / CURRENT LIABILITIES
 NETS/NWC = NET SALES / NET WORKING CAPITAL
 NIBIT/IP = NET INCOME BEFORE INTEREST & TAX / INTEREST PAID
 S/TA = SALES / TOTAL ASSETS

TROY'S FINANCIAL RATIOS (CORP W/ NET INCOME)

CONSTRUCTION	TL/NW	TD/TA	NIBT/TA	P/NW	RE/NI
1 GEN B CONT	3.20	76.10	6.20	20.60	83.70
2 OPER BLDR	3.20	76.10	5.40	18.20	96.20
3 HVY CONST	1.20	53.70	9.40	13.80	79.00
4 PLMB,HTG,AC	2.10	67.30	9.00	22.00	97.10
5 ELEC WK	1.40	58.40	9.20	16.80	94.40
6 OTHER SP TRD	1.50	60.50	11.20	23.00	94.80
SUM Y	12.60	392.10	50.40	114.40	545.20
AVERAGE	2.10	65.35	8.40	19.07	90.87

MANUFACTURING

1 MTR VEH&EQ	2.60	72.40	4.20	8.90	62.30
2 ELC CMP&ACC	1.00	50.20	7.80	9.40	77.90
3 G IND MACH	1.20	54.70	5.00	7.00	47.90
4 MIL,PLY&REL	1.10	52.30	4.40	6.20	60.30
5 FURN&FIXT	0.90	47.50	12.80	14.90	85.70
6 PLAS &SYN	0.80	43.90	4.80	5.00	22.30
SUM Y	7.60	321.00	39.00	51.40	356.40
AVERAGE	1.27	53.50	6.50	8.57	59.40

LEGEND:

TL/NW = TOTAL LIABILITIES / NETWORTH
 TD/TA = TOTAL DEBT / TOTAL ASSETS
 NIBT/TA = NET INCOME BEFORE TAXES / TOTAL ASSETS
 P/NW = PROFIT / NET WORTH
 RE/NI = RETAINED EARNINGS / NET INCOME

D & B'S FINANCIAL RATIOS

CONSTRUCTION	CA/CL	C+R/CL	CL/NW	CL/INV	TL/NW
1 RES CONTR	1.70	1.10	74.00	155.50	98.90
2 CONC WK	1.70	1.40	59.90	297.60	89.50
3 NONRES CONT	1.70	1.30	94.10	258.70	112.90
4 HWY&STR CONT	1.70	1.30	63.80	396.00	100.50
5 BR TUN&ELV HW	1.90	1.40	62.20	294.90	93.00
6 WTRR SWR&UTL	1.80	1.30	60.00	350.40	91.40
7 HVY CONST	1.70	1.20	61.80	269.90	95.60
8 PLBG, HTG, AC	2.00	1.40	66.10	200.50	90.60
9 ELEC WK	2.20	1.60	52.10	502.70	72.60
10 MASNRY&OTH	2.00	1.70	51.40	236.20	74.10
SUM Y	18.40	13.70	645.40	2962.40	919.10
AVERAGE	1.84	1.37	64.54	296.24	91.91

MANUFACTURING

1 MILLWK	2.00	1.10	57.10	120.70	90.80
2 WD KTCN CAB	2.00	1.20	49.80	168.90	84.70
3 CONSTR MACH	1.90	1.00	88.90	97.40	129.60
4 HTG EQP&ELC	1.90	0.90	51.40	106.40	90.50
5 AUTO, RE M VEH	1.70	0.60	110.50	98.80	143.00
6 HM FURNG	1.90	1.10	83.10	121.20	106.90
7 LMBR, PLWD, OTH	2.00	1.10	85.60	121.80	112.10
8 CONSTR MATL	1.90	1.10	81.70	126.70	109.00
9 COML MACH, EQP	1.90	1.00	77.70	117.40	101.80
10 ELEC EQP	2.50	1.40	44.80	111.60	66.20
SUM Y	19.70	10.50	730.60	1190.90	1034.60
AVERAGE	1.97	1.05	73.06	119.09	103.46

LEGEND:

CA/CL = CURRENT ASSETS / CURRENT LIABILITIES
C+R/CL = CASH + RECEIVABLES / CURRENT LIABILITIES
CL/NW = CURRENT LIABILITIES / NETWORTH
CL/INV = CURRENT LIABILITIES / INVENTORY
TL/NW = TOTAL LIABILITIES / NETWORTH

D & B'S FINANCIAL RATIOS

CONSTRUCTION	FA/NW	S/INV	A/S	S/NWC	AP/S
1 RES CONTR	29.10	27.60	34.70	10.80	5.40
2 CONC WK	63.50	81.00	33.70	10.00	4.80
3 NONRES CONT	26.20	77.00	28.50	11.60	7.10
4 HWY&STR CONT	75.70	64.40	43.60	9.50	5.20
5 BR TUN&ELV HW	46.90	51.10	43.20	7.80	6.30
6 WTR SWR&UTL	66.50	60.10	45.80	8.40	4.90
7 HVY CONST	70.50	42.00	50.20	8.20	5.30
8 PLBG, HTG, AC	36.70	26.90	32.10	8.70	5.30
9 ELEC WK	33.10	28.70	34.20	7.20	4.40
10 MASNRY&OTH	48.50	52.90	31.80	8.80	3.80
SUM Y	496.70	511.70	377.80	91.00	52.50
AVERAGE	49.67	51.17	37.78	9.10	5.25

MANUFACTURING

1 MILLWK	51.80	11.70	38.00	7.90	4.30
2 WD KTCHN CAB	58.80	20.60	33.50	9.10	4.00
3 CONSTR MACH	47.30	5.30	56.80	4.90	6.10
4 HTG EQP&ELC	36.60	7.30	52.40	5.80	5.60
5 AUTO, RE M VEH	26.90	7.80	29.20	11.90	2.70
6 HM FURNG	20.70	10.60	30.30	9.00	5.30
7 LMBR, PLWD, OTH	23.20	10.50	28.00	10.50	4.30
8 CONSTR MATL	29.40	11.20	33.20	8.60	6.80
9 COML MACH, EQP	23.60	10.10	31.90	8.60	5.20
10 ELEC EQP	31.70	8.00	55.10	4.50	5.30
SUM Y	350.00	103.10	388.40	80.80	49.60
AVERAGE	35.00	10.31	38.84	8.08	4.96

LEGEND:

FA/NW = FIXED ASSETS / NETWORTH
S/INV = SALES / INVENTORY
A/S = ASSETS / SALES
S/NWC = SALES / NET WORKING CAPITAL
AP/S = ACCOUNTS PAYABLE / SALES

D & B'S FINANCIAL RATIOS

CONSTRUCTION	RET/S	RET/A	RET/NW
1 RES CONTR	3.70	6.80	18.50
2 CONC WK	5.30	12.70	28.50
3 NONRES CONT	2.90	7.70	19.40
4 HWY&STR CONT	4.30	8.70	18.90
5 BR TUN&ELV HW	3.10	5.70	13.10
6 WTRR SWR&UTL	5.10	9.10	18.60
7 HVY CONST	4.60	6.70	14.40
8 PLBG, HTG, AC	3.90	9.00	19.40
9 ELEC WK	4.40	9.90	18.30
10 MASNRY&OTH	4.10	9.50	22.20
SUM Y	41.40	85.80	191.30
AVERAGE	4.14	8.58	19.13

MANUFACTURING

1 MILLWK	3.50	7.30	15.30
2 WD KTCHN CAB	5.70	11.10	25.90
3 CONSTR MACH	3.50	4.60	12.30
4 HTG EQP&ELC	1.80	2.20	8.60
5 AUTO, RE M VEH	1.50	4.30	14.30
6 HM FURNG	3.20	6.50	16.40
7 LMBR, PLWD, OTH	2.10	6.00	14.40
8 CONSTR MATL	3.10	6.80	16.40
9 COML MACH, EQP	4.10	7.60	20.00
10 ELEC EQP	5.40	8.60	14.60
SUM Y	33.90	65.00	158.20
AVERAGE	3.39	6.50	15.82

LEGEND:

RET/S = NET INCOME BEFORE TAX / SALES
RET/A = NET INCOME BEFORE TAX / ASSETS
RET/NW = NET INCOME BEFORE TAX / NETWORTH

ROBERT MORRIS ASSOCIATES' FINANCIAL RATIOS

CONSTRUCTION	CA/CL	RV/WC	EBIT/I	CF/CMLTD	FXA/TNW
1 GEN B RES	1.20	19.90	2.90	1.90	0.30
2 COMM CONS	1.40	15.80	3.30	3.60	0.30
3 ELEC WK	1.60	10.40	4.10	2.90	0.30
4 HVY CONS	1.50	13.20	2.00	2.40	0.70
5 HWY & STR	1.40	14.40	1.80	1.60	0.90
6 PLMB,HTG,AC	1.50	10.90	3.20	2.30	0.30
SUM Y	8.60	84.60	17.30	14.70	2.80
AVERAGE	1.43	14.10	2.88	2.45	0.47

MANUFACTURING

1 WD FURN	1.90	8.30	3.50	2.70	0.60
2 MILLWK	1.70	9.80	2.40	2.80	0.60
3 ELC CMP&ACC	1.70	6.90	3.70	3.20	0.60
4 G IND M&EQ	1.80	5.80	2.50	2.70	0.60
5 MTR VEH P&A	1.70	8.70	3.30	3.50	0.60
6 PLAS &SYN	1.50	11.90	4.40	4.10	0.80
SUM Y	10.30	51.40	19.80	19.00	3.80
AVERAGE	1.72	8.57	3.30	3.17	0.63

LEGEND:

CA/CL = CURRENT ASSETS / CURRENT LIABILITIES
 RV/WC = REVENUE / WORKING CAPITAL
 EBIT/I = EARNINGS BEFORE INTEREST & TAXES / INTEREST
 CF/CMLTD = CASH FLOW / CURRENT MATURITIES OF LONG TERM DEBT
 FXA/TNW = FIXED ASSETS / TANGIBLE NETWORK

RMA'S FINANCIAL RATIOS

CONSTRUCTION	D/TNW	%PBT/TNW	%PBT/TA
1 GEN B RES	3.10	24.80	5.20
2 COMM CONS	2.00	12.50	4.00
3 ELEC WK	1.30	14.30	6.00
4 HVY CONS	1.30	5.20	1.40
5 HWY & STR	1.60	8.20	2.90
6 PLMB,HTG,AC	1.70	11.30	4.50
SUM Y	11.00	76.30	24.00
AVERAGE	1.83	12.72	4.00

MANUFACTURING

1 WD FURN	1.30	18.80	8.20
2 MILLWK	1.50	16.90	6.00
3 ELC CMP&ACC	1.40	24.40	9.00
4 G IND M&EQ	1.40	11.80	5.20
5 MTR VEH P&A	1.40	17.80	7.60
6 PLAS &SYN	1.50	24.00	9.00
SUM Y	8.50	113.70	45.00
AVERAGE	1.42	18.95	7.50

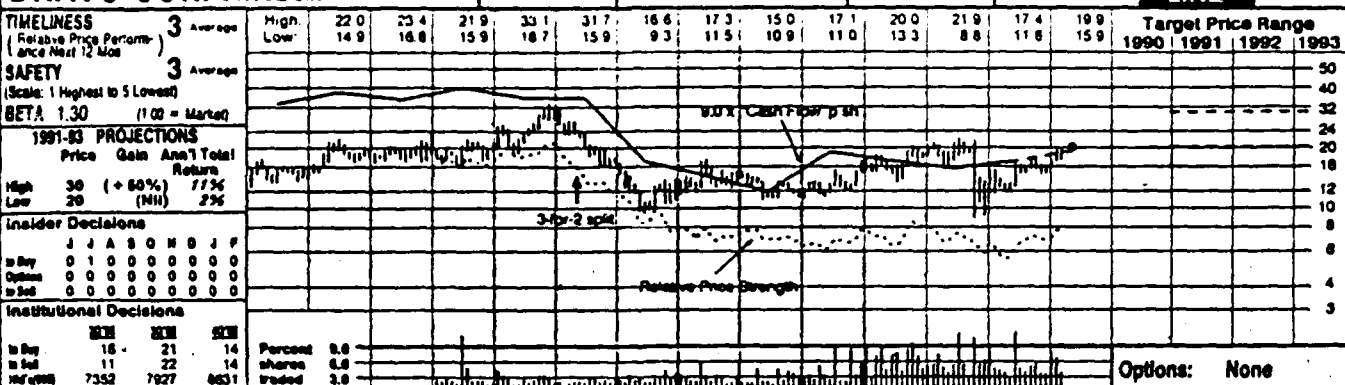
LEGEND:

D/TNW = TOTAL DEBT / TANGIBLE NETWORK
 %PBT/TNW = PERCENT PROFIT BEFORE TAX / TANGIBLE NETWORK
 %PBT/TA = PERCENT PROFIT BEFORE TAX / TOTAL ASSETS

APPENDIX C

The following pages are sample copies of construction and manufacturing from Value Line, Inc., "Investment Survey." Only three samples are included. The other companies can be obtained from the June 1989 edition.

DRAVO CORP. NYSE:DRV RECENT PRICE **20** P/E RATIO **22.0** (Trailing 36 Months) RELATIVE P/E RATIO **1.77** DIV YLD **Nil** VALUE LINE **859**



CAPITAL STRUCTURE as of 12/31/88												Options: None	
Total Debt \$64.0 mill. Due in 5 Yrs \$35.7 mill.													
LT Debt \$51.0 mill. LT Interest \$5.4 mill.													
Excludes \$20.1 million in deferred mineral production payments. Includes \$1.7 million in capitalized leases													
(LT Interest earned: 4.7%; total interest coverage: 2.6x)													
Leases, Uncapitalized Annual rentals \$24.9 mill.													
Pension Liability None in '88 vs. None in '87													
Pld Stock \$22.8 mill. Pld Div'd \$2.7 mill.													
47,886 shs. \$2.475 cum. (\$1 par), each convertible into 3.216 common shares; 200,000 shares, \$3.08 cum. Series D, each share convertible into 5.556 common shares. Dravo may opt to convert the Series D issue to 12.35% Senior Sub. Convertible notes (due 9/21/98) with same 5.556 common share conversion rate. (13% of Cap'l)													
Common Stock 14,699,479 shares (53% of Cap'l)													

1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	VALUE LINE INC.	91-93E
96.28	82.53	68.72	116.93	88.35	80.08	61.58	63.99	49.48	18.90	18.81	20.00	Sales per sh	24.00
3.86	4.43	3.94	3.94	1.87	1.58	1.32	2.09	1.89	1.72	1.88	2.75	"Cash Flow" per sh	2.65
2.30	2.31	1.69	1.31	0.68	0.65	0.84	2.1	1.61	.75	.75	1.85	Earnings per sh	1.50
.77	.85	.91	.96	.85	.50	.50	.50	.50	.25	.25	.25	Div'd Dec'd per sh	.45
2.01	3.16	3.65	3.02	.97	1.40	.73	1.21	1.09	1.04	.44	1.00	Cap'l Spending per sh	1.35
18.92	18.54	18.88	18.98	17.85	16.14	14.13	13.90	14.61	5.90	6.87	7.60	Book Value per sh	10.70
8.78	12.02	12.56	12.93	13.03	13.70	13.73	13.95	14.15	14.68	14.70	14.75	Common Shs Outst'g	14.80
8.1	8.1	14.7	16.3	---	---	---	61.7	27.3	19.3	---	---	Avg Ann'l P/E Ratio	18.0
1.10	1.17	1.95	1.98	---	---	---	5.01	1.85	1.56	1.59	---	Relative P/E Ratio	1.35
4.1%	4.5%	3.7%	4.5%	7.0%	3.7%	4.0%	3.9%	3.0%	1.4%	---	---	Avg Ann'l Div'd Yield	1.9%
845.4	992.3	1113.9	1511.9	1151.6	823.0	844.9	892.7	700.0	248.1	273.6	285	Sales (\$mill)	353
6.5%	8.6%	7.1%	4.8%	3.1%	2.1%	1.3%	4.0%	4.7%	13.7%	13.5%	13.5%	Operating Margin	14.0%
15.5	25.5	28.4	34.0	34.3	30.3	29.7	26.3	18.1	14.5	15.9	16.0	Depreciation (\$mill)	17.5
18.8	28.2	21.6	17.3	NM/F	NM/F	NM/F	3.2	8.9	10.9	11.8	13.5	Net Profit (\$mill)	22.0
41.7%	40.5%	40.0%	21.5%	---	---	---	40.0%	35.0%	22.9%	26.3%	27.0%	Income Tax Rate	32.0%
2.2%	2.8%	1.9%	1.1%	NM/F	NM/F	NM/F	4%	1.3%	4.4%	4.3%	5.2%	Net Profit Margin	6.2%
88.3	131.8	140.2	115.8	123.3	91.8	87.9	87.4	155.0	36.9	36.3	55.0	Working Cap'l (\$mill)	80.0
22.7	92.0	88.0	87.9	87.0	65.3	59.4	52.9	47.3	40.0	51.0	30.0	Long-Term Debt (\$mill)	30.0
175.2	232.0	245.7	254.1	241.0	229.2	202.0	199.0	210.5	89.5	101.0	110	Net Worth (\$mill)	150
11.6%	10.0%	7.7%	6.3%	NM/F	NM/F	NM/F	2.3%	4.3%	10.1%	11.1%	12.5%	% Earned Total Cap'l	13.5%
10.7%	12.1%	8.8%	6.8%	NM/F	NM/F	NM/F	1.6%	4.2%	12.2%	11.7%	14.0%	% Earned Net Worth	14.5%
7.4%	7.9%	4.3%	1.9%	NM/F	NM/F	NM/F	NM/F	8%	8.4%	13.5%	10.5%	% Retained to Comm Eq	18.0%
35%	38%	53%	73%	NM/F	NM/F	NM/F	NM/F	81%	34%	7%	25%	% All Div'd to Net Prof	37%

BUSINESS: Dravo Corp. began operating exclusively as a natural resources company on Jan. 1, 1988, when all its engineering and construction and materials handling businesses were listed as discontinued operations. Major lines: Dravo Lime, the largest U.S. lime supplier, sells principally by long-term contract to utilities (lime is used to help remove sulfur dioxide from fossil fuel emissions); Dravo Basic Materials sells aggregates. Employee costs: 25% of revs. '88 depreciation rate: 5.4%. Est'd plant age: 6 years. Has 2,455 employees; 4,890 shareholders. Insiders own 1% of common stock. Chairman & C.E.O.: W. G. Roth. President: C. A. Torbert, Jr. Incorporated: Pennsylvania. Address: One Oliver Plaza, Pittsburgh, Pennsylvania 15222. Telephone: 412-566-3000.

ANNUAL RATES			
of change (per sh)	Post 1978	Post 1979	Est'd '86-'88
Sales	-8.5%	-15.0%	-2.5%
"Cash Flow"	-8.0%	-10.0%	7.5%
Earnings	-13.0%	-7.5%	18.5%
Dividends	-4.0%	-11.0%	12.5%
Book Value	-3.5%	-5.5%	2.0%

QUARTERLY SALES (\$ mill.)					Full Year
Cal-ender	Mar.31	June30	Sep.30	Dec.31	
1985	199.7	218.0	233.9	241.1	892.7
1986	150.0	182.5	194.2	173.3	700.0
1987	54.5	68.4	70.6	58.6	248.1
1988	57.4	72.3	78.0	67.9	273.6
1989	62.0	75.0	77.0	78.0	292

EARNINGS PER SHARE					Full Year
Cal-ender	Mar.31	June30	Sep.30	Dec.31	
1985	0.18	.08	.12	.19	.21
1986	.01	.17	.33	.10	.81
1987	0.04	.17	.33	.29	.75
1988	0.01	.25	.30	.21	.75
1989	.07	.27	.30	.35	1.05

QUARTERLY DIVIDENDS PAID					Full Year
Cal-ender	Mar.31	June30	Sep.30	Dec.31	
1985	.125	.125	.125	.125	.50
1986	.125	.125	.125	.125	.50
1987	.125	.125	---	---	.25
1988	---	---	---	---	---
1989	---	---	---	---	---

We estimate the company's bottom line will top \$1.00 a share in 1989. Combine the abovementioned positives with a slight improvement in operating margins and further benefits from net operating loss carryforwards (which are now being netted directly against the company's tax liability under new accounting rules) and Dravo's earnings are likely to climb a hefty 40% this year.

The company's finances are on a better footing, too. Late last year, the company completed a long-term financing arrangement in excess of \$85 million with a unit of Prudential Insurance Company in return for senior notes and shares of a convertible preferred stock which, if converted, would represent 7% of Dravo's outstanding common shares. This move allows the company to consolidate much of its debt obligations and will also give it needed flexibility to grow its natural resource business.

Nonetheless, based on recent unexciting earnings comparisons, Dravo shares are likely to be only average performers in the year ahead. And under the company's current configuration, capital appreciation over the 3- to 5-year pull appears to be subpar.

Beverly G. Machtinger April 28, 1989

(A) Based on average shares outstanding. Excludes nonrecurring gains (losses): '82, 30%; '83, (46%); '84, 65%; extraordinary gain: '86, \$1.95; '87, 56%; '88, 4%; discontinued operations: '88, (\$1.57); '87, (\$10.04); '88, (\$1.33). Next earnings report due mid May. (B) Dividend omitted on 7/24/87. Date of next dividend meeting is unknown. (C) Includes intangibles. In '88, \$1 million, 16/sh. (D) In millions, adjusted for stock splits.

Factual material is obtained from sources believed to be reliable, but the publisher is not responsible for any errors or omissions contained herein.

BLOUNT, INC. 'A' ASE-B124

RECENT PRICE 13

PE RATIO NMF (Trading NMF Below 10:1)

RELATIVE NMF

DIV'D YLD 3.5%

VALUE LINE

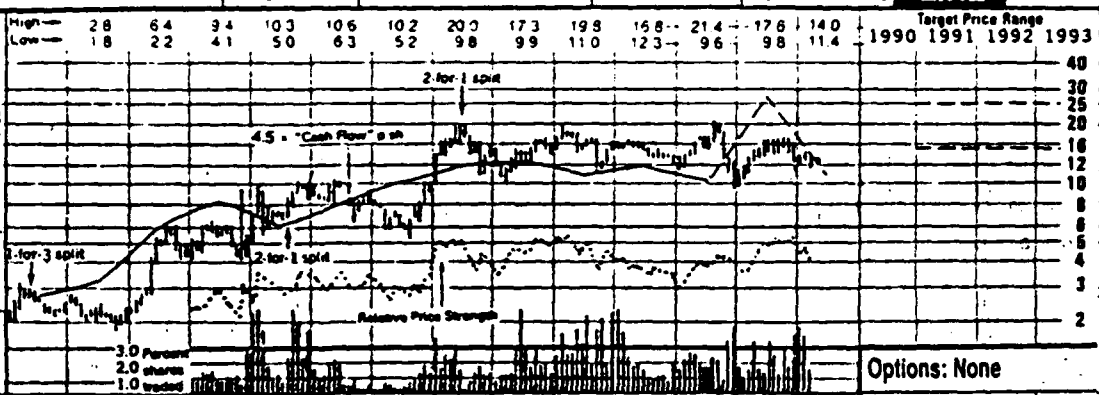
855

TIMELINESS
(Relative Price Performance since Next 12 Mos.)
SAFETY
(Scale: 1 Highest to 5 Lowest)
BETA .85 (1.00 = Market)

1991-93 PROJECTIONS
Price Gain Ann'l Total
High 25 (+ 90%)
Low 15 (+ 15%)

Insider Decisions
J A S O N D J F
to Buy 0 0 0 0 0 0 0 0
to Sell 0 0 0 0 0 0 0 0

Institutional Decisions
to Buy 5 7 5
to Sell 4 7 5
May's own 3608 3468 3878



Options: None

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	© VALUE LINE, INC. 91-93E
20.70	27.00	34.67	35.04	30.76	34.94	38.80	40.51	58.05	68.48	70.05	72.13	71.52	98.05	103.75	103.09	94.30	97.50	Revenues per sh
.49	.54	.61	.70	.63	.72	1.34	1.80	1.40	1.84	2.28	2.85	3.07	2.39	2.66	2.32	6.25	2.50	"Cash Flow" per sh
.32	.32	.37	.44	.40	.44	1.00	1.06	.80	1.02	1.38	1.83	2.03	.27	.60	.42	06.03	.60	Earnings per sh
.03	.05	.06	.06	.08	.10	.12	.15	.18	.23	.26	.41	.42	.45	.45	.45	1.45	.45	Div'd Decl'd per sh
.45	.38	.58	.37	.47	.53	.68	2.17	.98	1.01	.74	.55	1.28	1.42	1.20	1.57	1.65	.85	Cap'l Spending per sh
1.48	1.78	2.11	2.49	3.27	2.99	4.02	5.01	5.50	6.18	7.31	8.47	10.55	11.41	11.78	11.93	11.80	12.09	Book Value per sh
11.12	11.12	10.68	10.68	10.82	10.82	10.99	11.19	11.22	11.23	11.28	11.36	11.84	11.89	11.89	11.94	12.03	12.05	Common Shs Outst'g
10	6.5	4.3	5.0	6.5	5.0	4.5	5.5	13.4	11.3	6.0	8.3	7.2	57.0	23.7	35.3	NMF	NMF	Avg Ann'l P/E Ratio
.69	.64	.80	.87	.83	.65	.61	.80	1.78	1.37	.66	.70	.67	4.63	1.61	2.36	NMF	NMF	Relative P/E Ratio
.9%	2.5%	3.8%	2.7%	2.9%	4.3%	2.6%	2.6%	2.2%	2.0%	3.1%	2.7%	2.9%	2.9%	3.2%	3.0%	6.5%		Avg Ann'l Div'd Yield

CAPITAL STRUCTURE as of 11/30/88
Total Debt \$117.9 mil. Due in 3 Yrs \$27.2 mil.
LT Debt \$115.1 mil. LT Interest \$11.0 mil.
Incl. \$19.5 mil. capitalized leases.
(LT interest earned: 1.2%; total interest coverage: 1.1x) (45% of Cap'l)
Leases, Uncapitalized Annual rentals \$5.9 mil.
Pension Liability None in '87 vs. None in '86
Pld Stock \$5 mil. Pld Div'd \$0.4 mil.
(less than 1% of Cap'l)

Common Stock 11,992,222 shs. in (55% of Cap'l)
Class A: 7,396,189 shs.
Class B: 4,597,033 shs.

CURRENT POSITION	1986	1987	11/30/88
Cash Assets (SEMI.)	7.9	4.9	208.5
Receivables	284.3	199.0	195.6
Inventory (FIFO)	78.3	78.3	53.9
Other	58.3	30.1	15.2
Current Assets	424.8	312.3	474.2
Accounts Payable	239.4	152.5	144.8
Debt Due	33.0	21.7	2.8
Other	108.1	96.3	261.4
Current Liab.	378.5	270.5	429.0

ANNUAL RATES	10 YEARS	5 YEARS	Est'd 76-77 to 78-79
Sales	11.5%	9.0%	2.5%
"Cash Flow"	13.5%	6.0%	10.0%
Earnings	-	-15.5%	NMF
Dividends	19.5%	15.5%	12.0%
Book Value	15.0%	13.0%	4.0%

QUARTERLY REVENUES (\$ mil.)	May 31	Aug 31	Nov 30	Feb 28	Full Fiscal Year
1985	266.0	292.4	296.3	311.0	1165.7
1986	231.2	358.3	330.5	313.9	1233.9
1987	269.7	317.6	345.4	298.0	1230.7
1988	281.5	330.3	277.4	245.1	1134.5
1989	275	330	300	270	1175

EARNINGS PER SHARE	May 31	Aug 31	Nov 30	Feb 28	Full Fiscal Year
1985	.41	.23	.08	.03	.27
1986	.01	.23	.20	.18	.80
1987	.20	.01	.01	.20	.42
1988	.80	.09	.05	.12	.80
1989	.10	.15	.15	.20	.80

QUARTERLY DIVIDENDS PAID	Mar. 31	June 30	Sept. 30	Dec. 31	Full Year
1985	.113	.113	.113	.113	.45
1986	.113	.113	.113	.113	.45
1987	.113	.112	.112	.112	.45
1988	.112	.112	.112	.612	.95
1989	.112	.112			

BUSINESS: Blount, Inc. is a leading provider of construction services around the world (54% of 1987 revenues, -17% of operating income); Omark Industries (acquired 1/85) is the leading manufacturer of saw chain, hydraulic log loaders, and logging equipment (28%, 64%); Resource Recovery builds waste-to-energy generators (0%, -5%); Sold Washington Steel, producer of specialty stainless steels 10/88; (18%, 58%); Has 7,500 employees, 8,100 shareholders, 1987 dep. rate: 7.8%. Est. plant age: 4 years. Insiders hold about 60% of common stock. Chairman and Chief Executive Officer: W. M. Blount, Inc.; DE. Address: 4520 Executive Park Dr., P.O. Box 949, Montgomery, Alabama 36101. Tel.: 205-244-4000.

It's not easy to separate the wheat from the chaff in analyzing Blount. Difficulties with its mainstay Construction and Engineering unit, have severely trimmed the company's earnings power over the past three years. Previously, these problems were partially offset by the Machinery and Equipment manufacturing operations and the highly-profitable specialty steel business. However, this year the situation took a turn for the worse, due to some margin erosion in the M & E unit. Meanwhile, C & E took charges of \$61.7 million, primarily for increased reserves, as well as a charge of \$10.8 million for an accounting change in claim revenue on construction contracts. In the absence of profits from Washington Steel (which was sold in October), Blount posted a loss of \$6.03. Note: Our earnings presentation excludes a total of \$9.97 a share in nonrecurring items.

Has the Construction and Engineering unit finally turned the corner to profitability? The C & E unit posted an operating profit of \$2.0 million in the final interim, on revenues of \$151 million. We're not convinced that this modest profit signals a

sustainable upturn. For one thing, overall construction activity is likely to slow. And while the company's effort to maintain margins when bidding for new projects is all to the good, some business will be lost along the way. Thus, C & E's razor-thin margin will likely hover near breakeven and the unit's recovery will remain extremely vulnerable, in our view. Our share net estimate of 60¢ in fiscal 1989 is highly tentative and reflects a strong contribution from manufacturing operations and interest income.

Blount is sitting on a pile of cash. The proceeds from the sale of Washington Steel and interest income have boosted the cash per share to roughly \$10.15. At the current quote, this stock appears to be cheap. Still, with management holding 63% of the shares and most of the votes, the company is hardly raider bait. We think most investors would do better elsewhere.

Janet L. Falk

April 28, 1989

CASH POSITION	5-Year Avg	11/30/88
Current Assets to Current Liabilities:	128%	112%
Cash & Equiv's to Current Liabilities:	12%	49%
Working Capital to Revenues:	7%	4%

(A) Fiscal year ends Feb. 28th or 29th of following cal. year. (B) Based on avg. shs. outst. Next qtrs. report due late June. Etc. gain from disc. ops.: '88, \$10.87; nonrecurr.

gain (loss): '87, 24¢; '88, (30¢); extra. gain: '85, 74¢. (C) Next div'd mgt. about May 29. Goes ex about June 14. Div'd pmt. dates: Jan. 4, Apr. 3, July 3, Oct. 2. Inc. spec. div.

12.88, 50¢; (D) Incl. intn. in '87: \$61.9 mil. \$5.17/sh. (E) In mil., adj. for stock splits. (F) Class B elects 75% of board. Class A receives add'l div'd of 1/14¢.

Company's Financial Strength	C + +
Stock's Price Stability	60
Price Growth Persistence	45
Earnings Predictability	25

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DALLAS CORP. NYSE-DLS										RECENT PRICE	15	P/E RATIO	10.9	(Trailing 12.5)	RELATIVE P/E RATIO	0.88	DYD YLD	4.4%	VALUE LINE	858																			
TIMELINESS (Relative Price Performance since last 12 mos.) SAFETY (Scale: 1 Highest to 5 Lowest) BETA .85 (1.00 = Market)										High: 14.1 Low: 10.8	18.5 11.3	18.4 13.9	17.0 13.5	15.0 9.0	14.6 8.3	21.0 13.3	21.3 13.8	23.5 15.5	19.5 12.5	15.6 7.6	16.5 8.4	18.1 14.4	Target Price Range 1990 1991 1992 1993																
1991-93 PROJECTIONS Price Gain Ann'l Total High 38 (+135%) 27% Low 20 (+38%) 72%										7.0% Cash Flow Yield										Relative Price Strength																			
Insider Decisions to Buy 0 0 0 0 0 0 0 0 0 0 to Sell 0 0 0 0 0 0 0 0 0 0										Institutional Decisions to Buy 10 6 6 6 6 6 6 6 6 6 to Sell 2 4 2 2 2 2 2 2 2 2 Net Buys 4561 4799 4683										Percent shares traded: 6.8, 4.0, 2.0										Options: None									
1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989										1990 1991 1992 1993										VALUE LINE, INC. '91-'93E																			
21.16 24.17 25.82 22.07 27.26 35.08 40.65 53.79 42.80 45.28 40.81 38.39 52.41 53.88 53.90 54.64 43.35 49.30										Sales per sh 60.70										2.45 "Cash Flow" per sh 3.45																			
1.61 1.92 1.36 1.28 2.03 2.58 3.07 3.19 1.48 1.24 1.23 1.92 3.41 1.62 1.15 1.44 1.95 2.45										Earnings per sh 2.25										1.50 Div'd Decl'd per sh 1.50																			
1.30 1.58 1.00 85 1.81 2.15 2.60 2.60 82 .55 .38 1.25 2.30 .82 .18 .51 1.10 1.66										Cap'l Spending per sh 1.20										7.45 Book Value per sh 17.25																			
.31 .32 .40 40 45 .55 .70 .84 1.00 1.00 .90 80 60 65 .66 66 66										Common Shs Outst'd 7.00										14.50 Avg Ann'l P/E Ratio 12.0																			
.73 .76 1.19 .51 .46 .59 .70 87 1.29 1.04 .87 .88 1.79 1.17 1.22 1.27 54										Relative P/E Ratio 1.00										7.00 Avg Ann'l Div'd Yield 4.8%																			
7.77 8.88 9.01 9.46 10.60 12.18 14.03 15.51 14.20 13.69 13.17 14.55 16.11 15.20 14.71 13.62 12.96 14.50																																							
3.74 4.08 4.46 4.47 4.48 4.50 4.54 4.87 5.49 5.61 5.61 7.00 7.28 7.37 7.35 7.39 7.44																																							
13.4 9.1 9.8 7.9 5.8 5.8 5.8 6.3 18.4 22.6 29.4 14.1 7.5 22.6 87.5 25.4 10.7																																							
.92 .90 1.37 1.05 74 .73 .79 .91 2.44 2.75 3.24 1.19 .70 1.84 5.93 1.70 88																																							
1.8% 2.2% 4.1% 6.0% 4.8% 4.8% 4.6% 5.1% 6.6% 8.0% 8.1% 3.4% 3.5% 3.5% 4.2% 5.1% 5.6%																																							
CAPITAL STRUCTURE as of 12/31/88 Total Debt \$50.7 mill. Due in 5 Yrs \$44.5 mill. LT Debt \$48.8 mill. LT Interest \$6.2 mill. (LT interest earned: 3.6x; total interest coverage: 3.0x) (34% of Cap'l)										184.6 281.8 235.0 254.1 228.9 278.4 381.7 398.7 398.2 404.0 322.6 343										Sales (Smill) 425																			
Leases, Uncapitalized Annual rentals \$6.3 mill.										14.2 11.4 6.3 5.1 6.3 7.4 10.7 6.0 4.3 5.2 7.8 8.6										Operating Margin 8.5%																			
Pension Liability \$3.3 mill. in '88 vs. \$1.4 mill. in '87										2.2 3.0 3.6 3.9 4.8 5.4 8.3 6.0 7.2 6.9 6.3 6.6										Depreciation (Smill) 8.0																			
Pfd Stock None										11.7% 12.5% 4.5% 3.1% 2.1% 8.1% 16.6% 5.9% 1.3% 3.8% 8.2 16.5										Net Profit (Smill) 16.0																			
Common Stock 7,443,366 shs. (66% of Cap'l)										49.0% 48.2% 43.9% 45.3% 52.6% 45.2% 42.7% 43.9% 43.7% 43.2% 36.3% 37.5%										Income Tax Rate 37.5%																			
CURRENT POSITION 1986 1987 12/31/88										6.4% 4.8% 1.9% 1.2% 9% 2.9% 4.3% 1.5% 3% 9% 2.5% 2.0%										Profit Margin 3.7%																			
Cash Assets 5.3 .5 1.5										58.3 67.8 61.7 60.6 59.1 71.7 93.2 100.0 102.1 84.1 85.6 100										Working Cap'l (Smill) 120																			
Receivables 72.4 71.9 55.4										27.8 29.9 26.3 29.7 27.7 22.2 56.6 65.0 63.1 58.7 48.8 25.0										Long-Term Debt (Smill) 20.0																			
Inventory (LIFO) 71.2 67.4 50.7										63.7 75.5 77.9 76.8 73.9 101.8 117.3 111.9 108.1 100.7 96.4 100										Net Worth (Smill) 120																			
Other 10.0 8.2 27.1										13.6% 13.3% 5.7% 4.8% 4.0% 7.4% 11.2% 5.1% 2.4% 4.4% 7.3% 10.0%										% Earned Total Cap'l 12.0%																			
Current Assets 158.9 148.0 134.7										18.4% 16.6% 5.7% 4.0% 2.9% 7.9% 14.1% 5.3% 1.2% 3.8% 8.5% 10.5%										% Earned Net Worth 13.0%																			
Accts Payable 32.0 46.5 42.4										13.5% 11.3% NMF NMF NMF 4.1% 10.5% 1.1% NMF NMF 3.4% 6.0%										% Retained to Comm Eq 6.0%																			
Debt Due 17.3 10.2 1.9										27% 32% 114% NMF NMF 48% 26% 79% NMF NMF 60% 44%										% All Div'ds to Net Prof 53%																			
Other 7.5 7.2 4.8										BUSINESS: The Dallas Corp. (name changed from Overhead Door Corp. on 1/23/85) manufactures & sells products for use in residential & commercial construction, as well as vehicular equipment products. Leading U.S. maker of sectional doors & door operators. Also makes steel doors, automatic doors, metal roofing systems, traffic doors, laminated hardwood flooring for trucks & trailers.										loading dock levelers. At 12/31/88: \$12.5 million in operating loss and other unused deduction carryforwards. '88 deprec. rate: 7.4%. Has 4,620 emplos., 1,514 shhldrs. Insiders own 9.8% of com. Templeton, Galbraith & Hensberger, Inc. Bank of Colorado, 14.5%. Charter Oak Partners, 8.2%. Pres. R.C. Haugh, Incorporated. IN. Address: 6750 LBJ Freeway, Dallas, TX 75240. Tel.: 214-233-6611.																			
Current Liab. 56.8 63.9 49.1										DALLAS IS UNDERGOING A RESTRUCTURING. The company has already disposed of one operation, Johnson Metals, and intends to sell four other units that it is currently accounting for as discontinued operations. (Last year's results have been restated to reflect these changes.) The move should help the income statement: Not only were the discontinued operations losing money, but the proceeds from their sale should enable Dallas to significantly reduce its debt load, repurchase shares, or make acquisitions. We estimate that the disposal of the discontinued assets will fetch about \$40 million altogether and be largely completed before the end of this year. Also, cash flow should be enhanced another \$7 million to \$8 million this year by the utilization of operating losses and other unused deduction carryforwards. We think share earnings will advance 35% in 1989. We look for the Overhead Door group to lead the way with a 5% increase in volume and a more profitable product mix in the residential sector as Dallas increases penetration of the higher-margined retrofit and remodeling markets. Modest price adjustments, effective in Jan-										uary, should also nudge margins wider. Meanwhile, we expect specialty products operations to restore operating profits to 1986 levels, and TODCO to experience flat results. With strong cash flow (including non-operating sources) enabling a pay down of debt and/or share buyback, we think share net can reach \$1.50 this year. We see moderate investor appeal in these shares. We expect a marked share earnings advance this year to enable this equity to at least perform in line with the market. (The Timeliness rank has been suspended due to the restructuring.) As currently configured, capital appreciation potential to '91-'93 appears about average. We note, however, that strong cash flow should support the healthy dividend and could well encourage the making of small-to medium-sized acquisitions that might boost our long-range expectations.																			
ANNUAL RATES of change (per sh)										Post 10 Yrs. 5 Yrs. 1 Yr. '86-'88 to '91-'93										Mark A. Weintraub April 28, 1989																			
Sales 4.0% 4.0% NMF																				Revised Sales & Operating Margins by Business Line																			
"Cash Flow" -5.0% 0.5% NMF																																							
Earnings -12.0% -4.0% NMF																																							
Dividends 1.5% -4.5% NMF																																							
Book Value 1.0% -- NMF																																							
QUARTERLY SALES (\$ mil.)										Full Year																													
Cal-ender Mar.31 June.30 Sep.30 Dec.31																																							
1985 89.4 101.2 101.0 105.1 396.7																																							
1986 90.3 104.7 102.9 98.3 396.2																																							
1987 89.3 102.1 106.6 106.0 404.0																																							
1988 72.8 79.5 82.9 87.4 322.6																																							
1989 78.2 85.0 90.0 91.8 345.0																																							
EARNINGS PER SHARE \$										Full Year																													
Cal-ender Mar.31 June.30 Sep.30 Dec.31																																							
1985 .21 .27 .23 .11 .82																																							
1986 .11 .17 .12 .12 .18																																							
1987 .10 .23 .30 .08 .51																																							
1988 .15 .23 .38 .32 1.10																																							
1989 .25 .37 .47 .45 1.50																																							
QUARTERLY DIVIDENDS PAID										Full Year																													
Cal-ender Mar.31 June.30 Sep.30 Dec.31																																							
1985 .15 .15 .165 .165 .63																																							
1986 .165 .165 .165 .165 .66																																							
1987 .165 .165 .165 .165 .66																																							
1988 .165 .165 .165 .165 .66																																							
1989 .165 .165																																							
OVERHEAD DOOR 18.03 (3%) 18.38 (3%) 19.97 (4%) 23.02 (4%)																																							
SPECIALTY PROD. 40.04 (5%) 43.56 (6%) 48.85 (6%) 48.85 (6%)																																							
TODCO 63.85 (4%) 78.02 (9%) 75.98 (3%) 75.98 (3%)																																							
Company Total 328.94 (3%) 377.86 (6%) 372.84 (3%) 347.77 (3%)																																							

(A) Based on average shares outstanding. Includes nonrecurring charge (stemming from LIFO switch): 79, 486. Excludes loss on discontinued operations: 85, \$1.10; '88, \$1.08. Excludes extraordinary loss: 87, 936. Next earnings report due in mid May. (B) Next dividend meeting about May 17. Goes ex about June 17. Approximate dividend payment dates: Jan. 1, Apr. 5, July 6, Oct. 6. (C) Includes intangibles in '88: \$3.2 mill. 43d. (D) In millions. (E) Depreciation on accelerated basis prior to '79.

Factual material is obtained from sources believed to be reliable, but the publisher is not responsible for any errors or omissions contained herein.

APPENDIX D

The following are calculations for finding the average Z-score and standard deviation for the sample of construction and manufacturing firms. The Student Edition of MathCAD 2.0 was used to make these calculations.

Calculations for Z-score for the sample of construction firms.

	X1	X2	X3	X4	X5	
Yc :=	0.070	0.198	0.104	0.290	1.890	N := rows(Yc)
	0.118	0.038	0.110	2.360	0.888	J := cols(Yc)
	0.233	0.094	0.018	2.214	2.490	i := 0 .. N - 1
	0.196	0.255	0.015	1.038	2.125	j := 0 .. J - 1
	0.309	0.341	0.091	0.784	1.469	
	0.127	0.053	0.096	0.090	0.315	
	0.048	0.034	0.096	0.980	0.208	
	0.118	0.266	0.055	0.475	2.267	
	0.306	0.080	0.004	0.030	0.580	
	0.191	0.254	0.067	1.181	0.707	

X1 = Working Capital / Total Assets
 X2 = Retained Earnings / Total Assets
 X3 = EBIT / Total Assets
 X4 = Market Value of Equity / Book Value of Total Debt
 X5 = Sales / Total Assets

Mean value of each Xj:

Standard Deviation of each Xj:

$$M_j := \text{mean} \left[Yc_{<j>} \right]$$

$$S_j := \text{stdev} \left[Yc_{<j>} \right]$$

$$M = \begin{bmatrix} 0.172 \\ 0.161 \\ 0.066 \\ 0.944 \\ 1.294 \end{bmatrix}$$

$$S = \begin{bmatrix} 0.087 \\ 0.108 \\ 0.038 \\ 0.77 \\ 0.813 \end{bmatrix}$$

Altman's Discriminant Coefficients:

$$Z := \begin{bmatrix} 1.2 \\ 1.4 \\ 3.3 \\ 0.6 \\ 0.999 \end{bmatrix}$$

Following are the sampled construction Z-scores:

$$Zc := Yc \cdot Z$$

$$Zc = \begin{bmatrix} 2.767 \\ 2.861 \\ 4.287 \\ 3.387 \\ 3.086 \\ 0.912 \\ 1.218 \\ 3.245 \\ 1.09 \\ 2.221 \end{bmatrix}$$

Check the discriminant coefficients for significance:

$$Y_c^T \cdot Y_c = \begin{bmatrix} 0.369 & 0.308 & 0.093 & 1.61 & 2.318 \\ 0.308 & 0.376 & 0.102 & 1.354 & 2.538 \\ 0.093 & 0.102 & 0.058 & 0.625 & 0.729 \\ 1.61 & 1.354 & 0.625 & 14.837 & 13.675 \\ 2.318 & 2.538 & 0.729 & 13.675 & 23.352 \end{bmatrix}$$

$$Y_c^T \cdot Z_c = \begin{bmatrix} 4.463 \\ 4.58 \\ 1.547 \\ 28.453 \\ 40.274 \end{bmatrix}$$

$$\text{Beta} := (Y_c^T \cdot Y_c)^{-1} \cdot (Y_c^T \cdot Z_c)$$

$$\text{Beta} = \begin{bmatrix} 1.2 \\ 1.4 \\ 3.3 \\ 0.6 \\ 0.999 \end{bmatrix}$$

Since matrix $Z = \text{Beta}$, test of significance for Regression is OK.

Z-score Average for construction:

$$Z_{\text{avg}} := M \cdot \text{Beta}$$

$$Z_{\text{avg}} = 2.507$$

Z-score Standard Deviation:

$$\text{Sigma} := S \cdot \text{Beta}$$

$$\text{Sigma} = 1.655$$

Calculations for Z-score for the sample of manufacturing firms.

	X1	X2	X3	X4	X5	
Ym :=	0.367	0.264	0.092	0.991	1.761	N := rows(Ym)
	0.227	0.152	0.083	8.396	1.479	J := cols(Ym)
	0.367	0.614	0.219	3.515	1.471	i := 0 .. N - 1
	0.283	0.298	0.132	0.274	0.750	j := 0 .. J - 1
	0.064	0.550	0.372	0.571	1.774	
	0.288	0.104	0.002	0.673	1.768	
	0.241	0.460	0.099	1.082	1.166	
	0.490	0.381	0.122	0.837	1.168	
	0.456	0.331	0.139	1.803	2.746	
	0.279	0.193	0.200	1.659	1.940	

X1 = Working Capital / Total Assets
 X2 = Retained Earnings / Total Assets
 X3 = EBIT / Total Assets
 X4 = Market Value of Equity / Book Value of Total Debt
 X5 = Sales / Total Assets

Mean value of each Xj:

Standard Deviation of each Xj:

$$M_j := \text{mean} [Y_m^{<j>}]$$

$$M = \begin{bmatrix} 0.306 \\ 0.335 \\ 0.146 \\ 1.98 \\ 1.602 \end{bmatrix}$$

$$S_j := \text{stdev} [Y_m^{<j>}]$$

$$S = \begin{bmatrix} 0.116 \\ 0.16 \\ 0.095 \\ 2.31 \\ 0.514 \end{bmatrix}$$

Altman's Discriminant Coefficients:

$$Z := \begin{bmatrix} 1.2 \\ 1.4 \\ 3.3 \\ 0.6 \\ 0.999 \end{bmatrix}$$

Following are the sampled manufacturing Z-scores:

Zm := Ym · Z

$$Z_m = \begin{bmatrix} 3.467 \\ 7.274 \\ 5.601 \\ 2.106 \\ 4.189 \\ 2.668 \\ 3.074 \\ 3.193 \\ 5.294 \\ 4.198 \end{bmatrix}$$

Check the discriminant Coefficients for Significance:

$$Y_m^T \cdot Y_m = \begin{bmatrix} 1.072 & 1.009 & 0.398 & 5.823 & 5.004 \\ 1.009 & 1.375 & 0.592 & 5.895 & 5.241 \\ 0.398 & 0.592 & 0.303 & 2.599 & 2.397 \\ 5.823 & 5.895 & 2.599 & 92.559 & 32.15 \\ 5.004 & 5.241 & 2.397 & 32.15 & 28.316 \end{bmatrix}$$

$$Y_m^T \cdot Z_m = \begin{bmatrix} 12.503 \\ 13.863 \\ 6.261 \\ 111.473 \\ 68.829 \end{bmatrix}$$

$$\text{Beta} := (Y_m^T \cdot Y_m)^{-1} \cdot (Y_m^T \cdot Z_m)$$

$$\text{Beta} = \begin{bmatrix} 1.2 \\ 1.4 \\ 3.3 \\ 0.6 \\ 0.999 \end{bmatrix}$$

Since Matrix Z = Beta, test of significance for Regression is OK.

Z-score Average for Manufacturing:

$$Z_{\text{avg}} := M \cdot \text{Beta}$$

$$Z_{\text{avg}} = 4.107$$

Z-score Standard Deviation:

$$\text{Sigma} := S \cdot \text{Beta}$$

$$\text{Sigma} = 2.575$$