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Abstract: Managing a technical function is not the same as managing a nontechnical business. Technical functions deal with creating or improving something and providing operational groups with more predictable tasks. It may be postulated that a technical manager should have different characteristics from a non-technical manager.

Much of the literature dealing with studies related to engineers and scientists focuses on the relationship between engineers and scientist's academic achievement and job performance. We studied the characteristics of chief executive officers with technical degrees, according to their career path, size of the company that they manage, age, and the industry in which they are involved. In addition, we will determine any significant differences between chief executive officers who have technical degrees and those who do not.

**ENGINEERS AND SCIENTIST AS CHIEF  
CHIEF EXECUTIVE OFFICERS**

**E. Salgado**

**EMP - P9001**

**ENGINEERS AND SCIENTISTS AS CHIEF EXECUTIVE OFFICERS**

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**EAS 506**

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# ENGINEERS AND SCIENTISTS AS CHIEF EXECUTIVE OFFICERS

## 1. INTRODUCTION

Managing a technical function is not the same as managing a nontechnical business. Technical functions deal with creating or improving something and operational groups with more predictable tasks(9). It may be postulated that, due to these factors, a technical manager should have different characteristics from a non-technical manager. Those characteristics include education, career path, age, industry site and size of the company managed.

Much of the literature dealing with studies related to engineers and scientists focuses in the relationship between engineers and scientist' academic achievement and job performance (1, 4, 6, 7, 8, 10, 11). Different from them, we are going to study the characteristics of chief executive officers with technical degrees, according to their career path, size of the company that they manage, age, and the industry in which their company is involved. In addition, it will be determined if there is a significant difference between the distribution of age, company size, industry and career path of those chief executive officers who have technical degrees and those who do not.

## 2. METHODOLOGY

To achieve our objective, we decided to analyze one thousand

chief executive officers listed in The Business Week special issue on The Corporate Elite (12). We researched the educational background of these chief executive officers and were able to find education information on 864 of them. Those 864 of the original 1000 were chosen for further study.

In the first step of our analysis, we looked at the educational backgrounds of the chief executive officers, their career paths, the industries where their companies are located, their ages, and the size of their companies in 1988's sales volume. All of this information was collected through secondary data sources (2, 3, 5, 12, 13, 14 and 15). We categorized the educational background as:

1. Engineering-Science (technical degree)

- All engineering degrees
- Agriculture
- Architecture
- Biology
- Chemistry
- Geophysics
- Geography
- Geology
- Industrial Management
- Mathematics
- Metallurgy
- Mining
- Physics

-Textiles

2. Business

- Accounting
- Banking
- Commerce
- Economics
- Finance
- Insurance
- International Trade
- Management
- Marketing
- Retailing management

3. Legal

- Civil Law
- Law
- Prelegal

4. Other

- American Civilization
- Communications
- Education
- Foreign Affairs
- History
- International Relations
- Journalism

- Language
- Political Science
- Psychology
- Sociology
- Urban and Public Administration

We also identified eight additional categories that represent combinations of the four categories above. These are:

5. Engineering-Science/Business
6. Engineering-Science/Legal
7. Engineering-Science/Other
8. Business /Legal
9. Business/Other
10. Legal/Other
11. Engineering-Science /Business/Legal
12. Business/Legal /Other

A final additional category which takes into account those chief executive officers who do not have a high school diploma or an undergraduate degree. We consider that a CEO has a technical degree if he/she has at least one engineering-science degree.

"Career path" was categorized as:

1. Technical:
  - Engineering/Technical
  - Operations

- Production/Manufacturing
- Sales/Programming

## 2. Nontechnical

- Academician (non-technical)
- Administration
- Banking
- Broadcasting/Publishing
- Communications
- Contracts
- Corporate Lending
- Distribution
- Entrepreneur (non-technical)
- Finance/Accounting
- Founder (non-technical)
- Hospital Management
- Insurance
- Investment/Research & Trust
- Legal
- Management/General Management
- Merchandising/Marketing
- Planning
- Real Estate
- Real Estate Development
- Sales
- Security Service
- Strategic Planning

-Waste Management

---

3. Both technical and non-technical: It includes the chief executive officers who have followed both career paths.

The categories to identify the different industries where the CEOs' companies were located, were based in the classification done in the article "Executive Pay"(5). These categories include:

1. High Tech:

- Aerospace
- Electrical, Electronics
- Instruments
- Office Equipment and Computers

2. Low Tech:

- Building Materials
- Chemicals
- Conglomerates
- Containers & Packaging
- General & Special Machinery
- Manufacturing & Miscellaneous
- Steel
- Tire & Rubber

3. Transportation:

- Airlines
- Railroads
- Trucking

4. Consumer Products:

- Appliances & Home Furnishings
- Automotive
- Beverages
- Drugs
- Food Processing
- Leisure Time Industries
- Personal Care Products
- Textiles
- Apparel
- Tobacco

5. Service:

- Food & Lodging
- Publishing, Radio & Television
- Retailing Food
- Retailing Nonfood
- Service Industries

6. Resources:

- Metal & Mining
- Natural Resources (fuel)
- Oil Service Supply

-Paper & Forest Products

7. Financial Services:

-Banks & Bank Holding Companies

-Nonbank Financial

8. Telecommunications

9. Utilities

The chief executive officers' ages were categorized as:

1. Under 50
2. 50 to 59
3. Over 59

The sizes of the companies were determined according to the sales volume(\$) as follow:

1. Small Companies (sales under \$1 billion)
2. Medium Companies ( 1 - 10 billion dollars)
3. Large Companies (sales over \$10 billion)

To categorize the CEOs' companies using this variable, we used the sales volume(\$) at the end of 1988.

In all the different variables (except in education), an additional category, labeled MISSING, was added to indicate those values that we were unable to find.



To analyze the data, we first identified the overall data characteristics, making frequency tables for each of the variables studied to identify the most relevant characteristics. After that, we cross-tabulated the education background of the chief executive officers against each of the other variables (industry, company size, career path and age) to place the distribution of the engineers in each of the different variable categories and compare them to each educational backgrounds.

Finally, we compared the distribution of engineers and non-engineers in the different industries, company sizes, and career paths to study if any difference exist between these two distributions. To do this we formed two groups. Group -1 consisted of the chief executive officers who have at least one engineering-science background and Group -2 was formed of those chief executive officers who do not have an engineering-science background.

To make this comparison we hypothesized that there is no a significant difference between the two distributions. To test this hypothesis a Chi-square distribution was used at the 95% significance level.

### 3. DATA ANALYSIS AND INTERPRETATION

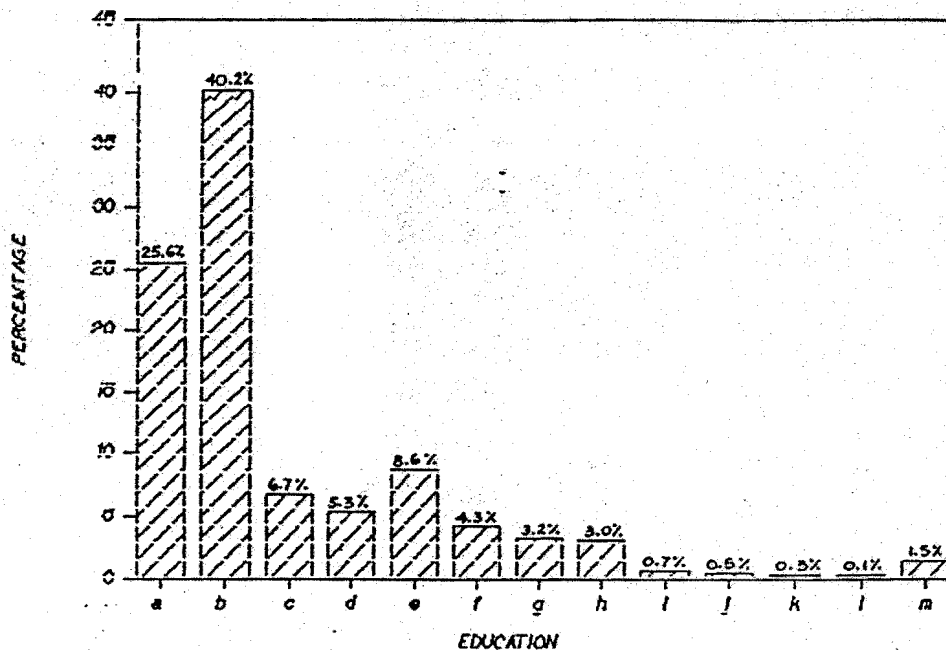
#### 3.1 OVERALL CHARACTERISTICS

##### a. EDUCATION

Looking at the educational background of the chief executive

officers, we found that 35.7% have an engineering-science background (25.6% have engineering-science background only, 10.1% have a combination of the technical background and a non-technical background), and 40.2% have a business degree. 20.7% of the CEOs have more than one degree. Among the multiple-degreed CEO's, the most common combination is engineering-science/business with 8.6%. 1.5% of the CEOs do not have a degree ( see Figure #1).

FIGURE #1. CEO's EDUCATION



- |                    |                   |                     |
|--------------------|-------------------|---------------------|
| a. Eng-Science     | f. Business/Other | k. Eng-Sc/Bus/Legal |
| b. Business        | g. Legal/Other    | l. Bus/Leg/Other    |
| c. Legal           | h. Business/legal | m. No degrees       |
| d. Other           | i. Eng-Sc/Legal   |                     |
| e. Eng-Sc/Business | j. Eng-Sc/Other   |                     |

The total of the combined degrees is as follows:

35.7% Engineering-Science degrees  
56.5% Business degrees  
14.0% Legal degrees  
13.4% Other degrees  
1.5% No degrees  
121.1% Total

Total is more than 100% percent because CEO's with multiple degrees are included in the above figures. Figure #2 shows the distribution of the combined degrees. The composition of the combined degrees is shown in table #1.

FIGURE #2: COMBINATION OF DEGREES

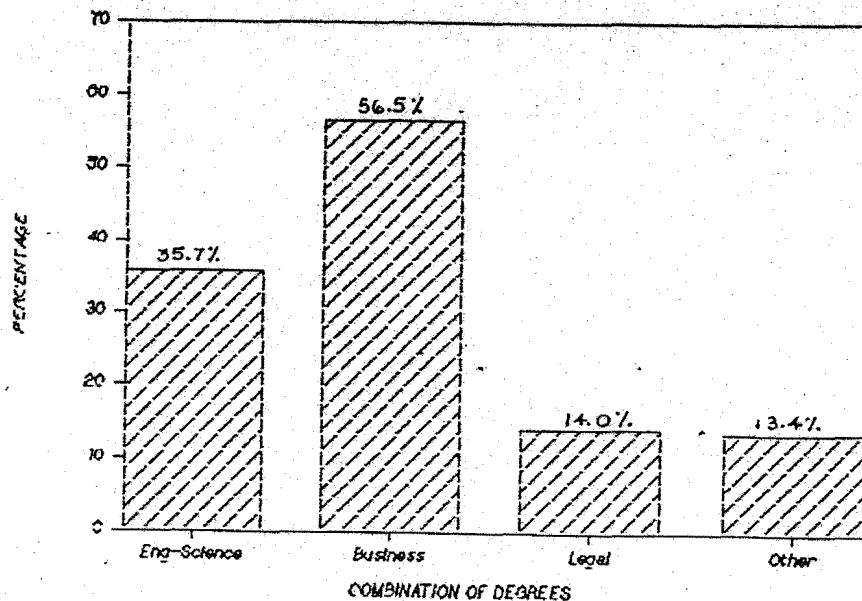


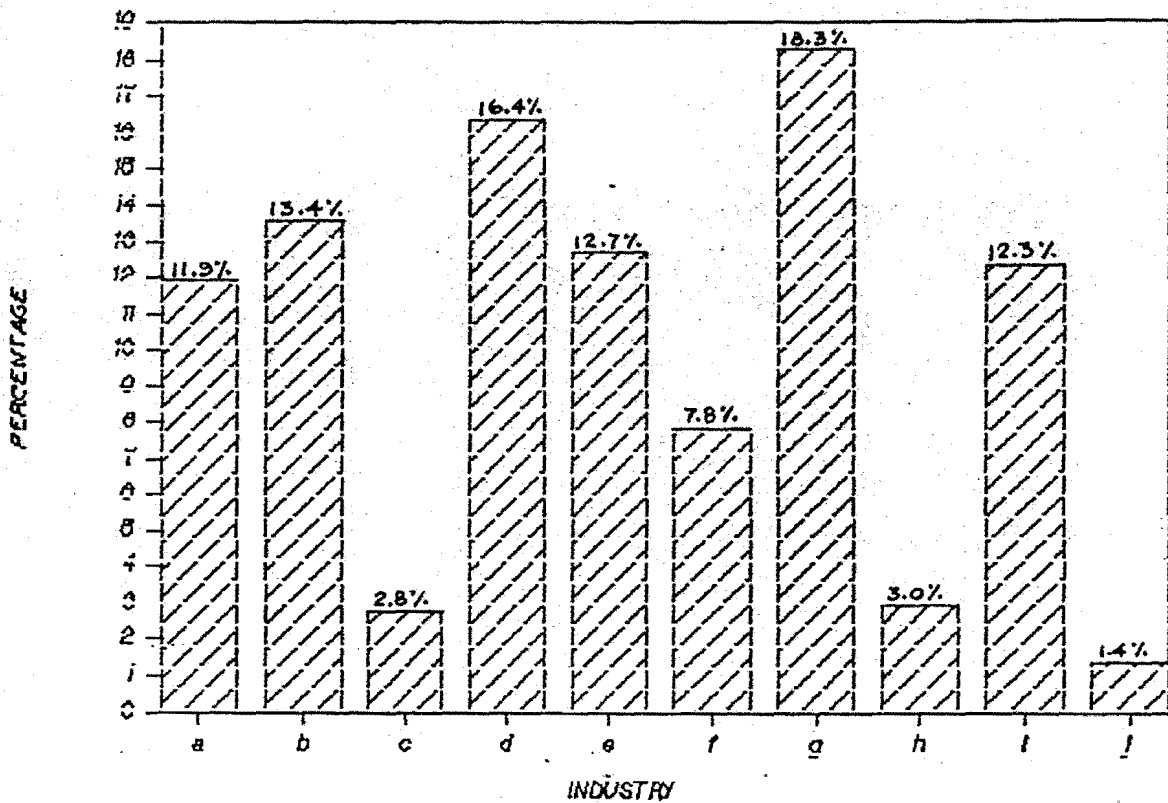
TABLE #1  
COMBINED DEGREES

	FREQ	%		FREQ	%
<b>a. ENG-SCIENCE:</b>			<b>b. BUSINESS</b>		
Eng-Science	221	25.6	Business	347	40.2
Eng-Science/Bus	74	8.6	Eng-Science/Bus	74	8.6
Eng-Science/Legal	6	0.7	Business/Other	37	4.3
Eng-Science/Other	4	0.5	Business/Legal	26	3.0
Eng-Science/Bus/Leg	3	0.3	Eng-Sc/Bus/Legal	3	0.3
TOTAL ENG-SCIENCE	308	35.7	Bus/Leg/Other	1	0.1
			TOTAL BUSINESS	488	56.5
<b>c. LEGAL:</b>			<b>c. OTHER:</b>		
Legal	58	6.7	Other	46	5.3
Legal/Other	28	3.2	Business/Other	37	4.3
Business/Legal	26	3.0	Legal/Other	28	3.2
Eng-Science/Legal	6	0.7	Eng-Science/Other	4	0.5
Eng-Sc/Bus/Legal	3	0.3	Bus/Legal/Other	1	0.1
Bus/Legal/Other	1	0.1	TOTAL OTHER	116	13.4
TOTAL LEGAL	122	14.0			

**b. INDUSTRY**

The majority of the top 1000 companies are in the Financial Service and Consumer Products Industries (18.3% and 16.4% respectively). Other industries have the following percentages: low tech (13.4%), service (12.7%), utilities (12.3%), and high tech industries (11.9%) (see figure #3).

**FIGURE #3: INDUSTRY**

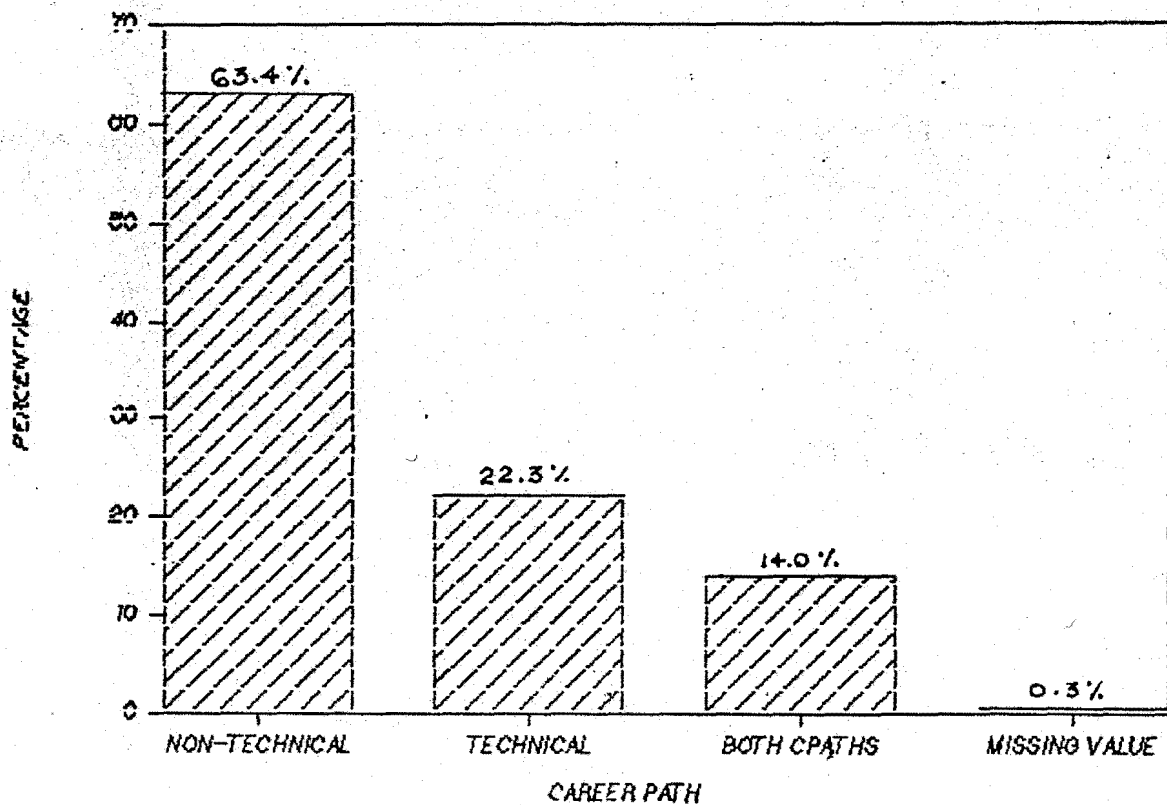


- |                      |                       |
|----------------------|-----------------------|
| a. High Tech         | f. Resources          |
| b. Low Tech          | g. Financial Services |
| c. Transportation    | h. Telecommunications |
| d. Consumer Products | i. Utilities          |
| e. Service           | j. Missing Value      |

### c. CAREER PATH

22.3% of the CEO's have followed a purely technical path in their careers, 63.4% have gone through a non-technical path, and 14% have combined the two (see figure #4). This shows that, of the 964 CEO's 36.3% have had at least part of their careers in the technical area.

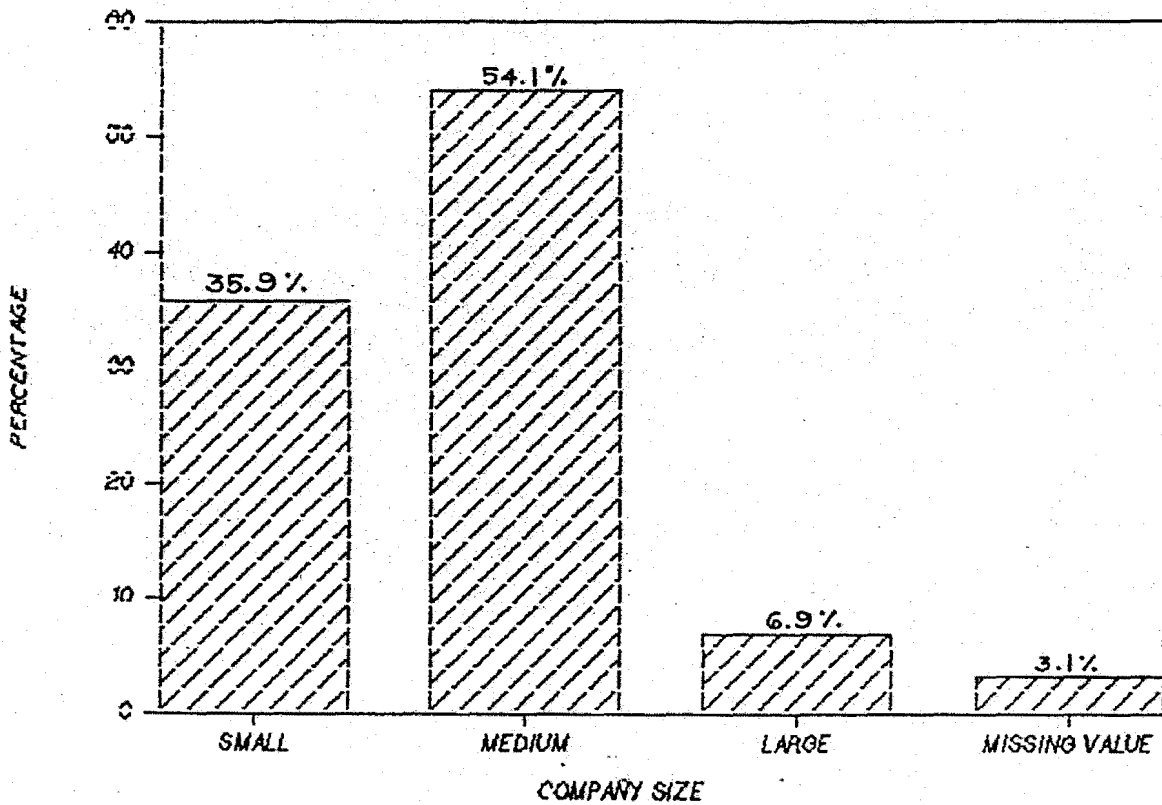
FIGURE #4: CEOs' CAREER PATH



d. COMPANY SIZE

54.1% of the top 1000 companies are medium-sized (sales between \$1 and \$10 billion), 35.9% are small (sales below \$1 billion), and 6.9% are large (sales above \$10 billion) (see figure #5).

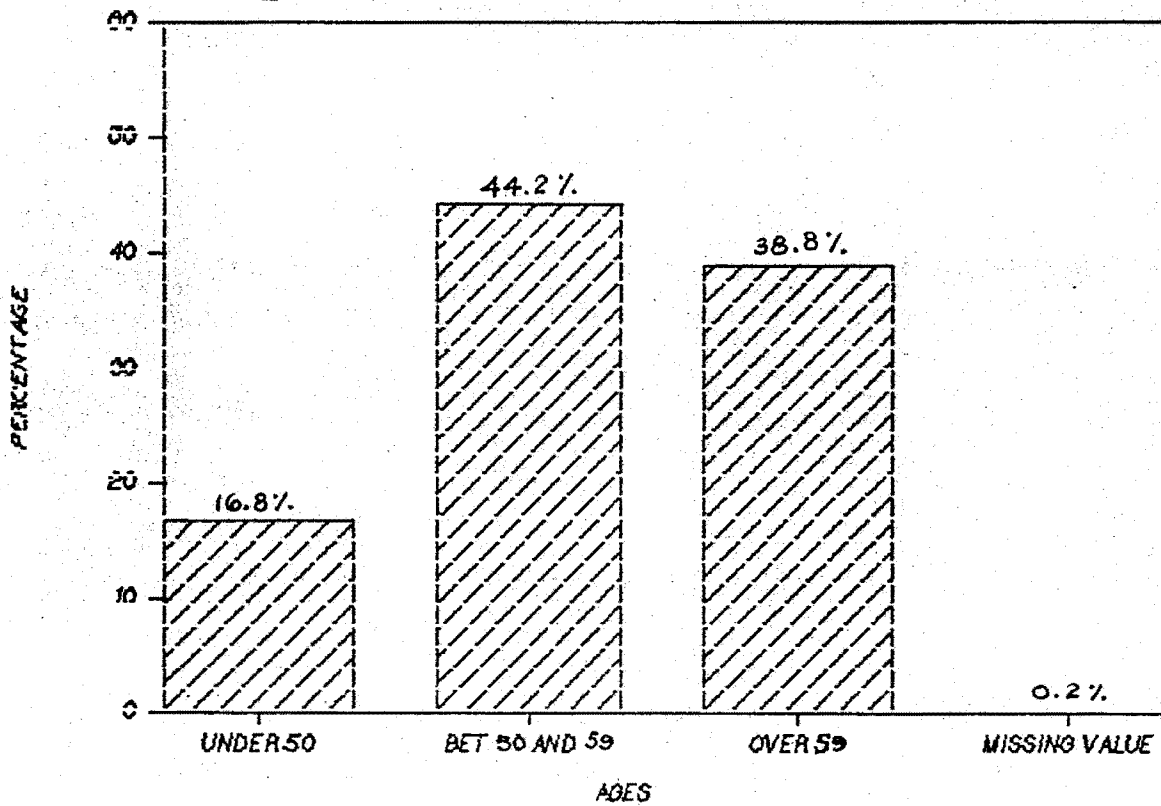
FIGURE #5: COMPANY SIZE



e. AGES

Most of the CEOs are between 50 and 59 years old (44.2%), followed by the over 59 category (38.8%). Only a low percentage (16.8%) are under 50 years old ( see Figure #6).

FIGURE #6: CEOs' AGES





3.2 OVERALL COMPARISONS OF THE EDUCATIONAL BACKGROUND VERSUS  
THE OTHER VARIABLES STUDIED

a. EDUCATION VS COMPANY SIZE

In table #2 we can see the distribution of the CEO's in the  
different company sizes.

TABLE #2  
EDUCATION VS COMPANY SIZE  
TOTAL PERCENTAGE

EDUCATION		SMALL	MEDIUM	LARGE	MISSING VALUE
ONE DEGREE	FREQ				
Business	347	13.7	22.2	2.4	1.9
Eng-Science	221	8.4	14.6	2.1	0.5
Legal	58	2.7	3.4	0.5	0.2
Other	46	2.4	2.4	0.3	0.1
MORE THAN ONE DEGREE:					
Eng-science/bus	74	3.9	3.8	0.7	0.1
Business/Other	37	1.9	2.1	0.1	0.2
Legal/Other	28	1.4	1.5	0.3	0.0
Business/Legal	26	0.7	2.1	0.2	0.0
Eng-Science/Leg	6	0.3	0.3	0.0	0.0
Eng-science/other	4	0.0	0.3	0.1	0.0
Eng-Sc/Bus/Leg	3	0.0	0.2	0.1	0.0
Bus/Leg/Other	1	0.0	0.0	0.0	0.1
No High or Und	13	0.5	1.0	0.0	0.0
TOTAL	864				

14.6% have an engineering-science education and work in medium-sized companies, compared to 22.2% who have a business background and work in medium-sized companies.

8.4% have an engineering-science degree and work in small-sized companies, compared to 13.7% who have a business degree and work in small-sized companies.

Of those chief executive officers who have more than one degree, 3.9% have an engineering-science/business degree and work in small-sized companies, 3.8% have an engineering-science/business degree and work in medium-sized companies. Only 0.7% of the CEOs have an engineering-science/business degree and are work on large-sized companies.

#### **b. EDUCATION VS CAREER PATH**

The following table presents the career paths followed by the CEO's of the top 1000 companies.

33.3% of CEOs have a business degree and have followed a nontechnical career path, 6.0% have a legal degree and have followed a non-technical career path. Only 5.2% of the CEOs have an engineering-science degree and have followed a non-technical career path.

TABLE #3  
EDUCATION VS CAREER PATH  
TOTAL PERCENTAGE

CAREER PATH		TECHNICAL	NONTECH	BOTH	MISSING
EDUCATION					
ONE DEGREE:	FREQ				
Business	347	2.8	33.3	3.9	0.1
Eng-Science	221	14.6	5.2	5.7	0.1
Legal	58	0.2	6.0	0.5	0.0
Other	46	0.5	4.3	0.6	0.0
MORE THAN ONE DEGREE:					
Eng-Science/Business	74	2.8	3.9	1.9	0.0
Business/Other	37	0.8	3.1	0.3	0.0
Legal/Other	28	0.0	3.2	0.0	0.0
Business/Legal	26	0.1	2.8	0.1	0.0
Eng-Science/Legal	6	0.2	0.1	0.3	0.0
Eng-Science/Other	4	0.1	0.2	0.1	0.0
Eng-Sc/Bus/Leg	3	0.1	0.0	0.2	0.0
Bus/Leg/Other	1	0.0	0.1	0.0	0.0
No High or Undergrad	13	0.1	1.0	0.3	0.0

Of those chief executive officers that have more than one degree, 3.9% have an engineering-science/business degree and a non-technical career path.

With respect to technical career path, 14.6% of the CEOs have an engineering-science degree and a technical career path, compared to 2.8% have a business degree and a technical career path, and 2.8% have an engineering-science/business degree and a technical career path.

5.7% of the CEOs have an engineering-science degree and both

career paths, compared to 3.9% who have a business degree and both career paths.

### c. EDUCATION VS INDUSTRY

The following table shows in which type of industry the CEO's studied are working.

TABLE #4  
EDUCATION VS INDUSTRY  
TOTAL PERCENTAGE

INDUSTRY		HIGH TECH	LOW TECH	TRANSP	CONSUMER	SERVICE	RESOURCE	FIN SERV	TELECOM	UTILITIES	MISSING
<b>EDUCATION</b>											
<b>ONE DEGREE:</b>	<b>FREQ</b>										
Business	347	3.1	4.9	1.0	7.2	5.0	2.3	11.2	1.4	3.7	0.3
Eng-Science	221	5.8	4.6	0.5	2.5	2.2	3.7	0.5	0.6	4.9	0.3
Legal	58	0.5	0.1	0.5	0.9	1.3	0.5	1.7	0.0	1.0	0.2
Other	46	0.2	0.3	0.0	1.3	1.5	0.0	1.5	0.2	0.2	0.0
<b>MORE THAN ONE DEGREE:</b>											
Eng-Science/Bus	74	1.4	2.1	0.1	2.0	0.6	0.7	0.8	0.5	0.5	0.0
Business/other	37	0.5	0.5	0.2	0.6	0.9	0.2	0.9	0.0	0.3	0.1
Legal/Other	28	0.0	0.3	0.5	0.5	0.5	0.1	0.6	0.1	0.6	0.1
Business/Legal	26	0.3	0.2	0.0	0.9	0.1	0.0	0.6	0.0	0.8	0.0
Eng-Sc/Legal	6	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.1
Eng-Sc/Other	4	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.0
Eng-Sc/Bus/Leg	3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Bus/Leg/Other	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
No High/Underg	13	0.1	0.1	0.0	0.5	0.5	0.1	0.2	0.0	0.0	0.0

11.2% have a business degree and work in the financial service industry, only 0.5 % of CEOs have an engineering-science degree and work in this industry.

Of those who have more than one degree, 0.8% have an engineering-science/business degree and work in this industry.

7.2% of the chief executive officers work in the consumer products industry and have a business degree, compared to 2.5% who have an engineering-science degree and work in this industry.

5.8% of the chief executive officers work in the high tech industry and have an engineering-science degree, compared to 3.1% who have a business degree and work in the high tech industry.

Five percent of the chief executive officers work in the service industry and have a business degree, compared to 2.2% who have an engineering-science background and work in this industry.

4.9% of the CEOs work in the low tech industry and have a business background compared to 4.6% who have an engineering-science background and work in the low tech industry.

4.9% of CEOs work in the utilities industry and have an engineering-science background, compared to 3.7% that have a business background and 1% that have a legal background.

3.7% of CEOs work in the resource industry and have an engineering-science background, compared to 2.3% who have a business background and work in this industry.

1.4% of CEOs work in the telecommunications industry and have a business degree compared to only 0.6% with engineering-

science background who work in this industry.

d. EDUCATION VS AGE

Table #5 presents the distribution of the CEO's age.

TABLE #5  
EDUCATION VS AGE  
TOTAL PERCENTAGE

AGE		UNDER 50	50 TO 59	OVER 59	MISSING
EDUCATION					
ONE DEGREE					
Business	347	5.8	19.8	14.4	0.2
Eng-Science	221	2.8	10.3	12.5	0.0
Legal	58	0.9	2.9	2.9	0.0
Other	46	1.4	2.0	2.0	0.0
MORE THAN ONE DEGREE:					
Eng-sc/bus	74	2.4	3.5	2.7	0.0
Business/Other	37	1.6	1.6	1.0	0.0
Legal/Other	28	0.3	1.9	1.0	0.0
Business/leg	26	0.9	1.4	0.7	0.0
Eng-sc/legal	6	0.2	0.2	0.2	0.0
Eng-sc/Other	4	0.0	0.2	0.2	0.0
Eng-sc/bus/leg	3	0.0	0.1	0.2	0.0
Bus/Leg/Other	1	0.1	0.0	0.0	0.0
No high or und	13	0.2	0.3	0.9	0.0

Looking at the CEOs' age distribution, we found that 19.8% of them are between 50 and 59 years old and have a business background, compared to 10.3% who are in this age range and have an engineering-science background.

14.4% of CEOs are over 59 and have a business background, compared to 12.5% who are in this age range and have an engineering-science background.

5.8% of CEOs are under 50 and have a business background, compared to 2.8% who are in this age range and have an engineering-science background.

### **3.3 DISTRIBUTION OF THE CHIEF EXECUTIVE OFFICERS OVER THE DIFFERENT VARIABLES STUDIED BASED ON EDUCATIONAL BACKGROUND**

Analyzing the education backgrounds of the chief executive officers and their distribution in the different categories studied (company size, industry, career path, and age), we find the following:

#### **a. EDUCATION VS COMPANY SIZE**

Of the 221 chief executive officers with an engineering-science background, 57% work in medium-sized companies, 33% work in small-sized companies, and only 8.1% work in large-sized companies (see Table #6).

TABLE #6  
EDUCATION VS COMPANY SIZE

COMPANY SIZE	SMALL	MEDIUM	LARGE	MISSING
<b>EDUCATION</b>				
<b>ONE DEGREE:</b>				
Business 347	118(34)	192(55.3)	21(6.1)	16(4.6)
Eng-Science 221	73(33)	126(57)	18(8.1)	4(1.8)
Legal 58	23(39.7)	29(50)	4(6.9)	2(3.4)
Other 46	21(45.7)	21(45.7)	3(6.5)	1(2.2)
<b>MORE THAN ONE DEGREE:</b>				
Eng-Sc/Business 74	34(45.9)	33(44.6)	6(8.1)	1(1.4)
Bus/Other 37	16(43.2)	18(48.6)	1(2.7)	2(5.4)
Legal/Other 28	12(42.9)	13(46.4)	3(10.7)	0
Bus/Legal 26	6(23.1)	18(69.2)	2(7.7)	0
Eng-Sc/Legal 6	3(50)	3(50)	0	0
Eng-SC/Other 4	0	3(75)	1(25)	0
Eng-Sc/Bus/Leg 3	0	2(66.7)	1(33.3)	0
Bus/Leg/Other 1	0	0	0	1(100)
No high/under 13	4(30.8)	9(69.2)	0	0

The most common combination of the degrees is the combination of engineering-science with business. Seventy four chief executive officers have that combination. Of them, 45.9% work in small-sized companies, 44.6% work in medium-sized companies, and 8.1 % work in large-sized companies.

Thirteen other chief executive officers have engineering-science degree combined with a degree other than business. Six CEOs have an eng-science/legal degree, 50% of them work in small



companies, and 50% in medium-sized companies. Four have an engineering-science/other degree, 75% work in medium-sized companies, and 25% work in large-sized companies. Three CEOs have an engineering-science/business/legal degree; of them 66.7% work in medium-sized companies and 33.3% in large-sized companies.

On the other hand, of the 347 chief executive officers who have a business background, 55.3% work in medium-sized companies, 34% work in small companies, and 6.1 % work in large-sized companies (see Table #5).

Fifty eight chief executive officers have a legal background. 50% work in medium-sized companies, 39.7% work in small-sized companies, and 6.9% work in large-sized companies.

Forty six chief executive officers have "other" background, 45.7% of them work in medium-sized companies, 45.7% work in small-sized companies, and 6.5% work in large-sized companies.

Of the 37 chief executive officers who have a combination business/other background, 48.6% work in medium-sized companies, 43.2% work in small-sized companies, and 2.7 % work in large-sized companies.

Of the 28 chief executive officer who have a legal/other background, 46.4% work in medium-sized companies, 42.9% work in small-sized companies, and 10.7% work in large-sized companies.

Of those 26 chief executive officer who have a business/legal background, 69.2% work in medium-sized companies, 23.1% work in small-sized companies, and 7.7% work in large-

sized companies.

Looking at this distribution, we see that there is a small difference in the percentage of chief executive officers who work in medium companies and have a business background and those who work in this company size and have an engineering-science background. The most significant difference is between those who have an engineering-science background and work in medium-sized companies and those who have an engineering-science/ business background and work in this company size category.

In small companies, there is also a small difference in the percentage of chief executive officers with engineering-science backgrounds and business backgrounds, but these two are very different from the chief executive officers who have engineering-science/business backgrounds (45.9%) and the chief executive officers with "other" background (45.7%), and also from those chief executive officers who have a business/legal background (23.1%) (see Table #6).

In large companies, the percentage of chief executive officers who have engineering-science background is the same as those who have engineering-science/business background (8.1%). There is very little difference in the percentage of chief executive officers who have business, legal, and "other" backgrounds (6.1, 6.9 and 6.5% respectively). The greatest difference that we can see is between the chief executive officers who have a business/other background (2.7%) and those who have engineering-science/ business/legal backgrounds (33.3%),

but this difference is due to the total numbers of chief executives in each category. There are 37 chief executives with business/other backgrounds and only 3 with engineering-science/business/legal backgrounds (see Table #6).

We can also see that a great percentage in each educational background category works in medium-size companies, with the exception of those chief executive officers who have engineering-science/business background, most of whom work in small-sized companies.

#### **b. EDUCATION VS INDUSTRY**

With respect to those CEOs who have an eng-science degree, 22.6% work in high tech industry, 19% in the utilities industry. Only 1.8% work in the financial service industry and 1.8% work in the transportation industry (see table #7).

Of those CEOs who have an engineering-science/business degree the greatest numbers (24.3%) work in low-tech industry, 23% work in the consumer product industry, and 16.2% work in high-tech industry. Only 1.4% work in the transportation industry.

No CEOs with engineering-science/legal degree work in the high-tech, transportation, financial service and utilities industries. For these CEOs there is no preference of industry (see table #7).

For the CEOs who have an engineering-science/other degree, the most common industry to work in is the financial service industry, with 50% of CEOs.

For the CEOs with engineering-science/business/legal degree, the three most common industries to work in are low-tech, telecommunication, and utilities industries which have 33.3% each.

TABLE #7  
EDUCATION VS INDUSTRY

INDUSTRY EDUCATION	HIGHTECH	LOWTECH	TRANSP	CONSUMER	SERVICE	RESOURCE	FIN SERV	TELECOM	UTILITIES	MISSING
ONE DEGREE FREQ(%)										
Business 347(40.2)	27(7.8)	42(12.1)	9(2.6)	62(17.9)	43(12.4)	20(5.8)	97(28)	12(3.5)	32(9.2)	3(0.9)
Eng-science 221(25.6)	50(22.6)	40(18.1)	4(1.8)	22(10)	19(8.6)	32(14.5)	4(1.8)	5(2.3)	42(19)	3(1.4)
Legal 58(6.7)	4(6.9)	1(1.7)	4(6.9)	8(13.8)	11(19)	4(6.9)	15(25.9)	0	9(15.5)	2(3.4)
Other 46(5.3)	2(4.3)	3(6.5)	0	11(23.9)	13(28.3)	0	13(28.3)	2(4.3)	2(4.3)	0
MORE THAN ONE DEGREE										
Eng-sc/bus 74(8.6)	12(16.2)	18(24.3)	1(1.4)	17(23)	5(6.8)	6(8.1)	7(9.5)	4(5.4)	4(5.4)	0
Business/Other 37(4.3)	4(10.8)	4(10.8)	2(5.4)	5(13.5)	8(21.6)	2(5.4)	8(21.6)	0	3(8.1)	1(2.7)
Legal/Other 28(3.2)	0	3(10.7)	4(14.3)	4(14.3)	4(14.3)	1(3.6)	5(17.9)	1(3.6)	5(17.9)	1(3.6)
Business/Leg 26(3.0)	3(11.5)	2(7.7)	0	8(30.8)	1(3.8)	0	5(19.2)	0	7(26.9)	0
Eng-sc/leg 6(0.7)	0	1(16.7)	0	1(16.7)	1(16.7)	1(16.7)	0	1(16.7)	0	1(16.7)
Eng-sc/Other 4(0.5)	0	0	0	0	1(25)	0	2(50)	0	1(25)	0
Eng-sc/bus/leg 3(0.3)	0	1(33.3)	0	0	0	0	0	1(33.3)	1(33.3)	0
Bus/Leg/Other 1(0.1)	0	0	0	0	0	0	0	0	0	1(100)
No high sch/under 13(1.5)	1(7.7)	1(7.7)	0	4(30.8)	4(30.8)	1(7.7)	2(15.4)	0	0	0

Of those chief executive officers with a business degree, 28% work in the financial service industry, 17.9% in the consumer product industry. Only 2.6% work in the transportation industry (see Table #7).

For those that have a legal degree the most common industry to work in is the financial service industry with 25.9% of CEOs. The second most common is the service industry with 19% of CEOs with legal degree. The least common industry to work in for CEOs with legal degrees is low-tech industry, with only 1.7% of the CEOs with legal degrees (see Table #7).

For those CEOs with "other" degree the two most common industries to work in are the service and financial service industry with 28.3% of CEOs each. The second most common industry for those CEOs with other degree is the consumer products industry. There are no CEOs with "other" degree working in the transportation or resource industry.

Of those CEOs who have a business/other degree the two most common industries to work in are the service and financial service industries with 21.6% each. The second most common industry to work in for these CEOs is the consumer products industry with 13.5%. No CEOs with business/other degree work in the telecommunication industry (see Table #7).

For those CEOs with a legal/other degree, the most common industries to work in are the financial services industry and the utilities industry, with 17.9% each. The second most common

industries are transportation, consumer products and service industries, with 14.3% of CEOs with a legal/other degree.

For those with a business/legal degree, the most common industry to work is the consumer products industry with 30.8% of the CEOs. The second most common industry for these CEOs is the utilities industry, with 26.9% of these CEOs. No CEOs with a business/ legal degree work in the transportation, resource, and telecommunication industries (see Table #7).

For those with no degrees the most common industries to work in are the consumer product industry and the service industry with 30.8% each.

Looking at this distribution, we can see that high-tech industry is the most common industry to work in for the CEOs with engineering-science degrees (22.6%), but it is not as common for CEOs with business (7.8%) and legal (6.9%) degrees. High-tech industry is one of the least common industries for CEOs with "other" degree (4.3%).

Low-tech industry is the most common industry to work in for CEOs with engineering-science/business degrees (24.3%), but it is the least common for CEOs with legal degree (1.7%). For CEOs with engineering-science degrees, this industry is the third most common (18.1%) to work in.

The transportation industry is one of the most common industries to work in for CEOs with legal/other degrees (14.3%), but the least common industry for CEOs with business (2.6%), engineering-science (1.8%), engineering-science/business (1.4%),

and business/other (5.4%) degrees (see Table #7).

The consumer products industry is the most common industry to work in for CEOs with business/legal degrees (30.8%). This industry is the second most common for CEOs with "other" degree (23.9%), engineering-science/ business (23%), business degree (17.9%), business/other (13.5%), and CEOs with legal/other (14.3%) degrees (see Table #7).

The service industry is the most common industry to work in for the CEOs with "other" degree (28.3), and CEOs with business/other degrees (21.6%). This industry is the second most common for CEOs with legal/other degrees (14.3%).

The resource industry is the least common industry to work in for CEOs with business/other degrees (5.4%), and CEOs with legal/other degrees (3.6%). Although this industry is not the first or second most common to work in for any of the CEOs, 14.5% of CEOs with engineering-science degree work in it as well as 8.1% of CEOs with engineering-science/business degrees.

The financial services industry is the most common industry to work in for the CEOs with business (28%), legal (25.9%), "other" (28.3%), and business/other (21.6%) degrees, but this industry is one of the least common industry to work in for CEOs with an engineering-science degree (1.8%) (see Table #7).

The telecommunication industry is the least common industry to work in for CEOs with legal/other degrees (3.6%). There is not a considerable percentage of CEOs with "other" background working in this industry.

The utilities industry is the most common industry to work in for CEOs with legal/other degrees (17.9%), but it is the second most common (26.9%) for CEOs with business/legal degree, engineering-science/other (25%), engineering-science (19%), and legal (15.5%) degrees. CEOs with no high school or undergraduate education work mostly in the consumer and service industries (30.8%).

**c. EDUCATION VS AGE**

For CEOs with engineering-science degrees the most common age is over 59 years old (48.9%) and the least common, as for business CEOs, is under 50 years old.

CEOs with engineering-science/business degrees are mostly (40.5%) found in the age range 50 to 59, but least commonly found under 50 years old (see table #8).

TABLE #8  
EDUCATION VS AGE

AGE		UNDER 50	50 TO 59	OVER 59	MISSING
<b>EDUCATION ONE DEGREE:</b>					
Business	347	50(14.4)	171(49.3)	124(35.7)	2(0.6)
Eng-Science	221	24(10.9)	89(40.3)	108(48.9)	0
Legal	58	8(13.8)	25(43.1)	25(43.1)	0
Other	46	12(26.1)	17(37)	17(37)	0
<b>MORE THAN ONE DEGREE:</b>					
Eng-Sc/Bus	74	21(28.4)	30(40.5)	23(31.1)	0
Bus/Other	37	14(37.8)	14(37.8)	9(24.3)	0
Leg/Other	28	3(10.7)	16(57.1)	9(32.1)	0
Bus/Legal	26	8(30.8)	12(46.2)	6(23.1)	0
Eng-Sc/Legal	6	2(33.3)	2(33.3)	2(33.3)	0
Eng-SC/Other	4	0	2(50)	2(50)	0
Eng-Sc/Bus/Leg	3	0	1(33.3)	2(66.7)	0
Bus/leg/Other	1	1(100)	0	0	0
No high/Underg	13	2(15.4)	3(23.1)	8(61.5)	0



CEOs with engineering-science/legal degrees are equally found (33.3%) in the three age ranges studied. CEOs with engineering-science/other degrees are equally found (50%) in the age ranges 50 to 59 and over 59 years old (see Table #8).

CEOs with business degrees are mostly (49.3%) between 50 and 59 years old. These CEOs are least commonly (14.4%) under 50 years old (see Table #8).

For CEOs with legal degrees the age range between 50-59 years old and over 59 are equally common (43.1%). These two age ranges are also the most common age ranges (37%) for CEOs with other degrees.

For the CEOs with legal/other degrees, the most common age ranges is between 50 and 59 years old (57.1%), and the least common (10.7%) is under 50 years old.

For CEOs with business/legal degrees most common age range (46.2%) is between 50 and 59 years old, and the least common (23.1%) is over 59 years old.

This distribution shows us that the age range 50 to 59 years old is the most common age range for almost all of the different chief executive officers, except for the chief executive officers with engineering-science degrees whose most common age range was over 59 years old. Even though this age range is not the most common for the CEOs with engineering-science background, there is a considerable percentage (40.3%) in this category, and this

percentage is not very different from the most common legal/other degree (57.1%) and business degree (49.3%).

The age range under 50 is the least common of almost all of the different CEOs backgrounds, except for CEOs with business/other degree (37.8%) and CEOs with business/legal degree (30.8%).

#### d. EDUCATION VS CAREER PATH

For CEOs with engineering-science degrees, technical career path is the most common (57%), both career paths as well as non-technical are least common for these CEOs (22.2% and 20.4% respectively) (see Table #9).

TABLE #9  
EDUCATION VS CAREER PATH

		CAREER PATH			
EDUCATION		TECHNICAL	NONTECH	BOTH	MISSING
<b>ONE DEGREE:</b>					
Business	347	24(6.9)	288(83)	34(9.8)	1(0.3)
Eng-Science	221	126(57)	45(20.4)	49(22.2)	1(0.5)
Legal	58	2(3.4)	52(89.7)	4(6.9)	0
Other	46	4(8.7)	37(80.4)	5(10.9)	0
<b>MORE THAN ONE DEGREE:</b>					
Eng-Sc/Bus	74	24(32.4)	34(45.9)	16(21.6)	0
Bus/Other	37	7(18.9)	27(73)	3(8.1)	0
Legal/Other	28	0	28(100)	0	0
Bus/Legal	26	1(3.8)	24(92.3)	1(3.8)	0
Eng-Sc/Legal	6	2(33.3)	1(16.7)	3(50)	0
Eng-SC/Other	4	1(25)	2(50)	1(25)	0
Eng-SC/Bus/Leg	3	1(33.3)	0	2(66.7)	0
Bus/Leg/Other	1	0	1(100)	0	0
No high or und	13	1(7.7)	9(69.2)	3(23.1)	0

A non-technical career path is the most common (45.9%) career path for CEOs with an engineering-science/business degrees. The least common (21.6%) career paths for these CEOs to follow are both career paths.

Of the CEOs with an engineering-science/legal degrees 50% followed both career paths and only 16.7% followed a non-technical career path.

None of the CEOs with an engineering-science/business/legal degree followed a nontechnical career path and 66.7% followed both career paths.

Non-technical career path is the most common (83%) career path for CEOs with a business degree. Technical career path is least common (6.9%) for these CEOs (see Table #9).

For CEOs with a legal degree a non-technical career path is the most common (89.7%), both career paths as well as technical career path are least common (6.9% and 3.4% respectively).

For CEOs with "other" degree a non-technical career path is the most common (80.4%). Technical career path is the least common (8.7%) for these CEOs.

For CEOs with business/other degrees the most common career path to follow is a non-technical career path (73%). Following both career paths is least common (8.1%) for these CEOs.

All CEOs with legal/other degrees followed a non-technical career paths. Of the CEOs with business/legal degrees, 92.3%

followed a non-technical career path and only 3.8% followed a technical career path.

Of those CEOs with no high school or undergraduate education, 69.2% followed a nontechnical career path and 23.1% followed both career paths.

We can see that the nontechnical career path was the most common career path for CEOs to follow, except for the CEOs with engineering-science degrees, of whom only 20.4% followed this career path.

A technical career path alone is the most common (57%) for CEOs with engineering-science degrees, although this career path is not the most common for CEOs with an engineering-science/business degree. Still, a considerable percentage (32.4%) of them followed this career path. The technical career path is least common (6.9%) for CEOs with only business degrees (see Table #9).

### **3.4 DISTRIBUTION OF CHIEF EXECUTIVE OFFICERS WITH A SPECIFIC EDUCATION AND INDUSTRY WITH RESPECT TO THE OTHER VARIABLES**

In this section the two or three most common industries to each educational background are studied.

Of those CEOs who have an engineering-science degree and are in high-tech industry, 52% work in medium-sized companies, 54% have

a technical degree and 42% are over 59 years old; 38% are between 50 and 59 years old.

Of those CEOs with an engineering-science degree working in the utilities industry, 50% are working in medium-sized companies, 66.7% have a technical degree and only 14.3% have a non-technical degree. 54.8% are over 59 years old and only 9.5% are under 50 years old.

Of those CEOs with engineering-science background in the low-tech industry, 75% are working in medium-sized companies, more than half (52.5%) have a technical career path, and 22.5% have both career paths, 47.5% are over 59 years old (see Tables #10, 11 and 12 in the appendix).

Of those CEOs with an engineering-science/business education working in low-tech industry, 55.6% work in medium-sized companies and only 5.6% work in large-sized companies. 44.4% are between 50 and 59 years old, and 38.9% are over 59 years old. 38.9% have a technical career path, 38.9% also have a non-technical career path.

Of those CEOs with engineering-science/business education working in the consumer industry, 47.1% are in small-sized companies and 41.2% are in medium-sized companies. 47.1% are over 59 years old, and 35.3% are between 50 and 59. The majority (58.8%) have a non-technical degrees.

Of those chief executive officers who have a business degree and are in the financial services industry, the majority (54.6%) are

in medium-sized companies, most of them (96.9%) have non-technical career paths, and the majority (54.6%) are between 50 and 59 years old (see Tables #9, 10 and 11 in the appendix).

Of those CEOs who have business degrees and are in the consumer industry, most of them (54.8%) are in medium-sized companies, most (87.1%) have a non-technical career path, and most are between 50 and 59 years old.

Of those who have a business degree and are in the service industry, the majority (58.1%) are working in medium-sized companies, most (86.1%) have a nontechnical career path, and the majority (46.5%) are between 50 and 59 years old.

Of those CEOs in the financial service industry with a legal education, 40% are in small companies, and 40% are in medium-sized companies. 86.7% have a non-technical career path and 6.7% have a technical career path and 6.7% have both career paths. 53.3% are over 59, 40% between 50 and 59 years old, and only 6.7% are under 50 years old.

Of those CEOs with a legal education in the service industry 54.5% work in medium-sized companies, 45.5% are between 50 and 59 years old, and 45.5% are over 59 years old. Most of these CEOs 90.9% have a non-technical career path.

Of those CEOs working in the service industry with "other" education, 61.5% work in small companies, 46.2% are over 59 years old, and only 23.1% are between 50 and 59 years old. The majority (76.9%) have a nontechnical career path, and 15.4% have

both career paths (see Tables #10, 11 and 12 in the appendix).

Of the CEOs with "other" education working in the financial service industry, 53.8% work in medium-sized companies and none work in large-sized companies. The majority (53.8%) are between 50 and 59 years old, 23.1% are under 50, and 23.1% are over 59 years old. The majority have followed a non-technical career path and none have a technical career path (see Tables #10, 11 and 12 in the appendix).

Of those CEOs with business/other education in the financial service industry, 50% are in small-sized companies and 12.5% are in the large-sized companies. 37.5% are under 50 years old and 37.5% are between 50 and 59 years old. All have a non-technical career path (see Tables #10, 11 and 12 in the appendix).

Of the CEOs with a business/other education in the service industry, the majority (62.5%) are in small-sized companies. 50% are under 50, only 12.5% are between 50 and 59 years old. 75% have non-technical career paths and none have both career paths (see Tables #10, 11 and 12 in the appendix).

Of those CEOs working in the financial service industry with a legal/other education, 80% work in medium-sized companies and none work in large-sized companies. Most of them (60%) are over 59 years old. All of them have a non-technical career path.

Of those CEOs with legal/other degrees working in the utilities industry, all have a non-technical career path, 60% are between 50 and 59 years old, 60% are in small companies and no

one works in large-sized companies.

Of those CEOs working in the consumer industry with a business/legal degree, the majority (75%) are in medium-sized companies. Most of them (62.5%) are between 50 and 59 years old, 87.5% have a non-technical career path, and none have a technical career path (see Tables #10, 11 and 12 in the appendix).

Of those CEOs working in the utilities industry with a business/legal education, 71.4% are in medium-sized companies and none are in large-sized companies. 57.1% are over 59 years old, and 28.6% are between 50 and 59 years old. All have a non-technical career path (see Tables #10, 11 and 12 in the appendix).

### **3.5 DISTRIBUTION OF THE CHIEF EXECUTIVE OFFICERS' EDUCATIONAL BACKGROUND IN THE DIFFERENT INDUSTRIES GIVEN A SPECIFIC VARIABLE**

CEOs with engineering-science education are most commonly found in high-tech industry and in the utilities industry (22.6% and 19% respectively) (see Table #7). In small companies the preference of these CEOs is utilities and high tech industries (26% and 23.3% respectively) (see Table #13 in the appendix). In medium-sized companies the preference of engineering-science people is low-tech industry, high tech, and the utilities industries (23.8%, 20.6%, and 16.7% respectively) (see Table #14



in the appendix). In large companies most of the engineering-science CEOs are in high tech and the resource industries (33.3% and 27.8% respectively). No CEOs working in large companies, work in the utilities industry (see Table #15 in the appendix).

Engineering-science CEOs under 50 are most commonly found in high-tech industry, low tech industry, and the utilities industry ( 41.7%, 16.7%, and 16.7% respectively) (see Table #16 in the appendix). For the engineering-science CEOs between 50 and 59 years old, the most common industries are high and low tech and utilities industries (21.3%, 19.1%, and 16.9% respectively) (see Table #17 in the appendix). For those over 59, the preference is maintained (utilities (21.3%) and high tech (19.4%)) (see Table #18 in the appendix).

For engineering-science CEOs with non-technical career path, low tech and service industries (22.2% and 17.8% respectively) are the most common (see Table #19 in the appendix). 13.3% of these CEOs are in the utilities industry. For CEOs with a technical career path, the utilities industry and high tech industry (22.2% and 21.4% respectively) are the most common (see table #20 in the appendix). For CEOs with both career paths, high-tech and low-tech industry are the most common (32.7% and 18.4% respectively) (see Table #21 in appendix). The utilities industry has 14.3% of these CEOs.

CEOs with an engineering-science/business education are mostly found in low-tech industry and the consumer industry (24.3% and 23% respectively) (see Table #7). In small companies these CEOs

are also found mostly in these industries: 23.5% in the consumer industry, 20.6% in high-tech industry, and 20.6% in low-tech industry (see Table #13 in the appendix). This also occurred in medium-sized companies (30.3% in low-tech industry and 21.2% in the consumer products industry)(see Table #14 in the appendix). In large-sized companies these CEOs are mostly found in the consumer industry (33.3%) and equally found in the financial service industry, low-tech industry, high-tech industry, and resource industry (see Table #15 in the appendix).

For the engineering-science/business CEOs under 50, the high-tech industry is the most common (23.8%) and they are equally found in low-tech and the service industries (14.3% each)(see Table #16 in the appendix). For those between 50 and 59 years old the most common industry is low-tech industry (26.7%) and they are found equally in high-tech and the consumer industries (20% in each one)(see Table #17 in the appendix). CEOs over 59 are found mostly in the consumer industry and in low-tech industry (34.8% and 30.4% respectively)(see Table #18 in appendix).

Those engineering-science/business CEOs with a non-technical career path are also found mostly in the consumer and low-tech industries (29.4% and 20.6% respectively)(see Table #19 in the appendix). Those with technical career paths are found mostly in low-tech industry (29.2%). These CEOs are equally found in the high tech industry, and consumer product industry (20.8% in each one)(see Table #20 in the appendix). Those who have both career paths are mostly found in low-tech and high-tech industries (25%

and 18.8% respectively)(see Table #21 in the appendix).

CEOs with business educations were most commonly found in the financial service industry and the consumer industry (28% and 17.9% respectively). In small-sized companies business people showed the same preference (29.7% in financial service and 19.5% in consumer products). The same occurred in medium-sized companies (27.6% in financial service and 17.7% in consumer products) (see Tables #7, 13, 14 and 15 in appendix). In large-sized companies business people are mostly in the consumer and service industries (23.8% each). With respect to age, business people under 50 years old are in the financial service and the service industries (24% and 18% respectively). For those between 50 and 59 years old the financial service and the consumer products industries are the most common (31% and 18.1% respectively). For the CEOs over 59 the preference is maintained (25.8% in financial service and 21% in the consumer product industry)(see Tables #7, 16, 17 and 18 in appendix).

For business people with a technical degree, the most common industries are the low-tech (33.3%) and the utilities industry (16.7%)(see Table #20 in the appendix). CEOs with a non-technical career path are most commonly found in the financial service industry and the consumer industry (32.6% and 18.8% respectively) (see Table #19 in the appendix). Those with both career paths are mostly found in low-tech industry, high tech industry and the consumer industry (32.4% , 14.7% and 14.7% respectively)(see Table #21 in appendix).

For those CEOs with a legal education, the most common industries to work in are the financial service industry and the utilities industry (25.9% and 15.5% respectively) (see Table #7). In small-sized companies, these CEOs work mostly in the financial service industry, the consumer product industry, and the service industry (26.1% , 17.4% and 17.4% respectively) (see Table #13 in the appendix). 13% of these CEOs work in the utilities industry. In medium-sized companies, these CEOs present the same preference for the financial service industry, the service industry, and the utilities industry (20.7% in each) (see Table #14 in the appendix). In large-sized companies, these CEOs work only in the financial service industry and in high-tech industry (75% and 25% respectively) (see Table #15 in appendix).

CEOs under 50 years old with legal education prefer the consumer industry and high-tech industry (37.5% and 25% respectively). 12.5% of these CEOs work in the utilities industry. CEOs between 50 and 59 years old prefer the financial service industry, the service industry, and the utilities industry (24% , 20% and 20% respectively) (see Tables #16 and 17 in the appendix). For those CEOs over 59, the preferences are the financial service industry and the service industry (32% and 20% respectively) (see Table #18 in the appendix), 12% of these CEOs work in the utilities industry.

Those CEOs with legal educations and a non-technical career path are found mostly in the financial service industry and the service industry (25% and 19.2% respectively) (see Table #19 in

the appendix), 17.3% of these CEOs work in the utilities industry. Those with a technical career path are equally found in the consumer and the financial service industries (50% and 50% respectively). Those CEOs with both career paths are equally found in high-tech industry, the service industry, the financial service industry, and the consumer industry (25% in each) (see Tables #20 and 21 in the appendix).

For those CEOs with "other" educations, the most common industries are the financial service industry, the service industry, and the consumer product industry (28.3% , 28.3% and 23.9% respectively) (see Table #7). In small companies these CEOs are found mostly in the service industry and in the financial service industry (38.1% and 28.6% respectively) (see Table #13 in the appendix), 14.3% of these CEOs work in the consumer products industry. In medium-sized companies these CEOs are found mostly in these industries also (33.3% financial service, 33.3% consumer products and 19.0% service industry) (see Table #14 in the appendix). In large-sized companies all are equally found in low-tech industry, consumer products industry and in the telecommunication industry (33.3% each) (see Table #15 in the appendix).

For CEOs under 50 years old the preferences of financial service industry and service industry are maintained (25% and 33.3% respectively) (see Table #16 in the appendix), 8.3% of these CEOs work in the consumer products industry. For those CEOs between 50 and 59 years old, the financial service industry and

the consumer industry are the most common (41.2% and 29.4% respectively)(see Table #17 in the appendix), 17.6% of these CEOs work in the service industry. For those CEOs over 59, the service industry and the consumer industry are the most common (35.3% and 29.4% respectively) (see table #18 in the appendix), 17.6% of these CEOs work in the financial service industry.

Those CEOs with non-technical career paths also maintained this preference (32.4% financial service, 27% service industry, and 24.3% consumer product industry)(see Table #19 in the appendix).

Those CEOs with "other" education and technical career paths are found mostly in the telecommunications industry(50%). These CEOs present equal preference for the service and the consumer industries (25% in each). Those CEOs with both career paths are found mostly in the service industry (40%) and are equally found in the consumer industry, financial service industry, and the utilities industry (20% in each) (see Table #20 and 21 in the appendix).

CEOs with a business/other education are found mostly in the financial service industry, service industry, and the consumer industry (21.6%, 21.6% and 13.5% respectively)(see Table #7 in the appendix). In small-sized companies, these CEOs are also found mostly in these industries (31.3% in the service industry, 25% in the consumer industry, and 25% in the financial service industry). In medium-sized companies, these CEOs are found mostly in low-tech industry and are found equally in the

financial service industry and the utilities industry (22.2%, 16.7% and 16.7% respectively) (see Tables #13 and 14 in the appendix). Only 5.6% of these CEOs work in the consumer products industry. In large companies, all CEOs are in the financial service industry (see Table #15 in the appendix).

For CEOs under 50, the service and the financial service industry are the most common (28.6% and 21.4% respectively), 7.1% of these CEOs work in the consumer products industry. For CEOs between 50 and 59 years old, the most common are the consumer and the financial service industries (21.4% and 21.4% respectively), 7.1% of these CEOs work in the service industry. For those CEOs over 59 years old, the service industry and the financial service industry are the most common (33.3% and 22.2% respectively) (see Tables #16, 17, and 18 in the appendix), 11.1% of these CEOs work in the consumer products industry.

Those business/other CEOs with a non-technical career path are found mostly in the financial service industry (29.6%) and in the service industry (22.2%). 14.8% are found in the consumer products industry. Those with technical career path are found mostly in the low-tech industry (28.6%) and in the service industry (28.6%). None of these CEOs are found in the consumer products industry. Those CEOs with both career path are found equally in the high-tech industry, low-tech industry, and the consumer industry (33.3% in each) (see Tables #19, 20 and 21 in the appendix).

The financial service industry, with 17.9%, and the utilities

industry, with 17.9%, are the most common industries among CEOs with legal/other educations (see Table #7). In small companies these CEOs are found mostly in the transportation industry (25%), the utilities industry (25%), and low-tech industry (16.7%). They are found equally in the service and the financial service industries (8.3% in each) (see Table #13 in the appendix). In medium-sized companies these CEOs are found mostly in the financial service industry (30.8%) and in the service industry (23.1%) (see Table #14 in the appendix). In large companies these CEOs are found only in the consumer industry (66.7%) and in the resource industry (33.3%) (see Table #15 in the appendix).

CEOs with legal/other educations and under 50 years old are found only in the transportation industry (33.3%), financial service industry (33.3%), and the utilities industry (33.3%) (see table #15 in the appendix). Those CEOs between 50 and 59 years old are found mostly in the service industry (25%) and in the utilities industry (18.8%). 6.3% work in the financial service industry (see Table #17 in the appendix). Those CEOs over 59 years old are found mostly in the financial service industry (33.3%) and in the consumer product industry (22.2%). None of these CEOs are found in the service industry (see Table #18 in appendix).

CEOs with legal/other educations and a non-technical career path are found mostly in the financial service industry (17.9%) and in the utilities industry (17.9%). 14.3% work in the service industry. There are no CEOs with legal/other education and a technical career path or with both career paths (see Tables #19,



20, and 21 in appendix).

CEOs with business/legal education are found mostly in the consumer industry (30.8%) and the utilities industry (26.9%). None of these CEOs work in the transportation, resources, and telecommunication industries (see Table #7 in the appendix). In small companies these CEOs are found mostly in the financial service industry (33.3%) and in the utilities industry (33.3%) (see Table #13 in the appendix). In medium size companies these CEOs are mostly in the consumer industry (33.3%) and in the utilities industry (27.8%) (see Table #14 in the appendix). In large-sized companies these CEOs are found only in high-tech industry (50%) and in the consumer industry (50%) (see Table #15 in the appendix).

Of these CEOs, those who are under 50 years old are found equally in the consumer and low tech industries (25% in each), 12.5% are found in the utilities industry. Those CEOs who are between 50 and 59 years old are found mostly in the consumer (41.7%) and the financial service industry (25%) (see Table #17 in the appendix). The majority of those CEOs over 59 years old are the utilities industry (66.7%) (see Table #18 in the appendix).

CEOs with a business/legal education and a non-technical career path are found mostly in the utilities industry (29.2%) and in the consumer industry (29.2%) (see Table #19 in the appendix). Those with technical career paths are all found in high-tech industry. Those with both career paths are all found

in the consumer industry (see Tables #20 and 21 in the appendix).

### 3.6 COMPARISONS OF THE DISTRIBUTION OF ENGINEERS AND NON-ENGINEERS IN THE DIFFERENT INDUSTRIES, DIFFERENT SIZE COMPANIES, THE DIFFERENT CAREER PATHS, AND THE DIFFERENT AGE GROUPS.

To make these comparisons we hypothesized (Ho) that there is no significant difference between engineers and non-engineers in their distribution in the different industries, company sizes, career paths, and age groups. The hypotheses were tested using a Chi-square distribution at the 95% significance level.

Comparing the distribution of engineering-science CEOs and non-engineers CEOs in the different industries we got that

$\chi^2_{\text{calculated}} = 211.63$ , and  $\chi^2_{\text{critical}} = 16.92$  which led to reject the null hypothesis. In other words, there is a statistically significant difference between the distribution of engineers and non-engineers in the different industries. This difference is mainly found in the financial service industry where the majority of CEOs have a non-engineering background. There is also a significant difference in high-tech industry, low-tech industry and the resource industry where most of the CEOs have an engineering-science background (see Table #22).

In the comparison of the distribution of engineering-science CEOs and non-engineering CEOs in the different sizes of companies we

found that  $\chi^2_{\text{calculated}} = 6.63$ , and  $\chi^2_{\text{critical}} = 7.81$ .

Given those results we failed to reject the null hypothesis. The distribution of engineers and non-engineers CEOs in the different sizes of companies is almost the same (see Table #23).

Comparing the distribution of engineering-science CEOs and non-engineers CEOs in the different career paths we found that

$\chi^2_{\text{calculated}} = 1010.54$ , and  $\chi^2_{\text{critical}} = 7.81$ .

Given those results we rejected the null hypothesis. There is a great difference in the distribution of the engineering-science CEOs and the non-engineers, in the different career paths. This difference is found mainly in the technical career path and the non-technical career paths. The technical career path is followed mostly by engineering-science CEOs and the non-technical career path by non-engineer CEOs (see Table #24).

In the comparison of the distribution of engineering-science CEOs and non-engineer CEOs in the different age groups we found that

$\chi^2_{\text{calculated}} = 13.22$ , and  $\chi^2_{\text{critical}} = 7.81$ , which led to reject the null hypothesis. There is a statistically significant difference in the distribution of the engineers and non-engineers in the different age groups. This difference is mainly found in the age range between 50 and 59 years old, where the majority of the CEOs have a non-engineering background (see Table #25).

TABLE #22  
TEST OF SIGNIFICANCE  
EDUCATION VS INDUSTRY

INDUSTRY		HIGHTECH	LOWTECH	TRANSP	CONSUMER SERVICE	RESOURCE	FIN SERV	TELECOM	UTILITIES	MISSING
EDUCATION	FREQ									
ENGINEERS	308	Fo 62	60	5	40	26	39	13	11	48 4
NON-ENGINEERS	543	40	55	19	98	80	27	143	15	58 8
	%	7.4	10.2	3.5	18.0	14.7	4.9	26.3	2.8	10.7 1.5
	Fe	22.79	31.42	10.78	55.44	45.28	15.09	81.00	8.62	32.96 4.62

LN  
P-3

$$\chi^2_{\text{CALCULATED}} = \sum \frac{(F_o - F_e)^2}{F_e} = 211.63$$

$$\chi^2_{\text{CRITICAL}} = 16.92$$

H<sub>0</sub>: there is no significant difference between engineers and non-engineers in their distribution in the different industries

H<sub>a</sub>: there is a significant difference

Reject H<sub>0</sub>

TABLE #23  
 TEST OF SIGNIFICANCE  
 EDUCATION VS COMPANY SIZE

COMPANY SIZE		SMALL	MEDIUM	LARGE	MISSING
EDUCATION					
ENGINEERS(308)	F <sub>o</sub>	110	167	26	5
NON-ENGINEERS(543)		196	291	34	22
	%	36.1	53.6	6.3	4.0
	F <sub>e</sub>	111.19	165.08	19.4	12.32

$$\chi^2_{\text{CALCULATED}} = \sum (F_o - F_e)^2 / F_e = 6.63$$

$$\chi^2_{\text{CRITICAL}} = 7.81$$

H<sub>0</sub>: there is no significant difference between engineers and non-engineers in their distribution in the different company sizes

H<sub>a</sub>: There is a significant difference

Accept H<sub>0</sub>

TABLE #24  
 TEST OF SIGNIFICANCE  
 EDUCATION VS CAREER PATH

CAREER PATH		TECHN	NONTECH	BOTH	MISSING
EDUCATION					
ENGINEERS (308)	F <sub>o</sub>	154	82	71	1
NON-ENGINEERS (543)		38	457	47	1
	f	6.99	84.2	8.65	0.18
	F <sub>e</sub>	21.53	259.34	26.64	0.56

$$\chi^2_{\text{CALCULATED}} = \sum (F_o - F_e)^2 / F_e = 1010.54$$

$$\chi^2_{\text{CRITICAL}} = 7.81$$

H<sub>o</sub>: There is no significant difference between engineers and non-engineers in thier distribution in the different career path

H<sub>a</sub>: There is a significant difference

Reject H<sub>o</sub>

TABLE #25  
TEST OF SIGNIFICANCE  
EDUCATION VS CEOs AGE

AGE		UNDER 50	50 TO 50	OVER 59
EDUCATION				
ENGINEERS (308)	Fo	47	124	137
NON-ENGINEERS (543)		96	255	190
	%	17.7	46.9	34.9
	Fe	54.52	144.5	107.5

$$\chi^2_{\text{CALCULATED}} = \sum (F_o - F_e)^2 / F_e = 13.22$$

$$\chi^2_{\text{CRITICAL}} = 7.81$$

H<sub>0</sub>: There is no significant difference between engineers and non-engineers in their distribution in the different age groups

H<sub>a</sub>: There is a significant difference

Reject H<sub>0</sub>

#### 4. SUMMARY

35.7% of the CEO's in the top 1000 companies have engineering-science background.

CEO's with engineering-science background tend to be older (over 59 years old) than CEO's with other degrees.

CEO's with engineering-science background follow a technical career path compared to the non-technical career path of the non-engineers.

These CEOs tend to be in the high-tech, utilities and low-tech industry and work in medium-sized companies.

CEOs with business background follow a non-technical career path and tend to be in the financial service industry and the consumer industry. They tend to be younger than the engineering-science people.

Business CEOs work in medium-sized companies as the engineering-science CEOs do.

CEOs with legal background tend to follow a non-technical career path and work in the financial service industry and the service industry.

These CEOs tend to work in medium companies and be more than 50 years old.



## 5. CONCLUSIONS

More than one-third of the CEO's in the top 1000 companies are engineers or scientists. They reach the top position through a technical career path mostly in the high tech industry.

There is no statistically significant difference between the distribution of engineers and non-engineers in different company sizes. A person with an engineering or science background can reach a CEO's position in a company of any size.

However, there is a statistically significant difference between the distribution of engineers and non-engineers in the different age ranges. Engineers and scientists reach the top position at older ages than the non-engineers.

On the other hand, non-engineers reach the top position through a non-technical career path mostly in the Financial Service Industry.

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