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Long-Term Viability of Mid-Size Engineering Firms

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ABSTRACT

The consulting engineering industry focusing on the built environment is characterized by a large number of small firms distributed across the United States. With over 55,000 firms and over 800,000 employees, the industry accounts for over $116 billion in revenue based on the last official census. However, this overall perspective provides little insight into the complexity of the individual sectors, trends, and long-term outlook that characterizes this diverse industry. Of particular interest in this study is the long-term success and viability of the mid-size engineering firm. This study addresses the question of mid-size firm viability from a new perspective, an analysis of 35 years of data to study the trends that are affecting the industry as a whole and the mid-size firms specifically. In this analysis, it is found that the Mega firms have increased their percentage of Top 500 income from 10% in 1986 to 41% in 2011. To facilitate this increase, the Mega firms have gained revenue percentage from the Large and the Mid-sized firms. The Very Large firms have remained static over time, garnishing 20% of the revenue in 1981 and 2011. In contrast, the Large and Mid-size firms have lost 12% and 21% of their relative income since their high points in the time series. Although this overall perspective leads to the documented conclusions that Mid-size firms are demonstrating reduced viability in the economy, a closer look at the Mid-size firm perspective reveals a different story. Specifically, it is at the individual sector level where the Mid-size firms demonstrate strength. In these sectors, the General Building and Transport clusters are led by Mid-size firms. Although Mid-size firms in clusters such as Power or Industrial may be seeing a redistribution of work, the traditional strengths of Mid-size firms remains strong.

KEYWORDS

Engineering industry, organization management, economic analysis, mid-size firms

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INTRODCUTION

The consulting engineering industry focusing on the built environment is characterized by a large number of small firms distributed across the United States. With over 116,000 firms and 1.4 million employees, the architecture-engineering industry accounts for over $254 billion in revenue (US Census 2007). Although much attention is paid to the largest of these firms, the majority of revenues (66%) in the industry are generated by the "small" firms (ENR 2012). As defined in the current study, these are firms that are ranked outside of the ENR Top 500 list of firms based on revenues (Table 1). At the other end of the industry spectrum, the "Mega-Firms", firms ranked in the Top 10 and the "Very Large" firms, those ranked 11-30, account for 21% of the total revenue. These statistics provide a data-driven perspective of the design-engineering industry. However, this overall perspective provides little insight into the complexity of the individual sectors, trends, and long-term outlook that characterizes this diverse industry. Of particular interest in the current study is the long-term success and viability of the mid-size engineering firm. As economic conditions change during industry cycles, the question continues to emerge as to whether mid-sized engineering organizations can afford to remain independent. This question has once again emerged in the current recession cycle. However, the basis for this question remains steeped in anecdotal evidence and conjecture rather than historical evidence. This study addresses the question of mid-size firm viability from a new perspective, an analysis of 35 years of data to study the trends that are affecting the industry as a whole and the mid-size firms specifically.

Category	ENR Ranking Range	% of 2011 Total Revenue	2011 ENR Revenue Range
Small	< ENR Top 500	66%	< $17 M
Mid-Sized	ENR 500 to ENR 101	7%	$17 M to $113 M
Large	ENR 100 to ENR 31	6%	$114 M to $447 M
Very Large	ENR 30 to ENR 11	7%	$481 M to $1.59 B
Mega	ENR Top 10	14%	$1.68 B to $ 6.87 B

Table 1: Characteristics of revenue categories used in the current study as determined by the authors.

The motivation for this study derives from the conflicting evidence provided in recent publications regarding the current and future financial health and prospects for midsized firms (Weingardt 2003; Stasiowski 2011; Salontai 2012). As detailed below in the Background section, mid-sized firms have been alternately referred to positively as "a great value", "a good entry point", and "a source of experienced talent", and negatively as "top-heavy with senior management", "under-capitalized", and "too-narrowly focused". However, what is in common with these evaluations is an overall perspective that mid-sized firms are having greater difficulty competing and sustaining in the current economic climate. Additionally, the studies are putting forward that this difficulty will likely continue in the future as the Mega-firms grow in size and clients continue to demand greater services for reduced fees (Stasiowski 2011).

This argument regarding the demise of the mid-sized engineering firm provided the specific motivation for this study and the overall research question of whether in fact mid-sized engineering firms are disappearing from the industry. Specifically, the current study investigates this question through a greater examination of the details underlying overall industry statistics including the role of industry sectors, internationalization, and industry mergers on the overall

industry characteristics. The result of addressing these questions is a statistically-based analysis of the ENR Top 500 that provides insights for firms that are questioning the viability of the mid-sized sector in the larger consulting engineering industry.

BACKGROUND

The distributed nature of engineering organizations, both geographically and knowledge-based, provides an opportunity to examine the impact of issues such as knowledge management, learning, systems thinking, as well as business focus points including marketing, strategic and project management, and human resource development. In the latest period of time, the focus on these issues has resulted in numerous academic publications including focal studies on internationalization (Krull, Smith and Ge 2012), systems analysis (Lloyd and Palmer 2000), sustainability (Shrake et al 2012), and global training (Gross 2012), among a host of other issues.

In addition to these academic efforts, numerous private consulting firms and professional associations publish economic and professional forecasts for the industry such as those by ZweigWhite (2012) and the American Society of Civil Engineers (2012). Each of these efforts follows a survey format as a base followed by individual processes to analyze the obtained data. Over time, these efforts have predicted and documented the overall trends in the industry, but have often failed to detect the severity or frequency of economic swings.

Of particular interest to the current study is the recent focus on the potential demise of the mid-size consulting engineering firm in the United States. Stasiowski (2011) has brought this perspective to the forefront by predicting that large firms will either absorb mid-size firms or mid-size firms will be forced to shut their doors. This sentiment is receiving significant attention and causing many firms to assess their own viability. However, this is not solely a recent focus of industry researchers and consultants. Blau and Lieben (1983) found that size in architectural firms did have an impact on long-term success in that larger firms were better positioned to withstand economic downturns. Hampton (1994) emphasized the challenge that mid-size firms experienced from excessive contract risk due to lower capacity to absorb project losses. Weingardt (2003) emphasized the need for mid-sized firms to focus on individual niche areas for long-term survival. Kreitl et al (2010) focused on the drive toward growth and the relative success of these attempts to achieve large-firm status.

This extended history of interest in firm performance is specifically concentrated within the Journal of Management in Engineering and the Journal of Construction Engineering and Management. In these publications, numerous papers have been published on the factors that influence firm performance and success. Areas of specific interest and representative efforts include; 1) the need to enhance a focus on globalization and better prepare for foreign markets (Comu, Taylor, and Messner 2013; Jin et al 2013; Ling, Ibbs and Hoo 2006; Cheah, Garvin and Miller 2004), 2) the role of strategy in enhancing firm success (Payne 1987; Kale and Arditi 2003; Yee and Cheah 2006) 3) the lack of accepted metrics as firm-level performance measures (Deng and Smyth 2013; Deng and Smyth 2014), and 4) the role of business planning in firm success (Tatum 1987). The common link between these efforts being the focus on examining current (at the time) practices that the firms were adopting in the particular field of interest. This is where the current study diverges from these efforts. Acknowledging the contribution of these efforts to the overall concept of the study, the current study emphasizes the use of longitudinal data to address the overall issue of firm performance.

These studies represent only a small sampling of the literature available related to size and the long-term success of consulting engineering firms. As illustrated, this theme emerges

and reemerges as economic cycles lead to increases or decreases in firm numbers. Thus, an underlying motivation for the current study is to establish conclusions on the long-term data record related to the mid-size consulting engineering firm.

METHODOLOGY

The basis for the quantitative data in the current study is the annual Engineering News Record list of the Top 500 Engineering companies. This list was selected for three primary reasons; 1) it is widely referenced as an industry standard, 2) it is based on numeric information, revenues, and 3) it has a consistent publication record extending back the required 35 years. As supplements to this data, information was also obtained from the United States Economic Census, the United States Department of Labor, and individual research reports. However, this data was used to fill in specific data requirements or to cross-reference the ENR data. The ENR Top 500 lists served as the primary reference for the current study.

Utilizing the data available in the given sources, the team focused on several areas of data as follows:

- Years on the Top 500 list – Each list was recorded to cross-reference which years each company was listed on the Top 500 list.
- Year-to-Year Revenue Change – The categorization of each company was recorded for each year to determine the volatility of each category of companies on the list.
- Sector Focus – The percentage income from each sector was recorded to enable analysis of the primary sectors that have historically existed in the industry.
- International Revenue – The percentage of international revenue obtained by each group of companies was analyzed to determine the relative influence of international work in the industry over time.
- Category Revenue – The Mega, Very Large, Large, Mid-Size, and Small categories of companies were analyzed from a revenue perspective to determine the relative percentage of income that each category received over time.
- Mergers and Acquisitions – Where possible, the trail of mergers and acquisitions for individual firms were followed back in time to obtain a perspective on the sector and size focus for mergers and acquisitions.
- Industry Information – General information including overall revenues, number of firms, number of employees, and economic conditions were obtained to provide a general perspective on the industry.
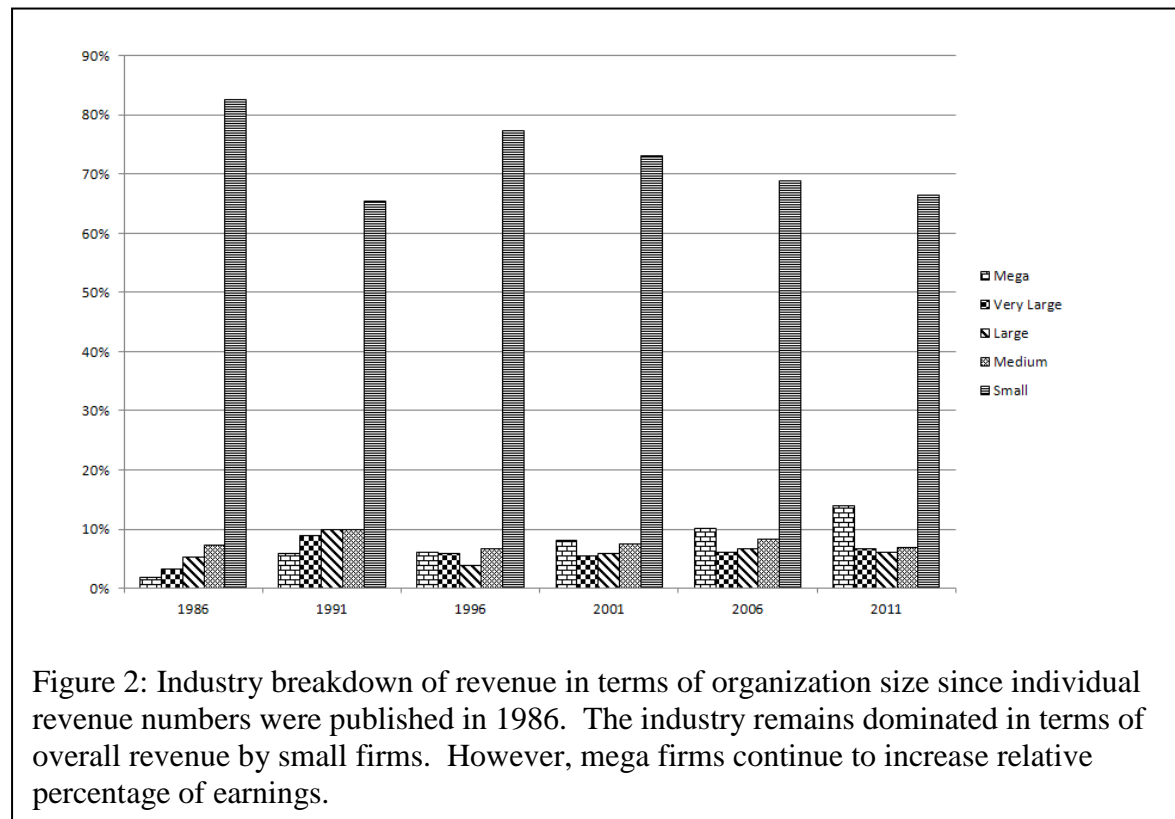
In total, 17,500 database records were developed to represent the 35 years of Top 500 entries. Additionally, annual records were compiled of industry, labor, and national economic data. Finally, a database of merger and acquisition data focusing on the Top 500 was created to enable tracking of individual firms and their transformations over the period of investigation. This broad set of data provided the foundation for the conclusions presented in the following sections.

AN OVERALL INDUSTRY PERSPECTIVE

The consulting engineering industry as a single entity has witnessed continued growth over the last 35 years. Although the growth has been cyclical, reflecting, the overall health of the economy, the industry remained in a growth pattern for 30 years until 2008 (Figure 1). As seen

in Figure 1, the industry reached a peak in billings/revenue in 2008 with $263 billion. Although the industry experienced a drop in revenues with the latest economic recession, revenues in 2011 and 2012 reflect an upward trend in the industry. Similar to the increase in revenue over the extended period of time, the number of professionals in the profession and the number of establishments witnessed continued growth through 2007.

The 2007 year is significant in the overall industry perspective in that it is the first year where the number of professionals and the number of establishments begins to decline. Until 2007, the number of professionals and the number of establishments grew consistently through economic cycles. However, since the economic downturn in 2007-2008, this trend has reversed. For the first time, the number of professionals in the industry is on the decline and that trend has not yet shown an indication of reversing. Similarly, the total number of establishments is declining with

Figure 1: Industry Statistics from 1977 – 2012. The last decade provides individual points to reflect the significant changes during the last cyclical period. Overall the trends continue to be positive throughout the study until the last economic downturn.

Figure 2: Industry breakdown of revenue in terms of organization size since individual revenue numbers were published in 1986. The industry remains dominated in terms of overall revenue by small firms. However, mega firms continue to increase relative percentage of earnings.

no reversal in that trend. This leads to the first indication that a level of consolidation is occurring in the industry with the total amount of billings and revenue being distributed among a smaller pool of establishments.

The second area of interest from a general industry perspective is the division of revenue between organizations in terms of size. As illustrated in Figure 2, the industry remains a small-firm focused industry. However, the percentage of revenue that the small firms receive has decreased consistently over the last 15 years. As illustrated, small firm revenue has reduced from a peak of 83% in 1986 to 67% in 2011. Concurrently, the revenue obtained by Mega firms has been on a slow increase to 14% in 2011. The remaining three categories have varied slightly over time, but the respective totals have remained static over the last 15 years. The observation from this set of data is that as a general industry, consulting engineering remains a small-firm focused industry. However, Mega firms are slowly increasing their share of the overall revenue, and thus reducing the amount of revenue available to other categories of firms.

In terms of answering the question of whether mid-size firms are disappearing, the data on percentage of total revenue provides little assistance. Specifically, the percentage of revenue obtained by mid-sized firms remains stable at approximately 8% of total revenue. In contrast, the data illustrates definite gains and losses by small and Mega firms. Thus, a different perspective is required to determine the relative health of the mid-size firm.
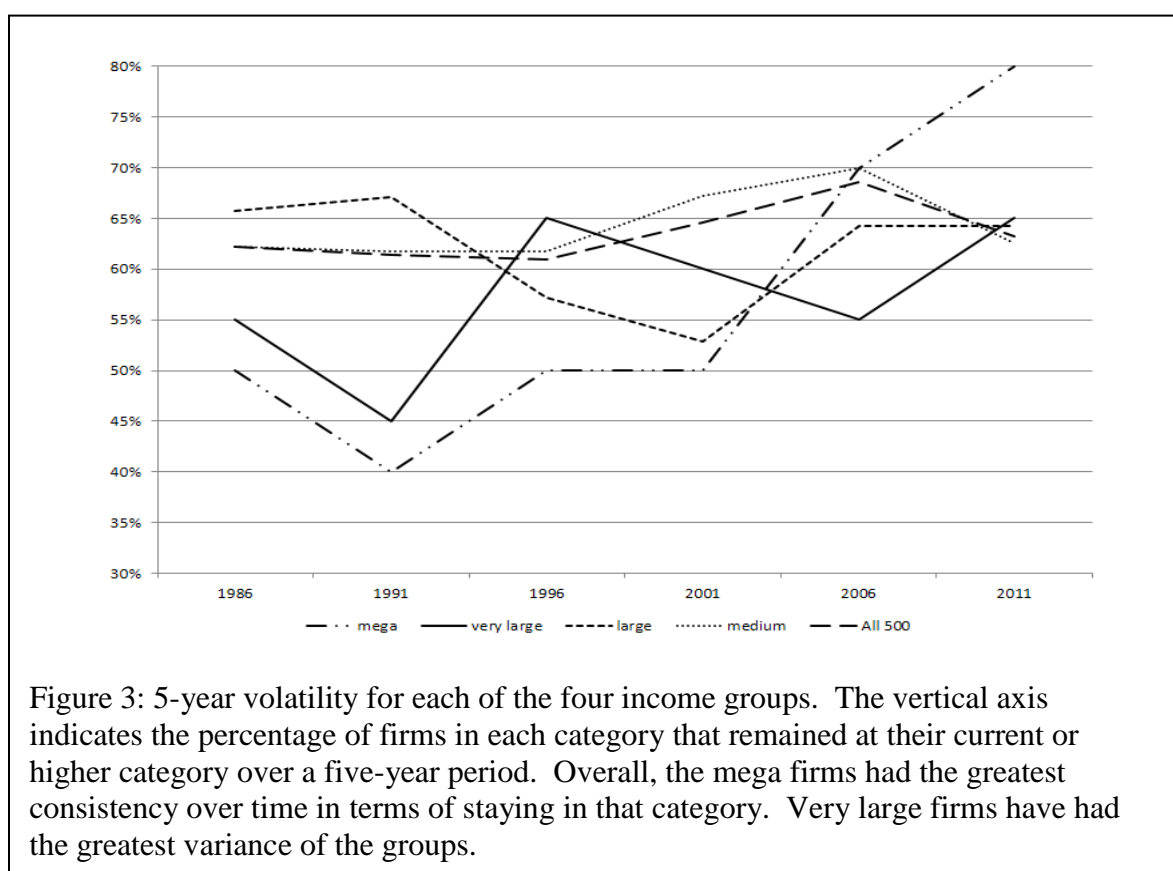
TOP 500 VOLATILITY

The current study delved further into the specifics of the revenue categories within the ENR Top 500 list by focusing on the difficulty that firms of different sizes have in staying on the Top 500 list. The intent of this analysis is to determine if any specific category or group of categories have a more difficult time remaining stable in terms of relative position in the industry rankings. For this analysis, the study examined each of the four groups on a 1-year, 5-year, and 10-year basis in terms of percentage of firms that remained on the Top 500 list in their current category or a higher level category. If the firm dropped in ranking category, then it was considered that the firm had a break in continuity in ranking.

Years Ranked 1987 – 2011	Number of Companies	Percentage of Total out of total companies	Median Company Revenue ($Million)*
25	103	7.9	64.5
20 – 24	133	10.1	40.1
15 – 19	112	8.5	29.2
10 – 14	168	12.8	28.2
5 – 9	266	20.3	25.2
1 - 4	529	40.5	23.9

Table 2: Breakdown of Top 500 volatility of all organizations over the last 25 years. Volatility is indicated by the number of firms that have remained on the Top 500 list for the indicated period of time.

Volatility was examined from two perspectives, an overall Top 500 volatility over time and a size-based analysis. In the first analysis, the individual Top 500 lists were analyzed for the past 25 years to determine what percentage of companies have stayed on the list consistently and what was the median size of the companies that have stayed on the list for various periods of times. As illustrated in Table 2, the study extends back to 1986 when the Top 500 list began to provide individual revenue levels for each organization rather than broad ranges. As illustrated, only 103 companies, or 7.9% of organizations were able to remain on the Top 500 list for the entire 25 years. These organizations had the highest median income at $64.5 million. As illustrated, the number of companies increases as the length of tenure on the list decreases. Concurrently, the median income decreases as the length of tenure decreases. This combination provides an indication that the larger organizations have less volatility than the smaller ones in terms of stability of income over time.

Figure 3: 5-year volatility for each of the four income groups. The vertical axis indicates the percentage of firms in each category that remained at their current or higher category over a five-year period. Overall, the mega firms had the greatest consistency over time in terms of staying in that category. Very large firms have had the greatest variance of the groups.

Using this as a basis for further analysis, a second round of analysis was completed to focus on the four defined income groups for this study. Specifically, this analysis looked at whether a firm was able to stay or improve its income category on a yearly, five-year, and ten-year basis. The intent being to determine if firms could retain or increase revenue on a consistent basis. The results of this analysis revealed that on a yearly basis, all categories of firms show a similar level of volatility with average volatility over the time period ranging from 83% to 87%. However, over the last decade, the Mega firms have demonstrated less volatility than the other groups. From a trend perspective, the Mega firms are demonstrating a distinct positive trend while the other three categories illustrate a static trend. On a five-year basis (Figure 3), the

overall group reduces stability from 86% to 64%. At this level of analysis, the Mid-Size and Large firms show less volatility over time than Very Large and Mega firms. However, the Mega and Very Large firms are the categories that are showing increasing stability whereas the lower categories remain static in their volatility levels. Finally, on a ten-year basis, the overall stability of the groups drops from 64% to 43%. From a long-term perspective, mid-size firms have the greatest stability at 44% while Mega firms have the lowest at 36%. However, starting in 2006, the Mega firms are the only firms that demonstrate an improvement in stability. Overall, when looking at volatility as an indicator, the short-term and long-term data sets indicate a strong preference towards larger organizations in terms of stability. However, it is important to note that the mid-size and large firms are not increasing their level of volatility. Thus, volatility does not indicate that the mid-size firm is finding it increasingly difficult to compete within the industry.

THE ROLE OF INTERNATIONAL REVENUE

The volatility seen in the previous section provides an overall perspective on the ability of organizations to remain in a revenue category. However, to achieve stability, organizations must have the ability to strategically maneuver between changing economic conditions. One element of this strategic perspective is the role of international revenue in the overall project portfolio. In an effort to determine how these international revenues are impacting the ENR Top 500, a time-series analysis was performed on each of the four revenue categories.

Figure 4: Impact of international revenues on each of the Top 500 revenue groups. Mega firms continue to increase while Very Large firms continue to decrease in terms of relative percentage of international revenues.
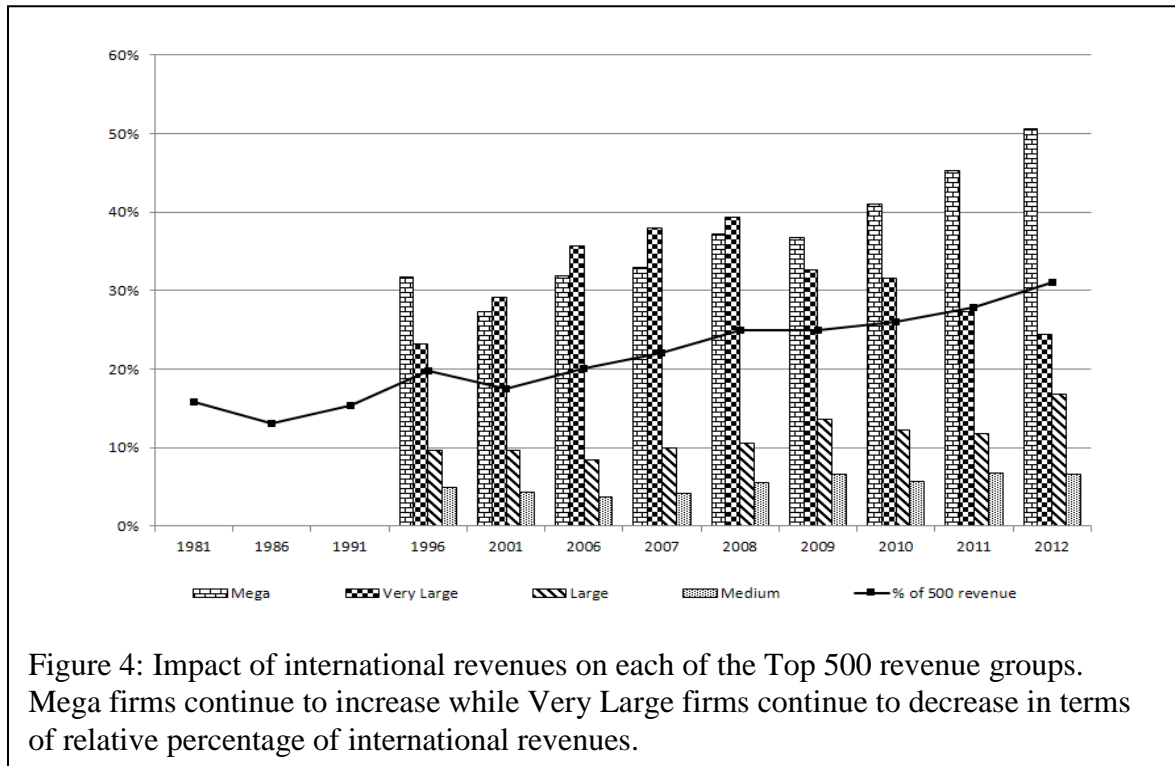
Figure 4 illustrates the overall percentage of international revenue in the Top 500 since 1981 and the individual group percentages since 1996, when specific data was available. In terms of the overall impact, it can be seen that international revenue has almost doubled, rising

from 16% to 31%. However, this increase is not equally distributed across the four revenue groups. At the lower end, the Mid-size firms have remained static, varying only a single percentage point. The large organizations have seen an increase in recent years, climbing from 9% to 17% in 2012. In contrast, the Very Large firms have seen their percentage of international revenues fall from a peak of 39% in 2008 to a current level of 24%, a drop of 15 percentage points. This drop has corresponded with a significant increase in the Mega firm international percentage. Accounting for the largest increase in international revenues, the Mega firms have for the first time received more than half of their income from international revenues at 51%.

The implication of this data set is that Mega firms will continue to balance domestic revenues with international revenue. However, the data indicate that international revenues may prove to be a greater percentage of this balance through the near future. Concurrently, the loss of this revenue by the Very Large firms raises the question of whether a similar trend will occur in this ranking of firms. For the Large and Mid-size firms, it is less apparent how international revenue will impact these revenue streams. However, if growth is a strategic goal of Mid-size and Large firms, then the overall growth in the Top 500 international revenues may be an indicator that these firms should increase their analysis of strategic positioning in the international market.

THE MID-SIZE FIRM PERSPECTIVE

The consulting engineering industry remains a Small-firm focused industry with Mega firms increasing their relative standing in terms of revenue. This provides mixed input to the overall question of how the Mid-size firms are performing in the industry. To gain a better perspective on this specific question, the study examined the long-term placement of these firms in the Top 500.

As illustrated in Figure 5, the Mega firms have increased their percentage of Top 500 income from 10% in 1986 to 41% in 2011. To facilitate this increase, the Mega firms have gained revenue percentage from the Large and the Mid-sized firms.
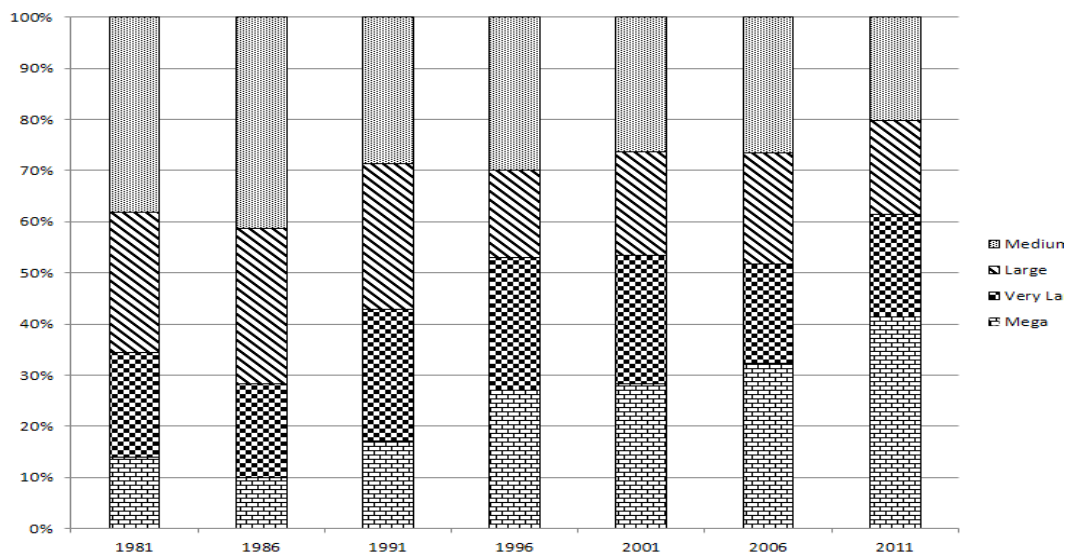

Figure 5: Revenue distribution between the Top 500 groups. The numbers represent the percentage of revenue that was received by the Top 500 companies in that year. As illustrated, the Mega firms continue to gain overall percentage of revenue.

The Very Large firms have remained static over time, garnishing 20% of the revenue in 1981 and 2011. In contrast, the Large and Mid-size firms have lost 12% and 21% of their relative income since their high points in the time series. In 2011, these firms were at 18% and 20% of relative income respectively. However, percentage of income does not inform us of whether the firms are increasing or decreasing total revenue. For this question it is necessary to look at actual revenue earned by these organizations.

In terms of actual revenues, the Mega firms have increased revenues from $2.3 billion in 1986 (2011 dollars) to $32.8 billion in 2011. This is an average of $3.05 billion per company. In comparison the Large firms have increased revenue from $7.2 billion (2011 dollars) to $14.5 billion. This is an average increase of $104 million per firm. Finally, the Mid-sized firms have the smallest increase in total revenue, from $9.7 billion (2011 dollars) to $16.1 billion. This is an average increase of only $16 million per firm. From this perspective, the Mid-sized firms could place a positive or negative view on the current scenario. From the positive perspective, the Mid-size firms continue to increase revenues, with each firm increasing average income by over $16 million during this time. However, from a negative perspective, these same firms can be concerned that their rate of relative growth falls short of the largest firms in the Top 500.

A Cluster Analysis

The overall Top 500 perspective shows Mid-sized firms underperforming in terms of revenue dollars. However, the consulting engineering industry is not a monolithic entity. The industry is comprised of diverse specialty areas that require different aptitudes and sizes of organizations.   In response to this diversity, the current study moves beyond the overall perspective by analyzing the role of the revenue categories within these individual specialty areas. The intent of this analysis is to determine if specialty areas provide a different perspective on the relative strength of individual revenue classes.

The determination of the specialty areas that historically have existed within the industry was completed through a cluster analysis completed in SPSS. The cluster analysis was based on the percentage work allocation indicated by each of the Top 500 organizations. SPSS derived a cluster if enough firms had a similar revenue basis in a given specialty area in a given year. These indications were compiled on an every 5-year basis starting in 1986. As illustrated in Table 3, five clusters form the core for the organizations in each time period.   For an organization to be considered as a sector-based organization, 60% of the organization revenue must come from a single sector and no other sector can account for more than 20% of revenue. If these conditions were not met, then the organization was considered a Balanced organization. Three of the clusters, General Building, a Balanced Portfolio, and Industrial have remained on the list throughout the period of the study. The Transport cluster has been a focus for the last four time periods while the Power cluster has been a focus for the last three time periods.

As illustrated in Table 3, all clusters except the Power cluster have experienced increases in actual revenues in the years they appear in the study. The largest of these increases belongs to the Balanced cluster which has seen revenues increase from $3 billion to $33 billion over the course of the study. Of the three clusters that consistently appear in the study, the General Building cluster has seen the smallest increase from $2.5 billion to $10 billion.

From a Mid-size firm perspective, two clusters, Transport and General Building, consistently represent areas of leadership for these firms.   However, these two clusters differ in terms of the competition that is evident from the numbers. In the General Building cluster, Mega firms do not appear at any of the points in time. Mid-size firms hold at least 60% of the revenues

in this category throughout the period of the study. In contrast, the Transport cluster shows a change in the competitive distribution over time. The percentage of revenue obtained by Mid-sized firms has reduced from a high of 45% to a current 31%. However, this level is only one percentage point lower than the leading 32% currently held by Large firms. The difference in the distribution is the emergence of Large firms in this cluster. Over the course of the study, Large firms have increased their percentage from 19% to 32% of the cluster revenue. This increase has been directly reduced from the Mid-sized firms.

The Industrial and Power clusters differ from the General Building and Transport clusters in that they are dominated by the Mega and Very Large firms. As illustrated, the Mega firms have led the Industrial cluster since 1991 and now account for 72% of the cluster revenue. Similarly, the Mega and Very Large firms have consistently led the Power cluster. Today, the Very Large firms account for 67% of the cluster revenue. The international scope of the Power and Industrial

		transport	balanced	general bldg	wastewater	industrial	power	haz **waste**
1986	Mega	9%	9%	0%	8%	25%		
	Very Large	26%	24%	10%	**31%**	**9%**		
	Large	**19%**	**28%**	**30%**	32%	39%		
	Medium	45**%**	39%	60%	29%	**27%**		
	Revenue	1.06	3.17	2.51	1.22	2.01		
1991	Mega		6%	0%		40%	47%	**0%**
	Very Large		23%	0%		30%	18%	47%
	Large		**32%**	**29%**		17%	28%	36%
	Medium		39%	71%		**13%**	6%	16%
	Revenue		8.99	3.41		5.82	3.90	5.18
1996	Mega	15%	22%	0%		57%		**0%**
	Very Large	16%	21%	0%		21%		50%
	Large	**30%**	**25%**	28%		14%		41%
	Medium	39%	**31%**	72%		**8%**		9%
	Revenue	3.45	9.96	3.28		**7.79**		5.08
2001	Mega	23%	35%	0%		38%	58%	
	Very Large	15%	20%	10%		36%	15%	
	Large	**26%**	21%	**30%**		15%	16%	
	Medium	36%	**25%**	60%		**10%**	10%	
	Revenue	6.73	16.10	7.46		8.52	4.66	
2006	Mega	14%	37%	0%		58%	**0%**	
	Very Large	26%	17%	9%		24%	46%	
	Large	**27%**	24%	**22%**		12%	34%	
	Medium	34%	**21%**	70%		**6%**	20%	
	Revenue	6.89	27.75	9.12		13.63	1.68	
2011	Mega	14%	50%	0%		72%	**0%**	
	Very Large	**23%**	18%	11%		15%	67%	
	Large	32%	16%	**28%**		8%	26%	
	Medium	31%	16%	**60%**		5%	8%	
	Revenue	11.26	33.48	9.96		20.21	4.28	

Table 3: The percentage of income for each income category in each cluster measured every five years. Each five year period also has the total revenue generated in that cluster for that year in billions of dollars. For example, the Transport cluster had $11.26 Billion in revenue generated by the Top 500 in 2011.

		transport	balanced	general bldg	waste water	industrial	power	haz waste
1986	Mega	1	3		1	5		
	Very Large	3	8	3	4	2		
	Large	5	21	19	**9**	**16**		
	Mid	**47**	**125**	**147**	34	47		
1991	Mega		1			**5**	**4**	
	Very Large		6			5	2	**7**
	Large		25	10		9	7	19
	Mid		**190**	**134**		33	10	33
1996	Mega	1	3			**6**		
	Very Large	2	7			4		**7**
	Large	10	22	9		9		19
	Mid	**68**	**157**	**131**		26		18
2001	Mega	1	**4**			**3**	**2**	
	Very Large	2	7	2		7	2	
	Large	12	26	20		8	4	
	Mid	**75**	126	**162**		25	12	
2006	Mega	1	**5**			**4**		
	Very Large	3	8	2		6	**1**	
	Large	13	35	13		6	3	
	Mid	**61**	140	**172**		20	7	
2011	Mega	1	**4**			**5**		
	Very Large	3	6	2		5	**4**	
	Large	**17**	24	16		7	6	
	Mid	49	121	**164**		23	9	

Table 4: The number of firms competing from each revenue category in each cluster.

clusters as well as the relative size of these projects makes it difficult for a smaller firm to lead these efforts.

The Balanced cluster is the lone cluster that varies over time as Mid-sized firms originally led this cluster and then the leadership transferred to Mega firms. Mid-sized firms have seen their revenue level reduced from 39% to 16% in the latest analysis period. Concurrently, Mega firms have increased their revenues from 9% to 50%. Very Large and Large firms have each absorbed small reductions over the same period of time. The question for further analysis in this cluster is why have Mega firms placed so much attention on this sector and why have Mid-size firms reduced their attention on a Balanced project portfolio. One component of this answer is the impact of mergers and acquisitions. Mega firms have placed recent emphasis on purchasing Small firms that specialize in specific industry sectors. Through a combination of purchases that complement traditional strengths, Mega-firms are increasing their sector diversity and thus achieving a Balanced project portfolio.

Competitive Data

A second level of detail from the cluster analysis is illustrated in Table 4. In this table the number of firms within each cluster are detailed for each of the time periods in the study. As illustrated, the Transport cluster has varied over time as the number of Mid-size and Large firms within the sector increase and decrease. Mid-size firms show an increase to a high of 75 firms in 2001and then a reduction back to the original level at 46. In terms of Large firms, the Transport cluster sees a consistent increase from 5 to 17 firms, resulting in the highest concentration of Large firms in a sector-specific cluster.

The Balanced cluster differs from the Transport cluster in that it stays consistent in terms of the number of firms in each revenue category. Although there are individual variances over the course of time, the overall groupings remain consistent. The remaining two clusters that exist throughout the study, the General Building and Industrial clusters, have opposite characteristics. The Industrial sector emerges as the domain of the Mega firms. With half of the Mega firms based in this cluster and owning 72% of the revenue, these firms control this sector. Concurrently, the smaller Mid-size firms have reduced their preence in this cluster by half and have reduced their percentage of cluster income from 27% to 5%.

In contrast to the Industrial cluster, the General Building cluster remains the strength of the Mid-size firms. As the largest base of the Mid-size firms, the General Building cluster has grown from 147 Mid-size firms to 164 firms. However, the relative percentage of income in the cluster owned by Mid-size firms has remained constant at 60%. Mega firms do not reside in this cluster and Very Large firms have a minimal presence.

In summary, from the Mid-size firm perspective, the clusters of focus for these firms remains consistent today as it has been for the last two decades. The General Building cluster remains domainated by the Mid-size firms. The Transport cluster has varied over time, but remains stable in terms of the current number of Mid-size firms. The Balanced cluster is similar to the Transport cluster. It is the Industrial cluster where the Mid-size firms have seen a reduction in numbers over time. This current state indicates that from a competitive numbers perspective, the Mid-size firm category remains in similar percentages and numbers as it did for the last two decades with core strengths in General Building and Transport.

PERFORMANCE COMPARİSON

  The consistency in the Mid-size revenue category and clusters indicates that Mid-size firms retain a foundation in specific sectors and/or regional locations. This leads to the final question in the study of how Mid-size firms are performing in relation to firms in other categories. To answer this question, the study developed a metric that combines revenue increase with positional increase in the ENR Top 500 to determine the top performers in the Top 500.

  For the first element, revenue increase, the firms that have been on the ENR Top 500 list for the last 35 years were extracted to form the initial selection list. These firms were then divided into their respective revenue categories. Table 5 includes the number of firms located in each of these categories. From these smaller groupings, the average revenue increase over the 35 years for each group was calculated. As illustrated in Table 5, this ranged from 130% for the Mid-size firms to 1,237% for the Mega firms. The next step required the individual revenue increase for each firm to be compared to the average group increase to obtain a relative revenue increase for each firm from the group average. This provided the revenue performance attribute for each firm in the group.
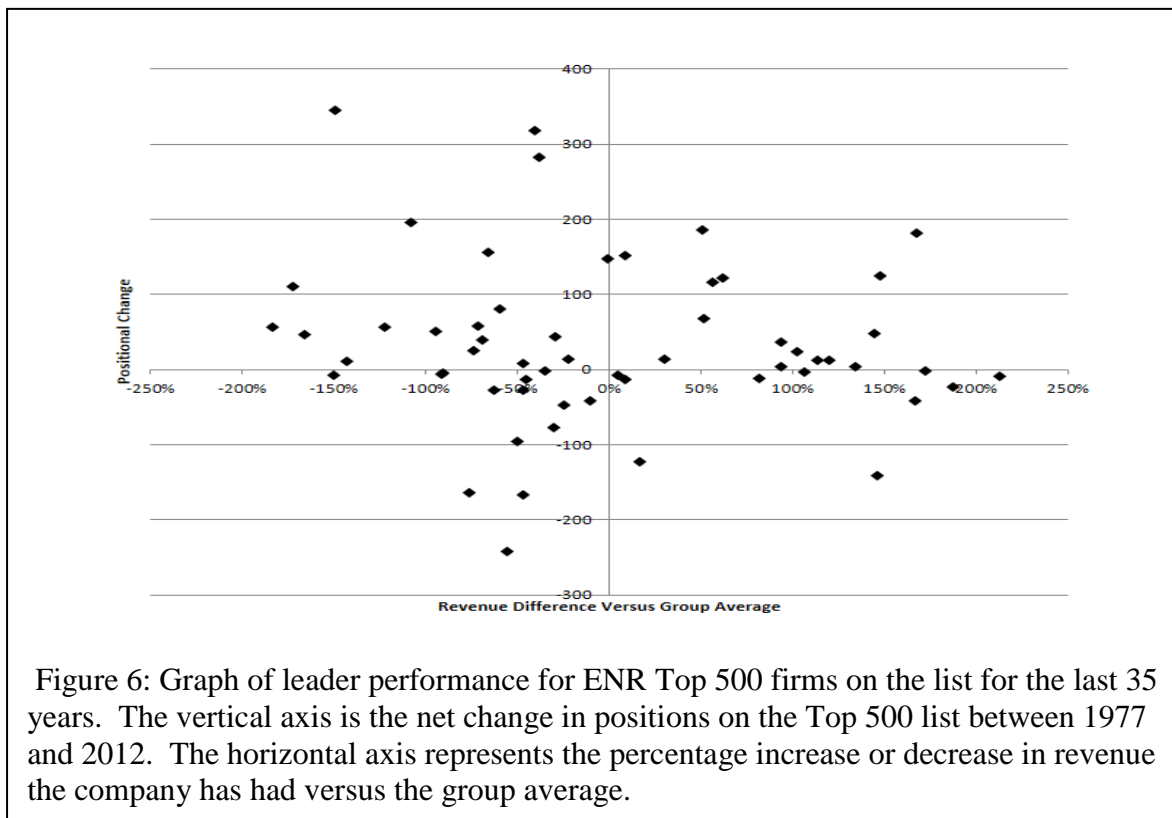
  For the second element in the performance metric, the positional increase on the Top 500 list over the 35-year period was determined for each firm. This number is important as it shows relative growth performance for each firm as it relates to positions in the ENR Top 500. These two metrics were then graphed as illustrated in Figure 6. The graph divides the organizations into four quadrants. The upper-right quadrant represents the organizations that exceed the group average in revenue increase and have a positive positional change. The graph excludes the two Mega firms on the list in the upper right quadrant as their revenue increase makes it difficult to see the detail for the remaining firms. The firms located in this quadrant are considered for the purpose of the current study the "Best of the Best" firms.

Category	Number of Firms	Average Revenue Increase
Mega	3	1,237%
Very Large	11	193%
Large	16	139%
Mid	31	130%

Table 5: Characteristics of initial list of Top 500 leaders. The number of firms from each revenue category and the average revenue increase of that group over the 35 year period of the study are listed.

  The final question for the current study is how the Mid-size firms are represented in this "best" group. The underlying hypothesis in this analysis is that if Mid-sized firms are proportionately represented in this group, then the concern for the ability of this group to compete over an extended period of time should be reduced. Table 6 documents the characteristics of the firms within the leadership quadrant. As illustrated, 10 of the 17 firms are from the Mid-size category. The Very Large category contains the fewest entries with only a single firm. Statistically, this distribution is significant in that it exceeds the Chi-Square test at 95% probability indicating that the difference from the expected distribution is not random based on the set of firms in the 35-year set. Specifically, the Mega and Mid-size firms exceed the expected values, the Large firms meet expectations, and the Very Large firms fall short of the expectations. The Mid-size firms are not only maintaining performance, but are exceeding the performance of the overall leaders.

  From the cluster perspective, the group leans towards the Balanced cluster with 10 entries from that cluster. However, from a statistical observation, the distribution of cluster membership in the leadership group is not statistically significant. Based on the original group of 35-year

Figure 6: Graph of leader performance for ENR Top 500 firms on the list for the last 35 years. The vertical axis is the net change in positions on the Top 500 list between 1977 and 2012. The horizontal axis represents the percentage increase or decrease in revenue the company has had versus the group average.

members, it is expected that the Balanced cluster would have the most representation,and in fact that is the case. The "Best of the Best" firms represent the overall group in terms of cluster membership. The issue of why the Balanced cluster has the greatest representation is left for further study.

CONCLUSİON

The current study examined the overall economic chracteristics of the engineering-architecture industry with a specific focus on the role of the Mid-size frm within the industry. The initial perspective examined the overall condition of the industry. As detailed, the industry has experienced continued growth since 1977 until 2008 when the first drops in the number of establishments and professionals occurred. Within this overall trend, the record shows that volatility increases as the size of the firm decreases. The long-term presence on the Top 500 list is biased towards larger firms. These firms are also beginning to see a growth in their overall percentage of the industry revenues as small firm revenue has decreased to 63% of the total.

The study found that a notable component of this increased revenue for Mega firms derives from international work. For the first time, the percenage of revenue obtained by Mega firms from international work exceeded 50%. In contrast, Large and Mid-size firms remained static in their receipt of international work revenue.

Although this overall perspective leads to the documented conclusions that Mid-size firms are demonstrating reduced viability in the economy, a closer look at the Mid-size firm perspective reveals a different story. As documented above, it is at the individual sector level where the Mid-size firms demonstrate strength. As shown, the General Building and Transport

clusters are led by Mid-size firms. Although Mid-size firms in clusters such as Power or Industrial may be seeing a redistribution of work, the traditional strengths of Mid-size firms remains strong.

Firm	Revenue Group	Positional Change	Revenue Change	Cluster
Firm 1	Mid	152	9%	Balanced
Firm 2	Mid	13	30%	General Building
Firm 3	Mid	68	51%	Balanced
Firm 4	Mid	116	56%	General Building
Firm 5	Mid	122	62%	Balanced
Firm 6	Mid	185	51%	Transport
Firm 7	Mid	3	93%	Balanced
Firm 8	Large	37	94%	Balanced
Firm 9	Very Large	23	102%	Balanced
Firm 10	Mid	12	113%	Transport
Firm 11	Mid	12	120%	General Building
Firm 12	Mid	3	134%	Balanced
Firm 13	Large	48	144%	Balanced
Firm 14	Large	124	148%	Industrial
Firm 15	Large	181	167%	Industrial
Firm 16	Mega	16	371%	Balanced
Firm 17	Mega	9	566%	Balanced

Table 6: Characteristics of 17 leading firms over the 35 year study as based on positional change in the Top 500 and revenue increase versus the average of their specific revenue group.

The stregth of these firms is reflected in the Mergers and Acquisition activity over the period of this study. In contrast to conventional wisdom, M&A activity involving Mid-size firms has not abnormally increased. Rather, the rate of this activity mirrors the overall economic condition over time. In this regard, interest in Mid-size firms has increased over the last decade, but this interest has been varied over the clusters with no specific focus. What the data does illustrate is an interest in purchasing firms that are in different sectors from the purchasers' core strength.

Finally, when examining the revenue categories from a perspective of long-term strength, it is the Mid-size firms that show a statistically significant over-representation in the "Best of the Best" firms. As illustrated, it is the size of the firm that has statistical significance in this group rather than the cluster in which they focus. This leads to the final perspective that the death of

the Mid-size firm has been miscalculated. These firms remain as strong as ever within their core clusters and demonstrate long-term leadership in the industry. Although the overall industry demonstrates greater movement toward Mega-firms, the closer analysis does not indicate that this movement has an overall negative effect on the Mid-size firm. Rather, it is the Mid-size firms that continue to out-perform all other categories on a long-term basis.

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