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A Study of the Supply and Demand for Construction Education Graduates

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In recent years, the construction industry has become more reliant on accredited construction education programs to supply individuals who are educationally and intellectually equipped to enter into an increasingly complex and demanding work environment. As this dependency grows, the necessity to assess industry needs and educational program production becomes increasingly apparent. The following study was conducted as part of this continual effort. It involved the survey of 54 accredited Construction Programs in the U.S. and over 773 companies which consistently hire graduates from these programs. A time series regression analysis was used to create a mathematical model to predict the demand for construction graduates from accredited construction programs. The model showed that there is in an increase in demand for construction graduates of approximately 600 students per annum. Given the continuation of current market growth and production levels of accredited construction programs, the results suggest a widening gap in the supply and demand of graduates for the near term.

Keywords: construction graduates, construction programs, construction industry, supply, demand

Introduction

The demand for construction education graduates has seemingly increased markedly in the past several years. As a result of this demand, construction education programs are flourishing throughout the nation with over fifty-four programs accredited by the American Council for Construction Education (ACCE) and the Accrediting Board for Engineering and Technology (ABET). Other construction graduates come from the National Association for Industrial Technology (NAIT) accredited programs, two-year construction programs and non-accredited four-year programs. NAIT is not oriented to construction, and accredits only construction programs that are part of an industrial technology program (Dorsey, 1992).

The fact that the construction graduate is a viable product and wanted by the industry is not in doubt. Pilot studies indicate a great demand for the construction graduate. In most construction education programs, institutions report a 100% placement rate, with many indicating that each graduate has three or four offers to select from. The question of "how many are and will be needed?", however, is largely unanswered. No extensive market research has recently been completed on either the supply or demand side for construction graduates. This study endeavors to address this problem by uncovering information relative to the supply and demand of construction graduates in the construction industry. More specifically, this study will attempt to:

1. Quantify the number of construction graduates currently produced nationwide by ACCE accredited construction programs and selected ABET accredited programs.
2. Quantify construction industry demand for construction graduates from ACCE accredited construction programs and selected ABET accredited programs.

Prior Studies of Construction Graduate Demand

Although the age of this study limits the ability to draw inferences for today's market, the findings of Jones (1983, p.49) offered interesting insights into the supply and demand question as far back as 1983. The study noted that statements regarding the construction industry's demand for construction program graduates are "more guesswork than factual". Mr. Jones cited a conclusion by the Business Roundtable's study on demand:

> Attempts to forecast supply and demand for construction and project management are inconclusive. Poor response from architect/engineer and construction management firms which hire considerable numbers of graduate engineers adds uncertainty to the results. The economic recession and in particular the slump in construction makes forecasting more difficult. Even so, the study indicated demand exceeding supply by about 2,500 (25%) over the next five years (The Business Roundtable, 1982, p7).

Jones (1983, p.50) continued with the following observations:

1. "Construction and construction engineering graduates, and the demand for them, must be held distinct from the demand for civil and other engineering disciplines". While ACCE accredited programs do not mix construction graduates with engineering graduates, ABET programs may.
2. "Construction programs are relatively new and therefore unknown to many construction companies". While this observation may have been true in 1983, a pilot study indicated a strong reliance on the graduates of construction programs.
3. "Demand statistics must be tempered by recognition of the fact that contractors will readily promote from within their organization when faced with a scarcity of qualified graduates".

The Jones study concluded there to be a small shortage of 300 to 500 graduates per year instead of the 2,000 to 3,000 shortages that was predicted by the Business Roundtable research (p.52). Mr. Jones acknowledged that a major factor, which might affect his demand projections, was a rise in construction program recruiting by contractors. It was believed that as construction programs became better known throughout the industry, there could be a large impact in demand for construction graduates. Recent reports from construction education programs indicate that increased recruiting has, in fact, occurred in the industry.

A more recent study by Robert W. Dorsey (1992, pp. 35-37) quoted the American Institute of Constructor's projection of 10,000 new managers of construction needed each year. This number included new and replacement positions ranging from assistant superintendents to senior

officers. Dorsey found that fewer candidates were being promoted from within construction companies; instead, construction companies appeared to be relying heavily on construction programs to provide recruits.

In addition to these studies, the Occupational Outlook Handbook published by the Bureau of Labor Statistics provides valuable information regarding the expected growth and opportunity in a wide range of industries. According to the 1998-1999 Handbook, construction managers held about 249,000 jobs in 1996. Over 85% were employed in the construction industry, primarily by trade contractors and general building contractors. The Bureau predicts employment of construction managers is projected to increase 10 – 20% between the years 1996 and 2006.

The study goes on to state that graduates with degrees in construction science, construction management, or construction engineering who have previous experience will find increasing prospects in construction management, engineering and architectural services, and contracting firms. This growth, according to the bureau is expected to result from various factors, which include an increase in activity and complexity of construction projects, as well as the need to replace workers who transfer to other occupations or leave the work force.

Addressing the supply of construction education graduates, the handbook estimates that over 100 colleges or universities offered 4-year degree programs in construction science or construction management in 1996 (This study surveyed only the 54 colleges or universities with construction programs accredited by either ACCE or ABET). Graduates from these programs, it says, are usually hired as assistants to project managers, field engineers, schedulers, or cost estimators. In addition, an increasing number of graduates in construction related fields (i.e. architecture, engineering) are entering into construction management, often after obtaining experience in their original occupation, or after completing graduate studies in a construction related program.

A common point expressed by all of these studies is that demand for the construction education graduate will increase in coming years, though the extent of this growth varies between studies. The remainder of this paper describes the study conducted in the Department of Construction Science at Texas A&M University in order to shed light on the supply and demand of the construction education graduate, and to assess the extent of the gap inferred by previous studies.

Research Methodology

Pilot Study

In order to determine the nature of the data, which could be provided by construction companies and universities, a pilot study was conducted. Both the companies and universities participating in the pilot study were sampled "by convenience". Table 1 lists the construction companies and contact persons included in the Pilot Study.

Table 1

Pilot Study Companies

Companies	Contact Person
Brown & Root, Inc.	Cindy Creeden
Centex Construction Group	Cindy DePrater
Fluor Daniel, Inc	Darlene Becker
H.B. Zachry Company	Bill Wemberly
HCB Contractors	Jerry Cooper

These five contractors have annual revenues ranging from 350 million dollars to over 9 billion dollars (ENR, 1997). They were sampled with the simple goal of determining what information would be available from the construction industry. Pilot study companies were able to provide the number of new employees they hire each year and the percentage of the new hires that have a construction education based university education. Additional information was provided in the following areas:

- factors influencing new hires;
- positions filled with construction graduates;
- five year forecasts for new hires;
- names of schools and departments from which they hire

They were not, however able to link the number of new hires directly to an easily quantifiable measure such as company revenue, backlog, or overall economic health. Some contacts were insistent that there was no connection between the number of new hires and the amount of work in progress or expectations of future work.

The pilot study continued by contacting the ACCE accredited construction programs listed in Table 2. Each department was asked to provide the number of graduates produced each year and was asked to provide a list of construction companies who regularly recruited from their programs. Rather than attempt to provide an exhaustive list of all companies, each department was asked to provide a list of the firms that recruited heavily, year in and year out. While most departments were willing to provide this information, the pilot study indicated that some programs would not provide this list without permission of the company. This permission was not sought.

Department heads were asked about their placement percentages and their subjective opinions on industry demand for construction graduates. All but one department reported 100% placement. In their subjective opinions, most department heads felt they could produce from 20% to 50% more students while maintaining 100% placement.

The universities listed in Table 2 were sampled out of convenience for the purpose of determining what information would be readily available from programs producing construction graduates. Information gathered during this pilot study was determined to be suitable for the proposed research, therefore these universities were not re-surveyed during the conduct of the research. The same telephone survey used in the pilot study was used to gather data for the remainder of the universities included in the study.

Table 2

Pilot Study Universities

Auburn University	*Arizona State University*
California Polytechnic University	*California State University, Chico*
California State University, Fresno	*California State University, Long Beach*
Florida International University	*University of Florida*
Southern Polytechnic University	*Boise State University*
University of Northern Iowa	*Purdue University*
Kansas State University	*Eastern Kentucky University*
Northeast Louisiana University	*University of Maryland, Eastern Shore*
Eastern Michigan University	*Central Missouri State University*
University of Nebraska	*Texas A&M University*

University Survey

The study was initiated by polling all ACCE-accredited construction education programs and selected ABET programs. Department heads were asked to reveal their average number of graduates per year for the three years prior to the study. The number of graduates from each program was then summed in order to calculate the current number of construction graduates produced by universities across the nation.

The department heads were also asked to provide a list of companies that recruit their construction students upon graduation. Responses from this question were used to compile a list which would represent the population of employers who hire new construction graduates.

Finally, the department heads were asked to estimate the percentage of the average number of yearly graduates who become employed by those companies listed as construction graduates employers. This question was asked in order to determine the number of students who could not be accounted for on the demand side of the study of construction companies.

Employer Survey

An attempt was made to survey every company on the list of employers established in the university survey. The survey targeted the past, present, and future number of new construction graduate hires within each company. Each employer was asked directly if the supply of graduates was sufficient to meet the needs of the company. If a company indicated there were not enough graduates available for hire, the employer was asked how many graduates would have met the needs of the company. This allowed a calculation of past and present demand for the construction graduate. To assess future estimates in construction graduate demand, several questions asked the employer to predict their hiring needs from 1998 to the year 2000. The employer was asked to make these predictions based on the current trend of steady economic growth.

Research Limitations

Interpretations based on the survey responses should be considered with due care. First, while the ACCE and selected ABET programs create a very large portion of the most desirable construction graduates; there are other sources beyond the scope of this research that provide graduates who are hired by construction companies. This research will not study sources of construction graduates outside of the previously specified ACCE and ABET programs. Likewise, it will not study the effects of other types of graduates on the demand for the construction graduate.

Secondly, the population of companies was limited to the companies identified by the construction education programs. Therefore, companies not identified by construction programs were not analyzed in this research. Finally, it is likely that the schools and companies surveyed have differing sources of historical data and planning processes that vary in completeness and accuracy. The reader should consider these limitations when interpreting the research results and conclusions presented in this paper.

Results

Supply of Construction Graduates

What is the current supply of construction graduates? In an attempt to address this question, a total of fifty-four universities with construction programs accredited by ACCE, ABET, and in some instances both, were surveyed. Results from the survey indicate 2350 construction graduates, as defined by this study, are produced each year. Of these graduates, 2179 students receive a bachelor's degree, and 171 students receive a master's degree.

Each university was also asked to list the companies that recruit construction graduates. The company names were aggregated into a list containing 773 employers. For the purpose of this study, this list is considered the population of companies who recruit construction graduates. Of these 773 companies, 295 responses were received to the employer survey. In summary, the projections within this study were based on responses from 38% of the total population of companies under investigation, and 36% of the total graduate supply as previously defined.

Employer Descriptions

Each employer was asked to identify the size of the company and the type of service the company provides. Figure 2 illustrates the percentage of small, medium, and large companies that responded to the survey. Not surprisingly, the majority of companies that hired construction graduates were large companies (>50M in annual revenue). Small (<25M) and medium sized companies (25-50M), together, make up less than 40% of the population surveyed.

When asked to reveal the type of service provided by their company, the majority of employers indicated commercial construction (48%), followed by industrial construction (18%),

construction management (15%), residential (7%), heavy/highway (7%), and "other" (5%). *Figure 1* illustrates the services provided by the surveyed companies.

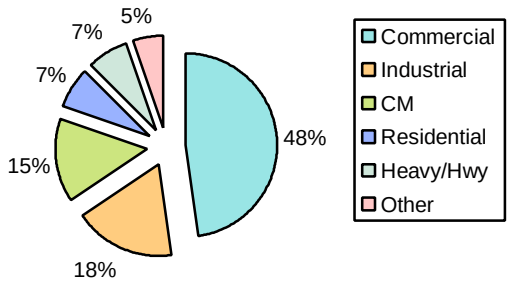

Figure 1 Breakdown of Company Type

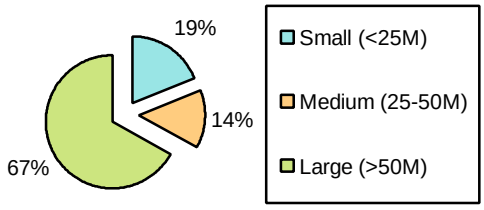

Figure 2 Breakdown of Company Size

Construction Graduate Demand

In the recent past, demand for the construction graduate has traditionally exceeded the available supply. To assess the extent of this supply-demand gap and estimate future trends, companies were asked about the past hiring activities of construction graduates, as well as estimates of their near-term hiring expectations. The next section presents the survey results regarding past, present and near-term demand for construction graduates. The results are followed by a long-term analysis conducted in order to predict trends in demand through the year 2005.

Current and Near-Term Demand for Construction Graduates

The demand for construction graduates was calculated in two ways. For the years 1995-1997 the annual demand was measured by summing the total number of graduates hired by responding companies and the total number of additional graduates companies would have hired had they been available. For the years 1998-2000 annual demands were based on the number of graduates responding companies predicted they would hire. Of all the companies issued with a questionnaire, only 38% of them completed the questionnaire. Taking this response rate into account, the annual demand totals were multiplied by 2.63 (1/0.38). The annual demand totals are set out in Table 3. *Figure 3* summarizes both the reported hiring figures and the predicted hiring figures based on the hiring quantity data.

Results from the survey suggest a steady growth in the hiring of construction graduates has occurred in recent years. Companies reported hiring approximately 2,300 construction graduates in 1995. For 1997, this figure increases by approximately 50% to 3,396 graduates hired translating into an average increase of 540 graduate students per year through 1997. This growth is depicted graphically in *Figure 3.*

The short-term predictions of the responding companies offer some interesting observations. Responding companies estimated there would be a total need for approximately 4,525 construction graduates in 1998. This is more than a thirty percent increase from the figures reported the year before. Between 1998 and 2000, however, the trend flattens with companies reporting an increase of only 9.8% in hiring expectations. It is interesting to note this slight decrease given that companies were asked to base their predictions on a steady growth in the construction market. It should be noted, however, that some companies did not respond to the questions regarding predictions in hiring which could explain, in part, this decrease in expected demand.

Table 3

Demand for Construction Graduates 1995-2000

Year	Calendar Year	Demand for Construction Graduates
0	1995	2303
1	1996	2708
2	1997	3396
3	1998	4525
4	1999	4800
5	2000	4972

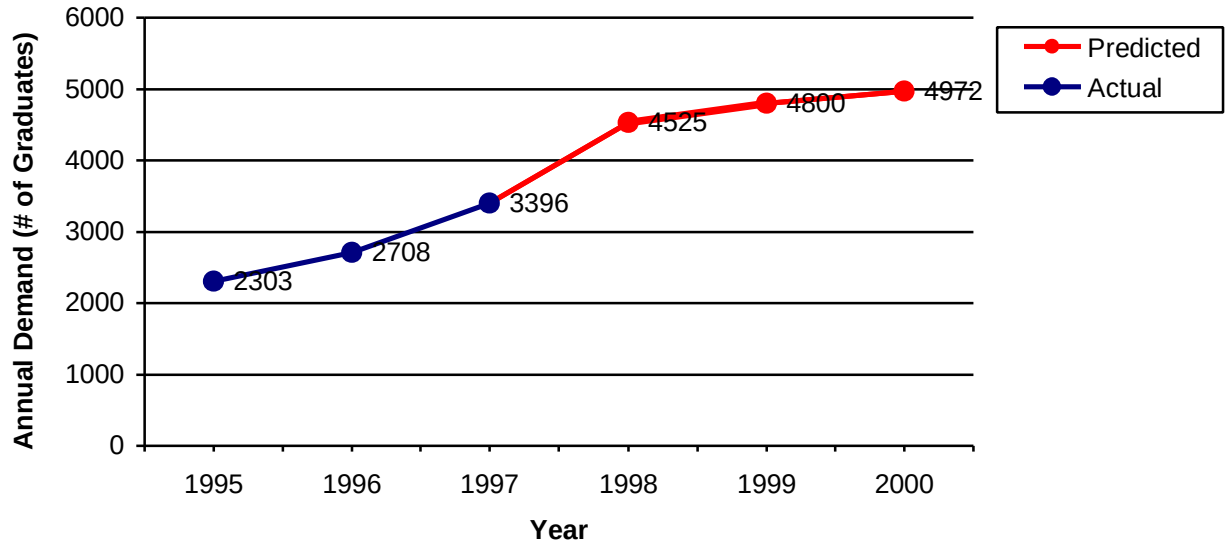

Figure 3. Demand based on employer's actual and predicted data

Long-Term Demand for Construction Graduates

The results from the current and near-term analysis suggest a steady increase in demand has occurred in recent years, and will most likely continue over for the next few years. But the question of long-term-demand remains largely unanswered. Predicting the future demand for construction graduates is a difficult task, and can be approached in several ways. One method of predicting the demand is to extrapolate from past trends. For this study, the historical hiring quantities and the short-term predictions through the year 2000 were used to formulate a simple regression model in order to extrapolate the data through the year 2005. It should be noted at this point, however, that straight-line extrapolations from the past are acceptable only during times of steady growth which was assumed for purposes of this study. The following section summarizes the model used for the data extrapolation and the resulting data.

For this analysis, the dependent variable was the measure of the demand for construction graduates of ACCE accredited construction education programs and selected ABET programs. The independent variable was the number of years from the first year surveyed. The first year surveyed is calendar year 1995, which was designated year 0 for purposes of the study. The final year surveyed (2000) was labeled year 5.

A simple linear regression model was used to predict the demand for the number of construction graduates based on the calendar year. The regression model was defined as:

Number of Construction Graduates = $?_o ? ? _1 Year ? ?$

Results of the General Linear Model procedure are displayed in Table 4. The R-square value (coefficient of determination), which measures the proportion of variability in the dependent variable explained by the independent variable (Ott, 1993), show that approximately 95% of the change in the number of construction graduates is caused by change in time. This indicates that this regression model would appear to be a good predictor of the demand for construction graduates, if the steady growth of the industry remains constant.

Table 4

Results of General Linear Model procedure

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr>F**
Model	1	6150892	6150892	71.63	0.0011
Error	4	343469	85867		
Total	5				

	R-Square	**C.V.**	**Root MSE**	**Mean**
	0.947113	7.743954	293.0312	3784

The results of the parameter estimates suggest the annual increase in the demand for construction graduates is approximately 600 based on the regression model. The parameter estimates for the linear regression model are shown in Table 5.

Table 5

Parameter estimates for linear regression model

Parameter	Description	Estimate	T for HO: Parameter =0	Pr>? T?	Std. Error of Estimate
? 0	Intercept	2302	10.85	0.0004	212
? 1	Year	593	8.46	0.0011	70

Using the parameter estimates of the linear regression model, the predicted demand for years 2001-2005 was calculated. Table 6 summarizes the demand of graduate students for 2001-2005 based on the regression model. The predicted demand for construction graduates is displayed graphically in *Figure 4.*

Table 6

Predictions for years 2001-2005

Year	Predicted	Prediction Intervals		*Confidence Intervals*	
		Lower 95%	Upper 95%	Lower 95%	Upper 95%
2001	5859	4747	6971	5102	6616
2002	6452	5212	7692	5516	7388
2003	7045	5660	8429	5925	8165
2004	7638	6098	9177	6331	8945
2005	8230	6528	9933	6734	9726

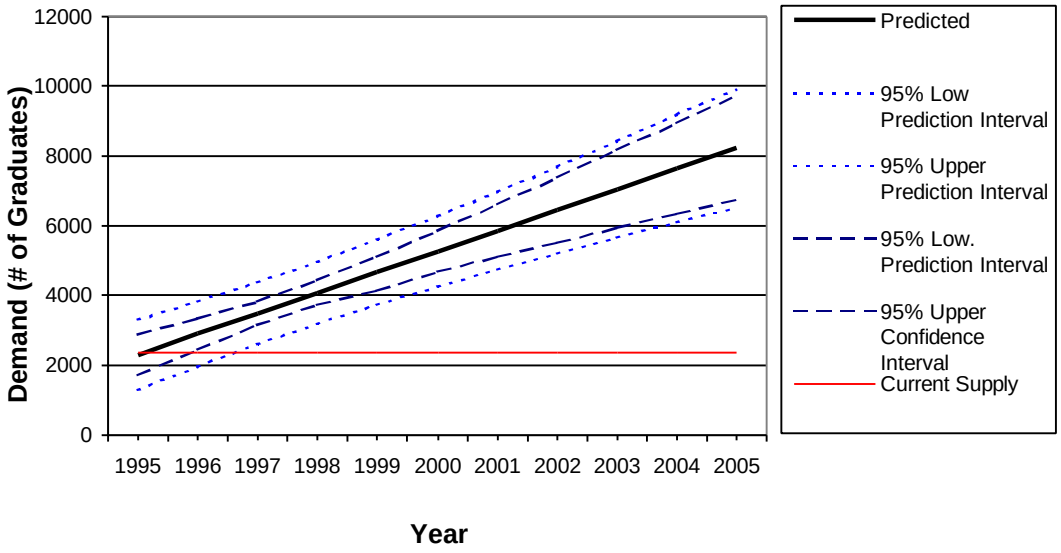

Figure 4. Predicted demand for construction graduates 1995-2005

These results suggest a growth in demand of approximately 600 construction graduates per year through 2005. Using the most conservative estimates, or the lower 95% prediction interval, the results of the analysis indicate the demand for construction graduates will reach approximately 4747 by the year 2001. By 2005, the lower 95% prediction interval indicates this demand will increase by almost 38% to 6528 graduates.

Based on the results, if the current supply of graduates from accredited construction programs is kept constant at 2,350, then by 2001 a shortage of approximately 2,400 graduates will exist. By 2005, the gap increases to 5,880. This "supply-demand gap" is illustrated in *Figure 5*.

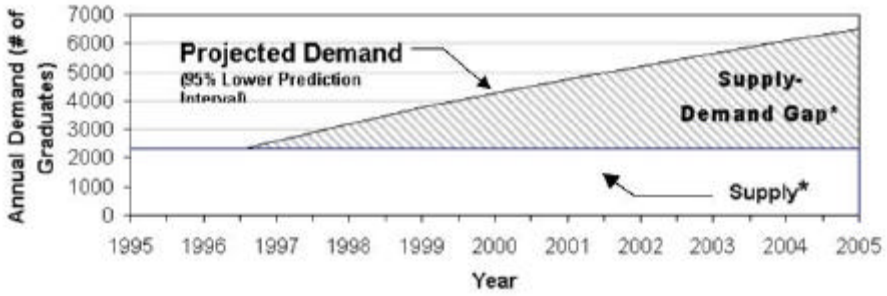

Figure 5 Conservative Prediction Estimates Based on Regression Model and a Constant Supply of Construction Graduates.
* Given the current supply of 2,350 remains constant through 2005

Summary and Conclusions

Based on the survey results, this study concludes that 2350 construction graduates are currently produced each year by ACCE accredited construction programs and selected ABET accredited programs. 773 companies constitute the majority of those who hire construction graduates as defined by this study.

Demand for the construction graduate has exceeded the available supply in recent years, and based on the results, this trend will continue in the near future. Companies have predicted a 9.8% increase in construction graduate demand between the years 1998 and 2000. Results from the regression analysis suggest the annual increase in demand for construction graduates will be approximately 600 per year through 2005. This figure more closely resembles the Jones Study findings which concluded there to be a shortage of 300-500 graduates per year instead of the 2,000 to3,000 shortage predicted by the Business Roundtable Research. From the available supply and demand data, we predict that there will be a sufficient number of construction positions available to match the supply of construction graduates in the near future.

Possibly the most significant results from this study, however, come not from the questions answered, but rather, those unanswered questions. For instance, how are companies satisfying the voids left unfulfilled by construction graduates? Additionally, what non-construction education programs are producing graduates capable of filling construction industry positions? Answers to these questions will require a look beyond the scope of this study into variables both within and outside the construction industry and related educational programs.

In conclusion, Construction Education programs are not meeting the current demands of the construction industry and it is unlikely that this fact will change in the projected future. Research data indicates that there is substantial demand within the construction industry to warrant the continued growth and expansion of construction education programs. An

exploration of these issues is necessary if we wish to gain a better understanding of the 'real' supply and demand of the construction education graduate.

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