Focusing Research on Fundamental Issues

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Introduction

Many construction projects are highly complex. This complexity causes many projects to be completed at a much higher cost and for a longer duration then was originally anticipated. The author has observed the difference between low bid and completed cost for competitively bid highway projects in New York, New Jersey and Great Britain. The research indicates that the larger projects tend to have a much larger cost escalation both in absolute terms and as a percentage of the original project costs (Williams et al. 1998).

We need to expand our understanding of the mechanisms of cost increases in large construction projects. Obviously, there is a need for new tools to manage complex projects. The complexity of construction has exceeded the capabilities of tools like CPM to allow for the orderly planning and control of many major construction projects. The focus of research in the past several years has been on the application of advanced computer models to provide solutions and on research into providing different forms of project delivery systems. It is the author's contention that we have never clearly understood many of the basic relationships between project size, duration and cost escalation and that we should concentrate on more basic research about the nature of the construction industry.

Research Problems

The problems involved with complex projects have caused many to search for solutions in new methods of project delivery. Methods like Design Build construction

are seeking to integrate design and construction. It is hoped that this integration will reduce the cost escalations observed on many projects. However, these new contractual techniques do nothing to provide a better understanding of the complexities involved in a major construction project, nor do they offer any new management methods to provide better control of large contacts. It still must be ascertained if this integration of design and construction solves problems related to the complexity of building large facilities on time and for the originally budgeted cost.

Another major area of research has been the development of advanced computer and artificial intelligence programs to solve construction problems. We have sought to apply computer methods to an industry resistant to change. Often, academicians have been guilty of promoting a particular technique and then have sought a construction problem to solve with it. Additionally, the construction industry has been slow to cooperate with research because they fear proprietary knowledge may be given up during the knowledge acquisition phase of techniques such as expert systems. Too much of the computer research we perform is completed with only a journal article as the result. When dealing with artificial intelligence, the research often delivers software that functions as a “black box” that provides answers but does not provide a deeper understanding of the nature of construction.

We need to study more fundamental issues about the construction industry and provide solutions more easily used in the field. The construction industry has always built unique projects. It seems that construction researchers have accepted the idea of the uniqueness of construction projects, and have therefore drawn the conclusion that construction projects are too complicated to be analyzed by conventional analytic

techniques. Instead of trying to understand general relationships that can be applied to all types of projects, we try to develop artificial intelligence programs that can quantify the many factors that affect an individual project.

Example: Predicting Completed Construction Costs

Recent research has attempted to apply artificial intelligence to the prediction of completed project costs. These efforts start with the *a priori* assumption that each project must be considered unique. Attempts have been made to develop extremely complex models that incorporate all of the many different factors and their interactions that can affect the cost of a construction project. These efforts have yielded software that require significant computing power, a sophisticated user, input of subjective information, and significant required input data. Hajek et al. (1996) have developed the COMPASS decision support system that models many of the complex factors affecting a construction project to produce a probable weighted percentage cost escalation. Alceron and Ashley (1996) have proposed a general performance model for analyzing individual construction projects. This model also requires the analysis of many factors such as labor productivity, design, quality, procurement and the interaction between factors.

When investigating project cost increases, the author was surprised to find that very little research has been conducted into the behavior of project costs during construction. We have invented techniques to analyze individual projects, but we have not studied if construction costs increase in any systematic way. In addition, little research has been conducted about how the behavior of bidders can be related to the completed cost of a project. A plethora of articles can be found that provide techniques for calculating a winning low bid. Examples include Skitmore and Patchall (1990), and Pin and Scot (1994). However, very little research exists that relates the low bid

calculated by these bidding models to the actual completed cost of a project. We may be able to find relationships in construction cost data that can be usefully and simply applied. For example, Williams et al. (1998) have described how simple linear regression models can be used to predict the completed cost of competitively bid highway construction projects using only the low bid as input. Certainly, research of this type has been hampered in the past because data has not been available. However, more data appears to be becoming available, particularly in the public sector.

Implications for Our Research Agenda

Based on the discussion above, the author believes that we have spent too much effort on developing computer applications that have no possibility of adaptation by the construction industry. These efforts have focused on methods of dissecting an individual project.

We need to refocus our research efforts to provide a more basic understanding of construction. Rather then concentrating our efforts on computer programs that analyze an individual project in detail, we should study aggregate data about construction projects to identify how common trends that occur can be quantified. These efforts can result in simpler, more generalized models that can more easily be used by the construction industry.

Information about the Author

Trefor P. Williams is an Associate Professor of Civil Engineering at Rutgers University. His research interests include the development of neural networks, expert systems and hypertext systems for construction management problems. Recently, he has concentrated on the relationship of the low bid and completed cost of competitively bid highway projects. This work has shown that complex projects tend to have much higher

cost increases as a percentage of the low bid amount then small projects. He has also found that by using a natural log transformation it is possible to produce a reasonable prediction of the completed cost of a project using only the low bid amount as input. He has received a B.S. in Civil Engineering from Syracuse University. He holds M.S. and Ph.D. degrees from the Georgia Institute of Technology.

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