

CONSTRUCTION
INDUSTRY
INSTITUTE

3D CAD LINK

The Construction Industry Institute
The University of Texas at Austin
3208 Red River
Suite 300
Austin, Texas 78705-2650
(512) 471-4319
FAX (512) 499-8101

Not printed with state funds

3D CAD Link

**Prepared by
The Construction Industry Institute
3D CAD Link Research Team**

**Research Summary 106-1
November 1995**

© 1995 Construction Industry Institute™.

The University of Texas at Austin.

CII members may reproduce and distribute this work internally in any medium at no cost to internal recipients. CII members are permitted to revise and adapt this work for the internal use provided an informational copy is furnished to CII.

Available to non-members by purchase; however, no copies may be made or distributed and no modifications made without prior written permission from CII. Contact CII at <http://construction-institute.org/catalog.htm> to purchase copies. Volume discounts may be available.

All CII members, current students, and faculty at a college or university are eligible to purchase CII products at member prices. Faculty and students at a college or university may reproduce and distribute this work without modification for educational use.

Printed in the United States of America.

Contents

<i>Chapter</i>	<i>Page</i>
Executive Summary	v
1. Introduction	1
2. Findings	
A. Research Overview	3
B. Applications	11
C. Impediments	16
D. Benefits	21
3. Conclusions and Recommendations	29

Executive Summary

The use of three-dimensional computer-aided design (3D CAD) in construction and construction management was identified by the Construction Industry Institute as an important area to investigate because of potential benefits to the industry. Work done in the past in 3D CAD has provided little substance into the exact nature of the value of using this technology. In addition, little guidance exists about how to achieve the best value of using 3D modeling. CII, therefore, created the 3D CAD Link Research Team and asked that it determine the benefits of and the impediments to using 3D in construction.

This publication summarizes the research effort of the team. The research found that the construction management applications currently being performed with the assistance of 3D were most commonly used to check clearances and access, to visualize details from nonstandard viewpoints, and to perform constructability reviews. Impediments to the use of 3D included undetermined economic impacts, a resistance to change within the construction industry, and a lack of trained personnel.

The benefits from using the technology were clear and conclusive, and indicate that increased usage of 3D CAD can provide significant reductions in cost growth, schedule slippage, and total rework. A detailed case study was performed by the research team to substantiate these benefits, and is described in summary fashion in this report. Complete analysis can be found in the team's research report to CII. The team feels that aggressive and broad use of 3D CAD technology can bring repeatable benefits provided that the user is willing to invest time and resources in becoming adroit with the technology.

Introduction

The Construction Industry Institute (CII) has previously researched the value of using three-dimensional based engineering software in the design process, but recognized that its application in the construction process would differ in both function and benefit. CII authorized Research Team I-106, 3D CAD Link, to study this area specifically and to report on the findings. This publication details the results. The methods and raw results of this effort can be found in the team's research report, RR106-11.

The research team assembled for this project included owner, engineer, and contractor company representatives. The members all had experience with the use of 3D computer models in construction and their input was critical to the success of this research.

The team's original mission statement included the following scope and objectives:

Scope

1. Survey of 3D computer models in construction to identify costs, benefits, penalties and rewards.
2. Study indicators that firms use to measure impacts associated with using 3D computer models on site.
3. Perform a case study and establish firm costs and impacts in the use of 3D computer models throughout the construction cycle.

Objectives

1. Develop a framework for categorizing and measuring impediments and benefits of the use of 3D computer models in construction.
2. Develop firm, explicit cost impacts on an actual project.

Data Gathering Efforts

The first phase of the research was to survey the CII member companies in order to find out how they currently use 3D models in construction, what they believe the benefits are in their use, what the impediments are to their implementation, and how the members believe these impediments can be overcome. This information was collected using questionnaires that focused on the current “state of belief” within the industry.

The second phase collected “hard number” data on a large number of projects that had been constructed within the last five years using either 3D computer models or using the traditional 2D approach. This questionnaire was designed to collect specific information regarding the characteristics and outcomes of each project so that it could be analyzed statistically. This was the critical step that went beyond previous unquantified analyses. This process gave statistically valid results contrasting projects constructed with and without 3D computer models.

The third phase of the research was to dissect an actual project in progress that was using a 3D computer model at the job site. This project was used to give specific examples illustrating how a 3D computer model was used on a construction site and to demonstrate its impacts on the project outcome.

In general, the responses received to the questionnaires and the willingness to allow access to the case study site exceeded all of the early expectations of the research team. There was a surprisingly positive response from the industry and the amount of data collected was sufficient to allow statistically conclusive results to be drawn.

The research team maintained a constant vigilance to prevent bias in the results and to perform a thorough examination. The team also carefully examined the definition of 3D and confirmed the difference in value between 3D visualization and a 3D system that has an intrinsic database used for much more than viewing or drawing.

Findings

A. Research Overview

Industry Practices and “State of Belief” Questionnaire

The first questionnaire sent out to the CII membership was used to find out what was currently being done with the 3D models in construction and how the people in the industry felt about their use. Figures 1 through 6 summarize these results.

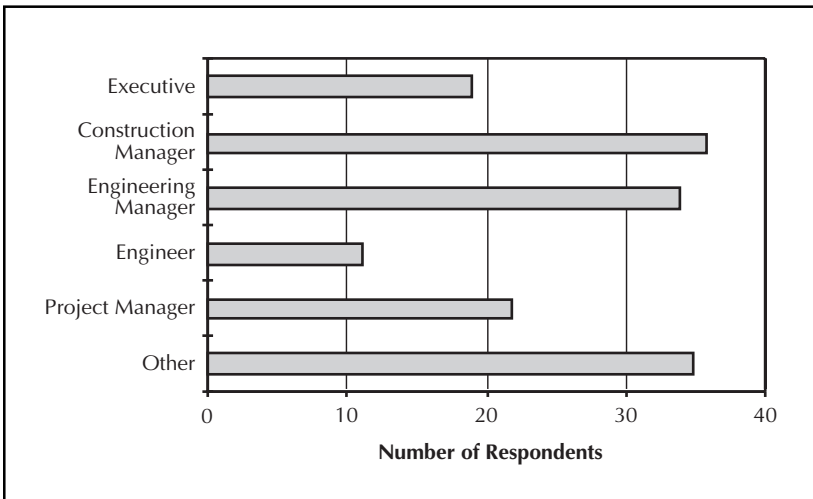


Figure 1. Respondents' Positions within their Companies

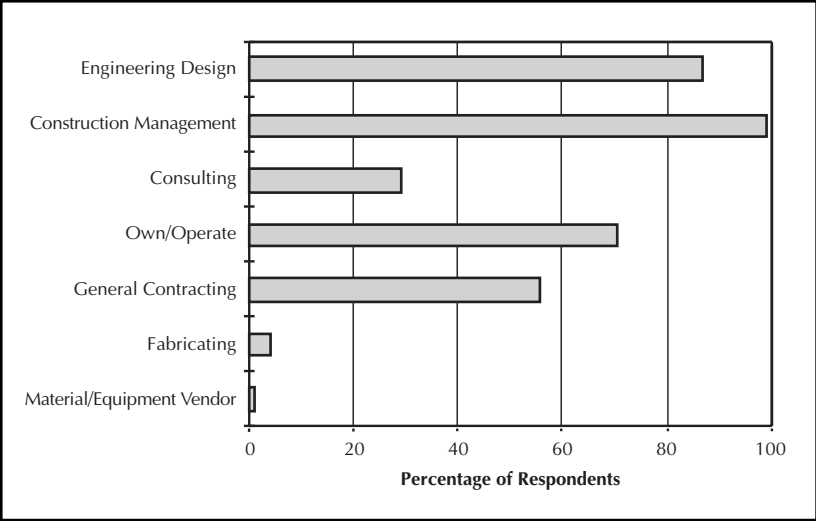


Figure 2. Respondents' Company Business

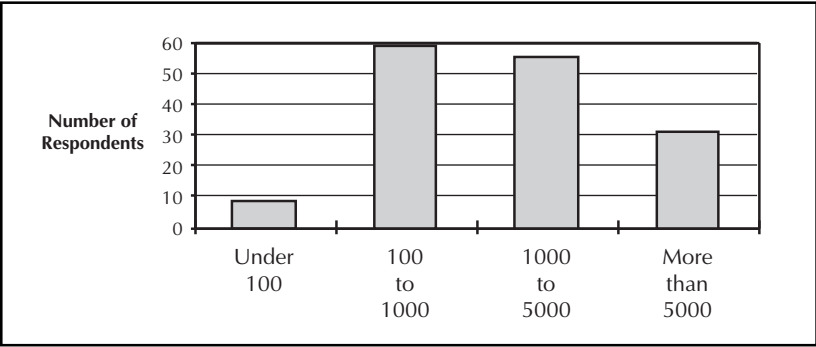


Figure 3. Size of Respondents' Companies' Design/Construction Divisions

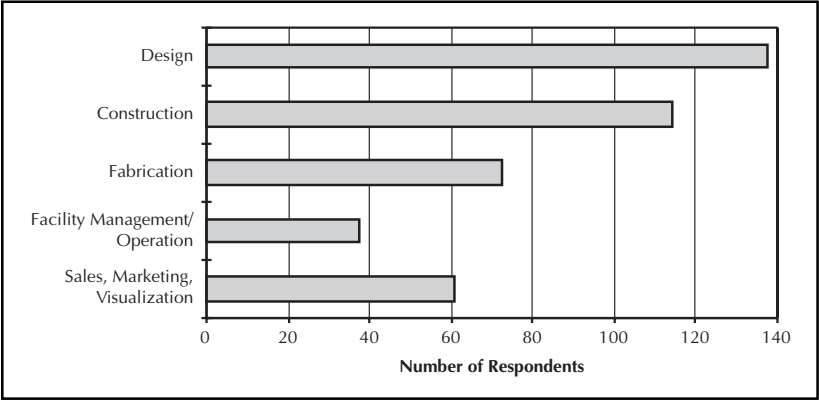


Figure 4. 3D Computer Application within Respondents' Companies

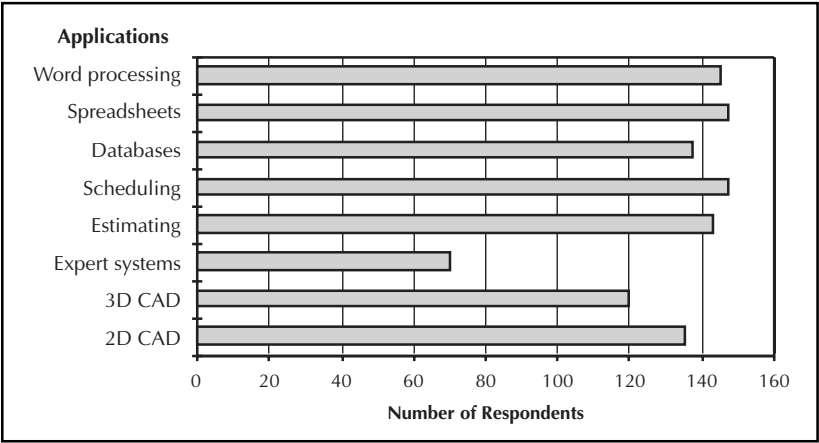


Figure 5. Computer Use within Respondent Companies

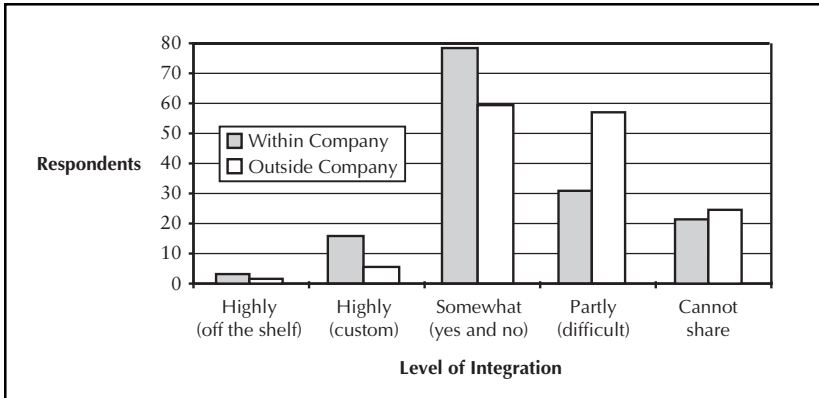


Figure 6. Respondents' Companies' Level of Computer Integration

Construction Project Data Questionnaire

Construction project data were also collected from CII members through the use of survey questionnaires. This questionnaire and the raw data responses can be found in Appendix D of the team's research report. These data were collected in a form that could be easily analyzed so that relationships could be found between descriptive factors, or cofactors, on a project (such as size, type, design quality, and labor availability) and the project metrics (outcomes such as cost overruns, schedule delays, and rework). Data from 93 projects were included in the database, 41 of which were designed and constructed using 3D computer models. Fifty-nine of these projects were built as additions to existing facilities, while the remaining 34 were constructed on new sites. Figures 7 through 13 show the survey results in general.