

CONSTRUCTION INDUSTRY INSTITUTE

ENGINEERING PRODUCTIVITY MEASUREMENT

Construction Industry Institute

3M	ABB Lummus Global
Abbott Laboratories	ALSTOM Power
Air Products and Chemicals	BE&K
Anheuser-Busch Companies	BMW Constructors
Aramco Services Company	Baker Concrete Construction
BP Amoco Corporation	Bechtel Group
Bayer Corporation	Black & Veatch
The Boeing Company	Burns & McDonnell
CITGO Petroleum Corporation	Burns and Roe Enterprises
Cargill	Butler Manufacturing Company
Celanese	CCC Group
ChevronTexaco	CDI Engineering Group
Conoco	Chicago Bridge & Iron Company
Dofasco	Day & Zimmermann International
The Dow Chemical Company	Dick Corporation
DuPont	Dillingham Construction Holdings
Eastman Chemical Company	Eichleay Engineers & Constructors
ExxonMobil Corporation	Emerson Process Management
FPL Energy	Fluor Daniel, Inc.
General Motors Corporation	Foster Wheeler USA Corporation
General Services Administration	Fru-Con Construction
GlaxoSmithKline	Graycor
Huntsman Corporation	Hilti Corporation
Intel Corporation	Honeywell
Eli Lilly and Company	Integrated Electrical Services
NASA	Jacobs
Naval Facilities Engineering Command	Johnson Controls
Ontario Power Generation	Kellogg Brown & Root
Phillips Petroleum Company	Kiewit Construction Group
Praxair	Kværner
The Procter & Gamble Company	M. A. Mortenson Company
Reliant Energy	Murphy Company
Rohm and Haas Company	PSEG Energy Technologies
Shell Oil Company	Parsons Energy & Chemicals Group
Smithsonian Institution	Petrofac LLC
Solutia	Primavera Systems
Tennessee Valley Authority	Rust Contractors
U.S. Air Force Research Laboratory	S&B Engineers and Constructors Ltd.
U.S. Army Corps of Engineers	SMS Demag
U.S. Department of Commerce/NIST	The Shaw Group
U.S. Department of Energy	Siemens Westinghouse Power
U.S. Department of State	Structural Group
U.S. Steel	Technip USA Corporation
Weyerhaeuser Company	Walbridge Aldinger Company
	Washington Group International
	Williams Group International
	H. B. Zachry Company

Engineering Productivity Measurement

**Prepared by
The Construction Industry Institute
Engineering Productivity Measurement Research Team**

**Research Summary 156-1
December 2001**

© 2001 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	4
3. Conceptual Productivity Model	9
4. Survey Results & Learnings	13
5. Conclusions and Recommendations	15
References	16
Appendix	17

Executive Summary

Engineering costs on major capital construction projects continue to rise to levels approaching 20 percent of total project cost on industrial projects. Increased facility complexity, OSHA documentation requirements, and the increasing need for more definitive and complete design are only a few of the factors driving this trend. In addition, the shortage of skilled craftsmen intensifies.

Reliable engineering productivity measurement is a critical element of predictable project performance and improvement. Unlike construction labor productivity, however, little research has been conducted in the area of engineering productivity measurement. Standard engineering productivity measurements must be established and applied to present day work processes before significant improvement and predictability of performance can be made.

CII established the Engineering Productivity Measurement Research Team (RT 156) to determine a valid measurement approach that will drive the improvement that present day design tools only promise. The research team concludes that a new model is required for measurement of engineering productivity. This model should focus on readily measurable, installed quantities. To be useful to the industry in driving continuous improvement, it should be applied at the discipline level in the detail design phase of projects using influencing factors appropriate to project characteristics and industry sector.

The research team has developed a model that meets these requirements. This publication presents the model as well as a summary of the research activities leading up to it.

Introduction

Introduction

The continual rise in engineering costs is of paramount interest to both owners and contractors. Present productivity methods focus on design deliverables such as drawings and specifications. Lack of standard formats and content requirements for these deliverables, the difficulty of a tracking effort dedicated to each deliverable, and the lack of correlation of the numbers to installed quantities and overall project effectiveness have rendered the current methods much less than ideal.

The increased use of computer-based engineering tools has further invalidated present methods. Specifications and schematic drawings both are produced largely from electronic databases, and physical drawings have been replaced with computer models.

These same design tools, however, present untapped opportunities to track engineering progress much the same as construction progress is tracked. When this potential is realized, the earned value systems in use today can be applied to “resource loaded” schedules with engineering and construction resources on an equivalent basis — a significant advancement in integrated project controls.

Purpose

Little effort has been expended in the area of engineering productivity at a time when design tools, work processes, and project cost and schedule constraints have been continuously changing. The general purpose of this research was to address this fact.

Specifically, the objectives were to:

- Determine present practices and their shortcomings.
- Find productivity improvement success stories in other industries and apply learnings.
- Develop a new productivity model that addresses the shortcomings of present practices.
- Test the model hypothesis.
- Develop plans for carrying results into actual project practice.

Methodology

The development of the overall productivity measurement system requires the collection of readily available data that are not presently of interest in the detail design phase of projects for many companies. Pilot projects with simple data sets established during the front-end loading process will be used to establish the significant variables for influence factors and input/output relationships for all disciplines. Support of this continuing effort coupled with actual use by CII member companies will ensure a successful move toward the use of standard engineering productivity measures throughout the industry, which is paramount to continued improvement of the project process.

Overall Results

Detailed model development is necessary since data that matches the model will be available only after its acceptance and use. The few companies that are presently using “installed quantity” data during the design phase of projects are using it primarily for detection of “scope creep.” Data collection efforts by the research team revealed that many companies are presently ignoring this readily available data.