

Benchmarking and Metrics



Summary Report



February 2002

BMM2002-3

CII Member Companies

3M

Abbott Laboratories

Air Products and Chemicals, Inc.

Anheuser-Busch Companies, Inc.

Aramco Services Company

BP Amoco Corporation

Bayer Corporation

CITGO Petroleum Corporation

Cargill, Inc.

Celanese

ChevronTexaco Corporation

Conoco Inc.

Dofasco, Inc.

The Dow Chemical Company

E. I. duPont de Nemours & Co., Inc.

Eastman Chemical Company

Eli Lilly and Company

ExxonMobil Corporation

General Motors Corporation

General Services Administration

GlaxoSmithKline

Huntsman Corporation

Intel Corporation

National Aeronautics & Space Administration

Naval Facilities Engineering Command

Ontario Power Generation

Phillips Petroleum Company

Praxair, Inc.

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Reliant Energy

Rohm and Haas Company

Shell Oil Company

Smithsonian Institution

Solutia Inc.

Sunoco, Inc.

Tennessee Valley Authority

U.S. Air Force Research Laboratory

U.S. Army Corps of Engineers

U.S. Department of Commerce/NIST/

Building & Fire Research Laboratory

U.S. Department of Energy

U.S. Department of State

U.S. Steel

Weyerhaeuser Company

ABB Lummus Global Inc.

ALSTOM Power Inc.

BE&K, Inc.

BMW Constructors Inc.

Baker Concrete Construction Inc.

Bechtel Group, Inc.

Black & Veatch

Burns & McDonnell

Burns and Roe Enterprises, Inc.

Butler Manufacturing Company

CCC Group, Inc.

CDI Engineering Group, Inc.

Chicago Bridge & Iron Company

Day & Zimmermann International, Inc.

Dick Corporation

Dillingham Construction Holdings Inc.

Eichleay Engineers & Constructors Inc.

Emerson Process Management

Fluor Daniel, Inc.

Foster-Wheeler USA Corporation

Fru-Con Construction Corporation

Graycor

H. B. Zachry Company

Hilti Corporation

Honeywell International

Integrated Electrical Services, Inc.

Jacobs

Johnson Controls, Inc.

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Kiewit Construction Group, Inc.

Kvaerner

M. A. Mortenson Company

Murphy Company

PSEG Energy Technologies Inc.

Parsons Energy & Chemicals Group, Inc.

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Primavera Systems, Inc.

Rust Constructors Inc.

S&B Engineers and Constructors Ltd.

The Shaw Group Inc.

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SMS Demag Inc.

Structural Group

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Walbridge Aldinger Company

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Benchmarking and Metrics Summary Report for 2001

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February 2002

Reviewed by CII 3Feb04

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Chapter 1 -- Introduction

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Activities during the past year mark the evolution of the CII Benchmarking and Metrics program into a Web-based system of data collection, performance reporting, and industry analysis. CII believes that it is appropriate to broaden the Benchmarking and Metrics paradigm from one with a program focus to one with a systems focus in order to fully capture the set of activities comprising Benchmarking and Metrics, and to better explain how each contributes to the promotion of the use of best practices for superior project performance within the industry. In addition to collecting data on project participants, project environment, cost and schedule, and practice use, data collection activities now include gathering information on productivity metrics on-line. Project-level Progress Key Reports showing metric scores, performance quartiles, and graphic comparisons of individual project performance to the entire database can also be accessed on-line during the life of the project. As had been the practice in the past, Final Key Reports, generated after the project is completed and submitted in final format to the CII database, are produced in hard copy and are provided to the company's Board of Advisors representative. Finally, industry analysis reports, including the annual Data Report, Safety Report, Value of Best Practices and Summary Report, and any reports resulting from funded studies are available on-line and in hard copy as they become available. The Data Report is available in CD format as well.

Priorities for the past year have included improving the Web-based questionnaire, developing Progress Key Reports for the Web, and increasing the number of best practices that can be used for benchmarking. Other systems initiatives continue to move forward as well. A Benchmarking questionnaire redesign effort is underway with the objective of minimizing respondent burden while maintaining a rich source of information. Increased emphasis has been placed on training Benchmarking Associates to ensure reliable and consistent data collection. Data collection has begun for the Productivity Metrics initiative. The quality and quantity of analyses continue to be improved through further automation and the application of more rigorous statistical techniques. More than 3,000 pages of findings were published within the past year, providing member companies quantitative data to support decision-making. Norms for performance and practice use and the benefits of adopting CII recommended best practices are provided annually to support continuous improvement activities. Practices are now categorized by project outcomes to assist in selecting those practices that support specific project goals. All of this is delivered in a lean and efficient benchmarking system described by one member company as a "best buy" among benchmarking services.

This Summary Report provides an overview of the CII Benchmarking and Metrics System. Following some background and a descriptive discussion of the database, an abridged presentation of key findings is offered. Although there is much to summarize, the report would be lacking without some discussion of evolving products. Since only a brief description of these products can be provided here, you are invited to visit the Benchmarking Web site at <http://www.cii-benchmarking.org/> for a more in-depth look at the system.

1.1 Benchmarking System Objectives

Objectives of the CII Benchmarking and Metrics System have changed little despite the many changes in implementation instituted during recent years. These objectives include:

- Provide the industry with a common set of metric definitions.
- Provide the industry with project performance norms.
- Measure the level of use of selected best practices.
- Quantify the value of implementing CII recommended best practices.
- Provide participating companies tools for self-analysis.

- Facilitate the development and sharing of benchmarking knowledge within the construction industry.
- Provide a credible and member accessible database that is efficient in terms of resources required for data submission, analysis, and the reporting of findings.

1.2 Benchmarking Scope

CII benchmarking is very focused, providing program activities that do not duplicate the efforts of other organizations. As such, the metrics utilized are high level and in many cases provide relative versus absolute results. In other words, performance metrics such as cost growth are measured against early estimates rather than against the “should cost” of a project. Other metrics, e.g. safety performance, use industry standard rates as defined by the Occupational Safety and Health Administration (OSHA). Practice use metrics are developed to strike a balance between the data required to accurately assess practice use and the resource concerns of member companies in supplying the data.

A primary difference between CII benchmarking and services provided by other organizations is the type of analysis and feedback provided to individual companies. The intent of CII benchmarking is to provide companies with the tools to allow in-house self-analysis of project performance and the identification of improvement opportunities. These tools include: a set of well-defined performance metrics, a report of performance and practice use norms for comparison purposes, and reports of general analyses documenting practices that correlate with successful project performance. Confidential, quantitative reports covering each metric are provided as feedback to participants; however, the scope of CII benchmarking does not include detailed, judgmental analyses of individual project or company performance. It does, however, provide assessments suitable for identifying performance problems and the critical link to implementation tools essential for addressing these problems. These tools are accessible to the project team during execution of the project, while they can still influence the project’s outcome.

1.3 Benchmarking System Participation

Participation is open to all interested member and non-member companies. Member companies join by sending a representative to a CII Benchmarking Associates training session, where they receive training on metric definitions, data collection procedures, interpretation of reports, and use of the Web-based tools. Member companies may submit an unlimited number of projects to the database each year. Member companies can also participate in the annual Benchmarking User’s Forum and on the Benchmarking and Metrics Committee, where they can contribute to program development.

Non-member companies can also participate in the CII Benchmarking and Metrics System through the Benchmarking Participants Program (BMPP). Non-member companies that join as Benchmarking Participants may submit up to 10 projects per year and receive the same analytic tools and capabilities described above. Benchmarking Participants participate in training, have access to CII’s on-line data collection and reporting system, and receive copies of all published reports for a nominal fee of \$5,000 per year.

Chapter 2 -- The Database

2.1 Database Description

Since the CII Benchmarking Program operates in a continuous data collection mode via its Web site, the size of the database is constantly changing. At present, it consists of over 1,000 projects valued at approximately \$54.2 billion in total installed costs. There is an almost even split between owner and contractor submitted projects as shown in Figure 1. Appendix A provides a listing of companies that have submitted projects to the database.

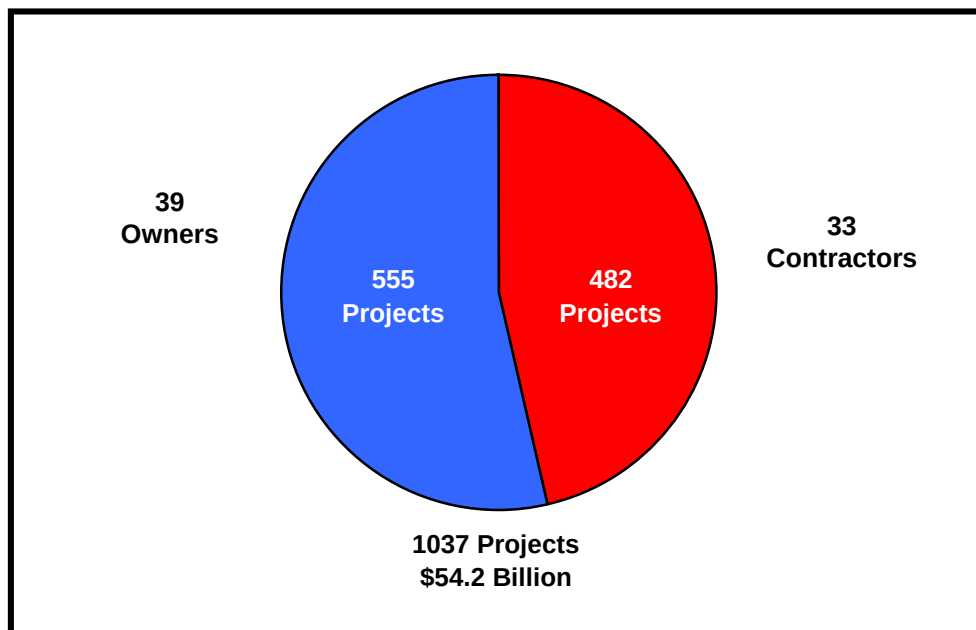


Figure 1 Database by Respondent Type

One of the more notable changes in the database is a trend towards more international projects. Nearly one-quarter of all projects in the database are now international – a significant change from recent years. While a majority of the international projects are from Europe, a considerable number are from the Middle East, Asia, and South America. Figure 2 depicts the number of projects by geographic region.

The number of building projects in the database has increased notably; otherwise there have been relatively minor changes in the overall makeup of project types submitted for analyses. Over 84 percent of all projects fall in the 15 categories of project type shown in Table 1. While the database remains largely heavy industrial, adequate numbers of building and light industrial projects are now available to support a reasonable amount of analyses in these areas.

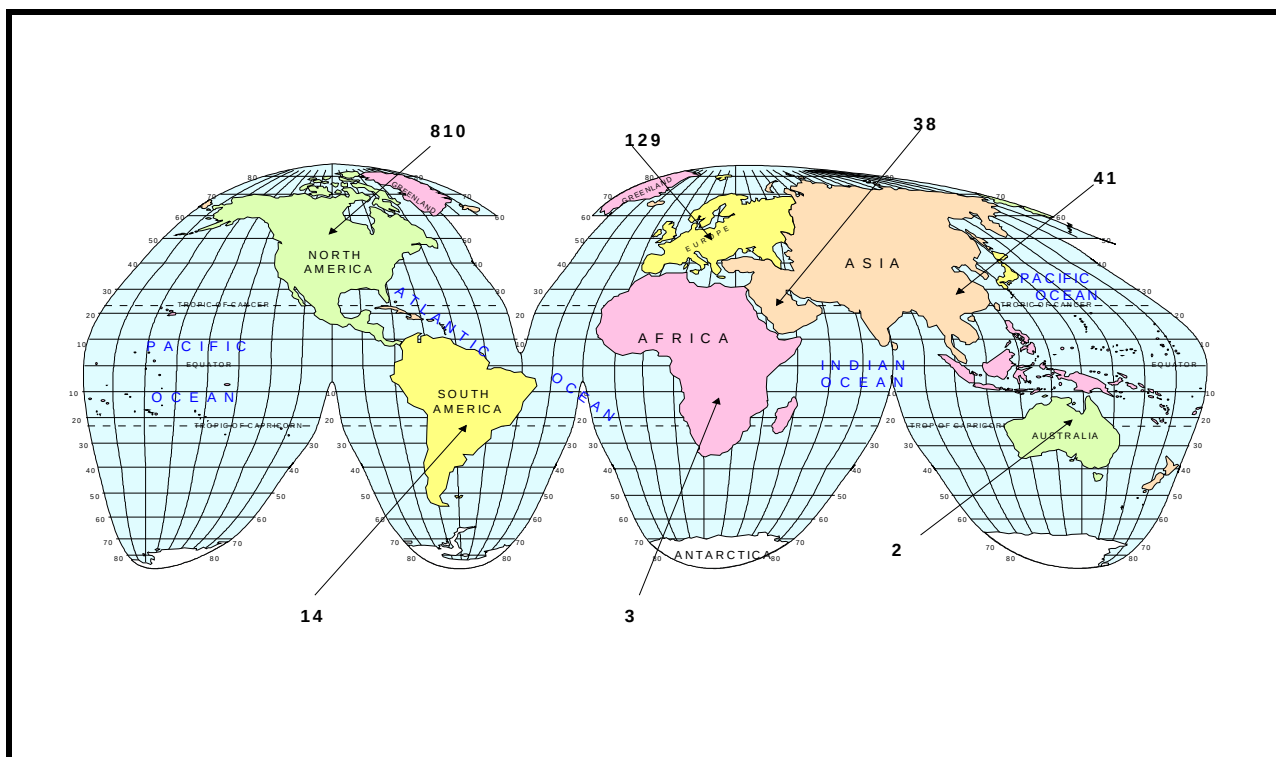


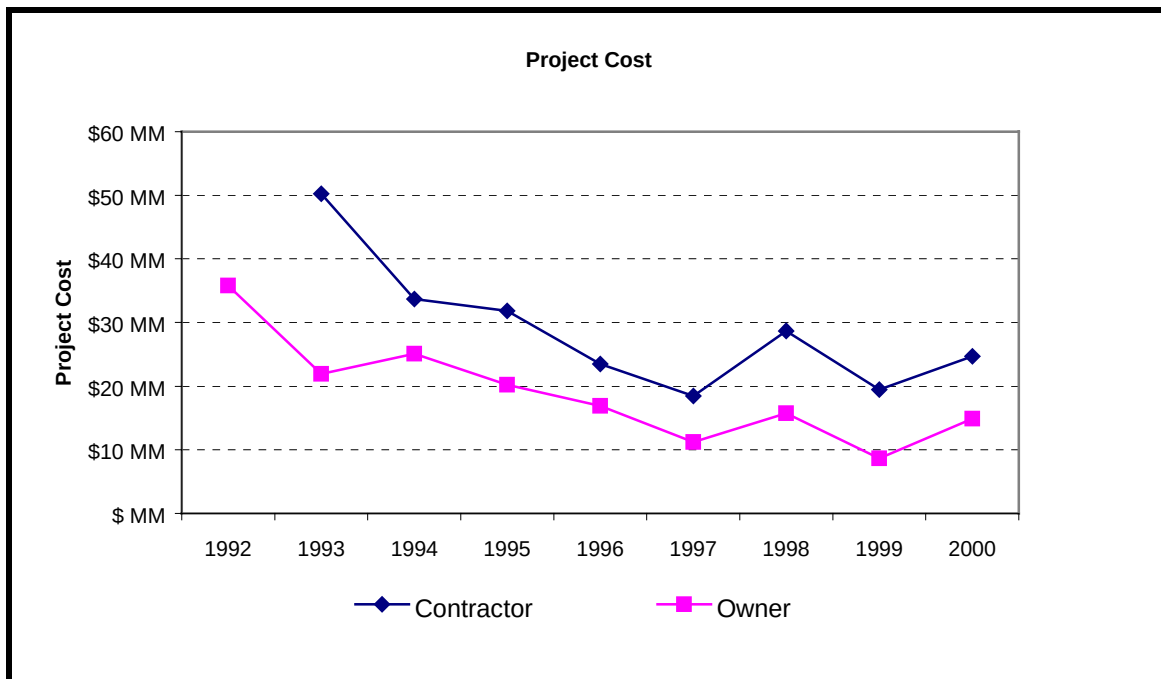
Figure 2 Project Location By Region

Table 1 Database by Project Type

Type	Both		Owner	Contractor
	Number	Percent	Number	Number
Chemical Mfg.	241	23.2%	91	150
Oil Refining	160	15.4%	83	77
Pulp and Paper	67	6.5%	21	46
Electrical (Generating)	66	6.4%	42	24
Low-rise Office	44	4.2%	40	4
Metals Refining/Processing	38	3.7%	26	12
Oil Exploration/Production	34	3.3%	18	16
Natural Gas Processing	34	3.3%	16	18
Foods	34	3.3%	24	10
Consumer Products Mfg.	32	3.1%	12	20
Water/Wastewater	29	2.8%	22	7
Laboratory	29	2.8%	22	7
Environmental	25	2.4%	12	13
Pharmaceuticals Mfg.	22	2.1%	12	10
Highway	18	1.7%	0	18

A notable change in the database in recent years has been the relatively constant size of the projects submitted for analysis. After consistent decreases in average project cost for both owners and contractors, it appears that the trend has begun to level with small projects being dominant. The trend to smaller projects is likely to continue based on a decision to reduce the threshold for benchmarked projects. This trend also yields the skewed distribution of cost categories reflected in Figure 4. The shift in project

size has important implications for practice use as well as research initiatives undertaken by CII. A recently published CII project team initiative, “Small Projects Toolkit,” has found that small projects often differ from larger projects in that they “tend to be retrofit in nature and often are executed in live manufacturing facilities.”¹ Consequently, the small project environment can have a direct impact on performance and practice use. Since many small projects are executed in operating facilities, the small project environment poses increased risks and hazards that may affect safety performance. Change management is typically less formal and can make small projects especially susceptible to cost and schedule overruns if changes in scope are not closely monitored. As the trend toward small projects continues, changes in aggregate performance and practice use metrics may also become apparent.



Note: Years indicate the mid-point of project execution; 2001 data will be included when analysis of projects submitted during 2002 is complete.

Figure 3 Project Size by Year

¹ CII Implementation Resource 161-2, “Small Projects Toolkit,” July 2001

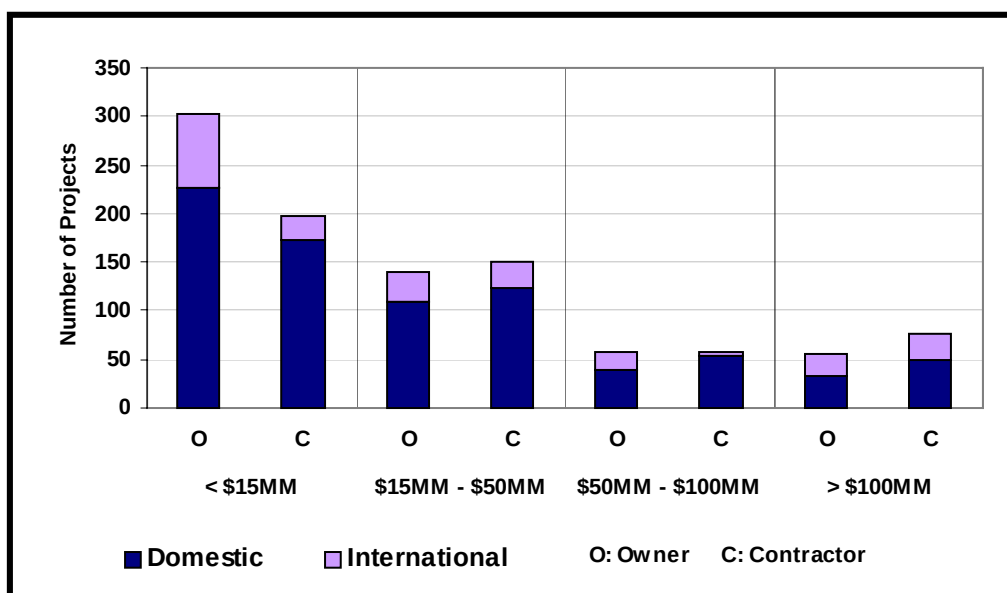


Figure 4 Database by Project Size and Location

Figure 5 mirrors the trend in Figure 3. While modernization projects submitted by owners are larger in number relative to grass roots and add-on projects, the trend for modernization projects in particular appears to have stabilized. To the extent that the cost of modernization projects is smaller than that of grass roots or add-ons this is consistent with the trend shown in Figure 3. While this is not the case for contractors as shown in Figure 6, it does have an impact on owner metric values sensitive to project nature and is a consideration in future analyses.

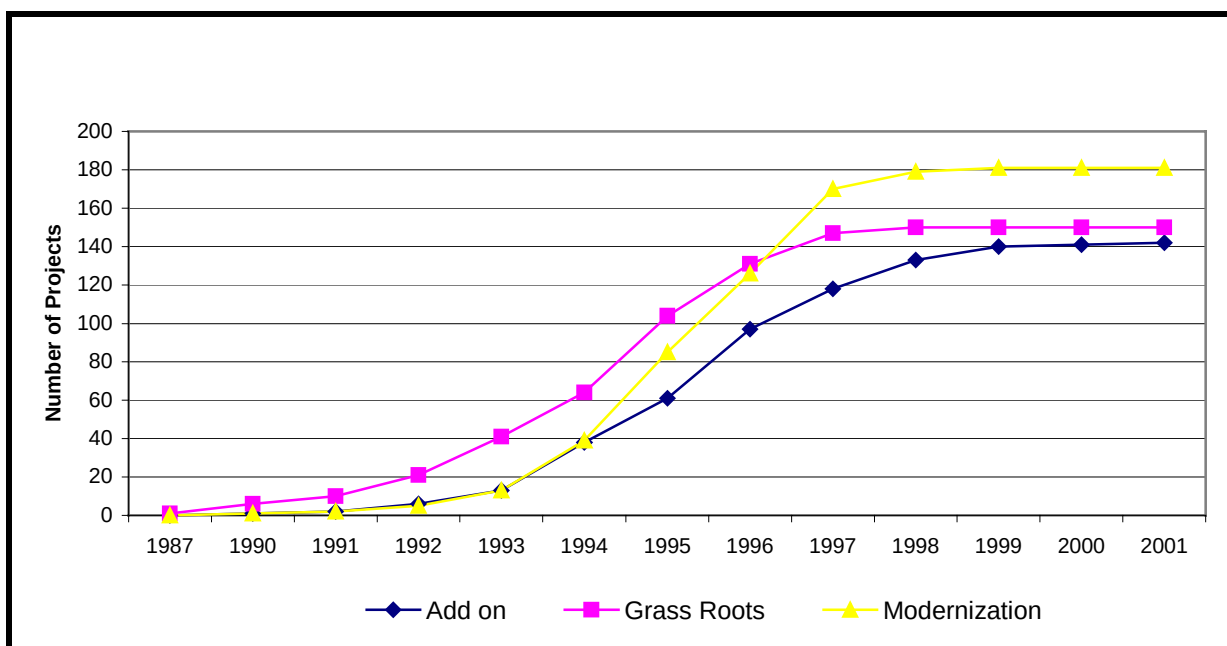


Figure 5 Owner Projects by Nature

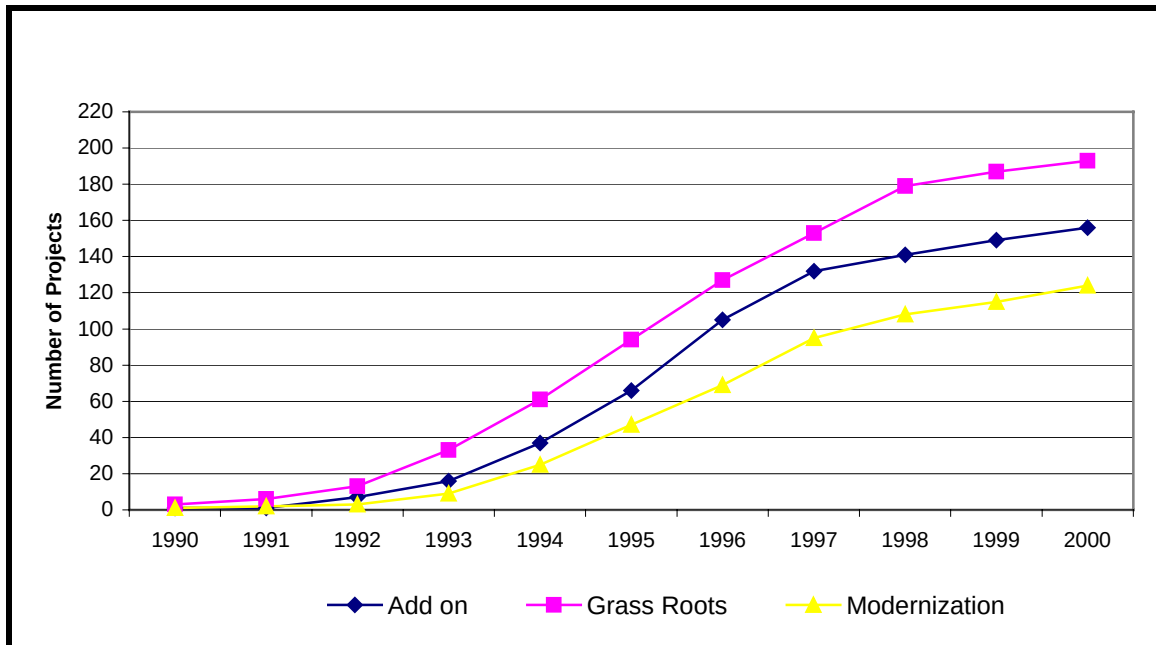


Figure 6 Contractor Projects by Nature

2.2 Database Use

As the database has matured, its value to member companies has increased. Companies have many tools available for self-assessment, and CII has access to a continuously updated source of information on practice use and value derived from best practices developed. Specific products of the database include:

- Norms for performance of *cost, schedule, safety, changes, and rework*. *Construction productivity metrics are expected in 2003.*
- Norms for practice use for *pre-project planning, constructability, team building, safety, change management, design/information technology, planning for start-up, and materials management.*
- Relative benefits of practice use.
- Trends for performance and practice use.
- Norms for phase costs and schedule metrics.
- Data support for project (research) teams and implementation champions.
- Common metric definitions.
- Cost effective, quantitative data to support business decisions and continuous improvement processes.

**Metric definitions, project phase definitions,
and a glossary of terms can be found at:**

<http://www.cii-benchmarking.org/>

While other services are available to benchmark project performance, few if any, are built on the depth of research that CII can provide. Also, it is doubtful that any can match the value provided by the CII Benchmarking and Metrics System. The efficiency of data collection, the ability to input data when it is most convenient to the project team, real-time feedback as data are submitted, and low costs of use enable

companies to benchmark essentially all projects, not just those surpassing a cost threshold. Other benefits reported by member companies include the training value afforded project teams for even the smallest of projects, and the links to CII implementation and education tools for convenient access to proven products that make a bottom-line difference.

2.3 Database Limitations

The number of heavy industrial and building projects provides adequate data for most analyses of these industry groups. Relatively small sample sizes for the other industry groups limit the statistical significance and the publication of many metric norms for these groups. With each year of data collection, however, the increased representation of projects in the other industry groups should permit publication of more of the metric norms. This is not to say that companies with projects in these groups cannot currently benefit from participation in the CII benchmarking effort; companies can still receive metric calculations for internal benchmarking even if insufficient data are available for publication of some metric norms.

While performance and practice use metric norms are established by rather straightforward descriptive statistics of reported data, correlations between practices and performance metrics, which serve as the basis for establishing the value of best practices, are based on multiple regression models. These models establish the value of best practices in terms of the practices currently being surveyed, and a limited number of performance and environment variables. Two sources of error can limit the reliability of these estimates: measurement error, largely due to constraints imposed by questionnaire length, and random error, often caused by reporting error or data quality limitations. For this reason, caution should always be used in predicting project performance based on practice use.

Another important consideration is the generalizability of the resulting statistics. The data reported reflect the experiences of CII member companies only, not the entire construction industry. Notwithstanding the fact that CII membership is broad, conclusions should not be drawn for the entire industry based on CII member company results. A good example of this is the safety performance of CII member companies compared to that of the entire construction industry. Comparisons with Occupational Safety and Health Administration (OSHA) data show that CII member companies outperform the industry in general in reportable incidence rates, lost workday case incidence rates, and in fatality rates.²

2.4 Data Confidentiality

CII recognizes the importance of maintaining the confidentiality of data provided by participating companies. Strict procedures have been implemented governing access and use of the data to ensure that confidentiality is maintained:

- Only designated CII staff members who have signed confidentiality agreements can access data submitted by benchmarking participants.
- If a third party is involved (e.g., project team, academic researcher, or other official), confidential project identifying data are removed and only limited subsets of data are released to third parties after they sign a confidentiality agreement.
- All data and findings published represent aggregated results in a way that precludes identification of individual company or project performance.
- Furthermore, aggregated data will be suppressed for publication purposes if the subset of the data being analyzed contains fewer than 10 projects, or if fewer than 3 companies submitted the data, to prohibit the identification of individual project or company performance.

² CII 2001 Safety Report, October 2001
8